OPERATORS MANUAL

Table of Contents

I. **Introduction** pg. 1
- A. Warnings
- B. Equipment ID
- C. Warranty
- D. Disclaimer

II. **Safety** pg. 2
- A. Fire Safety
- B. Fire Safety Equipment on all New Belt-o-matic Dryers
  1. Burner control power interlock
  2. Airflow switch
  3. High limit safety switches
- C. Emergency Fire Shut Down Procedure
- D. General Safety

III. **General Information** pg. 3
- A. Manufacturer Information
- B. Servicing Statement
- C. Using the Manual

IV. **Receiving and Handling** pg. 4
- A. Inspection
- B. Damages
- C. Handling
- D. Packaging

V. **Installation** pg. 4
- A. Installation Site
- B. Electric Hook Up
- C. Gas Hook Up
- D. Assembly of Parts
  1. Top cover and inlet hopper
  2. Shaft-mounted gearboxes with C-face motors
  3. Removed drive plate
  4. Air intake duct
- E. Air Ducts
- F. Rotations and Alignments
- G. Motors

VI. **Operations** pg. 7
- A. Start-up Procedure
- B. Shut Down Procedure
- C. Filling the Machine, Product Depth
- D. Adjustments and Controls
  1. Depth
     a. Inlet hopper and level gate
     b. Inlet spreaders
  2. Conveyor belt speed
  3. Flame adjustment
  4. Temperature adjustment
  5. Airflow

E Controlling Capacity
F. Controlling Efficiency

VII. **Maintenance** pg. 12
A. Housekeeping
B. Bearing Service
C. Gearboxes
D. Chain Adjustments
E. Maintaining Woven Wire Conveyor Belt
1. Belt maintenance
2. Belt traction
3. Belt adjustments
4. Belt removal and replacement
F. Maintaining Solid Tray Conveyor Belt
1. Belt maintenance
2. Belt tension
3. Belt adjustments
4. Belt removal and replacement
G. Conveyor Racks
H. Drive Roller Lagging

VIII. **Optional Equipment** pg. 16
A. Auto Fines Clean Out Systems
B. Stirring Equipment
C. Cyclones
D. Stainless Steel Contact Points and Construction
E. Steam Heat Exchangers
F. AC Inverters
G. Inlet Level Beater
H. Rotary Air Locks
I. Auger Discharge

IX. **Troubleshooting** pg. 18

Appendix

Roller Adjustment for Discharge Drive (fr#499 or lower) A-1
Roller Adjustment for Discharge Drive (fr#500 or higher) A-2
Fines Conveyor Adjustment B
Oscillating Inlet Spreader C
Web Disassembly D-1
Flat Wire Belt Assembly Instructions D-2
Roller Lagging E
Gas Train F-79
Electric Control Panel H-1
Power Hook Up H-2
Honeywell Controller Schematic and Lock Out Codes H-3-33
Definite Purpose Contact Assembly H-34-35
Drive Plate and Chain Tightener I
Setting the Fan Blade Pitch J-1
Fan Hub Assembly J-2
Level Gate Adjustment for Product Depth K
Air Duct to Cyclone Transition Diagram L

Gun Style Burner	M
Foot per Minute Web Travel Chart	N
Lesson Motors Technical Information	O-1-6
Leeson VFD Quick Reference Guide	O-8-9
Gear Speed Reducers	P-1-8
Gas pressure gauge, and thermometers	Q-1-2
High Limits	R-1-4
Pressure Switch	S-1-2
Parts List	T-1-2
Parts Order Form	T-3

I. INTRODUCTION

A. Warnings

When drying combustible material with heated air, there is a fire hazard.

Warning. Avoid pulling particles through the burner or heat exchanger. The heat source can ignite the particles and send sparks into the drying chamber.

Warning. Product left in and around the machine can ignite and start a fire. Clean the air chamber and the area around the machine daily or more often, if necessary

Warning. Check the high limit safety switches. These switches should be set about 20°F above the air temperature of the zone it is located in. These switches will shut off the fan and the burner to prevent overheating.

Warning. Immediately stop the burner and all fans in case of fire. Shutting off **all** airflow will reduce the size and temperature of the fire. Interlock all exhaust fans with the high limit safety switches.

Warning. Machines equipped with an auto fines clean out system need to run at all times to reduce the threat of fire.

Warning. Lock out and tag out power before opening and entering any access panel or inspection door.

Warning. Close and secure all access and inspection doors before operating the machine.

Warning. Maintain all safety guards and warning stickers.

B. Equipment ID

Each Belt-o-matic machine has a frame number for identification. The number is welded on the bottom left-hand corner of the frame next to the product discharge. The left-hand corner is determined by facing the product discharge. Each unit also has an ID tag on the electric control panel. This tag gives the model, serial number, voltage, amps, cycles, phase, fuel type, fuel pressure, maximum CFM, and fan horsepower. If the machine did not come equipped with an electric control panel, the tag is located above the bottom conveyor drive motor and gearbox.

C. Warranty

The Belt-o-matic has a one-year warranty which covers B.N.W. Industries manufactured parts and workmanship. Other component warranties are based on the manufacture warranty and may vary. Check with B.N.W. Industries on all other component warranties. The warranty begins on the day of delivery. Warranty parts must be returned to B. N. W. Industries for replacement.

D. Disclaimer

Improper installation, operation, handling, or unauthorized modifications of the Belt-o-matic constitutes loss of warranty. B.N.W. Industries is not responsible for loss if not all warnings and recommendations of this manual are observed.

II. SAFETY

A. Fire Safety

When drying combustible product with heated air there is a threat of fire. With certain products that are flammable and have a high amount of fines, the fines material can be ignited as it passes through the burner.

In a direct fire situation, the first source of fire comes from moving combustible product through the burner. The flame can ignite the product sending sparks into the drying chamber. These sparks may ignite product that is being dried or product that has not been cleaned out of the air plenum. Product left in the air plenum becomes very dry and can easily ignite.

To reduce the risks of fire and avoid sparks, maintain clean air to the burner. A clean air duct can supply fresh air supply to the fan and burner. This is necessary with certain products that have a high fire risk.

When heating air with a steam coil or other various heat exchangers, the danger of fire occurs when combustible product accumulates in and around the heat exchanger. The product will eventually ignite and send sparks into the drying chamber. Heat exchangers need to be inspected and cleaned daily. The frequency of cleaning and the extent of modification to avoid a fire depend on the flammability of the product, the amount of fines in the product being dried, and the air quality of the installation.

In many Belt-o-matic dryers and coolers, the vacuum side of the burner fan pulls the air through the cooling section. With certain products that are very flammable and have a high amount of fines, the fine material can be ignited as it passes through the burner. Observe the air chamber, while in operation, to see if there is a high amount of sparks. To reduce the amount of fines being pulled through the fan and decrease the amount of sparks, open the sliding fresh air intake doors as far as possible and yet achieve a cool product at the discharge. If you still observe sparks in the air chamber, it may be necessary to use a separate fan to do the cooling.

Fire safety starts with these prevention steps:

1. Cleanliness. Daily, if not more, clean heat exchangers, air plenums, and air ducts.

2. Provide clean air to the heat source. If needed install a fresh air duct to the heat source. Find the best and cleanest air to supply the heat source.

3. Observe the air chamber while in operation to see if there is a high amount of sparks.

B. Fire Safety Equipment on all New Belt-o-matic Dryers

1. **Burner control power interlock.** Power for the gas burner controls originates from the interlock with the fan starter. Turning the burner switch on without the fan running and the hand gas valve closed can check this interlock. If interlocked properly, the burner controller display will not illuminate. Older models without the external display will have a small light for indicating power to the burner controller.

2. **Airflow switch.** An airflow switch senses air movement at the fan. The fan must be running before the burner will light. This switch must send a signal to the burner controller before the burner will light. You can check this safety by disconnecting the copper or plastic tube at the airflow switch. The burner controller should not advance to trial for ignition (TFI).

3. **High limit safety switches.** High limit safety switches are located in the air chamber and on the top cover by the exhaust opening. The switches are normally closed. The two high limit switches

in the air chamber are wired in series with the burner controller. If these switches overheat, they will automatically shut the burner off. The fan will remain running. Once the switches cool and reset, the burner controller will once again light the burner. These switches are usually set at 250°F, but may vary. You can take a wire off one of the switches to test. The burner should not light. You can also take a switch out and place it in an oven at the temperature of the setting on the switch. The switch should open once it reaches the set temperature.

The other high limit by the exhaust opening is wired in series with the burner fan thermo overload. It is usually set at 210°F, but may vary. If this switch overheats, it will shut the fan off. This will interrupt the power to the burner controller shutting the burner off. The burner controller will go into lock out and will need to be reset before the burner can be lit again. It can be tested in the same manner as the other high limit switches. This switch is usually the first detection of a fire. The high heat from a fire will be first detected in the exhaust opening by this switch. It is very important to stop all airflow, if a fire occurs. Interlock all auxiliary fans to this high limit switch.

There are several safety features that are not standard Belt-o-matic components. Please contact B.N.W. Industries for further information.

- Automatic Sprinklers placed in the top cover of the dryer are a very good safety measure. These sprinklers can detect high temperatures and spray the dryer in case of a fire.
- Infrared spark detectors are also a good safety measure. These detectors can extinguish a spark before it enters the drying chamber.
- CO2 fire suppression systems are available. This system will release CO2 on the product bed, air plenums, and air ducts, if a fire is detected. This system is available for new and used units.

C. Emergency Fire Shut Down Procedure

Inspection and good housekeeping are one of the best fire preventions. In case of fire, follow these procedures:

1. Stop all airflow. All fans including exhaust fans should be shut down. Be sure to interlock exhaust fans with the high limit by the exhaust opening. Cover all air intakes and outlets to prevent any drafts. This is very important to contain a fire.
2. Unload the product into a noncombustible container or area so the product on fire can be extinguished.

D. General Safety

All OSHA safety practices need to be observed. Employee safety training is recommended.

III. GENERAL INFORMATION

A. Manufacturer Information

B.N.W. Industries takes pride in personal support of all clients and potential clients. If any questions occur, please feel free to contact Lee Norris (President), Dan Norris (Vice-President), or Aaron Norris (Sales Manager) at the following address and telephone number:

Mail/Shipping address – B.N.W. Industries
7930 N 700 E
Tippecanoe, IN. 46570 USA

Ph # - 219-353-7855 Fax # - 219-353-8152
Email – sales@belt-o-matic.com Web page – www.belt-o-matic.com

B. Servicing Statement

It is the customer's responsibility to maintain the equipment as written in this manual.

C. Using the Manual

Due to B.N.W. Industries involvement with different applications and customizations, parts of this manual may or may not apply to your specific machine. This manual is designed to give basic instruction on how to operate, maintain, and troubleshoot. Specific information on your machine can be obtained from B.N.W. Industries at the address or telephone number listed under manufacturer information. Miscellaneous parts manuals for various components on your machine are included with this manual. In many cases, refer to these manuals for more detailed instructions.

IV. RECEIVING AND HANDLING

A. Inspection

As soon as the equipment is received, it should be carefully inspected to make certain the machine is in good condition and all items are listed on the delivery receipt.

B. Damages

Even though the equipment is secure at our factory for shipment, it is possible for it to be damaged in shipment. All damages or shortages should be noted on the bill of lading. Purchasers should take immediate steps to file reports and damage claims with the carrier. All damages to the equipment in transit are the responsibility of the common carrier since it is the manufacturer's policy to make shipment F.O.B. Tippecanoe, IN. USA i.e., ownership passes to the purchaser when the unit is loaded and accepted by the carrier. The purchaser must make claims for damage or shortage, which occurs during transit, against the carrier.

C. Handling

All Belt-o-matic machines must be lifted and supported from the bottom frame. Lift and tie down hooks are provided on the four corners of this frame. Equipment placed in containers for overseas shipments will have braces welded to the bottom frame. These braces help prevent damage to the machine when taking it out of the container. When removing the machine from the container, do so with caution. Tight clearances of the container make it very easy to damage the equipment.

D. Packaging

Whenever possible, Belt-o-matic machines are shipped as complete as possible. In some cases, guards, air ducts, covers, and valves must be assembled. Check the machines air chamber, conveyors and electric control panel for the disassembled and stowed items. The maintenance manual and fasteners are usually located in the electric control panel. Machines with steam coils will have a metal or wooden protector over the face of the steam coils. Remove the protector before operating.

V. INSTALLATION

A. Installation Site

Place the machine on a level concrete pad with supports at each corner of the bottom frame. Additional supports are recommended every 10' along the frame of machines 20' or longer, but may vary. The machine should be supported at least one foot off the floor for maintenance purposes. Machines with auto fines clean out need space under the frame to discharge fines material.

Proper support is necessary for the machine to run correctly. Improper support will allow the machine to twist and cause the conveyors to not track properly. It is necessary for the machine to be level side to side. Level end to end is not as crucial.

For outside installations, it is also important that every machine be protected from weather. A shed roof over the machine works well.

B. Electric Hook Up

Connect proper voltage and amperage at the main disconnect in the electric control panel. The serial tag on the electric control panel gives recommended voltage and amperage. It is very important to isolate the electric supply on all models with AC inverters. The voltage must be maintained as follows: 200 volt (+10% -15%), (400 volt +10% -15%), 480 to 500 volt (+10% -15%). Improper voltage constitutes a loss in warranty. Some components must be wired on-site after assembly. Junction boxes are provided to accommodate this. Always match colored wires for proper connection. Change power wires at main disconnect for proper rotations.

The electric control panels on new production models are bolted to the machine's sidewall and have a removable backer plate. These electric control panels can be removed and installed in a new location. All wires must be extended to reach the new location. A general wiring diagram is provided in the appendix. It is not an exact electrical schematic of your machine. Specific wiring diagrams are available on new equipment at an additional charge.

Be sure that any auxiliary fan is interlocked with the machines high limit safeties. This will help reduce the intensity of a fire, if one should occur

C. Gas Hook Up

Proper pressure and size plumbing should be installed at the inlet of the provided gas plumbing train. The serial tag on the electric control panel gives the proper pressure range and maximum BTU's per hour. A proper size gas line must be engineered on a case-by-case basis. Contact B.N.W. Industries for consultation.

Natural or vapor LP gas hook up: Connect to supplied vapor gas line with proper pressure and volume. Refer to serial tag for minimum and maximum gas pressure as well as maximum BTU of the burner. The pressure needed depends on the amount of BTU's needed. The supplied gas line size might vary depending on the application.

Steam models: The line size varies with a maximum of 150 P.S.I. The temperature control valve, strainers, and traps must be installed before operating. The appendix shows a general diagram of how to install the steam plumbing valves. Uncover the protective shield over the steam coils before operating. Steam models have an air snorkel on the fan motor. This air snorkel provides fresh air to the motor. The air snorkel will receive air from under the machine. The machine must be off the floor to not restrict the airflow to the air snorkel.

Liquid LP models: Connect to the provided 1/2" inch liquid LP line with tank pressure. Frost may be seen before the internal vaporizer. If frost appears after the internal vaporizer, loss in heat will occur. You must reduce the flow or pressure into the vaporizer to eliminate this frost.

Alternate fuel sources: (i.e. electric coils, oil burners etc.) Refer to the manufacturer for specifications and requirements.

D. Assembly of Parts

1. **Top cover and inlet hopper**. In some cases, the top cover and inlet hopper may be removed for shipping or installation. In these cases, the top cover is made out of several pieces. Each piece is numbered along with a corresponding number on the sidewall of the machine. Match numbers for proper position. Bolts or screws are generally provided in the electric control panel. If an electric control panel is not provided, check boxes stowed in the air chamber.

2. **Shaft-mounted gearboxes with C-face motors**. Current production models have shaft-mounted gearboxes with C-face motors for the conveyor drives. No assembly is required.

3. **Removed drive plate**. Previous production models may have a removed drive plate that contains these components. Each drive plate is marked for proper installation. Properly line up the belt drive and chains for correct operation.

4. **Air intake duct**. Assembly of the air intake duct is required on models with removed fan and burner. The size and shape of this duct will vary with each machine. The air duct is numbered for correct assembly. Be sure to securely mount all fans and burners to a solid concrete pad. In most cases, the customer provides the exhaust air duct.

E. Air Ducts

The purpose of the air duct is to provide space between the burner and the product. With many combustible products, the air intake could have a 20’ long or longer air duct. It is important to properly plan the design and installation of all air ducts. These ducts are marked for proper assembly.

Air intake ducts should be designed with few or no turns. A bouncing effect of the air must be avoided. If a turn is necessary, it should be designed with a large and gradual sweep for best airflow. The size of the air duct should be no smaller than the fan housing.

The exhaust air duct provides a path to remove water and poisonous gases out of the building. Connect the duct at the provided exhaust opening. This duct can be screwed or bolted to the opening. The construction material depends on the composition of the product. With a corrosive product, it may be necessary to construct this duct out of 304SS.

A powered exhaust is required if the air duct creates backpressure. A powered exhaust will result in a very clean operation. **If the exhaust air duct creates backpressure, due to an insufficient size or designed air duct, product and dust will blow out every place possible including the inlet hopper and out the discharge.** Four factors will determine backpressure: the volume of air, size of the air duct, length of the air duct, and the number and size of turns in the air duct.

In general, the size of your air duct should not be smaller than the size of the provided exhaust air opening on the machine. On powered exhaust systems, the air duct needs to start at the exhaust opening size and gradually transition down to the cyclones air intake size. This will help improve cyclone efficiency and air movement. Be sure to match the cyclone CFM with that of the machines or manufacturers recommended CFM. Insufficient duct size and improper design will result in loss of warranty and capacity. Many problems can and will result if the air ducts are not designed and sized properly.

F. Rotations and Alignments

Check the rotation of all motors. Check and clean the fan housing of any debris before operating the fans and conveyors. Check the air chamber and the conveyors for any parts stowed there. The fan should rotate counter clockwise. With multiple fans, the rotation should alternate, with the fan next to the burner rotating counter clockwise. Also, run the conveyor belts and all other auxiliary equipment and check rotation. Running the conveyor belts backwards could destroy the conveyor belts and air locks. This will result in the loss of warranty.

In all cases, run the conveyor belts for a period of time before initial start-up. This will help insure the conveyor belts are tracking true. A conveyor belt is centered when a ½" of clearance exists between the edges of the belt and the sidewall of the machine. The belts are aligned at the factory but may shift during transit. For instructions on aligning the conveyor belt, see "Maintaining the Conveyor Belt".

G. Motors

All motors on the Belt-o-matic are TEFC and have thermo protection. All fan motors must be Lincoln or Leeson brand motors. Other motors can be of various types. Current machines use Leeson brand motors on the conveyor drives and all auxiliary equipment. These motors are inverter duty. Motors are protected and interlocked through the thermo protection in the motor windings.

VI. OPERATIONS

A. Start-up Procedure

Before starting the machine remove all parts and debris, close all doors and panels, and clear all personnel away from equipment.

1. Start the fan at the start/stop station. In some models, the fan is started with the AC inverter. The AC inverter is programmed at the factory and does not require customer programming. The fan next to the heat source must be started first. Models with a gas burner will not light, if this fan is not running. Fans are always numbered according to airflow direction. Fan #1 is by the entering air. For cooling applications start all fans and skip to step 3.

2. Light the burner or turn on the heat source. Refer to the burner manufacturer manual for heat sources other than the Belt-o-matic design gas burners. Turn the burner toggle switch to the ON position. The inlet hand gas valve must be open and have gas pressure. An adjustable orifice hand valve must be closed to slightly open. This valve is the last hand valve before the burner. Once the burner toggle is on, the burner controller will be powered. The burner controller will begin a 30-second purging of the air chamber. The burner controller must sense airflow through the Dwyer airflow switch to achieve further progression.

Next, the burner controller will go into trial for ignition. The safety gas valves will open and a current will be sent to the burner spark plug. After ignition has taken place, the burner controller inferred or UV eye scans the burner to assure ignition (Fireye is inferred, Honeywell is UV). Once the eye senses a flame, the burner controller will go into continuous operation. If the eye does not see a flame, the burner controller will go into lock out. The burner controller will need to be physically reset. On older models with a Fireye controller, push the reset button once for a description of flame failure. Push the button twice to reset the burner controller. Some older Fireye systems give a display pattern of lights with a code to determine failure. Some newer Fireye systems have a readout display. The Honeywell burner controller provides a reset button on the display module. This reset button offers instant reset after one push.

On newer systems, the burner controller readout gives a signal reading from the inferred or UV eye. This signal reading must be five or stronger for the Fireye and 3.5 to 7.5 for the Honeywell to run the burner. Older Fireye models have a run check switch. When placed in the check mode, the burner will stay lit and a DC volt tester can check the voltage at the test ports. Five volts or more is needed to run the burner. If a lower signal reading is a problem, go to the burner troubleshooting section.

3. Use the start/stop station to start all auxiliary equipment. This includes stirrers, rotary air locks and drops, cyclone fans, spreaders, discharge equipment, auto fines, etc. Start discharge equipment before starting the machine conveyors. It might be necessary to install alarms or interlock conveying equipment to the machine conveyors. This will help prevent plugging the machine or running the machine empty in cases of motor failure.

4. Next, start the conveyors. All new models use an AC inverter to control motor frequency. Some previous models use start/stop stations.

5. Finally, start inlet-conveying equipment to fill the machine.

B. Shut Down Procedure

At shut down, the machine may be left full or empty of product. Start-up time for an empty machine will take longer.

Product left in the machine must be cooled before shutting the fan off. Upon start-up, run the fan and burner to get the product and machine hot.

To empty the machine of product let the fan and burner run until all product discharges. Product temperature and moisture will vary as it discharges. Start-up time for an empty machine will take longer. At that point, you can proceed through the normal start-up.

1. Shut off the inlet conveyors, conveyor belts, auxiliary equipment, and discharge conveyor in this order. If equipped with the auto fines clean out, let this feature run until the very end.

2. Shut off the burner or other heat source in drying applications. You may either shut off the incoming gas flow or move the toggle switch to the OFF position. If you shut the gas flow off, be sure to switch the burner toggle off once the burner flame goes out.

3. Turn off all fans and the auto fines. Allow time for the machine and the product to cool.
4. Turn the main disconnect to the OFF position.

C. Filling the Machine, Product Depth

When filling the machine for the first time, start at a low capacity. Once full, it can be increased to a higher capacity.

An even depth is very important. The surface area of the conveyor belts **MUST** be completely covered for even drying and/or cooling and maximum capacity. The depth of the product greatly differs from one product type to another. Depth thickness depends on the particle size and integrity. A large product may run very deep (6” to 2'), whereas a small pellet (1 mm) may run very shallow (2" to 6"). This is because larger particle sizes leave larger air voids. There must be enough air space for the air to pass through, but yet not too much, which will waste fuel. In some cases, we allow the sides of the bed layer to run as much as 10% higher than the middle. This helps accommodate drag due to the sidewall friction.

The percentage of fine material will also determine the depth. A lower depth may be needed for a product with a high amount of fine material. Fines will tend to block the air causing an air restriction.

Be sure to spread all fine material evenly throughout the layer of product for even drying and/or cooling.

The product depth can change between levels on multiple pass machines. As the product dries and/or cools, the depth may be increased. This will help accommodate for product shrinkage. The speed ratio between the top and lower passes will determine the depth thickness. Each Belt-o-matic is designed to reach a certain range of depth. Typically, you need to run the product depth as deep as possible depending on the capacity and the product. A product depth too shallow will not give you the full energy potential. Running the product depth too deep might give you a wide variety of moisture and temperature between the top and bottom portion of the layer. Contact B.N.W. Industries for your machine's depth specification.

On machines with an inlet hopper and adjustable leveling gate, the inlet hopper must be flooded fuller than the bed layer. This will keep the sides of the conveyor belt completely full and will air lock steam, dust, and heat from escaping out of the hopper. In some cases, visible steam may be noticed above the hopper. The hopper top must be left uncovered to allow the steam to escape and not condense on the product. A high amount of air and dust blowing out of the hopper is the first sign of an air restriction in the exhaust air duct.

Machines with spreading devices such as the oscillating inlet spreader and the wiper belt spreader are fully adjustable to achieve an even depth. These spreading devices need a metered rate of product to work properly.

D. Adjustments and Controls

All Belt-o-matic machines have a wide range of adjustments and controls. This makes it very easy to adjust the machine to different products and capacities. Special attention is necessary to properly adjust and control your Belt-o-matic efficiently.

1. Depth

a. Inlet hopper and level gate. Either a side handle or jacks perform the level gate and hopper depth adjustment. Jacks have level indicating rods to insure the bottom edge is level. The hopper and gate system not only levels the depth but also meters the rate of feed based on the conveyor belt speed.

b. Inlet spreaders. Machines with spreading devices control the depth by the speed of the conveyor belts. These systems must have a metered feed rate to work. These spreaders will provide an even bed depth. The conveyor belt speed at the metered rate will determine the product depth.

The oscillating spreader should be fed from top center. The product should never be loaded from the sides or at a diagonal. The swing tube of this spreader moves back and forth to distribute product. The stroke length of the swing tube can be adjusted to provided more or less travel. This will change the product distribution to help achieve an even depth.

Two adjustments can be made to determine the travel of the swing tube. An adjustment can be made where the connecting link arm is bolted to the swing tube. More travel will happen when the connecting link arm is moved up and less travel when moved down. Another adjustment can be made where the crank arm and the connecting link arm meet. When adjusted down more travel will occur and less travel when moved up. Travel of the swing tube should be adjusted so it will fill the corners of the belt slightly deeper than the center. There needs to be no more than 10% variation in depth. This ensures an even flow of product on the bed due to the drag of the sidewall.

The wiper belt spreader distributes product on a belt across the machine's conveyor belt. When the spreader belt is full of product a wiper disperses the product evenly onto the

machines conveyor belt. To have a consistent bed depth the spreader needs to be fed evenly at a metered rate. It will control the evenness in the machine but not the volume or depth. The machine's conveyor belt speed will control the depth.

The cross belt of the spreader is one speed whereas the wiper is variable speed. Once in operation, use the variable speed of the wiper to control the evenness of the bed depth. Time the wiper so the wiper cleans the belt as the product reaches the opposite sidewall of the machine.

2. **Conveyor belt speed.** Current machines incorporate an AC inverter to control the motor frequency. The C-face motor is connected to multipliers, which are attached to a shaft mount gearbox. The ratio of the gearbox, multiplier ratio, and the frequency of the motor determine the belt speed. A chart with various overall drive ratios is provided in the appendix. This chart indicates the belt foot per minute speed at a specific drive ratio and motor frequency. Multiply the ratios of the multipliers and the gearbox to find the correct ratio on the chart. Example: a 4:1 and a 5:1 multipliers with a 250:1 gearbox equals 5000:1. Locate the correct foot per minute belt speed by intersecting to ratio column with the motor hertz row. Once you have the correct foot per minute speed, divide the speed by the conveyor length to get the total resident time.

   The multipliers can be changed to achieve a new speed range. Every time a multiplier is added or deleted, the direction of the belt must be changed. The direction can be changed in the AC inverter program menu. Running the conveyor backwards will damage the belt and air locks and will void all warranty.

   Former production machines use a mechanical variable speed on the motor and gearbox. Manually adjust the crank arm to speed or slow the belt. In some cases, an AC inverter was also used to adjust motor frequency. The foot per minute speed is determined by the ratio of the gearbox and the ratio of the drive sprocket in relation to the position of the belt on the variable speed pulleys. Measure a foot of distance on the machine's sidewall and time the conveyor belt at different pulley settings to determine belt foot per minute speed. Some machines come equipped with an encoder and decoder that measure this time. Change the gearbox ratio or the sprocket sizes to achieve different speed ranges. It is essential that the drive plate rod be threaded through the eyelet of the hand crank pulley rod. The pulley rod holds the pulley in place so that it can be adjusted. The rod needs to slide freely.

3. **Flame Adjustment.** (Dryers with Belt-o-matic manufactured gas burners only) - Once the temperature of the burner is set and the machine is full of product, the flame may be adjusted. A blue flame with small yellow tips is desired. If this is not the case, the fuel air mixture needs to be adjusted. A yellow flame is a rich mixture. Older machines with ring style burners cannot be adjusted.

   The air sweeps on the burner have four adjustable plates to allow more or less air into the mixing tube. Two of the plates are preset at the factory at approximately 1/2" open, but may vary. These plates will give you the proper range of fuel to air mixture. The other two plates can be manually adjusted from the exterior by throttle cable or a rod adjuster. These plates will fine-tune the burner flame. Close the plates for a richer mixture and open for a leaner mixture.

   Older machines incorporate the adjustable plates and a slide sleeve in the mixing tube. The adjustable plates offer the proper mixing range while the slide tube fine tune the flame from the exterior.

4. **Temperature Adjustment.** (Dryers with Belt-o-matic manufactured gas burner only) - Standard production dryer’s use a Partlow modulating gas valve to control gas flow and temperature. This valve has a dial with temperature indicating marks. Once in operation, this dial needs calibrated. After the machine is full of product, and the temperature is set, loosen the allen screws on the dial and turn the dial to the mark that corresponds with the plenum thermometer reading.

The Partlow minimum setting is set at the factory. If this needs to be changed, or adjusted, refer to the Partlow manual provided.

The orifice valve is the last ball valve downstream of the gas controller. This valve has a small hole drilled in the ball to act like an adjustable orifice. This valve will allow you to set different firing ranges of the burner. The orifice is open when the handle is parallel to the gas train and closed when perpendicular to the gas train. This valve should be closed when firing the burner. If the burner does not light, the orifice may be opened slightly until providing enough gas volume to light the burner. On start-up the Partlow valve is fully open. If the orifice valve is fully open, you will have full line pressure going to the burner. The plenum temperature may increase rapidly and hit the safety limit shutting the burner down. Keeping this valve closed allows the temperature to increase gradually.

Once the burner is to the set temperature, maintain one-half gas pressure at the pressure gauge by the orifice valve in relation to the pressure gauge by the inlet hand valve. For example, if the inlet pressure gauge reads ten PSI, the pressure gauge by the orifice valve should read five PSI. This will allow room for the Partlow valve to adjust the pressure up or down maintaining a constant flame. If the burner flame fails due to low gas volume and proper pressure and volume have been supplied adjustment of the orifice valve or Partlow valve minimum flame setting is required.

Machines provided with steam coils usually have a temperature control valve, traps, and strainers. The temperature control valve will vary the steam pressure to increase or decrease the temperature. Due to a wide range of coil sizes and steam quality, consult B.N.W. Industries for further information. Maximum steam pressure is listed on the serial tag.

5. **Airflow.** The fan blade size, pitch, horsepower, and static pressure determine airflow volume. More or less airflow can be achieved by altering any of these factors. All machines with vane axial fans have adjustable pitch fan blades. The blade can be pitched to achieve higher or lower airflow. Measure the amp draw of the motor before the fan is re-pitched. Full load amp figures can be obtained by contacting B.N.W. Industries. Some models will have an AC inverter to control the frequency of the fan motor. In these cases, only change the hertz on the AC inverter's program pad to change the airflow. These fans have been pitched at full load amps when running at 60 Hz.

   The fan blades are attached to a center hub with bolts. To change the pitch, loosen the bolts and turn the blades one at a time. Open the blades for more airflow and close for less airflow. More horsepower is needed, if pitching the blade open causes the motor to over amp. Change the pitch of each blade equally. A caliper consisting of a bolt and nut will work. Gauge the trailing edge of the blade and the back machined edge of the hub.

   Air is the vehicle used to remove moisture from the product. For most products use the maximum amount of airflow possible, but do not increase the airflow to the point that the product becomes fluid. A high airflow may not be good for product quality in some cases.

   Models that are dryer/coolers and use the burner fan to do the cooling have adjustable doors to adjust the cooling air to fresh air ratio. These doors need to be open as far as possible while maintaining proper cooling. The product should be cool and the conveyor belt should be warm to the hand. **Never restrict the air intake more than is provided by the adjustable doors**. Too much restriction of the fresh air inlet may cause an extreme amount of fines to be pulled through the burner which creates a fire hazard. Inspect for sparks in the air plenum. The cooling air in these cases enters above the product at the product discharge. Do not enclose this area. A hinge plate air lock separates the heat and cool sections.

   Models that have a separate cooling fan may have the cooling air intake between the upper and lower portions of the conveyor belt on the machine's sidewall. Do not restrict this area. Vacuum

coolers use the same air intake. Control the airflow by increasing or decreasing the fan pitch, motor hertz, or horsepower of the cooling fan.

E. Controlling Capacity

Capacity is adjusted through the product depth, airflow, and conveyor belt speed. The amount of time each process requires depends on the product temperature, moisture, size, and drying characteristics. Contact B.N.W. Industries for recommended speeds and depths.

Enough airflow must be introduced to remove the needed BTU's in cooling applications. Enough airflow and BTU's must be present to evaporate the required amount of water in drying applications. We use the factor of 18 to figure this. Take the fan cfm (in thousands) x 18 x heat rise °F x 60 minutes = BTU's produced. For example, if your fan is producing 20,000 cfm it will figure as followed: 20 x 18 = 360. 360 x 150°F = 54000. 54000 x 60 = 3,240,000 BTU per hour. In this example heat rise is based on 70°F ambient air temperature. A 150°F heat rise would equal 220°F plenum air temperature.

Altitude, humidity, air temperature, and barometric pressure will vary the required energy. We calculate 1,500 BTU's to evaporate one pound of water. Some products will take more while others take less. Multiply 1,500 BTU's by the total pounds of water per hour to be removed. This will give you the total BTU's required per hour. Vapor LP gas has 92,000 BTU's per gallon, natural gas has 1,000 BTU's per cubic foot, and steam has 950 BTU's per one pound.

Adjust the airflow and heat rise to produce the required energy based on the moisture removal. Maximum capacity will be reached when the depth, time, airflow, and temperature are correct. When cooling a product you need only enough airflow and time at a correct depth to remove the required BTU.

F. Controlling Efficiency

Efficiency of a machine is very important. Maximum efficiency is reached when the exhaust air is saturated. The air must be adjusted and/or recycled if it is not saturated. Correct airflow and bed depth are vital for good efficiency. Efficiency in drying applications is gauged by measuring the gas consumption and/or reading the machine's thermometers. Thermometers are placed in the bottom air plenum, between each conveyor belt, and at the provided exhaust opening. Generally, the lower the temperature reading at the exhaust opening the more efficient the process. This is due to evaporation cooling. Belt-o-matic dryers incorporate a bottom or top air chamber design. This design produces a gradient exhaust temperature. Exhaust air temperature can be measured at various points down the conveyor belt. The best air quality can be captured and recycled to produce better efficiency. Consult B.N.W. Industries for more information.

Changing the plenum air temperature, airflow, bed depth, and conveyor belt speed will vary the efficiency. For instance, increasing the bed depth will allow more energy to be absorbed. However, this can produce a slight variation in moisture content from the top of the bed depth to the bottom of the bed depth. Stirrers and multiple pass configurations lessen moisture variation. Contact B.N.W. Industries for best settings.

VII. MAINTENANCE

Belt-o-matic machines should be properly maintained to ensure years of continual service. The following guidelines need to be observed.

A. Housekeeping

As covered in various sections of this manual, it is very important to perform housekeeping functions daily, if not more often. The machine must be kept free of debris. Belt-o-matic machines have specific built-in features that promote cleanliness. It is important to maintain these features.

Most units have an auger style idle roller. This roller helps clean away the debris that might accumulate between the upper and lower portions of the conveyor belt. A small inspection door is provided at each auger roller to physically inspect and clean this roller as needed.

The optional cleaning features include: auto fines clean out system, belt wash downs, air pipe belt cleaners, and belt brushes. Although each Belt-o-matic is manufactured with few dust ledges, it is necessary to inspect and clean any accumulation of debris.

B. Bearing Service

Bearing service is minimal because of the slow speed of the conveyors. Bearings are found on the drive, wrap, tail rollers, and optional equipment. The bearings may need to be greased periodically. Use premium all-purpose grease.

New production models use cast bearings in removable framing. When replacing the bearing, remove the lock collar first, then take the framing bolts out. Next, support the roller shaft and slide the framing and bearing off of the shaft. Reverse procedure to install a new bearing.

Older models use non-serviceable bearings that may be installed on the drive and tail pulleys. These bearings consist of flanges with bearing inserts. To replace these bearings, unbolt the flange from the bearing framing, remove the flange, and insert bearing from the motor shaft. Remove the gearbox or sprockets on the drive side of the drive roller before replacing bearings.

C. Gearboxes

Service is needed periodically to check the oil level. Refer to gearbox manual for oil levels, service schedule, and oil type recommendations. The vent plug should always be located at the top of the gearbox.

D. Chain Adjustments

Older production models use sprockets and chains from the gearbox to drive the conveyor belt. These systems use a wooden block or a small sprocket to maintain tension on the drive chain. This wooden block or sprocket should be above the chain pushing downward. Provide enough tension so the chain does not ride off the sprockets.

E. Maintaining the Woven Wire Conveyor Belt

A standard feature on all new production models is the woven wire conveyor belt specification B-60-48-16. This belt will hold all products 1/8” or larger. An optional finer weave compound belt specification CB2-120-96-18 is available for smaller products. The belt B-30-30-14 is available for larger products. This belt has better cleaning characteristics than other specifications. These belts are made of either 304 stainless steel or galvanized steel wire. Some older machines have the course weave belt with filler wire inserts while others have a B-72-70-18 belt with filler wire inserts. These older belts are discontinued. Older machines may be retrofitted with the new style belts.

At initial start-up, allow the belt to run for several revolutions before loading the machine.

1. **Belt maintenance.** Cleaning the belt is important in many drying applications. A continuous wash down area or high-pressure washer works well. Work at the face of the tail pulley when cleaning the belt. Particles that are stuck in the belt are usually not a factor in reducing airflow. These particles will often fall out on the return portion of the belt or as the belt flexes around the rollers. Even though the belt may look plugged, it probably is not. Some products, especially extruded oil-seeds before oil extraction, may plug balanced weave belts. The oils may form a gum that will stop airflow. We recommend using a solid tray conveyor belt, especially for coolers.

2. **Belt traction.** Belt traction is achieved by the lagging on the drive roller and the tension of the spring loaded wrap roller. Adjust the wrap roller for more traction if the belt is slipping. The wrap roller is compressed against the drive roller with a coil spring. Tighten the spring for more traction**. Do not completely compress this spring.** A gap about 1/16" is needed between each coil to compensate for any debris that might travel between the wrap and drive rollers. **Do not tighten the belt to achieve better traction.** In many cases, this will decrease the traction. Remove a section of belt or slightly increase the distance of the tail pulley to take up extra slack.

3. **Belt adjustments.** Proper tracking will increase the life of the belt. The belt has a maximum of 1/2" clearance between the edge of the belt and the machine's sidewall. A belt that tracks to one side needs to be adjusted back to the center. All belts are squared within 1/8". This means that the belt could travel as much as 1/4" while running. Adjust the belt if it moves to one side and stays in that position.

   If a belt is not tracking properly, either the drive and tail rollers are not square or the product load on the belt is not uniform. Although the belts are aligned at the factory, it is possible for them to become unaligned during transit. Check both ends of the belt to see if it is cross-cornered or to one side. If it is cross-cornered, both drive and idle pulley may need to be adjusted to make them parallel, but always correct by first adjusting the idle pulley. Run the belt while making these adjustments. Remove the bearing covers and expose the roller bearings. New production models use cast bearings and threaded rods with adjusting nuts. Be sure to loosen any locking nut before making adjustments. On older production models adjust the roller position by loosening the bearing framing bolts and sliding the bearing in the slots.

   To adjust belt tracking tighten the adjusting nut on the side that the belt is close to. Adjust the rollers in small increments (1/4"). Allow the belt to run for two revolutions before making another adjustment. Measure the space between the belt and the sidewall to determine correct alignment. If after adjustment the belt travels to the other side, decrease your adjusting increments.

   In the rare case the drive roller needs adjusting, only adjust the side opposite the motor and the gearbox. If the drive roller is moved backward, the spring loaded wrap roller must be loosened to move the drive roller. Always adjust the tension of the wrap roller after moving the drive roller. The spring should not be compressed more than a 1/16" gap between each coil.

   If the drive and tail rollers are square, check the product bed for uniform depth. To achieve uniform product depth refer to “Filling the Machine” and “Adjustments and Controls.”

4. **Belt removal and replacement.** When removing the belt always work at the face of the drive roller. The belt must be removed in the same direction that it travels. Lock the bottom side of the belt to the drive roller by pinching the belt against the roller. More tension with the wrap roller or a wooden block with a floor jack might accomplish this. You must then tie or wire a piece of iron or wood to the topside of the belt above the drive roller. With this you must pull the belt toward you to achieve slack at the face of the drive roller. Once you have slack, clip the welds off at the edge of the belt and remove the splice wire that holds the coils together. The newer compound belts require removing two splice rods to be fully disconnected. Belts that have filler rod inserts must have the rods taken out in front and behind the splice. Once disconnected, be sure to hold the bottom side of the belt from falling back into the machine and remove tension.

If the belt is being completely replaced, attach the new belt to the old belt. As you pull the old belt out, the new belt will be installed. A long cable tied to the belt and a vehicle of some sort will help with this process. Be sure to properly insert the new belt over pipe hangers and through all airlocks. Be careful not to catch and tear the belt and/or airlocks. Once you have the belt in place, pull slack at the drive roller and pinch the bottom side of the belt. Rejoin the belt by inserting a new wire to mate the coils. Notice that the coils are left and right-handed. For easy assembly use a straight wire of the same size for the splice. A crimped wire must be used to splice the CB2-120-96-18 belt. Either weld the edge or thread the end of the wire back into the belt to secure it. Release the tension. Remember to check the belt tracking before loading.

F. Maintaining the Solid Tray Conveyor Belt

The solid conveyor belt is used in applications where the woven wire belt might plug or not appropriately handle the application. This design is a positive drive and not a traction driven system. Run the belt for several revolutions upon initial start-up.

1. **Belt maintenance.** The belt should have regular inspections for proper operation and alignment. Clean the belt periodically to reduce particle build-up on the trays. Use a wire brush to scrap or brush off the build-up. Removing the build-up will insure good airflow.

   Periodically, check the drive sprocket teeth for proper fit into the flat wire belt opening. These teeth must drive against the splice rod of the flat wire belt. Be sure that the teeth are in the correct spaces.

2. **Belt tension.** Enough tension is needed to prevent the belt from slipping off the drive sprockets. If the belt is not aligned or tensioned correctly, the belt will climb onto the sprocket teeth.

3. **Belt adjustments.** Adjust the drive and tail pulley in the same manner as stated in the woven wire belt aligning section of this manual. A 1/2" clearance between the belt and the sidewall of the machine should be observed

4. **Belt removal and replacement.** Remove the solid tray conveyor belt at the face of the drive roller. First, loosen the adjusting bolts at the bearings to allow the drive sprocket to slide back and loosen the tension. For more slack, loosen the tail pulley. Next, remove the splice rod that connects the flat wire belt under the s-shaped trays. At this point, remove the belt as explained in the section about woven wire belt removal. Reverse all procedures to reinstall the belt. Remember this belt is directional. The top edge of the tray is the leading edge.

G. Conveyor Racks

The conveyor rack supports the belt and consists of gravity spring-loaded rollers that can be popped in and out. The conveyor belt is carried on the roller rack and encases the roller rack. The conveyor belt may need to be removed to replace these rollers. Be careful not to damage these rollers when working at the topside of the conveyor belt. Some models have a slider rack instead of the roller rack. The slider rack consists of an iron structure in a herringbone layout. These racks do not require any maintenance.

H. Drive Roller Lagging

Lagging on the drive roller provides traction between the conveyor belt and the drive roller. Different types of lagging are used depending on the application. Previously, a grip top lagging was used on non-heat applications. A spiraled hot belt lagging is used in heat application. A vulcanized lagging is used in high heat and corrosive applications. Currently, asphalt belt lagging is used on all applications except food grade. Asphalt belt is rated for 300°F to 350°F and is excellent against oils.

The lagging consists of a rubber compound that will need replaced after time. An indication that the lagging need replaced is a loss of traction. Pre-lagged drive rollers are available at B.N.W. Industries for purchase. To replace the lagging the conveyor belt and drive roller will need to be removed. Remove the old lagging from the roller and scrape the roller clean. We recommend buying precut lagging from B.N.W. Industries for the best results.

If the lagging is spiraled onto the roller, start from the center of the roller and work out. It takes two 3" wide strips of lagging to accomplish this. Several rivets at each end and every quarter turn will help hold the lagging on to the roller. Contact cement will help in applying the lagging to the drum. Vulcanized lagging is adhered in quarters onto a metal backing. A cutout is provided to weld the metal backing to the roller. To disassemble, grind the welds off and remove the quarter pieces of lagging.

VIII. OPTIONAL EQUIPMENT

A. Auto Fines Clean Out Systems

This system provides automatic clean out of fine material in the air chamber. The auto fines clean out system must run at all times while the machine is in operation. Typically, there are three types of auto fines clean out systems.

1. Most machines with auto fines clean out systems have a v-shaped air chamber with a 12" drag chain in the center. The v-shaped floor allows any fine material to fall down to the 12" drag chain. The drag chain conveys the material toward the discharge opening. Metal airlocks are provided at both ends of the drag chain to prevent air from escaping. The fine material falls out of the machine under the machine's frame. The tail end of the drag chain also has an opening to allow fines to escape. The chain should convey all material in the direction of airflow.

The drag chain will stretch over time and will need more tension to prevent it from jumping on the drive sprockets. The tail end provides tightening capabilities. Two threaded rods on the outside of the frame tighten the chain. Before tightening, loosen the bearing bolts on the tail sprockets. Thread the adjusting bolts in to tighten the belt. This will slide the bearings back in the slotted holes. Tighten the chain until the slack is taken out of the chain under the drive sprockets. Once the chain is tight, tighten the tail bearing bolts.

Links may need to be removed if the chain is still loose. Links are removed by removing the rod that connects each link. The rod is bent over at each side to hold it in. Straighten the rod and pull it out. Slide the tail bearing forward to see how much chain needs to be removed. Remove the excess chain and reconnect. Periodically check the chain before starting to ensure proper operation and that it is free of any objects.

Some older styles of auto fines clean out systems incorporate a chain and sprocket to drive the chain. Be sure to keep good tension on these chains. Periodically grease all bearings for proper service.

2. Some machines incorporate the return portion of the bottom conveyor belt as the clean out mechanism. The belt drags the flat bottom floor and discharges the fine material below the tail pulley of the conveyor. No adjustments are made except those mentioned in the woven wire belt maintenance section. These systems are most common on the vacuum style coolers (PC models).

3. Some smaller machines incorporate an opening in the bottom floor of the machine to allow fines to discharge. This opening is located at the end opposite the fan. The short air chamber allows the fan to push all fine material out of the opening. A rotary air lock prevents air escaping out of this opening. A paddle style wheel continuously cleans fine particles out of the air chamber. The

paddle wheel is driven by a shaft mounted gearbox and a c-face motor. Be sure to frequently inspect the fines opening in the air chamber for blockage of the opening.

B. Stirring Equipment

Rotating stirrers help mix the product at various locations as the product travels on the conveyor belt. Mixing the product will provide better consistency in the moisture level of the product as well as reestablish the airflow. As the product mixes it will blow clean under the stirrers. This allows a good complete stir, but yet will not allow too much air to escape. Generally, the teeth of the stirrers are spiraled and travel the same direction as the conveyor belt. While most stirrers are stationary, some stirrers hinge up for varying products.

New production stirrers use a c-face motor and a shaft mounted gearbox on each stirrer. Most of the older production stirrers used chain and sprockets for the drive. One motor and gearbox runs multiple stirrers. Be sure to always keep proper tension of the chain on these stirrers.

The bearing framing on the stirrers are slotted so the stirrer can be removed, if necessary. **Always run the stirrers before the product enters the machine to prevent plugging**.

C. Cyclones

The HV high efficiency cyclone is an air cleaning system used for the exhaust air exiting off a dryer or cooler. Proper air ducts should be installed from the dryer or cooler to the cyclone. All air ducts should start out the size of the exhaust opening of the machine and gradually reduce until it fits the provided inlet size of the cyclone.

A rotary air lock should be installed in the cyclone at the bottom of the cone. This will prevent air from bypassing the exhaust duct. The two counter rotating vane axial fans are set on top of the cyclone roof mounted to the vent opening. Mount the fan to move air upward. The air direction is marked on the fan housing. Fans are numbered in the order of the airflow. Install angle braces from the cyclone roof to the fan housing to ensure firmness. A fan silencer is available to reduce noise in sensitive areas. Leg stands are optionally provided as well as rotary air locks.

Pitch the fan blades so the exhaust air plenum of the dryer or cooler is under a slight vacuum. Adjust the fan pitch only when in full operation and the machine's fan is precisely set. Generally, the cyclone only has a 10% dynamic range. Therefore, the fans must be running near full load. To adjust air volume, it is recommended that a baffle be installed in the exhaust air duct so air can by-pass the dryer or cooler. This will adjust the draw on the dryer or cooler if lower airflow is needed than what the cyclone is providing. The discharged fine material can be placed into an air conveying system or into a barrel drum. This fine material is typically dry and cool. The particle reduction chart of the HV cyclone is provided in the appendix.

D. Stainless Steel Contact Points and Construction

Stainless steel contact points are used in food grade and corrosive applications. This term usually refers to all points that may touch the product, which are made of 304 or 316 stainless steel. Total stainless construction is available.

E. Steam Heat Exchangers

Steam heat can be used as an alternative to gas heat. Traps, strainers, and a self-operating temperature control valve are usually provided with the steam package but are not installed.

The amount of BTU's needed determine whether one or two coils will be mounted at the air intake on the vacuum side of the fan. If there are two steam coils, the inlets will be plumbed together and the outlets separated.

An air snorkel is used to prevent heat damage to the motor. It draws fresh air from under the floor of the machine to the cooling fan on the fan motor. A bracket on the air snorkel of the fan motor will mount the sensor to the self-operating temperature control valve. A general diagram of the steam plumbing is provided in the appendix.

Steam coils on vacuum coolers are mounted to the air intake openings. A fan at the exhaust opening pulls the air through the coils, then through the product, and out the exhaust opening. No air snorkel is necessary.

Be sure to always keep the coils clean. Dirty coils will reduce capacity and **create a fire hazard**. These coils work on 0 to 150 PSI of steam pressure. The amount of heat rise is determined by the amount of air passing the coil, steam quality, and pressure.

F. AC Inverters

AC inverters are installed as an option on fans of all new equipment. All conveyor drives on new machines have a standard AC inverter. The program pad allows you to set different motor speeds. Special attention needs to be observed when installing power to an AC inverter. The inverters need to have a separate power supply, and voltage should not fluctuate. The voltage range is covered in the electric hook up section.

G. Inlet Level Beater

The inlet level beater is an option that may be used with the standard inlet hopper and leveling gate. It is positioned down stream from the hopper gate. The inlet level beater levels the top of the product layer of products that clump and bulge as they flow under the gate. Adjust the inlet level beater slightly lower than the gate. Indicating rods on top of the machine indicate the height of the gate and the beater. Crank jacks raise and lower both the hopper gate and the inlet level beater individually. The inlet level beater rotates opposite the product flow. A C-face motor and a shaft-mounted gearbox drive the inlet level beater.

H. Rotary Air Locks

Rotary air locks mechanically move the product where plugging and/or clumping of the product might occur. The paddles of the air lock pick the product up off of the conveyor belt and drop it onto the conveyor pass below establishing a level depth. Rotary air locks are also used at a conveyors discharge to help insure a good air lock in certain applications.

A C-face motor and a shaft-mounted gearbox drive the air lock. It is very important that the rotary air lock be electrically locked with the conveyor drives. This will help prevent the machine from plugging if a motor were to overheat. Older machines used chain and sprocket systems.

I. Auger Discharge

The auger discharge is a cross auger that removes the product as it falls off the conveyor at the discharge. This auger varies in size and has a C-face motor with a shaft-mounted gearbox. This auger drive should be interlocked with the conveyor drives. This prevents the machine from plugging should a motor overheat. Be sure the auger is running before starting the conveyor.

IX. TROUBLESHOOTING

A. The burner will not stay lit. (B.N.W. Industries manufactured gas burners)

1. If the burner lights but goes out before it enters continuous operation, the infrared or UV eye is not sending a good signal to the burner controller. Clean the lens of the infrared or UV eye then check the signal of the eye. Older burner controller systems have a run check switch. The check option holds the flame on. This will isolate the problem to the eye and eliminate other problems. Some burner controller systems have a (+) and (-) terminal on the burner controller. A DC voltage meter checks the signal when the flame is on. New burner controller systems have a readout that gives you the signal reading. <u>You need five volts or more of signal to maintain a constant flame.</u>

2. If the burner controller goes into continuous operation, but the flame goes out quickly.

a) The high limit switches might be opening. This indicates too high of heat. The orifice valve needs to be closed. The orifice valve is the last hand valve before the gas burner. This valve controls the gas orifice size to the burner. Closing the valve will reduce the gas flow and will reduce the flame size. Once the flame continues for some time and product is flowing through the machine, you can calibrate the Partlow valve so the temperature can be controlled.

b) This situation can also indicate that the burner is being starved for gas. Upon start-up the Partlow valve is completely open until the sensor throttles back at the set temperature. The orifice valve needs to be shut down to maintain pressure against the burner. Once the Partlow valve throttles back, the gas pressure gauge at the orifice valve should read one-half the pressure of the incoming line pressure at the inlet on/off valve. Adjust the orifice valve to achieve this reading.

The Partlow valve minimum flame setting may need to be increased to maintain enough gas volume when the valve is at the minimum setting. Refer to the Partlow manual to increase this setting.

B. The flame is very yellow. (B.N.W. Industries gun gas burners)

This indicates a very rich fuel air mixture. Older machines have a handle on the outside of the machine that operates a center slide sleeve in the mixing tube. Move this handle to increase the air coming into the burner. New machines have two throttle cables that control butterfly plates over the air pickup tubes. Open the adjustable plates to increase the amount of air entering the burner. You need to achieve a blue flame with a small yellow tip.

C. The burner controller will not come on when the heat switch is on.

Push the reset button twice to reset the burner controller. Older burner controllers have the reset button located on the main chassis. New burner controllers have a remote reset button on the exterior of the control panel or on the burner control display module.

D. The airflow light on the burner controller does not come on.

Check the airflow switch and the hose for particles that might be stuck inside.

E. Product is blowing out of the inlet hopper and/or out of the product discharge.

Check for level product depth. The inlet hopper should be filled higher than the depth of product. This will help maintain an air lock in the hopper.

Check the exhaust air duct for restriction. If the exhaust duct size is too small or restricted, a high amount of pressure will be evident in the top cover of the machine. This will cause product to blow out of the hopper and the discharge.

Also, check the hinge plate air locks at the discharge of the conveyor or at the separation of the heat and cool section. The air lock may need more tension to provide a better seal. Unlevel depth can also cause a problem with these airlocks.

F. The moisture is uneven from side to side.

This is an air distribution problem. This problem can result from modification made to the machines air intake ducts, fan, and heat sources. Check the levelness of the product bed. The bed should be full and level all the way across. Another cause may be a plugged conveyor belt.

G. The moisture greatly varies from the top to the bottom of the product.

This usually means that more airflow is needed. Reducing the depth of the product can help solve this. Less depth will decrease the static pressure and increase the airflow. Airflow can be increased by loading the motor to full amp draw by the pitch of the blade, increasing motor horsepower, and increasing fan diameter. Restriction of airflow either by the exhaust or intake air ducts or by a plugged conveyor belt will cause this problem. The adjustable fresh air doors on dryer / cooler models may need to be adjusted open to help reduce this problem.

H. The conveyor belt is slipping.

Check the tension of the wrap roller against the drive roller. The wrap roller spring should be compressed to 1/16" between each coil. The overall tension of the belt should not be too great. Some slack will enhance traction. If this does not solve the problem, inspect the conveyor to see if the belt might be bound up against something. Also, the lagging on the drive roller may be worn to the point were it needs to be replaced.

I. The fan and burner both shut off.

This may happen if the machine is empty and the temperature is running close to the preset temperature on the high limit safety switch by the exhaust opening. Reduce the temperature until you have product in the machine so this switch will not shut the fan off.

This can be an indication of a fire or hot spot within the machine. Observe the emergency fire shut down procedure. Another indication may be a hole in the bed of product.

J. The product is not cool enough (for cooling and dryer/cooler applications).

On dryer / cooler models the air intake doors need to be shut down to draw more air into the cool section. Before doing this check the bed for levelness. Correct the uneven bed, if this applies. Be sure that the air intake to the cool section has not been restricted in any way. The air intake for the cool section is above the product layer at the discharge. Also, be sure that the hinge plate door that separates the heat from the cool section is not leaking air or blowing open. More tension may need to be applied on the airlock to provide a better seal. An unleveled depth can also cause this problem.

In all cool applications, this is an airflow problem. Either more air is needed or a disruption of the air has occurred. Check the bed levelness. Also, check the air intake and exhaust for restriction. Inspect the machine for any possible air leakage that will allow the air to bypass the product.

K. The burner controller signal from the scanner is too low.

The scanner eye is either dirty or has moisture on it. Remove the scanner eye from the mounting pipe. Clean and dry the eye. If the photo lens is cracked, a poor signal will result. If this does not improve the signal, check the mounting pipe for proper alignment. The scanner should be directed at the flame. A new scanner eye may be needed, if all else fails.

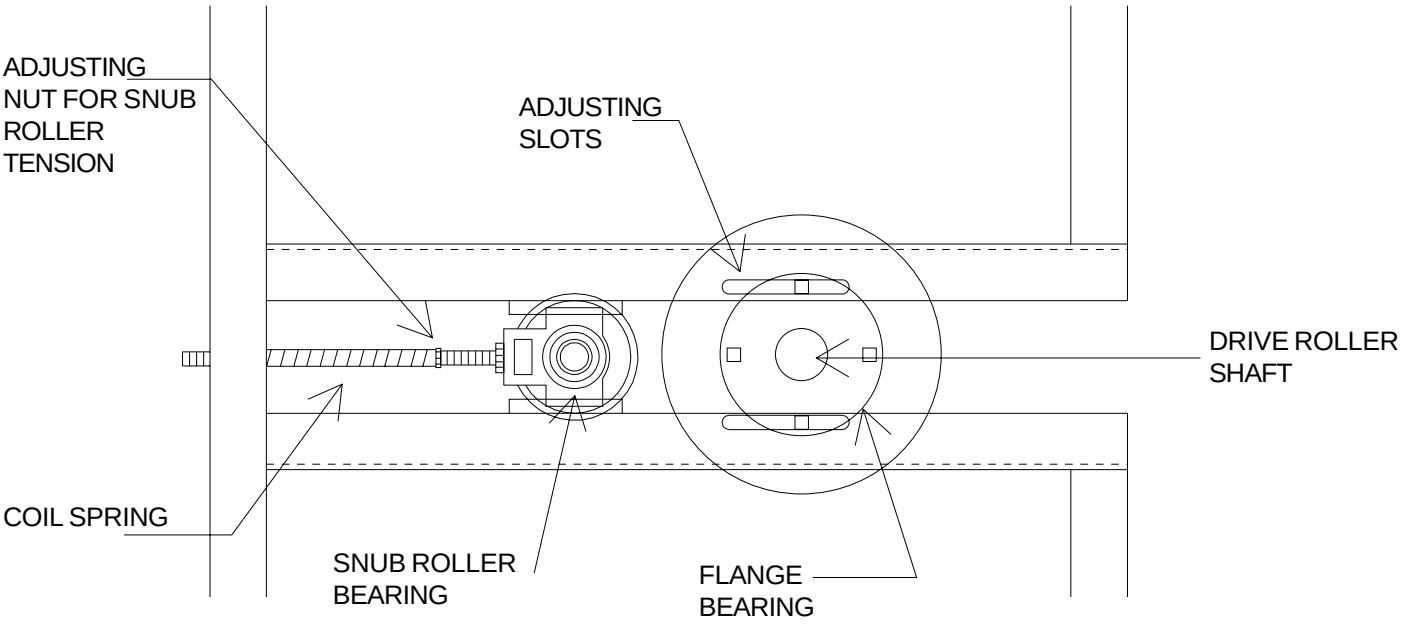
L. The air temperature will not go low enough even when the Partlow temperature dial is on the lowest setting.

The minimum flame setting needs to be adjusted. Reduce the Partlow temperature dial to the lowest setting. While watching the burner flame (to insure it does not go out), reduce the minimum flame setting until the air temperature drops. If flame fails prior to reaching the desired air temperature, airflow into the burner may need to be reduced. Close the burner adjustable plates further for less burner airflow.

Roller Adjustment for Discharge Drive

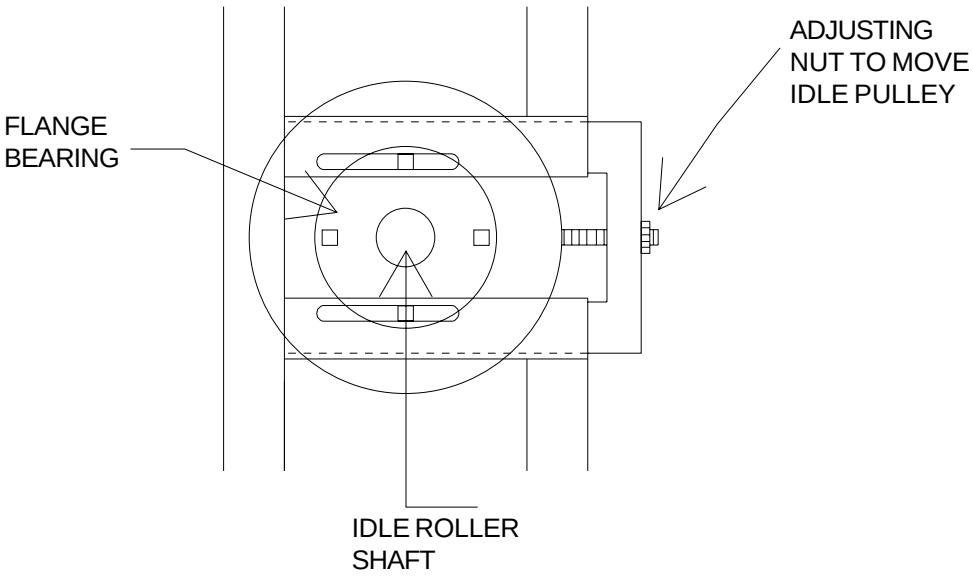
most units frame # 500 or lower

Discharge End of Conveyor (Drive Roller)



Side View

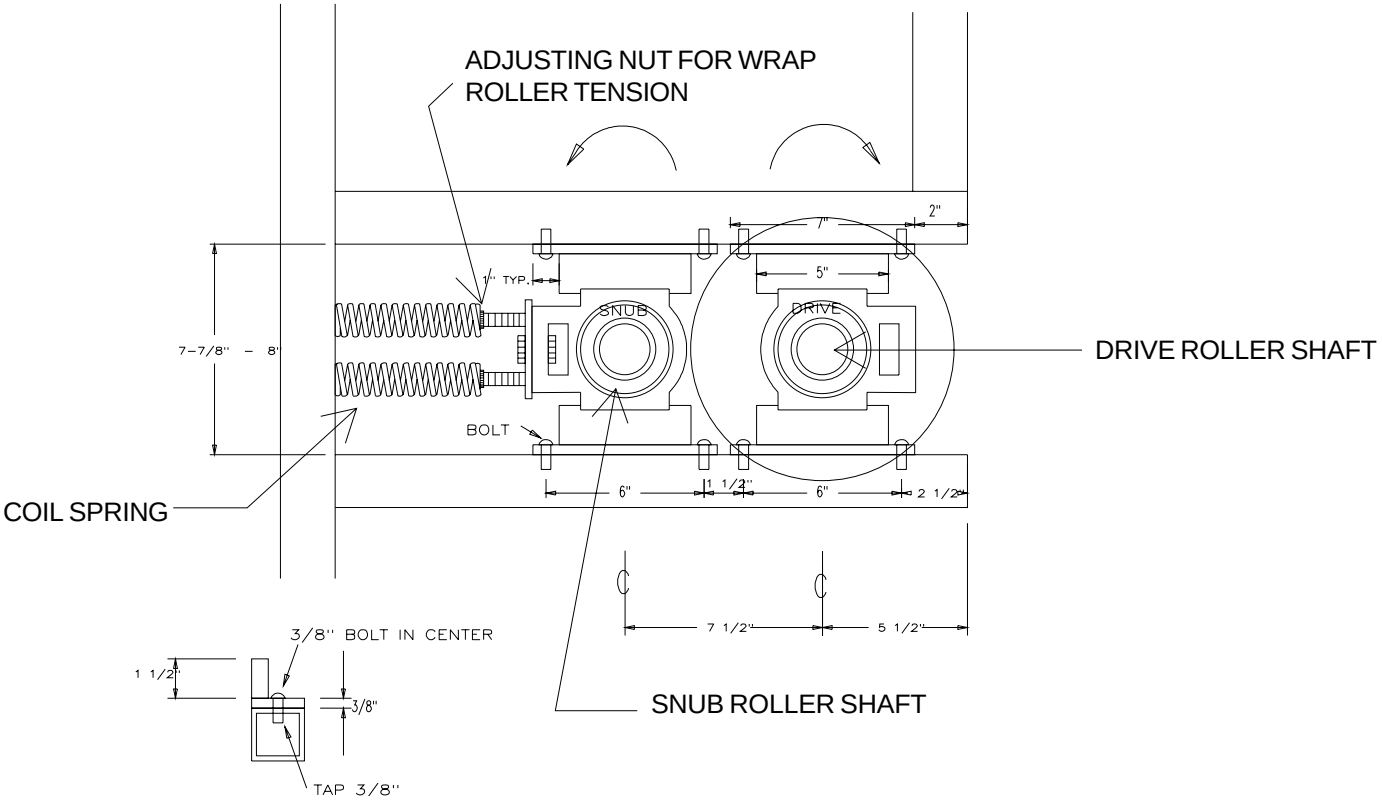
Inlet End of Conveyor (Idle Pulley)



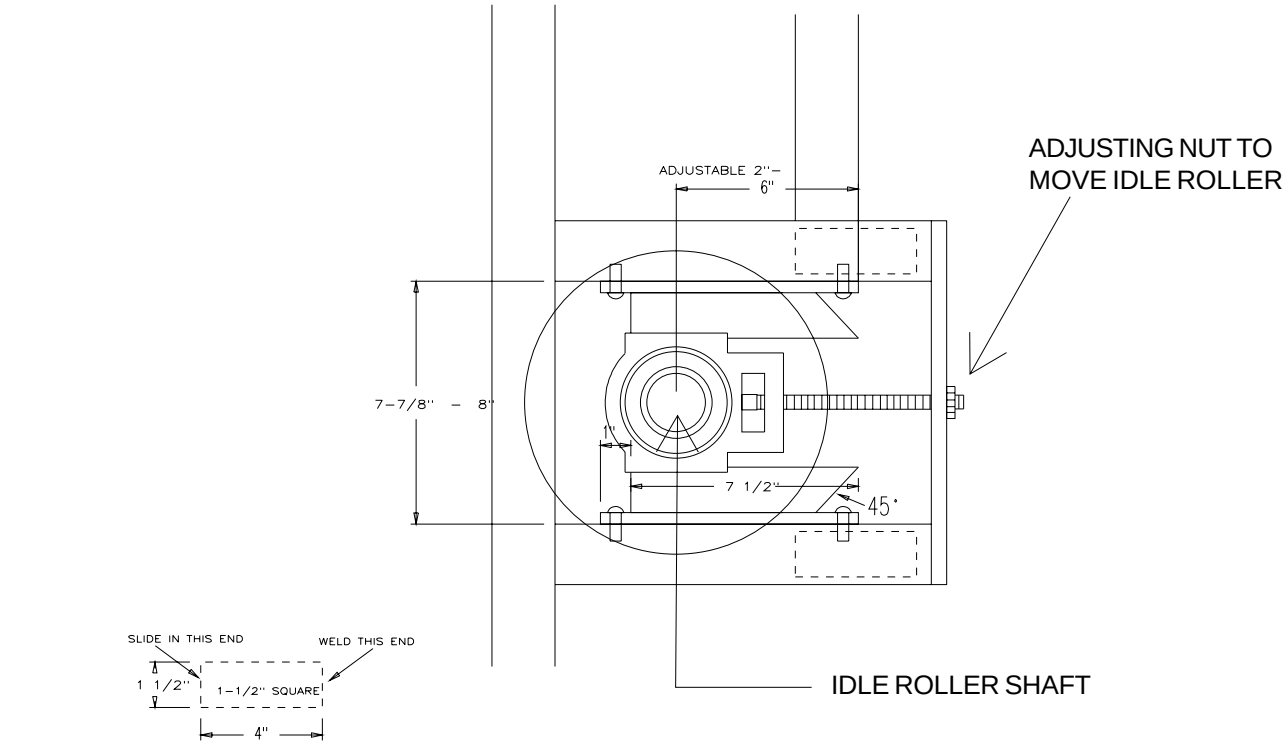
Roller Adjustment for Discharge Drive

most units frame # 500 or higher

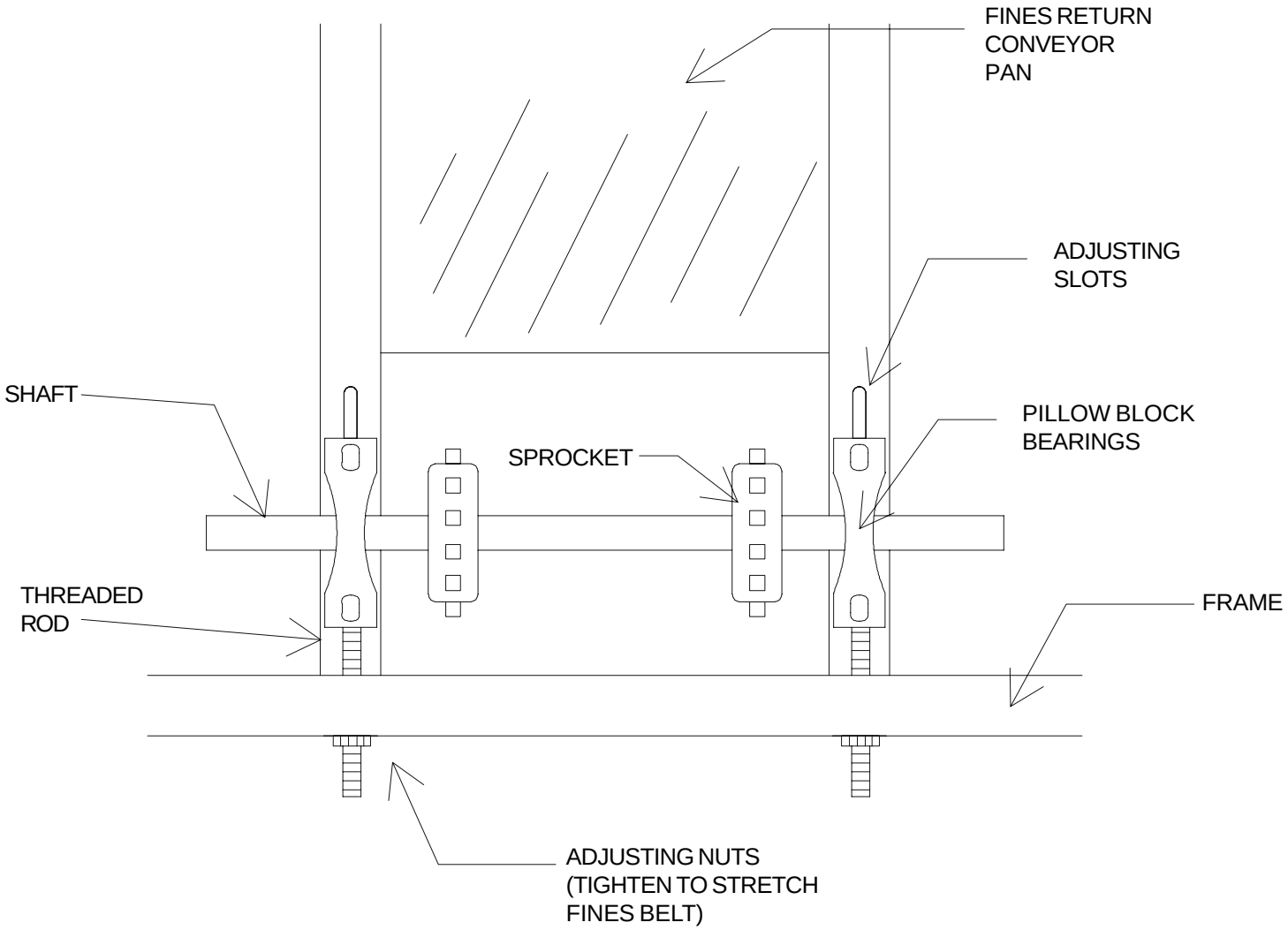
Discharge End of Conveyor (Drive Roller)



Inlet End of Conveyor (Idle Roller)



Fines Conveyor Adjustment

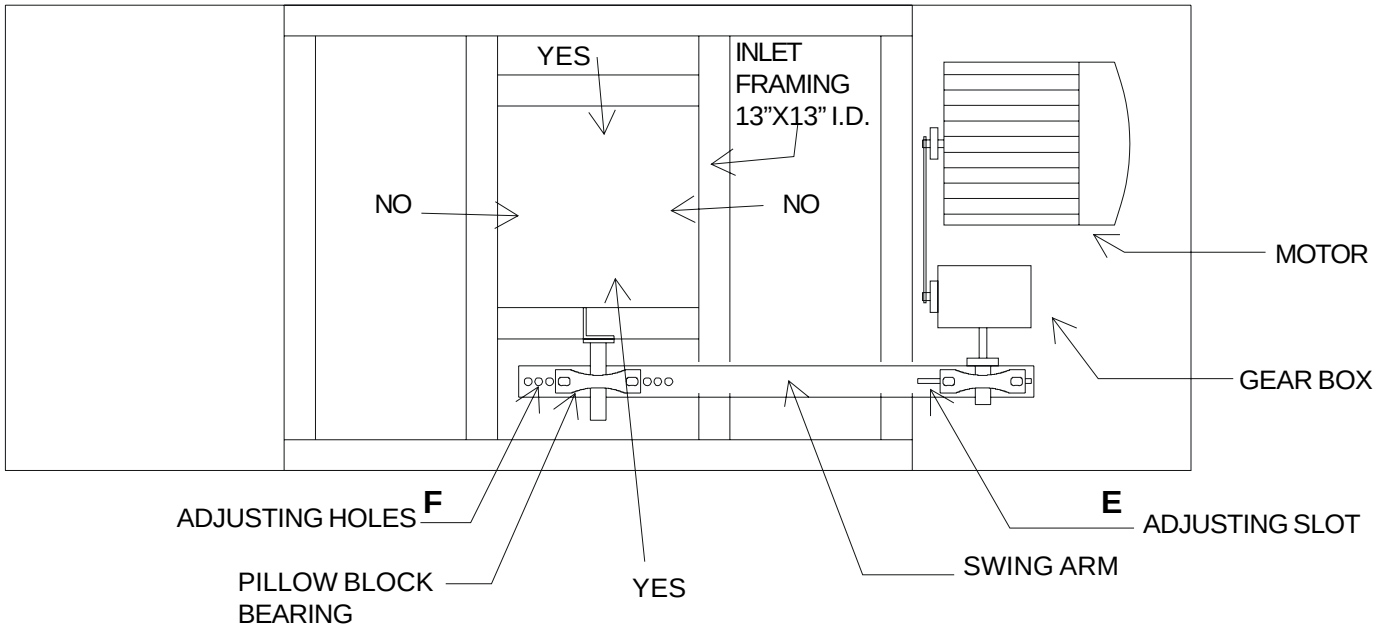


Top View

* Note - Idle End of Conveyor is Diagrammed

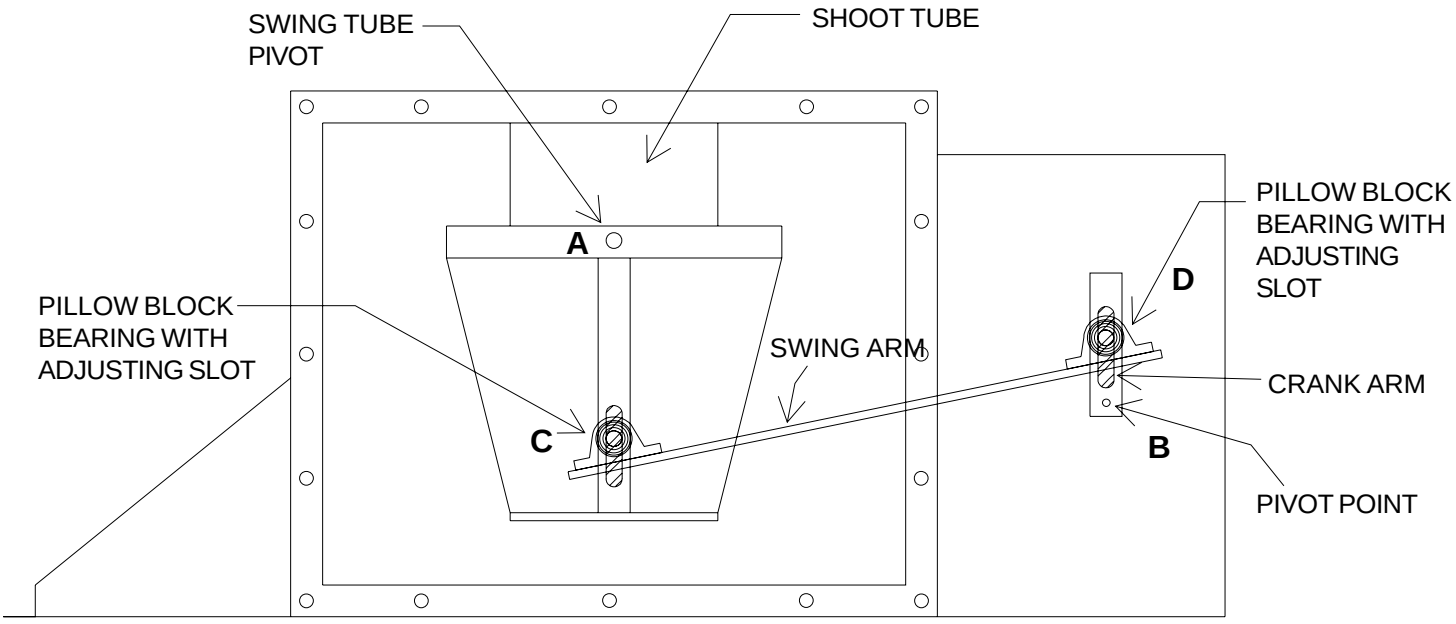
Oscillating Inlet Spreader

Top View

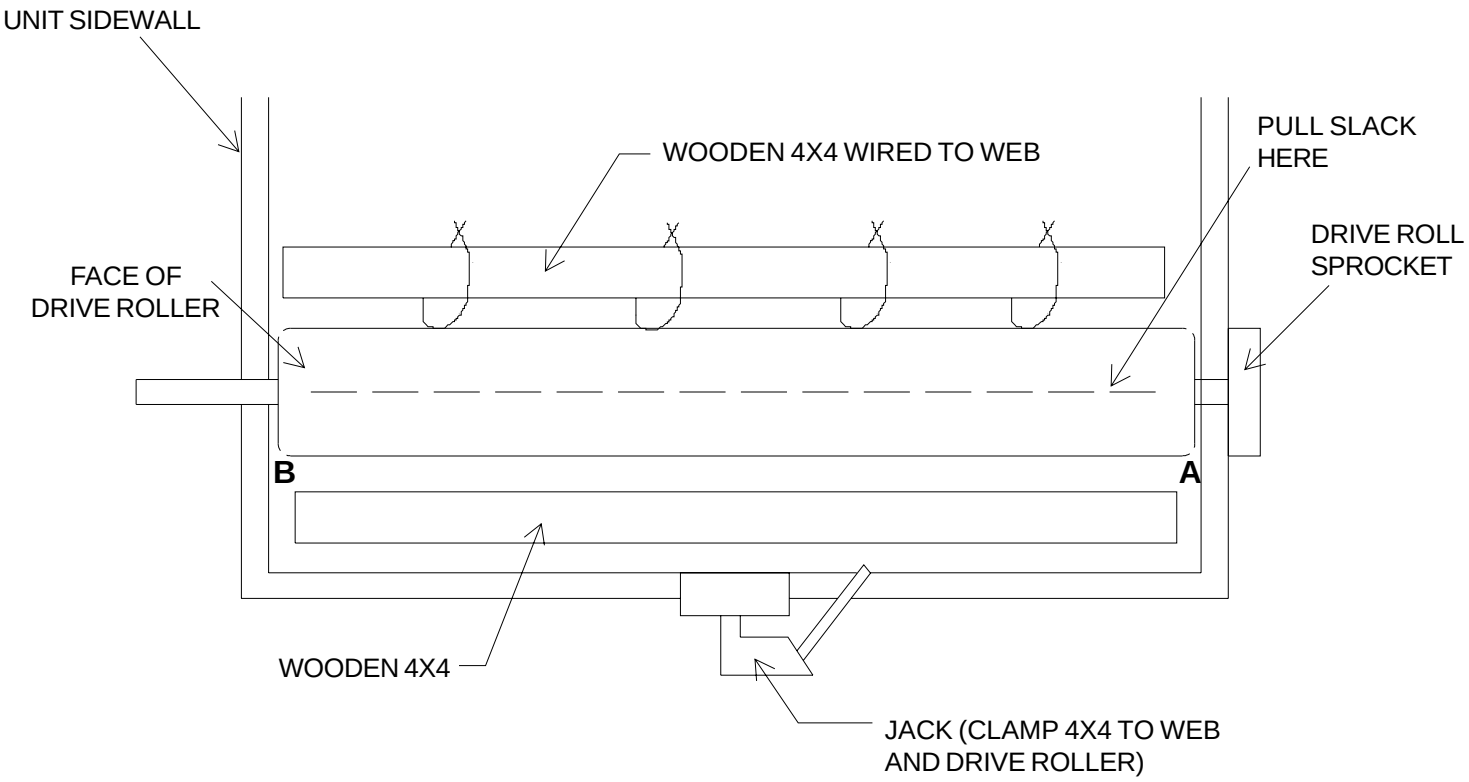


- Obtain more swing tube travel by moving bearing C closer to pivot A
- Obtain less swing tube travel by moving bearing D closer to pivot B
- The reverse is true for both adjustments
- Give swing tube more right throw by making swing arm shorter at point F & E
- Give swing tube more left throw by making swing arm longer at point F & E
- Always bring product in inlet tube from the front or rear; never the side; *yes* and *no* arrows show proper direction

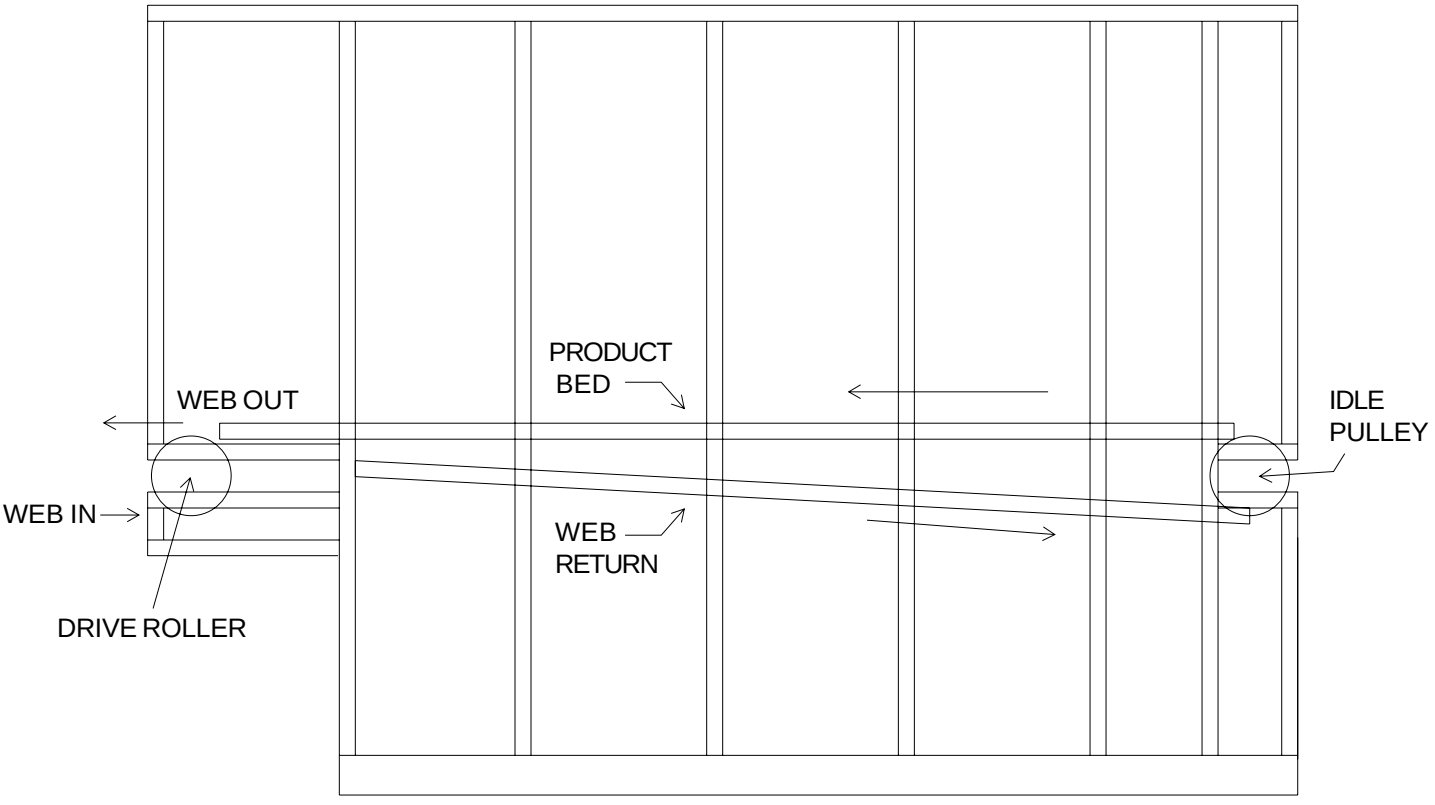
Side View



Web Disassembly

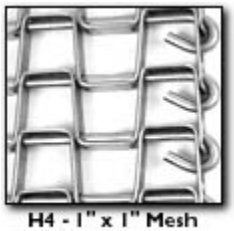


Side View



Measure distance between web and sidewall at point A & B for tracking purposes.

HEAVY DUTY CLINCHED SELVAGE BELTING



H4 - 1" x 1" Mesh
Clinched Selvage

H5 - 1/2" x 1" Mesh
Clinched Selvage

Heavy duty clinched selvage belts are available in two different mesh sizes and four different materials: low carbon galvanized steel, C-1045 bright high carbon steel, T-304 stainless steel and T-316L stainless steel. Clinched selvage belts can be ordered in any width from 10" to 192". These belts feature a better wearing edge surface than welded selvage for misaligned conveyor systems and they mechanically prevent the belt from narrowing under heavy loads. Additionally, heavy duty clinched selvage belts are just as flexible as those with welded selvage.

Sprockets driving heavy duty clinched selvage belts CANNOT be placed on the first drive opening on either side of the belt.

CLINCHED SELVAGE BELT SPECIFICATIONS

DESIGN	MESH	MIN. WIDTH	MAX. WIDTH	MAX. TENSION* (lbs./ft. of width)	APPROX. WGT. (lbs./sq. ft.)
H4	1" x 1"	10"	192"	1350	3.55
H5	1/2" x 1"	10"	192"	1750	3.95

* Maximum working tension per foot of belt width given for drum driven applications only. **All heavy duty belts have the following dimensions:**
Flat strip = 1/2" wide x .062" thick round edge
Connector rod = 6 gauge (.192" diameter) - high tensile strength

Flat Wire Belt Tracking

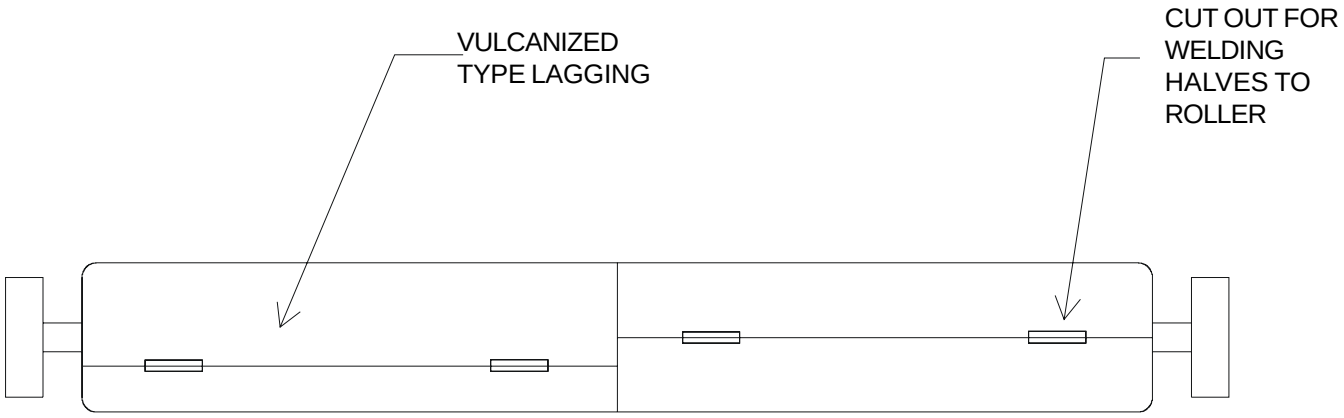
Since the majority of belting problems are alignment related, it is extremely important to have all shafts parallel to each other and perpendicular to the conveyer bed. If a good alignment is not completed before using a flat wire belt, longitudinal pitch can be distorted causing the belt to track to one side

Flat Wire Belt Assembly

Clinched Selvage connector rods are supplied with a pre-formed hook on one end and straight wire on the other. Bring together the two sections of belt to be spliced, and insert the connector rod. Close the hook using pliers. On the other side, bend the straight wire back through the hole in the edge of the belt and form a hook, then close it.

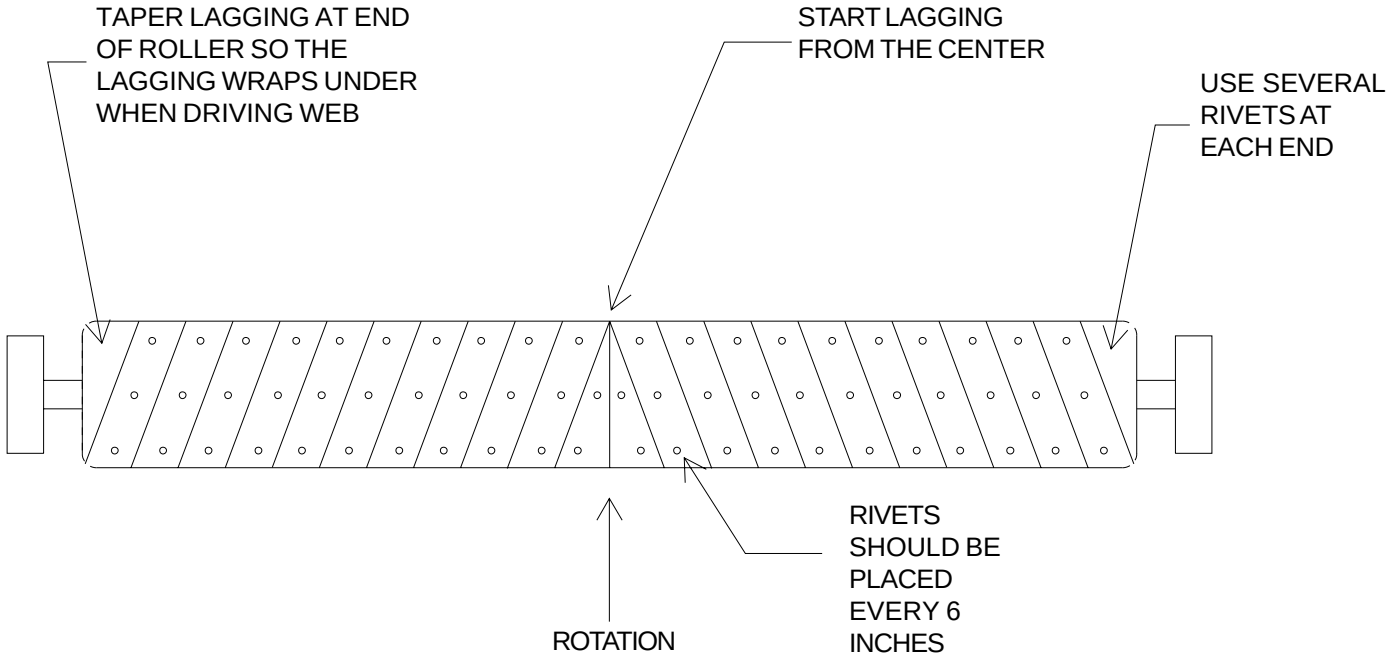
Roller Lagging

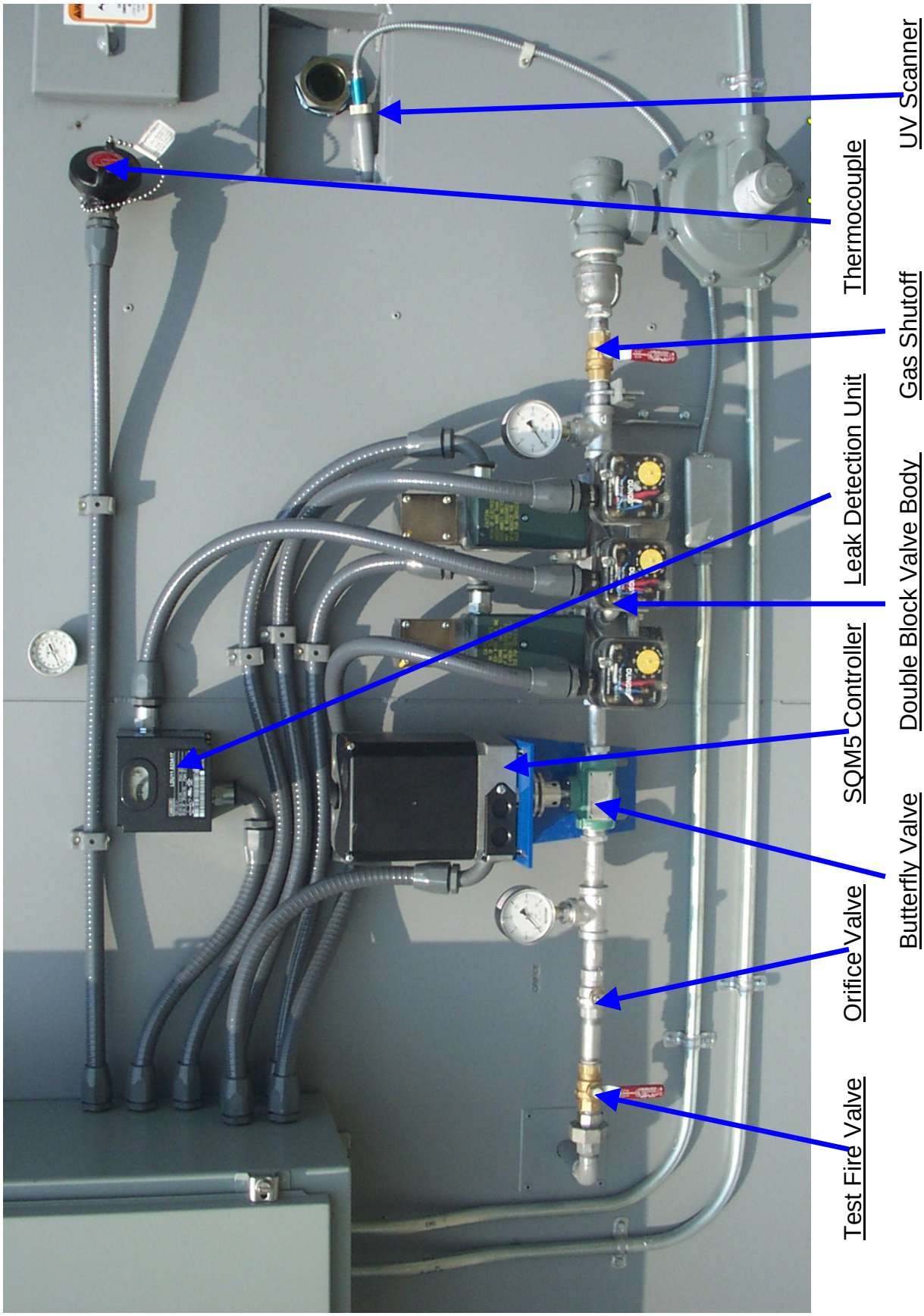
Vulcanized Style Lagging



- Vulcanized type lagging is in halves which weld to the roller at the cutouts. Stagger the splits in the halves.

Asphalt Belt Lagging




UV Scanner
Thermocouple
Gas Shutoff
Leak Detection Unit
Double Block Valve Body
SQM5 Controller
Butterfly Valve
Orifice Valve
Test Fire Valve

Gas Train Layout

1. **Main-gas regulator** evens out fluctuations in the incoming gas pressure and provides the down-stream pressure required by the combustion system being used.

2. **Main-gas cock** gives positive shut-off for overnight or extended periods of shut-down.

3. **Pressure gauge** gives continual monitoring of regulator performance.

4. **Low-gas pressure switch** interrupts interlocking safety circuitry whenever gas pressure falls below its set point.

5. **Main fuel shut-off valve** closes fuel line instantly and automatically upon interruption of its interlocking safety circuit.

6. **Valve leak test** utilizes a gas pressure switch set halfway between high and low pressure switches.

7. **Blocking valve** operates in unison with main gas shut-off valve in block and bleed system.

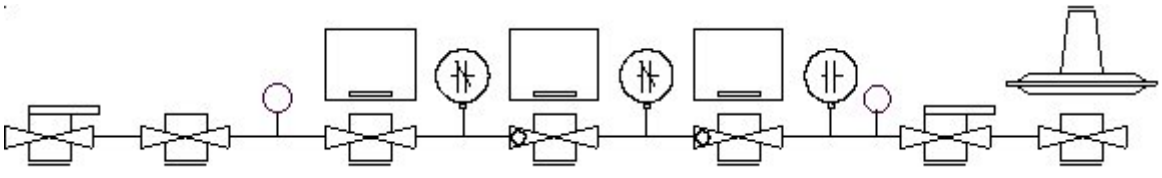
8. **High gas pressure switch** interrupts interlocking safety circuitry whenever regulated gas pressure exceeds set point.

9. **Modulating control valve**.

10. **Pressure gauge** gives continual monitoring of regulator performance.

11. **Gas orifice valve** preset at factory.

12. **Burner shut-off cock** provides system the isolation necessary for fuel shut-off valve leak test.



SIEMENS

7696

ISO 9001

UL recognized
FM approved

Automatic Valve Proving Control LDU11

Features

- **Performs leak test of the gas shut-off valves before start-up and/or immediately after burner shut-down**
- **No inlet gas pressure limitations**
- **Easy-to-read dial indicates progress of test program**
- **Ability to eliminate or leak test the vent valve**
- **Cost effective control improves system safety**
- **Globally Approved – cULus, FM, CE**

Application

The LDU11... control detects leakage of the shut-off valves on gas trains with two safety shutoff valves. During each burner cycle, the LDU control unit automatically sequences, and if a leak is detected, initiates a lockout and prevents the burner from starting up.

Function

The LDU11 (or control unit) is used in a gas-fired combustion system with or without a vent valve in the gas train.

Installed with one or two pressure switches mounted between the gas valves, the LDU automatically initiates gas valve proving either

- prior to burner start-up
- immediately after the controlled shutdown, or
- both prior to burner start-up and immediately after shutdown

The valve leak test is completed in two stages:

- First test phase «Test1», evacuates the pressure between the gas valves to test the upstream gas shutoff valve. The pipe between the gas valves is monitored by a leak detect pressure switch for no increase in pressure.
- Second test phase «Test2», pressurizes the area between the gas valves to test the downstream safety shutoff valve. The pipe between the gas valves is monitored by the leak detect pressure switch for no decrease in pressure.

If the leak detect switch signals excessive gas pressure increase during the first test phase «Test1», or decrease during the second test phase «Test2», the LDU control will lockout and prevent burner start-up. The indicator dial on the front of the unit indicates the progress of the leak test. When a fault occurs, the indicator dial stops at the time of lockout, and indicates which of the valves is leaking. In the event of a lockout, the reset button on the front of the control will light orange to indicate a fault.

Pushing the clear window in front of the indicator dial once will reset the LDU control. DO NOT hold in the reset button. The LDU may also be reset with a remote button (see wiring diagram).

Ordering

Control unit for gas valve proving, without plug-in base

- For AC 220...240 V, 50...60 Hz	**LDU11.523A27**
- For AC 100...110 V, 50...60 Hz	**LDU11.523A17**

Plug-in base **AGM11**

The following items must be ordered **separately**:

- (1) or (2) single-pole, double throw pressure switches. See bulletin 155-292 for Siemens QP... Series pressure switch selections.

Warning Notes

- **All regulations and standards applicable to the particular application must be observed!**
- **Qualified personnel must always carry out installation and commissioning work!**
- **The electrical wiring must be made in compliance with national and local standards and regulations!**
- **The LDU... must be completely isolated from the mains before performing any wiring!**
- **Secure the LDU to the base plate to ensure from protection against electric shock!**
- **Check wiring and all safety functions.**
- **Do not open or modify the control.**
- **Fall or shock can adversely affect the control. Do not put such units into operation, even if they do not exhibit any damage.**

Mounting notes

The LDU control must be mounted in an enclosure, typically in the control panel containing the flame safeguard. There are no distance restrictions from the gas train. The LDU control is not adversely affected by electromagnetic resonance caused by items such as ignition transformers.

One or two automatic reset single-pole, double-throw pressure switches must be mounted in between the gas safety shutoff valves. Manual reset switches are not permitted to be the leak detection switch. No additional piping modifications are required to the gas train.

The LDU control includes:

- The synchronous motor with its gear train and step action sequence switch
- The camshaft with its 15 nonadjustable cams
- The program indicator at the head of the camshaft
- One main and one auxiliary relay
- The lockout relay which can be electrically reset from a remote location
- The unit fuse and a spare fuse

The plug-in base carries the following terminals:

- 24 connection terminals
- 3 earth terminals
- 3 neutral terminals, prewired to terminal 2 (neutral input)

The front dial provides information about the program sequence, the type of fault and the point in time the fault occurred, using easy-to-remember symbols.

Technical data

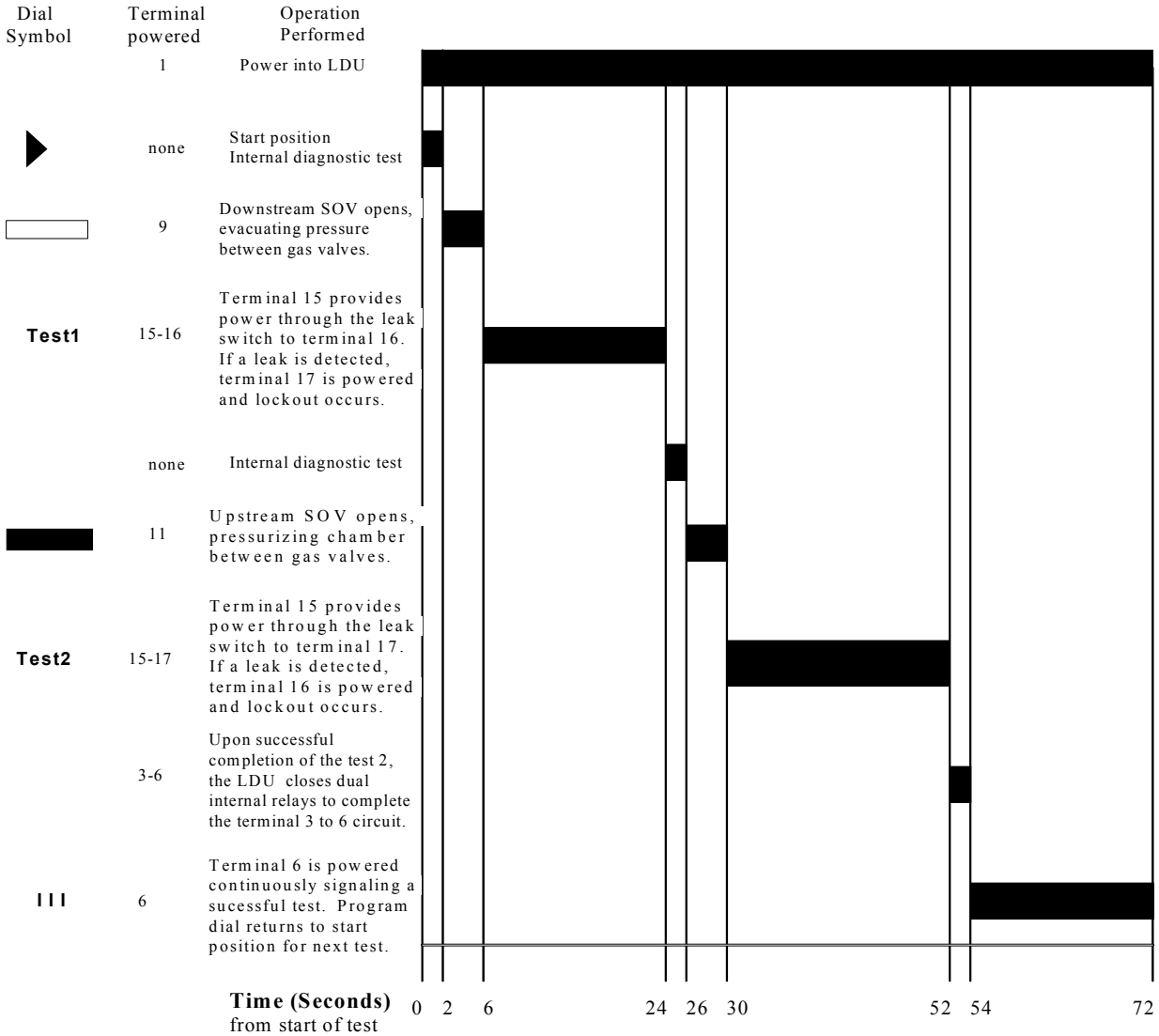
General unit data	Mains voltage	
	- LDU11.523A17	AC 100 V –15 %...AC 110 V +10 %
	- LDU11.523A27	AC 220 V –15 %...AC 240 V +10 %
	Mains frequency	50...60 Hz ±6 %
	Power consumption	
	- During the test	3.5 VA
	- During operation	2.5 VA
	Primary fuse (external)	T10 / 500V
	Unit fuse	T6.3H250V to IEC 127
	Perm. input current at terminal 1	5 A
	Perm. Current rating of control terminals	4 A
	Required switching capacity of pressure switch	min. 1 A, AC 250 V
	Mounting	In a panel or control cabinet
	Mounting orientation	No restrictions
	Degree of protection	NEMA 1, 2, 5, 12, 13
	Weight	
	- LDU11...	4 lbs
	- Plug-in base	½ lb
Environmental conditions	**Transport**	
	Temperature range	-58...+140 °F
	Operation	
	Temperature range	-5...+140 °F
	Approvals (110 V only):	
	FM	J.I. 1Z2A6.AF Dec 1995
	cULus	File MH26883
	CSA	In Progress
	Approvals (110 V and 220 V):	
	CE Electromagnetic compatibility EMC	89 / 336 EEC incl. 92 / 31 EEC
	CE Directive for gas appliances	90 / 396 EEC

The LDU monitors the automatic reset, leak detect pressure switch between the gas valves. During the first test phase, called «Test1», the downstream gas valve is powered for 4 seconds, providing atmospheric pressure between the valves being tested. If the upstream gas valve is leaking, causing the pressure to rise above the set point of the leak detect switch, the LDU will initiate a lockout and trigger an alarm (optional). The program indicator then stops at «Test1» to indicate the upstream gas valve is leaking. If no leak is detected in the upstream gas valve, the LDU control continues its program with the second test phase.

During the final test phase, «test 2», the upstream gas valve is powered for 4 seconds, pressurizing the area between the gas valves. During this test, the pressure between the gas valves may not decrease below the set point of the pressure switch. If pressure falls below the set point, the LDU control will initiate lockout and prevent the burner from starting up. The program indicator on the front dial then stops at «Test2» to indicate the downstream gas valve is leaking.

On successful completion of the second test phase, the control unit closes dual internal relays to complete the internal control loop between terminals 3 and 6. The LDU recycles to the start position for the next test. During these steps, the positions of the control contacts remain unchanged. If a lockout occurs, terminal 13 is powered and may be wired to an external alarm.

LDU Sequence of operations, 60 Hertz



LDU requires 54 seconds to complete a successful test.
From original start, 72 seconds required to return to start for next test.

Program and lockout indicator

In the event of lockout, the LDU control stops and the position indicator on the front of the unit lights bright orange. The symbol that stops above the reading mark indicates the test phase during which lockout occurred and also gives the number of programming steps completed from the start of this test phase (1 step = 2.5 seconds). In the event of lockout, all terminals receiving voltage from the control unit will be deenergized, except terminal 13, which is used for lockout indication. The clear window in front of the indicator dial is the reset button. Push once to reset the unit. After a reset, the programming mechanism automatically returns to its start position to immediately program a new valve leak test.

Note **Do not press and hold the reset button for more than 10 seconds.**

Calculating the leakage rate escaping from a length of pipe

$$V_{Leak} = \frac{(P_I - P_{set}) \times V \times 3600}{P_{atm} \times t_{Test}}$$

Legend

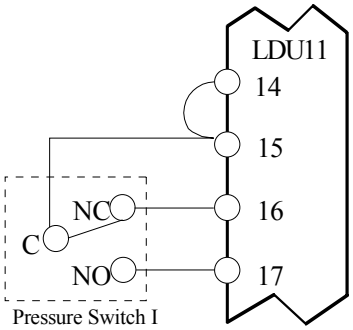
Symbol	Unit	Description
Vleak	ft^3 / hr	Valve leakage rate in ft^3 per hour
PI	PSI	Inlet gas pressure. Pressure upstream of both shut-off valves.
Pset	PSI	Gas pressure setting on pressure switch I (normally set to 50 % of PI)
Patm	PSI	Atmospheric Pressure downstream of gas valves. Typically 14.7 PSI.
V	ft^3 / hr	Volume between the gas valves to be tested. See table (1).
Ttest	seconds	Fixed at 22.5 seconds for test 1, and 27.5 seconds for test 2.

Pipe Size " NPT	Total Gas Volume (cu ft) by Pipe Length between valves						
	Siemens VGD Valves	.5 ft.	1 ft.	1.5 ft.	2 ft.	3.25 ft.	5 ft.
0.50				0.006	0.008	0.01	0.013
0.75				0.01	0.0125	0.015	0.02
1.00		0.01	0.013	0.016	0.019	0.025	0.034
1.50	0.026	0.022	0.032	0.042	0.052	0.064	0.088
2.00	0.028	0.043	0.055	0.067	0.078	0.102	0.138
2.50	0.046	0.08	0.103	0.13	0.15	0.177	0.247
3.00	0.054	0.17	0.191	0.222	0.242	0.311	0.4
4.00	0.106	0.21	0.3	0.37	0.466	0.508	0.65

Table 1. Volume between gas valves.

Example leak detection calculations can be found in the following section under single and dual switches.

Wiring and setting of LDU… Single Leak Detection Pressure Switch:



During Test 1, power is on Terminal 15. After the area between the gas valves has been evacuated of pressure, the switch should have power through terminal 15 to terminal 16. If the main gas valve is leaking, the area between the gas valves fills with gas, leak detection pressure switch I trips, sending power to terminal 17, causing a lockout.

During Test 2, Terminal 15 is powered, and with pressure between the gas valves, terminal 17 will also be powered. If the blocking gas valve is leaking, the area between the gas valves losses pressure. Leak detection pressure switch I trips, power is sent to terminal 16, resulting in a lockout.

Leak detection pressure switch should be set at 50% of the gas pressure upstream of the main shut-off valve.

Example Leakage Rate Calculation

Using Siemens 1-1/2" VGD gas valves with an inlet gas pressure of .5 PSI, calculate the expected leakage rate which will cause the LDU11 to lockout setting one leak detection pressure switch at .25 PSI:

$$V_{Leak} = \frac{(P_I - P_{set}) \times V \times 3600}{P_{atm} \times t_{Test}}$$

P_I = .5 PSI

P_{set} = .25 PSI

P_{atm} = 14.7 PSI

V = .026 ft^3 (From table 1)

T_{test} = 22.5 s (test 1)

= 27.5 s (test 2)

$$V_{Leak} = \frac{(.5 - .25) * .026 * 3600}{14.7 * 22.5 \text{ (test1)}} = 0.07 \text{ ft}^3\text{/hr}$$

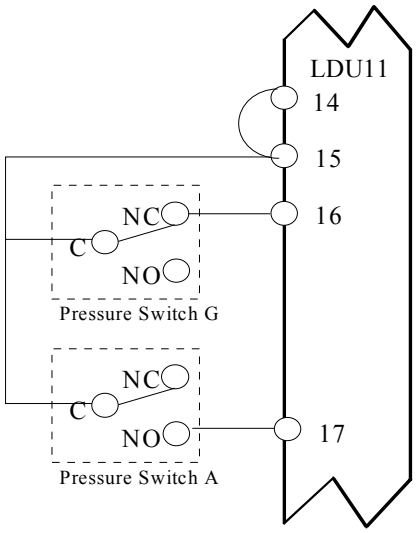
$$V_{Leak} = \frac{(.5 - .25) * .026 * 3600}{14.7 * 27.5 \text{ (test2)}} = 0.06 \text{ ft}^3\text{/hr}$$

In this example, if the 1st gas valve is leaking at a rate of 0.07 ft^3/hr or greater, the LDU will lockout during test 1. If the 2nd gas valve is leaking at a rate of 0.06 ft^3/hr or greater, the LDU will lockout during test 2.

Note

If the maximum permissible gas leakage rate (V_{leak}) exceeds the desired leakage testing rate, use dual leak detection pressure switches.

Wiring and setting of LDU… Dual Leak Detection Pressure Switches:



During Test 1, Terminal 15 is powered. After the area between the gas valves has been evaluated of pressure, pressure G switch should have power through terminal 15 to terminal 16. If the main gas valve is leaking, the area between the gas valves fills with gas, pressure switch A trips, sending power to terminal 17, causing a lockout.

Switch A needs to be set up to a maximum of 50% of the available gas pressure through the valves. The lower the pressure switch is set, the smaller of a leak will be detected through the blocking (downstream) gas valve. Setting the switch at or near atmospheric pressure may cause nuisance lockouts.

During Test 2, Terminal 15 is powered. With pressure between the gas valves, terminal 17 will also have power through pressure switch A. If the blocking gas valve is leaking, the area between the gas valves losses pressure, and pressure switch G trips, power is sent to terminal 16, causing a lockout.

Pressure Switch G need to be set at a minimum of 50%, up to 90%, of the inlet gas pressure through the valves. The higher this switch is set, the smaller a leak will be detected through the main (upstream) gas valve. Setting the pressure switch G at or near the inlet pressure may cause nuisance lockouts due to regulator fluctuations.

Example

Using Siemens 1-1/2" VGD gas valves with an inlet gas pressure of .5 PSI, calculate the expected leakage rate which will cause the LDU11 to lockout with two LDU pressure switches, Pa set at .1 PSI, and Pg set at .4 PSI:

$$V_{Leak} = \frac{(\text{Pressure differential} * V * 3600}{P_{atm} \times t_{Test}}$$

PI = .5 PSI

Pa = .1 PSI

Pg = .4 PSI

Patm = 14.7 PSI

V = .026 ft^3 (From table 1)

T_{test} = 22.5 s (test 1)

= 27.5 s (test 2)

$$V_{Leak} = \frac{(.1) * .026 * 3600}{14.7 * 22.5\ (test1)} = 0.027\ ft^3/hr$$

$$V_{Leak} = \frac{(.5 - .4) * .026 * 3600}{14.7 * 27.5\ (test2)} = 0.022\ ft^3/hr$$

In this example, if the 1st gas valve is leaking at a rate of 0.027 ft^3/hr or greater, the LDU will lockout during test 1. If the 2nd gas valve is leaking at a rate of 0.022 ft^3/hr or greater, the LDU will lockout during test 2.

In the event of a lockout, the following steps need to be performed to determine the cause.

1) Check the leak detection switch to ensure it is an automatic reset switch.

2) Determine at which point in the leak test sequence the lockout occurred, by viewing the front dial of the LDU control.

3) If the lockout occurs during Test 1, manually leak test the upstream gas valve as recommended by NFPA 86. If the main valve is leaking, lockout the appliance and replace the valve.

4) If the lockout occurs during Test 2, proceed to step 5.

5) Determine the set-point of the leak test pressure switch. Check the inlet pressure in the gas train and the set point of the leak detection switch. Use the guidelines on the previous pages. Re-adjusting the leak detect pressure switch and reset the LDU.

6) Check the wiring and functionality of the leak test pressure switch. If faulty, replace and/or rewire.

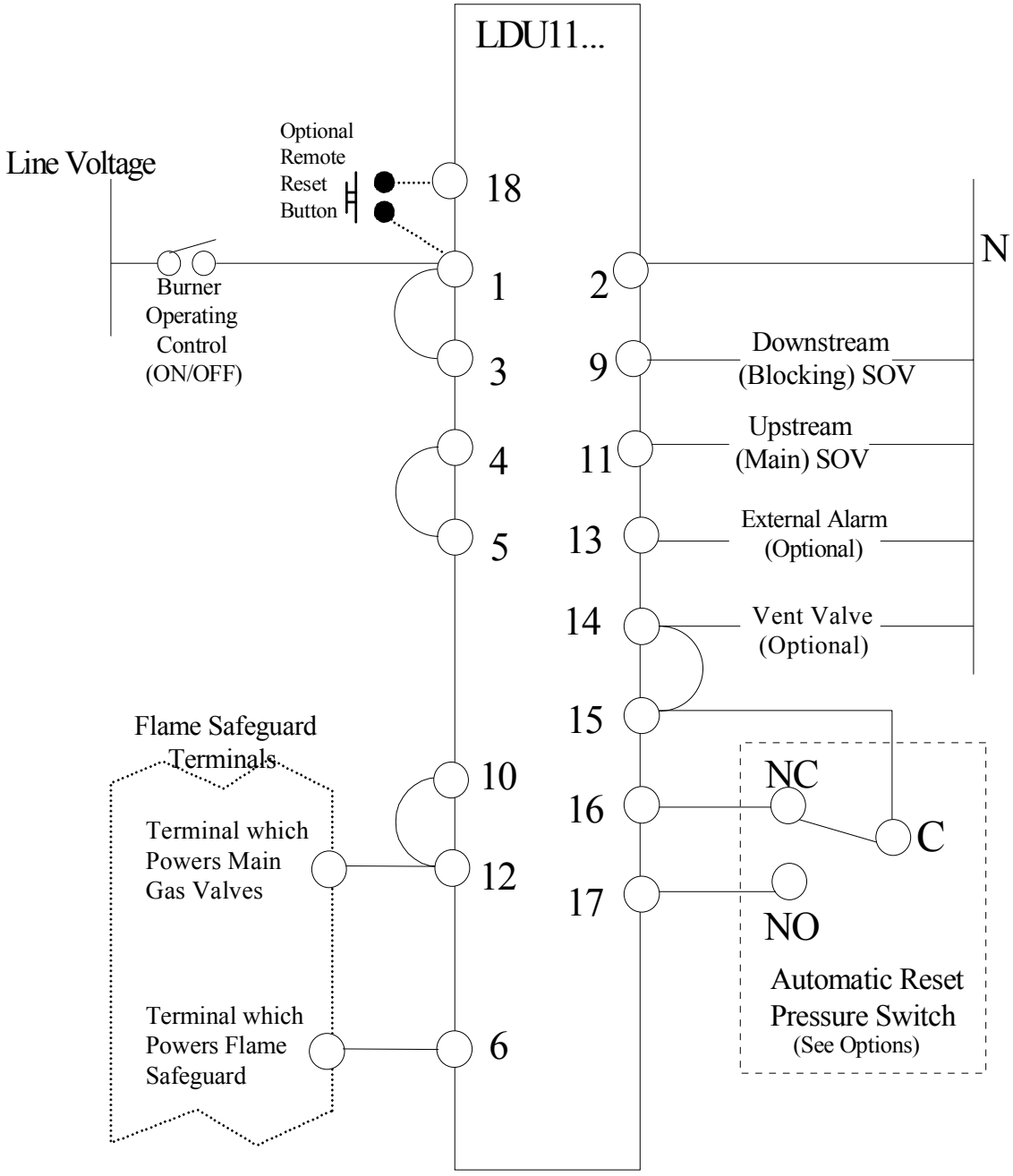
7) Manually leak test the downstream valve as recommended by NFPA 86. If found to be leaking, lockout the appliance and replace the valve.

8) Reset the LDU by pushing the clear window in front of the indicator dial (do not hold in).

9) Contact local Siemens combustion representative for assistance.

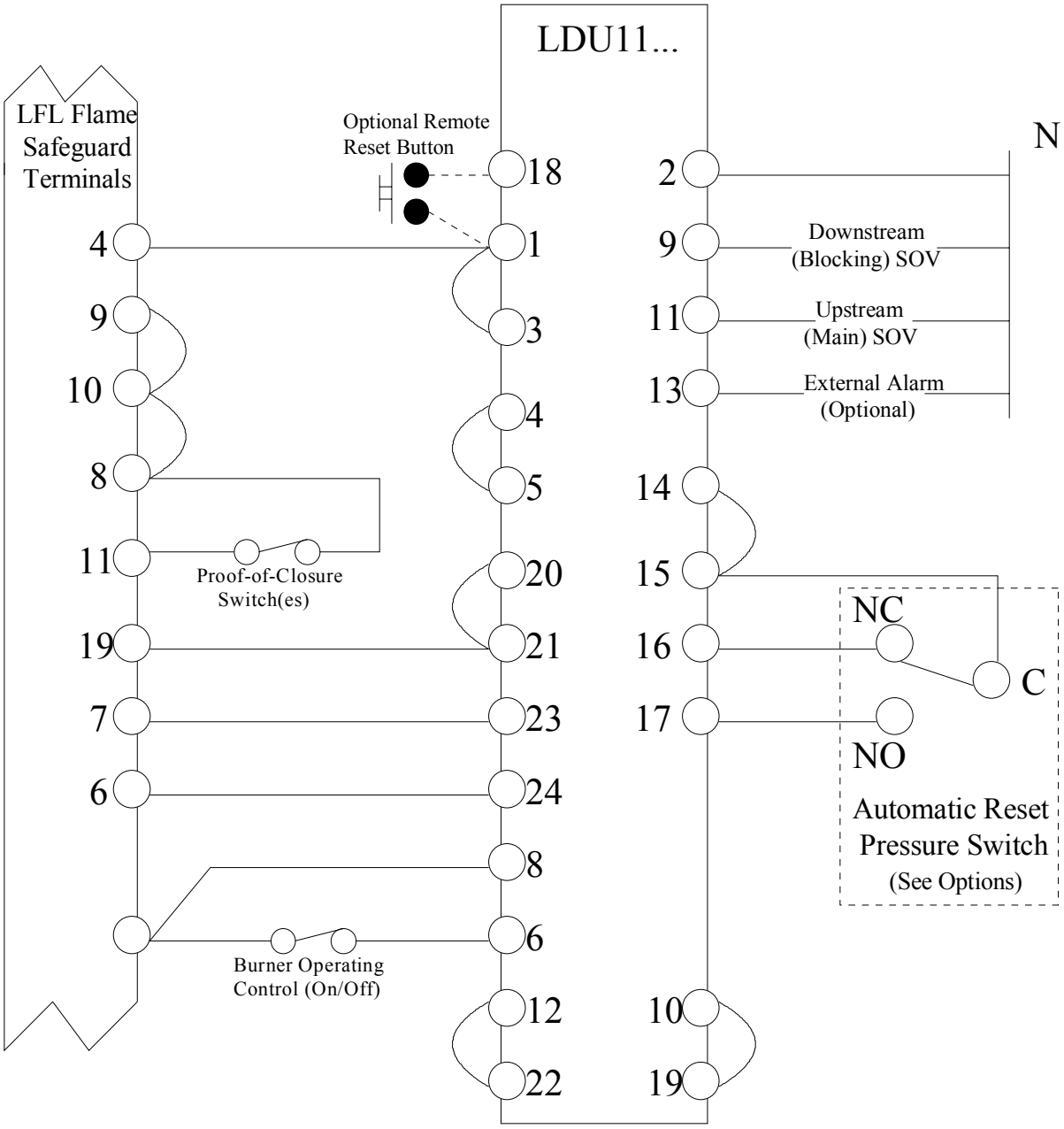
Connection examples for leak test before burner start-up:

The LDU control may be wired in many different manners, depending upon application, burner control version and sequence of operations. Below is the generic wiring diagram for performing the test before burner start-up. Contact Siemens with questions or for assistance.



Connection examples for leak test before burner start-up and after shut down with LFL burner control:

Below is the wiring diagram using a LFL flame safeguard performing the leak test before burner start-up and after a controlled shut-down. This diagram only depicts the wires that are connected to the LDU control. Please consult Siemens manual 7451 for further wiring instructions for the LFL burner control.

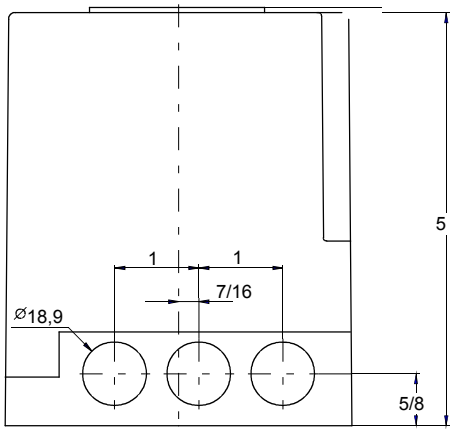


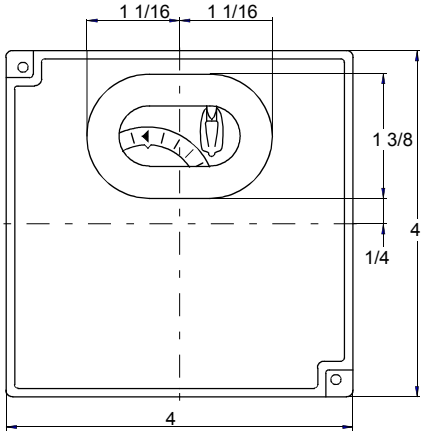
The base plates of the LDU and LFL controls are the same dimensions. Each is keyed during production in order that the controls may not be installed into the incorrect base plate.

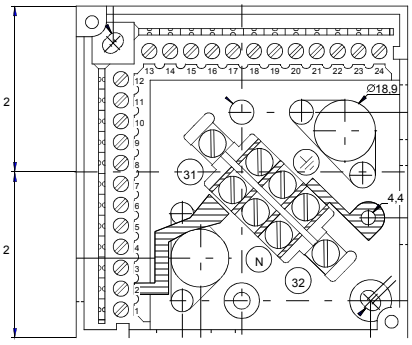
Dimensions

Dimensions in inches

LDU11... with plug-in base AGM11







AGM11

SIEMENS

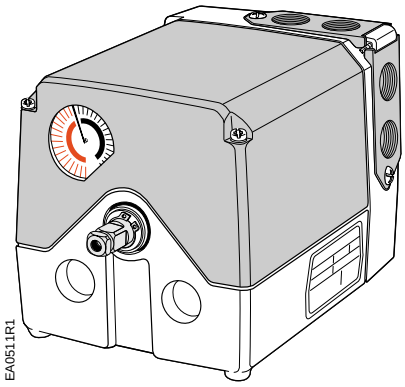
Technical Instructions

Document No. 155-517P25
Rev. 1, July, 2000

SQM5…

Reversing Actuators

ISO 9001
REGISTERED FIRM



Description

SQM5... reversing actuators are used for the positioning of flow control valves, butterfly valves, dampers, or any application requiring rotary motion. The SQM5… actuators accommodate control input signals of 4-20 mA, 0-135 Ω, 0-10 Vdc, 0-20 mA, position proportional and floating control. The available output signals include 4-20 mA, 0-135 Ω, 0-10 Vdc, 0-20 mA, and 0-1000 Ω. SQM5… actuators are available with up to eight internal, easily accessible and adjustable auxiliary switches.

A selection of exchangeable circuit boards provide a variety of functions including auto/manual selector switch, manual forward/reverse toggle switch, zero and span adjustment, parallel or master/slave operation, split range control, input signal override, and selectable electronic linearization.

The SQM5… is engineered for precision. It is particularly well suited to applications requiring a high degree of modulating accuracy and repeatability. Drive shaft play is limited to 0.3° with a modulating accuracy of 250 repositions through 90° of travel.

The SQM5… actuator may be mounted in any position. A selection of mounting brackets and shafts provide installation flexibility and allow for the simple replacement of most competitive actuators.

Features

- Modulating accuracy of 250 repositions through 90°
- Two limit switches, plus up to six internal auxiliary switches
- Full closed “economy position” switch
- Drive shaft and cam drum disengagement clutches
- Auto/manual switch, manual control forward/reverse toggle switch
- UL, CSA and CE approved 24, 110 and 220 Vac versions
- Field reversible clockwise (cw) or counterclockwise (ccw) operation
- Various torque ratings and running times available
- Selection of field exchangeable one and two ended shafts
- Mounting brackets to replace competitive actuators

Technical Instructions
Document No. 155-517P25
Rev. 1, July, 2000

Features, Continued

- Connections for both base and face mounting
- Low hysteresis actuator and potentiometer gearing
- Externally visible position indication
- Selection of input and output signals
- Zero and span adjustment
- Field exchangeable circuit boards and potentiometers
- Electronic damper linearization function
- Split range and selectable parallel or master/slave operation
- Adjustable input signal override function

Table Of Contents

Application Page 3
Product Numbers
Product numbers for pre-assembled UL/CSA/CE-approved actuators, Table 1 Page 3
Product numbers for accessories, Table 2 Page 4
SQM5… Product Number Identification Legend Page 5
Installation and Operating Instructions
Shaft Installation Page 6
Rotational Direction Verification Page 7
Actuator Mounting Page 7
Switch Adjustment Page 7
Shaft Adjustment Page 8
Cam Drum Adjustment Page 8
Wiring
Electrical Connection Page 8
Grounding Page 8
Wiring Connections
AGA56.1… circuit boards Page 8
AGA56.41/42/43… circuit boards Page 9
AGA56.9… circuit boards Page 11
Commissioning
Power Actuator Page 12
Modulation Adjustment Page 12
Zero Adjustment Page 12
Span Adjustment Page 12
Position Indicating Dial Adjustment Page 13
Cover Installation Page 13
Features
SQM5x.xxxxx**Z**x actuators Page 14
SQM5x.xxxxx**G**x actuators Page 15
SQM5x.xxxxx**H**x actuators Page 15
SQM5x.xxxxx**K**x actuators Page 15
SQM5x.xxxxx**A**x actuators Page 16
Service Guide
Reversing Rotational Direction Page 16
Shaft Installation Page 17
Circuit Board Installation Page 17
AGA56.41/42/43… Page 18
AGA56.9A Page 19
AGA56.1A97 Page 21
Potentiometer Removal/Installation Page 22
Specification Data Page 23
Dimensions Page 26

Application

SQM5… actuators are uniquely suited for both industrial and commercial applications. The high level of accuracy permits precise modulating control of industrial process and process heating applications, often significantly enhancing performance and product quality.

In commercial and industrial burner applications requiring high turndown and reliable ignition, the auxiliary switches can be applied to create separate positions for burner light off and low fire. In dual fuel applications, additional switches can be used to create separate high fire, low fire and light off positions for each fuel. The “economy position” switch is used to drive the actuator to the full closed position when the burner is off.

In all applications, commissioning is simplified. Shaft and switch cam drum disengagement clutches allow for the quick manual alignment of the actuator shaft and switch cams. The forward/reverse toggle switch in combination with the auto/manual selector switch provides direct manual control.

Product Numbers

Table 1. Product Numbers for Pre-assembled UL/CSA/CE-Approved Actuators.

Torque[1]	Running Time [2] 90°@ 60 Hz	Input Control Signals[3]				Number of switches	Product Number For SQM5x.xx0xxxx shafts must be ordered separately For shaft selection refer to *Table 2*.		
lb-in	sec	Line Voltage	4-20 mA	0-135 Ω	0-10 Vdc	limit/ aux.	110 V	220 V	24 V
90	8	X				2/4		SQM50.260R2A	
90	8	X	X			2/4	SQM50.260R1G4		
90	12	X	X			2/4	SQM50.364R1G3		
140	25	X				2/4	SQM50.464R1A3		
140	25	X	X	X	X	2/6	SQM50.480R1Z3 [3]		SQM50.480R8Z3 [3]
140	25	X				2/3	SQM50.450R1A		SQM50.450R8A
140	25	X	X			2/4	SQM50.460R1G3		SQM50.450R8G3
140	25	X		X		2/4	SQM50.460R1H3		SQM50.450R8H3
140	25	X	X	X	X	2/6		SQM50.480R2Z3 [3]	
200	25	X	X	X	X	2/6	SQM53.480R1Z3 [3]		
200	25	X	X			2/6	SQM53.480R1G3		
200	25	X				2/4	SQM53.460R1A		
310	37	X				2/4	SQM56.560R1A		
310	37	X	X			2/4	SQM56.560R1G4		
310	37	X		X		2/4	SQM56.564R1H4		
400	50	X	X	X	X	2/6	SQM56.680R1Z3 [3]		
400	50	X	X			2/6	SQM56.680R1G3		

1. Torque will vary with the selection of the shaft. See *Specifications*.
2. Running time for 135° ➔ multiply by 1.5 For 50 Hz ➔ multiply by 1.2
3. SQM5x.xxxxx**Z**x models also accept a 0-20 mA input signal.

Table 2. Product Numbers for Accessories.

Electronic circuit boards

AGA56.1A97	24-250 Vac	(A) board for SQM5x.xxxxx**A**x
AGA56.9A87	24 Vac	(Z) board for SQM5x.xxxxx**Z**x
AGA56.9A17	120 Vac	(Z) board for SQM5x.xxxxx**Z**x
AGA56.9A27	220 Vac	(Z) board for SQM5x.xxxxx**Z**x
AGA56.41A87	24 Vac	(G) board for SQM5x.xxxxx**G**x
AGA56.41A17	110 Vac	(G) board for SQM5x.xxxxx**G**x
AGA56.41A27	220 Vac	(G) board for SQM5x.xxxxx**G**x
AGA56.42A17	110 Vac	(H) board for SQM5x.xxxxx**H**x
AGA56.42A27	220 Vac	(H) board for SQM5x.xxxxx**H**x
AGA56.42A87	24 Vac	(H) board for SQM5x.xxxxx**H**x
AGA56.43A17	110 Vac	(K) board for SQM5x.xxxxx**K**x
AGA56.43A27	220 Vac	(K) board for SQM5x.xxxxx**K**x
AGA56.43A87	24 Vac	(K) board for SQM5x.xxxxx**K**x

See Product Number Identification Legend, *Figure 1*.

Mounting Brackets & Adapters

AGA57.3	for replacement of Honeywell MOD III, IV actuators
AGA57.4	for replacement of Honeywell M640/740/940 and Barber Colman EA20/40/50/60 actuators. Directly adaptable to Eclipse butterfly valves.
ASK33.9	mounting kit for direct attachment to Siemens VKF41... butterfly valve. (Shaft AGA58.1 required)

Shafts

AGA58.1	10 mm round with key. Gear end only
AGA58.2	12 mm round with key. Gear end only
AGA58.3	9 mm square. Two ended
AGA58.4	3/8 inch square. Two ended
AGA58.7	14 mm round with key. Gear end only

For exact shaft sizes, refer to *DIMENSIONS*.

Crank Arm, Push Rods

338 031 Crank arm kit. Includes two crank arms for connecting the AGA58.4 shaft to a ∅ 1/2-inch damper shaft with two ball joints. (does not include push rod)

338 041 ∅ 5/16" damper push rod, 12 inches long.
338 042 ∅ 5/16" damper push rod, 15 inches long.
338 043 ∅ 5/16" damper push rod, 18 inches long.
338 044 ∅ 5/16" damper push rod, 24 inches long.
338 045 ∅ 5/16" damper push rod, 36 inches long.
338 046 ∅ 5/16" damper push rod, 48 inches long.

Potentiometers

ASZ12.803 1000Ω, 90°
ASZ12.833 1000Ω, 135°
ASZ22.803 1000/1000Ω double potentiometer, 90°
ASZ22.833 1000/1000Ω double potentiometer, 135°
Additional potentiometer models available. See *Siemens technical data sheet 7921*.

Product Number Identification Legend

For actuator identification only. To select product numbers for ordering, see *Table 1*.

SQM5 0 . 4 8 0 R 1 Z 3 R

Actuator family

Torque in-lb @ 60 (50) Hz.

- **0** 90 for 8 (10) sec. running time
- **0** 140 for 12 (15), 25 (30), 37 (45) sec.
- **3** 200 for 25 (30) sec.
- **6** 310 for 37 (45) sec.
- **6** 400 for 50 (60), 75 (90)sec.

Running time for 90°

Not all actuator running times are available in each torque. Refer to table 1

60 Hz.		50 Hz.	
2	8 sec.	**2**	10 sec.
3	12 sec.	**3**	15 sec.
4	25 sec.	**4**	30 sec.
5	37 sec.	**5**	45 sec.
6	50 sec.	**6**	60 sec.
8	75 sec.	**8**	90 sec.

Number of SPDT switches

- **6** 2 limit and 4 auxiliary switches
- **8** 2 limit and 6 auxiliary switches

Shaft selection

- **0** no shaft **(shaft must be ordered separately)**
- **1** round 10 mm, one ended (for use with VKF41... butterfly valves)
- **2** round 12 mm, one ended
- **3** square 9 mm, two ended
- **4** square 3/8 inch, two ended
- **7** round 14 mm, one ended

Approvals

- **R** UL recognized, CSA certified, CE approved

Operating voltage (Vac @50-60 Hz)

- **1** 110-120 Vac
- **2** 220-240 Vac
- **8** 24 Vac

Internal circuit board (SQM5x.xxxxx **G, H, K , Z**x actuators require potentiometer ASZ…)

- **A** AGA56.1A97 (position proportional or floating control)
- **G** AGA56.41A... (4 to 20 mA input)
- **H** AGA56.42A... (0 to 135 Ohm input)
- **K** AGA56.43A... (0 to 10 Vdc input)
- **Z** AGA56.9... (all inputs/outputs, linearization, split ranging, override and pre-set positioning)

Potentiometer (required when using SQM5x.xxxxx **G, H, K, Z**x actuators)

- **3** ASZ12.803 (1000 Ohm, 90°)
- **4** ASZ12.833 (1000 Ohm, 135°)
- **6** ASZ12.863 (1000 Ohm 160°)
- **7** ASZ22.803 (1000/1000 Ohm, 90°)
- **8** ASZ22.833 (1000/1000 Ohm, 135°)

Rotational Direction (if no R, rotation is ccw)

- **R** Clockwise (when facing gear end. See *Figure 6*.)

Figure 1. SQM5… Product Number Identification Legend.

Installation and Operation Instructions

SQM5… actuators are generally shipped without the shaft installed. To install the selected shaft:

1. Loosen the two screws on the actuator cover corners. See *Figure 2*.
2. Lift the screws and raise the cover. See *Figure 3.*

Shaft Installation

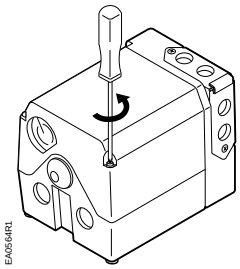


Figure 2.

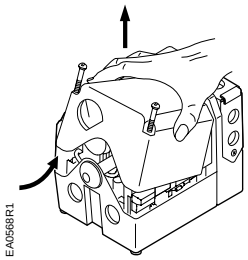


Figure 3.

3. Each shaft is supplied with two washers and a “C” clip. See *Figure 4*. Using spreading pliers, remove the “C” clip and the washers from the shaft.

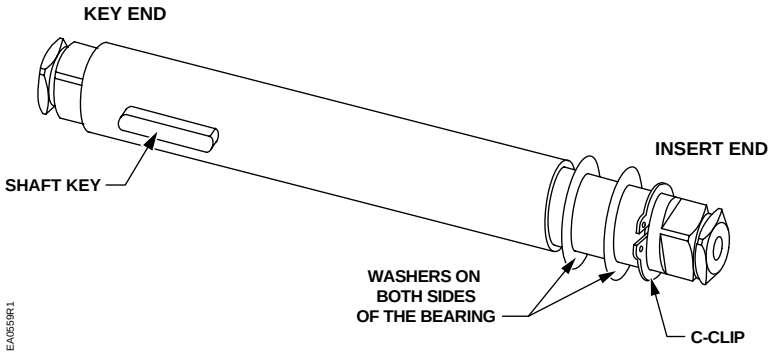


Figure 4.

4. Insert the “insert end” of the shaft into the “gear end” of the actuator.
5. Push the shaft until the “insert end” reaches just short of the brass bushing at the other end of the actuator.
6. Put one of the washers on the insert end of the shaft. See *Figure 5*.

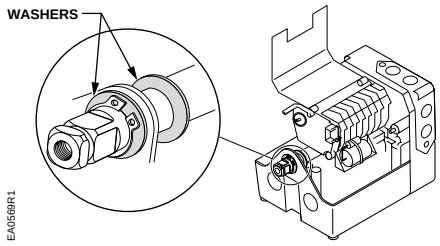


Figure 5.

7. Line up the “shaft key” with the key slot on the “gear end” of the actuator and slide the shaft until the “insert end” is completely through the brass bushing.

8. Place the second washer onto the “insert end” of the shaft. Using spreading pliers, install the “C” clip.

Rotational Direction Verification

Most SQM5… actuators are factory configured for counterclockwise (ccw), minimum to maximum rotation when facing the gear end of the actuator, or clockwise (cw) rotation when facing the other end of the actuator. SQM5.xxxxxxxR model numbers, ending with R are factory configured for clockwise (cw) operation. To field reverse the direction of rotation, see *Service Guide*, “Reversing Rotational Direction”.

Actuator Mounting

SQM5… actuators can be mounted in any orientation using the four 1/4"-20 UNC tapped holes located on the bottom corners of the actuator base. Optional base mounting brackets are available. See *Table 2 - Product Numbers for Accessories*. SQM5… actuators can also be face mounted using self tapping screws in combination with the various holes on the face of the actuator gear end.

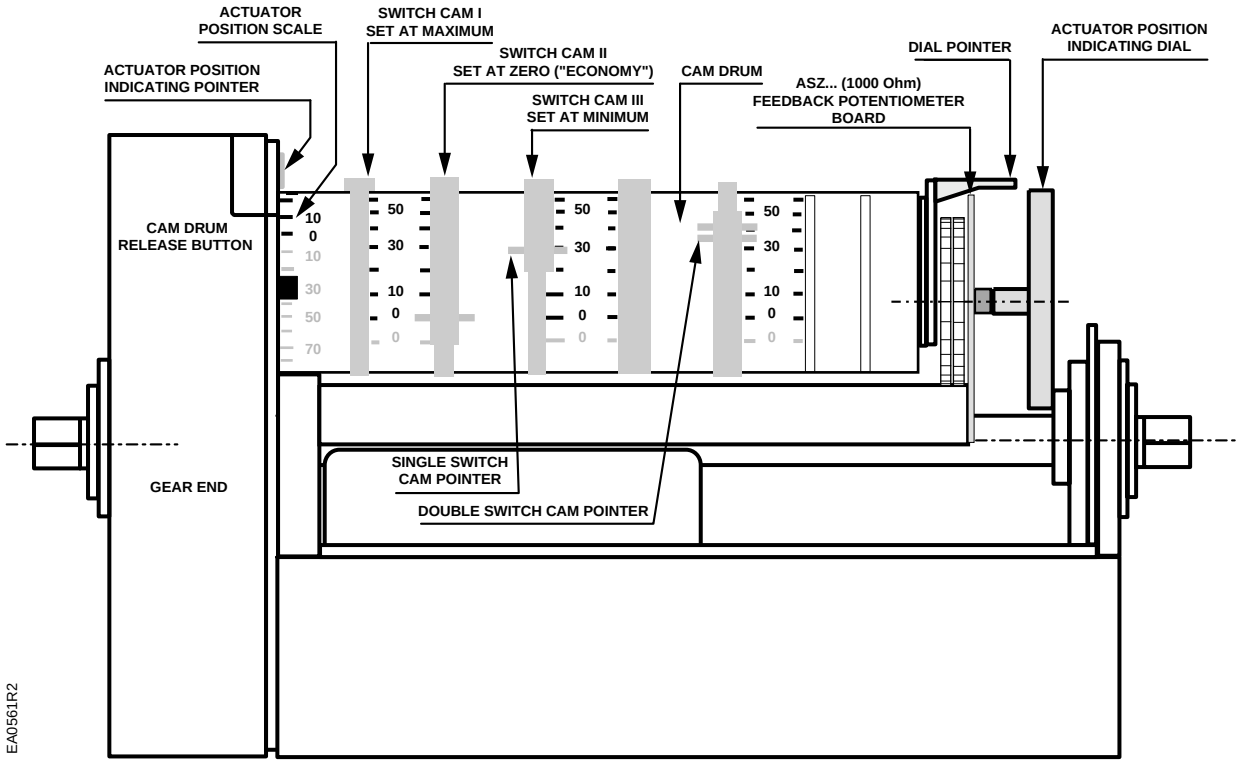


Figure 6. Component Identification on the Cam Drum Side of the SQM5… Actuator.

Switch Adjustment

See *Figure 6*.

All SQM5…actuators are factory wired with Switch I (maximum), Switch II (full closed “economy position”) and Switch III (minimum). The individual switch cams I, II, and III are factory set to 90°, 0° and 30° respectively.

NOTE: The single switch cam pointers are used together with the black scales when configured for counterclockwise (ccw) operation.

The double switch cam pointers are used together with the red scales when configured for clockwise (cw) operation.

The individual switch cams can be adjusted by hand or with the use of the tool attached to the outside of the hinged switch terminal protection lid.

Switch Adjustment, continued

NOTE: SQM5x.xxxxx**A**x actuators may be adjusted between 0° and 160°. SQM5x.xxxxxx**3** actuators have a 90° potentiometer and the switches must be adjusted only between 0 and 90°. SQM5x.xxxxxx**4** actuators have a 135° potentiometer and the switches must be adjusted only between 0 and 135°.

Shaft Adjustment

See *Figure 6*.

The actuator shaft can be disengaged by pressing the silver shaft release button located to the right of the auto/manual switch. The shaft can be manually rotated when the button is pressed. Once pressed, the button can be locked by pushing it slightly upwards. After the shaft has been manually aligned, re-engage the shaft by pushing the shaft release button downwards.

Cam Drum Adjustment

See *Figure 6*.

The cam drum must be manually aligned by pressing and holding the black cam drum release button. The cam drum must be rotated until the “0” mark on the cam drum position scale (left scale on the cam drum) is aligned with the gray actuator position indicating pointer.

Wiring

Electrical Connection

SQM5… actuators are equipped with two removable conduit connection plates located on the upper corner of the gear housing. Each plate is provided with two threaded connections for 1/2" NPSM conduit connectors. The use of flexible stranded wire is recommended.

Grounding

To avoid electro-magnetic interference, the SQM5… actuators must be grounded.

The ground terminal is located to the right of the auto/manual switch.

Wiring connections

NOTE: SQM5… actuators require a single source, single phase power supply.

Wiring connections vary depending on which AGA56…. circuit board is installed.

AGA56.1… circuit boards.

See *Figures 7* and *8*.

1. Connect line voltage to terminal L. Terminal L must be powered to enable manual operation.
2. Connect neutral to the double terminal block with the two gray motor wires, located on the left side of the gray switch housing.
3. Connect line voltage to terminal A to drive the actuator in the opening direction.
4. Connect line voltage to terminal Z to drive the actuator in the closing direction.

Wiring, continued

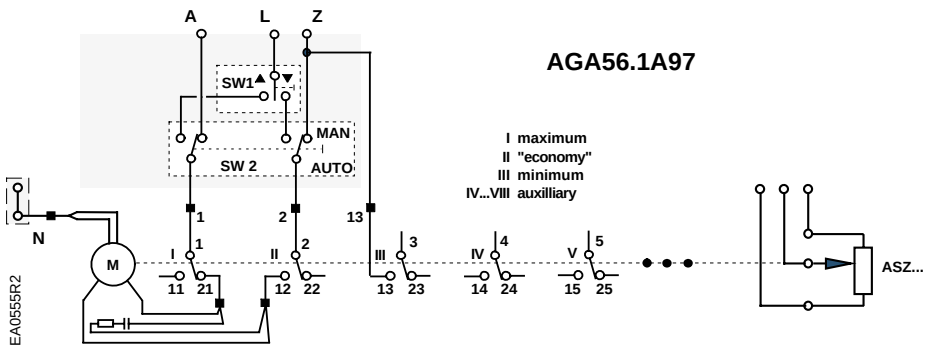


Figure 7. Basic Functional Diagram of AGA56.1…

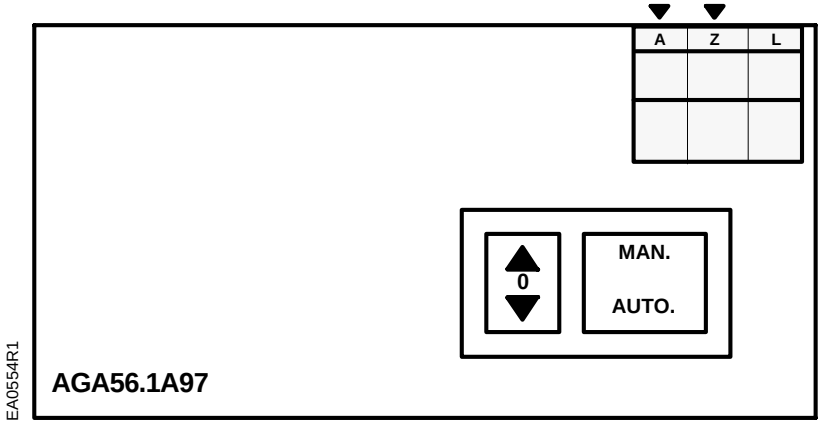


Figure 8. AGA56.1A97 Terminal/Auto-Manual Board.

AGA56.41/42/43… circuit boards.

See *Figures 9* and *10*.

1. Connect line voltage to terminal L. Terminal L must be powered at all times.
2. Connect neutral to terminal N.
3. Connect ground to the terminal located to the right of the auto/manual switch.
4. For applications where terminals Z, ZL, A and 13 are not used, bridge terminal LR and L. If any terminals Z, ZL, A or 13 are used, terminal LR must not be bridged with terminal L. In addition, terminal LR must never be powered simultaneously with any terminals Z, ZL, A or 13. However, terminal LR must be powered once Z, ZL, A and 13 are no longer powered and modulating operation is required (refer to application guide for typical installation examples).
5. Connect the input control signal wires to the appropriate terminals.

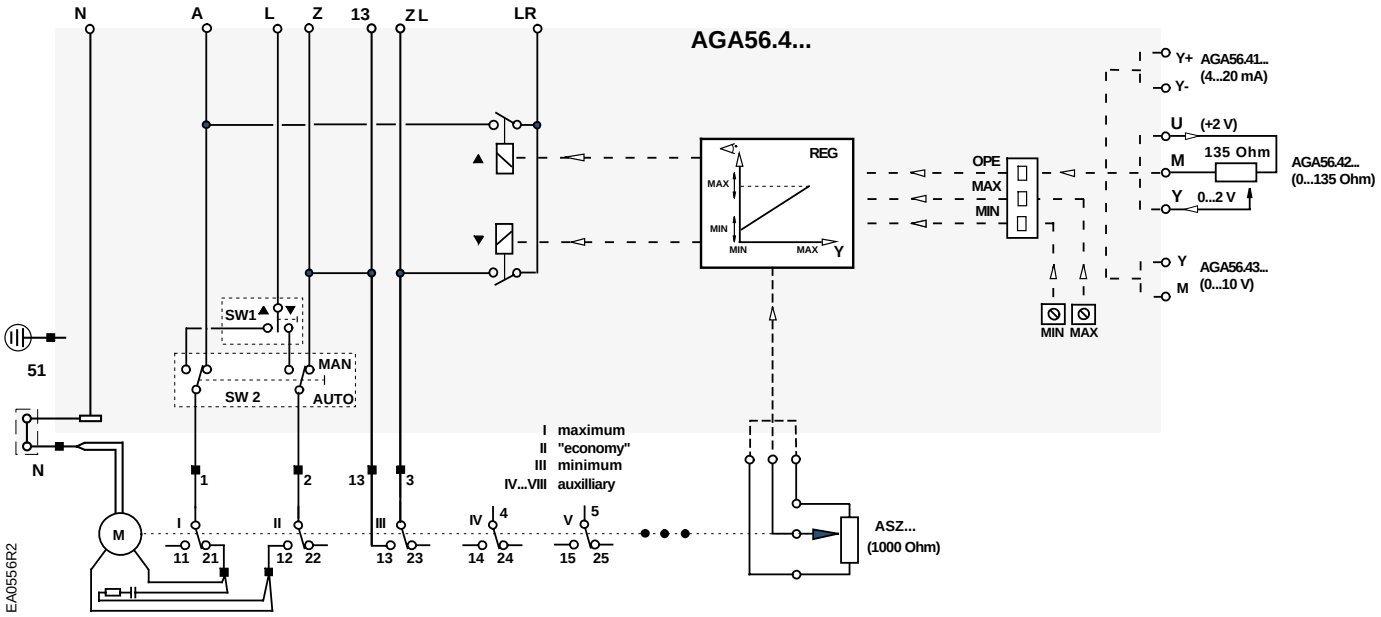
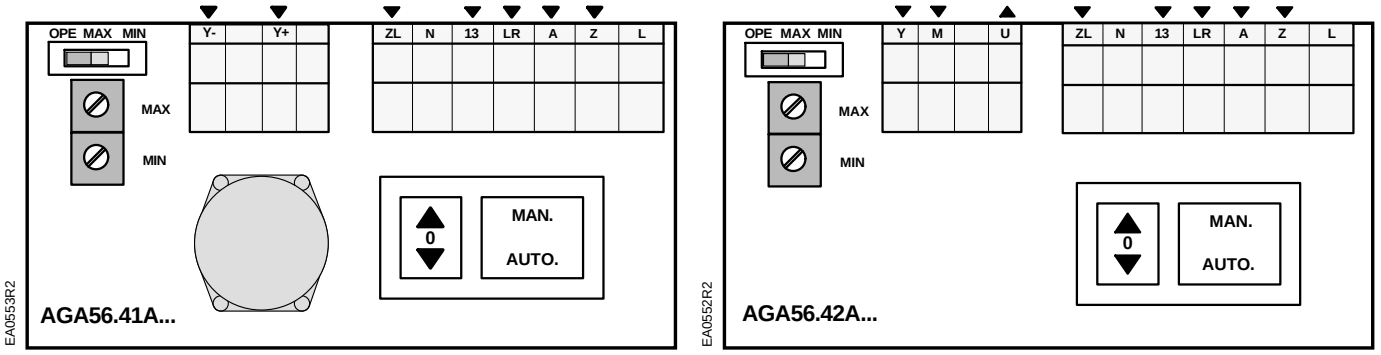


Figure 9. Basic Functional Diagram of AGA56.4…



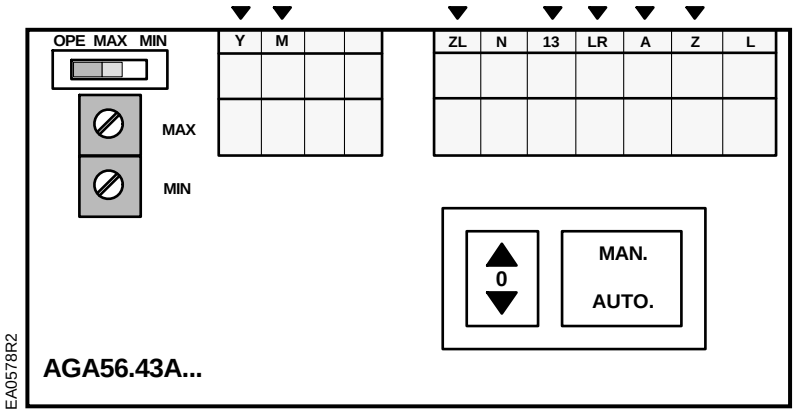


Figure 10. AGA56.41/42/43… Terminal/Trim Potentiometer Boards.

AGA56.9… circuit boards.

See *Figures 11* and *12*.

1. Connect line voltage to terminal L. Terminal L must be powered at all times.
2. Connect neutral to terminal N.
3. Connect ground to the terminal located to the right of the auto/manual switch.
4. For applications where terminals Z, ZL and A are not used, bridge terminals L1 and L. If terminals Z, A or ZL are used, terminal L1 must not be bridged with terminal L. In addition, terminal L1 must never be powered simultaneously with terminals Z, A or ZL. However, terminal L1 must be powered once terminals A, Z and ZL are no longer powered and modulating operation is required (refer to application guide for typical installation examples).
5. Connect the input and output control signal wires to the appropriate terminals.

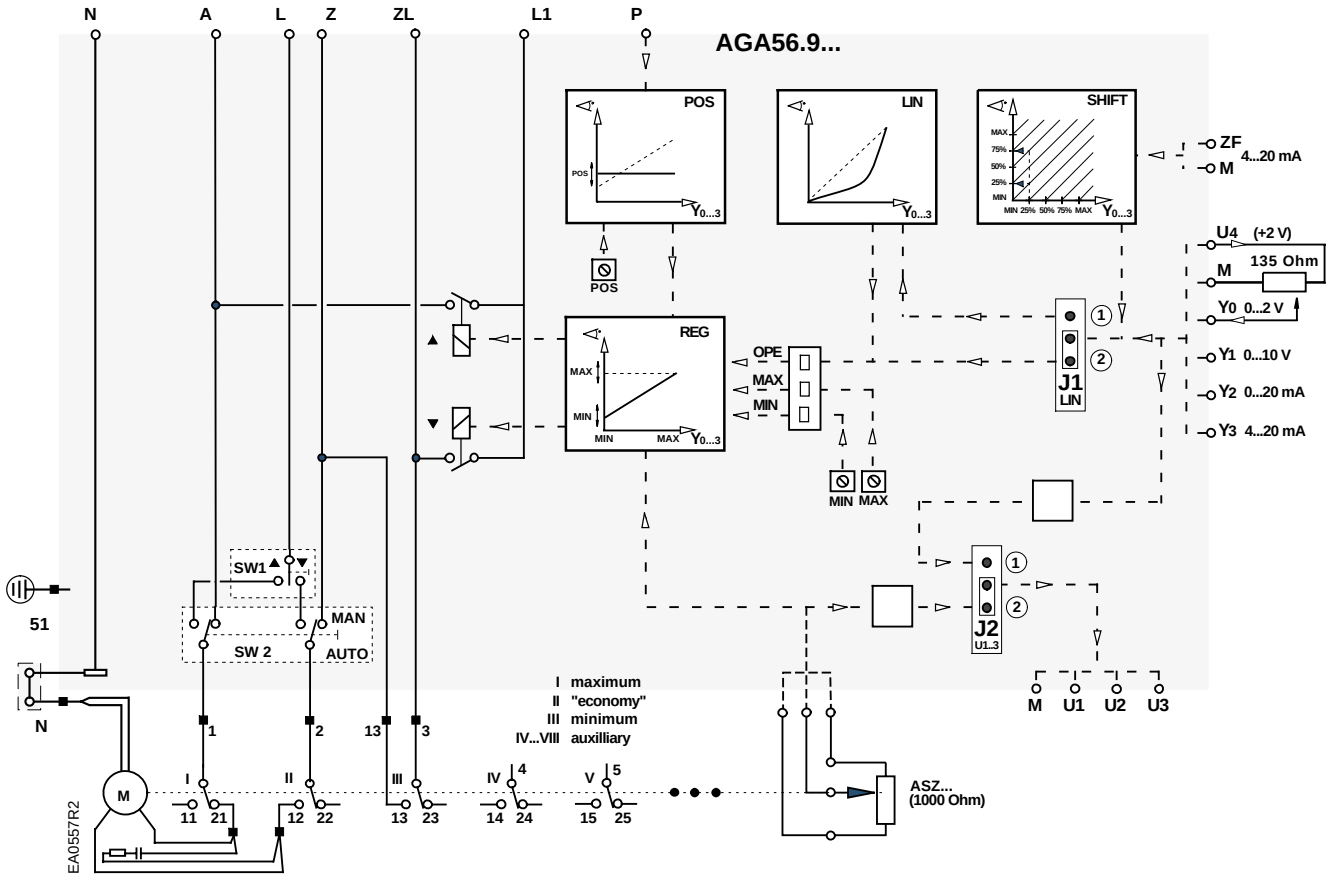


Figure 11. Basic Functional Diagram of AGA56.9…

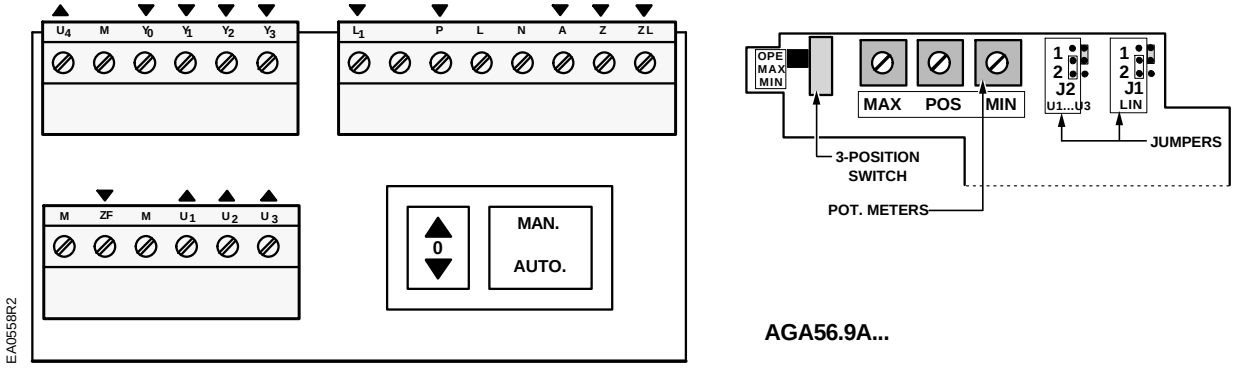


Figure 12. AGA56.9… Terminal and Trim Potentiometer/ Jumper Board.

Commissioning

Power Actuator

Set the auto/manual switch in the manual position and apply power to the actuator. The actuator can now be driven to the maximum position (switch cam I) or the full closed "economy position" (switch cam II) by using the toggle switch located to the left of the auto/manual switch.

Modulation Adjustment

See *Figures 10* and *12*.

Ensure that the OPE/MAX/MIN slide switch is set to operation (OPE). The blue MAX trim potentiometer should be gently turned in the clockwise direction until the end stop is reached. The blue MIN trim potentiometer should be gently turned in the counterclockwise direction until the end stop is reached. Set the auto/manual switch in the auto position. The actuator will now drive in response to the control input signal, between the maximum position setting (switch cam I) and the minimum position setting (switch cam III). If there is no control input signal, the actuator will drive to the minimum position setting (switch cam III).

NOTE: Switch Cam I must not be set higher than:

90° when using feedback potentiometers ASZxx..803,

135° when using feedback potentiometers ASZxx.833, or

160° when using feedback potentiometers ASZxx.863.

Zero Adjustment

See *Figures 10* and *12*.

Set the OPE/MAX/MIN slide switch to MIN. The blue MIN trim potentiometer can now be gently adjusted to the required minimum position.

Span Adjustment

See *Figures 10* and *12*.

Set the OPE/MAX/MIN slide switch to "MAX". The blue MAX trim potentiometer can now be gently adjusted to the required maximum position. Return the OPE/MAX/MIN slide switch to OPE.

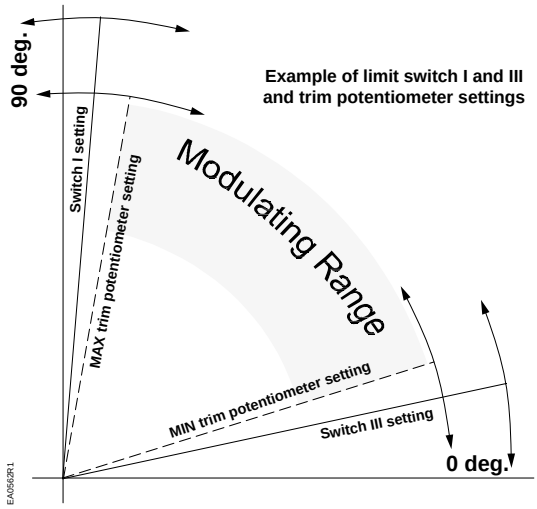


Figure 13. Switch cam and trim potentiometer setting.

NOTE: The actual minimum and maximum modulating range is determined either by the setting of the MIN and MAX trim potentiometers or the setting of Switch Cam III (Minimum) and Switch Cam I (Maximum). The actuator can never modulate outside of the range set by switch cam I and III. If the MIN and MAX trim potentiometers are set outside the setting range of switch cams I and III, then the switch cam settings determine the modulating range. If a soft stop is desired, the modulating range can be defined by the trim potentiometers if the MIN and MAX trim potentiometers are set inside the setting range of switch cams I and III. See the example in *Figure 13*.

Position Indicating Dial Adjustment

See *Figure 6*.

The **actual** position of the SQM5… actuator is indicated by the gray actuator position indicating pointer. The position is also indicated by the dial pointer. Ensure that the actuator position indicating dial is aligned with the actuator position scale by rotating the dial in the clockwise direction if necessary.

CAUTION:

Turning the dial in the counterclockwise direction may loosen the potentiometer locking screw.

Cover Installation

Lift the two screws on the cover corners and slide the cover end into the groves at the gear end of the actuator. See *Figure 14*.

Press the cover into place and then press the screws inward and tighten. See *Figure 15.*

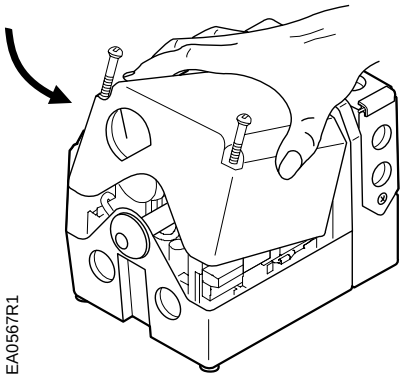


Figure 14.

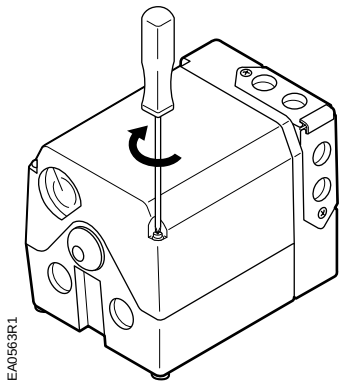


Figure 15.

Features of SQM5x.xxxxxZx Actuators

SQM5xx.xxxxx**Z**x actuators contain the AGA56.9A… multi function circuit board. This circuit board provides the following features:

Multiple Input Signals

The AGA56.9A… circuit board accepts the following input signals:

Line voltage

- Power to A drives the actuator open to the setting of switch cam I (Maximum).
- Power to ZL drives the actuator closed to the setting of switch cam III (Minimum).
- Power to Z drives the actuator closed to the setting of switch cam II (Economy).

- **4-20 mA** (Signal to Y3, common to M)
- **0-135 Ω** (Slide wire signal to Y0, potentiometer connected to M and U4)
- **0-10 Vdc** (Signal to Y1, common to M)
- **0-20 mA** (Signal to Y2, common to M)

Multiple Output Signals

The AGA56.9A… circuit board provides the following output signals:

- **4-20 mA** (Signal from U3, common to M)
- **0-10Vdc** (Signal from U1, common to M)
- **0-20mA** (Signal from U2, common to M)

Double potentiometers ASZ22… provide additional output signals.

Electronic Linearization Function

With jumper J1 in position 1 (upper position), the linearization function is enabled. The circuit board electronically converts the input signal to match the flow characteristics of a typical butterfly valve. Consequently, the actuator will make smaller rotational movements when subjected to lower input signals and larger rotational movements when subjected to higher input signals. For example (based on a 90° modulating range), a change in input signal from 4 to 8 mA (25% increase) will cause a rotational movement of 11.25°. An equal signal change from 16 to 20 mA will cause a rotational movement of 45°.

With jumper J1 in position 2 (lower position), the linearization function is disabled. When disabled, the rotational movement of the shaft is proportional to the input signal.

Input Signal Override

Line voltage to terminal P will drive the actuator to a pre-set adjustable position, overriding all modulating input signals. Use the potentiometer marked POS to adjust the override position to any setting within the setting range of switch cams I and III.

Parallel Operation

To configure the actuator for parallel operation, set the jumper J2 in position 1 (upper position). Input signals Y0, Y1, Y2 or Y3 are directly shunted to output signals U1, U2 and U3. All output signals are available regardless of which input signal is applied.

Master/Slave Operation

To configure the actuator for master/slave operation, set J2 in position 2 (lower position). The output signals U1, U2 and U3 reflect actual shaft position.

Split Ranging

AGA56.9… circuit boards have a modulating signal shift feature which can be used for split ranging. If no signal is present on Y0, Y1, Y2 or Y3, the actuator will modulate through the full rotational range in response to a 12 to 20 mA signal applied at ZF. If a

maximum signal is present on Y0, Y1, Y2, or Y3, then the actuator will modulate through the full rotational range in response to a 4 to 12 mA signal applied at ZF. (Maximum signal can be easily achieved by bridging terminals U4 and Y0.)

See *Figure 16.*

NOTE: It is possible to configure the actuator for split range operation 12 to 4 mA and 20 to 12 mA. Consult your authorized Siemens Building Technologies combustion products sales representative for details.

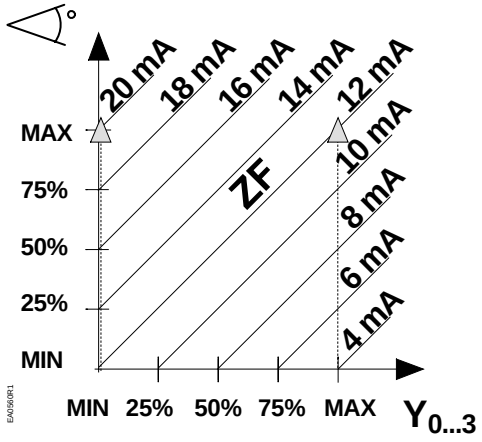


Figure 16. Split Ranging.

Features of SQM5x.xxxxxGx, SQM5x.xxxxxHx, SQM5x.xxxxxKx Actuators

SQM5x.xxxxx**G**x actuators contain the AGA56.41A… circuit board with terminals Y- and Y+ for 4-20 mA modulating input.

SQM5x.xxxxx**H**x actuators contain the AGA56.42A… circuit board with terminals Y, M and U for 0-135 Ω modulating input.

SQM5x.xxxxx**K**x actuators contain the AGA56.43A… circuit board with terminals Y and M for 0-10 Vdc modulating input.

Input Signals

The AGA56.4xA… circuit boards accept the following additional input signal:

Line voltage

- Power to A drives the actuator open to the setting of switch cam I (Maximum).
- Power to Z drives the actuator closed to the setting of switch cam II (Economy).
- Power to ZL drives the actuator closed to the setting of switch cam III (Minimum).

Output Signals

The AGA56.4xA… circuit boards do not provide output signals. Install a double potentiometer ASZ22…to obtain a 0-1000 Ω actuator position output signal.

Features of SQM5x.xxxxxAx Actuators

The AGA56.1A97… circuit boards accept the following additional input signal:

Line voltage

Input Signals

- Power to A drives the actuator open to the setting of switch cam I (Maximum).
- Power to Z drives the actuator closed to the setting of switch cam II (Economy).
- Power to switch III, terminal 3 drives the actuator to the setting of switch cam III (Minimum).

Output Signals

The AGA56.1A97 circuit board provides no output signals. Install a double potentiometer ASZ22…to obtain a 0-1000 Ω actuator position output signal.

Service Guide

WARNING:

Disconnect the power supply to the actuator before performing any service functions.

NOTE: Most SQM5… actuators are factory configured for counterclockwise (ccw), minimum to maximum rotation when facing the gear end of the actuator or clockwise (cw) rotation when facing the other end of the actuator.

Reversing Rotational Direction

1. Disconnect the double blue wires marked 21 and the double black wires marked 12 from switch I, terminal 21 and switch II, terminal 12 respectively.

2. Connect the double blue wires marked 21 to switch II, terminal 12. Connect the double black wires marked 12 to switch I, terminal 21.

3. See *Figure 6*. Adjust all switch cams to the desired settings using the red cam drum scales in combination with the double switch cam pointers.

NOTE: Press and hold the black cam drum release button to rotate the cam drum. This will give easy access to the switch cams and a better view of the cam drum scales.

4. If no potentiometer ASZ… is installed, the reversing procedure is complete. If a potentiometer ASZ… is installed, complete Steps 5 through 11.

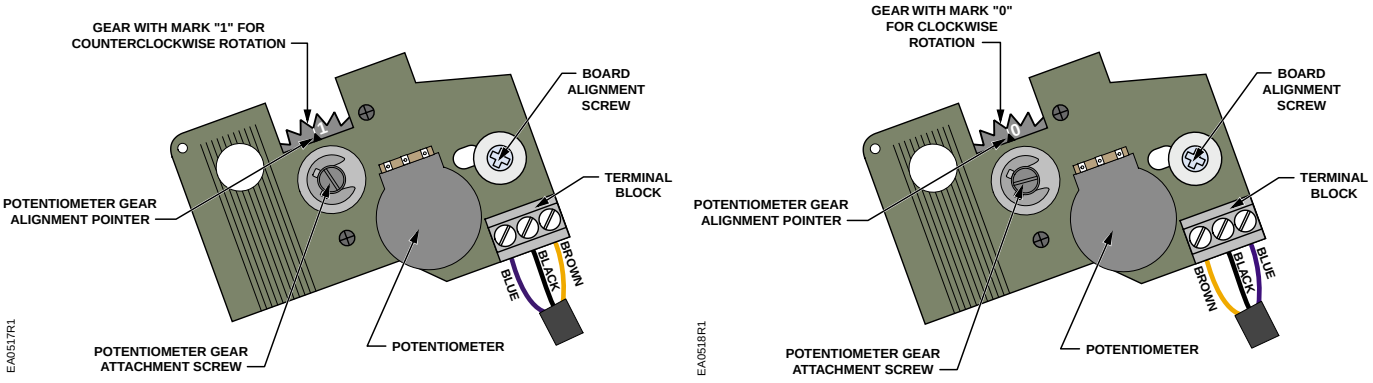


Figure 17. Reversing Rotational Direction on the ASZ Potentiometer Board.

5. See *Figure 17*. Disconnect the blue and brown wires from the terminal block located on the ASZ… potentiometer circuit board.

6. Reconnect the brown wire to the left terminal and the blue wire to the right terminal. The black wire remains connected to the middle terminal.

7. See *Figure 6*. Remove the white plastic actuator position-indicating dial by gently pulling while rotating in the clockwise direction.

8. The actuator position indicating pointer, located near the actuator gear end of the cam drum, must point to the “0” mark on the actuator position scale (scale on the cam drum nearest to the actuator gear end). Press and hold the black cam drum release button while manually rotating the cam drum.

9. See *Figure 17*. Loosen the black potentiometer gear attachment screw approximately one turn. Gently wedge a small screwdriver between the potentiometer gear and the gray plastic housing. Gently twist the screwdriver until the potentiometer gear releases from the cam drum shaft.

10. Manually rotate the potentiometer gear in the counterclockwise direction until the white line next to the “0” mark on the potentiometer gear face is **exactly** in alignment with the potentiometer gear alignment pointer. Firmly tighten the black potentiometer gear attachment screw while manually holding the potentiometer gear in alignment. Check the alignment again.

11. Re-install the white actuator-indicating dial by gently pressing it onto the potentiometer gear attachment screw. Align scale position “0” on the actuator position indicating dial with the dial pointer by rotating the dial in the clockwise direction to avoid loosening the potentiometer gear attachment screw.

Shaft Installation

See *Installation and Operation Instructions*.

Preparation before Circuit Board Installation

WARNING:

Disconnect the power supply to the actuator before replacing the circuit boards.

The black circuit board mounting bracket, installed on the inside base of the SQM5… actuator has four vertical, slotted circuit board supports. Remove the terminal section and circuit board(s) from the mounting bracket.

The actuator motor capacitor is attached to the lower section of the gray plastic switch housing using snap-on holding clips. Gently pull the capacitor forward until it unclips and temporarily place it on top of the gear housing. See *Figure 18*.

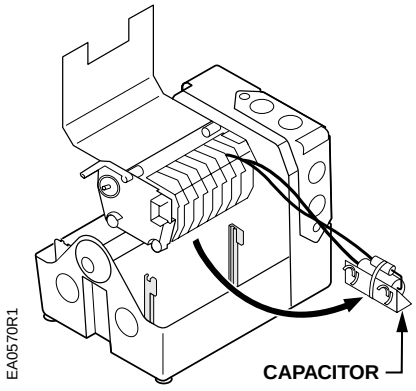


Figure 18.

CAUTION:

Do not disconnect any capacitor wiring.

Technical Instructions
Document No. 155-517P25
Rev. 1, July, 2000

AGA56.41/42/43 Circuit Board Installation

1. Remove the AGA56.41/42/43… circuit board from the packaging. The circuit board is shipped as one board.
2. Separate the board at the perforation by holding the circuit board at both ends and gently bending the board until it separates.
3. Move the terminal section containing the auto/manual switch to the opposite end of the base circuit board.
4. From the switch housing side of the actuator, guide the base circuit board into the bottom of the circuit board mounting bracket. See *Figure 19*.
5. Re-install the actuator motor capacitor. See *Figure 20*.
6. Connect the blue neutral wire, shipped loose with the AGA56.9A…, to the spade connector marked N located on the terminal board just below the auto/manual switch
7. Gently guide the terminal section into the support slots and slide the terminal board downward until both supports snap into place. Ensure that the four brown wires and the flat white connector cable which connect the two circuit boards are positioned correctly in their respective corners allowing the board to freely slide into place without pinching either wire. See *Figure 21*.
8. Connect the bundled blue, black and brown potentiometer wires to the terminal block located on the ASZ… potentiometer circuit board. See *Potentiometer Installation*.

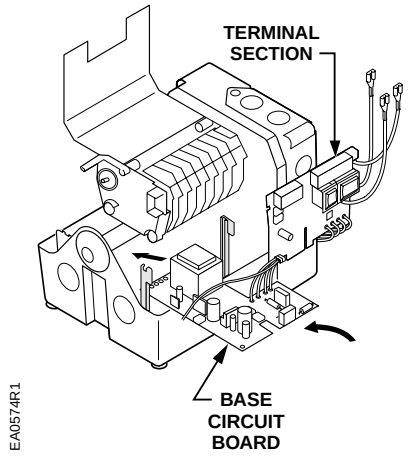


Figure 19.

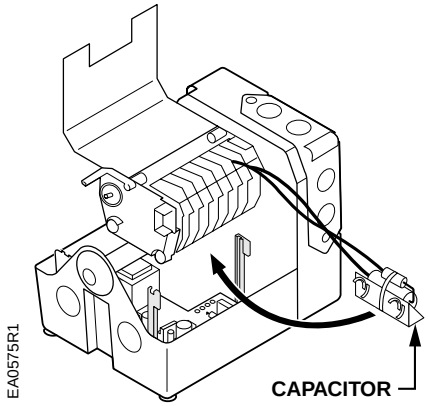


Figure 20.

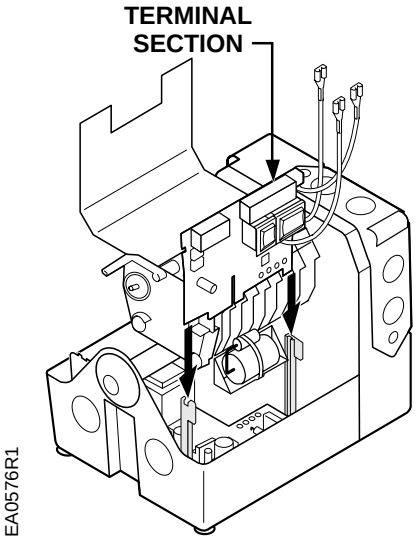


Figure 21.

AGA56.41/42/43 Circuit Board Installation, continued

9. Make the following connections to the actuator: See *Figure 22*.

   a. Connect the black wire, marked “1” from the circuit board to switch I, terminal 1.

   b. Connect the yellow wire, marked “2” from the circuit board to switch II, terminal 2.

   c. Connect the white wire, marked “3” from the circuit board to switch III, terminal 3.

   d. Connect the brown wire, marked “13” from the circuit board to switch III, terminal 13.

   e. Connect the other end of the blue neutral wire to the double terminal block located on the outer end of the switch housing

   f. Connect the gray grounding wire marked "51" to the ground terminal located to the right of the auto/manual switch.

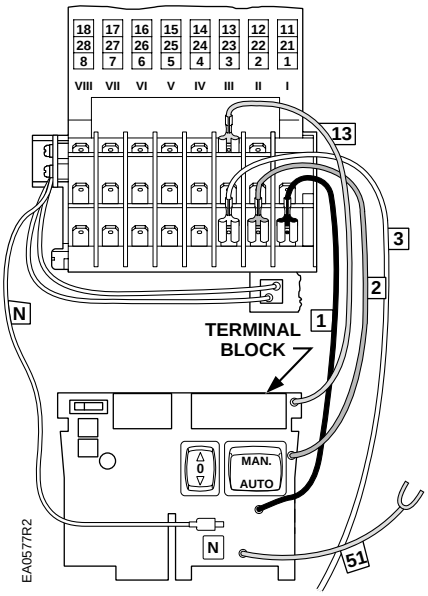


Figure 22.

AGA56.9A… Circuit Board Installation

1. Remove the ASZ... potentiometer if already installed on the SQM5... actuator. See *Potentiometer Removal/Installation Instructions*.

2. Remove the AGA56.9A… circuit boards from the packaging. The three separate AGA56.9A circuit boards are shipped in a circuit board mounting bracket.

3. Remove the two upright circuit boards from the mounting bracket by gently pulling aside the vertical supports and sliding the boards upward. Remove the base circuit board from the bottom of the mounting bracket. Discard the shipping mounting bracket.

**AGA56.9A…
Circuit Board
Installation, continued**

4. Guide the base circuit board from the switch housing side of the actuator into the bottom of the circuit board mounting bracket. See *Figure 23*.

5. Re-install the actuator motor capacitor. See *Figure 24*.

6. Connect the blue neutral wire, shipped loose with the AGA56.9A…, to the spade connector marked N located on the terminal board just below the auto/manual switch.

7. Gently guide the terminal board into the support slots and slide the terminal board downward until both supports snap into place. See *Figure 25*.

8. See *Figure 26* and make the following connections to the actuator:

   a. Connect the black wire, marked “1” from the circuit board to switch I, terminal 1.

   b. Connect the yellow wire, marked “2” from the circuit board to switch II, terminal 2. Connect the white wire, marked “3” from the circuit board to switch III, terminal 3.

   c. Connect the brown wire, marked “13” from the circuit board to switch III, terminal 13.

   d. Connect the other end of the blue neutral wire to the double terminal block located on the outer end of the switch housing.

   e. Connect the gray grounding wire marked "51" to the ground terminal located to the right of the auto/manual switch.

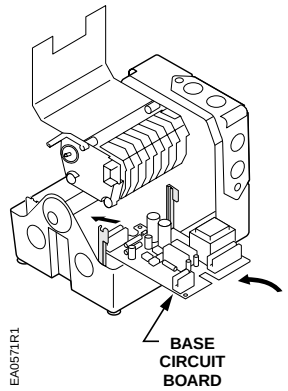


Figure 23.

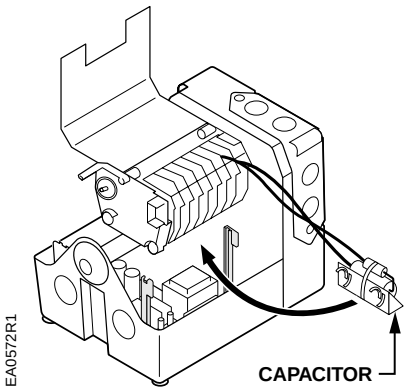


Figure 24.

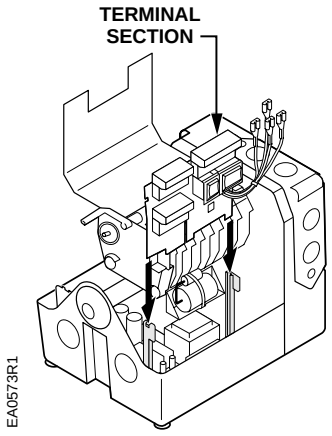


Figure 25

**AGA56.9A…
Circuit Board
Installation, continued**

9. Gently guide the L-shaped circuit board containing the three blue trim potentiometers into the vertical support slots located on the cam drum side of the actuator. See *Figure 27*.

10. Slide the circuit board downward until both supports snap into place. Install the ASZ… potentiometer (See *Potentiometer Removal/Installation Instructions*).

11. Connect the bundled blue, black and brown potentiometer wires to the terminal block located on the ASZ… potentiometer circuit board.

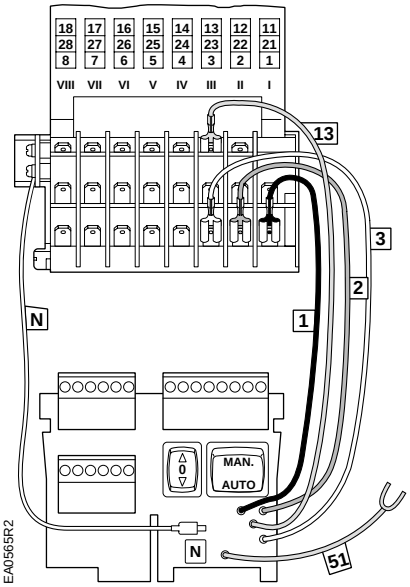


Figure 26.

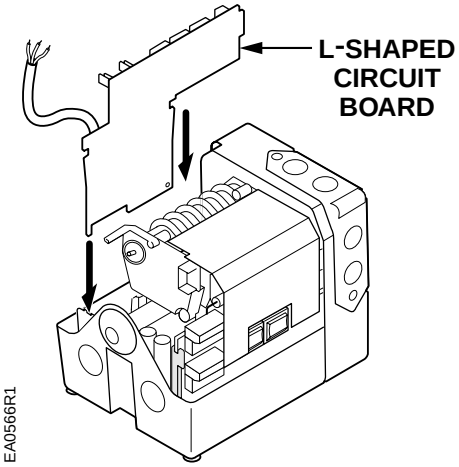


Figure 27.

**AGA56.1A97
Circuit Board Installation**

1. Install the AGA56.1A97 circuit board into the two slotted circuit board supports located on the switch housing side of the actuator.

2. Gently guide the AGA56.1A97 circuit board into the support slots and slide the board downward until both supports snap into place.

3. Make the following connections to the actuator:

   a. Connect the black wire, marked “1” from the circuit board to switch I, terminal 1.

   b. Connect the yellow wire, marked “2” from the circuit board to switch II, terminal 2.

   c. Connect the brown wire, marked “13” from the circuit board to switch III, terminal 13.

Potentiometer Removal

1. Remove the white plastic actuator position-indicating dial by gently pulling while rotating in the clockwise direction. See *Figure 6*.
2. Disconnect the blue, black and brown wire from the potentiometer terminal block. See *Figure 17*.
3. Remove the silver potentiometer board alignment screw.
4. Loosen the black potentiometer gear attachment screw approximately one turn.
5. Gently wedge a small screwdriver between the potentiometer gear and the gray plastic housing.
6. Carefully twist the screwdriver until the potentiometer gear releases from the cam drum shaft. Remove the ASZ… potentiometer.

Potentiometer Installation

1. Install the new ASZ… potentiometer by gently sliding the bushing inserted in the gear over the cam drum shaft.
2. Align the board alignment screw hole in the potentiometer board and install the board alignment screw. See *Figure 17*.
3. The actuator position indicating pointer, located near the actuator gear end of the cam drum, must point to the “0” mark on the actuator position scale. See *Figure 6*. The scale is located on the cam drum nearest to the actuator gear end. Press and hold the black cam drum release button while manually rotating the cam drum.
4. Manually rotate the potentiometer gear until the white line next to the “0” or “1” mark on the potentiometer gear face is **exactly** in alignment with the potentiometer gear alignment pointer. See *Figure 17*. For counterclockwise (ccw) operation the line beside the “1” mark must exactly align with potentiometer gear alignment pointer. For clockwise (cw) operation the line beside the “0” mark must exactly align with potentiometer gear alignment pointer. Firmly tighten the black potentiometer gear attachment screw while manually holding the potentiometer gear in alignment. Check the alignment again.
5. Connect the bundled blue, black and brown potentiometer wires to the terminal block located on the ASZ… potentiometer circuit board. See *Potentiometer Installation* and *Figure 17*.
6. Re-install the white actuator-indicating dial by gently pressing it onto the potentiometer gear attachment screw. Align scale position “0” on the actuator position indicating dial with the dial pointer by rotating the dial in the clockwise direction to avoid loosening the potentiometer gear attachment screw. See *Figure 6*.

Specifications

SQM5... Reversing actuator

SQM5... Reversing actuator	
Agency approvals	UL, CSA, CE
Operating voltage	24 Vac +10%-15% 110 Vac-15% to 120 Vac +10% 220 Vac-15% to 240 Vac +10%
Operating frequency	50-60 Hz
Power consumption	20 VA
Type of motor	Reversing synchronous motor
Duty cycle	100%
Torque	See *Table 1*.
Maximum shaft torque	
AGA58.1	90 lb-in
AGA58.2	200 lb-in
AGA58.3	220 lb-in
AGA58.4	270 lb-in
AGA58.7	350 lb-in
Timings	See *Table 1*.
Rotational range of operation	
SQM5x.xxxxx**A** models	0-160°
SQM5x.xxxxxx**3** models	0-90°
SQM5x.xxxxxx**4** models	0-135°
SQMSx.xxxxxx6 models	0-160°
Direction of rotation	Reversible, factory setting: ccw
Shaft	Selectable. See *Table 2*. Custom versions on request
Shaft disengagement	Independent, cam and drive shaft
Number of auxiliary switches	6 switches (maximum)
Limit switches	2 switches (standard)
Electrical rating of auxiliary switches	7.5 (3) A, 250 Vac
Mounting position	Optional
Ambient operating temperature	-5 to 140°F (-20 to 60°C)
Shipping temperature	-58 to 140°F (-50 to 60°C)
NEMA ratings	NEMA 1, 2, 3, 3R, 3S, 5, 12, and 13
Connections	
Switches	Spade connectors
Boards	Screwed and spade connectors
Dimensions	See *Figures 28* through *31*.
Weight	7.3 lbs. (3.3 kg)
Housing	Aluminum pressure die casting
Enclosure (cover)	Lexan
Motor	Lock resistant
Disengagements	Manual for drive and cam shaft

	Conduit connection	Two removable inserts with two 1/2-inch NPSM threads. Each insert allows insertion of entire cable tree for easy servicing
	Gears and bearings	Maintenance free
	Mounting	Four 1/4"-20 UNC screws in bottom Face mounting at gear side also possible
	Adaptation to other actuator brands	Screw pattern and shaft height Adaptation with AGA57... adapters See *Table 2*.
Circuit Boards		
AGA56.1A97	**AGA56.1A97 Switch circuit board**	
	Operating voltage	Voltage independent
	Operating frequency	50-60 Hz
	Auto/manual switch	2-position switch
	Manual toggle switch	3-position switch
	Ambient operating temperature	-5 to 140°F (-20 to 60°C)
	Shipping temperature	-58 to 140°F (-50 to 60°C)
	Weight	0.22 lb. (0.1 kg)
AGA56.41A…	**AGA56.41A… Electronic circuit boards**	Single potentiometer ASZ... (1000 ohm) is required
	Operating voltage	24 Vac +10%-15% 110 Vac -15% to 120 Vac +10% 220 Vac -15% to 240 Vac +10%
	Operating frequency	50-60 Hz
	Ambient operating temperature	-5 to 140°F (-20 to 60°C)
	Shipping temperature	-58 to 140°F (-50 to 60°C)
	Input signal	4-20 mA
	Impedance	
	Current input	≤300 Ω
	Zero adjustment	MIN: 0-75 %
	Span adjustment	MAX: min-100 %
	Auto/manual switch	2-position switch
	Manual toggle switch	3-position switch
	Weight	0.7 lb. (0.33 kg)
AGA56.42A…	**AGA56.42A… Electronic circuit boards**	Same specifications as AGA56.41A except
	Input signal	0-135 Ohm
	Impedance	
	Current input	≤300 Ω
	Voltage input	≥100kΩ

Specifications, continued

AGA56.43A…	**AGA56.43A… Electronic circuit boards**	Same specifications as AGA56.41A except:
	Input signal	0-10 Vdc
	Impedance	
	Voltage input	≥100kΩ
AGA56.9A	**AGA56.9A… Multi function electronic circuit boards**	Single potentiometer ASZ... (1000 ohm) is required
	Operating voltage	24 Vac +10%-15% 110 Vac -15% to 120 Vac +10% 220 Vac -15% to 240 Vac +10%
	Operating frequency	50-60 Hz
	Input signals	4-20 mA, 0-20 mA, 0-10 Vdc, 0-135 ohm
	Impedance	
	Current input	≤300 Ω
	Voltage input	≥100kΩ
	Output signals	4-20 mA 0-20 mA, 0-10Vdc
	Zero adjustment	MIN: 0-75 %
	Span adjustment	MAX: min-100 %
	Split ranging (SHIFT)	4-20 mA on terminal ZF
	Input signal override (POS)	Line voltage (... Vac) on terminal P adjust with POS potentiometer
	Ambient operating temperature	-5 to 140°F (-20 to 60°C)
	Shipping temperature	-58 to 140°F (-50 to 60°C)
	Auto/manual switch	2-position switch
	Manual toggle switch	3-position switch
	Weight	0.7 lb. (0.33 kg)
ASZ... Potentiometers	**ASZ... Potentiometers**	
	Versions	Single and double potentiometer
	Resistor values	See *Table 2* and *data sheet 7921*.
	Hysteresis	< 0.3 % related to drive shaft

Dimensions

The first dimension given is measured in inches. Millimeters are shown in parentheses.

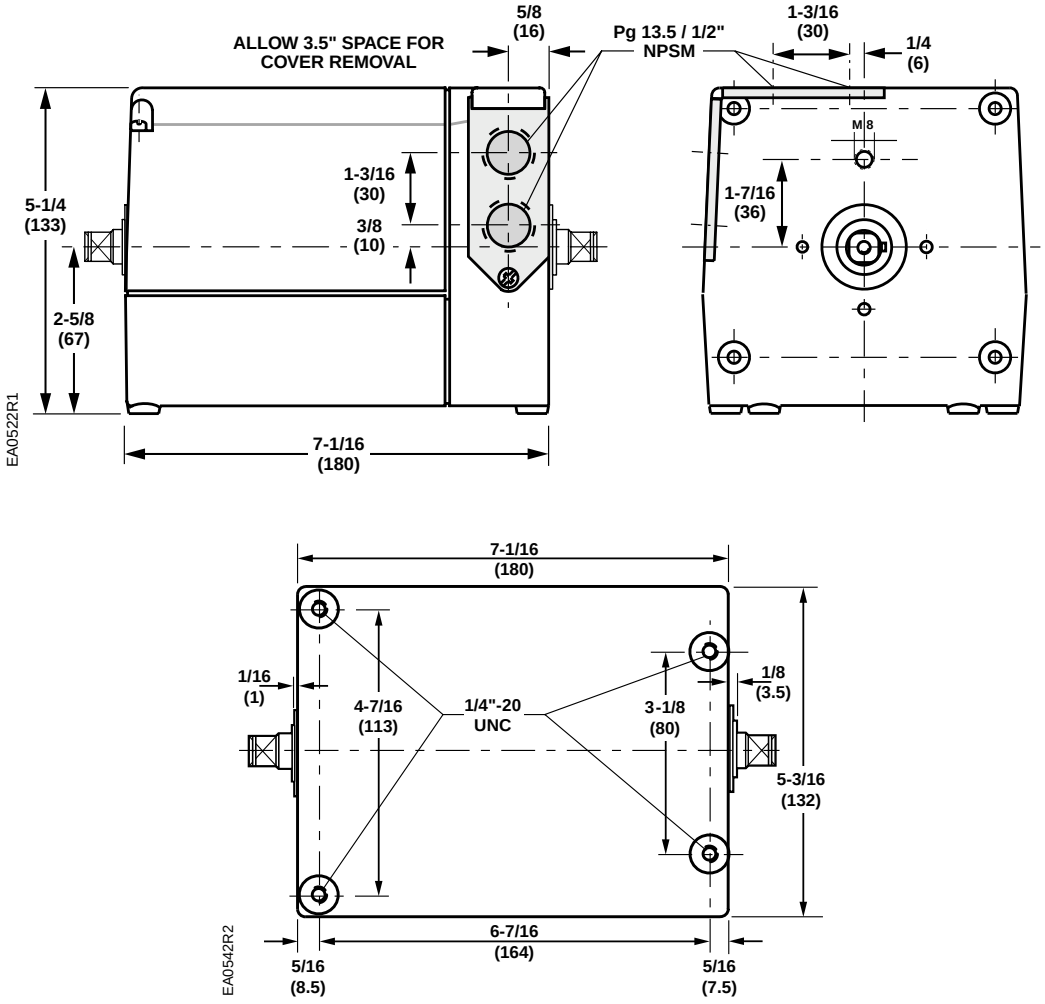


Figure 28. SQM5x.xxxRxx Dimensions.

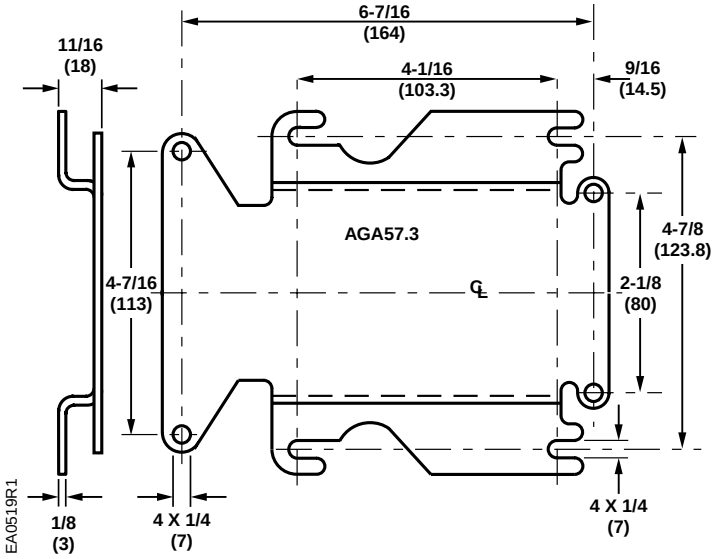


Figure 29. Mounting Bracket AGA57.3

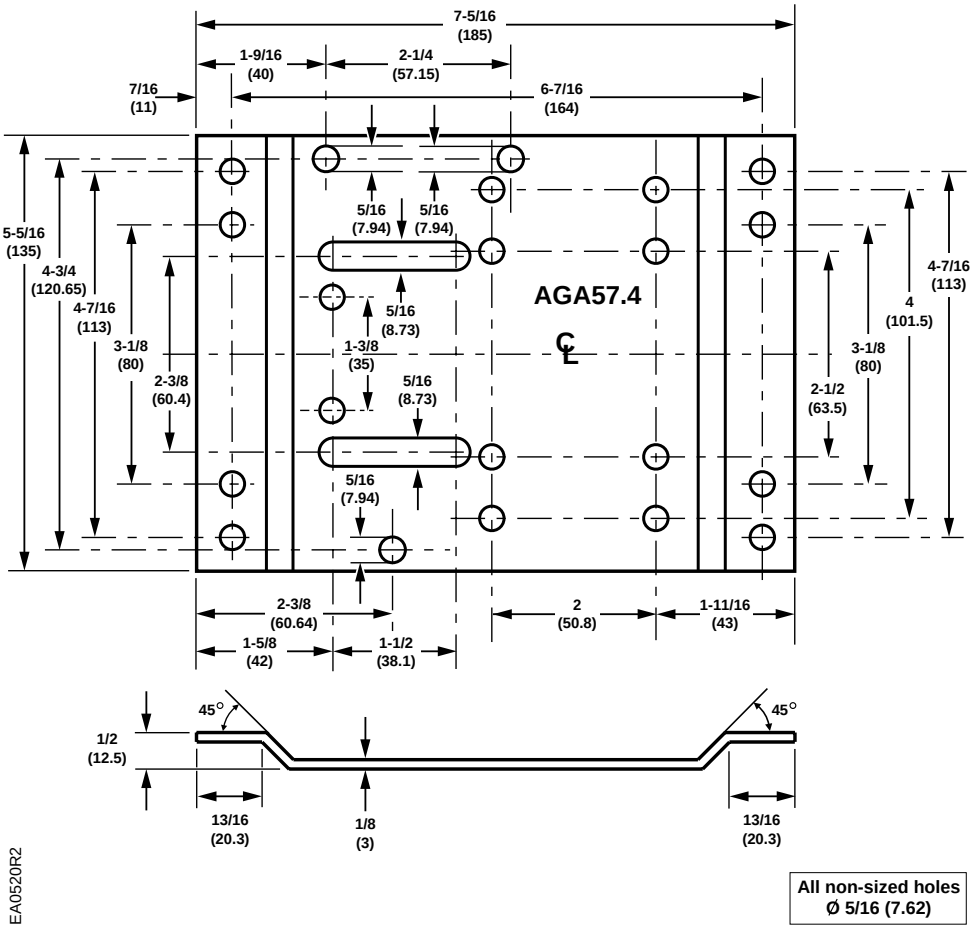


Figure 30. AGA57.4 Mounting Bracket.

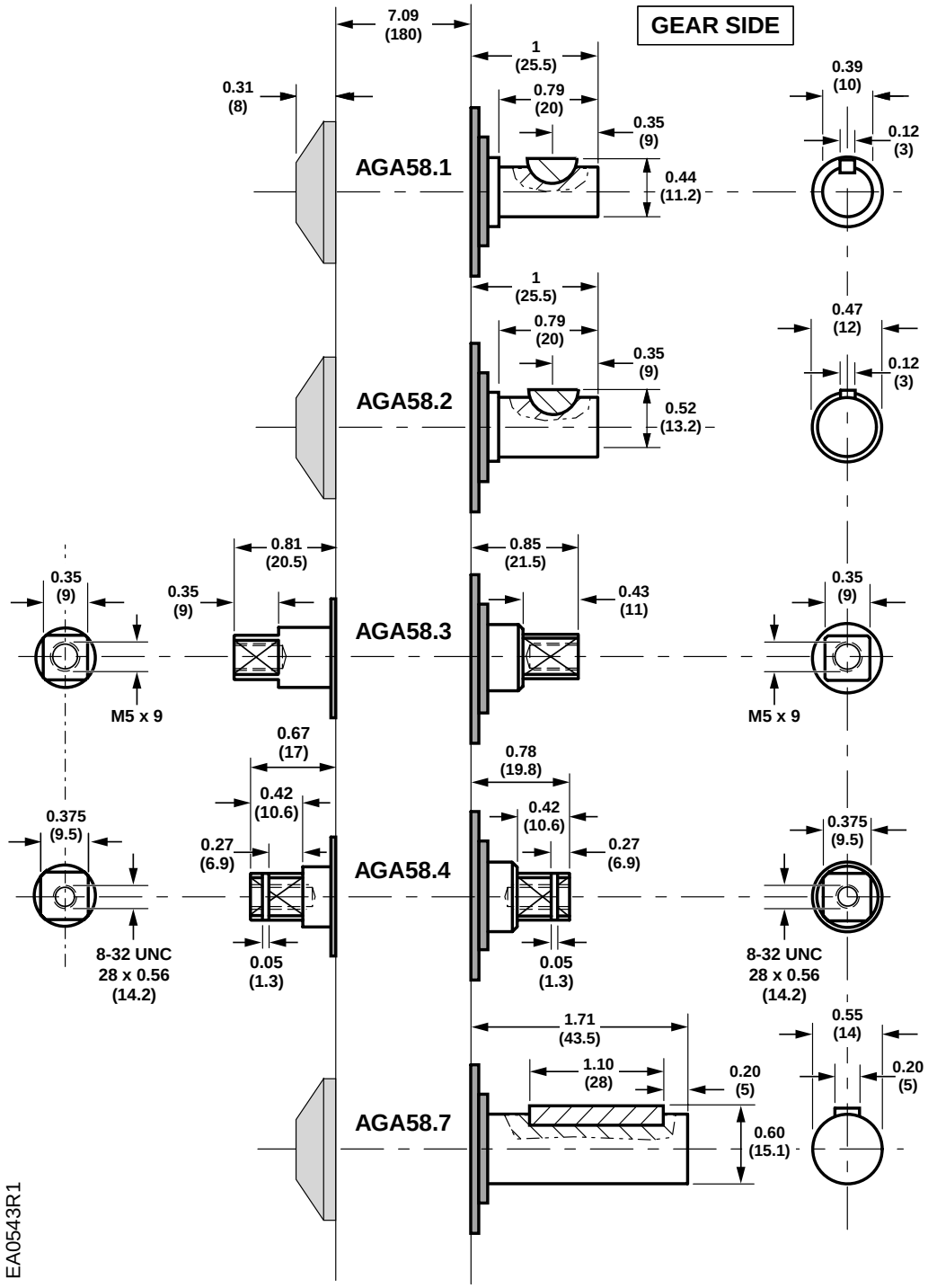


Figure 31. Shaft Dimensions.

GAO/GMH/GML

Pressure switches for gas and air
Pressostats pour gaz et air
Interruptor automático caída de presión de gas y aire
Pressostato para gás e ar

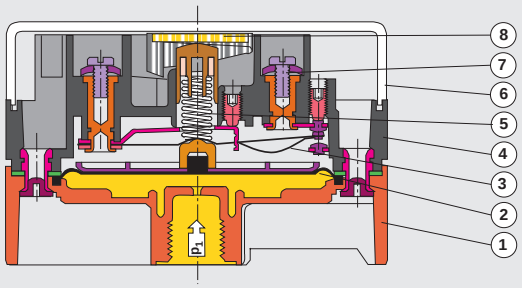
AA-...

DUNGS®

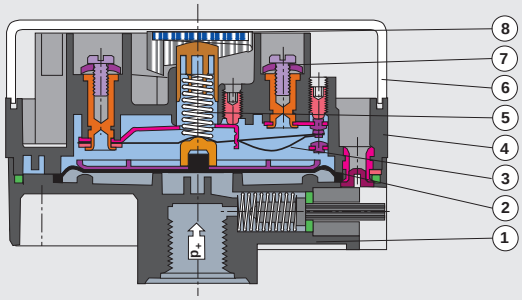
Differential pressure switches for air
Pressostats différentiel pour air
Interruptor diferencial automático caída de presión de aire
Pressostato diferencial para ar

UL / FM / CSA approved versions

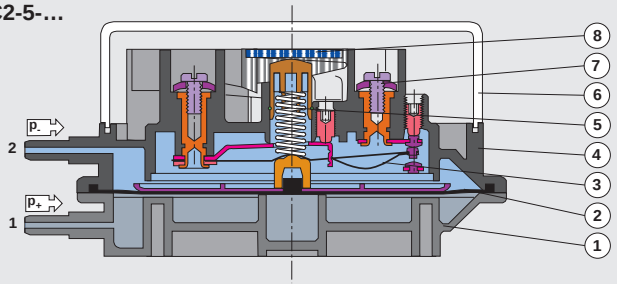
GAO-A4-4-...



AA-A2-6-...



AA-C2-5-...



1	Housing lower part	1	Parte inferior armazón	P_{1}	Pressure connection Prise de pression
2	Diaphragm	2	Diafragma	P_{+}	High pressure Pression haute
3	Contact spring	3	Resorte de contacto	P_{-}	Low pressure Pression basse
4	Housing upper part	4	Parte superior armazón		
5	Setting spring	5	Resorte de ajuste		
6	Cover	6	Cubierta		
7	Electrical connection	7	Conexión eléctrica		
8	Setting scale	8	Escala de ajuste		

1	Partie inférieure	1	Corpo, parte inferior	P_{1}	Conexión a presión Ligação da pressão
2	Membrane	2	Diafragma	P_{+}	alta presión Pressão alta
3	Ressort	3	Mola de contacto	P_{-}	Baja presión Pressão baixa
4	Partie supérieure	4	Corpo, parte superior		
5	Ressort de réglage	5	Mola de ajuste		
6	Capot	6	Tampa		
7	Raccordement électrique	7	Ligação eléctrica		
8	Bouton de réglage gradué	8	Escala de ajuste		

01.1998 KST

GAO-A2 (automatic reset)
Pressure switch for DMV
Pressostat pour DMV
Interruptor automático caída de presión para DMV
Pressostato para DMV

GMH-A2 (manual reset)
High Pressure limit
Limiteur de pression max.
Limitador de la presión máx. de gas
Limitador de pressão máxima

GML-A2 (manual reset)
Low Pressure limit
Pressostat mini gaz
Limitador de la presión mín. de gas
Limitador de pressão mínima

GAO-A2-... " w.c.		GMH/GML-A2-... " w.c.	code
0.16...	1.2		2
0.40...	4.0		3
		1.00... 20.0	4
2.00...	20.0		5
12.0 ...	60.0	12.0 ... 60.0	6
40.0...200.0		40.0...200.0	8

GAO-A4 (automatic reset)
Pressure switch
Pressostat
Interruptor automático caída de presión
Pressostato

GMH-A4 (manual reset)
High Pressure limit
Limiteur de pression max.
Limitador de la presión máx.
Limitador de pressão máxima

GML-A4 (manual reset)
Low Pressure limit
Limiteur de pression min.
Limitador de la presión mín.
Limitador de pressão mínima

GAO-A4-... " w.c.		GMH/GML-A4-... " w.c.	code
0.16...	1.2		2
0.40...	4.0		3
		1.00... 20.0	4
2.00...	20.0		5
12.0 ...	60.0	12.0 ... 60.0	6
40.0...200.0		40.0...200.0	8

AA-A2-6-...
Differential pressure switch for air
Pressostat différentiel pour air
Interruptor diferencial automático caída de presión de aire
Pressostato diferencial para ar

AA-A2-6-...
with test button
avec bouton de contrôle
Con botón de ensayo
com botão de teste

AA-A2-6-... " w.c.		code
0.16...	1.2	2
0.40...	4.0	3
1.00...	20.0	4
12.0 ...	60.0	6

AA-A1-0-...
Differential pressure switch for air
Pressostat différentiel pour air
Interruptor diferencial automático caída de presión de aire
Pressostato diferencial para ar

AA-A1-4-... " w.c.		code
0.16...	1.2	2
0.40...	4.0	3
1.00...	20.0	4
12.0 ...	60.0	6

AA-C2-5-...
Differential pressure switch for air
Pressostat différentiel pour air
Interruptor diferencial automático caída de presión de aire
Pressostato diferencial para ar

AA-C2-5-... " w.c.		code
0.08...	0.6	1
0.16...	1.2	2
0.40...	4.0	3

" w.c.		mbar	code
0.08...	0.6	0,2... 1.5	1
0.16...	1.2	0,4... 3	2
0.40...	4.0	1,0...10	3
1.00...	20.0	2,5...50	4
2.00...	20.0	5,0...50	5
12.0 ...	60.0	30 ...150	6
40.0...200.0		100 ...500	8

Karl Dungs Inc. • 524 Apollo Drive, Suite 10 • Lino Lakes, MN 55014 • U.S.A. • Phone 651-792-89 12 • Fax 651-792-89 19

Pressure switch for gas and air

Exhibit F-42

GAO-A4…
GMH-A4…
GML-A4…

DUNGS®

UL Listed
- **UL 353**
- **File # MH 16628**

CSA Certified
- **CSA C22.2 No. LR 53222**
- **Certification # 201527**

FM Approved
- **Class 3510, 3530**
- **File # J.I. 1T7A8.AF**

European models tested to EN1854 per Gas Appliance Directive 90/396/EEC and per Pressure Equipment Directive 97/23/EC.

DUNGS is an ISO 9001 manufacturing facility.

Description

The DUNGS GAO-, GMH- and GML-A4… pressure switches are adjustable pressure switches for automatic burner controls.

A4 pressure switches are suitable for making and/or breaking a circuit relative to changes in medium pressure relative to the set point. The set point can be set in the field by an adjustable dial with an integrated scale. Test nipple integrated in metal housing to verify setpoint.

Application

The DUNGS GAO-, GMH-, and GML-A4… pressure switch is recommended for industrial and commercial heating, ventilation and air-conditioning systems.

The GAO-, GMH-, and GML-A4… pressure switch is suitable for natural gas, propane, butane, air and other inert gases.

Printed in Germany • Edition 10.02 • Nr. 226 357

GAO-A4... SPDT pressure switch requires no auxiliary power. The GAO-A4… is suitable for making and/or breaking a circuit when the set point is exceeded or undershot. A tripped switch is indicated by a neon light after set point is exceeded or undershot. **Automatic reset** when pressure returns below or above set point.

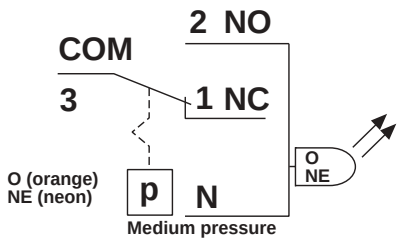
GMH-A4... SPDT pressure switch requires no auxiliary power. The GMH-A4… is suitable for making and/or breaking a circuit when the set point is exceeded. A tripped switch is indicated by a neon light after set point is exceeded. **Manual reset** is required to reset the switch.

GML-A4... SPDT pressure switch requires no auxiliary power. The GML-A4… is suitable for making and/or breaking a circuit when the set point is undershot. A tripped switch is indicated by a neon light after set point is undershot. **Manual reset** is required to reset the switch.

Specifications

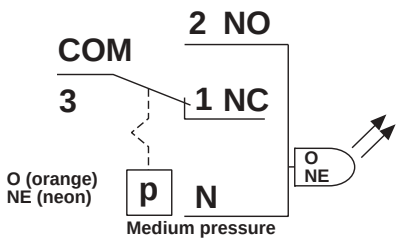
Max. operating pressure	GAO-A4-4-2,3,5,6 GMH-, GML-A4-4-4,6 GAO-, GMH- and GML-A4-4-8	7 PSI (500mbar) 7 PSI (500mbar) 14 PSI (1000 mbar)
Max. body pressure	15 PSI (1033 mbar)	
Pressure connection	Standard: 1/4" NPT female thread centered underside of housing.	
Temperature range GAO-, GMH- and GML-A4-4 GAO-, GMH- and GML-A4-4-8	Ambient temperature Medium temperature Ambient temperature Medium temperature	-40 °F to +140 °F (-40 °C to +60 °C) -40 °F to +140 °F (-40 °C to +60 °C) -22 °F to +140 °F (-30 °C to +60 °C) -22 °F to +140 °F (-30 °C to +60 °C)
Materials	Housing Switch Diaphragm Switching contact	Aluminium Polycarbonate NBR-based rubber Silver or Gold
Electrical ratings	AC eff. DC	min. 24 V max. 240 V min. 24 V max. 48 V
Current ratings	Silver (Ag) contact ratings AC 10A resistive @ 120 VAC AC 8A inductive @ 120 VAC DC min. 20 mA @ 24 VDC DC max. 1 A @ 48 VDC	Gold (Au) contact ratings DC min. 5 mA @ 5 VDC DC max. 20 mA @ 24 VDC
Electrical connection	Screw terminals via 1/2" NPT conduit connection	
Enclosure rating	NEMA Type 4	
Setting tolerance	± 15% switching point deviation referred to set point, adjusted as pressure rises, vertical diaphragm position	

GAO switching function (upper)
As pressure rises:
1 NC opens, 2 NO closes
As pressure falls:
1 NC closes, 2 NO opens

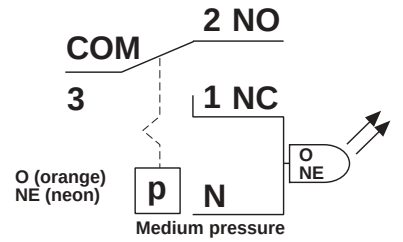


GMH switching function

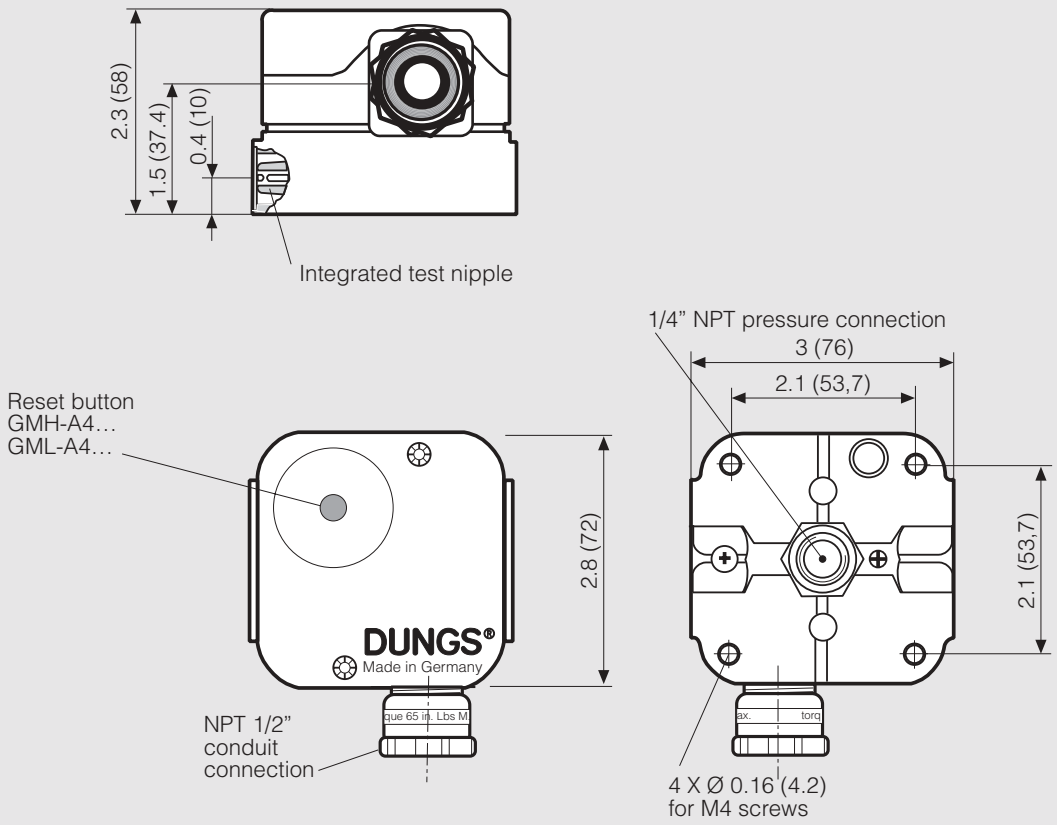
As pressure rises
2 NO closes, 1 NC opens
Neon light ON, tripped.



GML switching function shown in operating state.
As pressure falls
2 NO opens, 1 NC closes
Neon light ON, tripped.

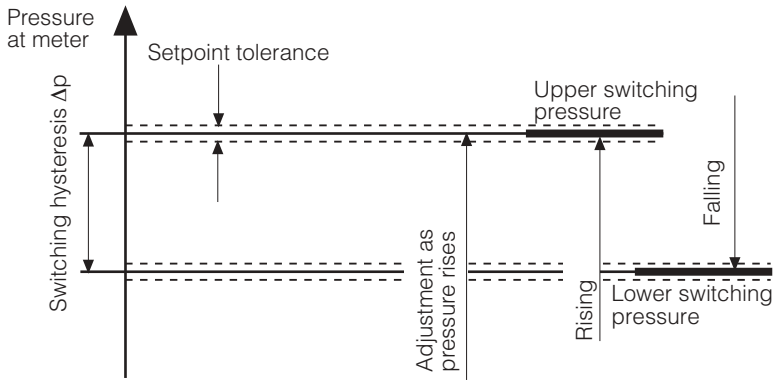


Dimensions inch (mm)
GAO-, GMH-, GML-A4…

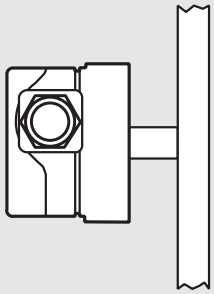


Replacement parts / Accessories	Order No.	For equipment	Notes
Replacement conduit adapter	46000-14	GAO, GMH, GML	1/2“ NPT
Replacement cover	D228 732	GAO	
Replacement cover	D233 113	GMH, GML	
Replacement light	D244 156	GAO, GMH, GML	120 VAC, Red bulb
Replacement light	D244 157	GAO, GMH, GML Gold contact versions	24 V, Red bulb
Electrical plug for A4 (For use with D210 318)	D219 659	GAO	N/A
Electrical plug for A4 (For use with D210 318)	D227 644	GMH, GML	N/A
DIN connector for A4 (For use with D219 659 & D227 644)	D210 318	GAO, GMH, GML	N/A
Double pressure switch mounting kit	D239 812	GAO, GMH, GML	N/A

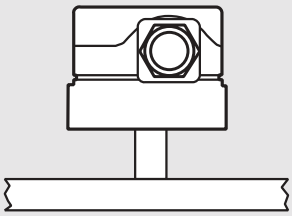
Definition of switching hysteresis Δp
The pressure difference between the upper and lower switching pressures



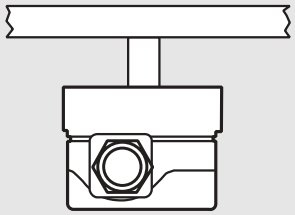
Installation position



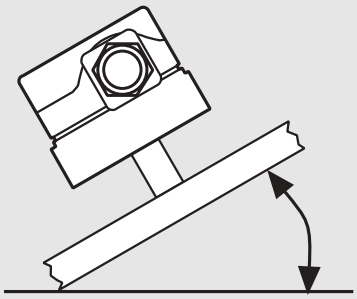
Standard installation position



When installed horizontally, the pressure switch switches at a pressure higher by approximately 0.2 in wc (0.5 mbar).



When installed upside down, the pressure switch switches at a pressure lower by approximately 0.2 in wc (0.5 mbar).



When installed in other position the pressure switch switches at pressure deviating from the set reference value by max. ±0.2 in wc (0.5 mbar).

NOTE: Always calibrate the switch in the desired mounting position

**Pressure switch
for gas and air**

**GAO-A4...
GMH-A4...
GML-A4...**

DUNGS®

Technical data

Type	Version	Order No.	Setting range In. W.C.	Switching hysteresis In. W.C.	(calibrated at)
GAO-A4... pressure switch	GAO-A4-4-2	46014-2	0.16 - 1.20“	≤ 0.12“	
	GAO-A4-4-3	46014-3	0.40 - 4.00“	≤ 0.20“	
	GAO-A4-4-5	46014-5	2.00 - 20.00“	≤ 0.40“	
	GAO-A4-4-6	46014-6	12.00 - 60.00“	≤ 1.20“	
	GAO-A4-4-8	46014-8	40.00 - 200.00“	≤ 4.00“	
	GAO-A4-4-2 Gold	46014-12	0.16 - 1.20“	≤ 0.12“	
	GAO-A4-4-3 Gold	46014-13	0.40 - 4.00“	≤ 0.20“	
	GAO-A4-4-5 Gold	46014-15	2.00 - 20.00“	≤ 0.40“	
	GAO-A4-4-6 Gold	46014-16	12.00 - 60.00“	≤ 1.20“	
	GAO-A4-4-8 Gold	46014-18	40.00 - 200.00“	≤ 4.00“	
GMH-A4... pressure switch	GMH-A4-4-4	46015-4	1.00 - 20.00“	--	
	GMH-A4-4-6	46015-6	12.00 - 60.00“	--	
	GMH-A4-4-8	46015-8	40.00 - 200.00“	--	
	GMH-A4-4-4 Gold	46015-14	1.00 - 20.00“	--	
	GMH-A4-4-6 Gold	46015-16	12.00 - 60.00“	--	
GML-A4... pressure switch	GML-A4-4-4	46016-4	1.00 - 20.00“	--	
	GML-A4-4-6	46016-6	12.00 - 60.00“	--	
	GML-A4-4-8	46016-8	40.00 - 200.00“	--	
	GML-A4-4-4 Gold	46016-14	1.00 - 20.00“	--	

**All switches with Silver contacts have 120 VAC neon lights factory installed
All switches with Gold contacts have 24 V lights factory installed**

We reserve the right to make any changes in the interest of technical progress.

**Karl Dungs Inc.
524 Apollo Drive, Suite 10
Lino Lakes, MN 55014, U.S.A.
Phone 651 792-8912
Fax 651 792-8919
e-mail info@karldungsusa.com
Internet http://www.dungs.com/usa/**

**Karl Dungs GmbH & Co. KG
P.O. Box 12 29
D-73602 Schorndorf, Germany
Phone +49 (0)7181-804-0
Fax +49 (0)7181-804-166
e-mail info@dungs.com
Internet http://www.dungs.com**

Valve position indication

CPI 400

Visual Indicator

DUNGS®

UL Listed
- **Covered under file # MH 16727**

CSA Certified
- **Covered under file # 157406**

FM Approved
- **Covered under report # J.I. 3007653**

DUNGS is an ISO 9001 manufacturing facility.

Description
The CPI 400 (closed position indicator) visually and electrically indicates when the valve is either open or closed.
The CPI 400 is suitable for making and/or breaking a circuit when the valve position changes.
The CPI 400 mount directly to DUNGS automatic shutoff valves.

Application
The DUNGS CPI 400 is recommended for industrial and commercial heating applications that require visual and / or electrical indication of valve position on automatic shutoff valves. The CPI 400 is suitable for natural gas, propane, butane, air and inert gases.

Description
The Visual Indicator indicates when the valve is either open or closed.

The Visual Indicator mount directly to DUNGS automatic shutoff valves.

Application
The DUNGS Visual Indicator is recommended for industrial and commercial heating applications that require visual indication of valve position on automatic shutoff valves. The Visual Indicator is suitable for natural gas, propane, butane, air and inert gases.

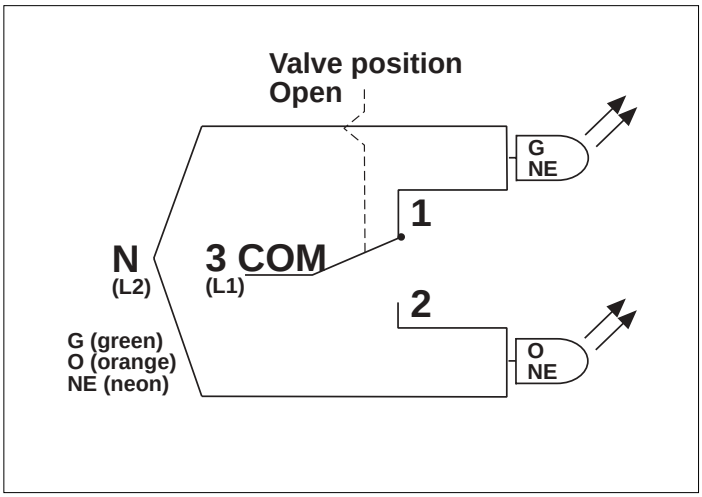
Printed in Germany • Edition 10.02 • Nr. 240 181

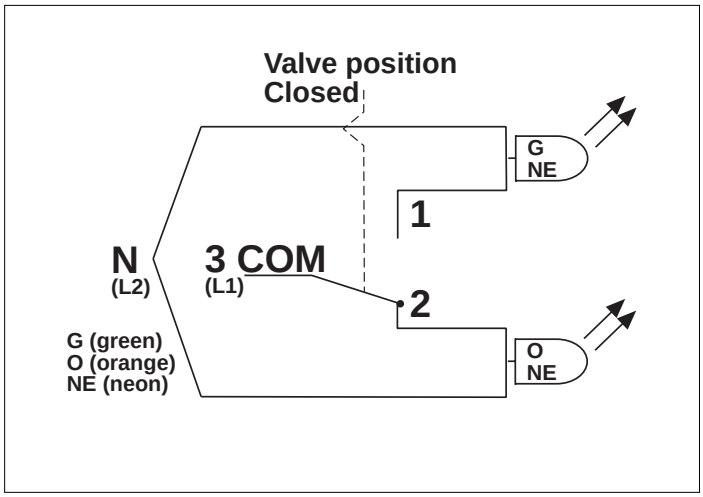
CPI 400 SPDT switch requires no auxiliary power. The CPI is suitable for making and/or breaking a circuit when the valve is opened or closed. An open valve is indicated by a green neon light. A closed valve is indicated by an orange neon light.

Specifications

Max. operating pressure	7 PSI (500 mbar)
Connection	Set screw with G 1/8" ISO 228 plunger
Temperature range	-40 °F to +150 °F (-40 °C to +65 °C)
Materials	CPI Housing: Polycarbonate Switching contact: Silver (Ag) Plunger: Brass Sealing: NBR based rubber
Electrical ratings	AC eff. 120 V
Nominal current	AC max. 10A resistive @ 120 Vac AC max. 8A inductive @ 120 Vac
Electrical connection	Screw terminals via 1/2" NPT conduit connection
Enclosure rating	NEMA Type 4

CPI 400 Switching function



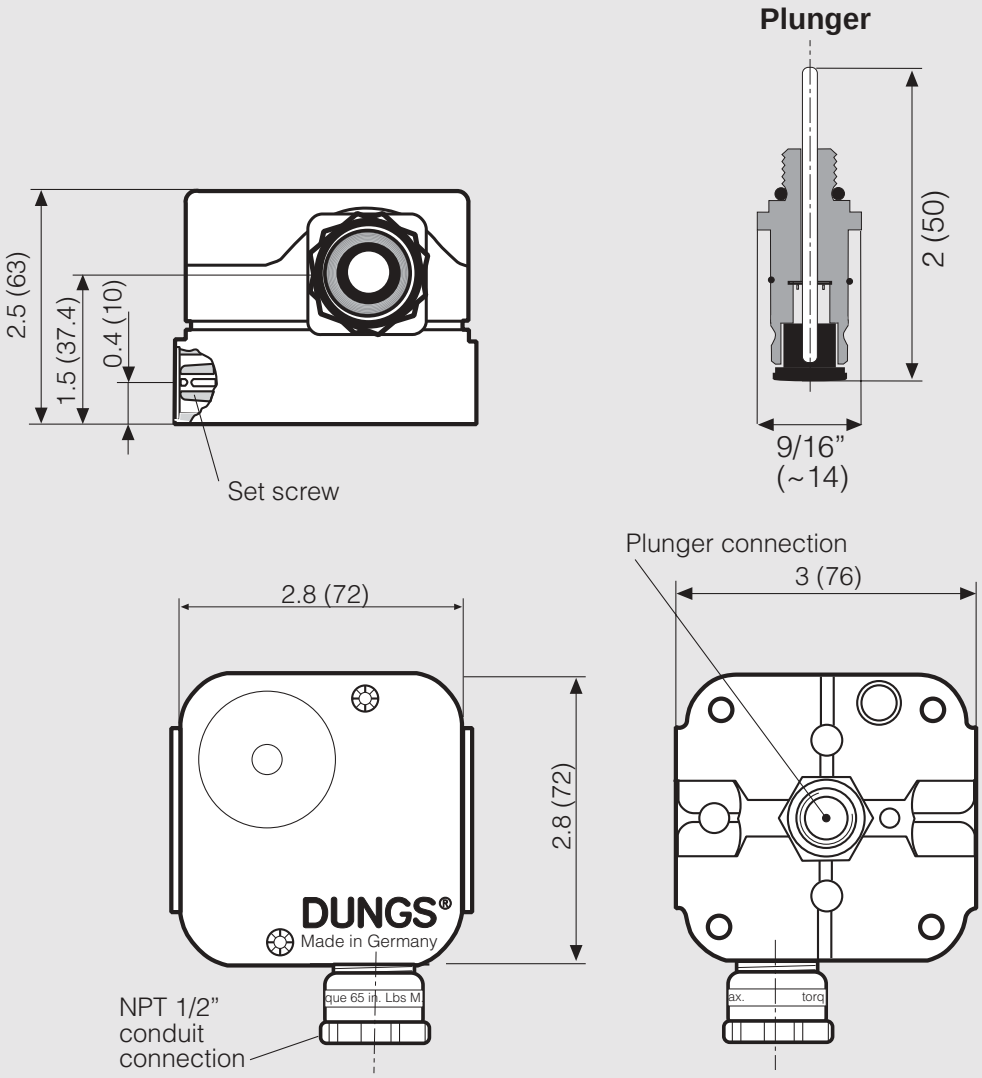


Visual Indicator Indicates closed and open position of the safety valve.

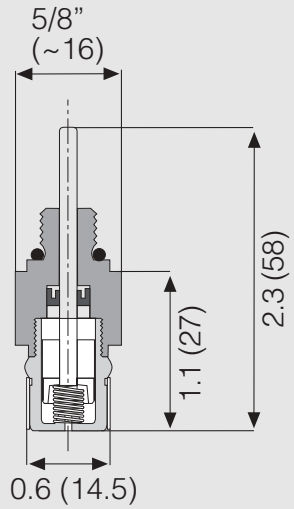
Specifications

Max. operating pressure	7 PSI (500 mbar)
Connection	G 1/8" ISO 228
Temperature range	-40 °F to +150 °F (-40 °C to +65 °C)
Materials	Brass housing NBR based rubber

Dimensions inch (mm)
CPI 400
Plunger



Dimensions inch (mm)
Visual Indicator



Valve position indication

CPI 400

Visual Indicator

DUNGS®

Technical data

Type	Order No.
CPI 400	D224 253
Visual Indicator	46000-6

We reserve the right to make any changes in the interest of technical progress.

Karl Dungs Inc.
524 Apollo Drive, Suite 10
Lino Lakes, MN 55014, U.S.A.
Phone 651 792-8912
Fax 651 792-8919
e-mail info@karldungsusa.com
Internet http://www.dungs.com/usa/

Karl Dungs GmbH & Co. KG
P.O. Box 12 29
D-73602 Schorndorf, Germany
Phone +49 (0)7181-804-0
Fax +49 (0)7181-804-166
e-mail info@dungs.com
Internet http://www.dungs.com

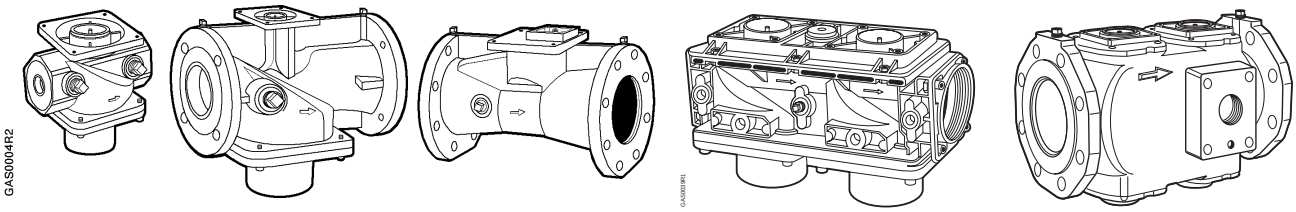
SIEMENS

Technical Instructions

Document No. 155-512P25
VG…U
Rev. 3, March, 2002

VG Series

VGD…, VGF…, VGG…, VGH… Gas Valves for Use with Electro-hydraulic Actuators SKP…



VGG… VGF… VGH… VGD20… VGD40…

ISO 9001
REGISTERED FIRM
GAS0001R1

LISTED

FM
APPROVED

Description

The spring loaded, normally closed VG… series of modular single and double-body gas valves combined with SKP… Series Electro-hydraulic Actuators to provide safety shut-off, gas pressure regulation and air/gas ratio control for commercial and industrial gas burners.

Table 1. Legend.

Model Numbers	Body Style	Connection
VGD…	Double	Threaded or flanged
VGF…	Single	Flanged
VGG…	Single	Threaded
VGH…	Single	Flanged

Features

All Models

- UL listed, FM approved, CSA certified, IRI approvable, ISO 9001 certified. European, Australian and Japanese approved versions available.
- Inlet and outlet 1/4-inch NPT plugged pressure taps standard on all models. Additional plugged taps provided on some models (See Table 2 for details).
- 3/4-inch NPT plugged port for pilot or vent line connection available on VGG…, VGF… and VGH… valves. One-inch NPT plugged port for pilot or vent line connection available on VGD20… Connection plates for vent line connection available on VGD40… valves (See Table 2).

VGG… and VGF… Models

- Dual stem guides ensure precise disc alignment and tight shut-off.
- Contoured valve disc provides smooth release of gas and stable regulating control.
- Easy to service stainless steel mesh filter protects the valve seat and disc as well as downstream components.

VGD20… Models

- Compact VGD20… double-valve bodies consist of two safety shut-off valves in series. The first (inlet) valve has a flat valve disc applicable for safety shut-off function only. The second (outlet) valve has a contoured valve disc for use with pressure regulating actuators (SKP20…, SKP50…, SKP70…).
- Easy to service stainless steel mesh filter in the inlet valve protects the valve seats and discs as well as downstream components.
- One-inch NPT vent connection between the valves.
- For installation, each VGD20… double valve requires two AGA..U threaded mounting flanges. The flanges are supplied together with the necessary installation hardware, bolts, nuts and seals. Each mounting flange has a 1/4-inch NPT plugged pressure tap. The flanges can be threaded independently onto a pipe, separate from the VGD20… gas valve body. This feature permits union free installation, allowing the gas valve assembly to be easily removed from a gas train without the use of pipe wrenches.
- The overall dimensions of both the 1-1/2 inch and 2-inch AGA…U flanges are identical. Either flange type can be fitted to both the 1-1/2-inch and 2-inch VGD20… valve bodies. This permits a 1-1/2-inch flange to be mounted on a 2-inch valve body or vice versa.

  NOTE: VGD20… valves and AGA..U threaded flanges are supplied as separate items (See Table 2 for ordering information).

VGD40… Models

- Compact VGD40… double-valve bodies consist of two safety shut-off valves in series. Each individual valve has double seats to achieve high flow.
- Patented seat construction with a closing spring for each seat assures independent shut-off.
- Stainless steel mesh filter at the inlet protects the valve seats and discs as well as downstream components.
- Vent line connection plates are available.

  NOTE: VGD40… valves and AGA..U vent connection plates are supplied as separate items (See Table 2 for ordering information).

Features, Continued

VGH… Models

- VGH… valves are high capacity, straight-through flow, levered flap-type valves. A progressive opening characteristic provides a smooth release of gas and stable pressure regulating control.
- A stainless steel mesh filter is available. (See Table 2 for ordering information).

Application

All VG… valves can be combined with any SKP… Series actuator by using the four bolts **contained in the terminal box of the actuator**. The actuator can be mounted while the valve is installed and under pressure. Sealing material is not required when mounting actuators.

SKP… regulating actuators are applicable for both low and high supply gas pressure applications, eliminating excessive regulator inventories. Maximum pressure capacities vary with valve size (See Table 2).

All VG… valves perform these functions in combination with each of the following actuators:

SKP10…U..; Safety shut-off
SKP20…U..; Safety shut-off and constant pressure regulation. Regulation output range 0 to 100" w.c., or zero governor.
SKP50…U..; Safety shut-off, pressure regulation and differential pressure air/gas ratio control.
SKP70…U..; Safety shut-off, pressure regulation and variable air/gas ratio control.

Since more than one function can be performed by a single valve, fewer components and fittings are required to assemble a gas train, significantly reducing both the size and weight of the gas train. The total pressure drop across the gas train arrangement is reduced, allowing the use of smaller diameter gas trains in most applications. For details on valve sizing see the Flow Charts (Figures 5 and 6).

CAUTION:

Do not oversize valves equipped with a regulating SKP… actuator. Oversizing may limit turndown and could cause oscillations.

Ordering Information

Gas valves and actuators are ordered separately. For additional SKP… actuator information, see the following Technical Instructions:

SKP10…U..;	155-513P25
SKP20…U..;	155-514P25
SKP50…U..;	155-515P25
SKP70…U..;	155-516P25

Accessories

Manual adjusting throttle attachment AGA61 permits VG… series valves to be used as hand operated adjusting throttles. Once adjusted the AGA61 has a provision to be sealed from further adjustment (See Table 2).

Adapter plate AGA60 permits VG… series valves to be used for modulating flow control when fitted with SQX… series modulating actuators (See Table 2).

NOTE: The VG… /SQX… valve/actuator combination does not provide safety shut-off function.

Table 2. Product Numbers.

Product Number	Size	Maximum Operating Pressure psi	Close-off Pressure psi	Capacity CFH Natural Gas at ΔP=1" W.C.	Number of Test Points, 1/4" NPT		3/4" NPT Port	Valve Body Material
					Inlet	Outlet		
VGG10.154U	1/2" NPT	20	75	334	2	2	—	Aluminum
VGG10.204U	3/4" NPT	20	75	627	2	2	—	Aluminum
VGG10.254U	1" NPT	20	75	933	2	2	—	Aluminum
VGG10.404U	1-1/2" NPT	20	75	2,250	2	2	—	Aluminum
VGG10.504U	2" NPT	15	75	3,511	2	2	—	Aluminum
VGG10.654U	2-1/2" NPT	10	25	5,085	1	1	2-inlet	Cast Iron
VGG10.804U	3" NPT	10	25	6,158	1	1	2-inlet	Cast Iron
VGF10.654U	2-1/2" Flanged	10	25	5,085	1	1	2-inlet	Cast Iron
VGF10.804U	3" Flanged	10	25	6,158	1	1	2-inlet	Cast Iron
VGH10.804U	3" Flanged	10	30	8,449	1	1	2-inlet	Cast Iron
VGH10.904U	4" Flanged	10	30	14,398	1	1	2-inlet	Cast Iron
VGH10.914U	5" Flanged	5	5	19,685	1	1	2-inlet	Cast Iron
*VGD20.403U	1-1/2"	20	30	1,890	Two 1/4-inch and one 1-inch port between valves		—	Aluminum
*VGD20.503U	2"	15	30	2,300			—	Aluminum
*AGA41U	Single 1-1/2" connecting flange with 1/4-inch port for VGD 20.403U						Two (2) needed per valve. Order separately	
*AGA51U	Single 2" connecting flange with 1/4-inch port for VGD 20.503U							
VGD40.065U	2-1/2" NPT	10	75	3,880	1	1	Two 1/4-inch NPT ports between the valves	Aluminum
VGD40.080U	3" NPT	10	75	5,370	1	1		Aluminum
VGD40.100U	4" Flanged	10	30	9,220	1	1		Aluminum
VGD40.150U	6" Flanged	10	30	15,900	1	1		Aluminum
AGA40.6580U	Vent connection plate with 1-1/4" NPT vent connection and 1/4" NPT test port						Order separately. For use with VGD40… only.	
AGA40.0100U	Vent connection plate with 2" NPT vent connection and 1/4" NPT test port							
AGA40.0150U	Vent connection plate with 2-1/2" NPT vent connection and 1/4" NPT test port							
AGA60	Adapter for use with SQX… actuators							
AGA61	Manual operation kit, allows VG… valves to be used as manually adjustable sealable orifice or throttle							
AGA80 AGA90 AGA91	Filter with clamping ring for VGH10.804U, 3-inch valve. Filter with clamping ring for VGH10.904U, 4-inch valve. Filter with clamping ring for VGH10.914U, 5-inch valve.							

* VGD20… double valves require 2 AGA…U threaded flanges for installation.

Specifications

Approvals	Agency approvals/standards	UL/429, FM/7400, CSA/AINSI Z21.21/CGA 6.5 Commercial/Industrial IRI approvable
Operating Environment	Maximum operation pressure	See Table 2
	Maximum back pressure (differential)	2.5 psi (150 mbar)
	Close-off pressure	See Table 2
	Permissible gases	Natural gas, manufactured gas, LPG, air
	Permissible gas temperature	15°F to 140°F (-10°C to 60°C)
	Permissible operating temperature	15°F to 140°F (-10°C to 60°C)
	Mounting	Any position except upside down
Physical Characteristics	Body materials	See Table 2
	Weight	See Tables 3 through 6 and 8
Connections	Pipe connections	NPT or ANSI Class 150 flange (See Table 2)
	Pressure and vent taps	See Table 2

Operation

All VG… gas valves are normally closed, two-way valves. The VGG…, VGF…, and VGD… valves have a standard, built-in, stainless steel mesh filter in the inlet to protect the downstream components against contamination.

Optional stainless steel mesh filters (order separately, see Table 2) can be installed in the inlet flange section of the VGH… valves.

VGG… and VGF… series gas valves have a contoured valve disc for stable regulating control and smooth release of gas (see Figure 1).

VGD20… double valves consist of two valves in series. The first (inlet) valve has a flat valve disc suitable for the safety shut-off function only. The second (outlet) valve has a contoured valve disc and is normally used in conjunction with actuators having additional control functions (SKP20…, SKP50…, and SKP70…) (see Figure 3).

VGD40… double valves consist of two valves in series. Each valve has a double seat to achieve high flow (see Figure 4).

VGH… valves are levered flap-type valves. Due to the absence of bends, the flow capacity is high. The progressive opening mode provides a smooth release of gas with stable control (See Figure 2).

All valves have plugged 1/4-inch NPT ports for pressure test connection. On the 2-1/2-inch and 3-inch VGG…, VGF..., and VGH… series, additional 3/4-inch NPT ports are provided for pilot or vent line connection. The VGD20… valves have a one-inch NPT port for pilot or vent line connection. The VGD40… valves can be equipped with a full size vent connection plate.

See Table 1 for details on ports and vent connection plates.

Operation, Continued

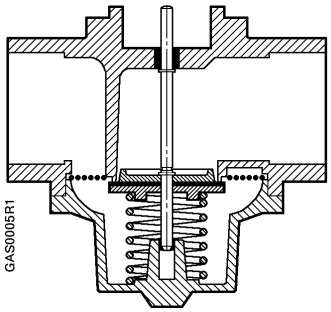


Figure 1. VGG… Models.

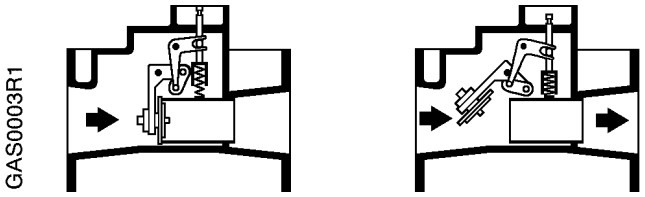


Figure 2. VGH… Models.

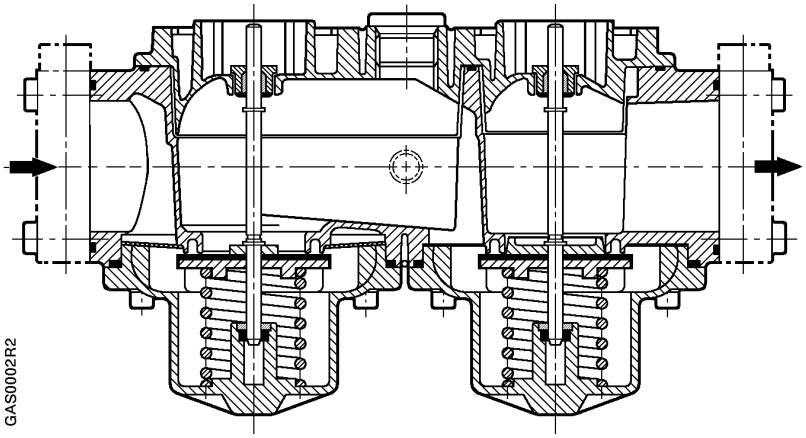


Figure 3. VGD20… Models.

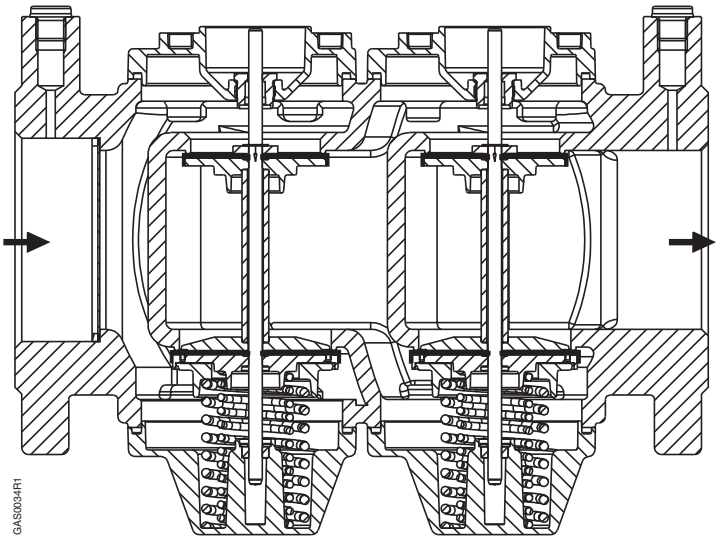


Figure 4. VGD40… Models.

Gas Flow Charts

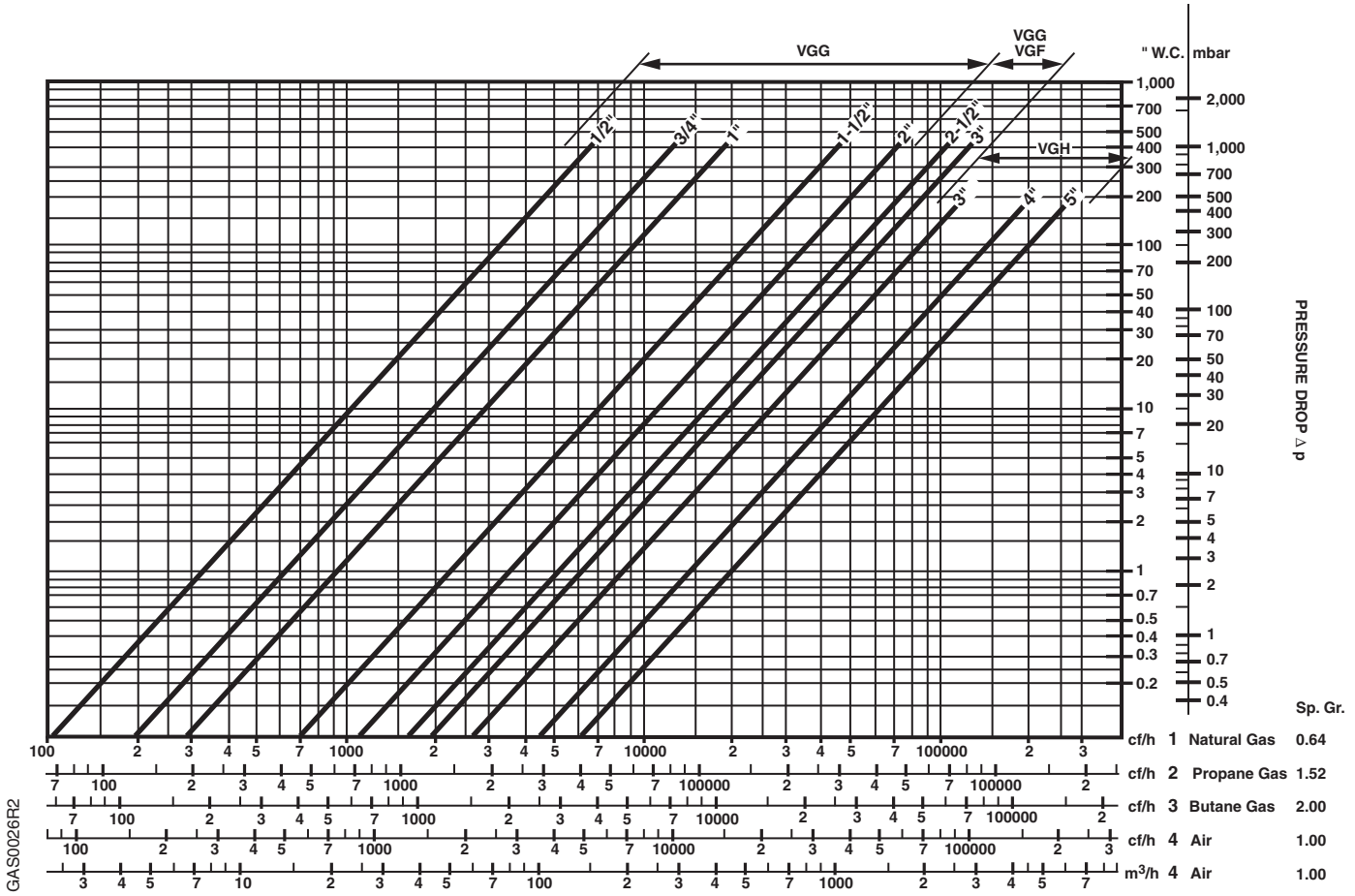


Figure 5. Sizing Single Valves.

NOTE: Pressure drop is for one valve.

CAUTION:

Do not oversize valves equipped with regulating actuators SKP20…, SKP50… or SKP70… Oversizing may limit turndown and could cause oscillations.

Gas Flow Charts, Continued

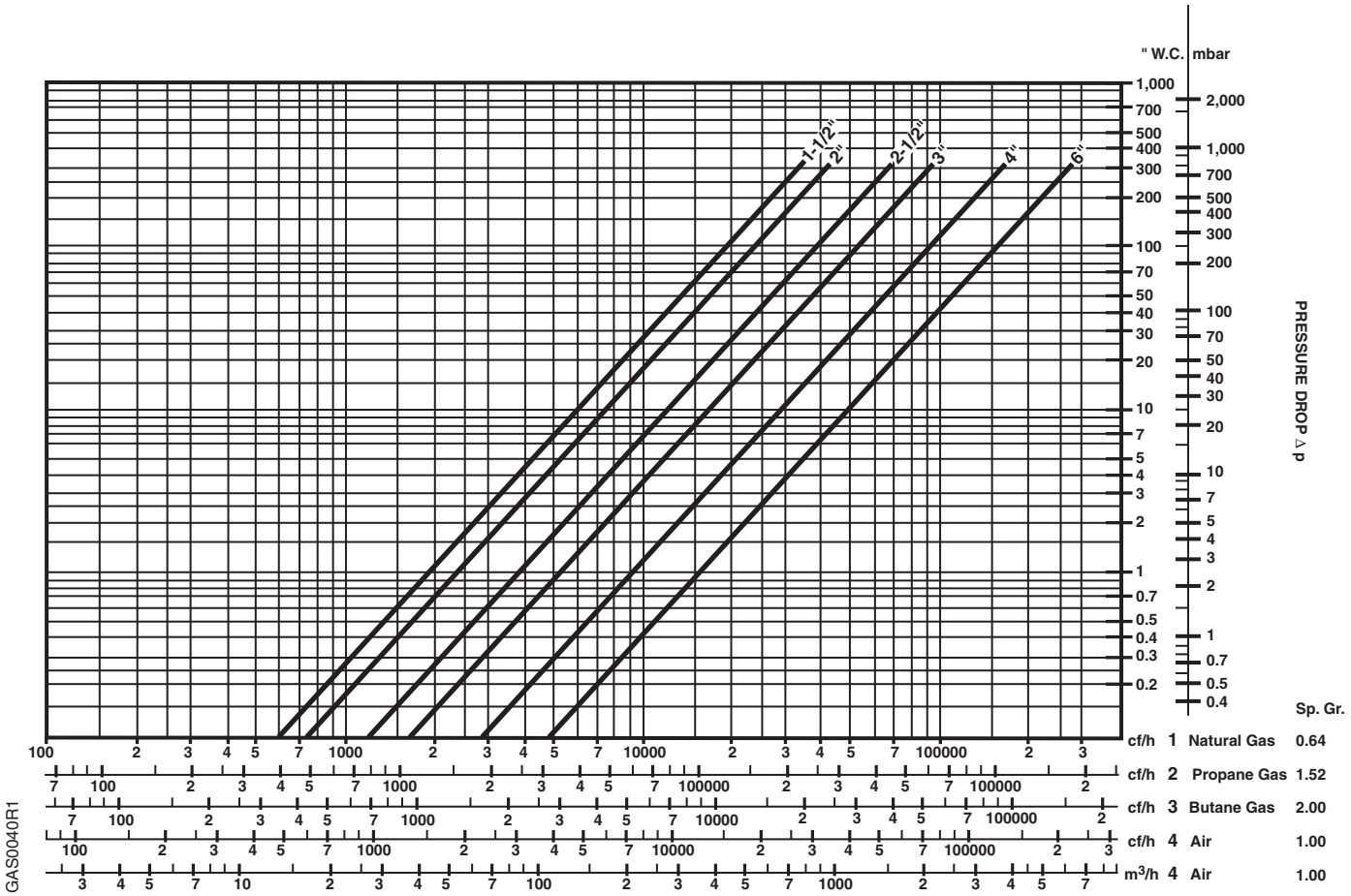


Figure 6. Sizing Double Valves.

NOTE: Pressure drop is total drop across both valves.

CAUTION:

Do not oversize valves equipped with regulating actuators SKP20…, SKP50… or SKP70… Oversizing may limit turndown and could cause oscillations.

Dimensions

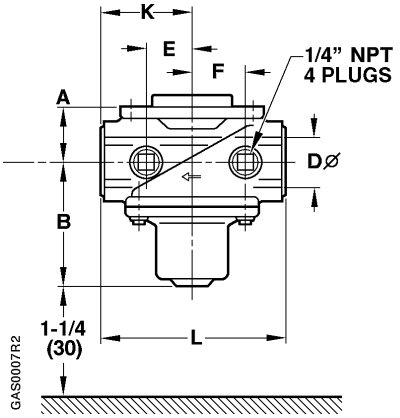


Table 3. VGG… Models.

Valve Model	Nominal Size D Inches	A Inches (mm)	B Inches (mm)	E Inches (mm)	F Inches (mm)	K Inches (mm)	L Inches (mm)	Weight Pounds (kg)
VGG…	1/2	1-1/4 (32)	3-1/8 (79)	1-1/8 (28)	1-7/32 (31)	2-3/16 (55)	4-3/8 (110)	1.65 (0.75)
	3/4	1-1/4 (32)	3-1/8 (79)	1-1/8 (28)	1-7/32 (31)	2-3/16 (55)	4-3/8 (110)	1.65 (0.75)
	1	1-1/4 (32)	3-18 (79)	1-1/8 (28)	1-7/32 (31)	2-3/16 (55)	4-3/8 (110)	1.5 (0.7)
	1-1/2	1-5/8 (41)	4 (102)	1-5/16 (34)	1-5/16 (34)	3 (75)	5-15/16 (150)	3.3 (1.5)
	2	2 (50)	4-1/4 (107)	1-5/16 (34)	1-5/16) (34)	3-3/8 (85)	6-3/4 (170)	4.0 (1.8)
	2-1/2	3-5/8 (92)	6-7/16 (163)	—	2-7/16 (62)	5-11/16 (145)	11-7/16 (290)	32.5 (14.8)
	3	3-15/16 (100)	6-7/16 (163)	—	2-7/16 (62)	6-1/16 (155)	12-3/16 (310)	34 (15.5)

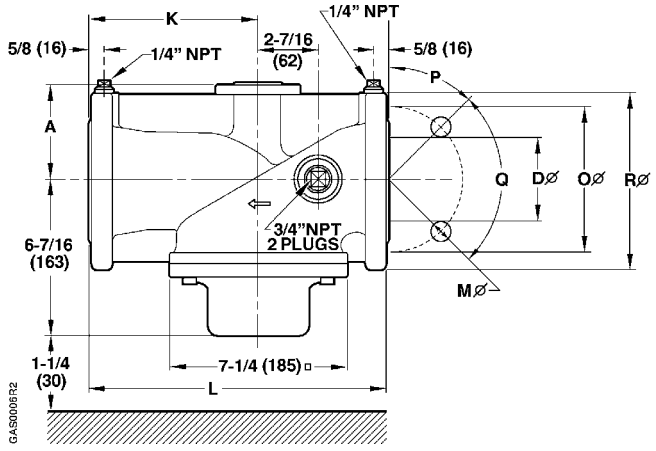


Table 4. VGF… Models.

Valve Model	Nominal Size D Inches	A Inches (mm)	K Inches (mm)	L Inches (mm)	M Inches (mm)	Number of Bolts	O Inches (mm)	P	Q	R Inches (mm)	Weight Pounds (kg)
VGF…	2-1/2	3-5/8 (92)	6-1/2 (165)	11-7/16 (290)	3/4 (19)	4	5-1/2 (140)	45°	90°	7 (178)	46 (20.9)
	3	3-15/16 (100)	6-7/8 (175)	12-3/16 (310)	3/4 (19)	4	6.0 (152)	45°	90°	7-1/2 (191)	46.6 (21.2)

Dimensions, Continued

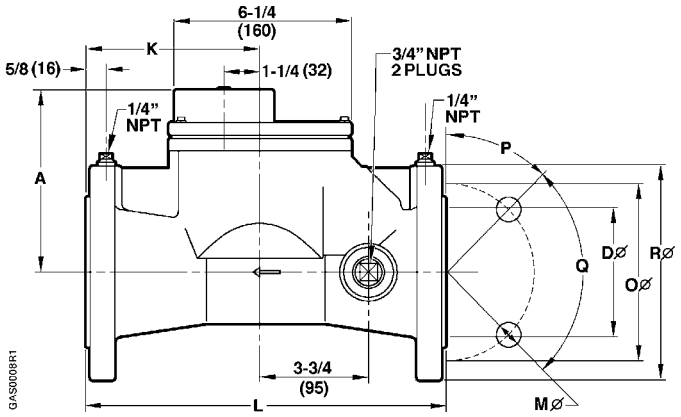


Table 5. VGH… Models.

Valve Model	Nominal Size D Inches	A Inches (mm)	K Inches (mm)	L Inches (mm)	M Inches (mm)	Number of Bolts	O Inches (mm)	P	Q	R Inches (mm)	Weight Pounds (kg)
VGH…	3	6-1/4 (159)	5-15/16 (150)	12-3/16 (310)	3/4 (19)	4	6 (914)	45°	90°	7-1/2 (190)	41.4 (18.8)
	4	6-1/2 (166)	6-1/2 (165)	13-3/4 (350)	3/4 (19)	8	701/2 (190)	22.5°	45°	9 (229)	57 (25.9)
	5	6-7/8 (174)	7-1/2 (190)	15-3/4 (400)	3/4 (19)	8	8-1/2 (216)	22.5°	45°	10 (254)	77 (35.0)

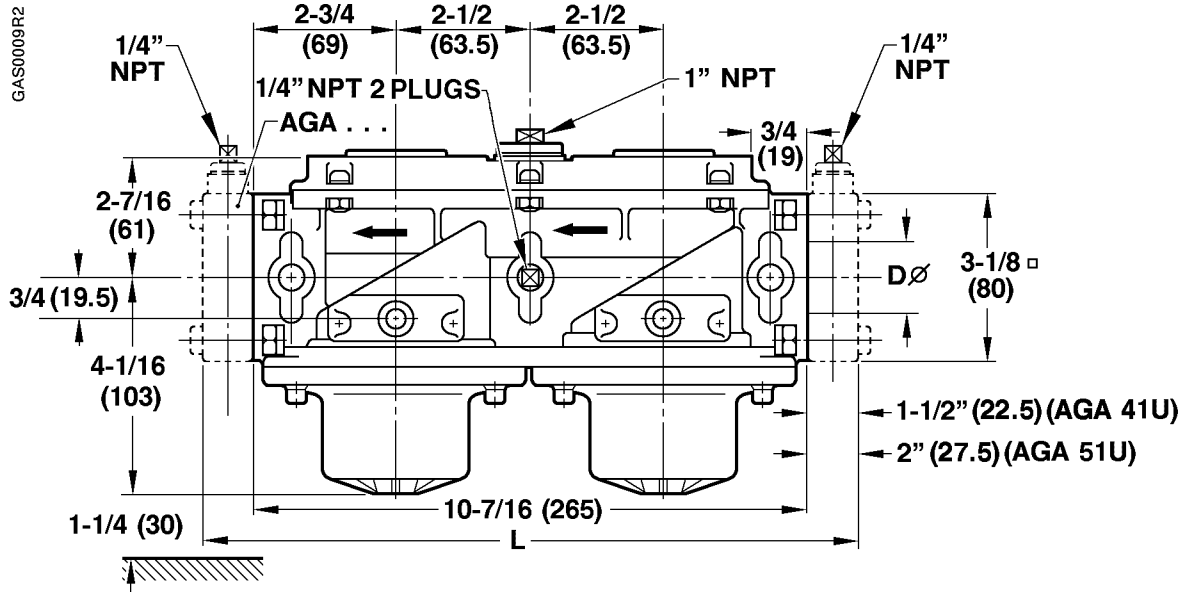


Table 6. VGD20… Models.

Valve Model	Nominal Size D Inches	L Inches (mm)	Weight Pounds (kg)
VGD20…	1-1/2	12-3/16 (310)	7 (3.2)
	2	12-5/8 (320)	6 (3.15)

Dimensions, Continued

Dimensions in Inches (mm)

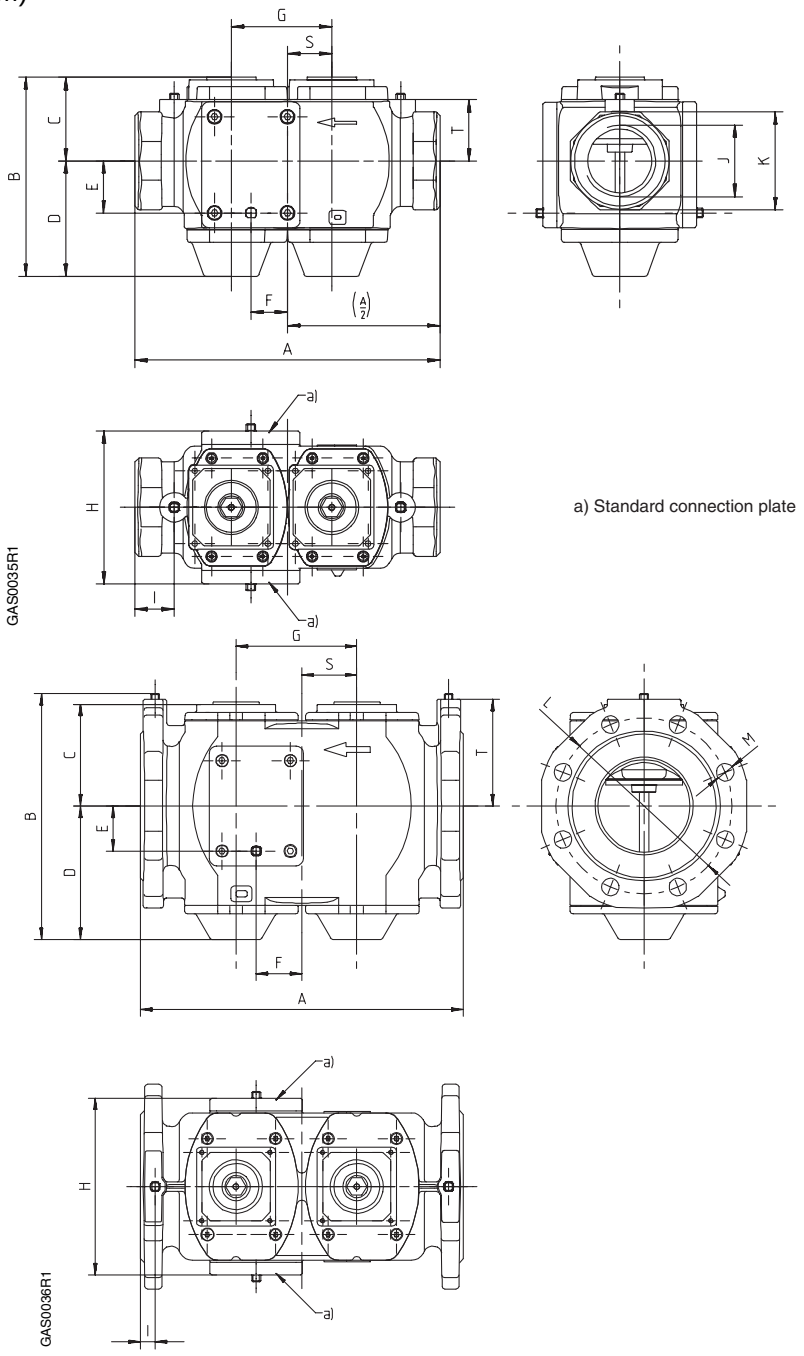


Table 7. VGD40… Models.

Valve Model	A	B	C	D	E	F	G	H	I	J	K *	L	M	S	T
VGD40.065U	12.09 (307)	7.00 (203)	3.25 (83)	4.63 (118)	2.09 (53)	1.46 (37)	4.02 (102)	6.14 (156)	1.57 (40)	2-1/2" NPT	SW 100	—	—	1.77 (45)	2.44 (62)
VGD40.080U	12.87 (327)	8.94 (227)	3.64 (93)	5.18 (132)	1.85 (47)	0.79 (20)	4.21 (107)	6.30 (160)	1.85 (47)	3" NPT	SW 120	—	—	2.34 (60)	2.83 (72)
VGD40.100U	13.78 (350)	10.50 (267)	4.33 (110)	5.70 (145)	1.93 (49)	1.95 (50)	5.16 (131)	7.56 (192)	0.63 (16)	—	—	d=7.50 (191)	d=0.75 (19)	2.34 (60)	4.55 (116)
VGD40.150U	18.90 (480)	13.29 (338)	5.71 (145)	7.40 (188)	2.09 (53)	2.30 (59)	6.61 (168)	10.31 (262)	0.63 (16)	—	—	d=9.49 (241)	d=0.91 (23)	3.54 (90)	5.61 (143)

* Spanner width in millimeters

Dimensions, Continued

Option a) Connection plate with 1/4" NPT plugged pressure test port
b) Vent connection plate with vent line connection and 1/4" NPT plugged pressure test port

Note: Plates a) and b) are interchangeable

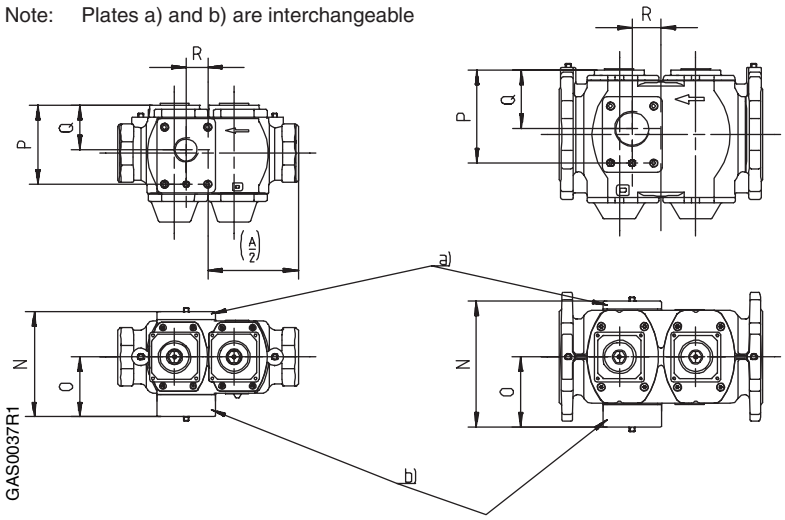
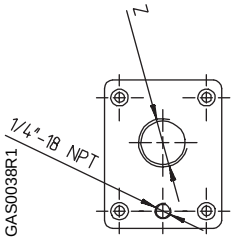


Table 8. VGD40… Dimensions in Inches (Millimeters).

Valve Model	N	O	P	Q	R	Weight Pounds (kg)
VGD40.065U	7.13 (181)	4.06 (103)	5.34 (136)	3.02 (77)	1.46 (37)	16 (7)
VGD40.080U	7.28 (185)	4.13 (105)	5.49 (140)	3.17 (81)	0.79 (20)	19 (3)
VGD40.100U	8.54 (217)	4.76 (121)	6.26 (159)	3.94 (100)	1.95 (50)	29 (13)
VGD40.150U	11.30 (287)	6.14 (156)	7.80 (198)	5.47 (139)	2.30 (59)	53 (24)

Table 9. Vent Connection Plate Dimensions.



	VGD40.065U	VGD40.080U	VGD40.100U	VGD40.150U	Thread Vent Connection Size
AGA40.6580U	X	X			1-1/4" NPT
AGA40.0100U			X		2" NPT
AGA40.0150U				X	2-1/2" NPT

SIEMENS

Technical Instructions
Document No. 155-513P25
SKP10…U..
Rev. 3, July, 2002

SKP Series

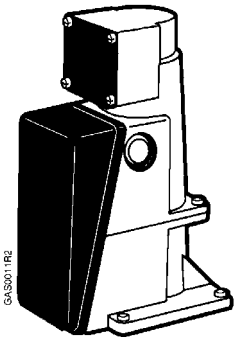
SKP10…U.. Electro-hydraulic Actuators with Safety Shutoff Function For Use With Gas Valves VG…

GAS0001R1

ISO 9001
REGISTERED FIRM

LISTED

FM
APPROVED



Description

SKP10… Electro-hydraulic actuators are used in combination with VG… series gas valves to provide safety shutoff control for industrial and commercial burner applications.

The compact SKP10 actuator opens slowly and closes rapidly upon interruption of power. The two-stage models provide adjustable low and high fire control. The modular design allows the SKP10… to be used in combination with all VG… series gas valves from 1/2-inch to 6-inch size. The actuator is easily mounted on the square flange of any VG… valve with the four bolts **contained in the terminal box of the actuator (under the green cover)**. No gaskets or seals are required when mounting the actuator. The valve position is shown by a visible position indicator displaying the entire stroke range of the actuator.

Features

- UL listed, FM approved, CSA certified for the United States and Canada, IRI approvable, ISO 9001 certified; European, Australian and Japanese approved versions available.
- Proof of Closure-Over Travel (POC-OT) versions available.
- Visual stroke indication.
- Optional auxiliary switches available.
- Modular construction allows 360^{o} rotation of actuator for easy field wiring and installation.
- Low, 23 VA power consumption.

Application

SKP10… series actuators may be combined with 1/2-inch to 6-inch VG… series gas valve bodies. VG… series gas valves are ordered separately (See *VG…U.. Technical Instructions No. 155-512P25*).

Product Numbers

Table 1.

Product Number	Operating Mode	Operating Voltage	Proof of Closure-Over Travel & Auxiliary Switch	Type of Switch
SKP10.110U17	On-Off	110 – 120 Vac	No	—
SKP10.111U17	On-Off	110 – 120 Vac	Auxiliary	SPDT
SKP10.191U17	On-Off	110 – 120 Vac	Proof of Closure-Over Travel	SPDT
SKP10.192U17	On-Off	110 – 120 Vac	Proof of Closure-Over Travel & Auxiliary	SPST SPST
SKP10.110U27	On-Off	220 – 240 Vac	No	—
SKP10.111U27	On-Off	220 – 240 Vac	Auxiliary	SPDT
SKP10.192U27	On-Off	220 – 240 Vac	Proof of Closure-Over Travel & Auxiliary	SPST SPST
SKP10.123U17	Two-stage	110 – 120 Vac	Auxiliary	SPDT
SKP10.923U17	Two-stage	110 – 120 Vac	Proof of Closure-Over Travel	SPDT

Specifications

Agency approvals	As safety shut-off valve	UL/429, FM/7400, ANSI Z21.21/GCA6.5C/I in combination with VG…U.. series gas valves
Power supply	Operating voltage	110 to 120 Vac + 10%-15% 220 to 240 Vac + 10%-15%
	Operating frequency	50 to 60 Hz ± 6%
	Power consumption	23 VA
	Duty cycle	100%
Operating environment	Ambient operating temperature	15°F to 140°F (-10°C to 60°C)
	Mounting position	Optional, but not upside down
Physical characteristics	Weight	2.75 lb (1.25 kg)
	Enclosure	NEMA 1, 2, 5 and 12
	Dimensions	See Figure 2
	Specification for valves	See VG Series *Gas Valves Technical Instructions* *No. 155-512P25*
Connections	Conduit connection	1/2-inch NPSM adapter
Operating characteristics	Output force	100 lb (450 N)
	Maximum stroke	0.7-inch (18 mm)
	Opening time	Varies with valve size, 12 seconds for maximum stroke
	Closing time	<0.8 second
Auxiliary features	Proof of closure-over travel switch	Non-adjustable
	Setting range of auxiliary switch	Full stroke
	Switch rating	6(3)A, 250 Vac
Two-stage control	Setting range of first stage	0 to 100% of stroke
	Setting range of second stage	0 to 100% of stroke

Operation

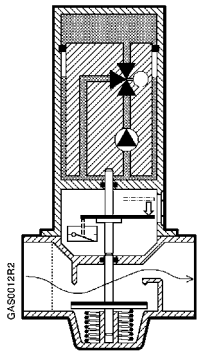


Figure 1. SKP10…U.. Operation.

The electro-hydraulic actuator consists of a cylinder filled with oil and a piston containing an electric oscillating pump. When power is supplied to the actuator, the pump moves oil from the reservoir into the pressure chamber. This action causes the piston to move downward in the cylinder, opening the gas valve. When power to the pump is interrupted, the valve closes in less than 0.8 seconds.

A visible disk fitted to the pump shaft indicates the entire stroke range of the actuator. This disk also operates optional auxiliary switches via a set of levers. The switching position of the auxiliary switch is adjustable over the entire stroke. The proof of closure switch is non-adjustable.

Installation

WARNING:

All installations must be carried out by qualified personnel only.

The SKP10… actuator is directly coupled to the VG… series valve body by four bolts, **contained in the terminal box of the actuator (under the green cover)**. The square mounting flange can be rotated in steps of 90^{o} to provide four different mounting positions. The actuator should be mounted so that the stroke position indicator is visible.

The SKP10… actuator can be mounted in any position except upside down. The actuator can be mounted or replaced while the gas valve is under pressure. The actuator packing contains an electrical conduit adapter to match the 1/2-inch NPSM conduit. If the actuator is equipped with an auxiliary or proof of closure switch, two adapters are included.

NOTE: Wiring must conform to local electrical codes.

Wiring and Switch Adjustment

Adjust the auxiliary switch (if provided) according to the wiring diagram located on the label affixed to the actuator's side. (Also see *Terminal Designations*.)

Auxiliary and Proof of Closure Switch

NOTES:

1. The auxiliary switch must not be used for proof of closure detection or other interlock functions.
2. The Proof of Closure Switch is non-adjustable.

Two-stage control

See the *wiring diagram located on the label affixed to the actuator's side*.

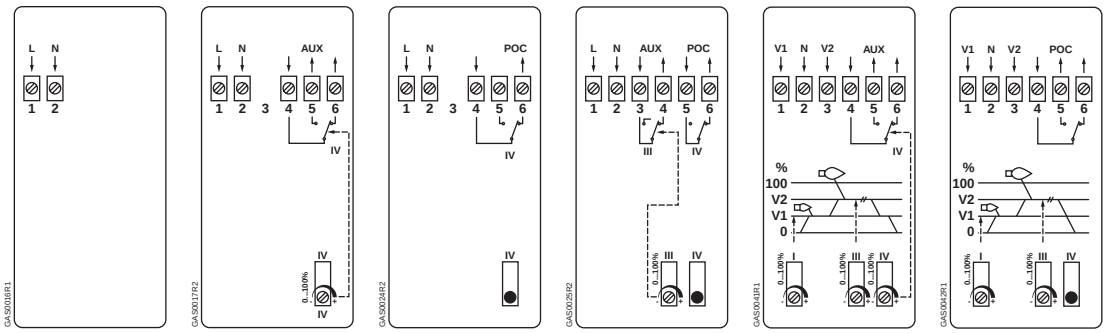
Connect the low fire power supply to Terminal 1, neutral to Terminal 2 and high fire power supply to Terminal 3.

Adjust the low fire and high fire positions according to the wiring diagram located on the label affixed to the actuator's side. (Also see *Terminal Designations*.)

Service

There are no serviceable parts on the SKP10… Series actuators. If inoperative, replace the actuator. Tag wires before replacing.

Terminal Designations



SKP10.110U | SKP10.111U.. | SKP10.191U.. | SKP10.192U.. | SKP10.123U | SKP10.923U

Dimensions

(Dimensions in inches; millimeters in parentheses)

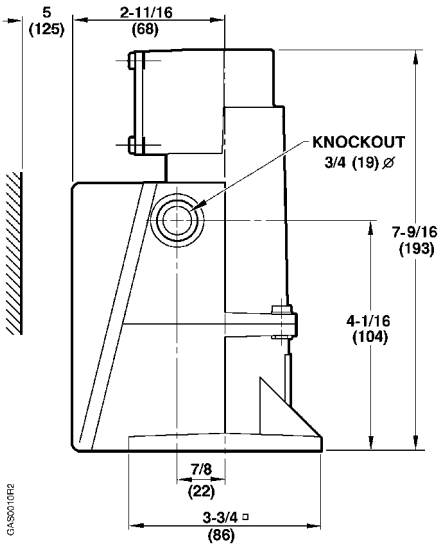


Figure 2. SKP10…U.. Dimensions.

Data 720
5/03

Eclipse Combustion

Butterfly Valves

Full Port & Reduced Port

version 2

Product Description

Eclipse Butterfly Valves are designed to control air and gas flow to all types of combustion systems. *They **should not** be used as tight shut-off valves.*

Types available

Valves are available for either manual or automatic control and in either full port or reduced port construction in 1/2" through 4", with NPT or Rc threads. High pressure drop valves are also available in 1/2", 3/4" and 1". Wafer type valves are available in 6" and 8".

Thread Connections

The 1/2" through 4" valves are available with either NPT or Rc threads. The 6" and 8" valves are wafer type butterfly valves designed to be sandwiched between flanges on connecting pipes.

Shutters

NPT versions: Furnished with beveled or nonbeveled shutters.

Rc versions: Furnished with nonbeveled shutters.

Indication

All Eclipse butterfly valves feature an easy to read indicator plate and a slot on the end of the shaft to provide visual indication of the disc position.

Control

Manual butterfly valves 4" and smaller have an adjusting cover for setting disc position. A locking screw secures the cover at the desired setting.

Automatic control butterfly valves are furnished with a control arm that can be attached to the shaft. This allows integration with a variety of position control devices.

Manual wafer butterfly valves are adjusted by rotating a control arm which can be locked to the indicating plate after positioning.

Manual Control BV

Automatic Control BV

Accessories

Eclipse stocks a selection of electric operators and mounting kits which can be ordered separately. The extended shaft length on the automatic butterfly valves allows the addition of either a second control arm for simultaneous automatic operation in dual valve applications, or a cam for a high/low fire microswitch arrangement.

Note:

ALL 1/2" Butterfly Valves (NPT/Rc, Manual/Automatic Beveled/Non-beveled) DO NOT have a "separate" shutter. The shutter is part of the shaft. The terms beveled and non-beveled do not apply to any of the 1/2" Butterfly Valves covered in this Data Sheet.

Main Specifications

PARAMETER	SPECIFICATIONS		
Maximum operating pressure:	1/2" thru 4" 6" & 8"	5 psig 3 psig	350 mbar 210 mbar
Operating temperature range:	NPT version Rc version	-40 to 140˚ F. 32 to 140˚ F.	-40 to 60˚ C. 0 to 60˚ C.
Materials of construction:	Body: Shaft: Shutter: Shaft Packing Seal:	Powder Coated Cast Iron Zinc plated steel Carbon steel Nitrile rubber (Buna-N)	
Approvals:	UL All models	CE Rc 1/2 thru Rc 3 models only	
Typical application:	Control of air or gas flow in combustion system		
Notes on European applications:	4" screwed not acceptable for gas use. 3" screwed is acceptable if pressure is limited to 100 mbar (1.5 psig).		

ECLIPSE™ Innovative Thermal Solutions

NPT Model Selection and Capacities

NPT Size	Full Port Valves						Reduced Port Valves			
	Manual		Automatic				Manual		Automatic	
	Beveled shutter 75º rotation		Beveled shutter 75º rotation		Nonbeveled shutter 360º rotation		Beveled shutter 75º rotation		Beveled shutter 75º rotation	
	Catalog Number	Item Code	Catalog Number	Item Code	Catalog Number	Item Code	Catalog Number	Item Code	Catalog Number	Item Code
1/2"	102BV-B	501238	--------	--------	2BV-A	501239	--------	--------	--------	--------
3/4"	103BV-B	501215	3BV-AB	501223	3BV-A	501200	--------	--------	--------	--------
1"	104BV-B	501216	4BV-AB	501224	4BV-A	501201	104BV-RB	501208	4BV-ARB	501231
1-1/4"	105BV-B	501217	5BV-AB	501225	5BV-A	501202	105BV-RB	501209	5BV-ARB	501232
1-1/2"	106BV-B	501218	6BV-AB	501226	6BV-A	501203	106BV-RB	501210	6BV-ARB	501233
2"	108BV-B	501219	8BV-AB	501227	8BV-A	501204	108BV-RB	501211	8BV-ARB	501234
2-1/2"	110BV-B	501220	10BV-AB	501228	10BV-A	501205	110BV-RB	501212	10BV-ARB	501235
3"	112BV-B	501221	12BV-AB	501229	12BV-A	501206	112BV-RB	501213	12BV-ARB	501236
4"	116BV-B	501222	16BV-AB	501230	16BV-A	501207	116BV-RB	501214	16BV-ARB	501237
6" wafer	124BV-B	500915	24BV-AB	500998	--------	--------	124BV-RB	500690	24BV-ARB	500975
8" wafer	132BV-B	500913	32BV-AB	500999	--------	--------	132BV-RB	500691	32BV-ARB	500976

NPT Size	High Pressure Drop Valve			
	Manual		Automatic	
	Nonbeveled shutter 90° rotation		Nonbeveled shutter 360° rotation	
	Catalog Number	Item Code	Catalog Number	Item Code
1/2"	402BV-HD	100129	402BV-AHD	100130
3/4"	403BV-HD	100133	403BV-AHD	100134
1"	404BV-HD	100119	404BV-AHD	100123

Note: Wafer Butterfly Valves are not threaded. For dimensional information, see page 6.

Multifactors for gases other than air

Gas - Sp. Gr.	Natural - .6	Propane - 1.5	Butane - 2.0
Multifactor	1.29	.81	.70

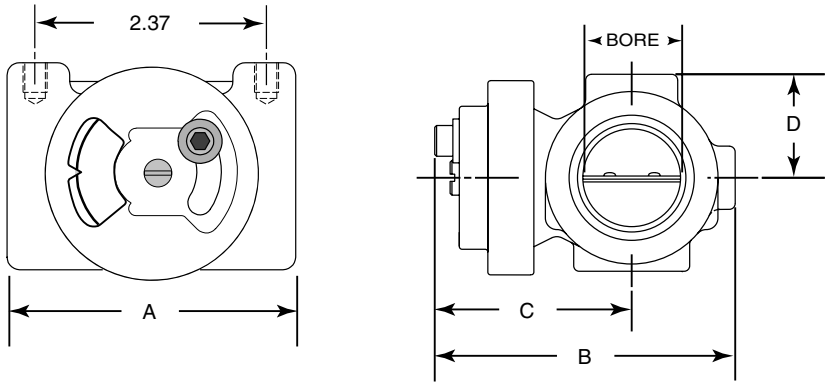
NPT Size	Flow Coefficient Cv-Full Open	Full Port								
		Capacity scfh air - "wc pressure drop								
		0.5	0.75	1	1.5	2	3	4	6	8
1/2"	5.5	173	212	244	299	345	422	487	595	685
3/4"	15.9	500	612	706	865	998	1,221	1,408	1,720	1,982
1"	29.7	933	1,143	1,319	1,615	1,864	2,280	2,630	3,213	3,702
1-1/4"	65.9	2,071	2,536	2,927	3,583	4,135	5,059	5,835	7,129	8,213
1-1/2"	111.0	3,489	4,272	4,931	6,036	6,965	8,521	9,828	12,009	13,834
2"	180.0	5,657	6,927	7,996	9,788	11,295	13,818	15,937	19,473	22,433
2-1/2"	322.0	10,121	12,391	14,304	17,509	20,206	24,719	28,510	34,836	40,131
3"	457.0	14,364	17,587	20,301	24,850	28,677	35,082	40,462	49,441	56,956
4"	819.0	25,741	31,517	36,383	44,534	51,394	62,871	72,513	88,604	102,072
6" wafer	2600.0	81,718	100,055	115,501	141,377	163,154	199,591	230,201	281,283	324,039
8" wafer	4200.0	132,007	161,628	186,578	228,379	263,557	322,417	371,864	454,380	523,448

NPT Size	Flow Coefficient Cv-Full Open	Reduced Port								
		Capacity scfh air - "wc pressure drop								
		0.5	0.75	1	1.5	2	3	4	6	8
1"	14.1	443	543	626	767	885	1,082	1,248	1,525	1,757
1-1/4"	22.8	717	877	1,013	1,240	1,431	1,750	2,019	2,467	2,842
1-1/2"	31.4	987	1,208	1,395	1,707	1,970	2,410	2,780	3,397	3,913
2"	62.7	1,971	2,413	2,785	3,409	3,935	4,813	5,551	6,783	7,814
2-1/2"	87.9	2,763	3,383	3,905	4,780	5,516	6,748	7,783	9,510	10,955
3"	149.0	4,683	5,734	6,619	8,102	9,350	11,438	13,192	16,120	18,570
4"	244.0	7,669	9,390	10,839	13,268	15,311	18,731	21,604	26,397	30,410
6" wafer	553.0	17,381	21,281	24,566	30,070	34,702	42,452	48,962	59,827	68,921
8" wafer	721.5	22,677	27,765	32,051	39,232	45,275	55,387	63,881	78,056	89,921

NPT Size	Flow Coefficient Cv-Full Open	High Pressure Drop								
		Capacity scfh air - "wc pressure drop								
		0.5	0.75	1	1.5	2	3	4	6	8
1/2"	2.7	85	104	120	147	169	207	239	292	337
3/4"	3.2	101	123	142	174	201	246	283	346	399
1"	4.2	132	162	187	228	264	322	372	454	523

Dimensions, Manual Valves with NPT threads

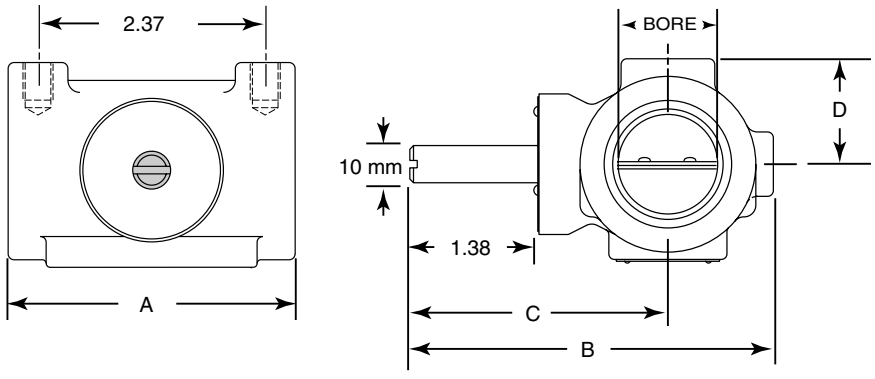
NPT Size	FULL PORT Beveled shutter 75˚ rotation			REDUCED PORT Beveled shutter 75˚ rotation			HIGH PRESSURE DROP 90˚ rotation			Dimensions, inches			
	Catalog Number	Item Code	BORE Inches	Catalog Number	Item Code	BORE Inches	Catalog Number	Item Code	BORE Inches	A	B	C	D
1/2	102BV-B	501238	0.61	-	-	-	402BV-HD	100129	0.44	3.00	3.05	2.05	1.19
3/4	103BV-B	501215	0.87	-	-	-	403BV-HD	100133	0.55	3.00	3.07	2.07	1.06
1	104BV-B	501216	1.10	104BV-RB	501208	0.87	404BV-HD	100119	2 x 0.44	2.87	3.33	2.14	1.31
1-1/4	105BV-B	501217	3.12	105BV-RB	501209	1.02				3.12	3.58	2.26	1.50
1-1/2	106BV-B	501218	1.46	106BV-RB	501210	1.18				3.12	3.82	2.38	1.63
2	108BV-B	501219	2.13	108BV-RB	501211	1.53				3.12	4.45	2.70	1.94
2-1/2	110BV-B	501220	2.64	110BV-RB	501212	1.77				3.87	5.09	3.09	2.25
3	112BV-B	501221	3.23	112BV-RB	501213	2.24				3.87	5.58	3.33	2.50
4	116BV-B	501222	4.17	116BV-RB	501214	2.80				5.00	6.65	3.84	3.06



Dim: inches

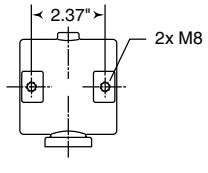
Dimensions, Automatic Valves with NPT threads

NPT Size	FULL PORT Beveled shutter 75˚ rotation		Nonbeveled shutter 360˚ rotation			REDUCED PORT Beveled shutter 75˚ rotation			HIGH PRESSURE DROP 360˚ rotation			Dimensions, inches			
	Catalog No.	Item Code	Catalog No.	Item Code	BORE In.	Catalog No.	Item Code	BORE In.	Catalog Number	Item Code	BORE In.	A	B	C	D
1/2	2BV-AB	501239	-	-	0.61	-	-	-	402BV-AHD	100130	0.44	3.00	3.66	2.66	1.19
3/4	3BV-AB	501223	3BV-A	501200	0.87	-	-	-	403BV-AHD	100134	0.55	3.00	3.60	2.60	1.06
1	4BV-AB	501224	4BV-A	501201	1.10	4BV-ARB	501231	0.87	404BV-AHD	100123	2 x 0.44	2.87	3.90	2.78	1.31
1-1/4	5BV-AB	501225	5BV-A	501202	1.46	5BV-ARB	501232	1.02				3.12	4.22	2.90	1.50
1-1/2	6BV-AB	501226	6BV-A	501203	1.65	6BV-ARB	501233	1.18				3.12	4.47	3.03	1.63
2	8BV-AB	501227	8BV-A	501204	2.13	8BV-ARB	501234	1.54				3.12	5.09	3.34	1.94
2-1/2	10BV-AB	501228	10BV-A	501205	2.64	10BV-ARB	501235	1.77				3.87	5.72	3.72	2.25
3	12BV-AB	501229	12BV-A	501206	3.23	12BV-ARB	501236	2.24				3.87	6.22	3.97	2.50
4	16BV-AB	501230	16BV-A	501207	4.17	16BV-ARB	501237	2.80				5.00	7.28	4.47	3.06



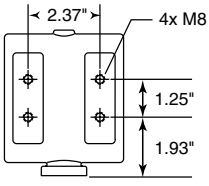
Dim: inches

Actuator Bracket Mounting Holes



1/2" thru 2-1/2"

Dim: inches



3" & 4"

Dim: inches

Rc Model Selection and Capacities

Rc Size	Full Port Valves				Reduced Port Valves			
	Manual		Automatic		Manual		Automatic	
	Nonbeveled shutter 90° rotation		Nonbeveled shutter 360° rotation		Nonbeveled shutter 90° rotation		Nonbeveled shutter 360° rotation	
	Catalog Number	Item Code	Catalog Number	Item Code	Catalog Number	Item Code	Catalog Number	Item Code
1/2	102BVM	101103	2BVM-A	202081	--------	--------	--------	--------
3/4	103BVM	101104	3BVM-A	101248	--------	--------	--------	--------
1	104BVM	101105	4BVM-A	101249	104BVM-R	101255	4BVM-AR	101261
1-1/4	--------	--------	--------	--------	--------	--------	--------	--------
1-1/2	106BVM	101106	6BVM-A	101250	106BVM-R	101256	6BVM-AR	101262
2	108BVM	101107	8BVM-A	101251	108BVM-R	101257	8BVM-AR	101263
2-1/2	110BVM	101108	10BVM-A	101252	110BVM-R	101258	10BVM-AR	101264
3	112BVM	101109	12BVM-A	101253	112BVM-R	101259	12BVM-AR	101265
4*	116BVM	101110	16BVM-A	101254	116BVM-R	101260	16BVM-AR	101266

6" wafer
8" wafer

Note: Selection information for these valves appears on page 2. Wafer BV Valves are not threaded and may be used with DN 150 and DN 200 flanged fittings. Dimensions page 6.

Rc Size	High Pressure Drop Valve			
	Manual		Automatic	
	Nonbeveled shutter 90° rotation		Nonbeveled shutter 360° rotation	
	Catalog Number	Item Code	Catalog Number	Item Code
1/2	402BVM-HD	100131	402BVM-AHD	100132
3/4	403BVM-HD	100135	403BVM-AHD	100136
1	404BVM-HD	100120	404BVM-AHD	100100

Multifactors for gases other than air

Gas - Sp. Gr.	Natural - .6	Propane - 1.5	Butane - 2.0
Multifactor	1.29	.81	.70

Rc Size	Flow Coefficient Kv-Full Open	Full Port							
		Capacity nm^3/h air - mbar pressure drop							
		1	2	3	5	8	10	13	15
1/2"	4.7	4	6	7	9	12	13	15	16
3/4"	13.7	12	17	21	27	34	38	43	46
1"	25.5	22	32	39	50	63	70	80	86
1-1/2"	95.8	84	118	145	187	236	264	300	322
2"	155.0	136	192	234	302	382	427	486	521
2-1/2"	277.0	242	342	419	541	683	763	868	932
3"	393.0	344	486	595	767	969	1,082	1,232	1,322
4"*	704.0	615	870	1,065	1,374	1,735	1,938	2,207	2,368
6" wafer*	2251.0	1,968	2,782	3,405	4,392	5,548	6,197	7,056	7,572
8" wafer*	3637.0	3,180	4,495	5,502	7,097	8,964	10,013	11,400	12,234

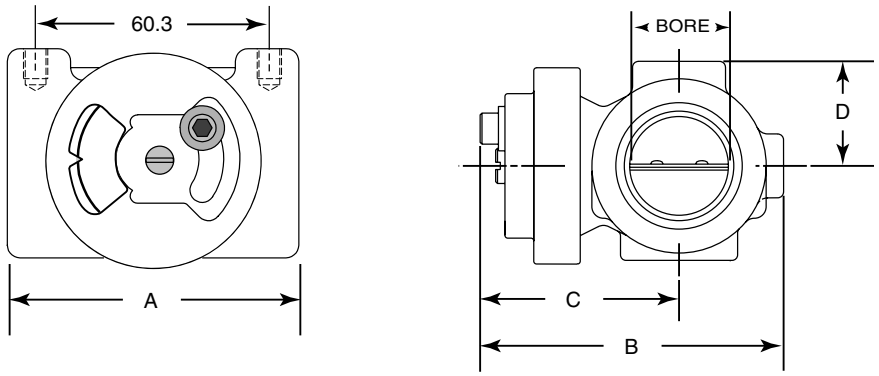
Rc Size	Flow Coefficient Kv-Full Open	Reduced Port							
		Capacity nm^3/h air - mbar pressure drop							
		1	2	3	5	8	10	13	15
1"	12.1	11	15	18	24	30	33	38	41
1-1/2"	27.0	24	33	41	53	67	74	85	91
2"	53.9	47	67	82	105	133	148	169	181
2-1/2"	75.9	66	94	115	148	187	209	238	255
3"	128.0	112	158	194	250	315	352	401	431
4"*	210.0	184	260	318	410	518	578	658	706
6" wafer*	479.0	419	592	725	935	1,181	1,319	1,501	1,611
8" wafer*	625.0	546	772	946	1,220	1,540	1,721	1,959	2,102

Rc Size	Flow Coefficient Kv-Full Open	High Pressure Drop							
		Capacity nm^3/h air - mbar pressure drop							
		1	2	3	5	8	10	13	15
1/2"	2.3	2.0	2.8	3.5	4.5	5.7	6.3	7.2	7.7
3/4"	2.8	2.4	3.5	4.2	5.5	6.9	7.7	8.8	9.4
1"	3.6	3.1	4.4	5.4	7.0	8.9	9.9	11.3	12.1

** 4" screwed valve not approved for European use.*
6" and 8" wafer type may be used with DN150 and DN200 flanged fittings.

Dimensions, Manual Valves with Rc threads

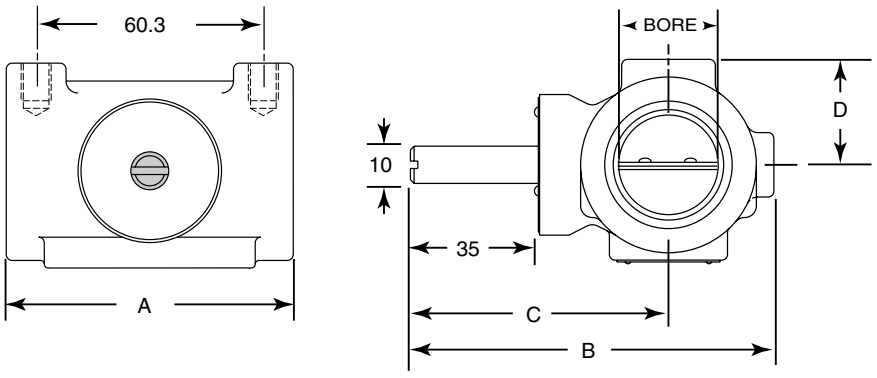
Rc Size	FULL PORT Nonbeveled shutter 90˚ rotation			REDUCED PORT Nonbeveled shutter 90˚ rotation			HIGH PRESSURE DROP 90˚ rotation			Dimensions, mm			
	Catalog Number	Item Code	BORE mm	Catalog Number	Item Code	BORE mm	Catalog Number	Item Code	BORE mm	A	B	C	D
1/2	102BVM	101103	15.5	-	-	-	402BVM-HD	100131	11.1	76.2	77.5	52.1	30.2
3/4	103BVM	101104	22	-	-	-	403BVM-HD	100135	13.9	76.2	77.9	52.5	27.0
1	104BVM	101105	28	104BVM-R	101255	22	404BVM-HD	100120	2 x 11.1	73.0	84.7	54.5	33.3
1-1/2	106BVM	101106	42	106BVM-R	101256	30				79.4	97.0	60.5	41.3
2	108BVM	101107	54	108BVM-R	101257	39				79.4	113.0	68.5	49.2
2-1/2	110BVM	101108	67	110BVM-R	101258	45				98.4	129.2	78.5	57.2
3	112BVM	101109	82	112BVM-R	101259	57				98.4	141.7	84.5	63.5
4	116BVM	101110	106	116BVM-R	101260	71				127.0	168.9	97.5	77.8



Dim: mm

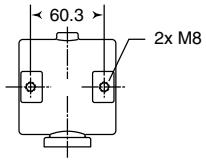
Dimensions, Automatic Valves with Rc Threads

Rc Size	FULL PORT Nonbeveled shutter 360˚ rotation			REDUCED PORT Nonbeveled shutter 360˚ rotation			HIGH PRESSURE DROP 360˚ rotation			Dimensions, mm			
	Catalog Number	Item Code	BORE mm	Catalog Number	Item Code	BORE mm	Catalog Number	Item Code	BORE mm	A	B	C	D
1/2	2BVM-A	202081	15.5	-	-	-	402BVM-AHD	100132	11.1	76.2	93.0	67.7	30.2
3/4	3BVM-A	101248	22	-	-	-	403BVM-AHD	100136	13.9	76.2	91.3	65.9	27.0
1	4BVM-A	101249	28	4BVM-AR	101261	22	404BVM-AHD	100100	2 x 11.1	73.0	99.2	70.6	33.3
1-1/2	6BVM-A	101250	42	6BVM-AR	101262	30				79.4	113.5	77.0	41.3
2	8BVM-A	101251	54	8BVM-AR	101263	39				79.4	129.4	84.9	49.2
2-1/2	10BVM-A	101252	67	10BVM-AR	101264	45				98.4	145.3	94.5	57.2
3	12BVM-A	101253	82	12BVM-AR	101265	57				98.4	158.0	100.8	63.5
4	16BVM-A	101254	106	16BVM-AR	101266	71				127.0	184.9	113.5	77.8



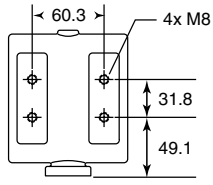
Dim: mm

Actuator Bracket Mounting Holes



1/2" thru 2-1/2"

Dim: mm

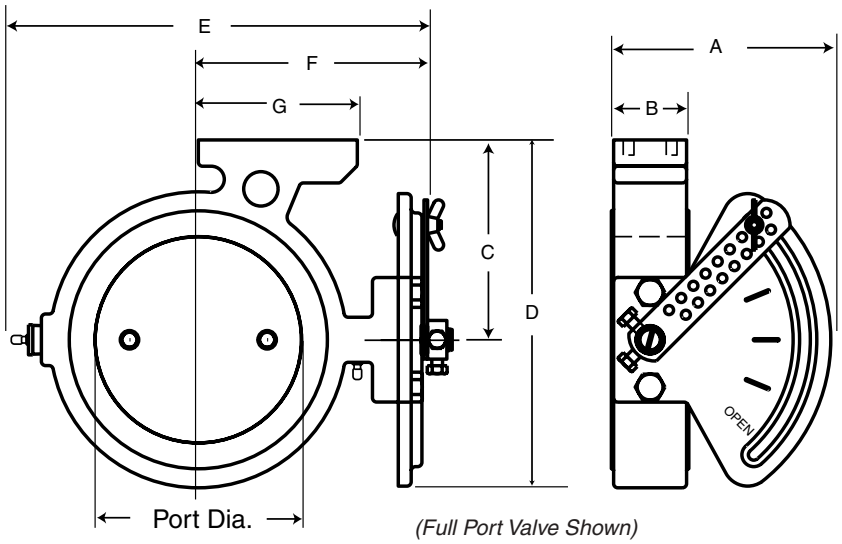


3" & 4"

Dim: mm

Dimensions, Wafer type valves

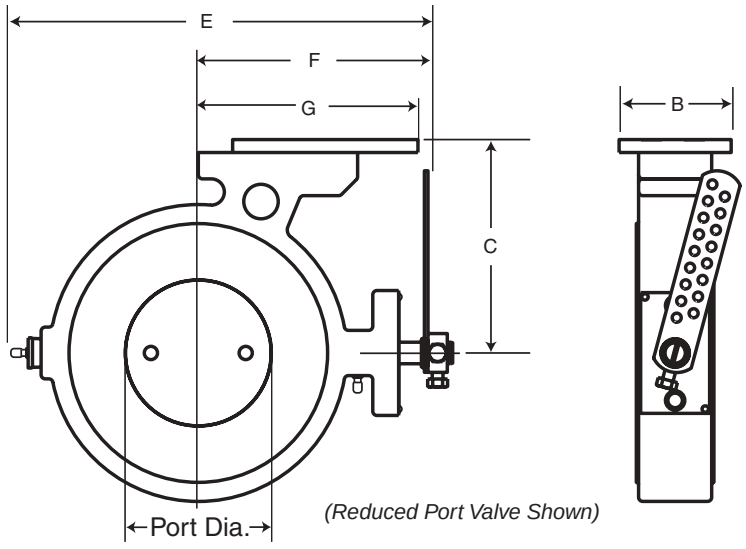
Manual valves



(Full Port Valve Shown)

Size	Cat. No.	Item Code	Dimensions mm (in) A	B	C	D	E	F	G	Port Dia.	Approx Wgt. kg (lb)
Full Port Manual											
6"	124BV-B	500915	162 (6.38)	57 (2.25)	148 (5.81)	257 (10.13)	289 (11.38)	97 (3.81)	117 (4.63)	152 (6.00)	13 (28)
8"	132BV-B	500913	162 (6.38)	57 (2.25)	178 (7.00)	317 (12.47)	351 (13.81)	206 (8.13)	130 (5.13)	203 (8.00)	16 (36)
Reduced Port Manual											
6"	124BV-RB	500690	162 (6.38)	57 (2.25)	148 (5.81)	257 (10.13)	289 (11.38)	97 (3.81)	117 (4.63)	108 (4.25)	16 (35)
8"	132BV-RB	500691	162 (6.38)	57 (2.25)	178 (7.00)	317 (12.47)	351 (13.81)	206 (8.13)	130 (5.13)	130 (5.12)	23 (50)

Automatic Valves



(Reduced Port Valve Shown)

Size	Cat. No.	Item Code	Dimensions mm (in) A	B	C	D	E	F	G	Port Dia.	Approx Wgt. kg (lb)
Full Port Auto											
6"	24BV-AB	500998	162 (6.38)	83 (3.25)	157 (6.18)	257 (10.13)	289 (11.38)	97 (3.81)	162 (6.38)	152 (6.00)	13 (28)
8"	32BV-AB	500999	162 (6.38)	83 (3.25)	187 (7.38)	317 (12.47)	351 (13.83)	206 (8.13)	193 (7.60)	203 (8.00)	16 (36)
Reduced Port Auto											
6"	24BV-ARB	500975	162 (6.38)	83 (3.25)	157 (6.18)	257 (10.13)	289 (11.38)	97 (3.81)	162 (6.38)	108 (4.25)	16 (35)
8"	32BV-ARB	500976	162 (6.38)	83 (3.25)	187 (7.38)	317 (12.47)	351 (13.81)	206 (8.13)	193 (7.60)	130 (5.12)	23 (50)

Accessories for automatic BV's

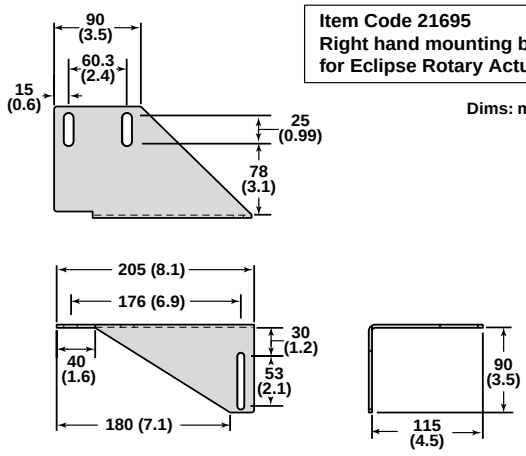
Control Motor Mounting Kits	Kit Item Code	Major Components: Bracket	Control Rod	Coupling	Crank Arm
Eclipse Rotary Actuator					
RH mount, 1/2 thru 4, ver. 1	**100124**	21695	Rod not required	20697	Crank arms not required
LH mount, 1/2 thru 4, ver. 1	**100125**	21696		20697	
RH mount, 1/2 thru 4, ver. 2	**100127**	21695		21048	
LH mount, 1/2 thru 4, ver. 2	**100128**	21696		21048	
Perpendicular mount, 1/2 thru 1-1/2, ver. 2	**100190**	21934		21048	
Perpendicular mount, 2 & 2-1/2, ver. 2	**100191**	21935		21048	
Perpendicular mount, 3 & 4, ver. 2	**100192**	21936		21048	
EMP/EMA, Honeywell					
1/2 thru 4 ver. 1	**500928**	13095	12730-1	14264	500527
1/2 thru 4 ver. 2	**100099**	13095	12730-1	14264	102265
6 and 8 valves	**500928-1**	13095	12730-2	14264	500537
Honeywell M640 & M940					
1/2 thru 4 ver. 1	**500758**	13095 & 12758	12730-1	14264	500527
1/2 thru 4 ver. 2	**120079**	13095 & 12758	12730-1	14264	102265

Notes:

- Each Eclipse ver. 2 automatic BV is sold with a Control Motor Arm, Item Code 102265.
- Control Motor Mounting Kits contain brackets, couplings and misc. screws & washers.
- The kits used with EMP/EMA and Honeywell valves also contain a control rod and crank arm.
- These mounting kits are designed to work with a majority of installations. Some applications may require special components.
- Not all kit components are available for individual sale.
- Contact the factory or your Eclipse representative for more detailed information.

Item Code 21695
Right hand mounting bracket for Eclipse Rotary Actuator

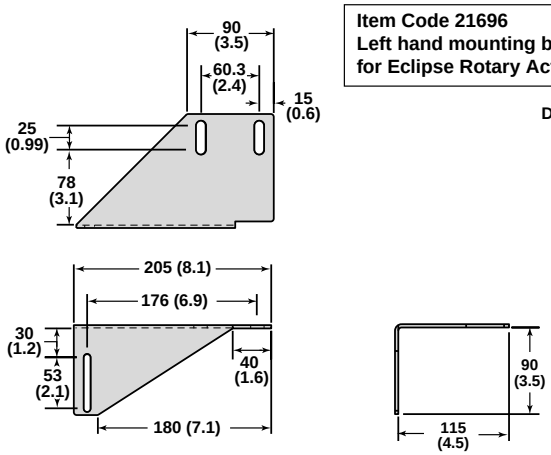
Dims: mm (in.)



Material:
Powder coated mild steel, 3.4mm (0.13) nominal thickness.

Item Code 21696
Left hand mounting bracket for Eclipse Rotary Actuator

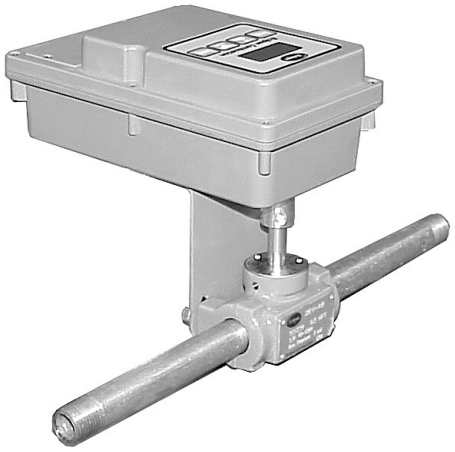
Dims: mm (in.)

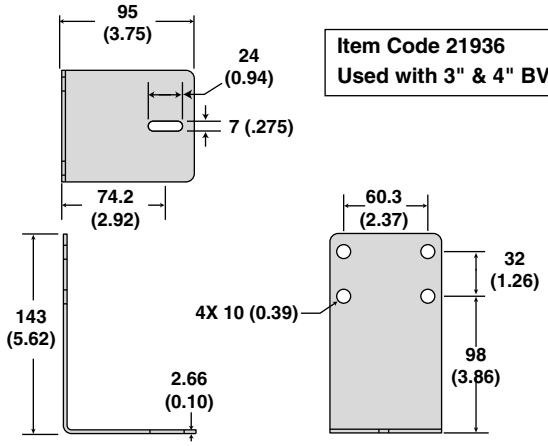


Material:
Powder coated mild steel, 3.4mm (0.13) nominal thickness.

Accessories for automatic BV's (continued)

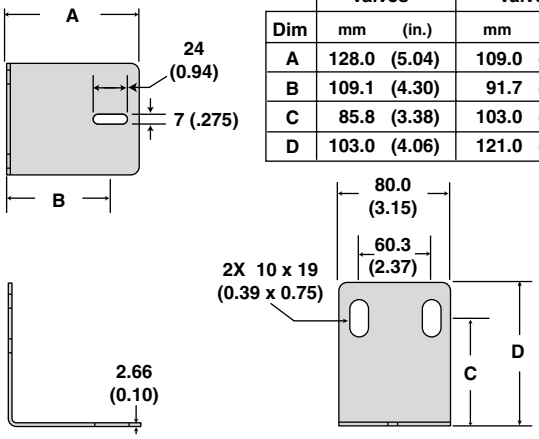
Perpendicular Brackets for Eclipse Rotary Actuator





Item Code 21936
Used with 3" & 4" BV's

Material:
Powder coated mild steel, 3.4mm (0.13) nominal thickness.

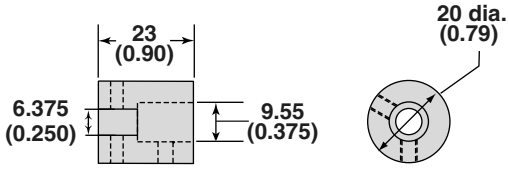


	Item Code	
	21934 use with 1/2 to 1-1/2 valves	21935 use with 2 to 2-1/2 valves
Dim	mm (in.)	mm (in.)
A	128.0 (5.04)	109.0 (4.29)
B	109.1 (4.30)	91.7 (3.61)
C	85.8 (3.38)	103.0 (4.06)
D	103.0 (4.06)	121.0 (4.76)

Material:
Powder coated mild steel, 3.4mm (0.13) nominal thickness.

Couplings for Eclipse Rotary Actuator

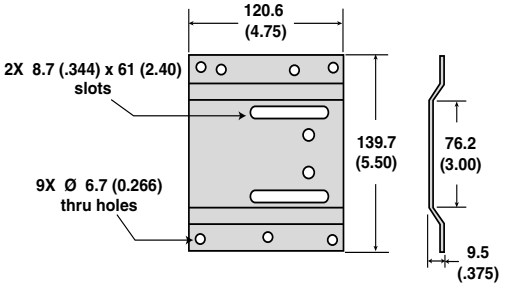
Item Code 20697
Coupling for Eclipse Rotary Actuator
Used with ver. 1 BV's (3/8" dia. shaft)



Material: T7075-T6 Aluminum

Item Code 13095
Mounting plate

Dims: mm (in.)

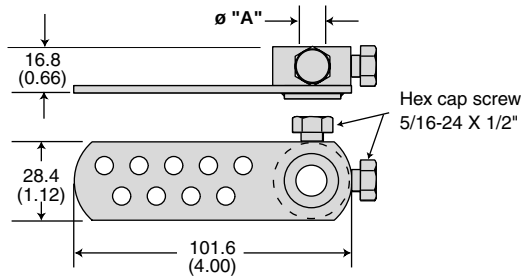


Material: Powder coated mild steel

Accessories for automatic BV's (continued)

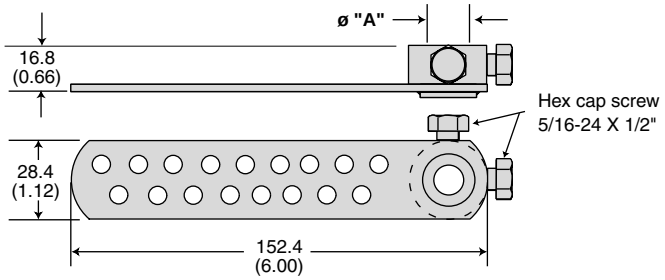
Crank arms for general use

Crank Arm Item Code	DIM "A" mm	(in.)
500527	9.6	(0.380)
500535	12.8	(0.505)
500536	16.0	(0.630)



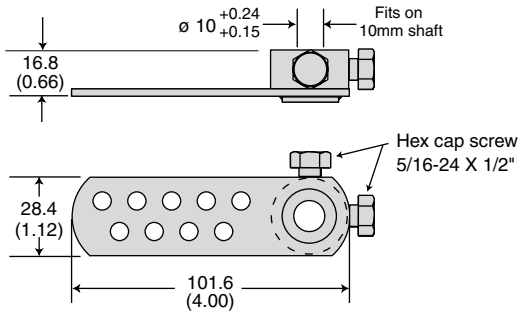
Materials: Zinc plated carbon steel

Crank Arm Item Code	DIM "A" mm	(in.)
500537	16.0	(0.630)
500538	9.6	(0.380)
500539	12.8	(0.505)



Materials: Zinc plated carbon steel

Item Code 102265 **Dims: mm (in.)**



Materials: Zinc plated carbon steel

Linkage control rods

Zinc plated cold rolled steel

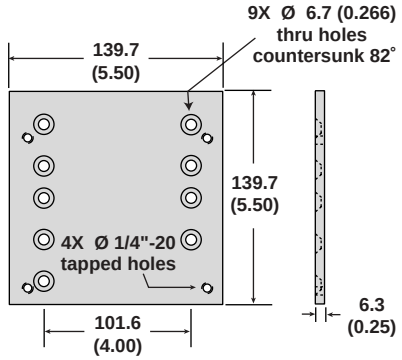
Dia. Inches	Item Code	Length In.	(mm)
5/16	12730	8	(203)
	12730-1	10	(254)
	12730-2	15	(381)
	12730-3	24	(610)
	12730-5	6	(152)

Dia. Inches	Item Code	Length In.	(mm)
1/2	10175-1	12	(305)
	10175-2	15	(381)
	10175-3	18	(457)
	10175-4	24	(610)
	10175-5	30	(762)
	10175-6	36	(914)
	10175-7	48	(1219)
	10175-8	60	(1524)
	10175-9	72	(1829)

Mounting plates for Honeywell and EMP/EMA actuators

Item Code 12758
Mounting plate

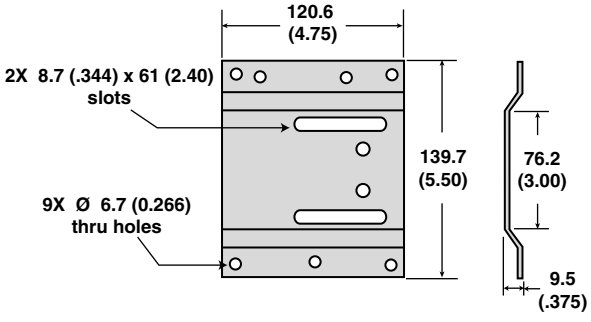
Dims: mm (in.)



Material: Powder coated mild steel

Item Code 13095
Mounting plate

Dims: mm (in.)



Material: Powder coated mild steel

Control Motors

Model	Eclipse Item Code	Stroke Degrees	Timing Seconds	Torque in-Lb	Electrical Volts	Hz.	Amps	Auxiliary Switch [3]	Crank Arm Item Code	Crank Arm Included w/Motor
Eclipse Rotary Actuator										
Std. keypad	ACT004A1A1A1AX	90	18	30	110/120	50/60	.04	2	Mounts directly	
Keypad inverted 180˚	ACT004A2A1A1AX	90	18	30	110/120	50/60	.04	2	to shaft	
Two Position										
EMA										
EMA-405	12616	180	20	16	120	60	.4	No	15181	Yes
EMA-405-1	10916	90	10	16	120	60	.4	No	15181	Yes
EMA-418-1	10912	90	10	60	120	60	.9	No	15181	Yes
Honeywell M6184 A 1015	10826	90	30	150	24	60	.9	No	18093	No
Position Proportioning with Slidewire Feedback										
EMP										
EMP-423-1[1]	12618	90	12	60	120	60	.65	Yes	15181	Yes
EMP-424-1[1]	12622	90	12[2]	60	120	60	.65	Yes	15181	Yes
EMP-453-1[1]	12632	90	40	220	120	60	.65	Yes	15181	Yes
EMP-454-1[1]	12634	90	40[2]	220	120	60	1.80	Yes	15181	Yes
Potentiometer Slaved Proportioning										
EMP										
EMP-423-2	12640	90	12	60	120	60	.65	Yes	15181	Yes
EMP-424-2	12642	90	12[2]	60	120	60	.65	Yes	15181	Yes
EMP-453-2	12646	90	40	220	120	60	.65	Yes	15181	Yes
EMP-454-2	12651	90	40[2]	220	120	60	.65	Yes	15181	Yes
Honeywell										
M9494 D 1000[4]	16107	90/160	60/120	300	24	50/60	0.8	No	18093	No
M9484 D 1002[4]	15800-4	90/160	15/30	75	24	50/60	0.8	No	18093	No
M9484 D 1028[4]	17997	90/160	30/60	150	24	50/60	0.8	No	18093	No
Proportioning, 4-20mA, Weathertight										
EMP										
EMP-423-4	15616-6	90	12	60	120	60	.65	Yes	15181	Yes
EMP-424-4	15616-4	90	12[2]	60	120	60	.65	Yes	15181	Yes
EMP-453-4	15616-7	90	40	220	120	60	.65	Yes	15181	Yes
EMP-454-4	15616-5	90	40[2]	220	120	60	.65	Yes	15181	Yes
Honeywell										
M7284 A 1004	12200	90	30	150	120	50/60	.65	No	18093	No

Notes:

[1] Can be used as two position if internal slidewire is not connected

[2] Timing can be increased (slower rotation) up to approximately ten times this rating by turning a slotted adjustment screw located on the outside of the case.

[3] Rotary actuator=SPST, 120VAC, 0.2A inductive, 0.4 non-inductive
EMP=SPDT, 120VAC, 5.8A inductive, 12A non-inductive. 240VAC, 2.9A inductive, 6A non-inductive

[4] Can be used with 4-20mA signal with Item Code 12740 resisistor kit.

Control Motor Accessories

Eclipse Item Code	Description	Eclipse Item Code	Description
EMP/EMA Only		**Honeywell Only**	
12674	Auxiliary slidewire kit.	14892	120 to 24VAC transformer. Mounts ininternally
12670	Auxiliary switch kit.	16291	Transformer, step down 120/50/60/25V secondary 40 VA
12676	Weather resistant cover.	11946	Adapter bracket
12677	Paralleling relay.	12659	Screw terminal kit
12707	135 ohm, 90˚ slidewire.	12740	Resistor kit
15766-2	Converter, 4-20mA, for EMP		

Swivel Connectors

for 5/16” Diameter Control Rods

Item Code 500558 is a rotating swivel block connector assembly for joining control rod to control arm. It allows 360° rotation.

Item Code 500569 serves to connect two control rods to one control arm and also allows 360° rotation.

Item Code 14316 swivel connector allows 360° rotation. It provides a 20° flex from the swivel center line to accommodate an angular approach of a linkage control rod, but immediacy of response is less positive than Item Code 14264 (at right).

Item Code 14264 is a non-flexing swivel connector that allows 360° rotation around swivel center line. Ite provides a more positive positioning and immediacey of response thatn Item Code 14316 (at left).

for 1/2” Diameter Control Rods

Item Code 500542 is a swivel block that rotates 360°

Item Code 500543 is a single ball swivel that rotates 360° while permitting an angular approach of rod toward control arm.

Item Code 500544 is a double ball swivel that connects two rods to one control arm. Allows angular approach of rod to arm, rotates 360°.

LEGEND VALVE

LEGEND PRODUCTS

Ball Valves

Legend Ball Valves are available in forged brass, bronze, carbon, or stainless steel. The stems are a bottom loaded-blowout proof design. Each series is available in full port or conventional port styles. Many are offered in F.I.P. x F.I.P., M.I.P. x F.I.P., Barb x Barb, F.I.P. x Solder, and C x C configurations. Please refer to the following list for more detailed information regarding pressure ratings and approvals.

T-1001 ISO-9002

FEATURES

- Meets Fed Spec. WWV-35-C, type ll Class A, Style 3
- 150 WSP-600 WOG
- Full port
- AGA, CGA 1/2"-3", U.L. & FM 1/2"-2"
- Threaded ends
- Forged brass body
- Blow-out proof
- *Teflon seats
- Sizes 1/8"-4"

Equimeter INCORPORATED
A BTR Metering Systems Company

Regulator Installation and Maintenance Instructions

243 Service Regulators

Introduction

The 243 is a large capacity, general-purpose gas pressure regulator.

Its outstanding performance and versatility make it an excellent choice for use on industrial meter sets, combustion equipment, boilers, burners, unit heaters, furnaces, ovens and other applications.

Use it for natural gas, air, dry CO_2, propane, butane, L.P.G., nitrogen, and others. Special materials are available for certain corrosive gases.

In addition to the standard models and internal relief models covered in this bulletin, the 243 is also available with low pressure cut-off, with built-in monitor, and as a pilot operated regulator (outlet pressures to 35 psig), a back pressure valve, a relief valve, a vacuum regulator and a vacuum breaker. For information please contact your Equimeter Sales Office or authorized industrial distributor. The 243 is manufactured in conformance with Code B31.8.

Note: The term standard refers to Non-IRV configurations.

Model Specifications

243-12-1 and 243-12-2
Maximum Inlet Pressure . . . . . .125 psi
Outlet Pressures . . . . . .3½" w.c. to 3 psi
Pipe Sizes . . . . . .1¼", 1½" and 2"
Diaphragm . . . . . .12" (nominal diameter)

243-8-1 and 243-8-2
Maximum Inlet Pressure . . . . . .125 psi
Outlet Pressures . . . . . .3½" w.c. to 4¼" psi
Pipe Sizes . . . . . .1¼", 1½" and 2"
Diaphragm . . . . . .8" (nominal diameter)

243-8HP
Maximum Inlet Pressure . . . . . .125 psi
Outlet Pressures . . . . . .3 to 10 psi
Pipe Sizes . . . . . .1¼", 1½" and 2"
Diaphragm . . . . . .8" (nominal diameter)

Maximum Inlet Pressures

243-12	ORIFICE SIZE - VALVE	243-8
15 psi	1 ¼" – 30°	• • •
25 psi*	1 ¼" – 10°	• • •
25 psi	1" – 30°	25 psi
40 psi*	1" – 10°	25 psi
40 psi	¾" – 30°	40 psi
60 psi †	¾" – 10°	40 psi
100 psi	½" – 10°	80 psi
125 psi	⅜" – 10°	100 psi
125 psi	¼" – 10°	125 psi
• • •	.207" – 10°	125 psi

* Applies only to 243-12 with external control line.
† 80 psi for 243-12 with external control line.

Temperature Limits

The Model 243 Service Regulators can be used for flowing temperatures from -20° F to 150°F.

Buried Service

The Model 243 Service Regulators are *not* recommended for buried service.

Installation and Start Up

(See Illustrations on Page 3.)

1. Make certain that regulator and piping are free of dirt, moisture, foreign matter and other debris.
2. Be sure all shipping screens or covers are removed and regulator is installed with flow in correct direction.
3. Regulator may be installed in any position; right-side-up, upside down, vertical pipe, horizontal pipe, diagonal pipe, etc.

   By loosening union bolts **(16)** , the diaphragm case assembly may be rotated to various positions in relation to the body. Make certain **(16)** are re-tightened to hold diaphragm case assembly in new position and to reseal.

CAUTION

The diaphragm case vent must be positioned to protect against flooding, drain water, ice formation, traffic, tampering, etc. The vent must be protected against nest building animals, bees, insects, etc. to prevent vent blockage and minimize the chances for foreign material from collecting in the vent side of the regulator diaphragm.

4. Make sure there are no leaks and all connections are firm and tight. Tighten flange bolts evenly and firmly. On screwed connections apply pipe dope to male threads only.

5. On regulators arranged for External Control Line, run pipe or tubing from ½" NPT connection in lower case to the control connection in the outlet piping. This control piping should not be less than ½" in size and should be adequately protected against breakage (regulators go wide open if the control line is broken). In general, the control connection should be at least 8 pipe diameters from the regulator and in as straight a run of pipe as possible. The connection itself must be smooth on the inside of the pipe. Pitch the control line away from the regulator and avoid moisture pockets. Keep inside of control line clean. Never install any type of automatic shut-off device, which closes completely, between the regulator outlet and the control line connection.

CAUTION

It is the user's responsibility to assure that all regulator vents and/or vent lines exhaust to a non-hazardous location away from any potential sources of ignition. Where vent line are used, it is the user's responsibility to assure that each service regulator is individually vented and that common vent lines are not used.

6. Adjust outlet pressure (set point) by removing cap **(1)** or **(1e)** and turning adjustment spring button **(3)**. On 243-8 HP remove cap **(1a)**, loosen locknut and turn adjustment screw **(1b)**. Turn clockwise to increase and counter-clockwise to decrease outlet pressure. Only adjust when gas is flowing through regulator. When adjustment is completed, seal cap **(1)** or **(1e)** must be securely screwed into place. The absence of this seal cap can result in unstable operation.

Equimeter INCORPORATED

A BTR Metering Systems Company

Installation and Start Up (Continued)

7. On regulators with Internal Relief Valve, there is no adjustment for the internal relief. It is fixed, with relief beginning at approximately 9" w.c. to 20" w.c., above regulator set point, depending on relief spring **(11k)** used.

   Internal Relief Valves must be carfully sized. For information, contact your Equimeter Representative

8. Regulators installed indoors must be vented outside. Run vent pipe from regulator vent connection to safe place outside. Vent piping should be as short and direct as possible.

   Vent piping for regulators with internal relief valve (Models 243-12-2 or 243-8-2) must be large enough to vent all relief valve discharge to atmosphere without excessive back pressure and resulting excessive pressure in regulator.

   Vent pipe outlet must be protected against nest building animals, bees, insects, etc., and positioned to protect against flooding, drain water, ice formation, etc. but must allow free and unobstructed passage of air or gas.

CAUTION

Turn gas on very slowly. If an outlet stop valve is used, it should be opened first. Do not overload the diaphragm with a sudden surge of inlet pressure. Monitor the outlet pressure during start-up to prevent an outlet pressure overload.

Servicing

1. Make sure the regulator is entirely depressured before disassembling.
2. Carefully note location and position of all disassembled parts to be certain reassembly is correct. Inspect each part and replace those that are worn or damaged or otherwise unsatisfactory.
3. For access to valve **(21)** and orifice **(24)** loosen union bolts **(16)** and remove diaphragm case assembly from body.

   To remove valve **(21)**, first remove hair pin cotter **(20b)**.

   Orifice **(24)** unscrews from body. Use 1-5/8" hex socket "thinwall" type. When replacing orifice use moderate amount of pipe dope on orifice threads.
4. Before reassembling and tightening union bolts **(16)**, make certain Tetraseal **(17)** is in position.
5. To replace diaphragm; remove spring **(4)**, remove flange bolts **(8)** and nuts **(9)**, and disassemble diaphragm assembly. Remove old diaphragm **(11a)** from diaphragm pan **(11b)**. Remove old adhesive from the diaphragm pan using a solvent such as methyl ethyl ketone (MEK).

   To reassemble, apply a thin, even layer of a rubber based adhesive such as 3M Industrial Adhesive #EC-847 to the cleaned, prepared side of the diaphragm pan.

   Attach the diaphragm to the adhesive side of the diaphragm pan, being careful to align the center hole of the diaphragm with the corresponding center hole in the diaphragm pan. Make certain all parts are reassembled in their correct order and bolts **(8)** are tightened to a torque of 150 in-lbs. Bolts must be tight enough to prevent leakage but not too tight that the diaphragm material is crushed or damaged. Diaphragm must not be twisted or pinched.
6. Upon completion of servicing, make certain that regulator installation is entirely free of leaks.

CAUTION

Regulators are pressure control devices with numerous moving parts subject to wear that is dependent upon particular operating conditions. To assure continuous satisfactory operation, a periodic inspection schedule must be adhered to with the frequency of inspection determined by the severity of service and applicable laws and regulations.

Condensed Parts List

The following are the parts generally required in maintenance and servicing. For a listing of all parts refer to Parts List RP-1306.

ILL. No.	Description	Part Number
1	Cover Cap (IRV)	143-16-005-00
1e	Cover Cap (STD)	143-16-005-08
1d	Tetraseal, 1 1/2X1 5/8"	906534
2	O-Ring #2-140	951357
2a	O-Ring #2-142	951376
3	Adjustment Spring Button	143-16-009-00
4	Spring (See Table, 1st page)	
5	243-12 Cover Assembly IRV (includes vent valve and spring)	143-16-503-03
	243-12 Cover Assembly STD (includes vent valve and spring)	143-16-503-19
	243-8 Cover Assembly (includes vent valve and spring)	143-82-503-04
8	Flange Bolt, 5/16 x 1" Hex Hd.	910030
9	Flange Nut, 5/16 - 18 Hex S.F.	921002
10	243-12 Lower Case	143-16-002-00
	243-12 Lower Case (tapped for external control line)	143-16-002-01
	243-08 Lower Case	143-82-002-00
	243-08 Lower Case (tapped for external control line)	143-82-002-01
[11a]	243-12 Diaphragm	143-16-150-00
	243-8 Diaphragm	143-82-150-00
	243-8 HP Diaphragm	121-10-150-50
11b	243-12 Diaphragm Pan	143-16-017-00
	243-8 Diaphragm Pan	143-82-017-00
	243-8 HP Diaphragm Pan	121-10-017-50
[11d]	Seal Washer	143-16-115-00
11e	Emery Cloth Washer (faces against top side of 243-8 HP diaphragm)	143-82-178-00
11f	Spring Guide	143-16-018-00
	Spring Guide (243-8 HP)	121-10-022-53
11k	Internal Relief Valve Spring, for 243-8-2 only. (relief begins at approx. 9" w.c. above regulator set point)	143-82-021-03
11k	Internal Relief Valve Spring, (relief begins at approx. 9" w.c. for 243-12-2, and approx. 20" w.c. for 243-8-2 above regulator set point)	143-16-021-02
11s	243-8 HP Diaphragm Plate	121-10-022-52
[13]	243-12 Coupling-Lever-Stem Assembly	143-16-530-00
	243-8 Coupling Lever-Stem Assembly	143-82-530-00
	243-8 (HP) Coupling-Lever-Stem Assembly	143-82-530-02
16	Union Bolts, 3/16 x 1 1/4" Hex	910056
[17]	Tetraseal (or O-Ring) 2 1/4 x 2 1/2"	904075
[18]	Throat Block with O-Ring Seal (for external control line)	143-16-508-00
20b	Hair Pin Cotter	143-62-118-00
[21]	Valve Assembly–10°–Buna N	143-16-511-09
	Valve Assembly–10°–Viton	143-16-511-11
	Valve Assembly–30°–Buna N	143-16-511-10
	Valve Assembly–30°–Viton	143-16-511-12
[24]	1 1/4" Orifice, Brass	143-16-023-03
	1" Orifice, Brass	143-16-023-02
	3/4" Orifice, Brass	143-16-023-01
	1/2" Orifice, Brass	143-16-023-00
	3/8" Orifice, Brass	143-16-023-04
	1/4" Orifice, Brass	143-16-023-10
	.207" Orifice, Brass	143-16-023-11
25	Travel Stop Stem	143-16-060-02
26	Warning Tag-Travel Stop	143-16-136-05
27	Warning Tag-Body Interchangeability	143-16-136-06
28	Clamping Plate	143-16-102-01

[ ] Denotes recommended spare parts.

Equimeter INCORPORATED
A BTR Metering Systems Company

Model 243 Regulator Illustrations

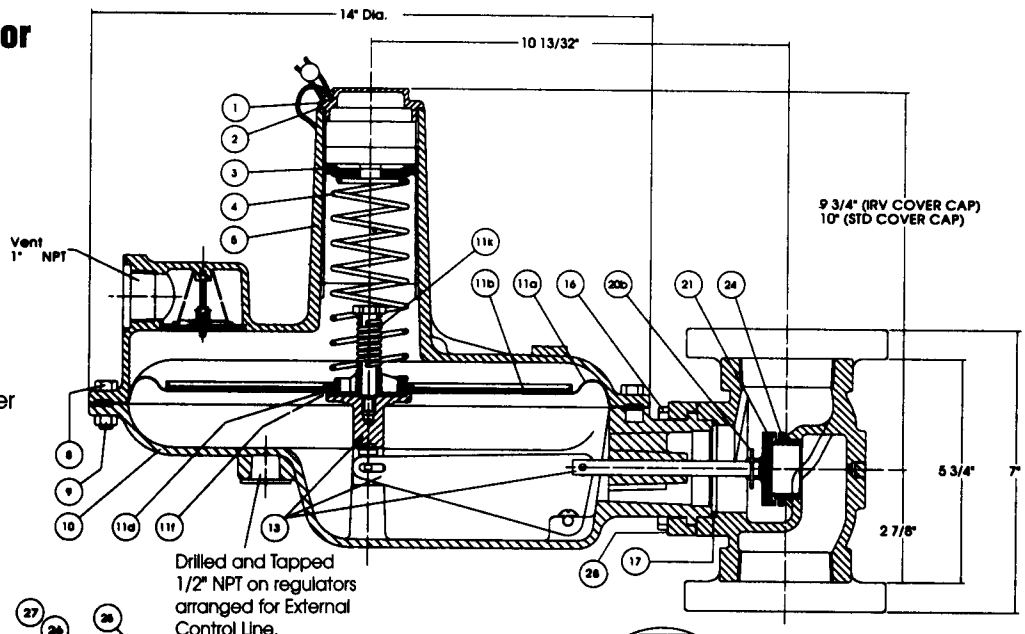
243-12-2

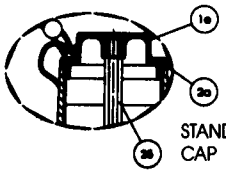
I.R.V. Regulator
- as shown-

243-12-1

Same as I.R.V. Regulator except no Internal Relief Valve and Standard Cover Cap as shown in inset.

PIPE SIZES
2" Flanged ANSI 125 lb FF
1 1/2" and 2" Screwed

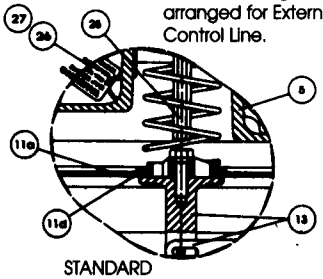


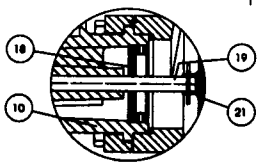


243-8 HP

Remainder of regulator same as 243-8-1

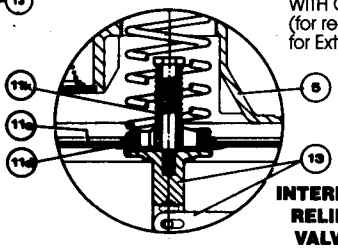
PIPE SIZES
2" Flanged ANSI 125 lb FF
1 1/4", 1 1/2" and 2" screwed





243-8-1

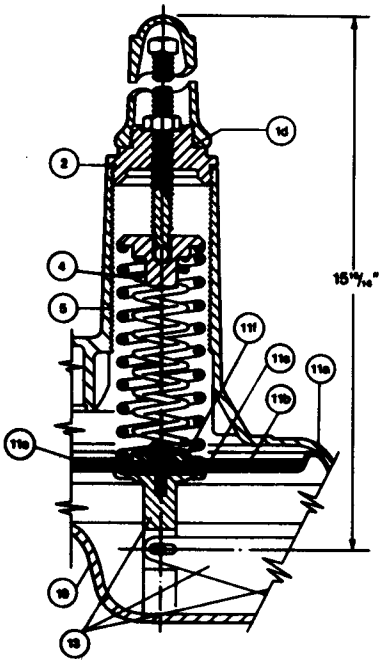
Standard Regulator
- as shown-

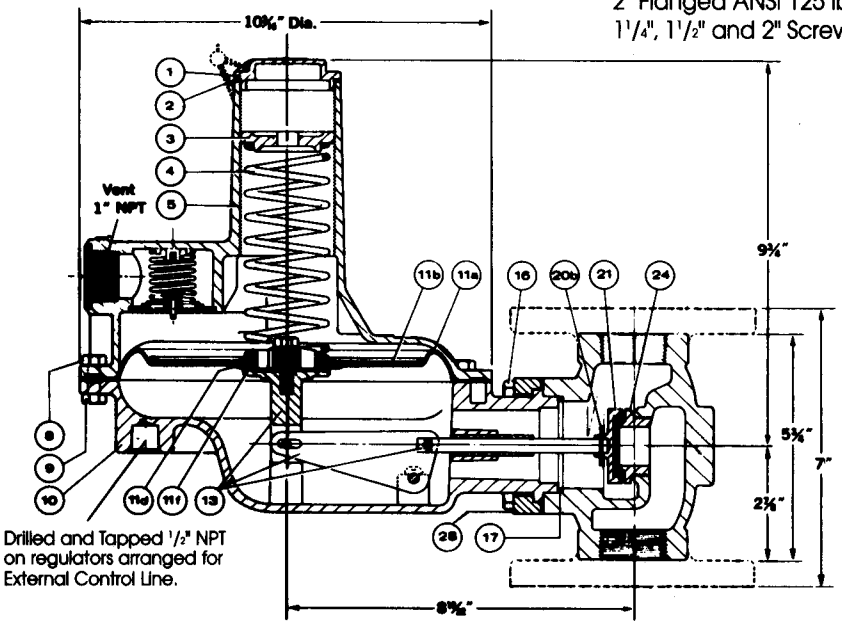


243-8-2

Same as Standard Regulator except Internal Relief Valve as shown in inset.

PIPE SIZES
2" Flanged ANSI 125 lb FF
1 1/4", 1 1/2" and 2" Screwed





Equimeter INCORPORATED

A BTR Metering Systems Company

Maximum Emergency Pressures

The maximum pressure the regulator inlet may be subjected to under abnormal conditions without causing damage to the regulator is the maximum inlet pressure (from the table below) plus 50 psi.

The maximum pressure the diaphragm may be subjected to without causing damage to the internal parts of the regulator is:

243-12-1 . . . . . .set-point +3 psi
243-12-2, 243-8-1 and 243-8-2 . . . . . .set-point +5 psi
243-8HP . . . . . .set-point +5 psi
Set point is defined as the outlet pressure a regulator is adjusted to deliver.

If any of the above pressure limits are exceeded, the regulator must be taken out of service and inspected. Damaged or otherwise unsatisfactory parts must be repaired or replaced.

The maximum pressure that can be safely contained by the diaphragm case is:

243-12-1 and 243-12-2 . . . . . .15 psi
243-8-1 and 243-8-2 . . . . . .45 psi
243-8HP . . . . . .45 psi

Safely contained means no leakage as well as no bursting.

Before using any of the above data, make sure this entire section is clearly understood.

Note: The use of an internal or external relief valve is recommended for installations subjected to no flow for extended periods of time such as pilotless ignition systems. A travel stop stem is located in the 243-12-1 and 243-12-4 to provide over pressurization protection to internal components during overpressurization.

Spring Ranges

SPRING COLOR	OUTLET PRESSURE RANGE		PART NUMBER
	243-12	243-8	
Red	3 1/2" to 6 1/2" w.c.	• • •	143-16-021-03
Red-Black	• • •	3 1/2" to 6 1/2" w.c.	143-82-021-00
Blue	5" to 8 1/2" w.c.	• • •	143-16-021-04
Blue-Black	• • •	5" to 8 1/2" w.c.	143-82-021-01
Green-Black	• • •	6" to 14" w.c.	143-82-021-02
Green	6" to 14" w.c.	12" to 28" w.c.	143-16-021-05
Orange-Black	10" to 18" w.c.	• • •	143-16-021-11
Orange	12" to 28" w.c.	1 to 2 psi	143-16-021-06
Black	1 to 2 psi	2 to 4 1/4 psi	143-16-021-07
Cadmium	1 1/2 to 3 psi	3 to 6 1/2 psi*	143-16-021-08
Cadmium	• • •	6 to 10 psi*	143-16-021-08
White†	• • •		143-16-021-13

†White is nested inside Cadmium. *243-8 HP only

Monitoring

The Model 243 Regulators make excellent monitors. They can act as standby regulators installed in series which assumes control if a failure in the operating regulator permits the outlet pressure to exceed the set-point. It can be located in either the upstream or the downstream position.

When a Model 243 Regulator is used to monitor a regulator with an identical inner valve (another 243 Regulator), the total maximum capacity through both regulators can be figured at 70% of the capacity of one regulator alone. This applies with the monitor located either up or downstream.

Full Open Capacity

Use the following formulae for the full open capacity for 243 regulators.

1. $Q = K\sqrt{P_O(P_I - P_O)}$ . . . . . .(for $\frac{P_I}{P_O}$ less than 1.894)

2. $Q = \frac{KP_I}{2}$ . . . . . .(for $\frac{P_I}{P_O}$ greater than 1.894)

Q = maximum capacity of the regulator (in SCFH of 0.6 specific gravity natural gas).
K = the **"K" factor**, the regulator constant (from the table).
P_I = **absolute** inlet pressure (psia).
P_O = **absolute** outlet pressure (psia).

Orifice Size-in.	.207"	1/4"	3/8"	1/2"	3/4"	1"	1 1/4"
K	90	132	292	520	1100	1800	2480

Other Gases

243 Regulators are mainly used on natural gas. However, they perform equally well on LP gas, nitrogen, dry CO_2 air and others.

For capacities, multiply the table values on pages 8 thru 19 in Bulletin R-1306 by the following correction factors:

OTHER GASES	CORRECTION FACTOR
Air (Specific Gravity 1.0)	0.77
Propane (Specific Gravity 1.53)	0.63
1350 BTU Propane-Air Mix (1.20)	0.71
Nitrogen (Specific Gravity 0.97)	0.79
Dry Carbon Dioxide (Specific Gravity 1.52)	0.63
For other noncorrosive gases: CORRECTION FACTOR =	$\sqrt{\frac{0.6}{\text{Specific Gravity of the Gas}}}$

While used primarily for natural gas services, Model 243 regulators perform equally well on LPG vapor, air, dry CO_2, nitrogen and other inert gas applications. Please contact your Equimeter representative for special construction which may be available for certain corrosive gases.

Note: The term standard refers to Non-IRV configurations.

Equimeter INCORPORATED
A BTR Metering Systems Company

CONDENSED CAPACITY TABLE IN SCFH OF NATURAL GAS (0.6 Specific Gravity–14.65 psia–60°F.)

	INLET PRESSURE psi	ORIFICE SIZE and VALVE ANGLE	OUTLET PRESSURE SET POINT and SPRING					
			6" w.c. RED SPRING (1" w.c. droop)	7" w.c. BLUE SPRING (1" w.c. droop)	11" w.c. GREEN SPRING (2" w.c. droop)	18" w.c. ORANGE SPRING (3" w.c. droop)	1 psi BLACK SPRING (0.2 psi droop)	2 psi CADMIUM SPRING (0.6 psi droop)
2" 243-12	2	1¼"–30°	6400	6000	5600	4200	3350	• • •
	5	1¼"–30°	11000	11000	10500	8000	6600	8200
	15	1¼"–30°	14000	14000	14000	13500	13000	15500
	25	1"–30°	15000	15000	15000	16500	15000	18000
	40	¾"–30°	20000	20000	20000	20000	20000	20000
	60	¾"–10°	15000	15000	15500	15000	15500	16500
	100	½"–10°	13000	13000	14000	14000	14000	16000
	125	⅜"–10°	12000	12000	12000	12000	12000	12000
1½" 243-12	2	1¼"–30°	4000	3800	4000	3000	2800	• • •
	5	1¼"–30°	6100	5700	6000	5600	5500	6000
	15	1¼"–30°	9300	9300	10000	10000	10000	13000
	25	1"–30°	11000	11000	11500	11500	11000	14500
	60	¾"–10°	12000	10500	12500	12500	12500	15000
	100	½"–10°	12000	12000	12500	13000	13000	16000
	125	⅜"–10°	11000	11000	11000	11000	11000	12000
1½" and 2" 243-12 with External Control Line	5	1"–10°	8200	6500	7200	5500	5400	6800
	5	1¼"–10°*	10500	7800	8500	6500	7000	8600
	10	1"–10°	12000	10000	11000	8000	8500	10500
	10	1¼"–10°*	15000	13000	13500	11000	10500	13000
	25	1"–10°	20000	17000	17000	15000	14500	20000
	25	1¼"–10°*	22000	20000	20000	18000	18000	25000
	40	1"–10°	24000	21000	24000	21000	20000	25000
	80	¾"–10°	30000	21000	27000	22000	22000	25000
	100	½"–10°	19000	19000	19000	19000	19000	19000
	125	⅜"–10°	15000	15000	15000	15000	15000	15000

2" size only.

	INLET PRESSURE psi	ORIFICE SIZE AND VALVE ANGLE	OUTLET PRESSURE SET POINT and SPRING						
			6" w.c. RED-BLACK SPRING (1" w.c. droop)	7" w.c. BLUE-BLACK SPRING (1" w.c. droop)	18" w.c. GREEN SPRING (3" w.c. droop)	1 psi ORANGE SPRING (0.2 psi droop)	3 psi BLACK SPRING (0.6 psi droop)	5 psi* CADMIUM SPRING (1 psi droop)	10 psi* CADMIUM and WHITE SPRING (2 psi droop)
1½" 243-8	2	1"–30°	3200	2700	2100	2100	• • •	• • •	• • •
	10	1"–30°	7400	7000	6600	6500	7100	6000	• • •
	25	1"–30°	12500	12500	11500	11000	12500	12000	12000
	40	¾"–10°	10500	10500	11000	11000	13000	12000	15000
	80	½"–10°	11500	11500	12000	11500	13500	11000	17000
	100	⅜"–10°	11000	11000	11000	11000	12000	11000	15000
	125	¼"–10°	8000	8000	8000	8000	8000	8000	9000
1¼" 243-8	2	¾"–10°	2250	1700	1900	1850	• • •	• • •	• • •
	10	¾"–10°	3100	2900	2950	2700	3600	3300	• • •
	25	¾"–10°	4200	4200	4400	4150	5000	4400	9000
	40	¾"–10°	4200	4800	5300	5300	6300	5800	12000
	80	½"–10°	5600	5600	4850	4650	5500	4500	13000
	100	⅜"–10°	6000	6000	6000	6000	6550	6000	13000
	125	¼"–10°	6000	6000	8000	8000	8000	8000	8800
2" 243-8	5	1"–30°			5500	4000	4400	• • •	• • •
	10	1"–30°			9400	7000	7600	6000	• • •
	25	1"–30°			14500	14500	15000	13000	15500
	40	¾"–30°			20000	17500	17500	12000	22000
	80	½"–10°			14000	13500	15000	11500	18500
	100	⅜"–10°			12000	11000	12000	11000	16000
	125	¼"–10°			8000	8000	8000	8000	9000

Refer to Bulletin R-1306 for detailed capacity tables and curves.

*243-8HP only.

Equimeter Incorporated, 805 Liberty Boulevard, DuBois, PA 15801
(814) 371-8000
FAX (814) 375-8460

Representatives in all principal cities.
Distributors throughout the world.

Equimeter Incorporated
805 Liberty Boulevard
P.O. Box 528
DuBois, Pa 15801

A BTR Metering Systems Company

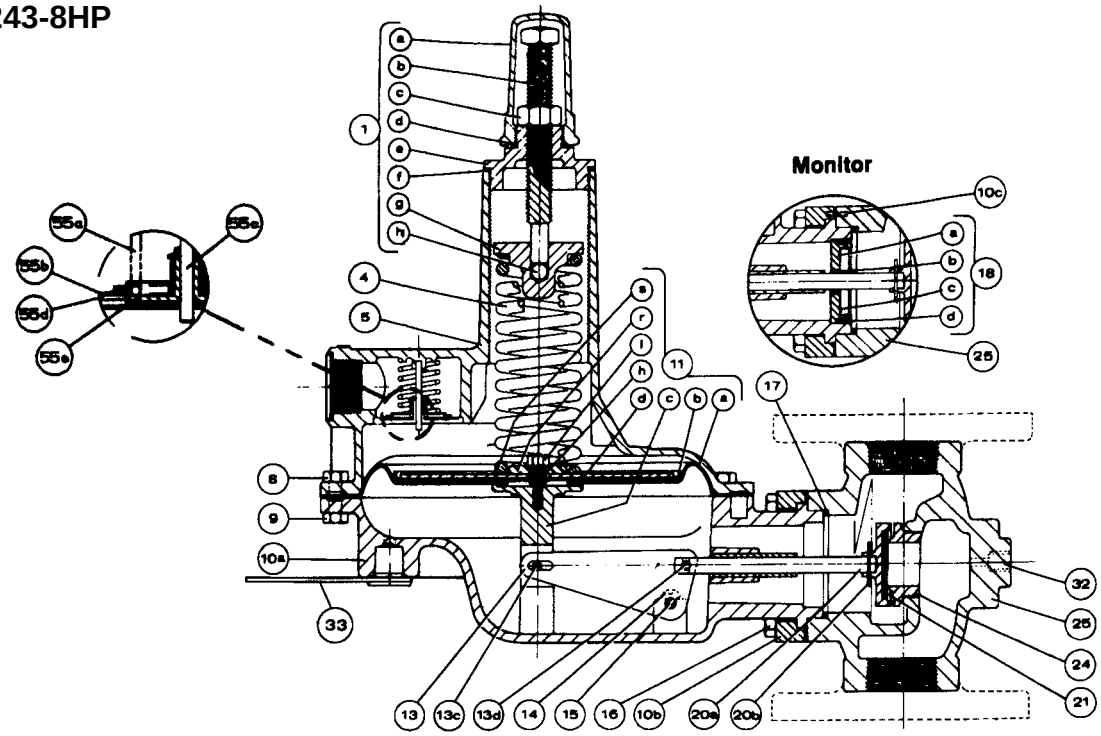
Authorized Distributor:

LIMITED WARRANTY Seller warrants the Goods to be free from defects in materials manufactured by Seller and in Seller's workmanship for a period of **[one (1) year]** after tender of delivery (the "Warranty Period"). **THIS LIMITED WARRANTY (a) IS IN LIEU OF, AND SELLER DISCLAIMS AND EXCLUDES, ALL OTHER WARRANTIES, STATUTORY, EXPRESS OR IMPLIED, INCLUDING, WITHOUT LIMITATION, ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, OR OF CONFORMITY TO MODELS OR SAMPLES; (b)** does not apply to any Goods which have been (i) repaired, altered or improperly installed; (ii) subjected to improper use or storage; (iii) used or incorporated with other materials or equipment, after Buyer or anyone using the Goods has, or reasonably should have, knowledge of any defect or nonconformance of the Goods; or (iv) manufactured, fabricated or assembled by anyone other than Seller; **(c)** shall not be effective unless Buyer notifies Seller in writing of any purported defect or nonconformance within **[thirty (30) days]** after Buyer discovers or should have reasonably discovered such purported defect or nonconformance; and **(d)** shall only extend to Buyer and not to any subsequent buyers or users of the Goods. Buyer shall provide Seller access to the Goods as to which Buyer claims a purported defect or nonconformance; upon request by Seller, Buyer shall, at its own risk and expense, promptly return the Goods in question to Seller's Plant.

Printed in U.S.A.
SPX 09-00-50M

invensys
Energy Metering

Model 243-8HP



ILL. NO.	DESCRIPTION	PART NUMBER
1	Seal Cap and Spring Adjustment Assembly	
	1a Seal Cap	121-10-005-52
	1b Adjustment Screw	906537
	1c Nut	921005
	1d Tetraseal, Seal Cap, 1-1/2" x 1-5/8"	906534
	1e Top Cap	121-10-005-51
	1f Tetraseal, Top Cap, 2-1/4" x 2-3/8"	905241
	1g Spring Button	121-10-009-51
	1h 3/.8" Dia. Stainless Steel Ball	930510
4	Spring, 3 to 6-1/2 psi, Cadmium (Outer)	143-16-021-08
	Spring, White	143-16-021-13
5	Upper Diaphragm Case Assembly	143-82-503-12
8	Screw, 5/16"-18 x 1" Hex Hd. Stl.	910030
9	Nuts, 5/16"-18 Hex Hd. Stl.	908152
10	Lower Diaphragm Case Assembly	
	10a Lower Diaphragm Case, Std.	143-82-002-00
	Lower DIaphragm Case, Monitor	143-82-002-01
	10b Clamping Plate	143-16-102-00
	10c Roll Pin, 1/8" x 5/8"	904103
11a	Diaphragm	121-10-150-50
	Diaphragm (Viton)	121-10-150-52
11b	Diaphragm Pan	121-10-017-50
11c	Diaphragm Coupling (Std.)	143-16-028-01
11d	Emery Cloth Washer	143-82-178-00
11h	Diaphragm Spacer	143-82-079-00
11l	Screw, 5/16"-18 x 1" Hex Hd. Stl.	910030
11r	Bottom Spring Button	121-10-022-53
11s	Diaphragm Plate	121-10-022-52
13	Lever	143-82-030-00
13c	Roll Pin - Lever Weight, 3/16" x 3/4" lg.	904106
13d	Roll Pin - Valve Stem, 5/32" x 7/16" lg.	904104
14	Screw, 1/4" x 5/8" Rd. Hd. Self Tap	950353
15	Fulcrum Pin	143-16-032-00
16	Cap Screw, 3/8"-16 x 1-1/4" Hex Hd. Stl.	901551
17	Tetraseal, Lower Case to Body	904075

ILL. NO.	DESCRIPTION	PART NUMBER
18	Seal Disc Assembly - Monitor	143-16-508-00
	18a Seal Disc, CRS cad. plated	143-16-008-00
	18b Inner O-ring	934007
	18c Outer O-ring	905809
	18d Set Screw, #6-32 x 1/4" Hex Soc. Cup Pt.	903197
	Seal Disc Assembly - Monitor for Corrosive Service	143-16-508-01
	18a Seal Disc, CRS cad. plated	143-16-008-00
	18b Inner O-ring, Viton	902418
	18c Outer O-ring, Viton	904842
	18d Set Screw, #6-32 x 1/4" Hex Soc. Cup Pt.	903197
20a	Stem	143-16-016-00
	Stem, for Corrosive Service	143-16-016-01
20b	Hair Pin Cotter	143-16-118-00
21	Valve, 10°, Buna-N	143-16-511-09
	Valve, 30°, Buna-N	143-16-511-10
	Valve, 10°, Viton	143-16-511-11
	Valve, 30°, Viton	143-16-511-12
24	Orifice, 1/4"	143-16-023-10
	Orifice, (.203)	143-16-023-11
	Orifice, 3/8"	143-16-023-04
	Orifice, 1/2"	143-16-023-00
	Orifice, 3/4"	143-16-023-01
	Orifice, 1"	143-16-023-02
	Orifice, 1/4", Stainless Steel	143-16-023-15
	Orifice, (.203), Stainless Steel	143-16-023-18
	Orifice, 3/8", Stainless Steel	143-16-023-16
	Orifice, 1/2", Stainless Steel	143-16-023-17
	Orifice, 3/4", Stainless Steel	143-16-023-12
	Orifice, 1", Stainless Steel	143-16-023-13
25	Body, 1-1/4" NPT - Std.	143-13-001-00
	Body, 1-1/4" NPT - 1/4" Inlet Tap	143-13-001-02
	Body, 1-1/4" NPT Inlet - 1-1/2" NPT Outlet	143-13-001-00
	Body, 1-1/2" NPT - Std.	143-14-001-00
	Body, 1-1/2" NPT - 1/4" Inlet Tap	143-14-001-02
	Body, 2" NPT - Std.	143-16-001-00
	Body, 2" NPT - 1/4" Inlet Tap	143-16-001-04
	Body, 2" Flanged - Std.	143-16-001-03
	Body, 2" Flanged, 1/4" Inlet Tap	143-16-001-05
32	1/4" Soc. Hd. Stl. Pipe Plug	904364
33	Instruction Tag (Monitor)	138-18-136-00
55a	Exhaust Spring	086-10-021-02
55b	Valve Seat (Washer)	143-16-024-00
55c	Stem Guide	143-16-012-00
55d	Retaining Ring	904013
55e	Valve Assembly	143-16-526-01

NUPP12/9810M
PRINTED IN U.S.A.

SIEMENS

RWF40...
Compact Universal Controllers

optimized for temperature and pressure control in connection with modulating or multistage burners

User Manual

The RWF40... controller and this User Manual are intended for use by OEMs which integrate the controller into their products!

Siemens Building Technologies
HVAC Products

CC1B7865en
05.12.2002

Exhibit 87A

SIEMENS

RWF40 CONTROLLER Hints:

1. **Auto Tuning:** Press (down arrow) and PGM keys simultaneously. “Tune” will flash on display.
    a. Perform **Auto Tune** under a constant load, relatively near the set point… not at ambient temperature.

    b. Press (Up arrow) key for 2 seconds to **accept** values of **Auto Tune** (after plashing parameters).

    c. Press Exit key fro 2 seconds to **decline** values of **Auto Tune** (after flashing parameters).

    d. Auto tuning stops if during auto tuning, temperature reaches upper switch-off threshold (HYS 3). Should initially set (HYS 3) well above set point. The HYS 3 value is added to the set point to determine upper switch-off threshold.

2. **To change set point:** Press PGM Key. Then press (up arrow) or (down arrow) key to change set point.

3. **To unlock control:** Press PGM and Exit keys Simultaneously and hold for 5+ seconds. Note: Must press these keys at the same time and release at the same time. Change from xxx3, xxx2, or xxx1 to xxx0. Press PGM key and then Exit key.

4. **To enter manual mode:** Press Exit key for 8 seconds.

5. **To leave manual mode:** Press Exit key again for 8 seconds.

6. **To change configuration:** Press & hold PGM key for 5 seconds. Then press and hold PGM key again for 5 seconds to get into the C1111 screen. Once in configuration, the (down arrow) key changes position in configuration, the (up arrow) key changes the value of the parameter.

7. **To slow motor acceleration:** Increase proportional band, Pb.1.

8. **GND** to **D1** jumper used to provide 2-stage control, hi-low. No jumper required for proportional control.

Contents

1. Introduction 6

1.1 General notes 6
1.2 Description 6
1.3 Typographical conventions 7
1.3.1 Warning symbols 7
1.3.2 Notification symbols 7
1.3.3 Presentation 7

2. Type of unit 8

2.1 Type field 8

3. Installation 9

3.1 Installation site and climatic conditions 9
3.2 Dimensions 9
3.3 Side-by-side mounting 10
3.4 Mounting in a panel cutout 10
3.5 Cleaning the front 11
3.6 Removing the controller module 11

4. Electrical connections 12

4.1 Installation notes 12
4.2 Block diagram 13
4.3 Assignment of terminals 14
4.4 Galvanic separation 17

5. Operating modes 18

5.1 Low-fire operation 18
5.2 High-fire operation 18
5.2.1 Modulating burner, floating output 18
5.2.2 Modulating burner, analog output 19
5.2.3 2-stage burner, floating output 19
5.2.4 2-stage burner, analog output 20
5.3 Safety shutdown 20
5.4 Predefined setpoint 20
5.4.1 Setpoint changeover «SP1 / SP2», analog setpoint shift 21
5.4.2 Setpoint changeover «SP1» / external setpoint 22
5.4.3 Setpoint «SP1», analog / binary setpoint shift 23
5.4.4 External setpoint, binary setpoint shift 24
5.5 Weather-dependent setpoint shift 25
5.5.1 Heating curve slope 26
5.6 Response threshold «Q» 27
5.7 Cold start of plant 28

6. Operation 29

6.1 Basic display 30
6.1.1 Meaning of the display and buttons 30
6.2 User level 31
6.2.1 Changing the setpoints 31
6.2.2 Manual operation of a modulating burner 33
6.2.3 Manual operation of a 2-stage burner 33
6.2.4 Start self-setting 34
6.2.5 Display of the software version and of unit of actual value 34
6.3 Parameter level 35
6.3.1 Entering parameters 35
6.4 Configuration level 35
6.4.1 Changing the configuration code 35

7. Parameter settings 36

8. Configuration 38

8.1 C111 inputs 38
8.2 C112 limit comparator, controller type, setpoint «SP1», locking 40
8.3 C113 unit address, dimensional unit, out-of-range 44
8.3.1 SCL scaling of standard signal range start, analog input 1 45
8.3.2 SCH scaling of standard signal range end, analog input 1 45
8.3.3 SCL2 scaling of standard signal range start, analog input 2 45
8.3.4 SCH2 scaling of standard signal range end, analog input 2 46
8.3.5 SPL lower setpoint limit 46
8.3.6 SPH upper setpoint limit 46
8.3.7 OFF1 actual value correction for analog input 1 46
8.3.8 OFF2 actual value correction for analog input 2 46
8.3.9 OFF3 actual value correction for analog input 3 46
8.3.10 dF1 2nd order digital filter for analog input 1 46
8.3.11 dF3 1st order digital filter for analog input 3 (only with RWF40.0X2B97) 46
8.3.12 oLLo lower working range limit (only with RWF40.0X2B97) 47
8.3.13 oLHi upper working range limit (only with RWF40.0X2B97) 47
8.3.14 dtt bus watchdog timer for remote operation (only with RWF40.0X2B97) 47

9. Self-setting function 48

9.1 Self-setting function in high-fire operation 48
9.2 Checking the controller parameters 50

10. What to do if... 51

10.1 ...numbers are flashing on the display 51

11. Technical data 52

11.1 Inputs 52
11.1.1 Analog input 1 (actual value) 52
11.1.2 Analog input 2 (external setpoint, setpoint shift) 52
11.1.3 Analog input 3 (outside temperature) 53
11.1.4 Binary input «D1» 53
11.1.5 Binary input «D2» 53
11.2 Outputs 53
11.2.1 Output 1 (release of burner) 53
11.2.2 Output 2, 3 (floating output) 53
11.2.3 Output 4 (limit comparator) 53
11.2.4 Output 5, analog output (option) 54
11.2.5 Transducer supply 54
11.2.6 Interface RS-485 (optional) 54
11.3 General ratings 54
11.3.1 Measuring accuracy 55
11.3.2 Monitoring of measuring circuit 55
11.3.3 Environmental conditions 55

12. Current settings 56

12.1 Process data 56
12.2 Parameter level 56
12.3 Configuration level 57

1. Introduction

1.1 General notes

Please read this User Manual before switching on the controller. Keep the User Manual in a safe place which can be accessed by all users at all times. Please help us improve the information given in the User Manual. Your suggestions will be welcome.

All necessary settings and, where required, the settings to be made inside the unit, are described in this User Manual (applicable to controller software version 126.01.01).

⇨ Section 6.2.5 «Display software version and dimensional unit»

Should any problems arise during commissioning, do not make any unauthorized manipulations on the unit. You could endanger your rights under the warranty terms! Please contact us in such a case.

When returning modules, assemblies or components to HVAC Products, the regulations as per DIN EN 100 015 «Protection of electrostatically sensitive devices» must be observed. Always use the appropriate **ESD** packaging for transport.

Please take note that we cannot assume liability for damage caused by ESD.

ESD = electrostatic discharge

1.2 Description

Use

The RWF40... is used primarily for the control of temperature or pressure in oil- or gas-fired heating plants. It is a compact modulating controller without position feedback acting on the burner. An external switch can be used to change it to a 2-position controller for the control of 2-stage burners. The integrated thermostat function switches the burner on and off. The thermostat (relay output 1) can be used as a thermal reset limit thermostat conforming to DIN 3440. An adjustable response threshold is used to switch to a higher burner output (high-fire operation).

Control

In modulating operation, the RWF40... operates as a PID controller.

In 2-stage operation, the RWF40... provides control based on the set switching threshold. The setpoint of the RWF40... can be adjusted either on the controller itself or externally. Minimum and maximum setpoint limits can be adjusted. A self-setting function is provided as a standard feature.

The plug-in controller module measures 96 x 48 x 127.5 mm and is especially suited for mounting in control panels. The controller features two 4-digit 7-segment displays for the actual value (red) and the setpoint (green). A limit comparator is also provided; its switching characteristic can be set on the configuration level.

A choice of 8 different limit comparator functions is available.

Options

An RS-485 interface is provided for integrating the controller into a data network. Output 5 can be used as an analog output for modulating or 2-stage operation.

All connections are made via screw terminals at the rear of the unit.

1.3 Typographical conventions

1.3.1 Warning symbols

The signs for **Danger** and **Caution** are used in this User Manual under the following conditions:

Danger — This symbol is used where there may be a **danger to staff** if the instructions are disregarded or not strictly observed!

Caution — This symbol is used where there may be **damage to equipment or data** if the instructions are disregarded or not strictly observed!

Caution — This symbol is used if **precautionary measures must be taken** in handling electrostatically sensitive components.

1.3.2 Notification symbols

Note — This symbol is used to draw your **special attention** to a remark.

⇨ **Reference** — This symbol refers to **additional information** in other Manuals, chapters or sections.

abc[1.] **Footnote** — Footnotes are **comments, referring to specific parts of the text.** They consist of 2 parts:

1) The **markings** in the text are arranged as continuous superscript numbers
2) The **footnote text** is placed at the bottom of the page and starts with a number and a period

✱ **Action** — This symbol indicates that **a required action** is described.

The individual steps are indicated by an asterisk, e.g.:
✱ Press the ▲ button

1.3.3 Presentation

PGM **Buttons** — Buttons are shown in a box. Either symbols or text are possible. If a button has multiple assignments, the text shown is always the one that corresponds to the function currently used.

EXIT + ▲ **Button combi-nations** — The representation of buttons combined with a plus sign means that, first, the EXIT button must be kept depressed before pressing the other button.

2. Type of unit

2.1 Type field

Location

The type field is glued onto the housing. The type designation consists of operating voltage and type reference of the unit.

Types

Type of unit	Description
RWF40.000A97 RWF40.010A97 [1·]	Basic version with floating output
RWF40.001A97 RWF40.011A97 [1·]	With additional analog output
RWF40.002B97 RWF40.012B97 [1·]	With additional analog output and RS-485 interface

[1·] Packaging variants

The power supply must agree with the operating voltage given on the type field.

Factory setting

The measured value range and the analog inputs are factory-set.

⇨ Chapter 8 «Configuration»

Accessories

Adapter frame ARG40 for plants where the RWF32... predecessor model was used (for conversion to RWF40...).

Bracket ARG41 for mounting the RWF40... on 35 mm DIN rails conforming to DIN 46277.

Dummy cover AVA10.200/109 for covering control panel cutouts for the RWF40...

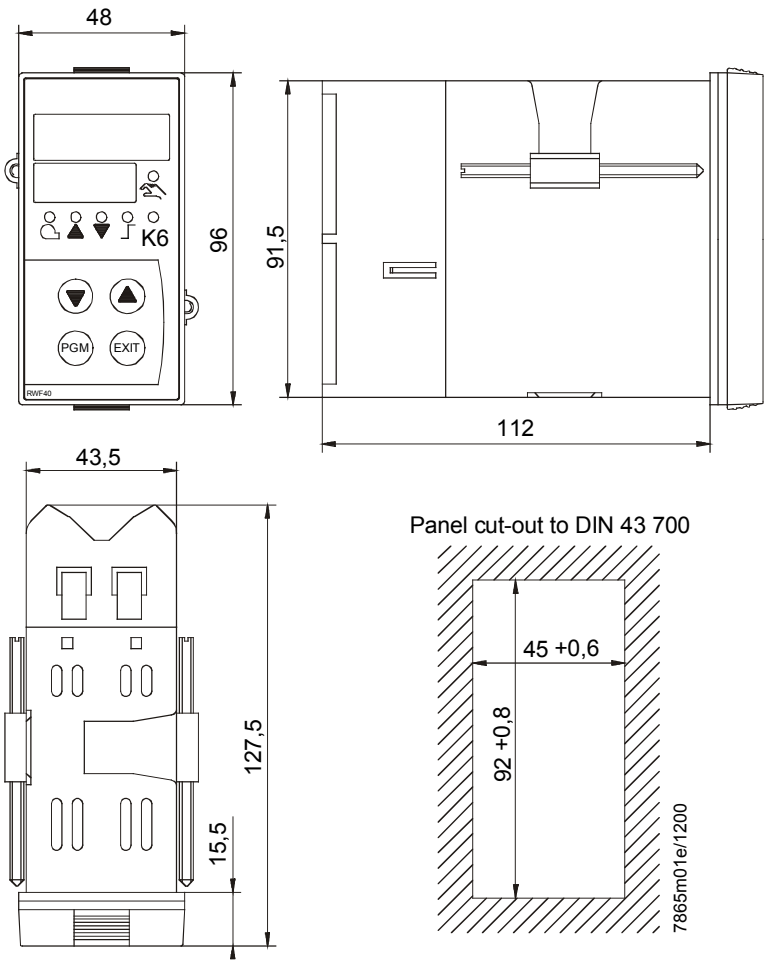
3. Installation

3.1 Installation site and climatic conditions

- The installation site should be free from vibrations, dust and corrosive media
- The controller should be installed away from sources of electromagnetic fields, such as variable speed drives or high-voltage ignition transformers

Relative humidity: ≤ 95 % (noncondensing)
Ambient temperature range: -20...+50 °C
Storage temperature range: -40...+70 °C

3.2 Dimensions



3.3 Side-by-side

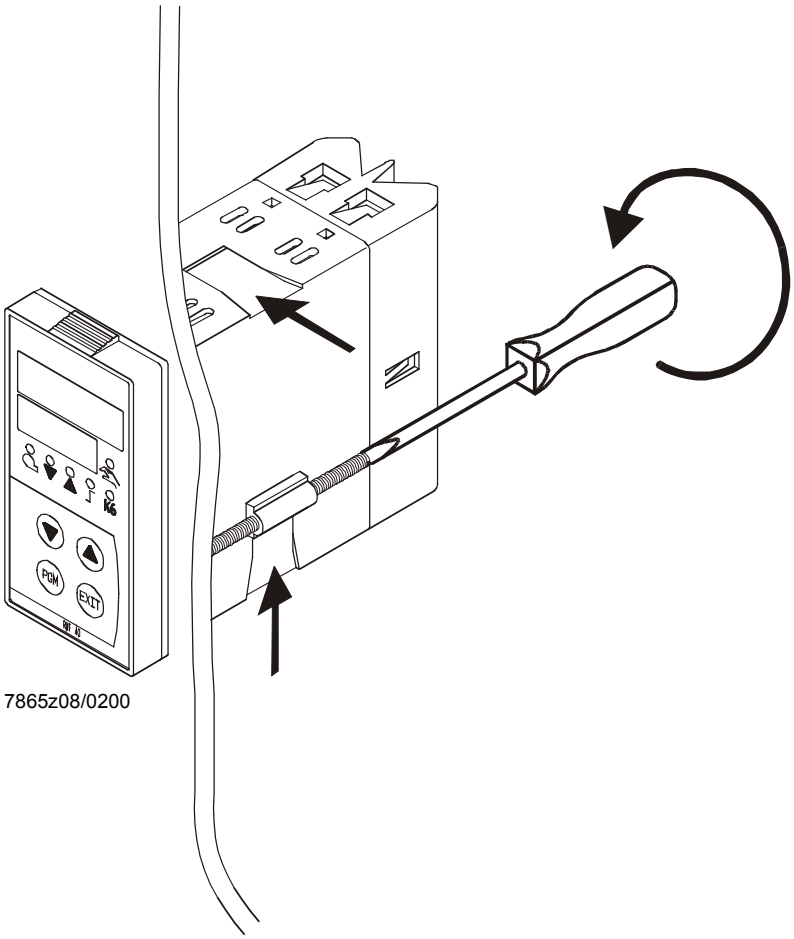
If several controllers are mounted side-by-side or above one another in a control panel, minimum spacing must be observed: 30.5 mm vertically and 10.5 mm horizontally.

3.4 Mounting in a panel cutout

* Place the seal supplied with the unit onto the controller housing.

The unit must be installed with the seal so that no water or oil can penetrate the housing!

* Insert the controller from the front into the panel cutout.



7865z08/0200

* At the rear of the panel, push the fixing elements into the guide slots from the side or top. The flat faces of the fixing elements must rest on the housing.

* Place the fixing elements against the rear of the panel and tighten them with a screwdriver.

3.5. Cleaning the front

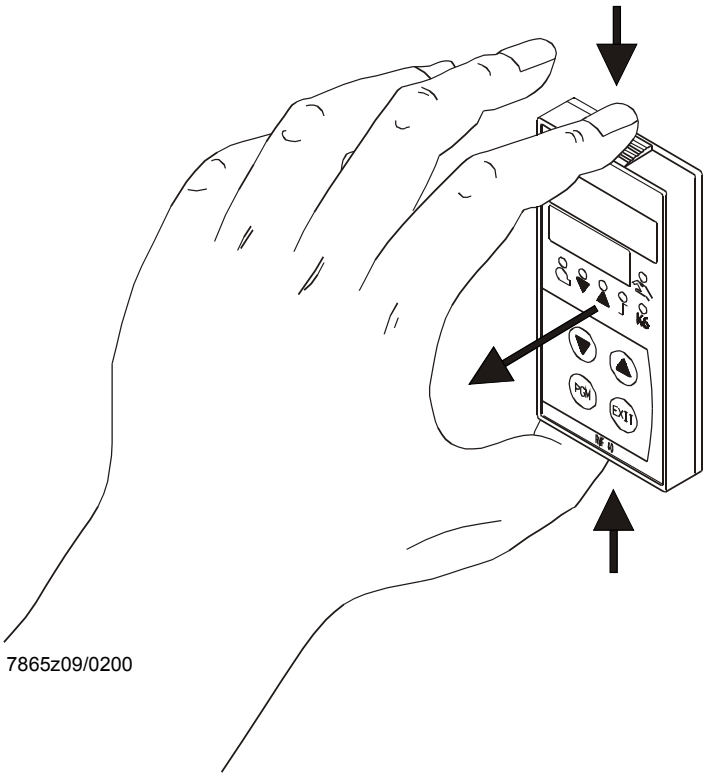
The front can be cleaned with normal washing and rinsing agents or detergents.

The front is **not** resistant to corrosive acids, caustic solutions and abrasive cleaners. Do not clean with high-pressure cleaners!

3.6 Removing the controller module

The controller module can be removed from the housing for service.

The rules as per DIN EN 100 015 «Protection of electrostatically sensitive devices » must be observed for internal work on the controller! **No liability** will be assumed for damage caused by electrostatic discharge.



7865z09/0200

* Press the ribbed surfaces together (at top and bottom) and pull out the controller module.

4.1 Installation notes

Safety regulations

- The choice of cable, installation and electrical connections of the controller must conform to VDE 0100 «Regulations for the installation of power circuits with nominal voltages below AC 1000 V», or the relevant local regulations
- The electrical connections must be made by qualified staff
- If contact with live parts is possible while working on the unit, the controller must be disconnected from the power supply (all-polar disconnection)

Fusing

- An internal current-limiting resistor cuts the supply voltage in the event of short-circuit. The external fusing should not be rated above 1 A (slow). The output relays must be fused for a maximum of 2 A to prevent contact welding in the event of a short-circuit in the load circuit

⇨ Section 11.2 «Outputs»

- No other loads may be connected to the controller's power supply terminals

Interference suppression

- The electromagnetic compatibility and interference suppression levels conform to the standards and regulations listed under «Technical data»

⇨ Chapter 11 «Technical data»

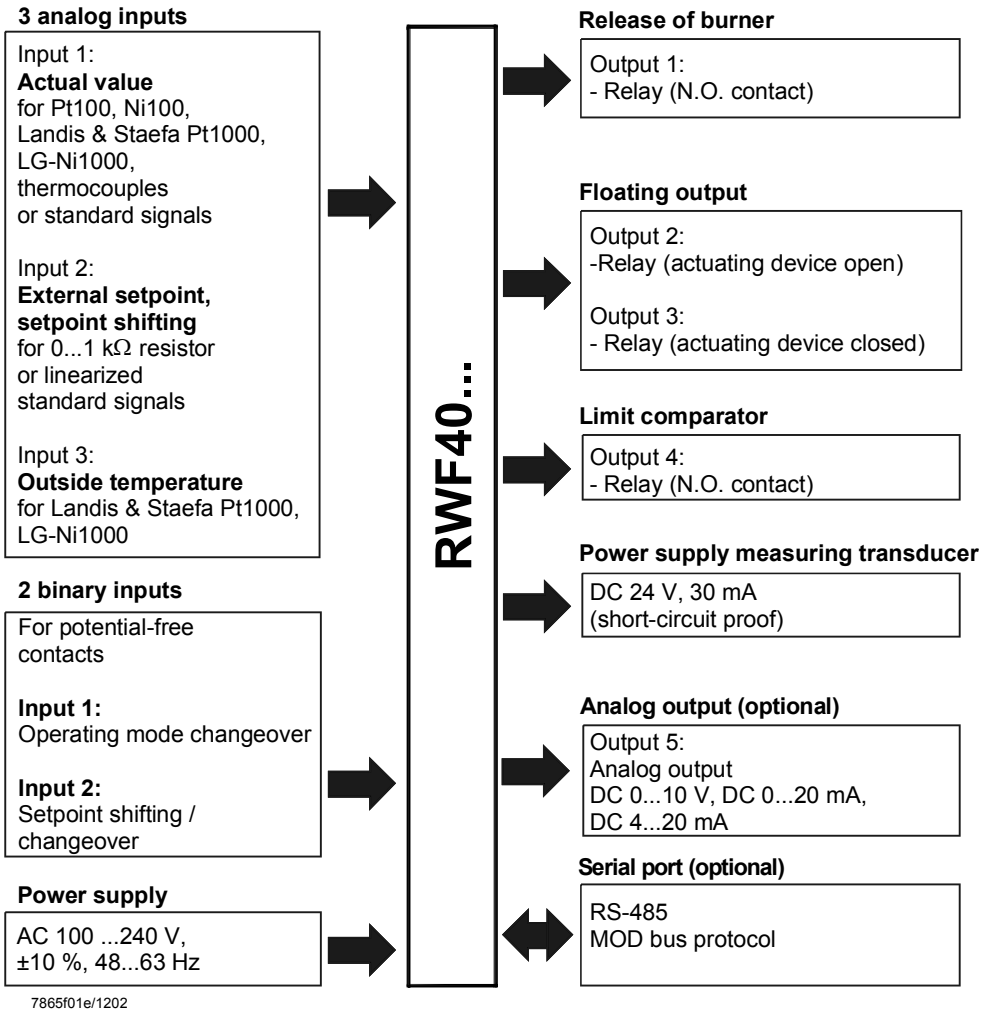
- Input, output and supply cables should be routed separately, not parallel to one another
- Arrange sensor and interface cables as twisted and shielded cables, and do not run them close to power cables or components. Ground the shielding to the controller **at one end** to the «TE» terminal
- Earth the «TE» terminal of the controller to protective earth. This cable must have a cross-sectional area that is at least as large as that of the supply cables. Earthing cables must be wired in a star configuration to a common earthing point connected to the protective earth of the supply. Earthing cables may not be looped from one controller to another

Incorrect use

- The unit is not suitable for installation in areas with an explosion hazard
- Incorrect settings on the controller (setpoint, data of parameter and configuration levels) can affect the proper functioning of the following process or lead to damage. Safety devices independent of the controller, such as overpressure relief valves or temperature limiters / monitors should therefore always be provided, and only be capable of adjustment by qualified staff. Please observe the relevant safety regulations. Since self-setting cannot be expected to handle all possible control loops, the stability of the resulting actual value should be checked
- The analog inputs of the controller may not exceed a maximum voltage of AC 30 V or DC 50 V against «TE»

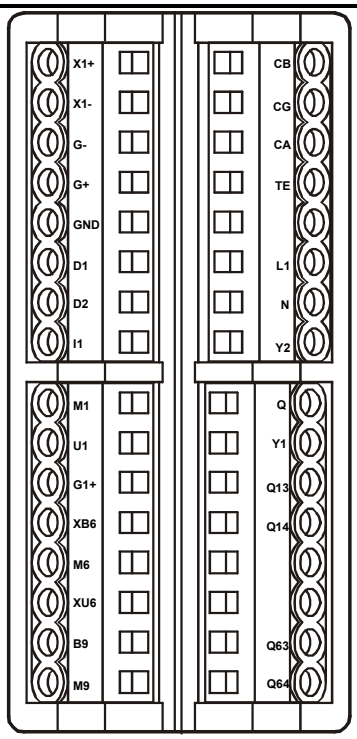
⇨ Section 4.3 «Galvanic separation»

4.2 Block diagram

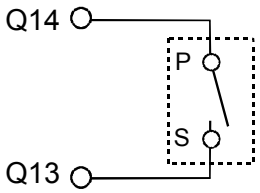
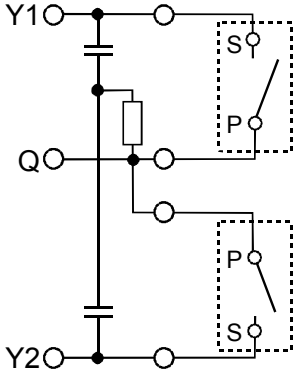
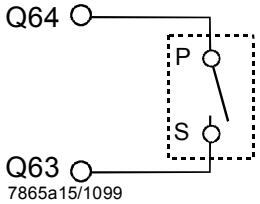
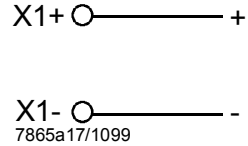


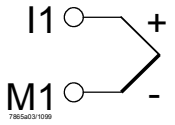
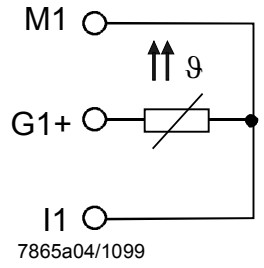
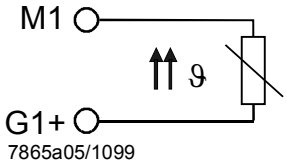
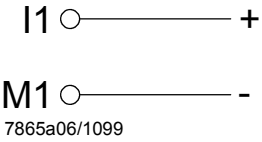
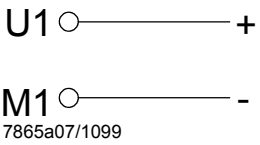
4.3 Assignment of terminals

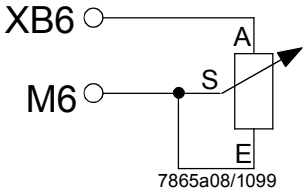
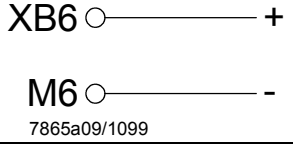
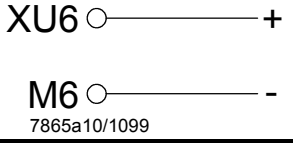
Electrical connections may only be made by qualified personnel!

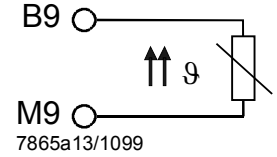


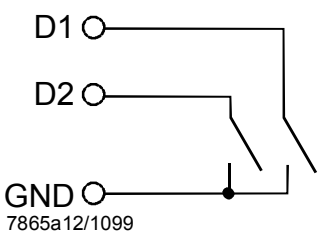
7865z07/1199

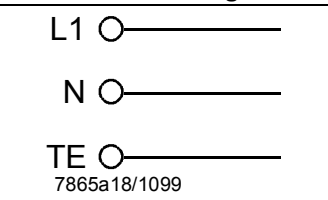
Outputs	Display LED	Terminal no.	Connection diagram
Relay 1: Release of burner Can be used as a thermal reset limit thermostat to DIN 3440 Contact protection: Varistor S07K275		Q14 pole Q13 N.O. contact	 7865a11/1199
Relay 2: Actuating device opens Contact protection: RC unit	▲	Y1 N.O. contact Q common pole	 7865a16/1099
Relay 3: Actuating device closes Contact protection: RC unit	▼	Y2 N.O. contact	
Relay 4: Limit comparator Contact protection: Varistor S07K275	K6	Q64 pole Q63 N.O. contact	 7865a15/1099
Analog output (optional) DC 0 (4)...20 mA, 0 (2)...10 V		X1+ X1-	 7865a17/1099

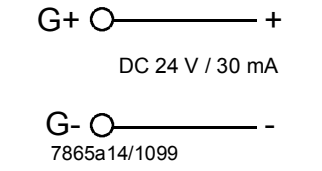
Analog input 1 (actual value)	Terminals	Connection diagram
Thermocouple	I1 M1	
Resistance thermometer in 3-wire circuit	M1 G1+ I1	
Resistance thermometer in 2-wire circuit, line compensation via offset correction (OFF1)	M1 G1+	
Current input DC 0...20 mA, 4...20 mA	I1 M1	
Voltage input DC 0...1 V, 0...10 V	U1 M1	

Analog input 2 (setpoint and setpoint shift)	Terminals	Connection diagram
Resistance potentiometer Offset correction (OFF2)	XB6 start M6 slider M6 end	
Current input DC 0...20 mA, 4...20 mA	XB6 M6	
Voltage input DC 0...1 V, 0...10 V	XU6 M6	

Analog input 3 (outside temperature)	Terminals	Connection diagram
Resistance thermometer in 2-wire circuit, line compensation via offset correction (OFF3)	B9 M9	

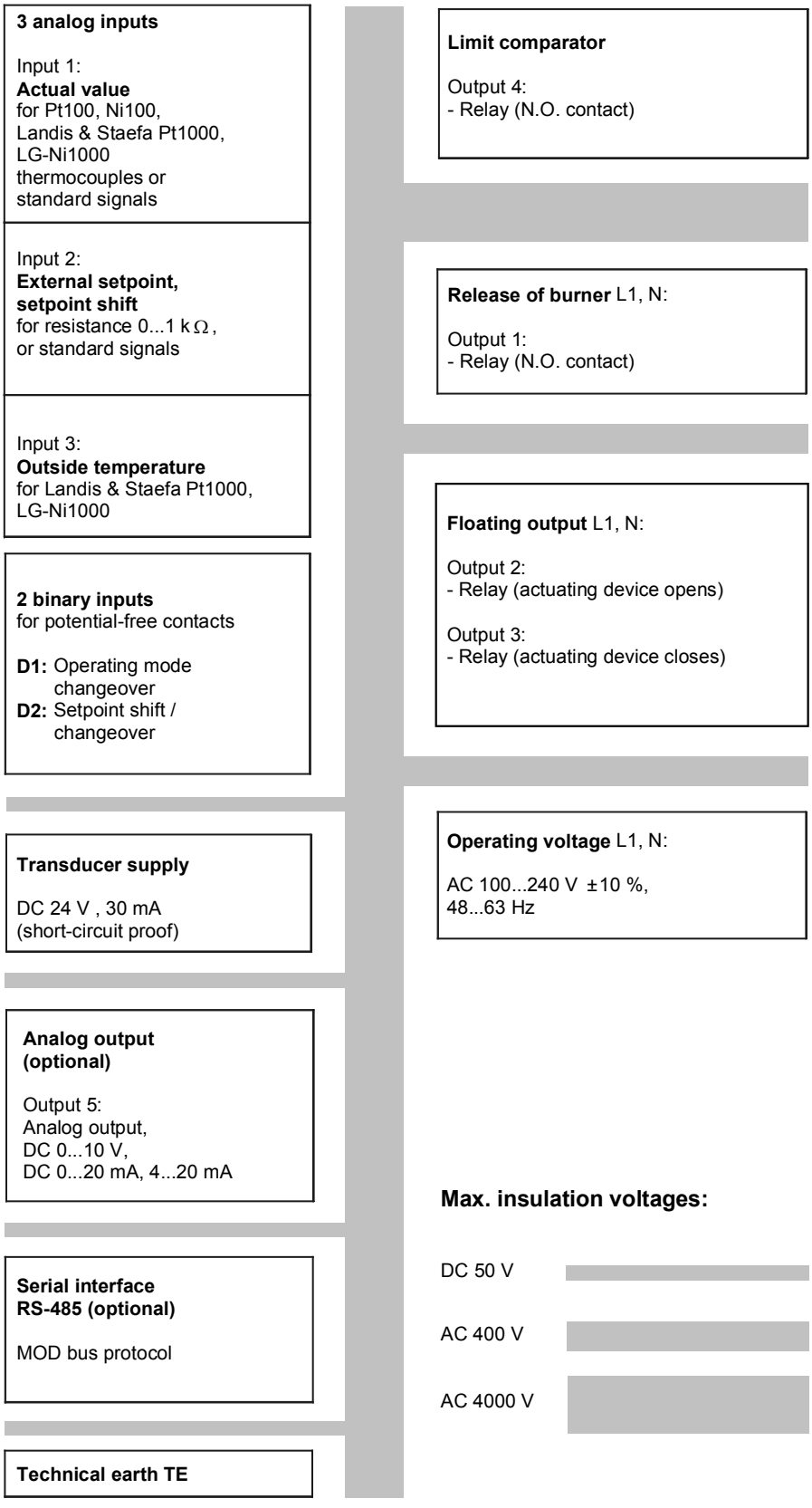
Binary inputs	Terminals	Connection diagram
Operating mode selector ⇨ Section 5.2 «High-fire operation»	D1	
Setpoint shift / changeover ⇨ Sections 5.4.1...5.4.4	D2	
Common ground	GND	

Operating voltage, interface	Terminals	Connection diagram
Operating voltage AC 100...240 V ±10 %, 48...63 Hz	L1 live conductor N neutral conductor	
Technical earth	TE	

Operating voltage for transducer	G+ G-	
Serial interface RS-485	CA CB CG	RxD / TxD+ RxD / TxD- GND

4.4 Galvanic separation

The diagram shows the maximum potential differences that may exist between the function modules in the controller.



7865f07e/1202

5.1 Low-fire operation

Low-fire operation means that only small amounts of heat are drawn from the boiler. A 2-position controller maintains the setpoint, switching the burner on and off like a thermostat.

Thermostat function

This mode of control is known as the **thermostat function**. An adjustable switching differential ensures that the burner's witching frequency can be selected, aimed at reducing wear.

Modulating and 2-stage operation:
Actual value between «HYS1» and «HYS3»

5.2 High-fire operation

High-fire operation means that large amounts of heat are drawn from the boiler so that the burner is continuously running. If the heating load during thermostat operation rises to a level where the actual value begins to fall below the switch-on threshold «HYS1», the controller will not immediately switch to a higher burner output, but makes a dynamic test of the control deviation first and switches to the higher output only when an adjustable threshold «Q» is exceeded (A).

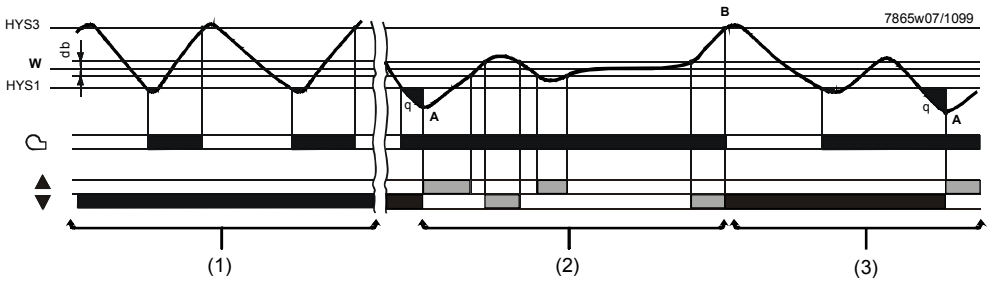
⇨ Section 5.6 «Response threshold Q»

Operating mode changeover

- In high-fire operation – depending on the application – the burner can be fired in **modulating** or **2-stage** operation, then burning larger amounts of fuel than in low-fire operation. The binary input «D1» can be used to switch between modulating and 2-stage operation
- When contact is open: Modulating burner operation
- When contact is closed: 2-stage burner operation

5.2.1 Modulating burner, floating output

In diagram area (1), the thermostat function is active. The modulating mode of burner operation is shown in area (2). In high-fire operation, a modulating controller acts on an actuator via relay 2 (open) and relay 3 (close).

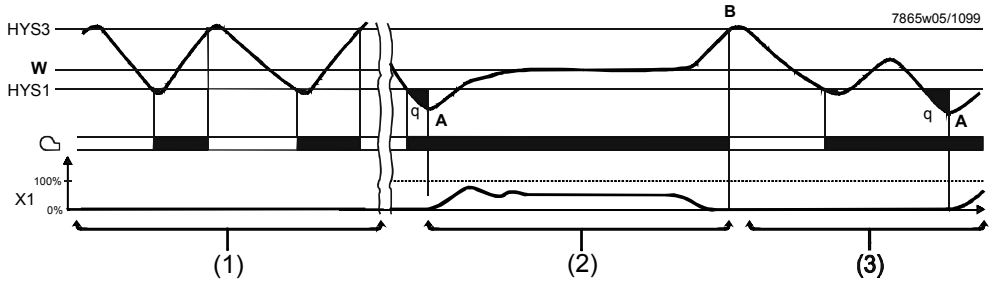


In area (3), the actual value exceeds the upper switch-off threshold «HYS3» and the controller switches the burner off (B). The controller only starts low-fire operation when the level falls below the switch-on threshold «HYS1» again. If «Q» is exceeded, the controller switches to high-fire operation (A).

⇨ Section 5.6 «Response threshold Q»

5.2.2 Modulating burner, analog output

In diagram area (1), the thermostat function is active.
In area (2), the controller maintains the adjusted setpoint.



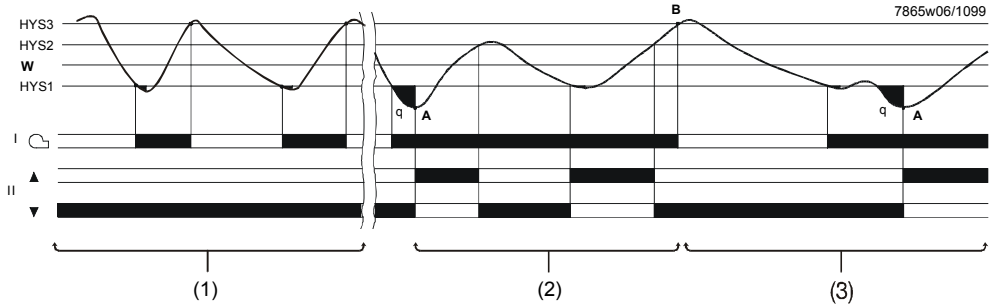
The positioning signal is delivered as a standard signal via the analog output.

☞ The modulating controller must be available and configured in the unit (optional).

⇨ Section 8.2 «C112 limit comparator, controller type, setpoint «SP1», locking»

5.2.3 2-stage burner, floating output

In diagram area (1), the thermostat function is active.
In area (2), a **2-position controller** acts on the second stage, via relay 2 (open) and relay 3 (close) by switching it into the circuit at the switch-on threshold «HYS1» / and out of circuit at the switch-off threshold «HYS2».

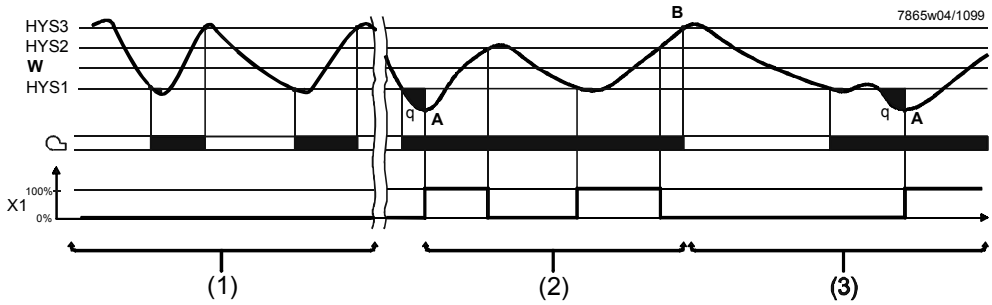


In area (3), the actual value exceeds the upper switch-off threshold «HYS3» and the controller shuts down the burner (B). The controller only starts low-fire operation when the level falls below the switch-on level «HYS1» again. If «Q» is exceeded, the controller switches to high-fire operation (A).

⇨ Section 5.6 «Response threshold Q»

5.2.4 2-stage burner, analog output

In this case, a standard binary signal switches the second stage into circuit with analog output «X1» on reaching the switch-on threshold «HYS1» and switches it out of circuit at the lower switch-off threshold «HYS2».



The modulating controller must be available and configured in the unit (optional).

⇨ Section 8.2 «C112 limit comparator, controller type, setpoint «SP1», locking»

5.3 Safety shutdown

In the event of a sensor failure, the controller cannot monitor the actual value of the boiler temperature (analog input 1). Safety shutdown will automatically be triggered to guard against overheating.
This also applies to the acquisition of the external setpoint at analog input 2.

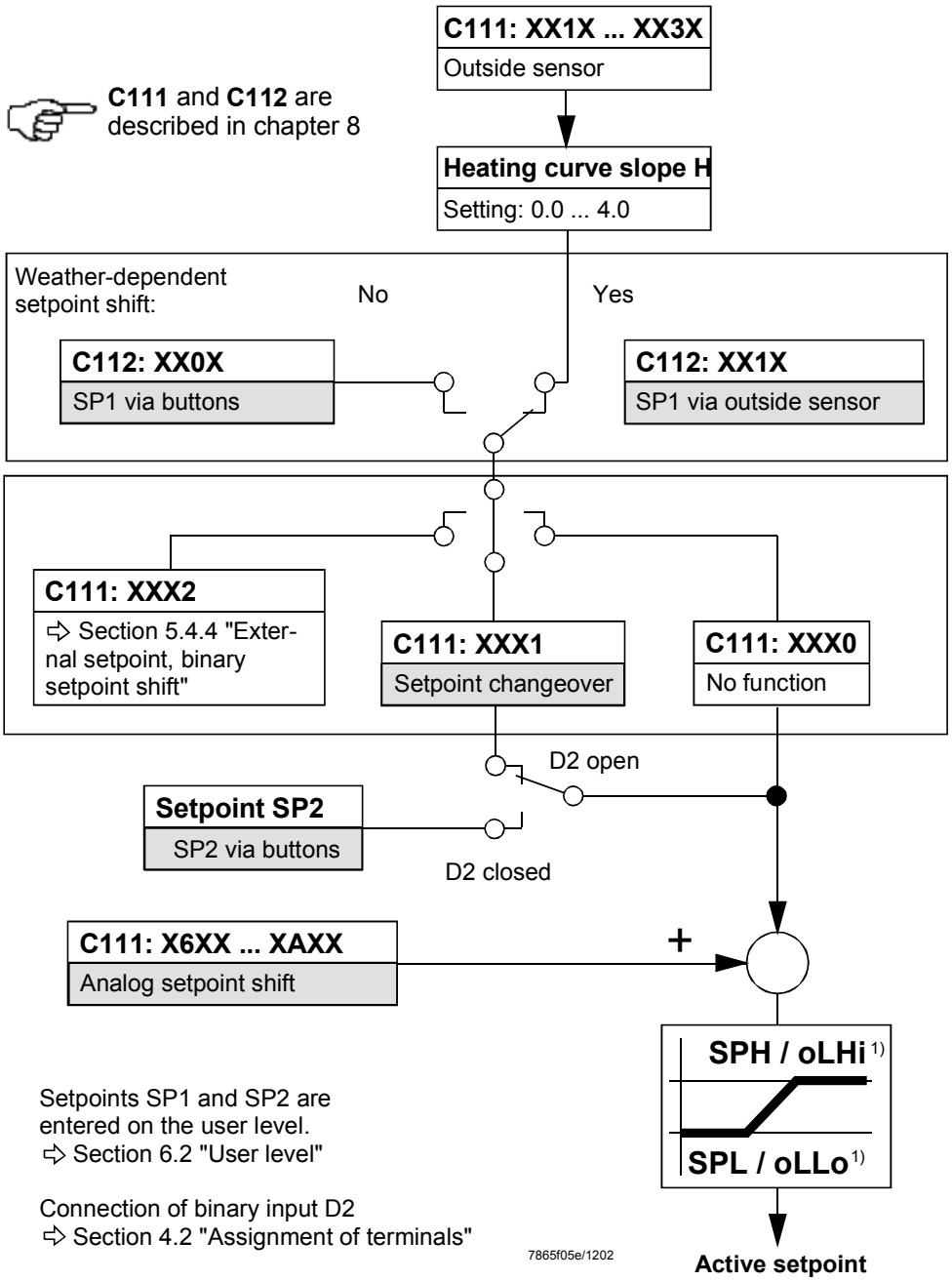
Functions

- Burner off
- Floating output for closing the actuating device
- Self-setting is ended
- Manual operation is ended

5.4 Predefined setpoint

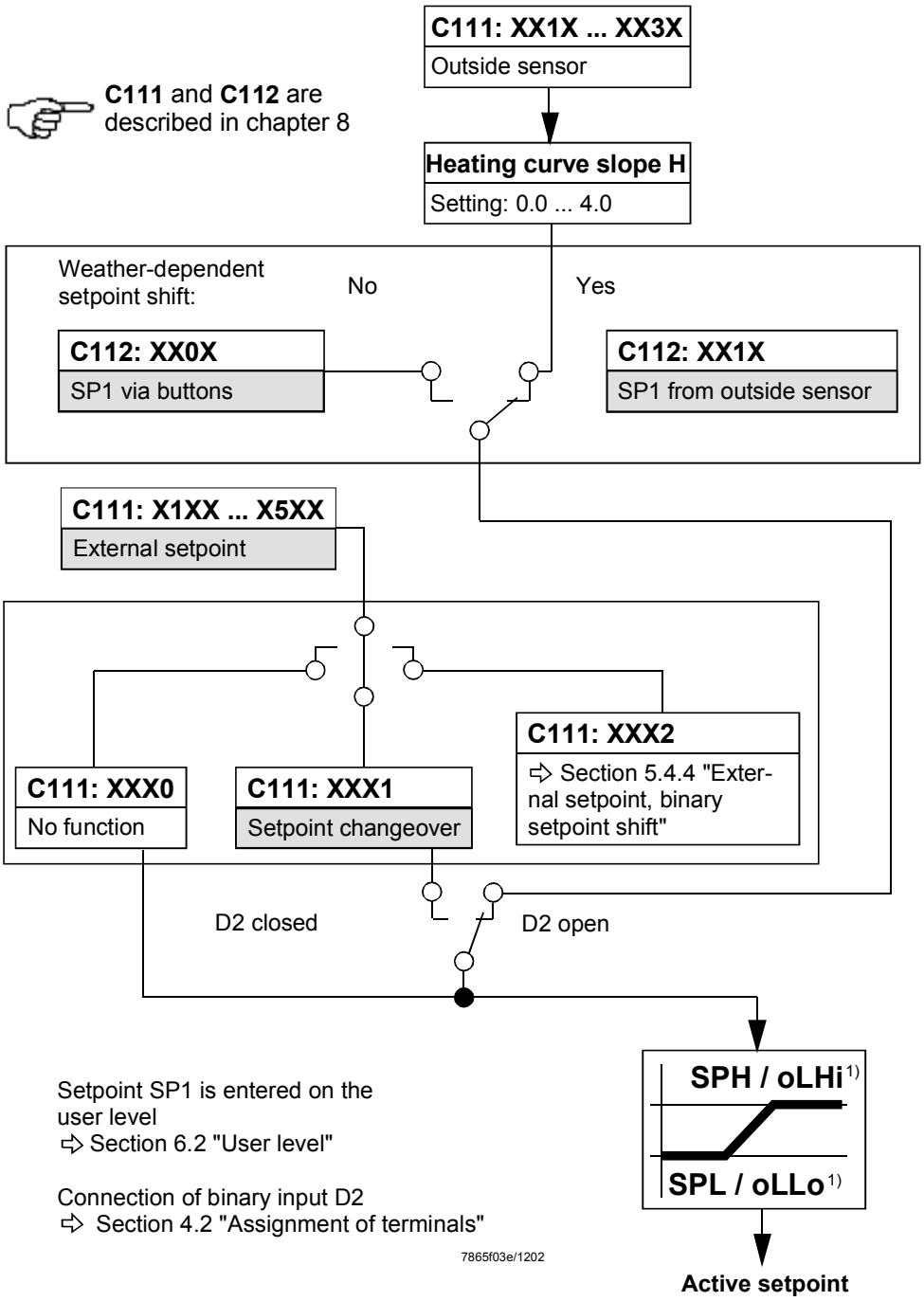
The setpoint is preselected within preset limits using the buttons, an external analog signal or the interface.
It is possible to shift the setpoint, either by an analog or binary signal, to influence it according to the weather, or to change it via an external contact.

5.4.1 Setpoint changeover «SP1 / SP2», analog setpoint shift



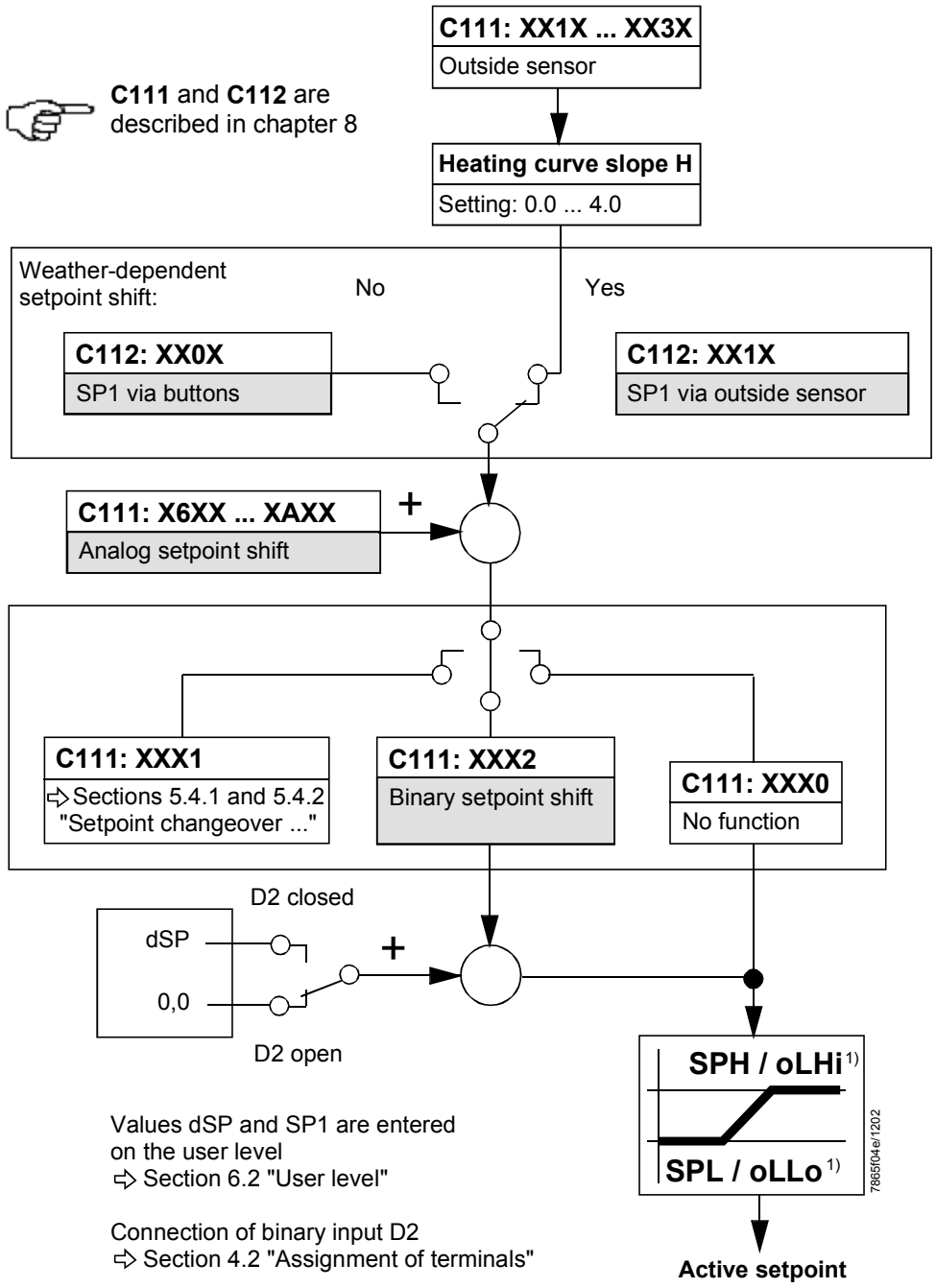
¹) Only with RWF40.0X2B97

5.4.2 Setpoint changeover «SP1» / external setpoint



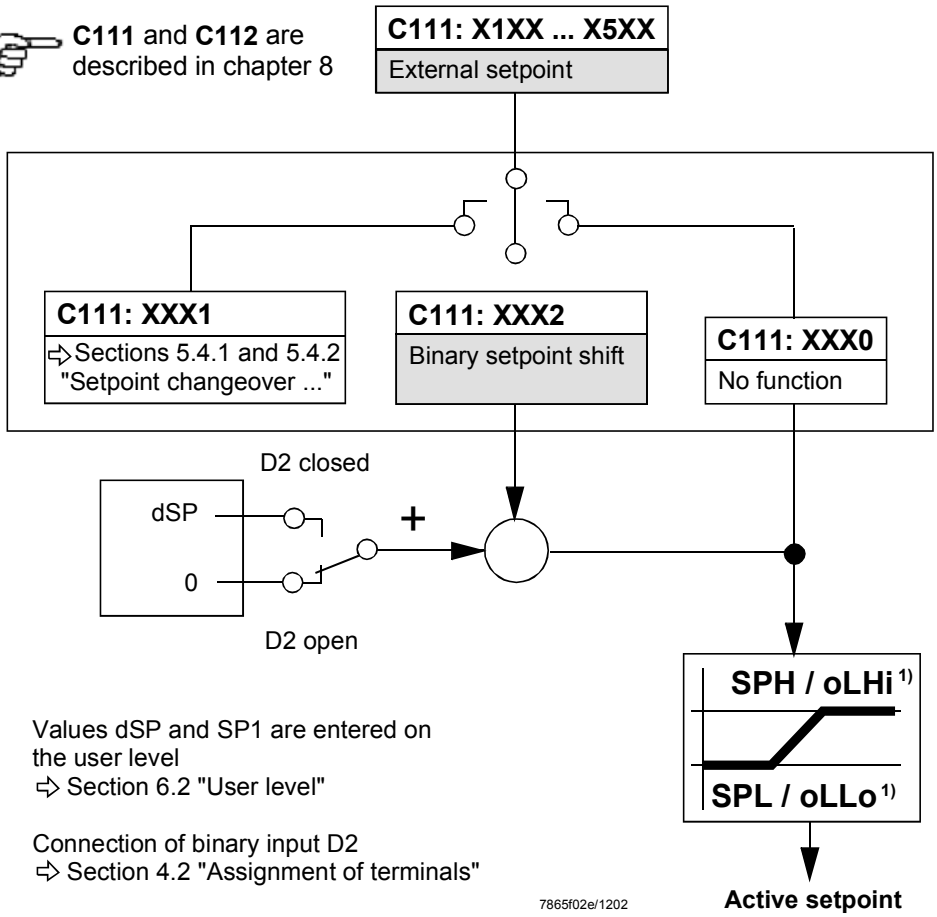
¹) Only with RWF40.0X2B97

5.4.3 Setpoint «SP1», analog / binary setpoint shift



¹) Only with RWF40.0X2B97

5.4.4 External setpoint, binary setpoint shift



1) Only with RWF40.0X2B97

5.5 Weather-dependent setpoint shift

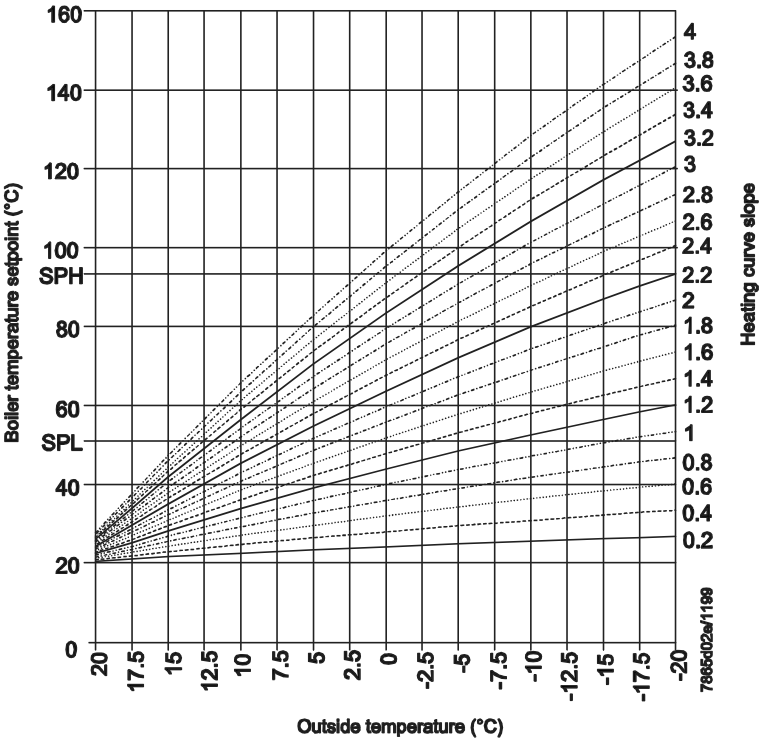
The RWF40... can be configured such that if an outside sensor with an LG-Ni1000 sensing element (e.g. QAC22) is used, a weather-dependent setpoint shift will be implemented. The minimum and maximum setpoint values can be set by the lower setpoint limit «SPL» and the upper setpoint limit «SPH». In addition, with the RWF40.0X2B97, the lower working range limit «oLLo» and the upper working range limit «oLHi» protect the plant by ensuring that the minimum plant temperature will be observed. Parameter «P» can be used to apply a parallel displacement to the heating curve.

Each RWF40... must have its own separate outside sensor (no parallel connection)!

This function has been optimized for space heating combined with domestic hot water heating.

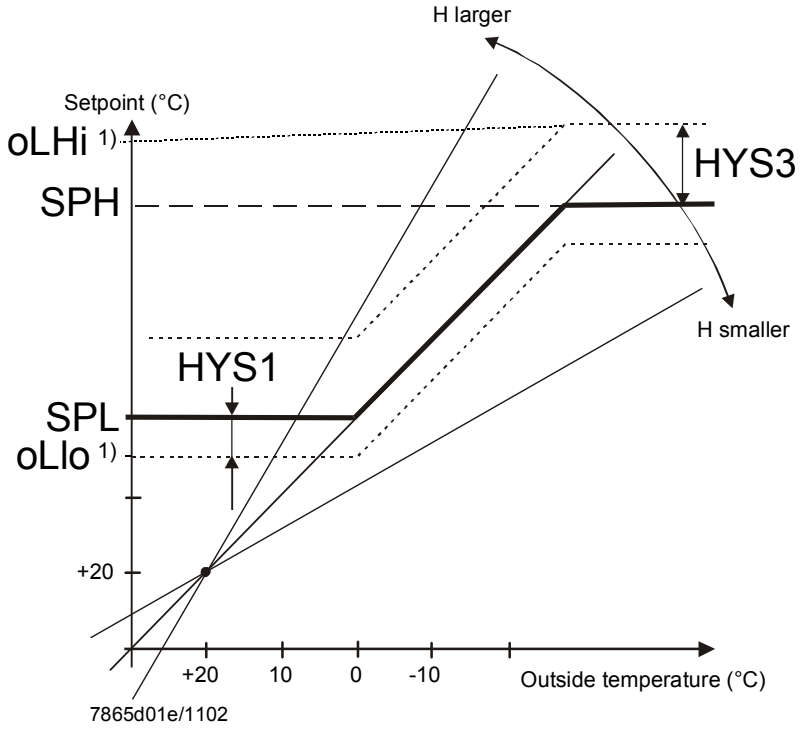
Parallel displacement of heating curve

⇨ Chapter 7 «Parameter settings»



5.5.1 Heating curve slope

Slope «H» of the heating curve can be used to adjust the setpoint in response to the outside temperature, as shown in the diagram. The common origin of the heating curves is set at (20 °C / 20 °C). The effective range of the weather-dependent setpoint is restricted by the setpoint limits «**SPH»** and **«SPL»**.



[1]) Only with RWF40.0X2B97

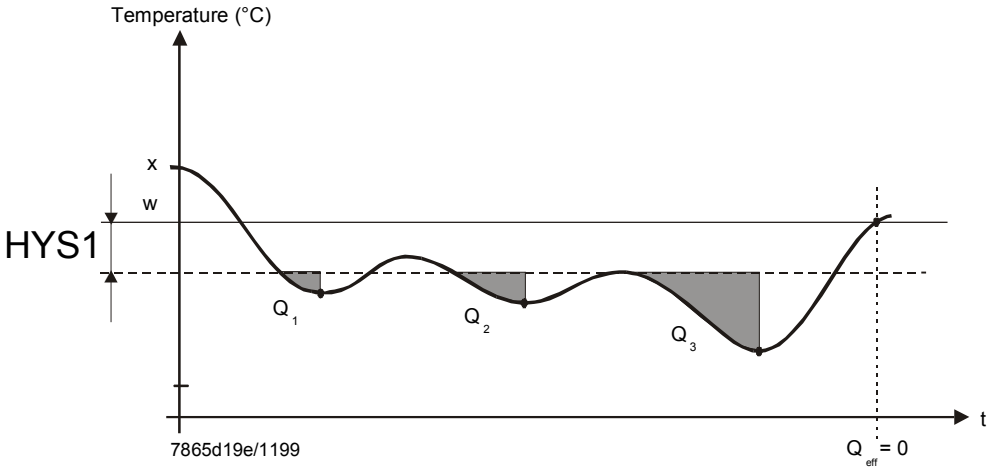
«HYS1» is the switch-on point for the burner, and «**HYS3»** is the switch-off point. As already described, they act with the set shift relative to the weather-dependent setpoint.

⇨ Section 5.2.1 «Modulating burner, floating output»

⇨ Section 5.2.2 «Modulating burner, analog output»

5.6 Response threshold «Q»

The response threshold «Q» defines for how long and how low the actual value is allowed to drop before the system switches to high-fire operation.
An internal mathematical calculation using an integration function determines the sum of all the areas Q_{eff} = Q1 + Q2 + Q3, as shown in the diagram. This only takes place when the control deviation (x-w) falls below the value of the switching threshold «HYS1». If the actual value increases, integration is stopped.
If «Q_{eff}» exceeds the preset response threshold «Q» (can be adjusted on the parameter level), this causes the second stage of the burner to switch on or - in the case of a floating controller / modulating controller – the actuating device to open.
If the actual boiler temperature reaches the required setpoint, Q_{eff} is reset to 0 .



Monitoring of the actual value ensures that the switching frequency is kept low in the transitional range from low- to high-fire operation, aimed at reducing wear.

5.7 Cold start of the plant

When a heating system is switched off for a longer period of time, the actual value will drop of course.
To achieve a faster control response, the controller immediately starts in high-fire operation as soon as the control deviation (x-w) drops below a certain limit value. This limit is calculated as follows:

Limit value = 2 * (HYS1-HYS3)

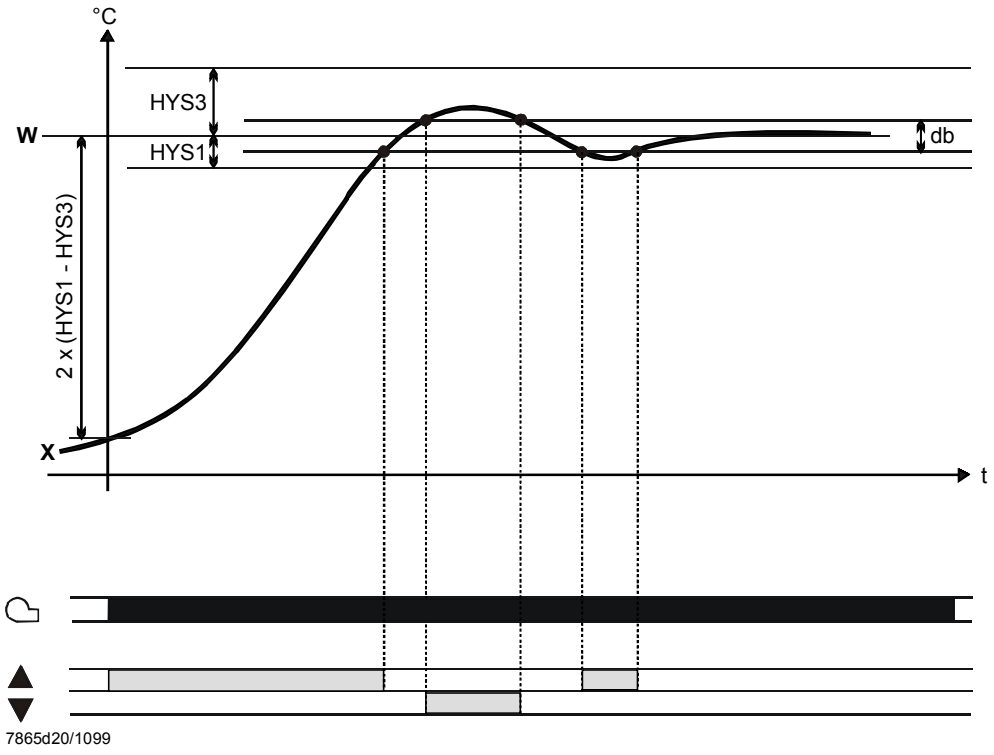
In that case, response threshold «Q» is inactive, independent of the operating mode and the controlled variable (temperature or pressure).

Example

Operating mode: Modulating, floating output
HYS1 = -3 K
HYS3 = +5 K
w = 60 °C

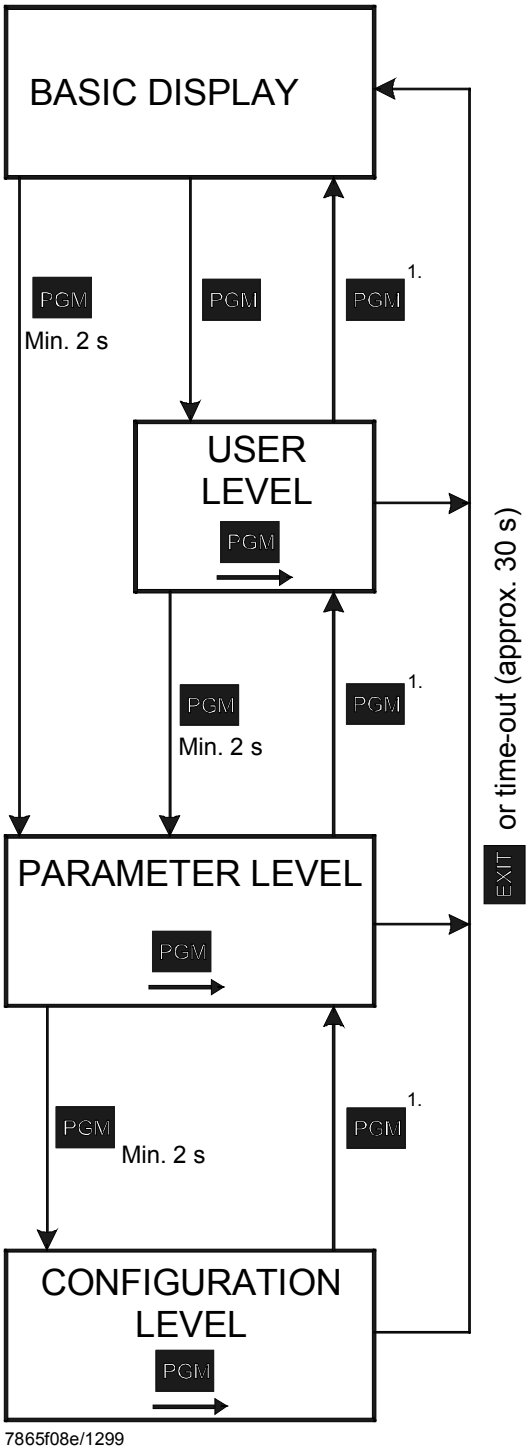
Limit value = 2 * (-3 - 5) = 2 * (-8) = -16 K

At an actual value below 44 °C, the heating up procedure immediately starts in high-fire operation, instead of in the thermostat mode.



Assignment of levels

All levels can be accessed from the basic display via the PGM button, as shown in the diagram.
The upper actual value display (red) shows the actual value and the parameter values for the various levels.
The setpoint and parameters are shown in the lower section of the display (green).

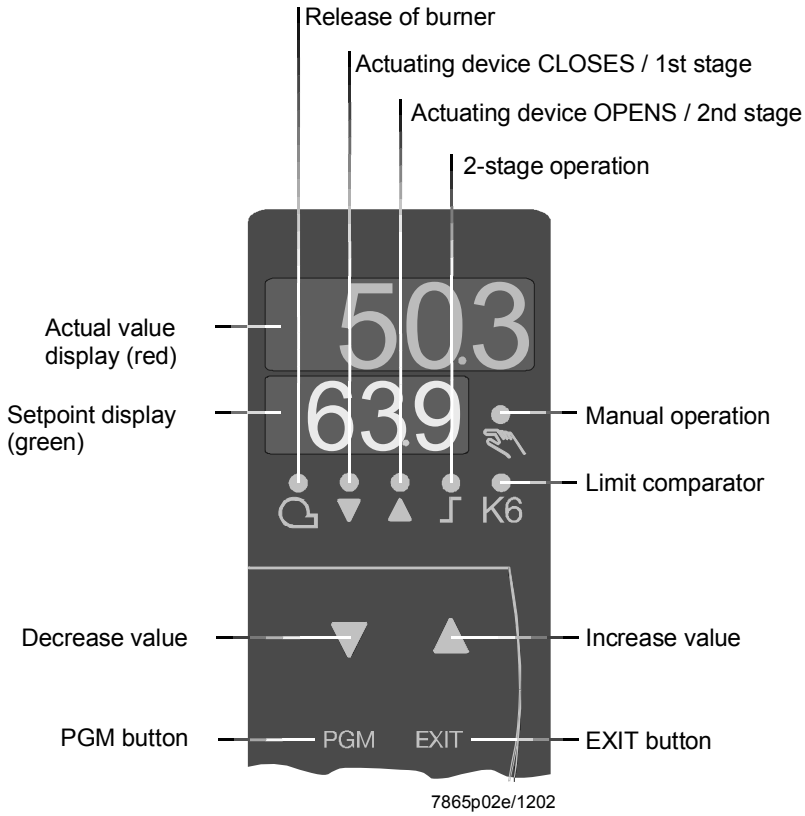


[1] After using «PGM» to step through all the parameters of a level, automatic return occurs after the last parameter has been confirmed.

6.1 Basic display

The diagram shows the RWF40... after switching power on. This condition is called the basic display. The actual value and the currently active setpoint are shown here. Manual operation, self-setting, the user, parameter and configuration levels can be activated from here.

6.1.1 Meaning of the display and buttons



Initialization

All displays light up. The setpoint display flashes for about 10 seconds after switching power on.

Manual operation

The upper display shows the actual value. The LED for manual operation is on.
Depending on the operating mode and the type of controller, the setpoint or the level of the manual actuator position is shown on the setpoint display (green).

⇨ Section 6.2.2 «Manual operation of a modulating burner»

Self-setting function

The actual value is shown on the actual value display (red) and the text «**tunE»** flashes on the setpoint display (green).

⇨ Section 9.1 «Self-setting function in high-fire operation»

Actual value display flashes

⇨ Chapter 10 «What to do if...»

2-stage operation

⇨ Section 5.2 «High-fire operation»

Time-out

☞ If there is no action by the operator, the controller will automatically return to the basic display after about 30 seconds.

6.2 User level

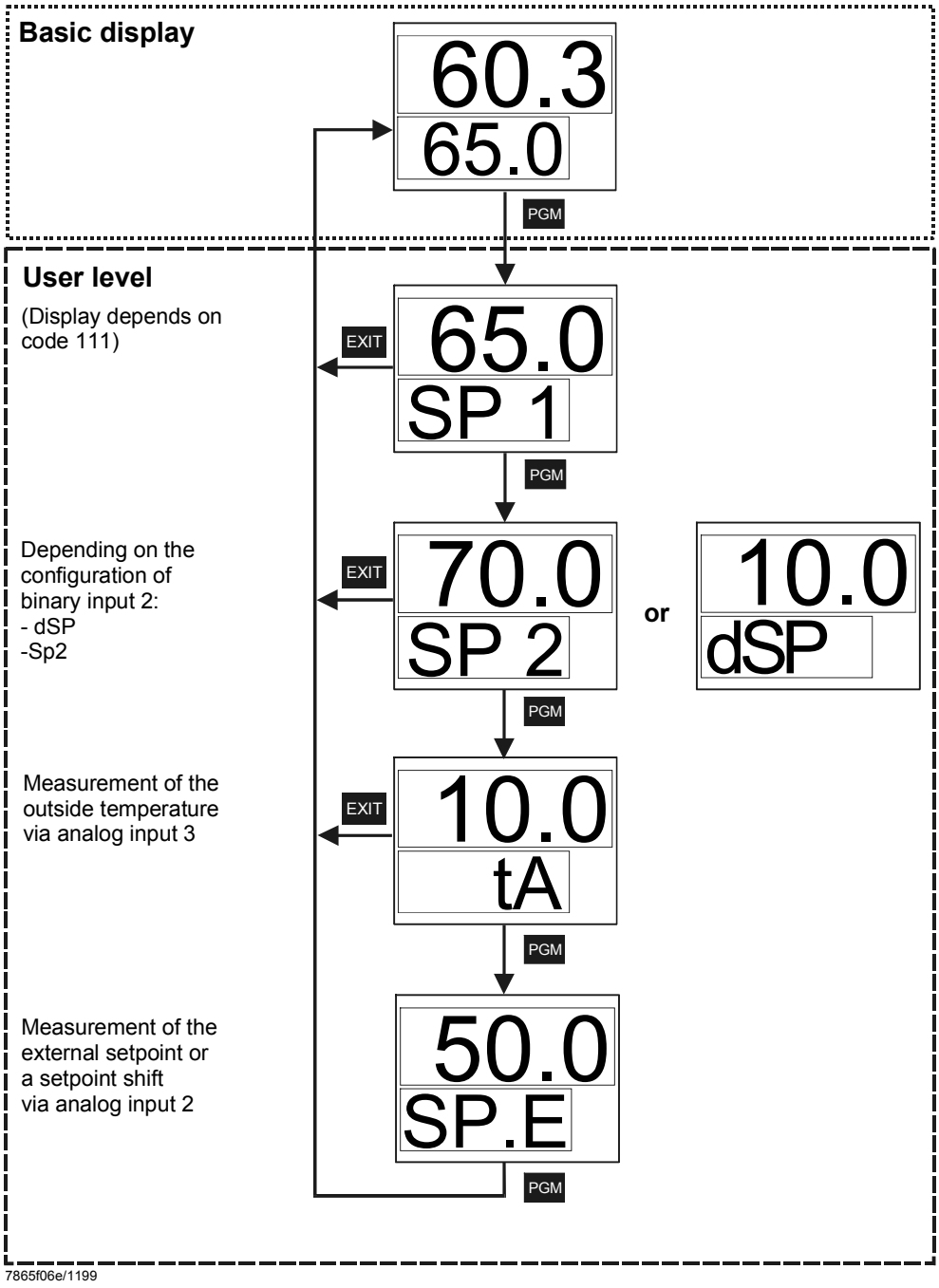
This level is started from the basic display. Setpoints «SP1» and «SP2 / dSP» can be altered, and the analog inputs «E2» (external setpoint / setpoint shift) and «E3» (outside temperature) can be displayed.

6.2.1 Changing the setpoints

To alter «SP1», «SP2» or «dSP»:

- Change to the user level with PGM
- Alter setpoint «SP1» with ▼ and ▲
- Change to setpoint «SP2» or «dSP» with PGM
- Alter setpoint «SP2» or «dSP» with ▼ and ▲
- Return to the basic display with EXIT or automatically via time-out after about 30 s

☞ After 2 seconds, the set value will automatically be adopted. The value can only change within the permitted value range


Basic display
60.3
65.0
PGM
User level
(Display depends on code 111)
EXIT
65.0
SP 1
PGM
Depending on the configuration of binary input 2:
- dSP
-Sp2
EXIT
70.0
SP 2
or
10.0
dSP
PGM
Measurement of the outside temperature via analog input 3
EXIT
10.0
tA
PGM
Measurement of the external setpoint or a setpoint shift via analog input 2
50.0
SP.E
PGM
7865f06e/1199

6.2.2 Manual operation, modulating burner

∗ Press EXIT for 5 seconds

The LED above the hand symbol will light up.

Floating controller

∗ Change the position of the actuating device with ▲ and ▼

Relay 2 opens the actuating device as long as ▲ is kept depressed.

Relay 3 closes the actuating device as long as ▼ is kept depressed.

The LEDs for the actuating device indicate if «OPEN» or «CLOSE» is activated.

Modulating controller

∗ Change the position of the actuating device with ▲ and ▼

The analog output delivers the position of the actuating device that was entered.

∗ Return to automatic operation by pressing EXIT for 5 seconds

☞ When manual operation is activated, the position of the actuating device will be set to 0 until another entry with the buttons is made.

Thermostat mode

Manual operation can only be activated if the thermostat function has set relay 1 **active**. If the thermostat function sets relay 1 **inactive** during manual operation, manual operation is terminated.

6.2.3 Manual operation, 2-stage burner

∗ Press EXIT for 5 seconds

∗ Press ▲ briefly

– Relay 2 is active, relay 3 is inactive
– Analog output (optional) delivers DC 10 V

The actuating device opens.

∗ Or press ▼ briefly

– Relay 2 is inactive, relay 3 is active
– Analog output (optional) delivers DC 0 V

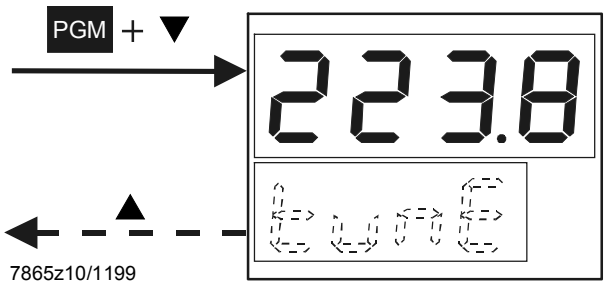
The actuating device closes.

∗ Return to automatic operation by pressing EXIT for 5 seconds

☞ If the thermostat function sets relay 1 **inactive** during manual operation, manual operation is terminated.

6.2.4 Start self-setting

* Start self-setting with PGM + ▼
* Cancel with ▲



When «**tunE**» stops flashing, self-setting has stopped.

* Accept the parameters that have been determined by pressing ▲ (press the button for at least 2 seconds!)

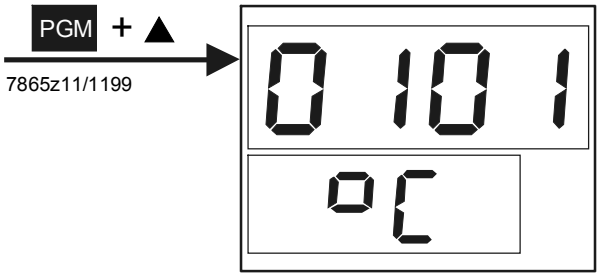
☞ It is not possible to start «**tunE**» in manual operation or thermostat operation.

6.2.5 Display of the software version and of unit of actual value

* Press PGM + ▲

Available units:

°C, °F and % (for standard signals)



6.3 Parameter level

The parameters involved in adapting the controller to the controlled system are set here after the system has been started up.

Within the level, you can proceed to the next parameter by pressing PGM.

☞ The display of the individual parameters depends on the type of controller.

6.3.1 Entering parameters

Entry and alteration of the parameters is made through continuous alteration of the value. The longer you keep the button pressed, the faster the rate of change.

* Increase value by pressing ▲
* Decrease value by pressing ▼
* Accept entry by pressing PGM

  or

* Cancel entry by pressing EXIT

☞ After 2 seconds, the set value will automatically be accepted. The value can only change within the permissible value range.

⇨ Chapter 7 «Parameter settings»

6.4 Configuration level

The settings made here are those required for commissioning a specific installation and, therefore, need hardly ever be altered later on (acquisition of measured value or type of controller).

Within the level, you can advance to the next parameter by pressing PGM.

6.4.1 Changing the configuration code

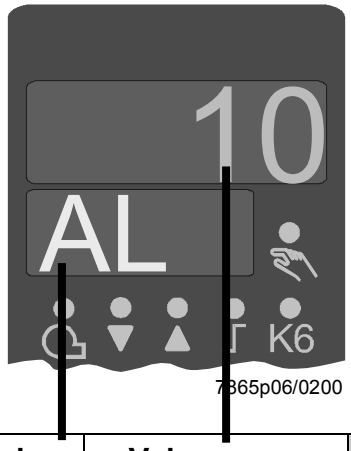
* Select position by pressing ▼ (position flashes!)
* Alter value by pressing ▲
* Accept code by pressing PGM

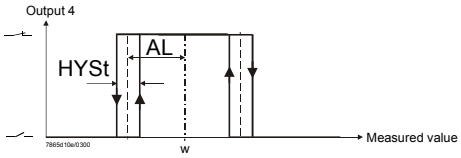
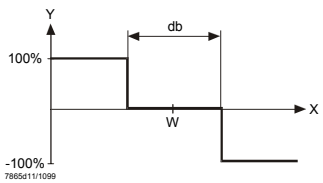
  or

* Cancel entry by pressing EXIT

⇨ Chapter 8 «Configuration»

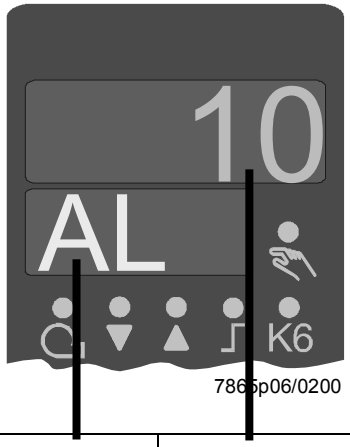
The parameter is shown on the lower setpoint display (green) and the parameter value on the upper / actual value display (red).



Parameter	Display	Value range	Factory setting	Remarks
Limit value for limit comparator [1)]	**AL**	-1999...+9999 digit	0	 ⇨ Chapter 8.2 «**C112** – limit comparator, controller type, setpoint «SP1», locking»
Switching differential for limit comparator [1)]	**HYSt**	0...999.9 digit	1	Switching differential at the edges for the limit comparators ⇨ Chapter 8.2 «**C112** – limit comparator, controller type, setpoint «SP1», locking»
Proportional band [1)]	**Pb.1**	0.1...999.9 digit	10	Affects the P-response of the controller
Derivative time	**dt**	0...9999 s	80	Affects the D-response of the controller. Within dt = 0, the controller has no D-response. For modulating controllers, dt = rt / 4 or 0 must be entered.
Integral action time	**rt**	0...9999 s	350	Affects the I-response of the controller. With rt = 0, the controller has no I-response
Dead band (neutral zone) [1)]	**db**	0...999.9 digit	1	For floating output 

[1)] Setting of the decimal place has an impact on this parameter.

The parameter is shown on the lower / setpoint display (green) and the parameter value on the upper / actual value display (red).

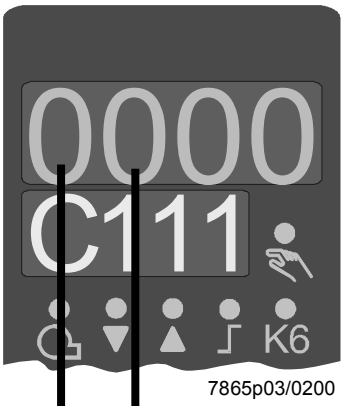


Parameter	Display	Value range	Factory setting	Remarks
Actuator running time	**tt**	10...3000 s	15 s	Running time of the valve for use with floating controllers
Switch-on threshold for burner stage II [1)]	**H Y S 1**	0...-199.9 digit	-5	⇨ Section 5.5.1 «Heating curve slope»
Switch-off threshold stage II [1)]	**H Y S 2**	0...HYS3 digit	3	⇨ Section 5.2 «High-fire operation»
Upper switch-off threshold [1)]	**H Y S 3**	0...999.9 digit	5	⇨ Section 5.2 «High-fire operation»
Response threshold	**q**	0...999.9	0	⇨ Section 5.6 «Response threshold Q»
Heating curve slope	**H**	0...4	1	⇨ Section 5.5.1 «Heating curve slope»
Parallel displacement [1)]	**P**	-90...+90	0	⇨ Section 5.5 «Weather-dependent setpoint shift»

[1)] Setting of the decimal place has an impact on this parameter.

8. Configuration

8.1 C111 inputs



7865p03/0200

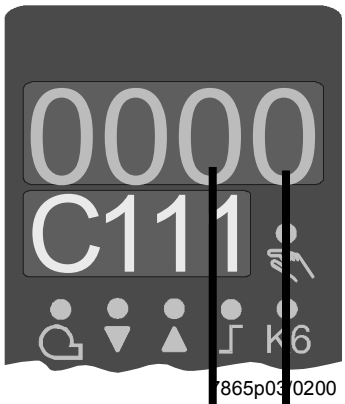
Analog input 1

Pt100, 3-wire, IEC 751	0
Pt100, 2-wire, IEC 751	1
Ni100, 3-wire, DIN 43760	2
Ni100, 2-wire, DIN 43760	3
Landis & Staefa Pt1000, 3-wire, IEC 751	4
Landis & Staefa Pt1000, 2-wire, IEC 751	5
Ni1000, 3-wire, DIN 43760	6
Ni1000, 2-wire, DIN 43760	7
LG-Ni1000, 3-wire	8
LG-Ni1000, 2-wire	9
NiCr-Ni / K	A
Cu-CuNi / T	b
NiCroSil-NiSil / N	C
Fe-CuNi / J	d
Standard signal DC 0…20 mA	E
Standard signal DC 4…20 mA	F
Standard signal DC 0…10 V	G
Standard signal DC 0…1 V	H
Pt-RhPt / S [1])	i
Pt-RhPt / R [1])	j
Pt-RhPt / B [1])	L

Analog input 2

No function	0
External setpoint, 1 kΩ resistance potentiometer	1
External setpoint, DC 0…20 mA	2
External setpoint, DC 4…20 mA	3
External setpoint, DC 0…10 V	4
External setpoint, DC 0…1 V	5
Analog setpoint shift, 1 kΩ resistance potentiometer	6
Analog setpoint shift, DC 0…20 mA	7
Analog setpoint shift, DC 4…20 mA	8
Analog setpoint shift, DC 0…10 V	9
Analog setpoint shift, DC 0…1 V	A
Position feedback resistance potentiometer 1 kΩ [1])	b
Position feedback 0...20 mA [1])	C
Position feedback 4...20 mA [1])	d
Position feedback 0...10 V [1])	E
Position feedback 0...1 V [1])	F

[1]) Only with RWF40.0X2B97



Analog input 3

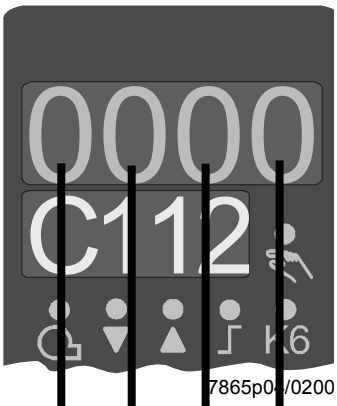
No function	0
Outside sensor Landis & Staefa Pt1000, 2-wire, IEC 751	1
Outside sensor Ni1000, 2-wire, DIN 43760	2
Outside sensor LG-Ni1000, 2-wire	3

Function of binary input «D2»

No function	0
Setpoint changeover	1
Setpoint shift (binary)	2

Factory setting	**9 0 3 0**

8.2 C112 limit comparator, controller type, setpoint «SP1», locking



Limit comparator

No function (lk off)	0
lk1, input 1	1
lk2, input 1	2
lk3, input 1	3
lk4, input 1	4
lk5, input 1	5
lk6, input 1	6
lk7, input 1	7
lk8, input 1	8
lk7, input 2	9
lk8, input 2	A
lk7, input 3	b
lk8, input 3	C

Controller type

Floating controller	0
Modulating controller DC 0…20 Ma	1
Modulating controller DC 4…20 mA	2
Modulating controller DC 0...10 V	3

Setpoint «SP1»

«SP1» via buttons	0
«SP1» with outside sensor (analog input 3 must be configured)	1

Locking

No locking	0
Locking of configuration level	1
Locking of parameter level	2
Locking of buttons	3

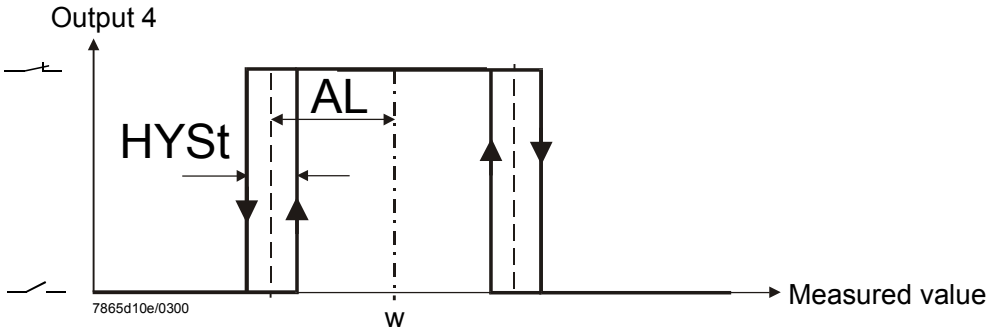
Locking of the buttons can be entered only **once** and adapted with PGM. Then, all button operations will be locked and can only be enabled again by the manufacturer!

Factory setting	**0 0 1 0**

Function lk1

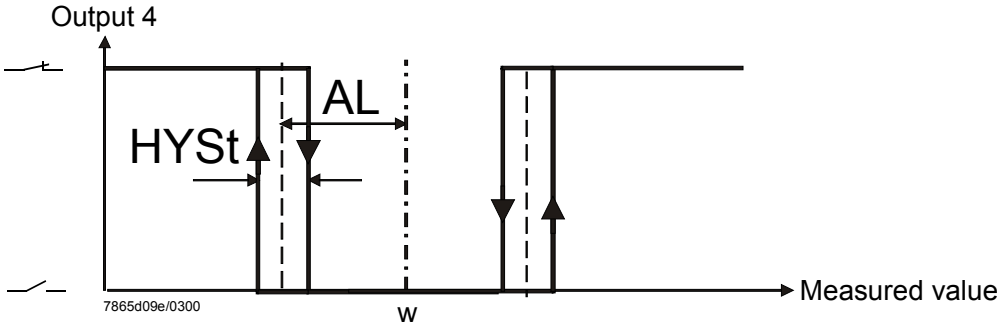
Window function: Relay «K6» is active when the measured value lies within a window about the setpoint (w).
Example: w = 80 °C, **AL** = 5, **HYSt** = 2

Measured value rising: Relay «K6» switches on at 76 °C and off at 86 °C.
Measured value falling: Relay «K6» switches on at 84 °C and off at 74 °C.



Function lk2

Like lk1, but inverted switching function.

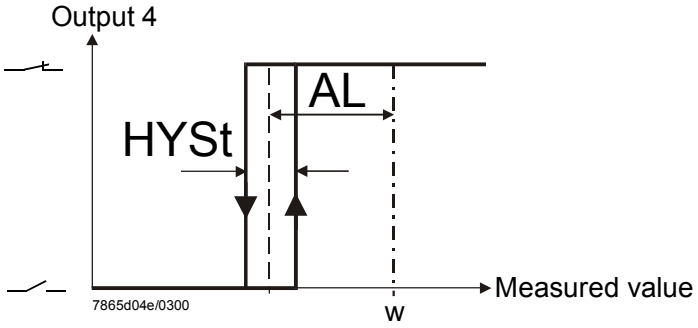


HYSt = switching differential of the window edges
AL = interval from setpoint (half the window-width)

Function lk3

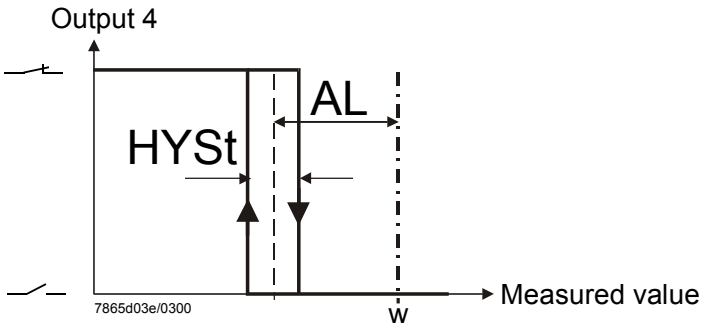
Lower limit signaling
Function: Relay inactive when measured value < (setpoint – limit value).
Example: w = 80 °C, **AL** = 10, **HYSt** = 2

Measured value rising: Relay «K6» switches on at 71 °C.
Measured value falling: Relay «K6» switches off at 69 °C.



Function lk4

Like lk3, but inverted switching function.



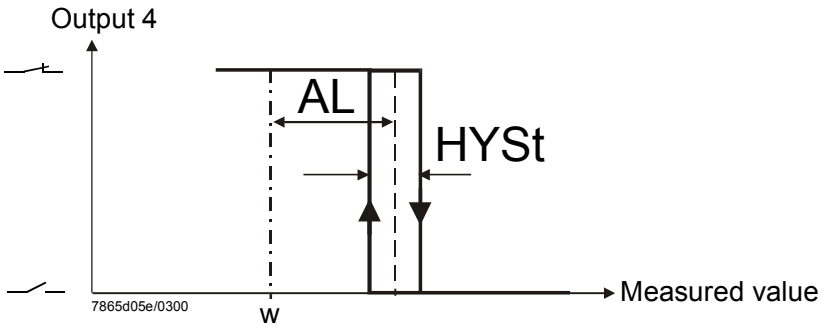
HYSt = switching differential
AL = interval from setpoint

⇨ Chapter 7 «Parameter settings»

Function lk5

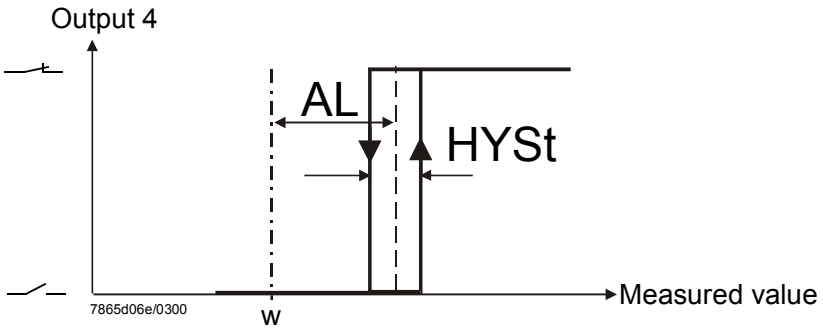
Upper limit signaling
Function: Relay inactive when measured value > (setpoint + limit value).
Example: w = 80 °C, **AL** = 10, **HYSt** = 2

Measured value rising: Relay «K6» switches off at 91 °C.
Measured value falling: Relay «K6» switches on at 89 °C.



Function lk6

Like lk5, but inverted switching function.

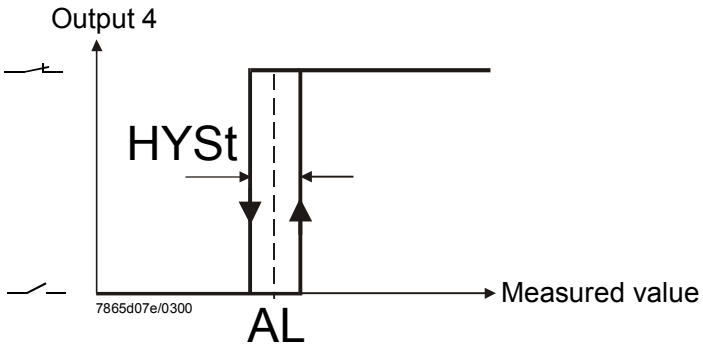


Function lk7

The switching point is independent of the controller setpoint; only the limit value «**AL»** determines the switching point.

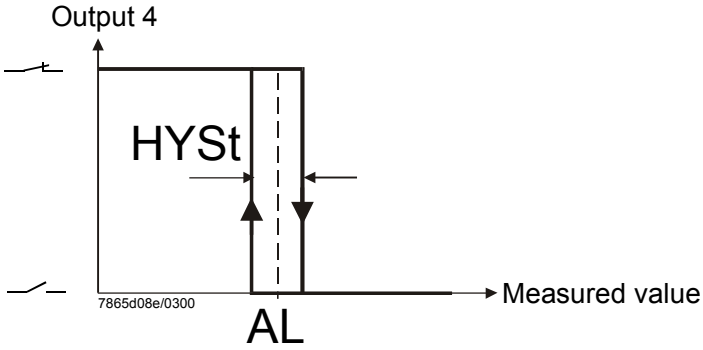
Function: Relay is active when measured value > limit value.
Example: **AL** = 50, **HYSt** = 2

Measured value rising: Relay «K6» switches on at 51 °C.
Measured value falling: Relay «K6» switches off at 49 °C.



Function lk8

Like lk7, but inverted switching function.

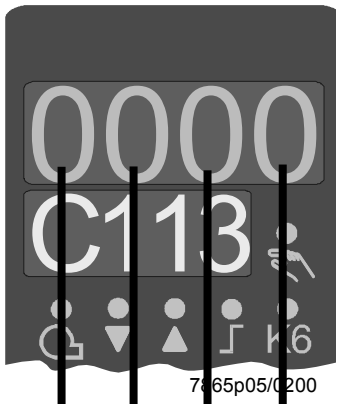


HYSt = switching differential
AL = limit value

⇨ Chapter 7 «Parameter settings»

8.3 C113 instrument address, dimensional unit, out-of-range

The setting of the decimal place has an impact on the parameters that are dependent on the actual value!



Unit address

Address 0	0	0
Address 1	0	1
...		...
Address 99	9	9

Decimal place, unit, Baud rate

No decimal place, degrees Celsius, 9600 Bd	0
One decimal place, degrees Celsius, 9600 Bd	1
No decimal place, degrees Fahrenheit, 9600 Bd	2
One decimal place, degrees Fahrenheit, 9600 Bd	3
No decimal place, degrees Celsius, 19200 Bd [1])	4
One decimal place, degrees Celsius, 19200 Bd [1])	5
No decimal place, degrees Fahrenheit, 19200 Bd [1])	6
One decimal place, degrees Fahrenheit, 19200 Bd [1])	7
No decimal place, degrees Celsius, 4800 Bd [1])	8
One decimal place, degrees Celsius, 4800 Bd [1])	9
No decimal place, degrees Fahrenheit, 4800 Bd [1])	A
One decimal place, degrees Fahrenheit, 4800 Bd [1])	b

Signal for out-of-range

Limit comparators OFF	0
Limit comparators ON	1

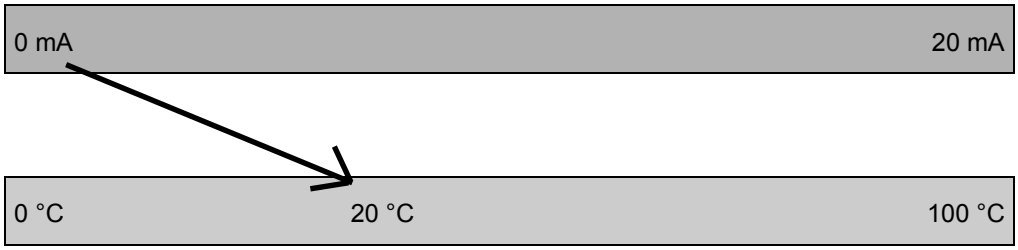
Factory setting	**0**	**1**	**1**	**0**

[1]) Only with RWF40.0X2B97

8.3.1 «SCL» scaling of standard signal range start, analog input 1

Example

SCL = 20; SCH = 100 °C
0 mA (start) corresponds to a measured value of 20 °C

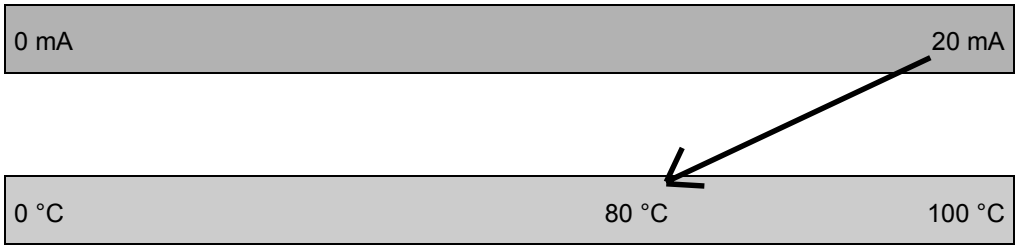


Value range: -1999...+9999 digit
Factory setting: 0 digit

8.3.2 «SCH» scaling of standard signal range end, analog input 1

Example

SCH = 80; SCL = 0 °C
20 mA (end) corresponds to a measured value of 80 °C



Value range: -1999...+9999 digit
Factory setting: 100 digit

8.3.3 «SCL2» scaling of standard signal range start, analog input 2

Example

SCL2 = 20:
0 mA corresponds to a measured value of 20 °C, as already described

Value range: -1999...+9999 digit
Factory setting: 0 digit

8.3.4 «SCH2» scaling of standard signal range end, analog input 2

Example

SCH2 = 80:
20 mA corresponds to a measured value of 80 °C, as already described
Value range: -1999...+9999 digit
Factory setting: 100 digit

8.3.5 «SPL» lower setpoint limit

The controller restricts the setpoints to the set value.
Value range: -1999...+9999 digit
Factory setting: 0 digit

8.3.6 «SPH» upper setpoint limit

The controller restricts the setpoints to the set value.
Value range: -1999...+9999 digit
Factory setting: 100 digit

8.3.7 «OFF1» actual value correction for analog input 1

The actual value correction can be used for correction of the measured value upwards or downwards by a specific amount. It is also used for line compensation when resistance thermometers are connected in a 2-wire circuit.

Value range: -1999...+9999 digit
Factory setting: 0 digit

Example

Measured value	Offset	Displayed value
294.7	+0.3	295
295.3	-0.3	295

8.3.8 «OFF2» actual value correction for analog input 2

Value range: -1999...+9999 digit
Factory setting: 0 digit

8.3.9 «OFF3» actual value correction for analog input 3

Value range: -1999...+9999 digit
Factory setting: 0 digit

8.3.10 «dF1» 2nd order digital filter for analog input 1

Value range for filter time constant: 0...100 s
Factory setting: 1 seconds

8.3.11 «dF3» digital filter of 1st order for analog input 3 (only with RWF40.0X2B97)

Value range filter time constant: 0...1440 min
Factory setting: 1278 min

8.3.12 «oLLo» lower working range limit (only with RWF40.0X2B97)

The lower working range limit limits the control range in the downward direction. This limitation is independent of the setpoint adjustment and hysteresis 1. If switch-on threshold «SP + Hyst1 < oLLo» falls below the lower working range limit, the switch-on threshold will be replaced by the lower working range limit. The setpoint does not change.

Example SP = 59 Hyst1 = -5 oLLo = 55

⇨ Switch-on threshold = 55
Current setpoint = 59

If the setpoint lies below the lower working range limit, the setpoint and switch-on threshold will be replaced by the lower working range limit.

Example SP = 54 Hyst1 = -5 oLLo = 55

⇨ Switch-on threshold = 55
Current setpoint = 55

As soon as supervision of the working range starts, «oL» and the current setpoint will flash alternately.

Value range: -1999...+9999 digit
Factory setting: -1999 digit

8.3.13 «oLHi» upper working range limit (only with RWF40.0X2B97)

The upper working range limit limits the control range in the upward direction. This limitation is independent of the adjustment of the setpoint and hysteresis 3. If switch-off threshold «SP + Hyst3 > oLHi» exceeds the upper working range limit, the switch-off threshold will be replaced by the upper working range limit. The setpoint does not change.

Example SP = 90 Hyst3 = +5 oLHi = 93

⇨ Switch-off threshold = 93
Current setpoint = 90

If the setpoint lies above the upper working range limit, the setpoint and switch-off threshold will be replaced by the upper working range limit.

Example SP = 95 Hyst3 = +5 oLHi = 93

⇨ Switch-off threshold = 93
Current setpoint = 93

Value range: -1999...+9999 digit
Factory setting: 9999 digit

8.3.14 «dtt» bus watchdog timer for remote operation (only with RWF40.0X2B97)

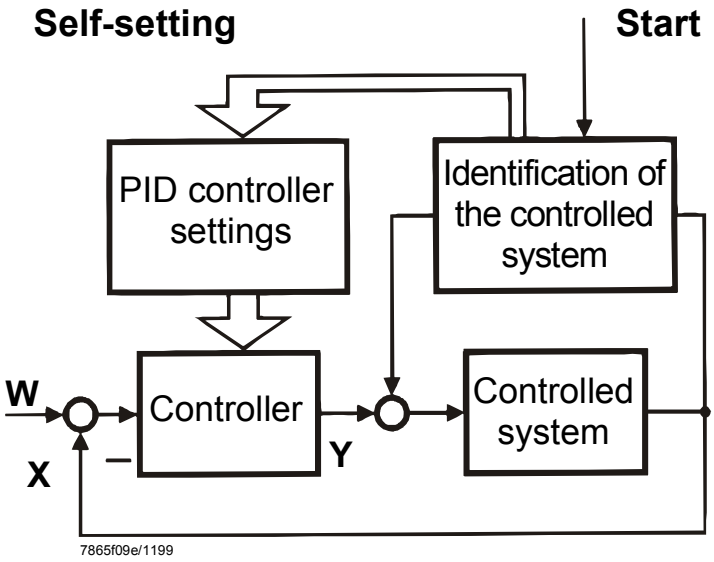
In remote operation, bus communication is monitored (refer to User Documentation CC1A7865.1en RWF40... interface RS-485). Within the setting, communication with the management system must take place. If that is not the case, the RWF40... will automatically change from remote operation to local operation (operation like RWF40.0X0... and RWF40.0X1...).

Value range: 0...7200 s
Factory setting: 30 s
Exception: 0 = watchdog timer function deactivated

9.1 Self-setting function in high-fire operation

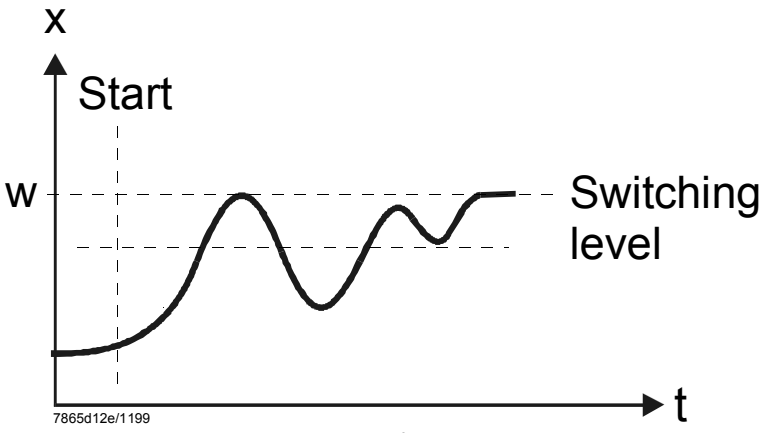
☞ «**tunE»** is only possible in high-fire operation, in the «modulating burner» mode.

The self-setting function «**tunE»** is a proper software function unit that is integrated into the controller. In the «modulating» mode, «**tunE»** tests the response of the controlled system to steps of the positioning signal according to a special procedure. A complex control algorithm uses the response of the controlled system (actual value) to calculate and store the control parameters for a PID or PI controller (set dt = 0!). The «**tunE»** procedure can be repeated any number of times.

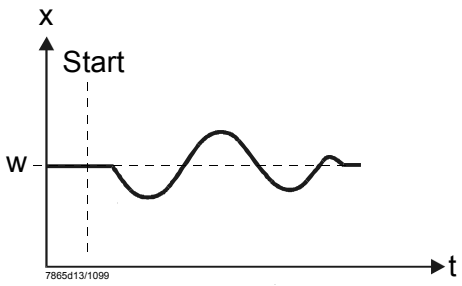


2 procedures

The «**tunE»** function uses 2 different methods that are automatically selected depending on the dynamic state of the actual value and the deviation from the setpoint at the start. «**tunE»** can be started from within any dynamic actual value sequence.
If there is a **large difference between actual value and setpoint** when «**tunE»** is activated, a switching line is established about which the controlled variable performs forced oscillations during the self-setting procedure. The switching line is set at such a level that the actual value should not exceed the setpoint.



With a **small deviation** between setpoint and actual value (after the controlled system has stabilized, for instance), a forced oscillation is performed about the setpoint.



The controlled system data recorded for the forced oscillations are used to calculate the controller parameters «rt, dt, Pb.1» and a filter time constant for actual value filtering that is optimized for this controlled system.

Conditions

- High-fire operation in the «modulating burner» mode
- The thermostat function (relay 1) must be constantly activated, otherwise «**tunE»** will be canceled and no optimized controller parameters will be adapted
- The above mentioned actual value oscillations during self-setting may not exceed the upper threshold of the thermostat function (increase if necessary, and lower the setpoint)

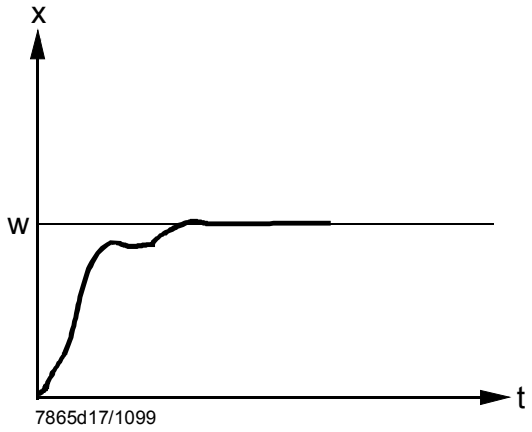
9.2 Checking the controller parameters

The optimum adjustment of the controller to the controlled system can be checked by recording a startup sequence with the control loop closed. The following diagrams indicate possible incorrect adjustments, and their correction.

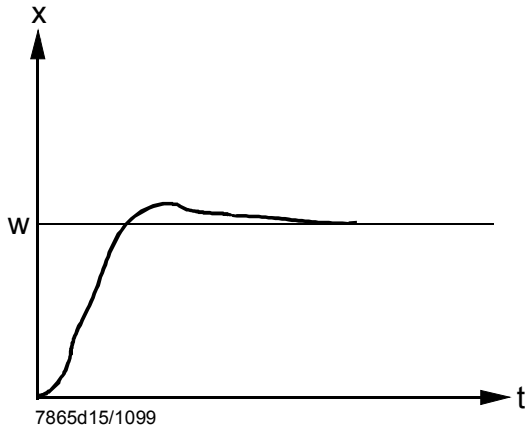
Example

The response to a setpoint change is shown here for a 3rd order controlled system for a PID controller. The method used for adjusting the controller parameters can, however, also be applied to other controlled systems.
A favorable value for «dt» is «rt» / 4.

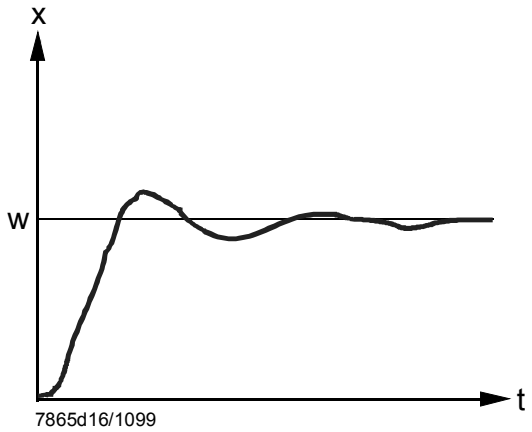
«PB too small»



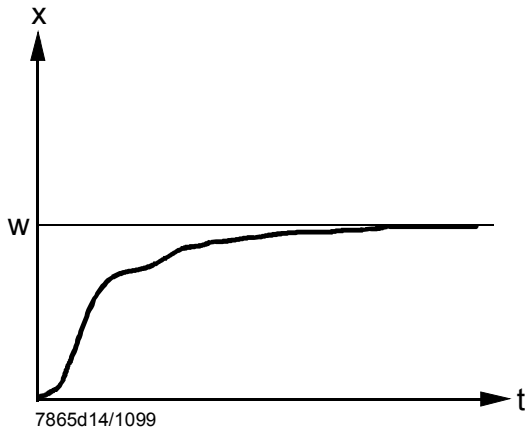
«PB too large»



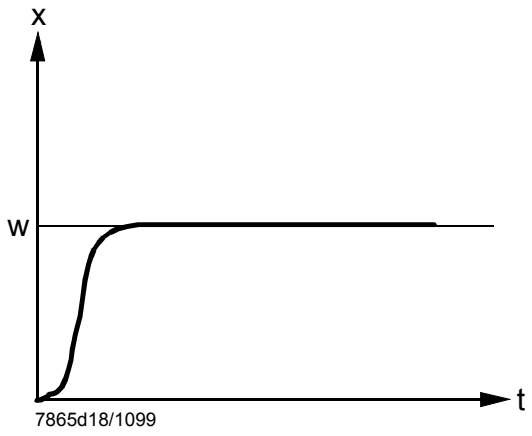
«rt, dt» too small



«rt, dt» too large



Optimum adjustment

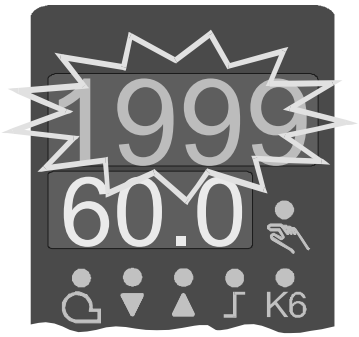
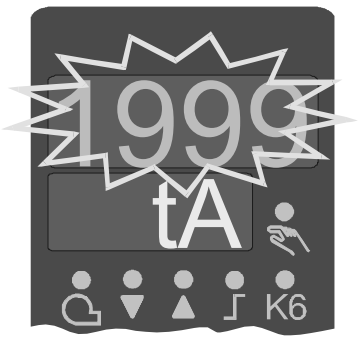


10.1 ...numbers are flashing on the display

This is an indication of incorrect measured value acquisition.

Detection of measured value range crossings depends on the type of sensor used.

⇨ Section 11.3.2 «Measured value circuit monitoring»

Display	Description		Cause / controller behavior / remedy
 7865p08/0200	Actual value display (red) shows «1999» flashing. Setpoint display shows the setpoint.		Overrange or underrange on analog input 1. Actual value is not measured. Controller initiates lockout. ⇨ Section 5.3 «Safety shutdown» The limit comparator responds to analog input 1 according to the configuration (C113). ∗ Check electrical connections for open-circuit of sensor
 7865p10/0200	When analog input 3 is configured for outside temperature (C111) and the measured value is called up, the actual value display (red) shows «1999» flashing.		Overrange or underrange on analog input 3. Outside temperature is not measured! The weather-dependent setpoint is inactive! ∗ Check electrical connections for open-circuit of sensors
 7865p09/0200	When analog input 2 is configured (C111) and the measured value is called up, the process value display (red) shows «1999» flashing.		Overrange or underrange on analog input 2. External setpoint is not measured. Controller initiates lockout ⇨ Section 5.3 «Safety shutdown» ∗ Check electrical connections for open-circuit of sensors
 7865p07/0200	Actual value display (red) shows «XXXXXX». Setpoint display (green) shows «1999» flashing.		Overrange or underrange on analog input 2. Setpoint shift is not measured. Controller initiates lockout ⇨ Section 5.3 «Safety shutdown» ∗ Check electrical connections for open-circuit of sensor

11.1 Inputs

11.1.1 Analog input 1 (actual value)

For resistance thermometers, thermocouples or standard signals with 2nd order digital filter (configurable).

Resistance thermometers

In 2-wire or 3-wire circuit:

Type	Measured value range
Pt100, Landis & Staefa Pt1000, IEC 751	-200...+850 °C (-328...+1562 °F)
Ni100, Ni1000, DIN 43760	-60...+250 °C (-76...+482 °F)
LG-Ni1000	-50...+160 °C (-58...+320 °F)

Line resistance: < 30 Ω
Line compensation
Not required with 3-wire circuit.
When using a resistance thermometer in a 2-wire circuit, line compensation can only be made by means of the offset correction.

Thermocouples

Type	Measured value range
Fe-CuNi «J»	-200...+1000 °C (-328...+1832 °F)
NiCr-Ni «K»	-200...+1372 °C (-328...+2502 °F)
Cu-CuNi «T»	-200...+400 °C (-328...+752 °F)
NiCrSi-NiSi «N»	-100...+1300 °C (-148...+2372 °F)
Pt-RhPt «S»	0...1768 °C (-32...3214 °F) ¹)
Pt-RhPt «R»	0...1768 °C (-32...3214 °F) ¹)
Pt-RhPt «B»	0...1820 °C (32...3308 °F) ¹)

¹) Only with RWF40.0X2B97

Cold-junction temperature: Internal

Standard signals

Signal	Internal resistance Ri Voltage drop ΔUe
DC 0...10 V	R_i = 2 MΩ
DC 0...1 V	R_i = 2 MΩ
DC 0...20 mA	ΔU_e = < 1 V
DC 4...20 mA	ΔU_e = < 1 V

Sampling time: 210 ms

11.1.2 Analog input 2 (external setpoint, setpoint shift)

Resistance measured value 0…1 kΩ standard signals without linearization.

Potentiometer

With 2-wire circuit
R = 0…1 kΩ

Standard signals

Signal	Internal resistance Ri Voltage drop ΔUe
DC 0...10 V	R_i = 2 MΩ
DC 0...20 mA	ΔU_e = 1 V
DC 4...20 mA	ΔU_e = 1 V

Sampling time: 630 ms

11.1.3 Analog input 3 (outside temperature)

For resistance thermometers in a 2-wire circuit, with fixed filter time constants (21 h 18 min for weather-dependent setpoint enable)

Resistance thermometer

Type	Measured value range
Landis & Staefa Pt1000	-200...+850 °C (-328...+1562 °F)
Ni1000, DIN 43760	-60...+250 °C (-76...+482 °F)
LG-Ni1000	-50...+160 °C (-58...+320 °F)

Sampling time: 6 seconds

11.1.4 Binary input «D1»

Potential-free contact for changeover of operating mode:
- Modulating burner, when contact is open, LED on the front is not lit
- 2-stage burner, when contact is closed, LED on the front is lit

11.1.5 Binary input «D2»

Potential-free contact for the following functions, depending on the configuration:
- No function
- Setpoint shift
- Setpoint changeover

11.2 Outputs

4 relay outputs, 1 analog output (optional) and a transducer supply are provided as standard.

11.2.1 Output 1 (release of burner)

Relay output (N.O. contact)

Contact rating: AC 24…240 V, 2 A at p.f. (cos φ) > 0.6
Contact life: > 2 x·10^5 switching cycles at rated load
Internal contact protection: Varistor S07K275

11.2.2 Output 2, 3 (floating output)

2 relay outputs (N.O. contacts) with a common pole, for actuating device open / close

Contact rating: AC 24…240 V, 2 A at cos φ > 0.6
Contact life: > 2 x·10^5 switching cycles at rated load
Internal contact protection: RC combination (C = 2.5 nF, R = 100 Ω)

11.2.3 Output 4 (limit comparator)

Relay output (N.O. contact)

Contact rating: AC 24…240 V, 2 A at cos φ > 0.6
Contact life: > 2 x·10^5 switching cycles at rated load
Internal contact protection: Varistor S07K275

11.2.4 Output 5, analog output (option)

Analog output, electrically isolated from the analog inputs:
∆U < AC 30 V , ∆U < DC 50 V

Standard signals	Load, burden
DC 0…10 V (short-circuit proof)	Load = > 500 Ω
DC 0…20 mA	Burden = < 500 Ω
DC 4…20 mA	Burden = < 500 Ω

Accuracy: ±0.25 % ±50 ppm / K

11.2.5 Transducer supply

DC 24 V, 30 mA (short-circuit proof)

11.2.6 Interface RS-485 (optional)

Baud rate: 4,800, 9,600 or 19,200
Protocol: MOD bus
Unit address: 1…99

Galvanic separation between supply voltage, analog inputs and outputs.

⇨ Section 4.3 «Galvanic separation»

11.3 General ratings

Weight:	approx. 430 g
Data backup:	EEPROM
Operating voltage:	AC 100…240 V ±10 %, 48…63 Hz
Power consumption:	approx. 5 VA
Electrical connection:	at the rear, via plug-in screw terminal strips, angled at 45°
Electrical safety:	to EN 60730
Case:	mounting depth 130 mm plastic body with rear panel, self-extinguishing flammability class: UL94 V0 seal between case and control panel

11.3.1 Measuring accuracy

Resolution: > 15 bit

Measuring accuracy	Ambient temperature error
Resistance thermometer:	
≤ 0.05 %	≤ 50 ppm / K
Thermocouples:	
≤ 0.25 %	≤ 100 ppm / K
Standard signals:	
≤ 0.1 %	≤ 100 ppm / K

Values include linearization tolerances.

11.3.2 Monitoring of measuring circuit

Transducer	Probe break	Short-circuit
Resistance thermometer	X	X
Thermocouples	X	-
DC 0…10 V	-	-
DC 0…20 mA	-	-
DC 4…20 mA	X	X

- = is **not** detected

X = is detected, and «–1999» appears on the display

⇨ Chapter 10 «What to do if...»

11.3.3 Environmental conditions

Permissible ambient temperature range:
-20…+50 °C (short-time up to 60 °C)

Permissible storage temperature range:
-40…+70 °C

Climatic conditions:
Relative humidity ≤ 95 % (noncondensing)

Degree of protection to EN 60529:
Front IP 65
Rear IP 20

Electromagnetic compatibility (EMC):
To NAMUR recommendation NE 21, EN 50 081 part 1, EN 50 082 part 2

12.1 Process data

Parameter	Display	Value range	Factory setting	Setting
Setpoint 1 [1)]	**SP1**	SPL-SPH	0	
Setpoint 2 (option) [1)]	**SP2**	SPL-SPH	0	
Digital setpoint shift (optional) [1)]	**dSP**	SPL-SPH	0	
Outside temperature (optional)	**TA**	⇨ Section 8.1 «**C111** inputs»	-	
Predefinition of external setpoint [1)]	**SP.E**	SPL-SPH	-	

[1)] Setting of the decimal places has an impact on these parameters

12.2 Parameter level

Parameter	Display	Value range	Factory setting	Setting
Limit value of limit comparator [1)]	**AL**	-1999...+9999 digit	0	
Switching differential for limit comparator [1)]	**HYSt**	0...999.9 digit	1	
Proportional band [1)]	**Pb.1**	0.1...999.9 digit	10	
Derivative time	**dt**	0...9999 s	80	
Integral action time	**rt**	0...9999 s	350	
Dead band (neutral zone) [1)]	**db**	0...999.9 digit	1	
Actuator running time	**tt**	10...3000 s	15 s	
Switch-on threshold burner / stage II [1)]	**H Y S 1**	0...-199.9 digit	-5	
Switch-off level stage II [1)]	**H Y S 2**	0... HYS3 digit	3	
Upper switch-off threshold [1)]	**H Y S 3**	0...999.9 digit	5	
Response threshold	**q**	0...999.9	0	
Heating curve slope	**H**	0...4	1	
Parallel displacement [1).]	**P**	-90...+90	0	

[1)] Setting of the decimal place has an impact on these parameters

12.3 Configuration level

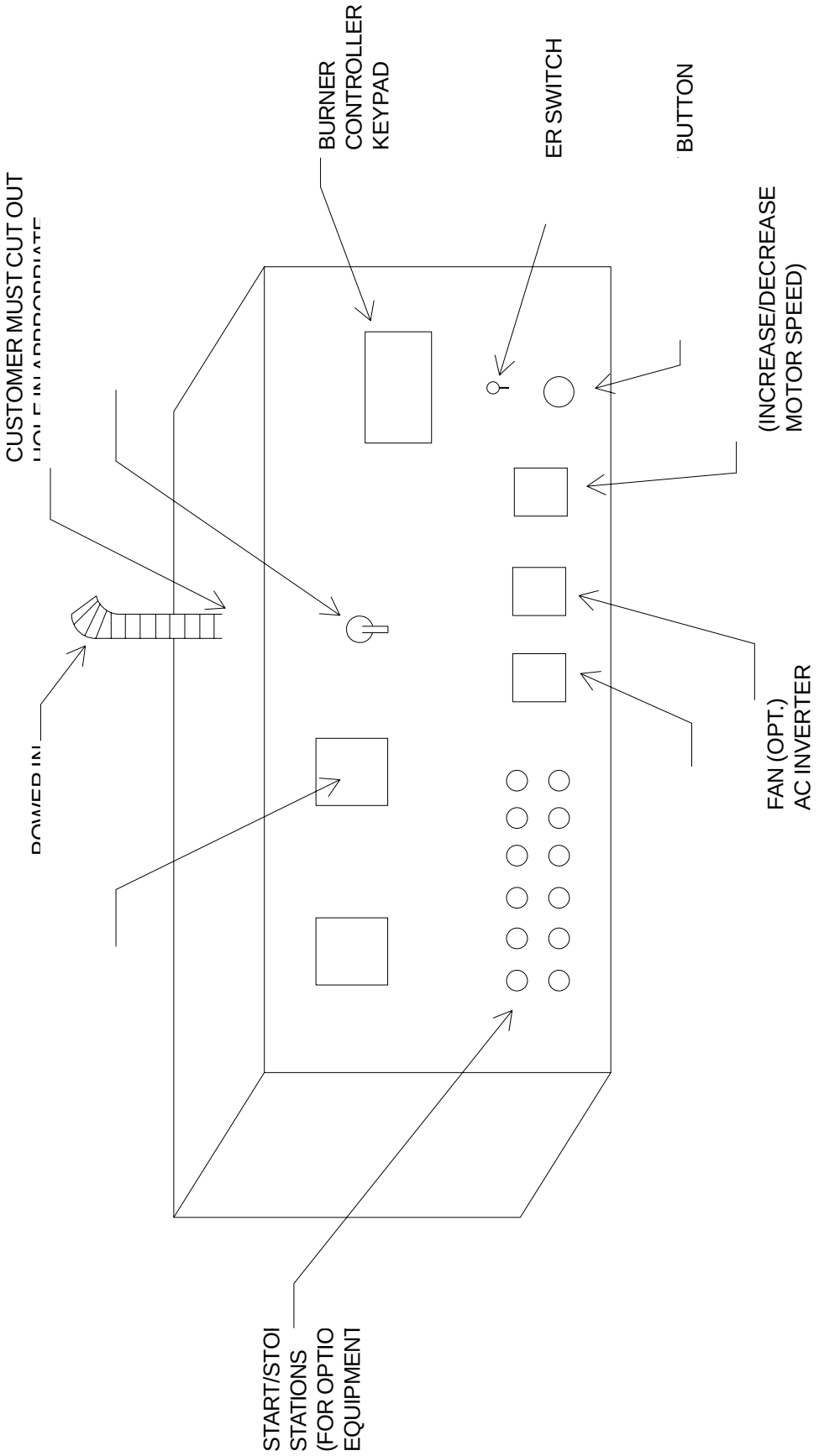
Parameter	Display	Factory setting	Setting
Analog input 1, 2 and 3; setpoint changeover / shift	**C111**	9030	
Limit comparator; controller type; setpoint 1; locking	**C112**	0010	
Unit address; decimal place / unit, signal for out-of-range	**C113**	0110	
Measured value range start analog input 1 [1)]	**SCL**	0	
Measured value range analog input 1 [1)]	**SCH**	100	
Measured value range analog input 2 [1)]	**SCL2**	0	
Measured value range analog input 2 [1)]	**SCH2**	100	
Lower setpoint limit [1)]	**SPL**	0	
Upper setpoint limit [1)]	**SPH**	100	
Actual value correction, analog input 1 [1)]	**OFF1**	0	
Actual value correction, analog input 2 [1)]	**OFF2**	0	
Actual value correction, analog input 3 [1)]	**OFF3**	0	
Filter time constant for digital filter, analog input 1	**dF1**	1	
Filter time constant for digital filter, weather-dependent setpoint shift	**dF3** [2.]	1278	
Lower working range limit [1.]	**oLLo** [2.]	-1999	
Upper working range limit [1.]	**oLHi** [2.]	9999	
Bus watchdog timer	**dtt** [2.]	30	

[1.] Setting of the decimal place has an impact on these parameters
[2.] Only with RWF40.0X2B97

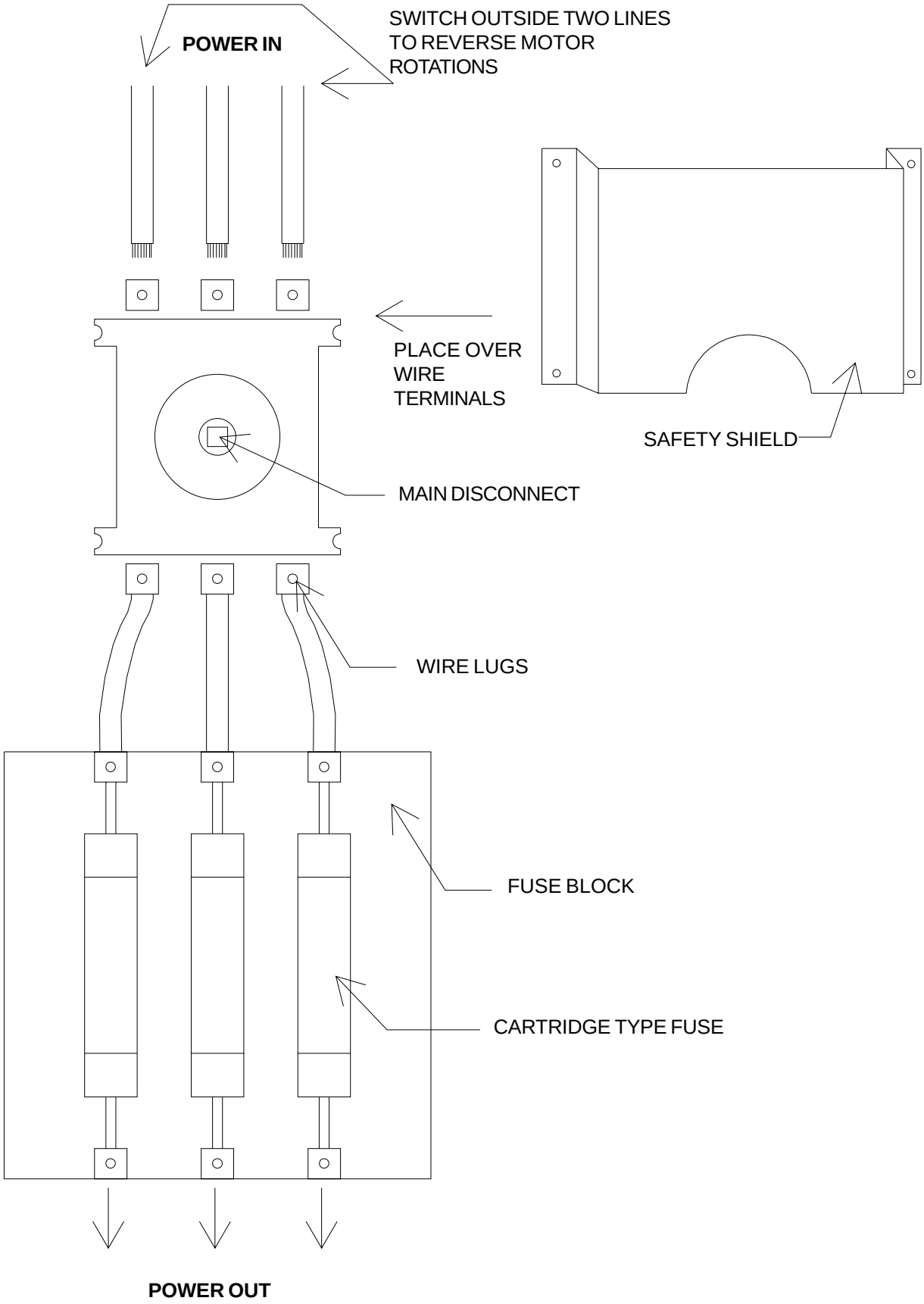
Siemens Building Technologies
Landis & Staefa Produktion GmbH
Berliner Ring 23
D - 76347 Rastatt
Tel. 0049 - 7222 - 598 - 0
Fax. 0049 - 7222 – 598 269

http://www.landisstaefa.com

Electrical Control Box



Power Hook Up



7800 SERIES RM7895A,B,C,D Relay Module

The Honeywell RM7895 is a microprocessor based integrated burner control for automatically fired gas, oil, or combination fuel single burner applications. The RM7895 consists of the Relay Module. Subbase, Amplifier and Purge Card are required to complete the system. Options include Keyboard Display Module, Personal Computer Interface, DATA CONTROLBUS MODULE™, Remote Display Module, First-Out Expanded Annunciator and COMBUSTION SYSTEM MANAGER- Software.

The RM7895 is programmed to provide a level of safety, functional capability and features beyond the capacity of conventional controls.

Functions provided by the RM7895 include automatic burner sequencing, flame supervision, system status indication, system or self-diagnostics and troubleshooting.

- Safety features:
  - — Airflow switch check.
  - -Closed loop logic test.
  - — Dynamic AMPLI-CHECK™ .
  - — Dynamic input check.
  - — Dynamic safety relay test.
  - — Dynamic self-check logic.
  - -Internal hardware status monitoring.
  - — Tamper resistant timing and logic.
- Access for external electrical voltage checks.
- Airflow switch check feature (RM7895B,D).
- Application flexibility.
- Communication interface capability.
- Delayed main valve (RM7895C,D).
- Dependable, long-term operation provided by microcomputer technology.
- Early spark termination (RM7895A1048 and RM7895C1020).
- First-out annunciation and system diagnostics provided by a 2 row by 20 column Vacuum Fluorescent Display (VFD) located on the optional Keyboard Display Module (optional).
- First-out expanded annunciation with 26 Light Emitting Diodes (LEDs) for limits and interlocks (optional).
- Five (LEDs) for sequence information.
- Two function Run/Test Switch (RM7895C,D).
- Interchangeable plug-in flame amplifiers.
- Local or remote annunciation of RM7895 operation and fault information.
- Nonvolatile memory; RM7895 retains history files and sequencing status after loss of power.
- Remote reset (optional).
- Report generation (optional).
- Selectable recycle or lockout on loss of airflow.
- Selectable recycle or lockout on loss of flame.
- Shutter drive output.
- Burner controller data (optional):
  - — Expanded annunciator status.
  - — Flame signal strength.
  - — Hold status.
  - — Lockout/alarm status.
  - — Sequence status.
  - — Sequence time.
  - -Total cycles of operation.
  - -Total hours of operation.
  - — Fault history providing for the six most recent faults:
    - Cycles of operation at the time of the fault.
    - Expanded annunciator data at the time of the fault.
    - Fault message and code.
    - Hours of operation at the time of the fault.
    - Sequence status at the time of the fault.
    - Sequence time at the time of the fault.
  - — Diagnostic information:
    - Device type.
    - Flame amplifier type.
    - Flame failure response time.
    - Manufacturing code.
    - On/Off status of all digital inputs and outputs.
    - Selected prepurge time.
    - Software revision and version of RM7895 and optional Keyboard Display Module.
    - Status of configuration jumpers.
    - Status of Run/Test Switch (RM7895C,D).

CONTENTS

Specifications	2
Ordering Information	2
Principal Technical Features	8
Safety Provisions	9
Installation	10
Wiring	12
Assembly	15
Operation	18
Checkout	22
Troubleshooting	28

B. M. • Rev. 9-93 • @Honeywell Inc. 1993 • Form Number 65-0086-2

Specifications

ELECTRICAL RATINGS, see Table 1:
Voltage and Frequency: 120 Vac (+10/-15%), 50 or 60 Hz (+/- 10%). [1]
Power Dissipation: RM7895: 10W maximum.
Maximum Total Connected Load: 2000 VA.
Fusing Total Connected Load: 20A maximum, type FRN or equivalent.

TABLE 1—TERMINAL RATINGS.

Terminal No.	Description	Ratings
G	Flame Sensor Ground	
Earth G	Earth Ground[2]	
L2(N)	Line Voltage Common	
3	Alarm	120 Vac, 1A pilot duty.
4	Burner Motor	120 Vac, 9.8 AFL, 58.8 ALR (inrush).
5	Line Voltage Supply (L1)	120 Vac (+10/-15%), 50 or 60 Hz (+/- 10%).[3,4]
6	Burner Controller and Limits	120 Vac, 1 mA.
7	Airflow Interlock	120 Vac, 9A.
8	Pilot Valve/Ignition	120 Vac, 4.5A ignition and 50VA pilot duty.[4]
9	Main Fuel Valve	120 Vac, 2A pilot duty.[5]
10	Ignition	120 Vac, 4.5A ignition.[4]
F(11)	Flame Sensor	60 to 220 Vac, current limited.
12	Unused	
13	Unused	
14	Unused	
15	Unused	
16	Unused	
17	Unused	
18	Unused	
19	Unused	
20	Unused	
21	Delayed Main Valve (RM7895C,D)	20 Vac, 2A pilot duty.
22	Shutter	120 Vac, 0.5A.

[1] Operating frequency chosen by RM7895 selection.
[2] The RM7895 must have an earth ground providing a connection between the subbase and the control panel or the equipment. The earth ground wire must be capable of conducting the current to blow the 20A fuse (or breaker) in event of an internal short circuit. The RM7895 needs a low impedance ground connection to the equipment frame which, in turn, needs a low impedance connection to earth ground. For a ground path to be low impedance at RF frequencies, the connection must be made with minimum length conductors that have maximum surface areas. Wide straps or brackets rather than leadwires are preferred. Be careful to verify that mechanically tightened joints along the ground path, such as pipe or conduit threads or surfaces held together with fasteners, are free of nonconductive coatings and are protected against mating surface corrosion.
[3] 2000 VA maximum connected load to RM7895 Assembly.
[4] Can also be 120 Vac, 1A pilot duty.
[5] Can also be 65 VA pilot duty with motorized valve, 1150 VA inrush, 460 VA open, 250 VA hold.

Ordering Information

When purchasing replacement and modernization products from your 7800 SERIES distributor, refer to the TRADELINE® Catalog for complete ordering number.

If you have additional questions, need further information, or would like to comment on our products or services, please write or phone:
1. Your local Home and Building Control Sales Office (check white pages of your phone directory).
2. Home and Building Control Customer Satisfaction
   Honeywell Inc., 1885 Douglas Drive North
   Minneapolis, Minnesota 55422-4386 (612) 951-1000

   In Canada—Honeywell Limited/Honeywell Limitée, 740 Ellesmere Road, Scarborough, Ontario M1P 2V9 International Sales and Service Offices in all principal cities of the world. Manufacturing in Australia, Canada, Finland, France, Germany, Japan, Mexico, Netherlands, Spain, Taiwan, United Kingdom, U.S.A.

ENVIRONMENTAL RATINGS:
Ambient Temperature:
Operating: -40° F to 140° F.
Storage: -60° F to 150° F.
Humidity: 85% RH continuous, noncondensing.
Vibration: 0.5G environment.
DIMENSIONS: Refer to Figs. 1 and 2.

WEIGHT: RM7895 with Dust Cover: 1 pound 15 ounces, unpacked.

IMPORTANT: *Flame Detection System available for use with RM7895. To select your Plug-in Flame Signal Amplifier and applicable Flame Detector, see Table 2 and Figs. 3-5.*

TABLE 2—FLAME DETECTION SYSTEMS (Figs. 3, 4, 5)

Plug-in Flame Signal Amplifiers					**Applicable Flame Detectors**		
Type	**Color**	**Self-Checking**	**Model**	**Flame Failure Response Time**	**Fuel**	**Type**	**Models**
Rectification	Green	No	R7847A	.8 or 3 sec	Gas	Rectifying Flame Rod Holders[a]	C7004, C7007, C7011, CompleteAssemblies: C7008, C7009, Q179.
		No	R7847A	.8 or 3 sec	Oil	Rectifying Photocell	C7003, C7010, C7013, C7014.[b]
		No	R7847A	3 sec	Gas, oil, coal	Ultraviolet (Purple Peeper)	C7012A,C.[c]
		Dynamic AMPLI-CHECK™	R7847B[d]	.8 or 3 sec	Gas	Rectifying Flame Rod Holders[a]	C7004, C7007, C7011. Complete Assemblies: C7008, C7009, Q179.
		Dynamic AMPLI-CHECK™	R7847B[d]	.8 or 3 sec	Oil	Rectifying Photocell	C7003, C7010, C7013, C7014.[b]
		Dynamic AMPLI-CHECK™	R7847B[d]	3 sec	Gas, oil, coal	Ultraviolet (Purple Peeper)	C7012A,C.[c]
		Dynamic Self-Check	R7847C[e]	3 sec	Gas, oil, coal	Ultraviolet (Purple Peeper)	C7012E,F.
Infrared	Red	No	R7848A	3 sec	Gas, oil, coal	Infrared (Lead Sulfide)	C7015.
		Dynamic AMPLI-CHECK™	R7848B[d]	3 sec	Gas, oil coal	Infrared (Lead Sulfide)	C7015.
Ultraviolet	Purple	No	R7849A	.8 or 3 sec	Gas, oil	Ultraviolet (Minipeeper)	C7027, C7035, C7044.[c]
		Dynamic AMPLI-CHECK™	R7849B[d]	.8 or 3 sec	Gas, oil	Ultrviolet (Minipeeper)	C7027, C7035, C7044.[c]
	Blue	Dynamic Self-Check	R7886A[e]	3 sec	Gas, oil, coal	Ultraviolet (Adjustable Sensitivity)	C7076.

[a] Order flame rod separately; see holder Instructions.
[b] Use *only* Honeywell Photocell, part no. 38316.
[c] The C7012A,C, C7027, C7035 and C7044 Flame Detectors should be used only on burners that cycle on-off at least once every twenty-four hours. Appliances with burners that remain on continuously for twenty-four hours or longer should use the C7012E,F Flame Detector with the R7847C Amplifier or the C7076A,D Flame Detector with the R7886A Amplifier as the ultraviolet flame detection system.
[d] Circuitry tests the flame signal amplifier at least 12 times a minute during burner operation and shuts down the burner if the amplifier fails.
[e] Circuitry tests all electronic components in the flame detection system (amplifier and detector) 12 times a minute during burner operation and shuts down the burner if the detection system fails.

SEQUENCE TIMING FOR NORMAL OPERATION:

Device	Initiate	Standby	Purge	Flame Establishing Period		AFSC[1]	DMV[2]
				Pilot	Main		
RM7895A	10 sec.	*	**	4 or 10 sec.	No	No	No
RM7895B	10 sec.	*	**	4 or 10 sec.	No	Yes	No
RM7895C	10 sec.	*	**	4 or10 sec.[3]	10 sec.	No	Yes
RM7895D	10 sec.	*	**	4 or 10 sec.	10 sec.	Yes	Yes

* STANDBY and RUN can be an infinite time period.
** PURGE will be determined by which ST7800A Purge Card is selected.
1 AFSC is Airflow Switch Check. Factory configured by model only.
2 DMV is Delayed Main Valve.
3 The RM7895C1020 (only) has a fixed pilot flame establishing period of ten seconds.

APPROVAL BODIES:
Underwriters Laboratories Inc. listed: File no. MP268, Guide no. MCCZ.
Canadian Standards Association certified: LR9S329-3.
Factory Mutual approved.
International Approval Services (formerly AGA) Report no. C2030002.
IRI acceptable.
Federal Communications Commission: Part 15, Class B—Emissions.

MOUNTING: Q7800A for panel mount or Q7800B for wall or burner mount.

REQUIRED COMPONENTS:
Plug-in Flame Signal Amplifier, see Table 2.
Plug-in Purge Timer Cards: selectable ST7800A: two seconds to 30 minutes.
Q7800A or Q7800B.

ACCESSORIES:
Optional:
Communication Interface Base Unit, part no. Q7700A1014.
Communication Interface ControlBus Module, part no. QS7800A1001.
COMBUSTION SYSTEM MANAGER™, part no. ZM7850A1001.
ControlBus 5-Wire Electrical Connector, part no. 203541.
DATA CONTROLBUS MODULE™, part no. S7810A1009.
Dust Cover, part no. 221729A.
Expanded Annunciator, part no. S7830A1005.
Flame Simulators:
UV Flame Simulator, part no. 203659.
Rectification Simulator, part no. 123514A.
Keyboard Display Module, part no. S7800A1001.
Remote Display Mounting Bracket, part no. 203765.
Remote Display Power Supply, part no. 203968A Plug-in.
Remote Reset Module, part no. 57820A1007.
Sixty-inch Extension Cable Assembly, part no. 221818A.
Tester, part no. A7800A1002.

Fig. 1—Mounting dimensions of RM7895 Relay Module and Q7800A Subbase in inches [millimeters].

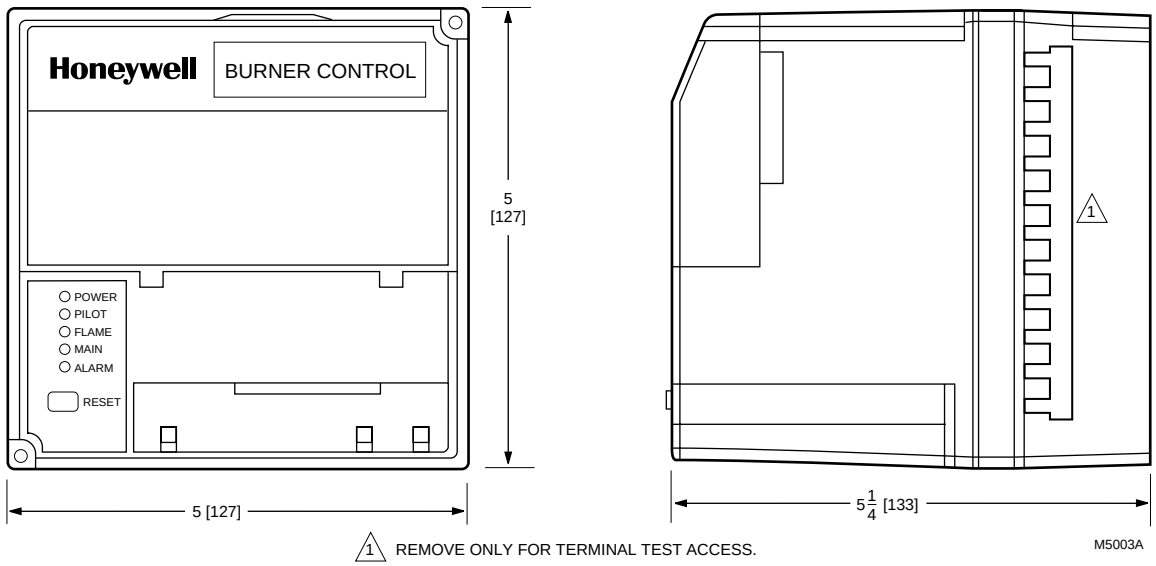


Fig. 2—Mounting dimensions of RM7895 Relay Module and Q7800B Subbase in inches [millimeters].

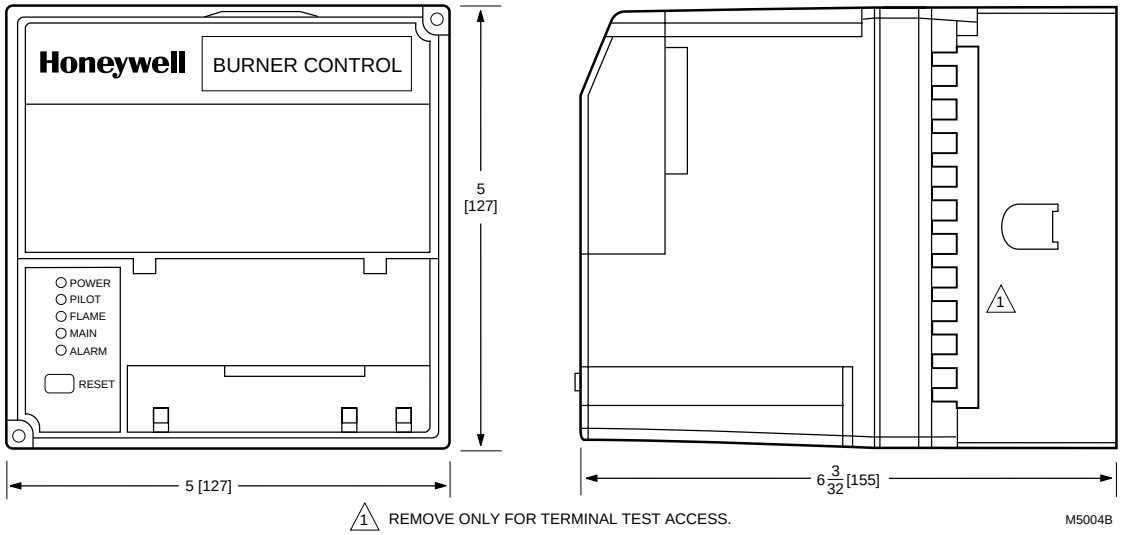
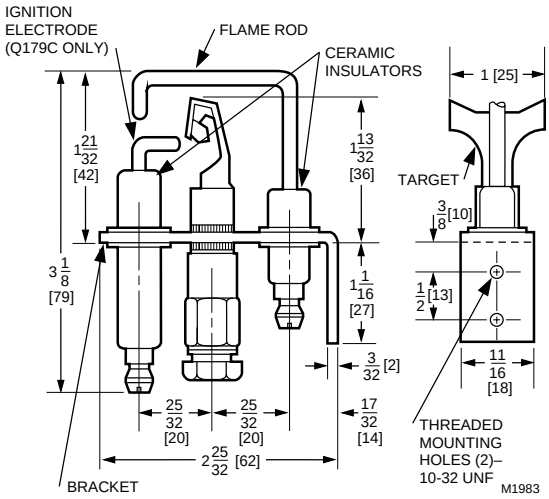
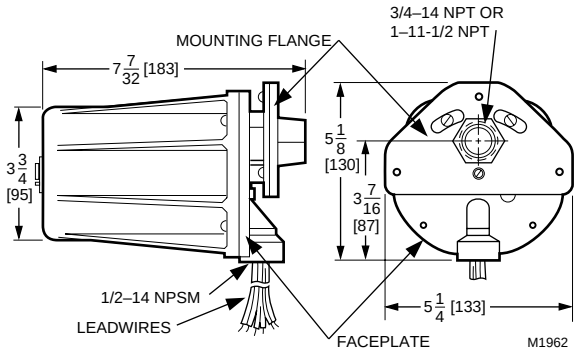


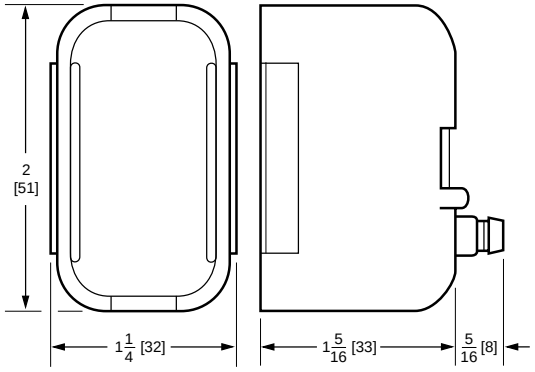
Fig. 3—Rectification detectors.



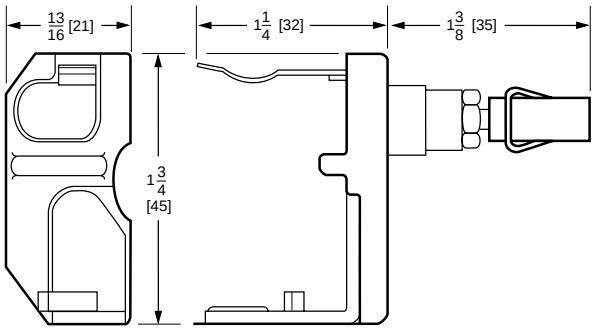
Q179



C7012A,C,E,F

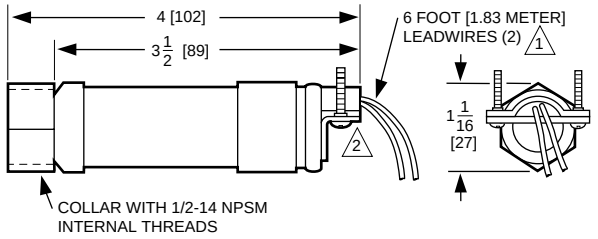


C7013A



C7014A

Fig. 4—Ultraviolet detectors.

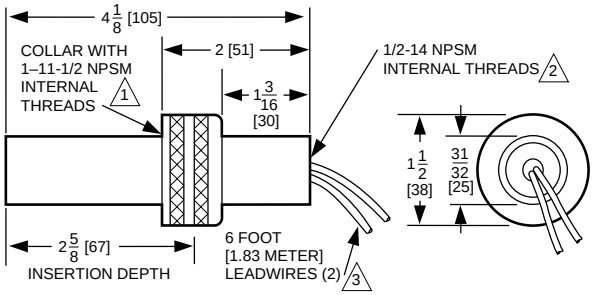


1 MODEL AVAILABLE WITH 24 FOOT [7.32 METER] LEADWIRES.

2 MODELS AVAILABLE WITH SPUD CONNECTOR (1/2-14 NPSM INTERNAL THREADS) INSTEAD OF CLAMP TYPE CONNECTOR.

M1943A

C7027



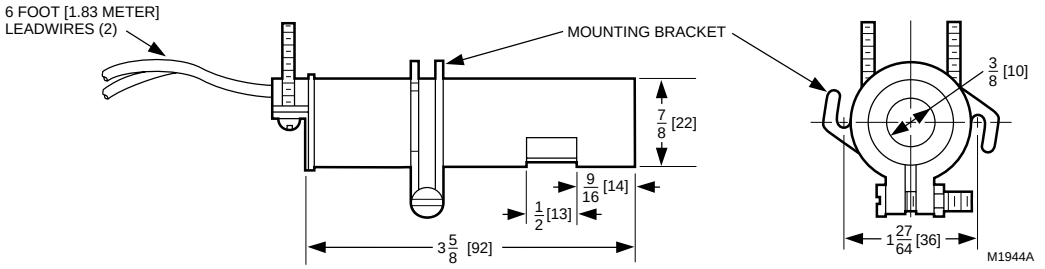
1 DIN APPROVED C7035A1064 HAS 1-11 BSP.P1 INTERNAL THREADS.

2 DIN APPROVED C7035A1064 HAS 1/2-14 BSP-F INTERNAL THREADS.

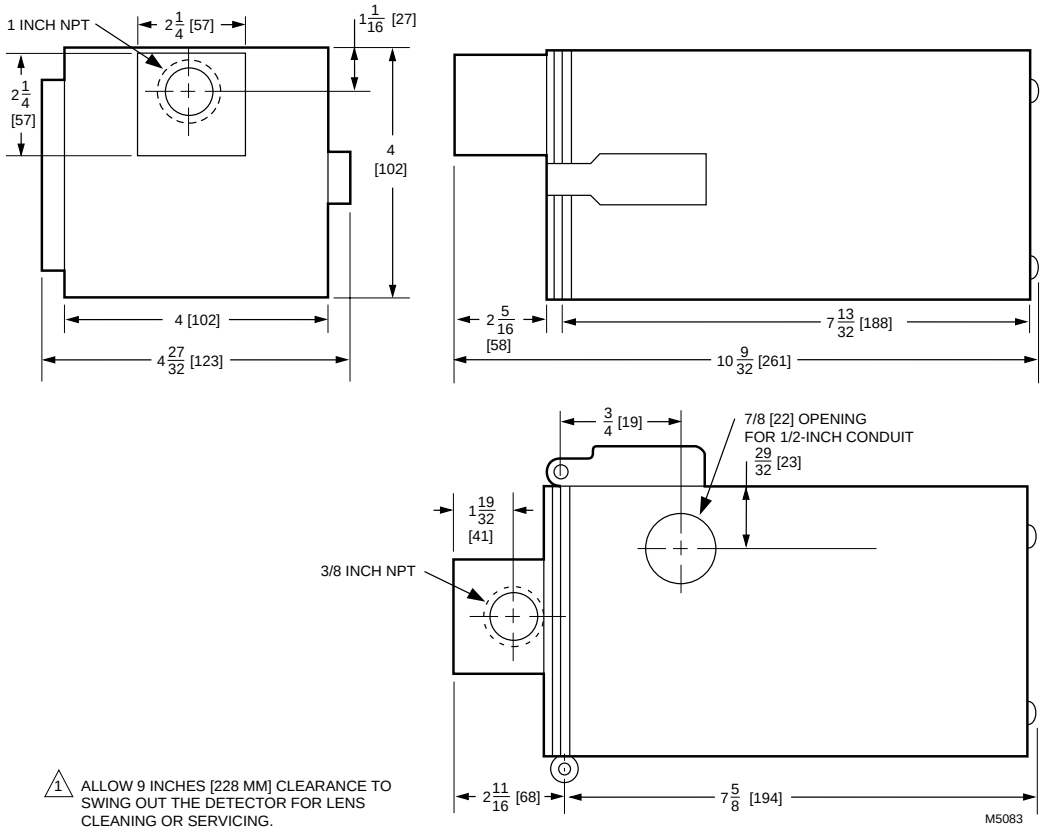
3 MODEL AVAILABLE WITH 12 FOOT [3.66 METER] LEADWIRES.

M1945A

C7035



C7044



1 ALLOW 9 INCHES [228 MM] CLEARANCE TO SWING OUT THE DETECTOR FOR LENS CLEANING OR SERVICING.

C7076A

Fig. 4—Ultraviolet detectors *(Continued).*

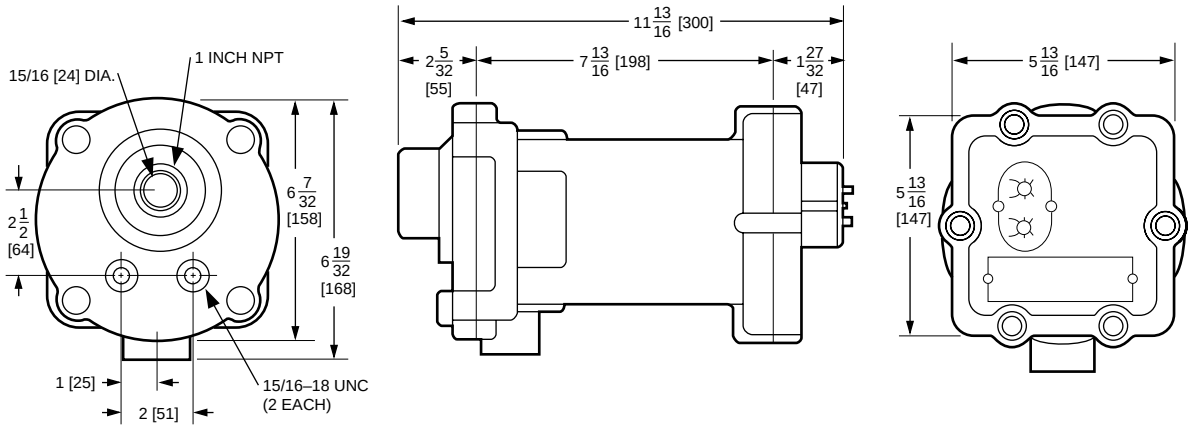
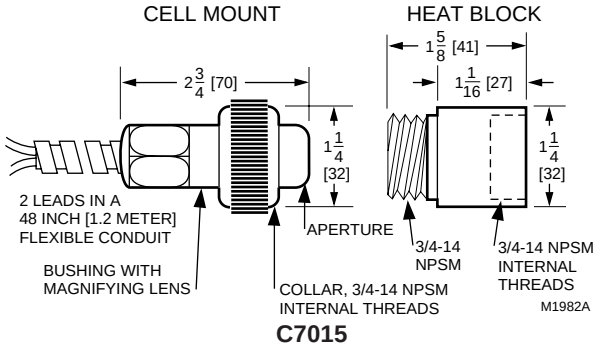


Fig. 5—Infrared detector.



Principal Technical Features

The RM7895 provides all customary flame safeguard functions while providing significant advancements in the areas of safety, annunciation and system diagnostics.

SAFETY SHUTDOWN (LOCKOUT) OCCURS IF:

1. INITIATE PERIOD
   a. Purge card is not installed or removed.
   b. Purge card is bad.
   c. Configuration jumpers have been changed (after 200 hours).
   d. AC line power errors occurred, see Operation.
   e. Four minute INITIATE period has been exceeded.
2. STANDBY PERIOD
   a. Flame signal is present after 40 seconds.
   b. Airflow switch check feature model is selected and the airflow switch is closed for 120 seconds with controller closed (RM7895B,D).
   c. Ignition/pilot valve/intermittent pilot valve terminal is energized.
   d. Main valve terminal is energized.
   e. Delayed main valve terminal is energized (RM7895C,D).
   f. Internal system fault occurred.
   g. Purge card is not installed or removed.
   h. Purge card is bad.
3. PREPURGE PERIOD
   a. Airflow lockout feature is enabled and the airflow switch does not close after ten seconds or within the specified purge card timing.
   b. Flame signal is detected after 30 seconds.
   c. Ignition/pilot valve/intermittent pilot valve terminal is energized.
   d. Main valve terminal is energized.
   e. Delayed main valve terminal is energized (RM7895C,D).
   f. Internal system fault occurred.
   g. Purge card is removed.
   h. Purge card is bad.
4. PILOT FLAME ESTABLISHING PERIOD (PFEP)
   a. Airflow lockout feature is enabled and the airflow switch opens.
   b. Ignition/pilot valve terminal is not energized.
   c. No flame present at end of PFEP.
   d. Main valve terminal is energized.
   e. Delayed main valve terminal is energized (RM7895C,D).
   f. Internal system fault occurred.
   g. Purge card is removed.
   h. Purge card is bad.
5. MAIN FLAME ESTABLISHING PERIOD (MFEP) (RM7895C,D)
   a. Airflow lockout feature is enabled and the airflow switch opens.
   b. Ignition terminal is energized.
   c. Ignition/pilot valve terminal is not energized.
   d. Main valve terminal is not energized.
   e. Delayed main valve terminal is energized.
   f. No flame present at end of MFEP.
   g. Internal system fault occurred.
   h. Purge card is removed.
   i. Purge card is bad.
6. RUN PERIOD
   a. No flame present.
   b. Airflow lockout feature is enabled and the airflow switch opens.
   c. Interrupted pilot valve terminal is energized (RM7895C,D).
   d. Main valve terminal is not energized.
   e. Delayed main valve terminal is not energized (RM7895C,D).
   f. Internal system fault occurred.
   g. Purge card is removed.
   h. Purge card is bad.

Safety Provisions

INTERNAL HARDWARE STATUS MONITORING

The RM7895 checks the purge card for correct parity to prevent purge timing shifts and circuitry failures. It also analyzes the integrity of the configuration jumpers and internal hardware. The POWER LED will blink every four seconds, signifying an internal hardware check.

CLOSED LOOP LOGIC TEST

The test verifies the integrity of all safety critical loads, terminals 8, 9, 10 and 21. If the loads are not energized properly; i.e., the main valve terminal is powered during PREPURGE, the RM7895 will lockout on safety shutdown. The RM7895 must react to input changes but avoid the occurrence of *nuisance* shutdown events. Signal conditioning is applied to line voltage inputs to verify proper operation in the presence of *normal* electrical line noise such as transient high voltage spikes or short periods of line dropout. Signal conditioning is tolerant of synchronous noise (line noise events that occur at the same time during each line cycle).

DYNAMIC AMPLI-CHECK™

Dynamic AMPLI-CHECK™ circuitry tests the flame signal amplifier during burner operation and shuts down the RM7895 if the flame amplifier fails.

DYNAMIC FLAME AMPLIFIER AND SHUTTER CHECK

Self-checking circuitry tests all electronic components in the flame detection system and amplifier 10 to 12 times per minute and shuts down the RM7895 if the detection system fails.

DYNAMIC INPUT CHECK

All system input circuits are examined to assure that the RM7895 is capable of recognizing the true status of external controls, limits and interlocks. If any input fails this test, a safety shutdown occurs and the fault will be annunciated.

DYNAMIC SAFETY RELAY TEST

Checks the ability of the dynamic safety relay contact to open and close. Verifies that the safety critical loads, terminals 8, 9, 10 and 21, can be de-energized, as required, by the Dynamic Self-Check logic.

DYNAMIC SELF-CHECK SAFETY CIRCUIT

The microcomputer tests itself and related hardware, and at the same time, the safety relay system tests the microcomputer operation. If a microcomputer or safety relay failure occurs and does not allow proper execution of the self-check routine, safety shutdown occurs and all safety critical loads will be de-energized.

EXPANDED SAFE-START CHECK

The conventional safe-start check, which prevents burner start-up if flame is indicated at start-up, is expanded to include a flame signal check during STANDBY, an airflow switch check and a safety critical load check.

OFF CYCLE (Standby or Prepurge) FLAME SIGNAL CHECK

The flame detection subsystem (flame detector and amplifier) is monitored during STANDBY. If a flame simulating condition or an actual flame exists, a system hold occurs and start-up is prevented. If the flame signal exists at any time after the first 40 seconds of STANDBY, a safety shutdown occurs and is annunciated. A shutter-check amplifier and self-checking detector are energized for the first 40 seconds during STANDBY and the last two seconds before exiting STANDBY. If a flame exists, a safety shutdown occurs. An AMPLI-CHECK™ Amplifier is energized continually through STANDBY and PREPURGE to detect any possibility of a runaway detector or a flame. If a flame exists, a safety shutdown occurs. A standard amplifier is energized continually through STANDBY and PREPURGE; if a flame exists, a safety shutdown occurs.

TAMPER RESISTANT TIMING AND LOGIC

Safety and logic timings are inaccessible and cannot be altered or defeated.

VERIFIED SPARK TERMINATION

The ignition terminal is monitored to assure early spark termination (ten seconds ignition and pilot and ten seconds *pilot and main only*).

FIRST-OUT ANNUNCIATION AND SELF-DIAGNOSTICS

Sequence Status Lights (LEDs) provide positive visual indication of the program sequence: POWER, PILOT, FLAME, MAIN and ALARM. The green POWER LED blinks every four seconds, signifying that the RM7895 hardware is running correctly.

Optional multi-function Keyboard Display Module shows elapsed time during PREPURGE, PILOT IGN and MAIN IGN. As an additional troubleshooting aid, it provides sequence timing, diagnostic information, historical information and expanded annunciator information when a safety shutdown or hold or normal operation occurs.

First-out Annunciation reports the cause of a safety shutdown or identifies the cause of a failure to start or continue the burner control sequence with an English text and numbered code via the optional Keyboard Display Module. It monitors all field input circuits, including the flame signal amplifier. The system distinguishes 43 modes of failure and detects and annunciates difficult-to-find intermittent failures.

Self-Diagnostics add to the First-out Annunciation by allowing the RM7895 to distinguish between field (external device) and internal (system related) problems. Faults associated within the flame detection subsystem, RM7895 or Plug-in Purge Card are isolated and reported by the optional Keyboard Display Module. See the 7800 SERIES System Annunciation Diagnostics and Troubleshooting, form 65-0118.

INTERLOCK REQUIREMENTS

The following interlock input is provided:

Airflow Switch Interlock

This interlock is typically connected to an airflow switch. The Airflow Interlock (ILK) input must close ten seconds into PREPURGE or within the specified purge card timing; otherwise, a recycle to the beginning of PREPURGE or lockout will occur, depending on how the airflow switch selectable jumper is configured (see Table 3 in Operation section). The RM7895B,D has an airflow switch safe-start check feature. If the control input terminal 6 is energized and the airflow switch is closed during STANDBY, RM7895B,D will lockout after 120 seconds.

Installation

WARNING

FIRE OR EXPLOSION HAZARD CAN CAUSE PROPERTY DAMAGE, SEVERE INJURY, OR DEATH

To prevent possible hazardous burner operation, verification of safety requirements must be performed *each time* a control is installed on a burner.

WHEN INSTALLING THIS PRODUCT…

1. Read these instructions carefully. Failure to follow them could damage the product or cause a hazardous condition.
2. Check the ratings given in the instructions and marked on the product to make sure the product is suitable for your application.
3. Installer must be a trained, experienced, flame safeguard service technician.
4. After installation is complete, check out the product operation as provided in these instructions.

CAUTION

1. Disconnect the power supply before beginning installation to prevent electrical shock and equipment damage. More than one power supply disconnect may be involved.
2. Wiring connections for the RM7895 are unique; therefore, refer to Figs. 7 or 8 or the correct Specifications for proper subbase wiring.
3. Wiring must comply with all applicable codes, ordinances and regulations.
4. Wiring, where required, must comply with NEC Class 1 (Line Voltage) wiring.
5. Loads connected to the RM7895 must not exceed those listed on the RM7895 label or the Specifications, see Table 1.
6. Limits and interlocks must be rated to carry and break current simultaneously to the ignition transformer, pilot valve, and main fuel valve(s).
7. All external timers must be listed or components recognized by authorities who have jurisdiction for specific purpose for which they are used.

IMPORTANT:

1. *For on-off gas-fired systems, some authorities who have jurisdiction prohibit the wiring of any limit or operating contacts in series between the flame safeguard control and the main fuel valve(s).*
2. *Two Detectors can be connected in parallel with the exception of Infrared Detectors (C7015).*
3. *This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause interference to radio communications. It has been tested and found to comply with the limits for a Class B computing device of part 15 of FCC rules, which are designed to provide reasonable protection against such interference when operated in a commercial environment. Operation of this equipment in a residential area may cause interference; in which case, the user at their own expense may be required to take whatever measures are required to correct this interference.*
4. *This digital apparatus does not exceed the Class B limits for radio noise of digital apparatus set out in the Radio Interference Regulations of the Canadian Department of Communications.*

HUMIDITY

Install the RM7895 where the relative humidity never reaches the saturation point. The RM7895 is designed to operate in a maximum 85% RH continuous, noncondensing, moisture environment. Condensing moisture may cause a safety shutdown.

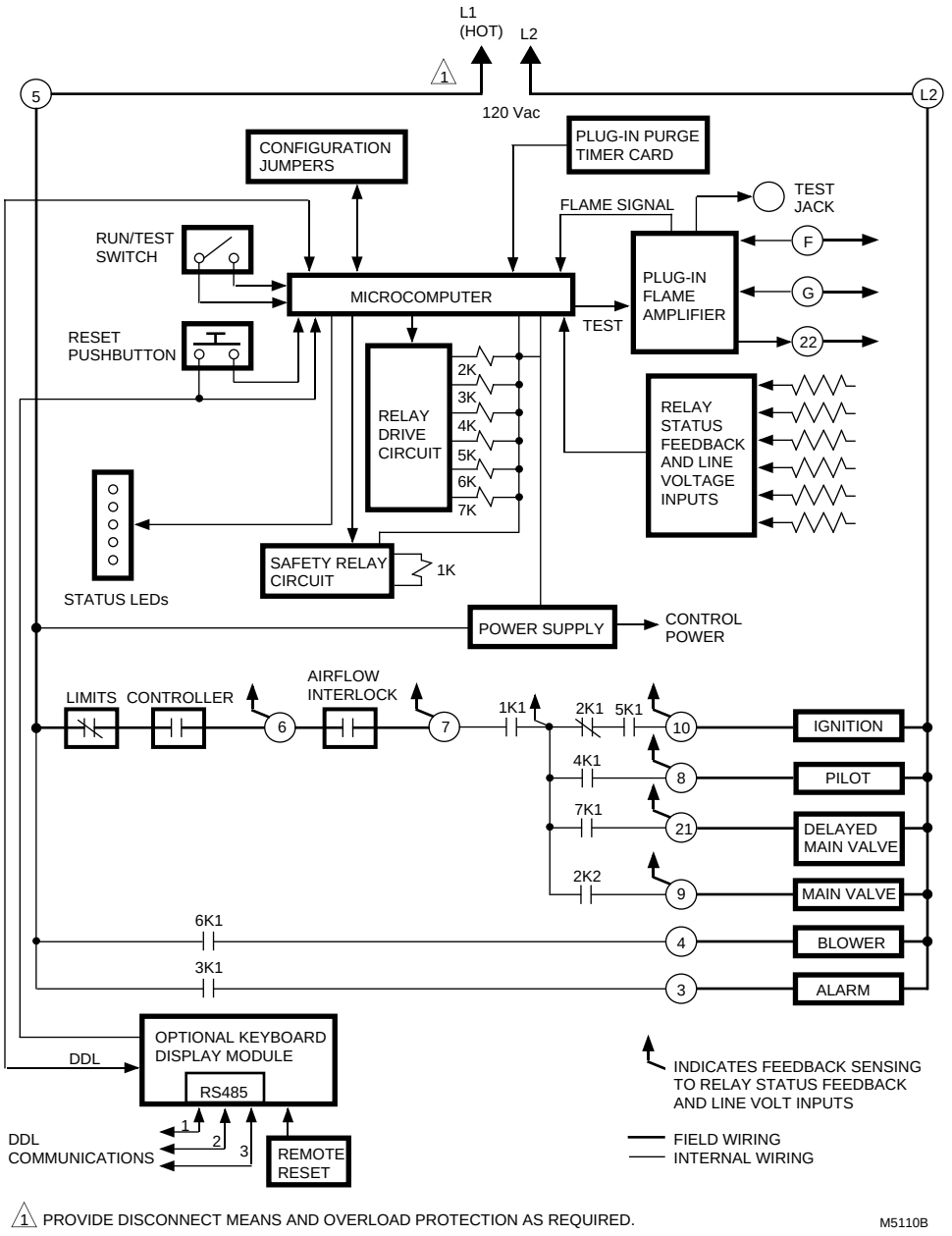
VIBRATION

Do not install the RM7895 where it could be subjected to vibration in excess of 0.5G continuous maximum vibration.

WEATHER

The RM7895 is not designed to be weather tight. If installed outdoors, the RM7895 must be protected by an approved weather-tight, enclosure.

Fig. 6—Internal block diagram of the RM7895 (see Figs. 7 and 8 for detailed wiring instructions).



MOUNTING WIRING SUBBASE

NOTE: For installation dimensions, see Figs. 1 or 2.

1. Mount the subbase in any position except horizontally with the bifurcated contacts pointing down. The standard vertical position is recommended. Any other position decreases the maximum ambient temperature rating.
2. Select a location on a wall, burner or electrical panel. The Q7800 can be mounted directly in the control cabinet. Be sure to allow adequate clearance for servicing, instal-lation, access and removal of the RM7895, Dust Cover, flame amplifier, flame amplifier signal voltage probes, Run/Test Switch, electrical signal voltage probes and electrical field connections.
3. For surface mounting, use the back of the subbase as a template to mark the four screw locations. Drill the pilot holes.
4. Securely mount the subbase using four no. 6 screws.

Wiring

1. a. For proper wiring, refer to Figs. 7 or 8.
   b. For proper remote wiring of the Keyboard Display Module, refer to the Specifications for the Keyboard Display Module (65-0090), Communication Interface Base Unit (63-2278), DATA CONTROLBUS MODULE™ (65-0091) or Extension Cable Assembly (65-0131).
2. Disconnect the power supply from the main disconnect before beginning installation to prevent electrical shock and equipment damage. More than one disconnect may be involved.
3. All wiring must comply with all appropriate electrical codes, ordinances and regulations. Wiring, where required, must comply with NEC Class 1 (Line Voltage) wiring.
4. Recommended wire size and type: use no. 14, 16, or 18 copper conductor (TTW60C or THW75C or THHN90C) 600 volt insulation wire for all Line Voltage terminals. For high temperature installations, use wire selected for a temperature rating above the maximum operating temperature. All leadwires must be moisture resistant.
5. Recommended grounding practices:
   a. Use the earth ground to provide a connection between the subbase and the control panel or the equipment. The earth ground wire must be capable of conducting the current to blow the 20A fuse (or breaker) in event of an internal short circuit. The RM7895 needs a low impedance ground connection to the equipment frame which, in turn, needs a low impedance connection to earth ground. For a ground path to be low impedance at RF frequencies, the connection must be made with minimum length conductors that have a maximum surface area. Wide straps or brackets are preferred rather than leadwires. Be careful to verify that mechanically tightened joints along the ground path, such as pipe or conduit threads or surfaces held together with fasteners, are free of nonconductive coatings and are protected against mating surface corrosion.
   b. RM7895—Each RM7895 will have an earth ground terminal that must be grounded to the metal control panel with wire as short as practical. Each ground wire must be capable of carrying a fault current equal to the rating of the protective fuse (20A). A number 14 copper conductor is adequate but wide straps or brackets are preferred rather than leadwires.
6. Recommended wire routing for flame detector leadwires:
   1. Do not run high voltage ignition transformer wires in the same conduit with the flame detection wiring.
   2. Do not route scanner wires in a conduit with line voltage circuits.
   3. Enclose scanner wires without armor cable in metal cable or conduit.
   4. Follow directions given in the flame detector Instructions.
7. Maximum wire lengths:
   a. For the RM7895, the maximum length of leadwire to the terminal inputs is 300 feet (Control and Airflow Interlock).
   b. For the flame detector leadwires, the maximum flame sensor leadwire length is limited by the flame signal strength.
8. Make sure loads do not exceed the terminal ratings. Refer to the label on the RM7895 or to the ratings in the Specifications, see Table 1.
9. Check the power supply circuit. The voltage and frequency tolerance must match those of the RM7895. A separate power supply circuit may be required for the RM7895 with the required disconnect means and overload protection added.
10. Check all wiring circuits and complete the Static Checkout, see Table 4, before installing the RM7895 on the subbase.
11. Install all electrical connectors.
12. Restore power to the panel.

Fig. 7—Wiring the RM7895A,B.

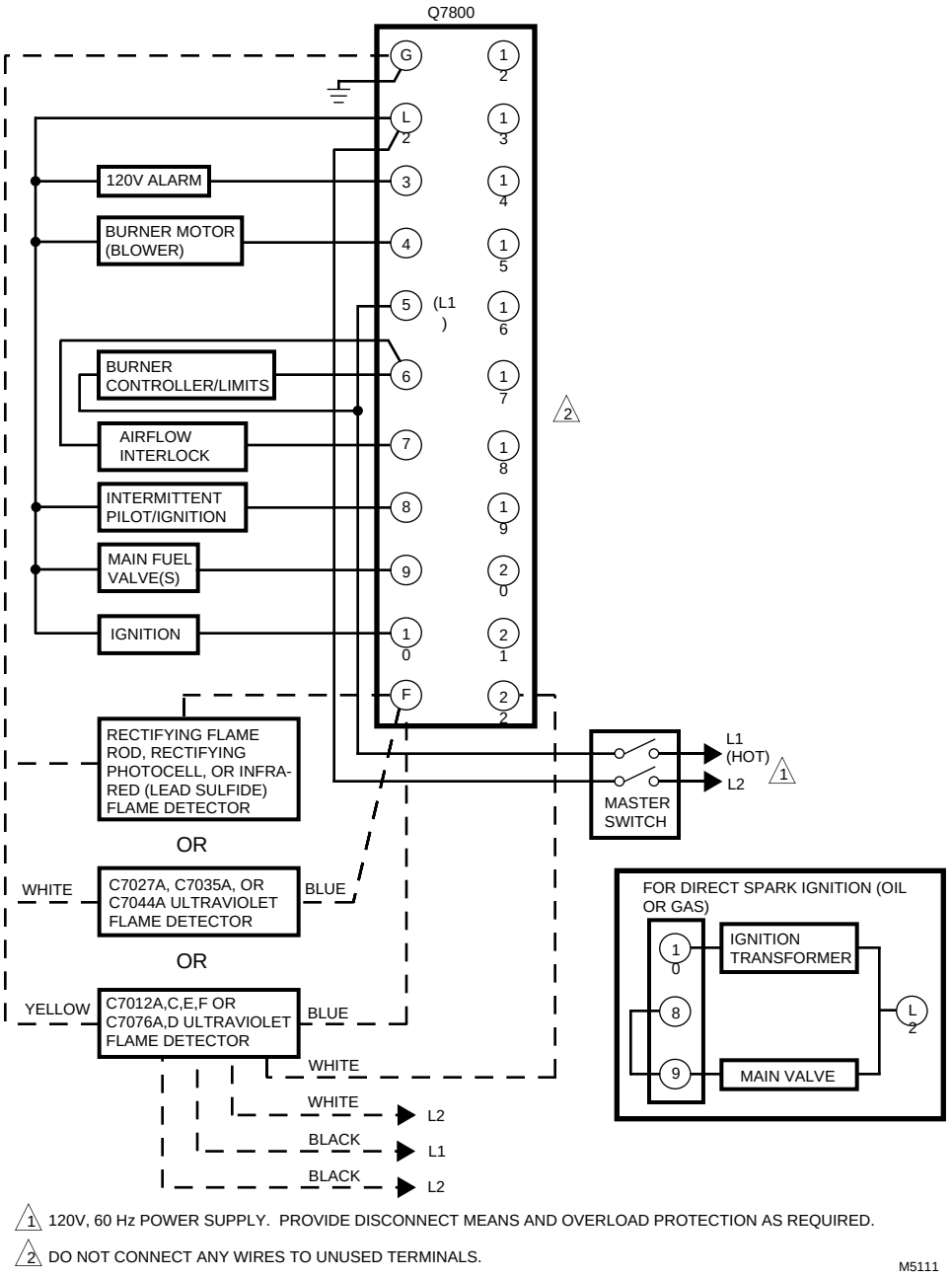
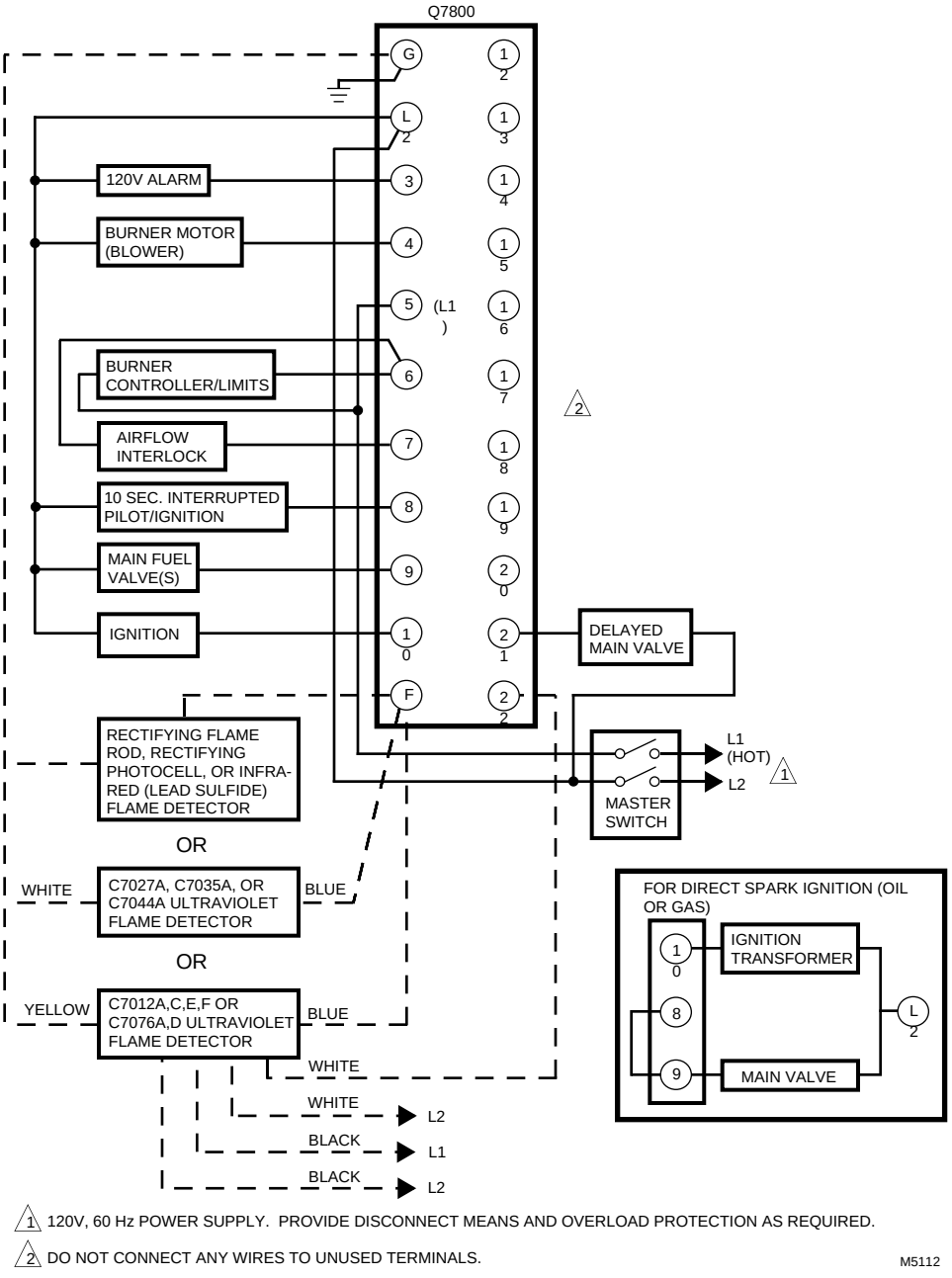


Fig. 8—Wiring the RM7895C,D.



Assembly

MOUNTING RM7895

NOTE: For installation dimensions, see Figs. 1 or 2.

RELAY MODULE MOUNTING

1. Mount the RM7895 vertically, see Figs. 9 or 10, or mount horizontally with the knife blade terminals pointing downward. When mounted on the Q7800A, the RM7895 must be in an electrical enclosure, see Fig. 9.
2. Select the location in the electrical enclosure. Be sure to allow adequate clearance for servicing, installation and removal of the RM7895, Dust Cover, flame amplifier, flame amplifier signal voltage probes, electrical signal voltage probes and electrical connections.
   a. Allow an additional two inches below the RM7895 for the flame amplifier mounting.
   b. Allow an optional three-inch minimum to both sides of the RM7895 for electrical signal voltage probes.
   c. Allow an optional two inches above the RM7895C,D for access to the Run/Test Switch.
3. Make sure no subbase wiring is projecting beyond the terminal blocks. Tuck wiring in against the back of the subbase so it does not interfere with the knife blade terminals or bifurcated contacts.
4. Mount the RM7895 by aligning the four L shaped corner guides and knife blade terminals with the bifurcated contacts on the wiring subbase and tightening the two screws securely without deforming the plastic.

IMPORTANT*: Install the RM7895 with a plug-in motion rather than a hinge action.*

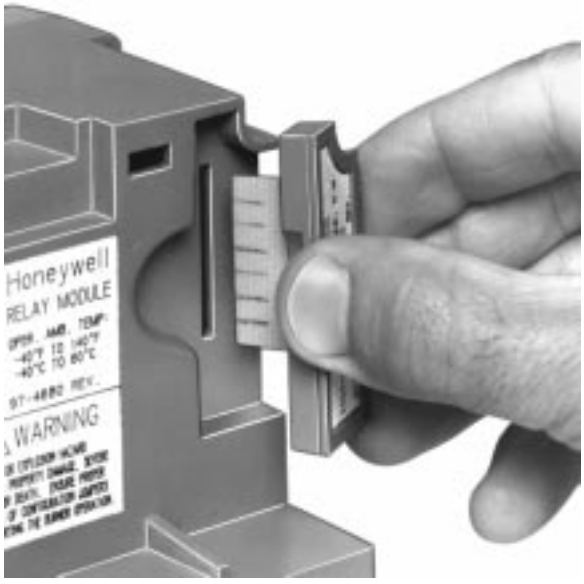
Fig. 9—Electrical panel installation.

Fig. 10—Wall or burner installation.

INSTALLING ST7800 PURGE CARD

1. Remove the Dust Cover, Keyboard Display Module, DATA CONTROLBUS MODULE™or Extension Cable Assembly.
2. Remove the current ST7800 from the RM7895 by pulling upward on the plastic support cover, see Fig. 11.
3. Make sure that the ST7800 selected has the desired timing.
4. Insert the Purge Card into the opening of the RM7895 compartment, see Fig. 11.

Fig. 11—ST7800 Purge Card installation.



5. Reinstall the Dust Cover, Keyboard Display Module, DATA CONTROLBUS MODULE™ or Extension Cable Assembly onto the RM7895 and restore power to the device.

Run the burner system through at least one complete cycle to verify the system is operating as desired.

MOUNTING DUST COVER

1. Align the two interlocking ears of the Dust Cover with the two mating slots on the RM7895, see Fig. 12.
2. Insert the two interlocking ears into the two mating slots, and with a hinge action, push on the upper corners of the Dust Cover to secure it to the RM7895.
3. Be sure the Dust Cover is firmly in place.

Fig. 12—Dust Cover mounting.

INSTALLING PLUG-IN FLAME SIGNAL AMPLIFIER

1. Disconnect the power supply before beginning installation to prevent electrical shock and equipment damage. More than one disconnect may be involved.
2. Align the amplifier circuit board edge connector with the keyed receptacle on the RM7895. Ensure the amplifier nameplate faces away from the Relay Module, see Fig. 13.
3. Push in the amplifier until the circuit board is fully inserted into the receptacle and then push the amplifier toward the RM7895 retaining clasp.
4. Verify the amplifier is firmly in place.
5. Perform all required checkout tests.

Fig. 13—Flame signal amplifier mounting.

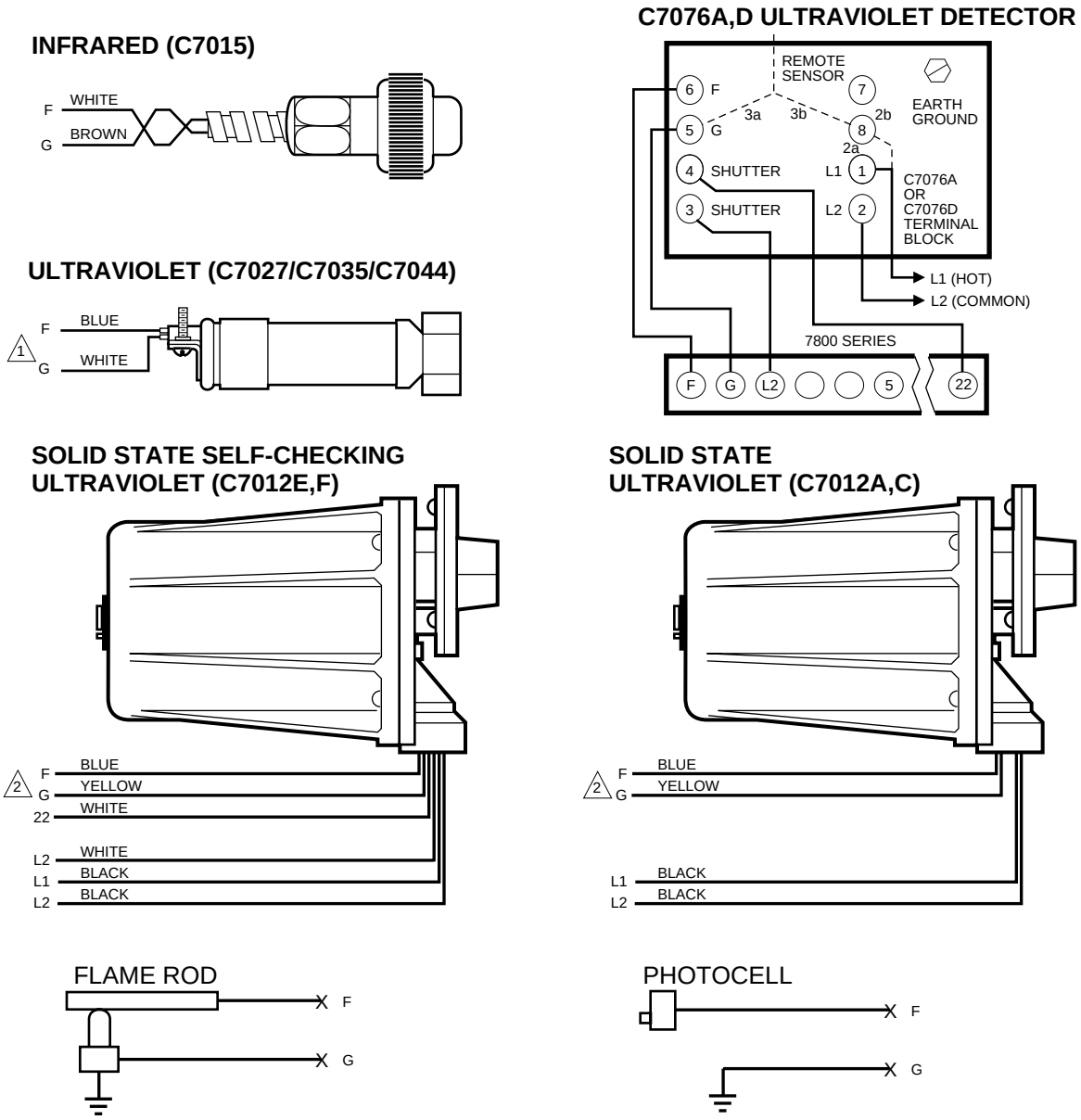
INSTALLING THE FLAME DETECTOR

NOTE: Table 2 and Fig. 14 list the flame detection systems available for use with the RM7895. Make sure the correct combination of amplifier and flame detector(s) is used.

Proper flame detector installation is the basis of a safe and reliable flame safeguard installation. Refer to the Instructions packed with the flame detector and the equipment manufacturer instructions.

Keep the flame signal leadwires as short as possible from the flame detector to the wiring subbase. Capacitance increases with leadwire length, reducing the signal strength. The maximum permissible leadwire length depends on the type of flame detector, leadwire and conduit. The ultimate limiting factor in the flame detector leadwire is the flame signal, see Table 5.

Fig. 14—Flame detector wiring.



1 FLAME DETECTOR LEADS ARE COLOR CODED. THE BLUE LEAD MUST BE CONNECTED TO THE F TERMINAL AND THE WHITE MUST BE CONNECTED TO THE G TERMINAL. THE UV SENSING TUBE IS POLARITY SENSITIVE. REVERSING THE LEADS EVEN MOMENTARILY CAN DAMAGE OR DESTROY THE UV TUBE.

2 FLAME DETECTOR LEADS ARE COLOR CODED. THE BLUE LEAD MUST BE CONNECTED TO THE F TERMINAL AND THE YELLOW MUST BE CONNECTED TO THE G TERMINAL. THE UV SENSING TUBE IS POLARITY SENSITIVE. REVERSING THE LEADS EVEN MOMENTARILY CAN DAMAGE OR DESTROY THE UV TUBE.

M1969B

Operation

Sequence of Operation

The RM7895 has the following operating sequences, see Figs. 15, 16 and 18.

INITIATE

The RM7895 enters the INITIATE sequence when the Relay Module is powered. The RM7895 can also enter the INITIATE sequence if the Relay Module verifies voltage fluctuations of +10/-15% or frequency fluctuations of +/- 10% during any part of the operating sequence. The INITIATE sequence lasts for ten seconds unless the voltage or frequency tolerances are not met. When the tolerances are not met, a hold condition will be initiated and will be displayed on the optional VFD for at least five seconds. When the tolerances are met, the INITIATE sequence will restart. If the condition is not corrected and the hold condition exists for four minutes, the RM7895 will lockout. Causes for hold conditions in the INITIATE sequence are:

- AC line dropout is detected.
- AC line frequency error caused by using a 60 Hz device on a 50 Hz line, or vice versa.
- AC line noise that can prevent a sufficient reading of the line voltage inputs.
- Brownouts caused by a low line voltage.

The INITIATE sequence also delays the burner motor starter from being energized and de-energized from an intermittent AC line input or control input.

STANDBY

The RM7895 is ready to start an operating sequence when the operating control input determines a *call for heat* is present. The burner switch, limits, operating limit control and all microcomputer monitored circuits must be in the correct state for the RM7895 to continue into the PREPURGE sequence.

NORMAL START-UP
PREPURGE

The RM7895 provides a selectable PREPURGE timing from two seconds to 30 minutes with power applied and the RM7895 operating control indicating a *call for heat*.

a. Airflow Interlock, burner switch, Run/Test Switch and all microcomputer monitored circuits must be in the correct operating state.
b. The blower motor output, terminal 4, is powered to start the PREPURGE sequence.
c. The Airflow Interlock input must close ten seconds in PREPURGE or within the specified purge card timing; otherwise, a recycle to the beginning of PREPURGE or lockout will occur depending on how the airflow switch selectable jumper is configured.

IGNITION TRIALS

a. Pilot Flame Establishing Period (PFEP):
   1. The pilot valve and ignition transformer, terminals 8 and 10, are energized. The RM7895A,B has an intermittent pilot valve, terminal 8. The RM7895C,D has an interrupted pilot valve, terminal 8.
   2. Flame must be proven by the end of the 4 or 10 second PFEP (RM7895C1020 has a fixed ten second PFEP) to allow the sequence to continue. If flame is not proven by the end of PFEP, a safety shutdown occurs.
   3. At the end of PFEP, the ignition, terminal 10, is de-energized. For RM7895A1048 and RM7895C1020 only, when flame is proven, the ignition, terminal 10, is de-engergized. If the flame is lost and still in PFEP the ignition, terminal 10, is re-energized.

Fig. 15—RM7895A,B sequence.

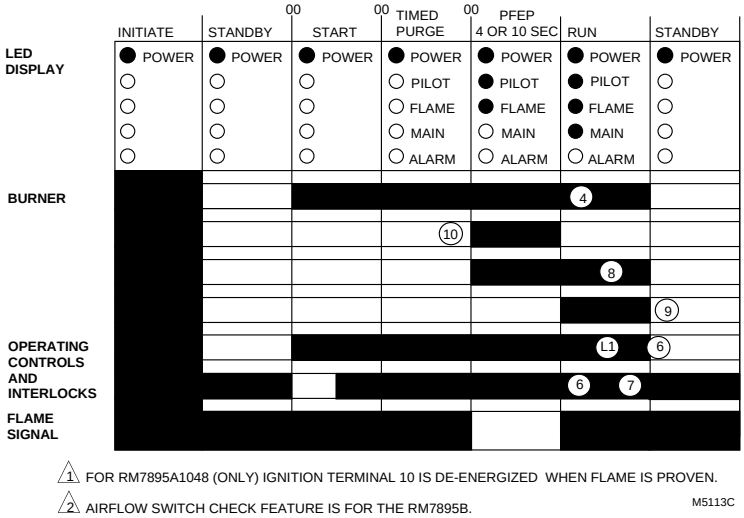
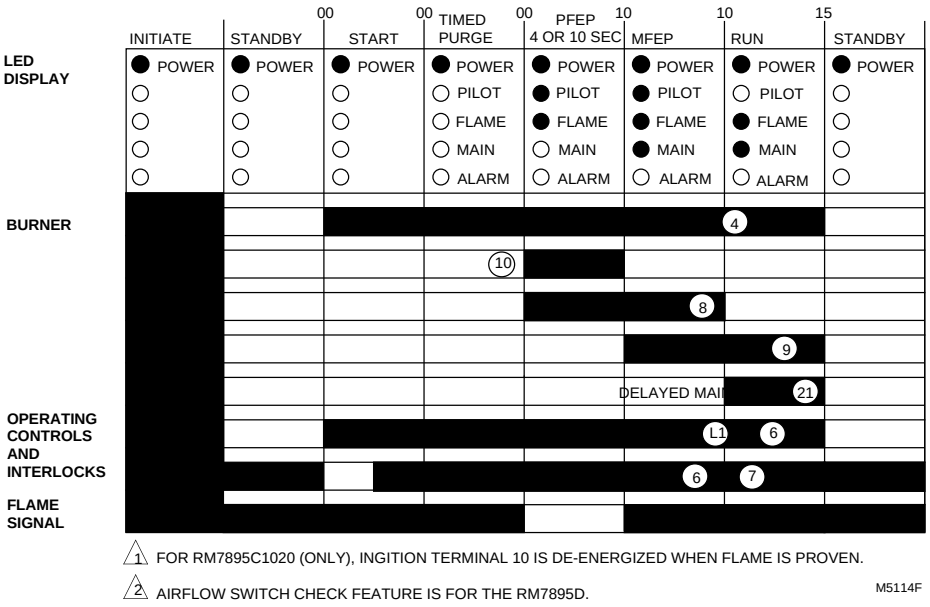


Fig. 16—RM7895C,D sequence.



b. Main Flame Establishing Period (MFEP):

1. After the Ignition Trials, and with the presence of flame, the main fuel valve, terminal 9, is powered. If a flameout occurs, the RM7895A,B will lockout or recycle within .8 or 3 seconds, depending on the Flame Failure Response Time (FFRT) of the amplifier.
2. The RM7895C,D has a ten second MFEP. After the Ignition Trials, and with the presence of flame, the main fuel valve, terminal 9, is powered. If a flameout occurs, the RM7895C,D will lockout within .8 or 3 seconds, depending on the Flame Failure Response Time (FFRT) of the amplifier.

RUN

1. The RM7895C,D has a delayed main valve. The delayed main valve is energized once the RUN period is entered. A ten second stabilization period occurs.

2. The RM7895 is now in RUN and will remain in RUN until the controller input, terminal 6, opens, indicating that the demand is satisfied or a limit has opened.

Fig. 17—Sequence status LEDs.

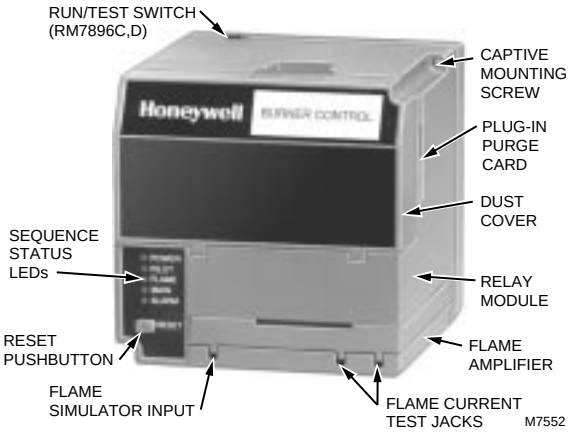


Fig. 18—Sequence status LEDs.

BURNER SEQUENCE:

INITIATE	STANDBY	STANDBY: F/G HOLD (FLAME DETECTED)	PURGE HOLD: F/G (FLAME DETECTED)	PURGE	PILOT IGNITION	MAIN IGNITION	RUN (RM7895A,B INTERMITTENT PILOT)	RUN (RM7895C,D INTERRUPTED PILOT)	RESET/ ALARM
● POWER	● POWER	● POWER	● POWER	● POWER	● POWER	● POWER	● POWER	● POWER	● POWER
○ PILOT	○ PILOT	○ PILOT	○ PILOT	○ PILOT	● PILOT	● PILOT	● PILOT	○ PILOT	○ PILOT
○ FLAME	○ FLAME	● FLAME	● FLAME	○ FLAME	● FLAME	● FLAME	● FLAME	● FLAME	○ FLAME
○ MAIN	○ MAIN	○ MAIN	○ MAIN	○ MAIN	○ MAIN	● MAIN	● MAIN	● MAIN	○ MAIN
○ ALARM	○ ALARM	○ ALARM	○ ALARM	○ ALARM	○ ALARM	○ ALARM	○ ALARM	○ ALARM	● ALARM

M3356

See Table 6 for further details of Hold conditions.

RUN/TEST SWITCH FUNCTIONS

The Run/Test Switch is located on the top side of the RM7895C,D, see Fig. 17. The Run/Test Switch allows the burner sequence to be altered as follows:

1. In the measured PREPURGE sequence, the Run/Test Switch, when placed in the TEST position, causes the PREPURGE timing to stop.

2. In Pilot Flame Establishing Period, the Run/Test Switch, when placed in the TEST position, stops the timer during the first eight seconds of a ten second PFEP selection or during the first three seconds of a four second PFEP selection. It also allows for pilot-turn-down test and other burner adjustments. This activates a fifteen second flame-out timer that permits pilot flame adjustment without nuisance safety shutdowns. The Run/Test Switch is ignored during PFEP for RM7895C,D if terminals 8 and 9 or 9 and 21 are jumpered.

NOTE: When the RM7895C,D is switched to the TEST mode, it stops and holds at the next Run/Test Switch point in the operating sequence. *MAKE SURE THAT THE RUN/TEST SWITCH IS IN THE RUN POSITION BEFORE LEAVING THE INSTALLATION.*

WARNING

Do not use the Run/Test Switch during Pilot Flame Establishing Period for the RM7895C,D when using direct spark ignition.

SELECTABLE SITE-CONFIGURABLE JUMPERS

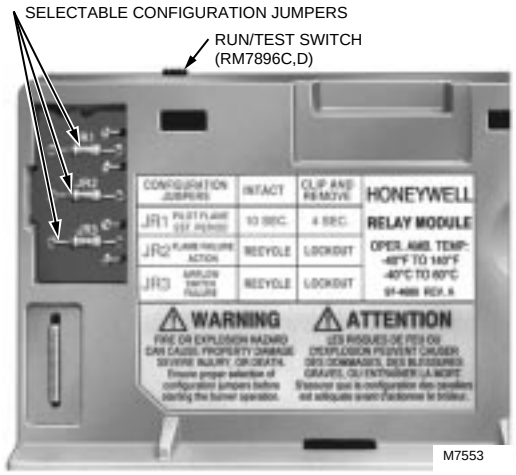
The RM7895 has three site-configurable jumper options, see Fig. 19 and Table 3. The site-configurable jumpers should be clipped with side cutters and the resistors removed from the Relay Module.

TABLE 3—SITE CONFIGURABLE JUMPER OPTIONS.

Jumper Number	Description	Intact	Clipped	RM7895 Type
JR1[a]	Pilot Flame Establishing Period	10 seconds	4 seconds	(ALL)
JR2	Flame Failure Action	Recycle	Lockout	(ALL)
JR3	Airflow Switch (ILK) Failure	Recycle	Lockout	(ALL)

[a] The RM7895C1020 has a fixed pilot flame establishing period of ten seconds. The model does not have jumper JR1.

Fig. 19—Selectable site-configurable jumpers.



SERVICE NOTE: Clipping and removing a site-configurable jumper enhances the level of safety.

STATIC CHECKOUT

CAUTION

1. Use extreme care while testing the system. Line voltage is present on most terminal connections when power is on.
2. Open the master switch before installing or removing a jumper on the subbase.
3. Before continuing to the next test, be sure to remove test jumper(s) used in the previous tests.
4. Replace all limits and interlocks not operating properly. Do not bypass limits and interlocks.
5. Close all manual fuel shutoff valve(s) before starting these tests.

After checking all wiring, perform this checkout before installing the RM7895 on the subbase. These tests verify the Q7800 Wiring Subbase is wired correctly, and that the external controllers, limits, interlocks, actuators, valves, transformers, motors and other devices are operating properly.

NOTE: Do not perform a dielectric test with the RM7895 installed. Internal surge protectors will break down and conduct a current. This could cause the RM7895 to fail the dielectric test or possibly destroy the internal lightning and high current transient protection components.

EQUIPMENT RECOMMENDED

1. Voltmeter (20 kohm/volt minimum sensitivity) set on the 0-300 Vac scale.

2. Two jumper wires; no. 14 wire, insulated, 12 inches (304.8 mm) long, with insulated alligator clips at both ends.

GENERAL INSTRUCTIONS

1. Perform all applicable tests listed in Static Checkout, Table 5, in the order listed.
2. *MAKE SURE THAT ALL MANUAL FUEL SHUT-OFF VALVE(S) ARE CLOSED.*
3. Perform only those tests designated for the specific RM7895 model being tested.
4. Raise the set point of the operating controller to simulate a *call for heat.*
5. For each test, open the master switch and install the jumper wire(s) between the subbase wiring terminals listed in the **Test Jumpers** column of Table 4.
6. Close the master switch before observing operation.
7. Read the voltage between the subbase wiring terminals listed in the **Voltmeter** column of Table 4.
8. If there is no voltage or the operation is abnormal, check the circuits and external devices as described in the last column.
9. Check all wiring for correct connections, tight terminal screws, correct wire, and proper wiring techniques. Replace all damaged or incorrectly sized wires.
10. Replace faulty controllers, limits, interlocks, actuators, valves, transformers, motors and other devices as required.
11. Obtain normal operation for each required test before continuing the checkout.
12. After completing each test, be sure to remove the test jumper(s).

TABLE 4—STATIC CHECKOUT.

Test No.	RM7895 Models	Test Jumpers	Volt-meter	Normal Operation	If Operation Is Abnormal, Check The Items Listed Below
⚠ ***WARNING*** Make sure all manual fuel shutoff valves are closed.					
IMPORTANT: *Low fuel pressure limits, if used, could be open. Bypass them with jumpers for the remaining Static Tests (if required).*					
1	All	None	5-L2	Line voltage at terminal 5.	1. Master switch. 2. Power connected to the master switch. 3. Overload protection (fuse, circuit breaker) has not opened the power line.
2	All	None	6-L2	Line voltage at terminal 6.	1. Limits. 2. Burner controller.
3	All	4-5	7-L2	1. Burner motor (fan or blower) starts. 2. Line voltage at terminal 7 within 10 seconds.	1. Burner motor circuit. a. Manual switch of burner motor. b. Burner motor power supply, overload protection and starter. c. Burner motor.
4	All	5-10	—	Ignition spark (if ignition transformer is connected to terminal 10).	1. Watch for spark or listen for buzz. a. Ignition electrodes are clean. b. Ignition transformer is okay.
5	All	5-8	—	1. Ignition spark (if ignition transformer is connected to terminal 8). 2. Automatic pilot valve opens (if connected to terminal 8). NOTE: Refer to wiring diagram of system being tested.	1. Watch for spark or listen for buzz. a. Ignition electrodes are clean. b. Ignition transformer is okay. 2. Listen for click or feel head of valve for activation. a. Actuator if used. b. Pilot valve.
6	All	5-9	—	Automatic fuel valve(s) opens. If using direct spark ignition, checkthe first stage fuel valve(s) instead of the pilot valve.	Same as test no. 6. If using direct spark ignition, check the first stage fuel valve(s) instead of the pilot valve.
7	RM7895 C,D	5-21	—	Automatic delayed main fuel valve(s) opens.	1. Listen for and observe operation of the delayed main fuel valve(s) and actuator(s). 2. Valve(s) and actuator(s).
8	All	5 -3	—	Alarm (if used) turns on.	1. Alarm
Final	All	⚠ ***CAUTION*** After completing these tests, open the master switch and remove all *test jumpers* from the subbase terminals. Also remove bypass jumpers from the low fuel pressure limits (if used).			

Checkout

WARNING

Do not allow fuel to accumulate in the combustion chamber. If fuel is allowed to enter the chamber for longer than a few seconds without igniting, an explosive mixture could result. It is recommended that you limit the trial for pilot to ten seconds, and limit the attempt to light the main burner two seconds from the time the fuel has reached the burner nozzle. In any case, do not exceed the nominal lightoff time specified by the equipment manufacturer. Close the manual fuel shutoff valve(s) if the flame is not burning at the end of the specified time.

CAUTION

1. Use extreme care while testing the system. Line voltage is present on most terminal connections when power is on.
2. Open the master switch before removing or installing the RM7895.
3. Make sure all manual fuel shutoff valve(s) are closed before starting the initial lightoff check and the Pilot Turndown tests.
4. Do not put the system in service until you have satisfactorily completed all applicable tests in this section and any others required by the equipment manufacturer.

CAUTION

If an RM7895 is replaced with a lower or higher functioning 7800 SERIES Relay Module, the burner will not sequence unless wiring changes are made.

IMPORTANT:

1. *If the system fails to perform properly, refer to 7800 SERIES System Annunciation Diagnostics and Troubleshooting, form 65-0118.*
2. *Repeat ALL required Checkout tests after all adjustments are made. ALL tests must be satisfied with the flame detector(s) in its FINAL position.*

EQUIPMENT RECOMMENDED

Volt-ohmmeter (20 kohm/volt minimum sensitivity):

- 0-300 Vac capability.
- 0-6000 ohm capability.
- 0-10 Vdc capability.

CHECKOUT SUMMARY

- Preliminary inspection—all installations.
- Flame signal measurement—all installations.
- Initial lightoff check for proved pilot—all installations using a pilot.
- Initial lightoff check for direct spark ignition of oil—all burners using DSI.
- Pilot turndown test—all installations using a pilot.
- Hot refractory saturation test—all installations using Infrared (lead sulfide) Flame Detectors.
- Hot refractory hold-in test—all installations.
- Ignition interference test—all installations using flame rods.
- Ignition spark pickup—all installations using Ultraviolet Flame Detectors.
- Response to other ultraviolet sources—all installations using Ultraviolet Flame Detectors.
- Flame signal with hot combustion chamber—all installations.
- Safety shutdown tests—all installations.

See Figs. 1 and 2 for location of component parts and see Figs. 7 and 8 or Q7800 Specifications for terminal locations.

PRELIMINARY INSPECTION

Perform the following inspections to avoid common problems. Make certain that:

1. Wiring connections are correct and all terminal screws are tight.
2. Flame detector(s) is clean, installed and positioned properly. Consult the applicable Instructions.
3. Correct combination of amplifier and flame detector(s) is used. See Table 2 in the Specifications.
4. Plug-in amplifier and purge card are securely in place.
5. Burner is completely installed and ready to fire; consult equipment manufacturer instructions. Fuel lines are purged of air.
6. Combustion chamber and flues are clear of fuel and fuel vapor.
7. Power is connected to the system disconnect switch (master switch).
8. Lockout switch is reset (push in reset pushbutton) only if the RM7895 is powered, see Figs. 1 and 2.
9. Run/Test Switch is in RUN position (RM7895C,D).
10. System is in the STANDBY condition. POWER LED is energized.
11. All limits and interlocks are reset.

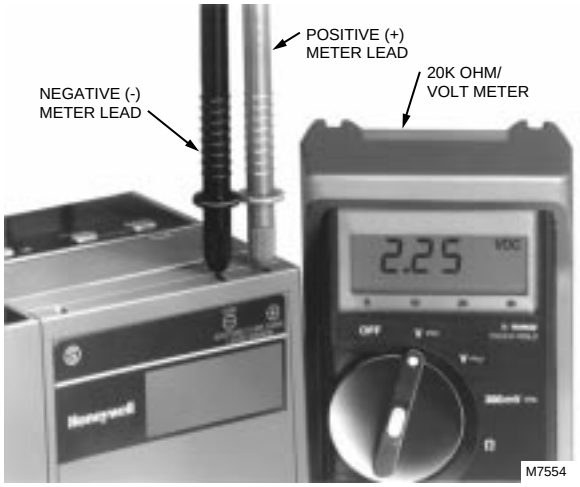
FLAME SIGNAL MEASUREMENT (Fig. 20 and Table 5)

TABLE 5—FLAME SIGNAL.

Flame Detector	Acceptable Flame Signal Amplifier	Minimum Maximum Steady DC Voltage[a]	Expected DC Voltage
Flame Rod Photocell C7012A,C	R7847A,B[b]	1.25 Vdc	5.0 Vdc at the Keyboard Display Module
C7012E,F	R7847C[c]		
C7015A	R7848A,B[b]		OR
C7027A C7035A C7044A	R7849A,B[b]		5.0 Vdc at a 20 kohm/volt meter
C7076A,D	R7886A		

[a] This minimum or a stronger signal should easily be obtained if the detector is correctly installed and positioned to properly sense the flame. This voltage must be obtained before completing checkout.
[b] The flame amplifiers are AMPLI-CHECK™ type.
[c] The flame signal amplifier circuitry is tested one-half second every five seconds during burner operation and shuts down the burner if the amplifier fails (all installations).

Fig. 20—Flame signal measurement.



Measure the flame signal at the appropriate times defined in the following checkout tests. Read the flame signal volts dc at the flame amplifier test jacks + and - (Com).

1. Use a 20 kohm/voltmeter with a 0 to 10 Vdc capability.
2. Set the 20 kohm/voltmeter to the 0 to 10 Vdc range.
3. Insert the positive (red) probe into the + jack of the flame amplifier. Insert the negative (black) probe into the - (Com) jack of the flame amplifier, see Fig. 20.
4. Allow a few seconds for the meter reading to stabilize.
5. If using AMPLI-CHECK™ or shutter check amplifiers, read the average stable voltage, disregarding the peaks caused by the self-checking operation.
6. The meter reading must be as specified in Table 5 after all tests are completed and all adjustments are made.

As an option, the flame signal can be checked by using the optional Keyboard Display Module.

If the signal is unstable or less than the minimum acceptable voltage, check the flame detector installation and circuitry.

1. Check the supply voltages at terminals 5 (L1) and L2 (N). Make sure the master switch is closed, connections are correct, and the power supply is of the correct voltage and frequency and is sinusoidal.
2. Check the detector wiring for defects including:
   - Incorrect connections.
   - Wrong type of wire.
   - Deteriorated wire.
   - Open circuits.
   - Short circuits.
   - Leakage paths caused by moisture, soot or accumulated dirt.
3. For a flame rod, make sure:
   - Ground area is large enough.
   - Flame rod is properly located in the flame.
   - Temperature at the flame rod insulator is no greater than 500° F [260° C].
4. For all optical detectors, clean the detector viewing window and inside of the sight pipe as applicable.
5. With the burner running, check the temperature at the detector. If it exceeds the detector maximum rated temperature:
   - Add a heat block to stop conducted heat traveling up the sight pipe.
   - Add a shield or screen to reflect radiated heat.
   - Add cooling (refer to sight pipe ventilation in the detector Instructions).
6. Make sure that the flame adjustment is not too lean.
7. Make sure that the detector is properly sighting the flame.
8. If necessary, resight or reposition the detector.

INITIAL LIGHTOFF CHECK FOR PROVED PILOT

Perform this check on all installations that use a pilot. It should immediately follow the preliminary inspection.

NOTE: Low fuel pressure limits, if used, could be open. If so, bypass them with jumpers during this check.

1. Open the master switch.
2. Make sure that the manual main fuel shutoff valve(s) is closed. Open the manual pilot shutoff valve. If the pilot takeoff is downstream from the manual main fuel shutoff valve(s), very slightly open the manual main valve to supply pilot gas flow. Make sure the main fuel is shutoff just upstream from the burner inlet, or disconnect power from the automatic main fuel valve(s).
3. Close the master switch and start the system with a *call for heat* by raising the set point of the operating controller, see Figs. 15, 16 or 18. The primary sequence should start the ten-second INITIATE sequence.
4. Let the sequence advance through PREPURGE. Ignition spark should occur and the pilot should light. If the pilot ignites, the FLAME LED will be energized. Proceed to step 7.
5. If the pilot flame is not established in four or ten seconds, safety shutdown occurs. Let the sequence complete its cycle. Consult the equipment operating manual for further information.
6. Push the reset pushbutton, and let the system recycle once. If the pilot still does not ignite, make the following ignition/pilot adjustments:
    a. Open the master switch and remove the RM7895 from the subbase.
    b. On the subbase, jumper terminal 5 to ignition terminals 8 or 10; refer to the appropriate wiring diagram to determine the proper terminal. Disconnect the leadwire to the pilot valve if it is connected to the same terminal.
    c. Close the master switch to energize only the ignition transformer.
    d. If the ignition spark is not strong and continuous, open the master switch and adjust the ignition electrode spark gap setting to the manufacturer recommendations.
    e. Make sure the ignition electrodes are clean.
    f. Close the master switch and observe the spark.
    g. After a continuous spark is obtained, open the master switch and add a jumper on the subbase from terminal 5 (L1) to the pilot terminal 8. Reconnect the leadwire from the pilot valve if it was disconnected in step b.
    h. Close the master switch to energize both the ignition transformer and the pilot valve.
    i. If the pilot does not ignite and if the ignition spark is still continuous, adjust the pressure regulator until a pilot is established.
    j. When the pilot ignites properly and stays ignited, open the master switch and remove the jumper(s) from terminals 5 - 8 or 5 - 10 of the subbase.
    k. Check for adequate bleeding of the fuel line.
    l. Reinstall the RM7895 on the subbase and close the master switch, then return to step 4.
7. When pilot ignites, measure the flame signal. If the pilot flame signal is unsteady or approaching the 1.25 Vdc minimum value, adjust the pilot flame size or detector sighting to provide a maximum and steady flame signal.
8. Recycle the system to recheck lightoff and pilot flame signal.
9. When the MAIN IGN period is displayed by the MAIN LED, make sure the automatic main fuel valve is open; then smoothly open the manual main fuel shutoff valve(s) and watch for main burner flame ignition. When the main burner flame is established, proceed to step 16.
10. If the main burner flame is not established within five seconds or the normal lightoff time specified by the equipment manufacturer, close the manual main fuel shut-off valve(s).
11. Recycle the system to recheck the lightoff and pilot flame signal.
12. Smoothly open the manual fuel shutoff valve(s) and try lightoff again. (The first reattempt may have been required to purge the lines and bring sufficient fuel to the burner.)
13. If the main burner flame is not established within five seconds or the normal lightoff time specified by the equipment manufacturer, close the manual main fuel shut-off valves(s). Check all burner adjustments.
14. If the main burner flame is not established after two attempts:
    a. Check for improper pilot size.
    b. Check for excess combustion air.
    c. Check for adequate fuel flow.
    d. Check for proper gas supply pressure.
    e. Check for proper valve operation.
    f. Check for proper pilot flame positioning.
15. Repeat steps 8 through 14 to establish the main burner flame; then proceed to step 16.
16. With the sequence in RUN, make burner adjustments for flame stability and BTU input rating.
17. Shut down the system by opening the burner switch or by lowering the set point of the operating controller. Make sure the main flame goes out. There may be a delay due to gas trapped between the valve(s) and the burner. Make sure all automatic fuel valve(s) close.
18. Restart the system by closing the burner switch and/or raising the set point of the operating controller. Observe that the pilot is established during PILOT IGN and the main burner flame is established during MAIN IGN within the normal lightoff time.
19. Measure the flame signal. Continue to check for the proper signal, see Table 5, through the RUN period.
20. Run the burner through another sequence, observing the flame signal for:
    a. Pilot flame alone (unless using direct spark ignition).
    b. Pilot and main flame together.
    c. Main flame alone (unless monitoring an intermittent pilot).

Also observe the time it takes to light the main flame. Ignition of main flame should be smooth.

21. Return the system to normal operation.
22. Make sure all readings are in the required ranges before proceeding.

NOTE: Upon completing these tests, open the master switch and remove all test jumpers from the subbase terminals, limits/controls or switches.

INITIAL LIGHTOFF CHECK FOR DIRECT SPARK IGNITION

This check applies for gas and oil burners that do not use a pilot. It should immediately follow the preliminary inspection. Refer to the appropriate sample block diagram of field wiring for the ignition transformer and fuel valve(s) hookup.

NOTE: Low fuel pressure limits, if used, could be open. If so, bypass them with jumpers during this check.

1. Open the master switch.
2. Complete the normal checkout of the fuel supply and equipment as recommended by the equipment manufacturer.
3. Close all manual main fuel shutoff valve(s). Check that the automatic fuel valve(s) are closed. Make sure fuel is not entering the combustion chamber.
4. Close the master switch and start the system with a *call for heat* by raising the set point of the operating controller, see Figs. 15, 16 or 18. The primary sequence should start the ten-second INITIATE sequence.
5. Let the sequence advance through PREPURGE. Ignition spark should occur after the PREPURGE period. Listen for the click of the first stage fuel solenoid valve(s).
6. Let the program sequence complete its cycle.
7. Open the manual fuel shutoff valve(s).
8. Reset the Lockout Switch and recycle the primary sequence through PREPURGE.
9. Watch for the FLAME LED to help determine when the first stage burner flame is established. If it is established, proceed to step 15.
10. If the first stage burner flame is not established within four seconds, or within the normal lightoff time specified by the equipment manufacturer, close the manual fuel shutoff valve(s), and open the master switch.
11. Check all burner adjustments.
12. Wait about three minutes. Close the master switch, open the manual fuel shutoff valve(s), and try again to lightoff the burner. The first attempt may have been required to purge the lines and bring sufficient fuel to the burner.
13. If the first stage burner flame is not established within four seconds, or within the normal lightoff time specified by the equipment manufacturer, close the manual fuel shutoff valve(s) and open the master switch.
14. If necessary, repeat steps 8 through 13 to establish the first stage burner flame. Then proceed to step 15.
15. When the first stage burner flame is established, the sequence will advance to RUN. Make burner adjustments for flame stability and input rating. If a second stage is used, proceed to step 18.
16. Shut down the system by opening the burner switch or by lowering the set point of the operating controller. Make sure the burner flame goes out and make sure all automatic fuel valve(s) close.
17. If used, remove the bypass jumpers from the low fuel pressure limit and subbase.
18. If a second stage is used, make sure the automatic second stage fuel valve(s) has opened and check the lightoff as follows. Otherwise proceed to step 19:
    a. Open the manual second stage fuel valve(s).
    b. Restart the system by raising the set point of the operating controller.
    c. When the first stage burner flame is established, watch for the automatic second stage fuel valve(s) to open. Observe that the second stage lights off properly.
    d. Make burner adjustments for flame stability and input rating.
    e. Shut down the system by lowering the set point of the operating controller. Make sure the burner flame goes out and all automatic fuel valve(s) close.
19. Restart the system by closing the burner switch and/or raising the set point of the operating controller. Observe that the burner flame is established during PILOT IGN, within the normal lightoff time specified by the equipment manufacturer.
20. Measure the flame signal. Continue to check for the proper signal, see Table 5, through the RUN period. Any pulsating or unsteady readings will require further attention.
21. Make sure all readings are in the required ranges before proceeding.

NOTE: Upon completing these tests, open the master switch and remove all test jumpers from the subbase terminals, limits/control or switches.

22. Return the system to normal operation.

PILOT TURNDOWN TEST (All Installations using a Pilot)

Perform this check on all installations that use a pilot. The purpose of this test is to verify that the main burner can be lit by the smallest pilot flame that will hold in the flame amplifier and energize the FLAME LED. Clean the flame detector(s) to make sure that it will detect the smallest acceptable pilot flame. If using AMPLI-CHECK™ or Self-Checking Amplifier and 20 kohm/voltmeter, the flame signal will fluctuate every time the amplifier does a self-check or a shutter check.

NOTE: Low fuel pressure limits, if used, could be open. If so, bypass them with jumpers during this test.

1. Open the master switch.
2. Close the manual main fuel shutoff valve(s).
3. Connect a manometer (or pressure gauge) to measure pilot gas pressure during the turndown test.
4. Open the manual pilot shutoff valve(s).
5. Close the master switch and start the system with a *call for heat*. Raise the set point of the operating controller. The primary sequence should start and PREPURGE should begin.

NOTE: INTERMITTENT PILOT MODELS should continue with step 6. INTERRUPTED PILOT MODELS should proceed to step 7.

6. INTERMITTENT PILOT MODELS—After the sequence has entered the normal burner run period, turn pilot gas pressure down very slowly, reading the manometer (or gauge) as the pressure drops. Stop immediately when the FLAME LED goes out. Note the pressure at this point.

a. If the Flame Failure Action jumper *is not clipped*: allow the RM7895A,B to recycle through PREPURGE. If the Flame Failure Action jumper *is clipped*: push the reset pushbutton and allow the RM7895A,B to recycle through PREPURGE.
b. As the control attempts to relight the pilot, turn the pilot gas pressure back up slowly until the FLAME LED comes on. This step must be completed within 4 or 10 seconds, depending on the selected PFEP, or lockout will occur.
c. Turn the pilot back down slightly but not enough to cause the FLAME LED to go out. (Keep the pilot gas pressure just above the reading noted in step 6 above.)

NOTE: Step d requires two people, one to open the manual main fuel valve(s) and one to watch for ignition.

d. With the sequence in the normal burner run mode, make sure the automatic main fuel valve(s) is open. Smoothly open the manual main fuel shutoff valve(s) and watch for main burner lightoff.
e. If the main flame is not established within five seconds or the normal lightoff period specified by the burner manufacturer, close the manual main fuel shutoff valve(s) and open the master switch. Return to step 6. If the burner flame is established in the normal lightoff period, proceed to step 16.

7. INTERRUPTED PILOT MODELS—When the PILOT IGN begins, set the Run/Test Switch to TEST position to stop the sequence. The FLAME LED will come on when the pilot ignites.

NOTE: If the sequence does not stop, reset the system and make sure you set the Run/Test Switch to TEST within the first three or eight seconds of the PILOT IGN sequence.

IMPORTANT: *You have eight seconds or three seconds, depending on the PFEP selected, to position the Run/Test Switch in the TEST position to stop the sequence after the start of the PILOT IGN period.*

8. Turn the pilot pressure down very slowly, reading the manometer (or pressure gauge) as it will drop. Stop instantly when the FLAME LED goes out. Note the pressure at the RM7895 flame relay dropout point. The pilot is at the minimum turndown position. Immediately, turn up the pilot pressure until the FLAME LED comes on again.

NOTE: If there is no flame for fifteen seconds with the sequence stopped at this point, the RM7895 will lockout.

9. Repeat step 8 to verify the pilot gas pressure reading at the exact point the FLAME LED light goes out.

10. Increase the pilot pressure immediately until the FLAME LED comes on, and then turn it down slowly to obtain a pressure reading just above the dropout point.

NOTE: Step 11 requires two people—one to open the manual valve(s) and one to watch for ignition.

11. Set the Run/Test Switch in the RUN position and let the sequence proceed. At ten seconds into the Ignition Trial period, make sure the automatic main fuel valve(s) open; then smoothly open the manual main fuel shutoff valve(s) (or any other manually opened safety shutoff valve(s), if used) and watch for main burner ignition. If the main burner flame is established, proceed to step 16.

12. If the main burner flame is not established within five seconds, or within the normal lightoff time specified by the equipment manufacturer, close the manual main fuel shutoff valve(s) and open the master switch. If the lightoff was rough, the pilot flame size is too small.

13. Recycle the burner and stop the sequence in the PILOT IGN period by using the Run/Test Switch.

14. Increase the pilot flame size by increasing its fuel flow until a smooth main flame is accomplished.

15. Reposition the flame scanner sight tube or use orifices until the pilot flame signal voltage is approximately 1.25 - 1.50 Vdc.

16. When the main burner lights reliably with the pilot at turndown, disconnect the manometer (or pressure gauge) and turn the pilot gas flow up to that recommended by the equipment manufacturer.

17. If used, remove the bypass jumpers from the subbase terminals, limits/controls or switches.

18. Run the system through another cycle to check for normal operation.

19. Return the system to normal operation.

IGNITION INTERFERENCE TEST (All Flame Rods)

Test to be sure that a false signal from a spark ignition system is not superimposed on the flame signal.

Ignition interference can subtract from (decrease) or add to (increase) the flame signal. If it decreases the flame signal enough, it will cause a safety shutdown. If it increases the flame signal, it could cause the FLAME LED to come on when the true flame signal is below the minimum acceptable value.

Start the burner and measure the flame signal with both ignition and pilot (or main burner) on, and then with only the pilot (or main burner) on. Any significant difference (greater than .5 Vdc) indicates ignition interference.

TO ELIMINATE IGNITION INTERFERENCE

1. Be sure there is enough ground area.
2. Be sure the ignition electrode and the flame rod are on opposite sides of the ground area.
3. Check for correct spacing on the ignition electrode:
   a. 6,000V systems - 1/16 to 3/32 in. [1.6 to 2.4 mm].
   b. 10,000V systems - 1/8 in. [3.2 mm].

4. Make sure the leadwires from the flame rod and ignition electrode are not too close together.

5. Replace any deteriorated leadwires.

6. If the problem cannot be eliminated, the system may have to be changed to an ultraviolet or infrared flame detection system.

HOT REFRACTORY SATURATION TEST (All Infrared Detectors)

Test to be sure that radiation from hot refractory does not mask the flickering radiation of the flame itself.

Start the burner and monitor the flame signal during the warmup period. A decrease in signal strength as the refractory heats up indicates hot refractory saturation. If saturation is extreme, the flame signal will drop below 1.25 Vdc and the system will shut down as though a flame failure has occurred.

If hot refractory saturation occurs, the condition must be corrected. Add an orifice plate in front of the cell to restrict the viewing area, try to lengthen the sight pipe or decrease the pipe size (diameter). Continue adjustments until hot refractory saturation is eliminated.

HOT REFRACTORY HOLD-IN TEST (Rectifying Photocell or All Infrared Detectors)

Test to be sure hot refractory will not delay the flame detection system response to a flameout. This condition can delay response to flame failure and also can prevent a system restart as long as hot refractory is detected.

To check rectifying photocells for hot refractory hold-in, operate the burner until the refractory reaches its maximum temperature. Then terminate the firing cycle by lowering the set point of the operating controller or setting the Fuel Selector Switch to OFF. Do not open the master switch. Visually observe when the burner flame or FLAME LED goes out. If this takes longer than .8 or 3 seconds (depending on the FFRT of the amplifier), the photocell is sensing hot refractory. This condition must be corrected as described in the last paragraph of this test.

Infrared (lead sulfide) detectors can respond to infrared rays emitted by a hot refractory, even when the refractory has visibly ceased to glow. Infrared radiation from a hot refractory is steady, but radiation from a flame has a flickering characteristic. The infrared detection system responds only to flickering infrared radiation; it can reject a steady signal from hot refractory. The refractory steady signal can be made to fluctuate if it is reflected, bent or blocked by smoke or fuel mist within the combustion chamber. Be careful when applying an infrared system to verify its response to flame only.

To check infrared (lead sulfide) detectors for hot refractory hold-in, operate the burner until the refractory reaches its maximum temperature. If the installation has a multi-fuel burner, burn the heaviest fuel that is most likely to reflect, bend or obscure the hot refractory steady infrared radiation. When the maximum refractory temperature is reached, close all manual fuel shutoff valve(s) or open the electrical circuits of all automatic fuel valve(s). Visually observe when the burner flame or FLAME LED goes out. If this takes more than three seconds, the infrared detector is sensing hot refractory. Immediately terminate the firing cycle. Lower the set point to the operating controller, or set the Fuel Selector Switch to OFF. Do not open the master switch.

NOTE: Some burners continue to purge oil lines between the valve(s) and nozzle(s) even though the fuel valve(s) is closed. Terminating the firing cycle (instead of opening the master switch) will allow purging of the combustion chamber. This will reduce a buildup of fuel vapors in the combustion chamber caused by oil line purging.

If the detector is sensing hot refractory, the condition must be corrected. Add an orifice plate in front of the cell to restrict the viewing area of the detector. If this does not correct the problem, resight the detector at a cooler, more distant part of the combustion chamber. While resighting the detector, be aware that it must also properly sight the flame. When using infrared detector, try lengthening the sight pipe or decreasing the pipe size (diameter). For details, refer to the detector Instructions and the equipment Operating Manual. Continue adjustments until hot refractory hold-in is eliminated.

ULTRAVIOLET SENSOR, IGNITION SPARK RESPONSE TEST (All Ultraviolet Detectors)

Test to be sure that the ignition spark is not actuating the FLAME LED:

1. Close the pilot and main burner manual fuel shutoff valve(s).

2. Start the burner and run through the PILOT IGN period. Ignition spark should occur, but the flame signal should not be more than 0.5 Vdc and the FLAME LED should not turn on.

3. If the flame signal is higher than 0.5 Vdc and the FLAME LED does come on, consult the equipment Operating Manual and resight the detector further out from the spark, or away from possible reflection. It may be necessary to construct a barrier to block the ignition spark from the detector view. Continue adjustments until the flame signal due to ignition spark is less than 0.5 Vdc.

NOTE: The Honeywell Q624A Solid State Spark Generator will prevent detection of ignition spark when properly applied with the C7027, C7035 or C7044 Minipeeper Ultraviolet Flame Detectors. The Q624A is only for use with gas pilots.

RESPONSE TO OTHER ULTRAVIOLET SOURCES

Under certain conditions, an ultraviolet detector will respond to other ultraviolet sources as if it is sensing a flame. These ultraviolet sources include artificial light, such as incandescent or fluorescent bulbs, mercury and sodium vapor lamps or daylight. To check for proper detector operation, check the Flame Failure Response Time (FFRT) and conduct Safety Shutdown tests under all operating conditions.

FLAME SIGNAL WITH HOT COMBUSTION CHAMBER (All Installations)

After all initial start-up tests and burner adjustments are completed, operate the burner until the combustion chamber is at the maximum expected temperature. Observe the equipment manufacturer warmup instructions. Recycle the burner under these hot conditions and measure the flame signal. Check the pilot alone, the main burner flame alone, and both together (unless monitoring only the pilot flame when using an intermittent pilot, or only the main burner flame when using DSI).

Check the FFRT of the Flame Amplifier. Lower the set point of the operating controller and observe the time it takes for the burner flame to go out. This should be within .8 or 3 seconds maximum depending on the amplifier selected.

If the flame signal is too low or unsteady, check the flame detector temperature. Relocate the detector if the temperature is too high. If necessary, realign the sighting to obtain the proper signal and response time. If the response time is still too slow, replace the Plug-in Flame Signal Amplifier. If the detector is relocated or resighted, or the amplifier is replaced, repeat all required Checkout tests.

SAFETY SHUTDOWN TESTS (All Installations)

Perform these tests at the end of Checkout after all other tests have been completed. If used, the external alarm should turn on. Press the RM7895 reset pushbutton to restart the system.

1. Close the Airflow interlock during STANDBY for 120 seconds, (RM7895B,D).
2. Close the Airflow Interlock during PREPURGE, PILOT IGN, MAIN IGN or RUN period.
   a. Safety shutdown will occur if the Airflow ILK Switch Failure configuration jumper (JR3) is clipped.
3. Detect flame 40 seconds after entry to STANDBY. Detect flame 30 seconds during measured PREPURGE time.
   a. Simulate a flame to cause the flame signal voltage level to be at least 1.25 Vdc for 40 seconds after entry to STANDBY and also simulate a flame signal for 30 seconds during PREPURGE.
   b. Safety shutdown will occur.
4. Failure to ignite pilot.
   a. Close the pilot and main fuel manual shutoff valve(s).
   b. Depress the reset push button.
   c. Start the system.
   d. Automatic pilot valve(s) should be energized but the pilot cannot ignite.
   e. Safety shutdown will occur.
5. Failure to ignite main.
   a. Open the manual pilot valve(s); leave the main fuel manual shutoff valve(s) closed.
   b. Depress the reset push button.
   c. Start the system.
   d. Pilot should ignite and the flame signal should be at least 1.25 Vdc but the main burner cannot light.
   e. Close the manual pilot valve(s).
   f. Flame signal should drop below 1.25 Vdc within .8 or 3 seconds (depending on the FFRT of the amplifier) after the pilot goes out.
   g. Safety shutdown will occur.
6. Loss of flame during RUN.
   a. Open the main fuel manual shutoff valve(s). The manual pilot shutoff valve(s) must also be opened.
   b. Depress the reset push button.
   c. Start the system. Startup should be normal and the main burner should light normally.
   d. After the sequence is in the normal RUN period for at least ten seconds with the main burner firing, close the manual main and pilot fuel shutoff valve(s) to extinguish the main burner flame.
   e. The flame signal should drop below 1.25 Vdc within .8 or 3 seconds (depending on the FFRT of the amplifier) after the main flame goes out.
   f. Safety shutdown will occur.

IMPORTANT:

1. *If the RM7895 fails to shut down on any of these tests, take corrective action (refer to Troubleshooting, RM7895 diagnostics and return to the beginning of all Checkout tests).*
2. *When all Checkout tests have been completed, reset all switches to original states.*

Troubleshooting

RM7895 SYSTEM DIAGNOSTICS

Troubleshooting control system equipment failures is easier with the RM7895 self-diagnostics and first-out annunciation. In addition to an isolated spst alarm relay (audible annunciation), the RM7895 provides visual annunciation by displaying the ALARM LED.

Self-diagnostics of the RM7895 enable it to detect and annunciate both external and internal system problems. External faults such as interlock failures, flame failures and false flame signals are annunciated by the RM7895, which energizes the ALARM LED or by using the optional Keyboard Display Module. The 7800 SERIES provides a System Annunciation Diagnostics and Troubleshooting manual, form 65-0118.

The RM7895 provides diagnostic information to aid the service mechanic to obtain information when troubleshooting the system, see Table 6.

The optional Keyboard Display Module displays sequence status messages indicating: STANDBY, PRE-PURGE, PILOT IGN, MAIN IGN and RUN. The selectable messages also provide visual indication, current status and historical status of the equipment such as: Flame Signal, Total Cycles,

Total Hours, Fault History, Diagnostic Information and Expanded Annunciator Terminal Status (if used). With this information most problems can be diagnosed without extensive trial and error testing. Information available in the Diagnostic Information file includes: Device Type, Device Suffix, Software Revision, Manufacturing Code, Flame Amplifier Type, Flame Failure Response Time, Selectable Jumper Configuration Status, Run/Test Switch Status (RM7895C,D) and Terminal Status.

Diagnostic Information Index

The RM7895 with the optional Keyboard Display Module can monitor input/output terminals and can display the status of the terminal at the VFD (example; Pilot Valve T8 ON<), see S7800A1001 Keyboard Display Module Specifications. A complete terminal description and number are provided. The display will show the actual status of the terminal. If voltage is detected at the terminal, ON is displayed; but if no voltage is detected at the terminal, OFF is displayed.

Historical Information Index

The RM7895 has nonvolatile memory that allows the Relay Module to retain Historical Information for the six most recent lockouts. Each of the six lockout files retains the cycle when the fault occurred, the hour of operation when the fault occurred, and the fault message and burner status when the fault occurred. The Historical Information can be viewed by the optional S7800A1001 Keyboard Display Module Specifications.

SERVICE NOTE: A Lockout condition or restart of a RM7895 can be accomplished by pressing the reset push-button on the RM7895, or by pressing a remote reset pushbutton wired through an optional Keyboard Display Module, DATA CONTROLBUS MODULE™, Extension Cable Assembly or Remote Reset Module. A power-up reset will cause an electrical reset of the RM7895 but will not reset a lockout condition.

SERVICE NOTE: Remove the access slot covers on the sides of the Q7800A,B to check voltages.

CAUTION

Reinstall access slot covers on the Q7800A,B Subbase after performing voltage checks.

SERVICE NOTE: Maximum ambient operating temperature of a C7012E,F Series 1 through 6 will be reduced to 125° F because of the duty cycle operation of the RM7895 Relay Module.

TABLE 6—SEQUENCE AND STATUS HOLD INFORMATION.

NOTE: **Normal sequences** are in **bold type**, while abnormal sequences are not in bold type.

Sequence	Status
INITIATE	The LED indicates the burner status, POWER, which is a stabilization period for the RM7895 to check for any fluctuations in AC line voltage inputs or control input on power-up or during normal operation. The timing of the INITIATE period is ten seconds before entering STANDBY.
If the RM7895 is in a HOLD status, the following conditions could exist:	
INITIATE HOLD: (AC Frequency/Noise)	The LED indicates the burner status, POWER, and that it is waiting for excess line noise to clear up. The burner sequence will not advance into STANDBY until the excess line noise, which prevents sufficient reading of the line voltage inputs, ceases or a line frequency error is corrected (perhaps caused by using a 60 Hz device on a 50 Hz line, or vice versa).
INITIATE HOLD: (AC Line Dropout)	The LED indicates the burner status, POWER, and that AC Line power has momentarily dropped out. The burner sequence will not advance into STANDBY until the AC line voltage has stabilized throughout the INITIATE sequence.
INITIATE HOLD: (AC Frequency)	The LED indicates the burner status, POWER, and that line frequency is faster than the expected value. The burner sequence will not advance into STANDBY until the line frequency returns to the proper value (perhaps caused by using a 60 Hz device on a 50 Hz line).
INITIATE HOLD: (Low Line Voltage)	The LED indicates the burner status, POWER, and that low line voltage has occurred. The burner sequence will not advance into STANDBY until the line voltage is at a sufficient level for proper operating parameters.

(continued)

TABLE 6—SEQUENCE AND STATUS HOLD MESSAGES *(Continued)*

NOTE: **Normal sequences** are in **bold type**, while abnormal sequences are not in bold type.

Sequence	Status
STANDBY	The LED indicates the burner status, POWER. The burner can be placed in STANDBY by opening the burner switch or if the operating controller indicates its set point has been satisfied. If a demand is present for burner operation, the burner sequence will not advance from STANDBY to PURGE until the recycle limits close.
If the RM7895 is in a HOLD status, the following conditions could exist:	
STANDBY HOLD: F/G (Flame Detected)	The LEDs indicate the burner status, POWER and FLAME, and that a flame is detected. A demand is present for burner operation. The burner sequence will not advance to PREPURGE because a flame is detected as being present. The sequence will not advance to PREPURGE until the flame signal clears. If the flame signal does not clear within 40 seconds, the RM7895 will lockout.
STANDBY HOLD: T7 (Airflow Interlock)	The LED indicates the burner status, POWER, and that the Air-flow Interlock is closed. A demand is present for burner operation and the burner sequence will not advance to PREPURGE until the Airflow Interlock proves open. If this time exceeds the 120 second hold, the RM7895B,D will lockout.
PURGE	The LED indicates the burner status, POWER, and that it is the period of time before ignition during which time the blower motor is running. The timing of the PURGE period is selectable.
If the RM7895 is in a HOLD condition, the following conditions could exist:	
PURGE HOLD: TEST (Run/Test Switch)	The LED indicates the burner status, POWER, and that the Run/Test Switch is in the TEST position. The sequence will not continue until the Run/Test Switch is placed in the RUN position (RM7895C,D).
PURGE HOLD: F/G (Flame Detected)	The LEDs indicate the burner status, POWER and FLAME, and that a flame is detected. The burner sequence will not advance through PREPURGE because a flame is detected as being present. The sequence will hold waiting for the flame signal to clear. If the time exceeds 30 seconds, the RM7895 will lockout.
PURGE HOLD: T7 (Airflow Interlock)	The LED indicates the burner status, POWER, and that the Air-flow Interlock is not closed. The sequence will not advance to ignition until the Airflow Interlock proves closed. If this time exceeds a 30 second HOLD, the RM7895 will lockout.
PILOT IGN	The LEDs indicate the burner status, POWER, PILOT and FLAME, which is the period of time the RM7895 permits the pilot valve to be open and the pilot flame to be established.
If the RM7895 is in a HOLD status, the following condition could exist:	
PILOT HOLD: TEST (Run/Test Switch)	The LEDs indicate the burner status, POWER, PILOT and FLAME, and that the Run/Test Switch is in the TEST position. The sequence will not continue until the Run/Test Switch is placed in the RUN position (RM7895C,D).
MAIN IGN	The LEDs indicate the burner status, POWER, PILOT, FLAME and MAIN, which is the period of time the RM7895 permits the main valve to be open and the main flame to be established.
RUN	The LEDs indicate the burner status, POWER, PILOT, FLAME and MAIN, which is the period of time after the Ignition Trials and before the operating controller set point is reached. During this time, the burner is firing under the control of the operating controller (RM7895A,B).

(continued)

TABLE 6—SEQUENCE AND STATUS HOLD MESSAGES *(Continued)*

Sequence	Status
RUN	The LEDs indicate the burner status, POWER, FLAME and MAIN, which is the period of time after the Ignition Trials and before the operating controller set point is reached. During this time, the burner is firing under the control of the operating controller (RM7895C,D).
RESET/ALARM TEST	The LED indicates the burner status, POWER and ALARM. This condition indicates the reset push button is pressed. If it is held for more than four seconds, the alarm output is energized. The alarm output will be de-energized after the reset pushbutton is released.

SIEMENS

For replacement parts information or an application guide, visit our website at www.sea.siemens.com or contact your local Siemens sales office.

Instructions

February, 2003
Supersedes Issue of
December, 1999

IMPORTANT

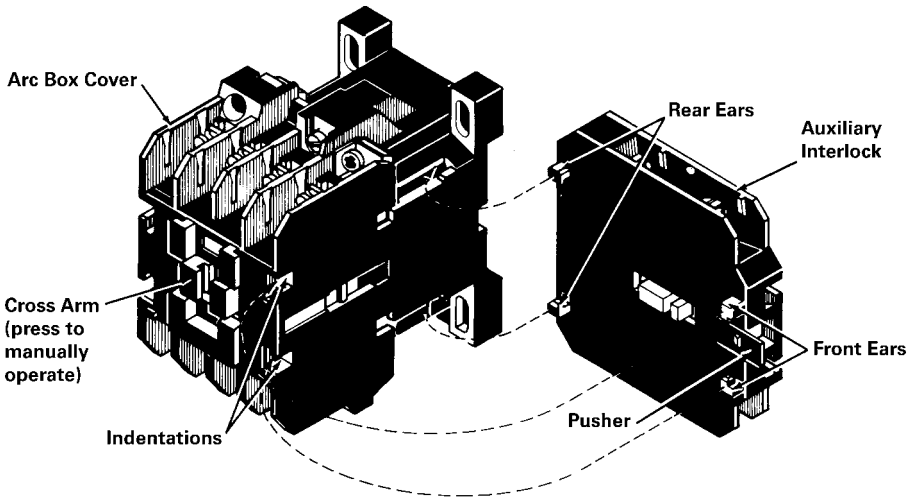
THESE INSTRUCTIONS DO NOT PURPORT TO COVER ALL DETAILS OR VARIATIONS IN EQUIPMENT, NOR TO PROVIDE FOR EVERY POSSIBLE CONTINGENCY TO BE MET IN CONNECTION WITH INSTALLATION, OPERATION OR MAINTENANCE. SHOULD FURTHER INFORMATION BE DESIRED OR SHOULD PARTICULAR PROBLEMS ARISE WHICH ARE NOT COVERED SUFFICIENTLY FOR THE PURCHASER'S PURPOSES, THE MATTER SHOULD BE REFERRED TO THE LOCAL SIEMENS SALES OFFICE.

THE CONTENTS OF THIS INSTRUCTION MANUAL SHALL NOT BECOME PART OF OR MODIFY ANY PRIOR OR EXISTING AGREEMENT, COMMITMENT OR RELATIONSHIP. THE SALES CONTRACT CONTAINS THE ENTIRE OBLIGATION OF SIEMENS. THE WARRANTY CONTAINED IN THE CONTRACT BETWEEN THE PARTIES IS THE SOLE WARRANTY OF SIEMENS. ANY STATEMENTS CONTAINED HEREIN DO NOT CREATE NEW WARRANTIES OR MODIFY THE EXISTING WARRANTY.

49-HACRO

Side Mount Auxiliary Interlock
US/15 Controller Sizes B-E, Q
Class 15, 21, 23, 24
Cat No 49ACRO, C, 6, 7, 8

Listed Ind Cont Eq A163



Description

The side mounted auxiliary is a snap on single or multiple pole contact assembly. Each controller can accommodate 2 interlocks, one on each side.

Use with Series B, Class 15, 21, 23, and 24 controller sizes B-E, Q

49ACRO - 1 NO
49ACRC - 1 NC
49ACR7 - 2 NO
49ACR6 - 1 NO & 1NC
49ACR8 - 2 NC

Rating: NEMA A600, 10 Amps AC
NEMA P600, 5 Amps DC

⚠WARNING

Hazardous voltage.
Can cause death, serious personal injury, or property damage.

Disconnect power before working on this equipment.

Installation

The auxiliary interlock can be installed on either side of the controller.

1. Tag and remove wires from the line and load terminals. For a starter, remove the overload relay at the contactor load terminals.
2. Place your thumb over the pusher and slide the interlock assembly onto the contactor so that the rear ears are engaged in the slots on the contactor base. The rear ears must first be positioned on the base for proper assembly and operation of the interlock.
3. The front ears should then properly align with the indentations on the top side of the controller and snap into place.
4. Manually operate the controller by pressing and releasing the cross arm. In the released position, the front surface of the interlock pusher will be approximately flush with the top surface of the interlock housing.
5. Connect any removed wires. For a starter, assemble the overload relay to the contactor load terminals. Terminal power screw minimum tightening torque is 20 inch-pounds.
6. Wire the interlock as required for installation.
7. To remove the interlock from the controller, compress the black nib near the pusher assembly and lift the interlock away from the controller.

(For Engineering Reference Only - Rev. D)

Overview

for Non-Fusible Disconnect Switches
CDNF16 – CDNF160

CDNF16 CDNF25 CDNF32

CDNF30 CDNF60 CDNF100

CDNF160

Catalog number	3 pole	CDNF16	CDNF25	CDNF32	CDNF45	CDNF63	CDNF30	CDNF60	CDNF100	CDNF160
General purpose amp rating	**A**	**16**	**25**	**40**	**60**	**80**	**30**	**60**	**100**	**125**
Approvals①										
	2 pole	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UL98
	3 pole	UL508	UL508	UL508	UL508	UL508	UL98	UL98	UL98	UL98
	4 pole	UL508	UL508	UL508	UL508	UL508	UL98	UL98	UL98	UL98
Technical ratings UL,CSA②										
Max operating voltage	V	600	600	600	600	600	600	600	600	600
Max horsepower rating Three phase										
200 – 208V	HP	3	7.5	10	15	20	10	20	25	—
240V	HP	5	7.5	10	15	20	10	20	25	30
480V	HP	10	15	20	30	40	20	40	50	60
600V	HP	10	20	25	20	40	30	40	40	75
Single phase										
120V	HP	1/2	3/4	1	2	2	2	3	5	7.5
240V	HP	1.5	2	3	5	5	5	7.5	15	20
Technical ratings IEC②										
Rated insulation and operational voltage. AC20 and DC20③	V	750	750	750	750	750	750	750	750	750
Rated thermal current, I_{th}										
AC 20/DC 20 open	A	25	32	40	63	80	40	63	115	200
AC 20/DC 20 enclosed	A	25	32	40	63	80	40	63	115	160
AC 21A 500V	A	16	25	32	63	80	40	63	100	160
690V	A	16	25	32	63	80	40	63	100	160
Rated operational power AC23										
400/415V	kW	7.5	9	11	22	37	15	18.5	37	75
690V	kW	7.5	9	11	15	18.5	15	15	37	75
Physical characteristics										
Weight④ 3 pole	lb	0.24	0.24	0.24	0.59	0.59	0.79	0.79	0.79	2.42
Dimension 3 pole H	in	2.68	2.68	2.68	3.60	3.60	3.94	3.94	3.94	5.00
W	in	1.38	1.38	1.38	2.07	2.07	2.76	2.76	2.76	4.96
D	in	2.20	2.20	2.20	2.85	2.85	2.95	2.95	2.95	2.93
Accessories										
Terminal lug kit		Integral	Integral	Integral	Integral	Integral	Integral	Integral	Integral	integral
Terminal shroud		•	•	•	•	•	•	•	•	•
Auxiliary contact		•	•	•	•	•	•	•	•	•
Handle UL/NEMA type										
Type 1, 3R, 12		•	•	•	•	•	•	•	•	•
Type 1, 3R, 4, 4X, 12		•	•	•	•	•	•	•	•	•
Handle type										
Selector		•	•	•	•	•	—	—	—	—
Pistol		•	•	•	•	•	•	•	•	•
Conversion kits										
6 pole		•	•	•	•	•	•	•	•	•
Transfer		•	•	•	•	•	•	•	•	•
Bypass		•	•	•	•	•	•	•	•	•
Mechanical interlock		•	•	•	•	•	•	•	—	•
Electrical interlock		—	—	—	—	—	—	—	—	—

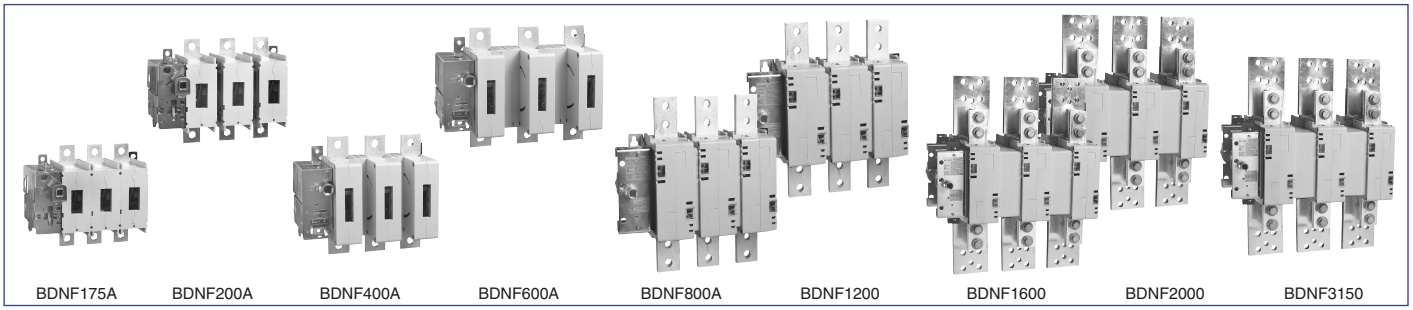
• = Available
— = Not available

UL listed, CSA approved, IEC rated, CE marked

① UL listed switches are also CSA approved.
② For complete technical information please see page 58 & 59.
③ 1000V, IEC 408.
④ Switch only

for Non-Fusible Disconnect Switches

BDNF200A – BDNF3150



BDNF175A BDNF200A BDNF400A BDNF600A BDNF800A BDNF1200 BDNF1600 BDNF2000 BDNF3150

Catalog number	3 pole	BDNF175A	BDNF200A	BDNF400	BDNF600A	BDNF800A	BDNF1200	BDNF1600	BDNF2000	BDNF3150
General purpose amp rating	**A**	**175**	**200**	**400**	**600**	**800**	**1200**	**1600**	**2000**	**3150**
Approvals①										
	2 pole	UL508 & IEC	UL98 & IEC	UL98 & IEC	UL98 & IEC	UL98 & IEC	UL98 & IEC	UL98 & IEC	UL98 & IEC	IEC
	3 pole	UL508 & IEC	UL98 & IEC	UL98 & IEC	UL98 & IEC	UL98 & IEC	UL98 & IEC	UL98 & IEC	UL98 & IEC	IEC
	4 pole	IEC	IEC	UL98 & IEC	UL98 & IEC	IEC	IEC	IEC	IEC	IEC
Technical ratings UL,CSA②										
Max operating voltage	V	600	600	600	600	600	600	600	600	600
Max horsepower rating Three phase										
200 – 208V	HP	30	60	100	150	200	—	—	—	—
240V	HP	40	75	125	200	250	—	—	—	—
480V	HP	75	150	250	400	500	—	—	—	—
600V	HP	100	200	350	500	600	—	—	—	—
Single phase										
120V	HP	—	—	—	—	—	—	—	—	—
240V	HP	—	—	—	—	—	—	—	—	—
Technical ratings IEC②										
Rated insulation and operational voltage. AC20 and DC20③	V	1000	1000	1000	1000	1000	1000	1000	1000	1000
Rated thermal current, I_{th}										
AC 20/DC 20 open	A	200	315	630	800	1250	1600	2500	2500	3150
AC 20/DC 20 enclosed	A	200	270	630	720	1250	1600	2300	2300	2600
AC 21A 500V	A	200	250	630	800	1250	1600	2500	2500	3150
690V	A	200	250	630	800	1250	1600	2500	2500	3150
Rated operational power AC23										
400/415V	kW	90	132	315	355	400	400	400	400	400
690V	kW	170	200	355	355	—	—	—	—	—
Physical characteristics										
Weight ④ 3 pole	lb	6.61	6.61	13.66	13.66	35.9	38.55	127.7	127.7	127.7
Dimension 3 pole H	in	8.35	8.35	11.81	11.77	19.09	19.09	25.04	25.04	25.04
W	in	7.83	8.62	10.24	11.93	14.29	14.29	18.43	18.43	18.43
D	in	4.55	4.55	5.12	5.12	4.92	4.92	10.67	10.67	10.67
Accessories										
Terminal lug kit		BDTL25	BDTL25	BDTL26	BDTL27	BDTL30	BDTL28	BDTL28	BDTL28/2	BDTL28/2
Terminal shroud		•	•	•	•	•	•	—	—	—
Auxiliary contact		•	•	•	•	•	•	•	•	•
Handle UL/NEMA type										
Type 1, 3R, 12		•	•	•	•	•	•	•	•	•
Type 1, 3R, 4, 4X, 12		•	•	•	•	•	•	•	•	•
Handle type										
Selector		—	—	—	—	—	—	—	—	—
Pistol		•	•	•	•	•	•	•	•	•
Conversion kits										
6 pole		•	•	•	•	•	•	—	—	—
Transfer		•	•	•	•	•	•	—	—	—
Bypass		•	•	•	•	•	•	—	—	—
Mechanical interlock		•	•	•	•	•	•	•	•	•
Electrical interlock		•	•	•	•	•	•	•	•	•

S = Standard feature
• = Available
— = Not available

UL listed, CSA approved, IEC rated, CE marked

① UL listed switches are also CSA approved.
② For complete technical information please see page 58 & 59.
③ 1000V, IEC 408.
④ Switch only

for Non-Fusible Disconnect Switches
Base & DIN Rail Mounted

For a complete assembly, please select one of each:

1 switch
1 handle
1 shaft


CDNF63

+


CDS85S

+


CDH3S

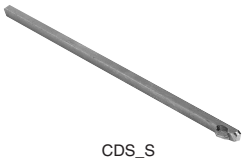

CDNF16
CDNF25
CDNF32


CDNF30
CDNF60
CDNF100


CDH1S


CDH15S


CDH6S


CDS_S

16 – 100 Amp switches, 600V, 3 pole①

UL general purpose amp rating	IEC AC21 amp rating	Maximum horsepower rating						Terminal lugs		Catalog number
		Single phase		Three phase						
		120V	240V	200V	240V	480V	600V	Wire size	Wire type	
16	16	1/2	1.5	3	5	10	10	#18 – 8	Cu	CDNF16
25	25	3/4	2	7.5	7.5	15	20	#18 – 8	Cu	CDNF25
40	40	1	3	10	10	20	25	#18 – 8	Cu	CDNF32
60	63	2	5	15	15	30	20	#14 – 4	Cu	CDNF45
80	80	2	5	20	20	40	40	#14 – 1	Cu	CDNF63
30	40	2	5	10	10	20	30	#14 – 4	Cu	CDNF30
60	63	3	7.5	20	20	40	40	#14 – 4	Cu	CDNF60
100	115	5	15	25	25	50	40	#8 – 1/0	Cu	CDNF100

Selector handles — for use with shafts □ .20 x .20" (□ 5x5mm)

NEMA type	IEC type	Color	Defeatable	Padlockable	Weight (lbs)	Catalog number
All marked both O/I & Off/On						
1	IP54	Black	—	—	0.09	CDH1S②
1	IP54	Red/Yel	—	—	0.09	CDH2S②
1	IP54	Black	—	Yes	0.12	CDH15S②
1	IP54	Red/Yel	—	Yes	0.12	CDH16S②
1,3R,12	IP65	Black	—	Yes	0.16	CDH3S
1,3R,12	IP65	Red/Yel	—	Yes	0.16	CDH4S
1,3R,12	IP65	Black	Yes	Yes	0.16	CDH5S
1,3R,12	IP65	Red/Yel	Yes	Yes	0.16	CDH6S

Shafts — for use with CDH selector handles □ .20 x .20" (□ 5x5mm)

Shaft length inches/mm	Mounting depth③ in inches					Weight (lbs)	Catalog number
	CDNF16 CDNF25 CDNF32		CDNF45 CDNF63		CDNF30 CDNF60 CDNF100		
	CDH1S, CDH2S CDH15S, CDH16S	CDH3S, CDH4S CDH5S, CDH6S	CDH1S, CDH2S CDH15S, CDH16S	CDH3S, CDH4S CDH5S, CDH6S	CDH3S, CDH4S CDH5S, CDH6S		
3.3/85	4.2 – 5.0	3.6 – 4.3	4.9 – 5.6	4.4 – 5.0	3.9 – 4.9	0.04	CDS85S
4.1/105	5.0 – 5.8	4.4 – 5.1	5.7 – 6.4	5.1 – 5.8	4.7 – 5.7	0.04	CDS105S
4.7/120	5.6 – 6.4	5.0 – 5.8	6.3 – 7.0	5.7 – 6.4	5.3 – 6.3	0.05	CDS120S
5.1/130	6.0 – 6.7	5.4 – 6.1	6.7 – 7.4	6.1 – 6.8	5.6 – 6.7	0.05	CDS130S
7.1/180	7.1 – 8.7	7.4 – 8.1	8.6 – 9.4	8.1 – 8.7	7.6 – 8.6	0.08	CDS180S
9.8/250	10.7 – 11.5	10.1 – 10.8	11.4 – 12.1	10.9 – 11.5	10.4 – 11.4	0.10	CDS250S
13/330	13.8 – 14.6	13.3 – 14.0	14.6 – 15.3	14.0 – 14.7	13.5 – 14.5	0.14	CDS330S

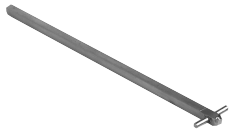
① A snap on fourth pole may be added
② Not suitable for use with CDNF30, 60, 100.
③ Mounting depth is the distance from the outside of door to the disconnect switch mounting plate. Shaft can be cut to desired length.

for 16A – 100A Non-Fusible Disconnect Switches

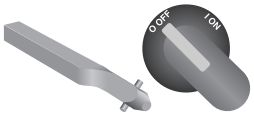
Base & DIN Rail Mounted

BDH104, 6

BDH105



CDS_P



CDS_T

OPMRH

CDBY68306

CDBY68419/1

CDMC1

Pistol handles — for use with shafts □ .20 x .20" (□ 5 x 5 mm)

NEMA type	IEC type	Color	Marking	Length inches/mm	Defeatable	Padlockable	Weight (lbs.)	Catalog number
1,3R,12	IP65	Black	O/I & Off/On	1.8/45	Yes	Yes	0.28	BDH104
1,3R,12	IP65	Red/Yel	O/I & Off/On	1.8/45	Yes	Yes	0.28	BDH105
1,3R,12	IP65	Black	O/I & Off/On	2.6/65	Yes	Yes	0.29	BDH106
1,3R,12	IP65	Red/Yel	O/I & Off/On	2.6/65	Yes	Yes	0.29	BDH107
1,3R,12,4,4X	IP66	Black	O/I & Off/On	2.6/65	Yes	Yes	0.29	CDHXB65
1,3R,12,4,4X	IP66	Red/Yel	O/I & Off/On	2.6/65	Yes	Yes	0.29	CDHXY65

Shafts — for use with pistol handles □ .20 x .20" (□ 5 x 5 mm)

Shaft length (inches/mm)	Mounting depth① in inches: CDNF16 CDNF25 CDNF32	CDNF45 CDNF63	CDNF30 CDNF60 CDNF100	Weight (lbs.)	Catalog number
5.9/150	6.2 – 6.7	6.9 – 7.4	6.4 – 7.4	0.07	CDS48P
6.7/170	7.0 – 7.5	7.7 – 8.1	7.2 – 8.1	0.08	CDS67P
10.4/265	10.7 – 11.3	11.4 – 11.9	10.9 – 11.9	0.12	CDS49P
15.8/400	16.0 – 16.6	16.8 – 17.2	16.2 – 17.2	0.18	CDS50P
19.7/500	20.0 – 20.5	20.7 – 21.1	20.1 – 21.1	0.23	CDS99P

Twisted shafts — Rotates handle 45° □ .20 x .20" (□ 5 x 5 mm)

Shaft length (inches/mm)	Mounting depth① in inches: CDNF16 CDNF25 CDNF32	CDNF45 CDNF63	CDNF30 CDNF60 CDNF100	Weight (lbs.)	Catalog number
5.9/150	6.2 – 6.7	6.9 – 7.4	6.4 – 7.4	0.07	CDS48T
6.7/170	7.0 – 7.5	7.7 – 8.1	7.2 – 8.1	0.08	CDS67T
10.4/265	10.7 – 11.3	11.4 – 11.9	10.9 – 11.9	0.12	CDS49T
15.8/400	16.0 – 16.6	16.8 – 17.2	16.2 – 17.2	0.18	CDS50T

Replacement knob — mounts directly to switch; no shaft necessary

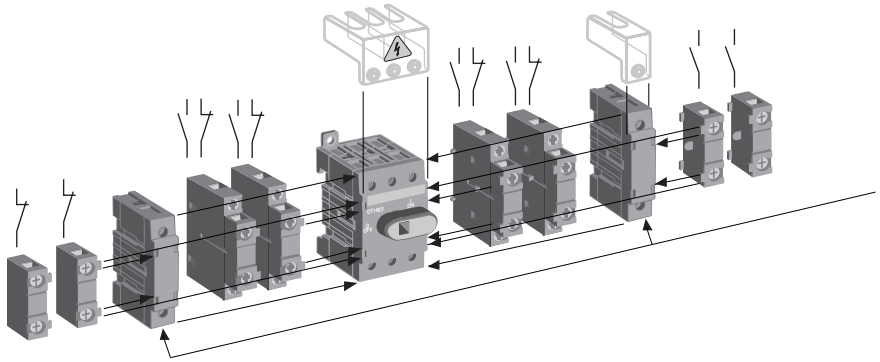
NEMA Type	Color	For use on:	Length (inches)	Padlockable	Catalog number
1	Red	CDNF16, 25, 32	1.0	—	OPMRH
1	Red	CDNF30, 45, 60, 63,100	1.4	—	CDBY68306③
1	Red	CDNF30, 45, 60, 63,100	1.6	Yes②	CDBY68419/1③
Metal collar		CDNF16 – CDNF100	—	—	CDMC1
Set screw		CDNF16, 25, 30, 32, 45, 60, 63, 100	—	—	CDSWM5X8

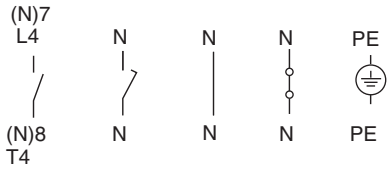
① Mounting depth is the distance from the outside of door to the disconnect switch mounting plate. Shaft can be cut to desired length.
② .1875" (3/16") diameter shackle required.
③ Set screw CDSWM5X8 needed with replacement knobs CDBY__.

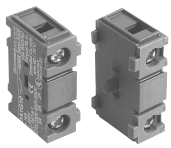
for 16A – 100A Non-Fusible Disconnect Switches

Base & DIN Rail Mounted

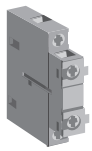
Base and DIN rail mounted switches



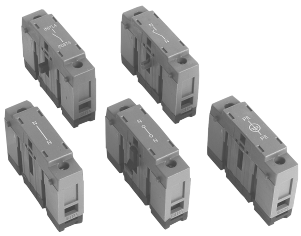




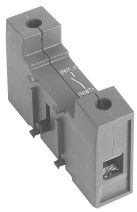
CDAUX__



CDAUX11



CD_32P



CD_63P

CD_125P

Auxiliary contacts① — snap-on mounting

Description	For use on:	Weight (lbs.)	AC thermal amp rating	AC rated voltage	Catalog number
1 N.O. mounts on right hand side of switch only	CDNF16 – CDNF100	0.07	10	600	CDAUX10
1 N.C. mounts on left hand side of switch only	CDNF16 – CDNF100	0.07	10	600	CDAUX01
1 N.O. + 1 N.C. mounts on left or right hand side of switch	CDNF16 – CDNF100	0.07	10	600	CDAUX11

Max. two contacts on each side of switch

Power poles

- **Only one power pole per switch**
- **Mounts on left or right side of switch**

Description	For use on:	Weight (lbs.)	AC thermal amp rating	AC rated voltage	Catalog number
(N)7 L4 / (N)8 T4 — Fourth pole②	CDNF16 – CDNF100	0.07 0.13 0.31	40 80 100	600 600 600	CDS32P CDS63P CDS125P
N / N — Late-break/early-make②	CDNF16 – CDNF100	0.07 0.13 0.31	40 80 100	600 600 600	CDL32P CDL63P CDL125P

Terminal poles

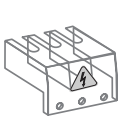
- **Switch accepts one terminal pole per side**
- **Mounts on left or right side of switch**

Description	For use on:	Weight (lbs.)	AC thermal amp rating	AC rated voltage	Catalog number
N / N — Solid neutral②	CDNF16 – CDNF100	0.07 0.13 0.31	40 80 100	600 600 600	CDN32P CDN63P CDN125P
N / N — Detachable neutral②	CDNF16 – CDNF100	0.07 0.13 0.31	40 80 100	600 600 600	CDD32P CDD63P CDD125P
PE / PE — Ground terminal②	CDNF16 – CDNF100	0.07 0.13 0.31	40 80 100	600 600 600	CDE32P CDE63P CDE125P

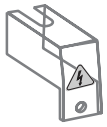
① UL File # E83510
② Switch accepts one power pole or one terminal pole per side. Only one power pole per switch.

for 16A – 100A Non-Fusible Disconnect Switches

Base & DIN Rail Mounted



CDTS__T3



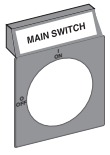
CDTS__T1

CDSA1

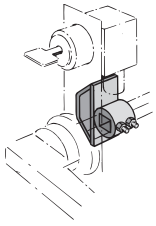
CDSA2

CDTL-ST

CDP__2



CDP__2EN1



CDETL-ZW16

NDNA100
NDNA200

Terminal shrouds* — snap on mounting for line or load side

Description	For use on:	Weight (lbs.)		Catalog number
3 pole includes one shroud for line or load side	CDNF16, CDNF25, CDNF32, CDNF45, CDNF63, CDNF30, CDNF60, CDNF100	0.02 0.02 0.02		CDTS32T3 CDTS63T3 CDTS125T3
4th pole includes one shroud for line or load side	CD_32P CD_63P CD_125P	0.02 0.02 0.02		CDTS32T1 CDTS63T1 CDTS125T1

* All disconnects are IP20 touch safe as standard. Terminal shrouds provide an additional level of protection.

Padlocking adapter

Description	For use on:	Weight (lbs.)		Catalog number
Adapter for one padlock with a max. 0.137" shackle	CDNF30, CDNF45 CDNF60, CDNF63 CDNF100	0.02		CDSA1
Padlock for DS-SA1		0.22		CDSA2
Adapter and padlock		0.24		CDSA3

Labelling accessories

Description	For use on:		Package quantity	Catalog number
1 Pkg. of label carriers	CDNF30, CDNF45 CDNF60, CDNF63 CDNF100		100 pieces	CDTL-ST
1 Pkg of blank description labels			315 pieces	CDT-E

Legend plates for selector handles

Description	For use on:			Catalog number
Blank plate Black Yellow	CDH15, 25, 75, 85, 115, 125 155, 165, 175, 185, 195, 205			CDPB1 CDPY1
Black Yellow	CDH35, 45, 55, 65, 95, 105, 135, 145			CDPB2 CDPY2
Plate marked with: MAIN SWITCH Black Yellow	CDH15, 25, 75, 85, 115, 125 155, 165, 175, 185, 195, 205			CDPB1EN1 CDPY1EN1
Black Yellow	CDH35, 45, 55, 65, 95, 105, 135, 145			CDPB2EN1 CDPY2EN1

Locking accessories

Description	For use on:	Weight (lbs.)		Catalog number
Cam attachment for Kirk Key, Castell, Lowe & Fletcher and Ronis interlock. For adapting to the interlock system. The interlock is not included.	5, 6 & 8mm shafts	0.29		CDETL-ZW16

DIN rail

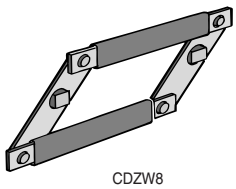
Description	For use on:	Weight (lbs.)	Length inches/mm	Catalog number
35mm DIN Rail	CDNF16 – CDNF100	.38	39.4/1000	NDNA100
35mm Aluminum DIN Rail	CDNF16 – CDNF100	.75	78.8/1000	NDNA200

Shaft support

Description	For use on:	Weight (lbs.)		Catalog number
Shaft support	CDNF16 – CDNF100	0.30		CDTL-ZX58

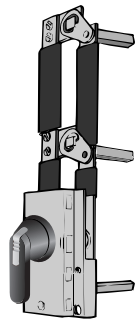
for 16A – 100A Non-Fusible Disconnect Switches

Base & DIN Rail Mounted

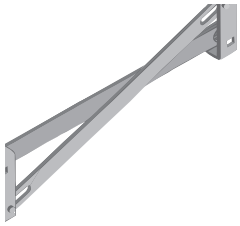


CDZW8

CDZW6



CDZW17



CDZW24

Conversion mechanisms

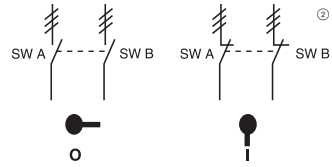
- **For use with Base and DIN rail mounted switches only**
- **Switches are not included**

Description	For use on:	Weight (lbs.)		Catalog number
6 or 8 pole	CDNF16 – CDNF100	0.33		CDZW8
Transfer		1.87		CDZW6
Bypass		1.54		CDZW17

6 or 8 pole — CDZW8

6 (8) pole mechanism allows two switches controlled by one handle to open or close simultaneously.
Equipment required for a complete installation:

- One conversion mechanism
- Two disconnect switches
- One handle①
- One 5mm shaft



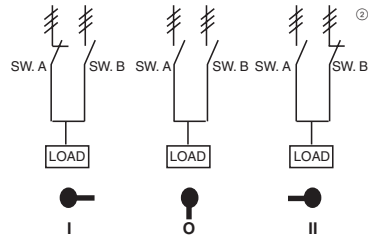
	POS. O	POS. I
SW. A	O	X
SW. B	O	X

X = Closed
O = Open

Transfer — CDZW6

Transfer mechanism manually transfers between two power sources using two switches and a center OFF position.
A 3-position handle is included:
(UL Type 1, 3R & 12) or
(UL Type 1, 3R, 4, 4X, 12)
Shafts included. Equipment required for a complete installation:

- One conversion mechanism
- Two disconnect switches



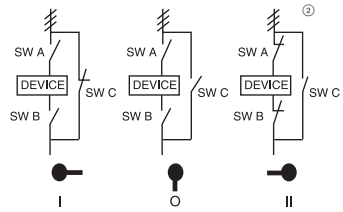
	POS. I	POS. O	POS. II
SW. A	X	O	O
SW. B	O	O	X

X = Closed
O = Open

Bypass — CDZW17

Bypass mechanism operates three switches: Two switches in series and one changeover switch to allow power bypass.
A 3-position handle is included:
(UL Type 1, 3R & 12) or
(UL Type 1, 3R, 4, 4X, 12) Shafts included.Equipment required for a complete installation:

- One conversion mechanism
- Three disconnect switches



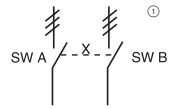
	POS. I	POS. O	POS. II
SW. A	O	O	X
SW. B	O	O	X
SW. C	X	O	O

X = Closed
O = Open

Mechanical interlock — CDZW24

Mechanical interlock mechanism prevents both switches from being in the ON position at the same time.
Equipment required for a complete installation:

- One conversion mechanism
- Two disconnect switches
- Two handles
- Two shafts



	SW. A POS. I	SW. B POS. I
SW. A	X	O
SW. B	O	X

X = Closed
O = Open

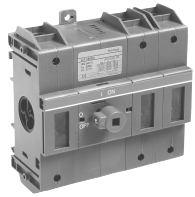
① CDNF16 – CDNF32 can use a selector or pistol handle. All other sizes must use a pistol handle.

② = Three poles

Non-Fusible Disconnect Switches

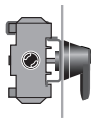
For a complete assembly, please select one of each:

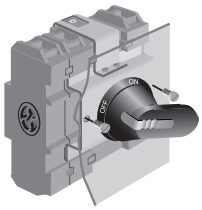
1 switch
1 handle
1 shaft


CDNF160


BDS210


BDH60

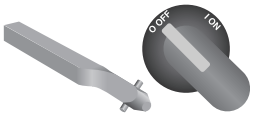



CDNF160D


BDH60


BDH61


BDS__


BDST__

125 Amp Base & DIN rail mounted switches①, 600V

UL general purpose amp rating	IEC AC21 amp rating	Maximum horsepower rating					Terminal lugs		Catalog number
		Three phase							
		200V	208V	240V	480V	600V	Wire size	Wire type	
2 pole									
125	160	—	—	—	—	—	#8 – 1/0	Cu	CDNF160-2
3 pole									
125	160	30	30	30	60	75	#8 – 1/0	Cu	CDNF160

125 Amp Door mounted switch①, 600V, 3 pole

UL general purpose amp rating	IEC AC21 amp rating	Maximum horsepower rating					Terminal lugs		Catalog number
		Three phase							
		200V	208V	240V	480V	600V	Wire size	Wire type	
125	160	30	30	30	60	75	#8 – 1/0	Cu	CDNF160D

Pistol handles — for use with □ .24 x .24" (□ 6 x 6 mm)

NEMA type	IEC type	Color	Length in/mm	Marking	Defeat-able	Padlock-able	Weight (lbs)	Catalog number
1, 3R, 12	IP65	Black	2.6/65	O/I & Off/On	Yes	Yes	0.29	BDH58
1, 3R, 12	IP65	Red/Yel	2.6/65	O/I & Off/On	Yes	Yes	0.29	BDH59
1, 3R, 12	IP65	Black	3.1/80	O/I & Off/On	Yes	Yes	0.30	BDH60
1, 3R, 12	IP65	Red/Yel	3.1/80	O/I & Off/On	Yes	Yes	0.30	BDH61
1, 3R, 4, 4X, 12	IP66	Black	3.1/80	O/I & Off/On	Yes	Yes	0.30	CDHXB86
1, 3R, 4, 4X, 12	IP66	Red/Yel	3.1/80	O/I & Off/On	Yes	Yes	0.30	CDHXY86

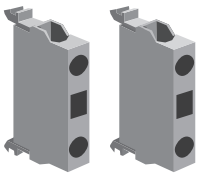
Shafts — for use with pistol handles □ .24 x .24" (□ 6 x 6 mm)

Shaft length inches/mm	H	Mounting depth② in inches	Weight (lbs)	Catalog number
5.2/130		4.3 – 6.0	0.08	BDS130
5.9/150		5.0 – 6.7	0.09	BDS150
8.3/210		7.4 – 9.1	0.13	BDS210
11.4/290		10.5 – 12.2	0.18	BDS290
14.2/360		13.3 – 15.0	0.23	BDS360
16.9/430		16.0 – 17.8	0.27	BDS430

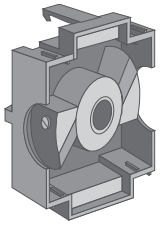
Twisted shafts — Rotates handle 45° □ .24 x .24" (□ 6 x 6 mm)

Shaft length inches/mm	H	Mounting depth② in inches	Weight (lbs)	Catalog number
5.2/130		4.3 – 6.0	0.08	BDST4
8.3/210		7.4 – 9.1	0.13	BDST25
11.4/290		10.5 – 12.2	0.18	BDST29
14.2/360		13.3 – 15.0	0.23	BDST30

① A snap on fourth pole may be added
② Mounting depth is the distance from the outside of the door to the disconnect switch mounting plate. Shaft can be cut to desired length.

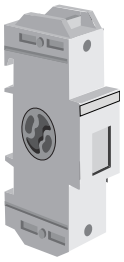


CDAUXCA10 CDAUXCA01

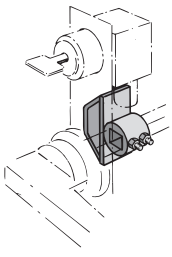


CDAUXB160

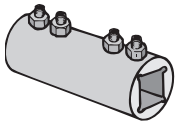
CDAUX16011 CDMB160



CD_160P



CDETL-ZW16



BDZX167
BDZX95

Auxiliary contacts, top mounted

- Accepts four contacts maximum, mounting base always required

Description	For use on:	Weight (lbs)	AC thermal amp rating	AC rated voltage	Catalog number
1 N.O.	CDNF160	0.07	10	600	CDAUXCA10
1 N.C.			10	600	CDAUXCA01
1 N.O. gold plated①	CDNF160	0.07	10	600	CDEA-10AU
1 N.C. gold plated①			10	600	CDEA-01AU
Mounting base – required for CDAUX_	CDAUX__	0.06	—	—	CDAUXB160

Auxiliary contacts, side mounted

- Accepts four contacts maximum

Description	For use on:	Weight (lbs)	AC thermal amp rating	AC rated voltage	Catalog number
1 N.O. & 1 N.C.	CDNF160	0.07	10	600	CDAUX16011
Mounting base, required for CDAUX16011	CDNF160	0.06	—	—	CDMB160

Max. two contacts on each side of switch. One mounting base required for each side of switch

Numbering stickers②

Description	For use on:		Package qty.	Catalog number
1 Pkg. of blank labels for OBEA-10, 1 N.O.	CDNF160		10	CDEA-ZX10
1 Pkg. of blank labels for OBEA-01, 1 N.C.	CDNF160		10	CDEA-ZX01

Power pole — for use with base or door mounted switch

- Only one power pole per switch
- Mounts on left or right side of switch

Description	For use on:	Weight (lbs)	AC thermal amp rating	AC rated voltage	Catalog number
Fourth pole	CDNF160	0.66	125	600	CDS160P

Terminal poles — for use with base or door mounted switch

- Switch accepts one terminal pole per side
- Mounts on left or right side of switch

Description	For use on:	Weight (lbs)	AC thermal amp rating	AC rated voltage	Catalog number
Detachable neutral mounts on side of switch or DIN rail	CDNF160	0.66	125	600	CDN160P
Ground terminal	CDNF160	0.66	125	600	CDE160P

Locking accessories

Description	For use on:	Weight (lbs)		Catalog number
Cam attachment for Kirk Key, Castell, Lowe & Fletcher and Ronis interlock. For adapting to the interlock system The interlock is not included.	5, 6 & 8mm shafts	0.29		CDETL-ZW16

Handle support bracket

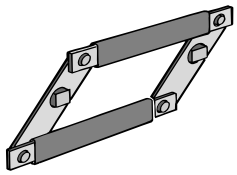
Description	For use on:	Weight (lbs)		Catalog number
Allows pistol handle to be directly mounted to switch behind the door	CDNF160	0.33		CDZX5

Shaft extension couplers

Description	For use on:	Weight (lbs)		Catalog number
Joins two shafts together for applications where extended length is required	for 6mm shafts for 12mm shafts	0.26 0.26		BDZX167 BDZX95

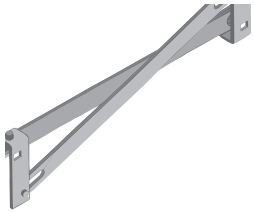
① Type _AU for low energy applications. The contacts are gold-plated. AC & DC ratings — Maximum: A600 & P600. Minimum: 12V, 1mA; 5V, 2mA

② Required if several contact blocks are used in the same installation.



BDZW2

BDZW1



CDZW10

CDZK19
(X = 6mm)

CDBY68005

CDMC2

Conversion mechanisms

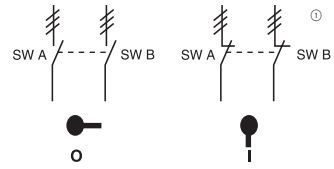
- **For use with Base and Din rail mounted switches only**
- **Switches are not included**

Description	For use on:	Weight (lbs.)		Catalog number
6 or 8 pole	CDNF160	1.52		BDZW2
Transfer (1, 3R, 12)		2.20		BDZW1
Transfer (4X)		2.20		BDZW1X
Mechanical interlock		0.55		CDZW10

6 or 8 pole — BDZW2

6 (8) pole mechanism allows two switches controlled by one handle, to open or close simultaneously. Shafts included.
Equipment required for a complete installation:

- One conversion mechanism
- Two disconnect switches
- One handle



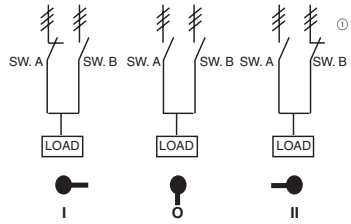
	POS. O	POS. I
SW. A	O	X
SW. B	O	X

X = Closed
O = Open

Transfer — BDZW1

Transfer mechanism manually transfers between two power sources using two switches and a center OFF position. A 3 position handle is included. (UL Type 1, 3R & 12) or (UL Type 1, 3R, 4, 4X, 12) Shafts included. Equipment required for a complete installation:

- One conversion mechanism
- Two disconnect switches



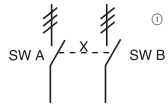
	POS. I	POS. O	POS. II
SW. A	X	O	O
SW. B	O	O	X

X = Closed
O = Open

Mechanical interlock — CDZW10

Mechanical interlock mechanism prevents both switches from being in the ON position at the same time.
Equipment required for a complete installation:

- One conversion mechanism
- Two disconnect switches
- Two handles
- Two shafts



	SW. A POS. I	SW. B POS. I
SW. A	X	O
SW. B	O	X

X = Closed
O = Open

Shaft adapter

Description	For use on:	Weight (lbs)		Catalog number
Adapts one end of a 5 or 6mm shaft to 12mm Use with shaft extension coupler	5 & 6mm shafts	0.20		CDZK19

Power pole interlock (replacement part)

Description	For use on:	Weight (lbs)		Catalog number
Interlocks a power pole with an adjacent power pole	CDNF160	0.05		CDBY68005

Replacement collar (optional replacement for knob)

Description	For use on:	Weight (lbs)		Catalog number
Red knob (like original) for locking shaft in place ** re-use original set screw **	CDNF160	0.05		CXBY68100
Replaces original red knob for locking shaft in place ** re-use original set screw **	CDNF160	0.05		CDMC2

① = Three poles

for Non-Fusible Disconnect Switches

CDNF16 – CDNF160

UL & CSA

Catalog number	3 pole	CDNF16	CDNF25	CDNF32	CDNF45	CDNF63	CDNF30	CDNF60	CDNF100	CDNF160
Approvals[1]	2 pole	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UL98 & IEC
	3 pole	UL508 & IEC	UL508 & IEC	UL508 & IEC	UL508 & IEC	UL508 & IEC	UL98 & IEC	UL98 & IEC	UL98 & IEC	UL98 & IEC
	4 pole	UL508 & IEC	UL508 & IEC	UL508 & IEC	UL508 & IEC	UL508 & IEC	UL98 & IEC	UL98 & IEC	UL98 & IEC	UL98 & IEC
General purpose amp rating	-40° to 40°C									
pf = 0.7 – 0.8	**A**	**16**	**25**	**40**	**60**	**80**	**30**	**60**	**100**	**125**
Max. operating voltage	V	600	600	600	600	600	600	600	600	600
Max. horsepower rating/motor FLA current, pf = 0.4 – 0.5										
Three phase	200V – 208V HP/A	3/10.6	7.5/24.2	10/30.8	15/46.2	20/60.0	10/30.8	20/60.0	25/75.0	30/88.0
	240V HP/A	5/15.2	7.5/22.0	10/28.0	15/42.0	20/54.0	10/28.0	20/54.0	25/68.0	30/80.0
	480V HP/A	10/14.0	15/21.0	20/27.0	30/40.0	40/52.0	20/27.0	40/52.0	50/65.0	60/77.0
	600V HP/A	10/11.0	20/22.0	25/27.0	20/22.0	40/41.0	30/32.0	40/41.0	40/41.0	75/77.0
Single phase	120V HP/A	0.5/9.8	0.75/13.8	1/16.0	2/24.0	2/24.0	2/24.0	3/34.0	5/56.0	7.5/80
	240V HP/A	1.5/10.0	2/12.0	3/17.0	5/28.0	5/28.0	5/28.0	7.5/40.0	15/68.0	20/88.0
Short circuit rating with fuse										
Fuse type CC	kA	10 —	10 —	10 —	— —	— —	— —	— —	— —	—
Fuse type J	kA	10 10	10 10	10 10	100 —	100 —	50 —	50 25	50 25	100
Fuse type T	kA	10 10	10 10	10 10	100 —	100 —	50 —	50 25	50 25	—
Fuse type RK1	kA	10 —	10 —	10 —	— —	— —	— —	— —	— —	—
Fuse type RK5	kA	5 5	5 5	5 5	— 5	10 5	— —	— —	— —	—
Fuse type L	kA	— —	— —	— —	— —	— —	— —	— —	— —	—
Fuse type H	kA	— —	— —	— —	— 5	— 5	— —	— —	— —	—
Fuse size	A	30 60	30 60	30 60	100 150	100 150	60 —	60 100	60 100	200
Short circuit rating with MCCB	kA	—	—	—	—	—	—	—	—	25
Endurances										
Min. Electrical endurance, pf = 0.75 – 0.80	operation cycles	6000	6000	6000	6000	6000	6000	6000	6000	6000
Min. Electrical endurance, pf = 0.40 – 0.50	operation cycles	1000	1000	1000	1000	1000	[2]	[2]	[2]	[2]
Mechanical endurance	operations	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	16,000
Physical characteristics										
Weight, switches 3 pole	lb	0.24	0.24	0.24	0.59	0.59	0.79	0.79	0.79	2.42
4 pole	lb	0.33	0.33	0.33	0.77	0.77	1.10	1.10	1.10	2.86
Dimension, switches 3 pole H	in	2.68	2.68	2.68	3.60	3.60	3.94	3.94	3.94	5.00
W	in	1.38	1.38	1.38	2.07	2.07	2.76	2.76	2.76	4.96
D	in	2.20	2.20	2.20	2.85	2.85	2.95	2.95	2.95	2.93
Shaft size — square □	in	.20 x .20	.20 x .20	.20 x .20	.20 x .20	.20 x .20	.20 x .20	.20 x .20	.20 x .20	.24 x .24
	mm	5 x 5	5 x 5	5 x 5	5 x 5	5 x 5	5 x 5	5 x 5	5 x 5	6 x 6
Switch operating torque for rotary 3 pole switches	lb. in.	8.8	8.8	8.8	10.5	10.5	17.5	17.5	17.5	52.5
Terminal lug kits		Not required	Not required	Not required	Not required	Not required	Not required	Not required	Not required	Not required
Wire range	AWG	#18 – 8	#18 – 8	#18 – 8	#14 – 4	#14 – 1	#14 – 4	#14 – 4	#8 – 1/0	#8 – 1/0
Torque:										
Wire tightening	lb. in.	7	7	7	18	18	55	55	55	70
Lug mounting	lb. in.	Integral	Integral	Integral	Integral	Integral	Integral	Integral	Integral	Integral
Auxiliary contacts		CDAUX_ _	CDAUX_ _	CDAUX_ _	CDAUX_ _	CDAUX_ _	CDAUX_ _	CDAUX_ _	CDAUX_ _	CDEA_ _ _ _ _
NEMA ratings, AC		A600	A600	A600	A600	A600	A600	A600	A600	A600
AC rated voltage	VAC	600	600	600	600	600	600	600	600	600
AC thermal rated current	A	10	10	10	10	10	10	10	10	10
AC maximum volt-ampere making	VA	7200	7200	7200	7200	7200	7200	7200	7200	7200
AC maximum volt-ampere breaking	VA	720	720	720	720	720	720	720	720	720
NEMA ratings, DC		R300	R300	R300	R300	R300	R300	R300	R300	P600
DC rated voltage	VDC	300	300	300	300	300	300	300	300	600
DC thermal rated current	A	1	1	1	1	1	1	1	1	5
DC maximum make-break	VA	28	28	28	28	28	28	28	28	138
Torque:										
Wire tightening	lb. in	7	7	7	7	7	7	7	7	7
Wire range	AWG	#18 – 14	#18 – 14	#18 – 14	#18 – 14	#18 – 14	#18 – 14	#18 – 14	#18 – 14	#22 – 14

[1] UL Listed switches are also CSA Approved.
[2] UL98 overload test, 50 operations, pf 0.40 – 0.50 at 2x FLA.

for Non-Fusible Disconnect Switches
CDNF16 – CDNF160

IEC

Catalog number		3 pole	CDNF16	CDNF25	CDNF32	CDNF45	CDNF63	CDNF30	CDNF60	CDNF100	CDNF160
Rated insulation and operation		40°C									
voltage, AC20 and DC20①	V	750	750	750	750	750	750	750	750	750	
Rated impulse withstand voltage		kV	8	8	8	8	8	8	8	8	12
Rated thermal current, I_{th}											
AC 20/DC 20	open②	A	25	32	40	63	80	40	63	115	200
	40°C enclosed	A	25	32	40	63	80	40	63	115	160
	60°C enclosed	A	25	32	40	63	80	40	63	115	160
Rated operational currents											
AC 21A	≤500V	A	**16**	**25**	**32**	**63**	**80**	**40**	**63**	**100**	**160**③
	≤690V	A	16	25	32	63	80	40	63	100	160③
	≤1000V①	A	—	—	—	—	—	—	—	—	—
AC 22A	≤500V	A	16	25	32	63	80	40	63	100	160③
	≤690V	A	16	25	32	63	80	40	63	100	160③
	≤1000V①	A	—	—	—	—	—	—	—	—	—
AC 23A	≤415V	A	16	20	23	45	75	40	63	80	135
	≤500V	A	16	20	23	45	58	40	63	60	125
	≤690V	A	10	11	12	20	20	40	40	40	80
	≤1000V①	A	—	—	—	—	—	—	—	—	—
Rated operational currents/poles in series											
DC21A	48V	A	16/1	25/1	32/1	④	④	40/1	63/1	100/1	160/1
	110V	A	16/2	25/2	32/2	45/2	63/2	40/2	63/2	100/2	160/1
	220V	A	16/3	25/3	32/3	④	④	40/4	63/4	100/4	160/2
	440V	A	④	④	④	④	④	④	④	④	160/3
	750V	A	④	④	④	④	④	④	④	④	160/4
DC22A	48V	A	16/1	25/1	32/1	④	④	40/1	63/1	100/1	160/1
	110V	A	16/2	25/2	32/2	45/2	63/2	40/2	63/2	100/2	160/1
	220V	A	16/3	25/3	32/4	④	④	40/4	63/4	63/4	160/2
	440V	A	④	④	④	④	④	④	④	④	160/3
	750V	A	④	④	④	④	④	④	④	④	④
DC23A	48V	A	16/1	25/1	32/1	④	④	40/1	63/1	100/1	160/1
	110V	A	16/2	25/2	32/2	45/2	63/2	40/2	63/2	100/2	160/1
	220V	A	16/4	25/4	32/4	④	④	40/4	63/4	63/4	160/2
	440V	A	④	④	④	④	④	④	④	④	160/3
	750V	A	④	④	④	④	④	④	④	④	④
Rated operational power											
AC23A	230V	kW	3	4	5.5	11	22	7.5	11	22	45
	400/415V	kW	7.5	9	11	22	37	15	18.5	37	75
	500V	kW	7.5	9	11	22	37	15	18.5	37	75
	690V	kW	7.5	9	11	15	18.5	15	15	37	75
Short-circuit current		kA	50	50	50	50	50	50	50	50	50
with back-up fuses of size①	A	25	32	40	63	80	100	100	100	200	

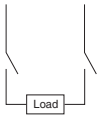


Figure 1

Figure 2

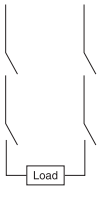


Figure 3

① 1000V, IEC 408.
② The ambient air temperature does not exceed +40°C and its average over a period of 24 hours does not exceed +35°C according to IEC 947.
③ IEC 947-3, utilization category B, infrequent operation.
④ Not available at time of printing, please consult factory.

for Non-Fusible Disconnect Switches

CDNF16 – CDNF160

IEC

Catalog number		3 pole	CDNF16	CDNF25	CDNF32	CDNF45	CDNF63	CDNF30	CDNF60	CDNF100	CDNF160
Rated voltage, U^e		V/V	415	415	415	415	415	415	415	415	415/690
Rated conditional short-circuit current		kA	50	50	50	50	50	50	50	50	80/50
Max. allowed fuse size, type OFAA		A	16	32	40	63	80	100	100	100	160/250
Max. allowed cut-off current, peak value		kA	4	4.3	4.6	8.3	11	9.2	9.2	9.2	21.0/21.6
Rated short-circuit making capacity, prospective peak value, I^{cm}		kA 0.7	0.7	0.7	1.4	1.4	3.6	3.6	3.6	12	
Rated short time withstand current,											
RMS I^{cw}	0.2s	kA	—	—	—	—	—	—	—	—	7
RMS I^{cw}	1.0s	kA	0.5	0.5	0.5	1	1	2.5	2.5	2.5	4
AC breaking capacity											
pf = 0.35	≤415V	A	128	160	184	240	304	320	504	640	1080
	≤500V	A	128	160	184	240	256	320	504	504	1000
	≤690V	A	80	88	96	160	160	320	320	320	640
	≤1000V①	A	—	—	—	—	—	—	—	—	—
DC breaking capacity/poles in series											
L/R = 15ms, 3 pole in series											
	≤48V	A	64/1	100/1	128/1	180/1	252/1	160/1	252/1	400/1	640/1
	≤110V	A	64/2	100/2	128/2	180/2	180/2	160/2	252/2	400/2	640/1
	≤220V	A	64/3	100/4	128/4	180/4	180/4	160/4	252/4	252/4	640/2
	≤440V	A	②	②	②	②	②	②	②	—	640/3
	≤750V	A	②	②	②	②	②	②	②	—	—
Capacitor ratings	≤400/415V	kVar	②	②	②	②	②	②	②	②	②
Rated capacitor duty		kA	②	②	②	②	②	②	②	②	②
Physical characteristics											
Electrical endurance at rated operational current, pf = 0.65		operation cycles	3000	3000	3000	3000	3000	3000	3000	3000	1000
Mechanical endurance		operations	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	16,000
Weight	3 pole	kg	0.11	0.11	0.11	0.27	0.27	0.36	0.36	0.36	1.1
	4 pole	kg	0.15	0.15	0.15	0.35	0.35	0.5	0.5	0.5	1.3
Dimension 3 pole	H mm	68	68	68	91.5	91.5	100	100	100	127	
	W mm	35	35	35	52.5	52.5	70	70	70	126	
	D mm	56	56	56	72.5	72.5	75	75	75	74.5	
Power loss per pole		W	0.3	0.6	1	1.4	2.8	1	1.6	4	6.5
Shaft size — square □		mm	5 X 5	5 x 5	5 x 5	5 x 5	5 x 5	5 x 5	5 x 5	5 x 5	6 x 6
Switch operating torque for rotary 3 pole switches		Nm	1	1	1	1.2	1.2	2	2	2	6
Suitable conductor cross section Cu		mm^2	0.75 – 10	0.75 – 10	0.75 – 10	1.5 – 35	1.5 – 35	1.5 – 25	1.5 – 25	1.5 – 25	10 – 70
Bolt size			—	—	—	—	—	—	—	—	—
Auxiliary contacts			CDAUX_ _	CDAUX_ _	CDAUX_ _	CDAUX_ _	CDAUX_ _	CDAUX_ _	CDAUX_ _	CDAUX_ _	CDAUX_ _
Ratings according to IEC 9-47-5-1											
Rated voltage, U_i		VAC	690	690	690	690	690	690	690	690	690
Thermal current, I_{th}		A	16	16	16	16	16	16	16	16	10
AC12/DC12 I_e, A U_e =	120V	A	—	—	—	—	—	—	—	—	8/—
	125V	A	—	—	—	—	—	—	—	—	—/1.1
	240V	A	6③	6③	6③	6③	6③	6③	6③	6③	6/—
	250V	A	—	—	—	—	—	—	—	—	—/0.55
	400V	A	4③	4③	4③	4③	4③	4③	4③	4③	4/—
	415V	A	—	—	—	—	—	—	—	—	4/—
	440V	A	—	—	—	—	—	—	—	—	—/0.31
	480V	A	—	—	—	—	—	—	—	—	3/—
	500V	A	—	—	—	—	—	—	—	—	3/0.27
	600V	A	—	—	—	—	—	—	—	—	—/0.2
	690V	A	2③	2③	2③	2③	2③	2③	2③	2③	2/—

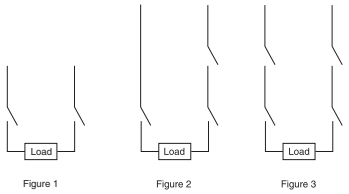


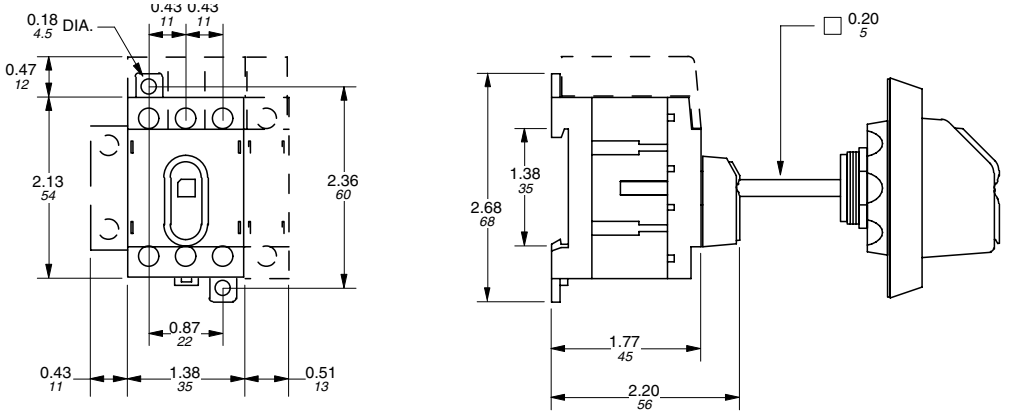
Figure 1 Figure 2 Figure 3

① 1000V, IEC 408.
② Not available at time of printing, please consult factory.
③ AC15, according to IEC947-5-1.

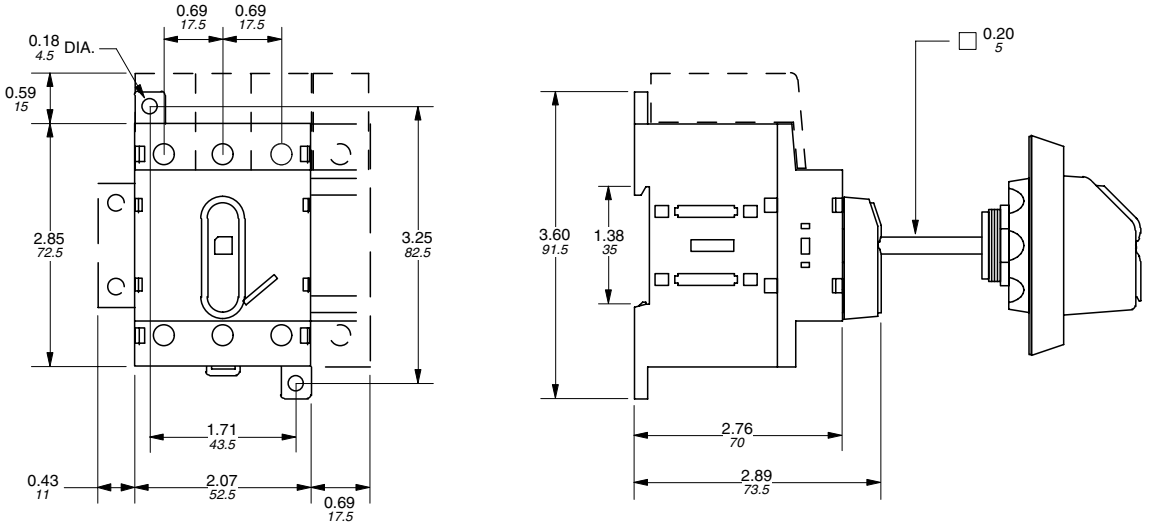
for Non-Fusible Disconnect Switches

CDNF16 — CDNF100

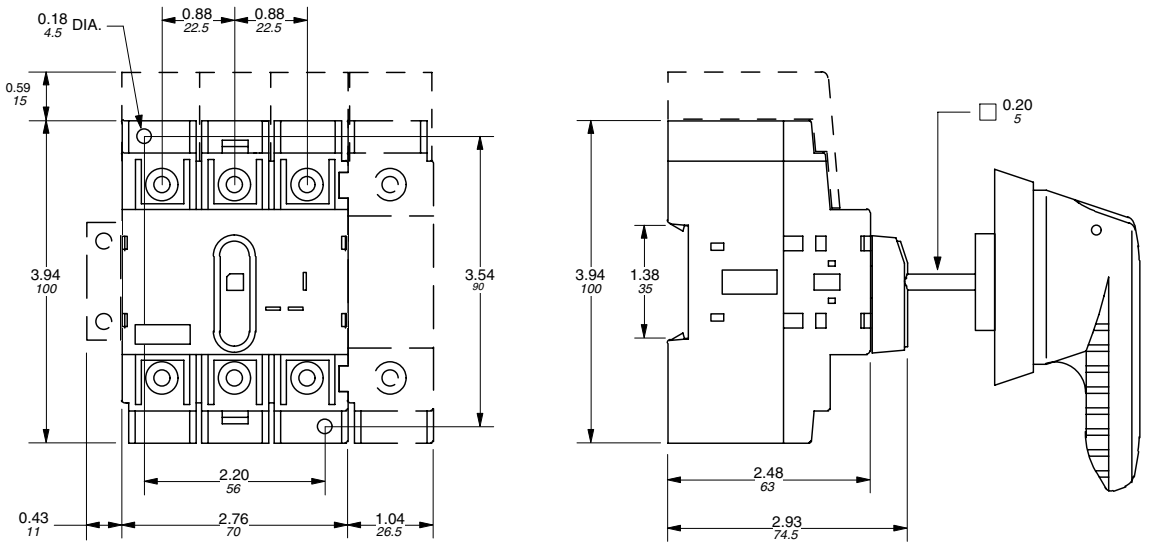
CDNF16, CDNF25, CDNF32 — base & DIN rail mounted switch



CDNF45, CDNF63 — base & DIN rail mounted switch

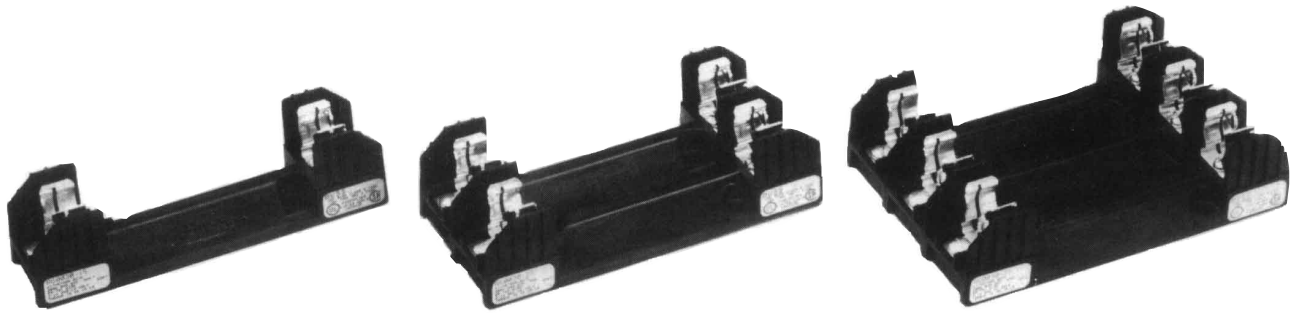


CDNF30, CDNF60, CDNF100 — base & DIN rail mounted switch



Class R Fuseblocks
600 Volts

R600 Series



Catalog Symbol: R600 Series
Ampere Rating: 1/10 to 600A
Voltage Rating: 600V
Agency Information:
UL Listed, UL 512, Guide IZLT, File E14853
CSA Certified, C22.2 No. 39, Class 6225-01, File 47235
Withstand Rating: 200,000A RMS Sym.
For use with Class R fuses (LPS-RK and FRS-R)
UL Flammability: 94VO
Materials: Thermoplastic

Class R Fuseblocks (600V) Catalog Data (for LRS-RK, FRS-R, DLS-R and KTS-R Fuses)

Amps	Poles	Basic Catalog Number	Terminal Type (Suffix No.)					Dimensions (Inches)											Wire Range
			Screw w/		Box Lug w/		0.25″ Quick-Connect	Fig. No.	A	B	C	D	E	F	G	H	J Dia. x C' Bore	K	
			—	Pres. Plate	—	Clip Cu Only													
1/10	1	R60030-1	SR	PR	CR	COR	—	1	6.25	1.73	1.54	1.56	0.25	0.62	3.13	1.56	0.28 x 0.5	.26	COR #6-14 CU ONLY
to	2	R60030-2	SR	PR	CR	COR	—	2			2.90								CR #2-14 CU, #2-12 AL
30	3	R60030-3	SR	PR	CR	COR	—	3			4.25								PR, SR #10-18 CU ONLY
31	1	R60060-1	—	—	CR	COR	—	4	(See Figures)										COR #2-14 CU ONLY
to	2	R60060-2	—	—	CR	COR	—	5											CR #2-14 CU, #2-8 AL
60	3	R60060-3	—	—	CR	COR	—	6											
61	1	R60100-1	—	—	CR	COR	—	7	9.5	2.38	2.22	2.63	0.67	0.88	4.25	1.81	0.28 x 0.5	0.34	COR 1/0 -8 CU ONLY
to	2	R60100-2	—	—	CR	COR	—	8			4.03								CR, CRQ 1/0-8 CU/AL
100	3	R60100-3	—	—	CR	COR	CRQ†	9			5.84								
101	1	R60200-1	—	—	CR	—	CRQ†	10	9.63	3.09	3.0	3.31	0.5	2.0	3.0	0.75	—	0.31	CR, CRQ
to	3	R60200-3	—	—	CR	—	—	11	(See Figures)										250kcmil-6 CU/AL
200																			
201	1	R60400-1	—	—	CR‡	COR‡	—	10	12.0	4.0	3.0	4.5	0.63	1.75	3.0	1.0	—	0.56	COR
to	3	R60400-3	—	—	CR†	—	—	12	(See Figures)										500kcmil-4/0 CU ONLY
400																			CR 500kcmil-4 CU/AL
401	1	R60600-1	—	—	CR	—	—	10	14.0	4.97	3.0	5.5	1.125	1.75	4.0	1.0	—	0.56	CR (2) 500kcmil-4/0 CU/AL
to	3	R60600-3	—	—	CR†	—	—	13	(See Figures)										
600																			

†No UL, No CSA Certification.
‡UL Recognized, CSA Certification

Dimensional Data: See pages 2 and 3.

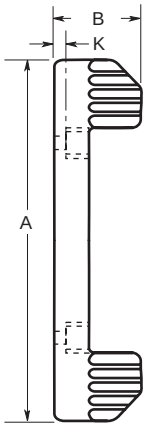
CE CE logo denotes compliance with European Union Low Voltage Directive (50-1000Vac, 75-1500Vdc). Refer to Data Sheet: 8002 or contact Bussmann Application Engineering at 314-527-1270 for more information.

Class R Fuseblocks
600 Volts

R600 Series

Dimensional Data

600V, 1/10 to 30A



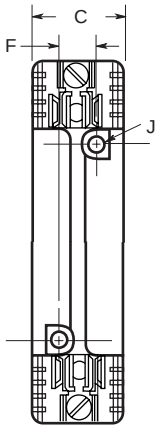


FIGURE 1.

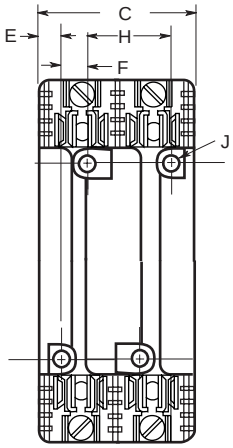


FIGURE 2.

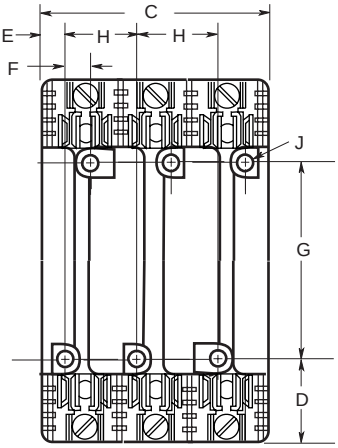
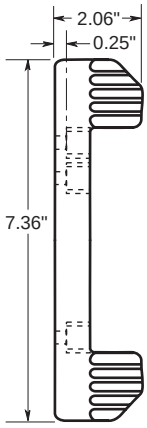


FIGURE 3.

600V, 31 to 60A



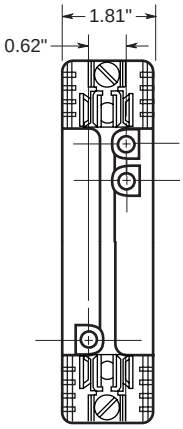


FIGURE 4.

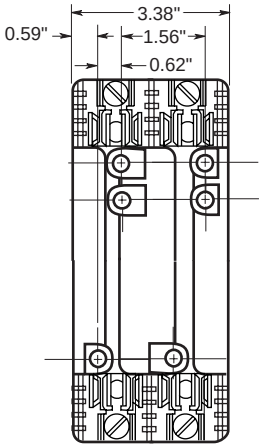


FIGURE 5.

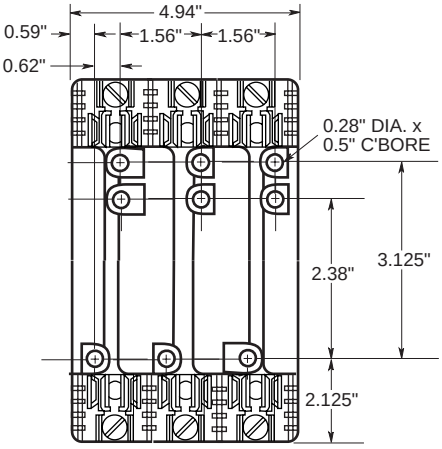
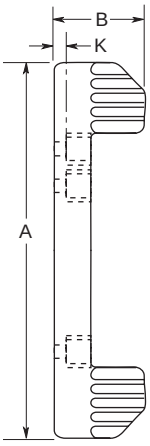


FIGURE 6.

600V, 61 to 100A



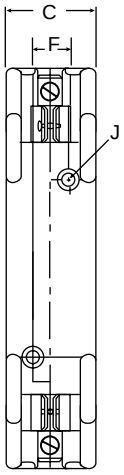


FIGURE 7.

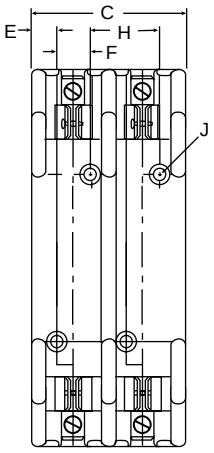


FIGURE 8.

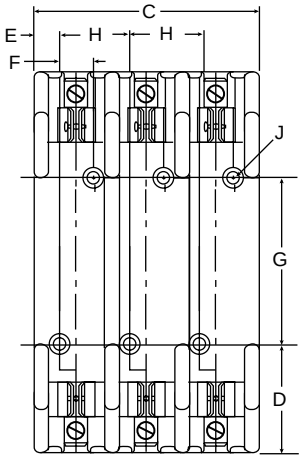


FIGURE 9.

Class R Fuseblocks
600 Volts

R600 Series

600V, 101 to 600A

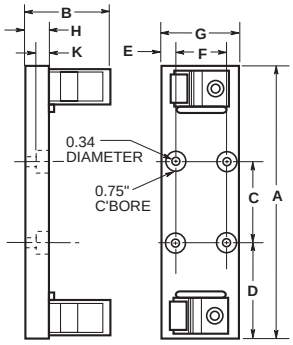


FIGURE 10.

600V, 101 to 200A

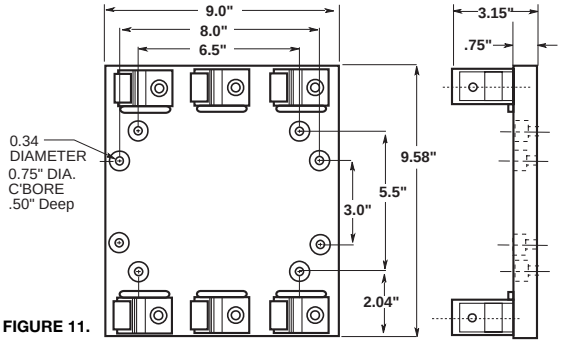


FIGURE 11.

600V, 201 to 400A

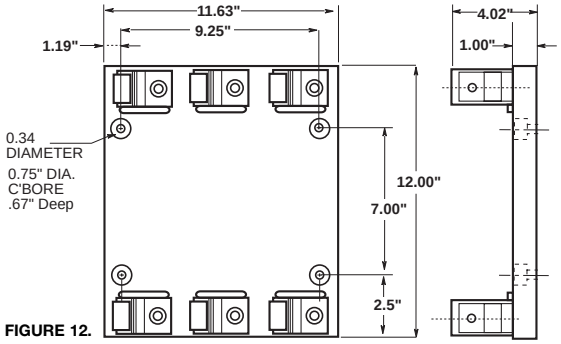


FIGURE 12.

600V, 401 to 600A

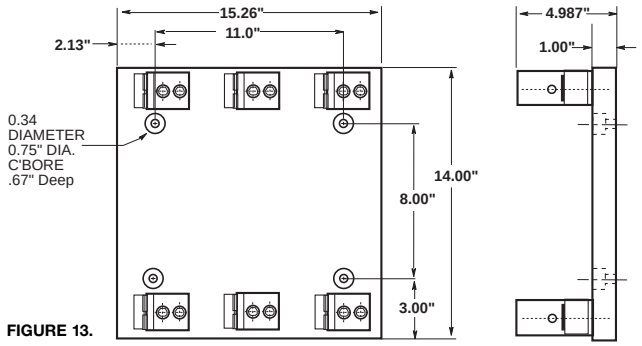
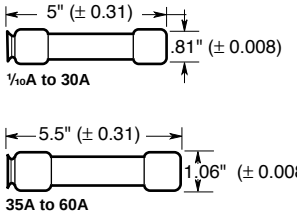


FIGURE 13.

Fusetron®
Dual-Element, Time-Delay Fuses
Class RK5 – 600 Volt

FRS-R
1/10-60A

Dimensional Data



Catalog Symbol: FRS-R
Dual-Element, Time-Delay – 10 second (minimum) at 500% rated current
Current-Limiting
Ampere Rating: 1/10 to 60A
Voltage Rating: 600Vac (or less)
Interrupting Rating: 200,000A RMS Sym.
dc Ratings (20,000AIC @ 250Vdc)
Agency Information:
UL Listed, Std. 248-12, Class RK5, Guide JDDZ, File E4273
CSA Certified, C22.2 No. 248.12, Class 1422-02, File 53787

Catalog Numbers

FRS-R-1/10	FRS-R-1 8/10	FRS-R-8
FRS-R-1/8	FRS-R-2	FRS-R-9
FRS-R-15/100	FRS-R-2 1/4	FRS-R-10
FRS-R-2/10	FRS-R-2 1/2	FRS-R-12
FRS-R-1/4	FRS-R-2 8/10	FRS-R-15
FRS-R-3/10	FRS-R-3	FRS-R-17 1/2
FRS-R-4/10	FRS-R-3 3/10	FRS-R-20
FRS-R-1/2	FRS-R-3 1/2	FRS-R-25
FRS-R-6/10	FRS-R-4	FRS-R-30
FRS-R-8/10	FRS-R-4 1/2	FRS-R-35
FRS-R-1	FRS-R-5	FRS-R-40
FRS-R-1 1/8	FRS-R-5 6/10	FRS-R-45
FRS-R-1 1/4	FRS-R-6	FRS-R-50
FRS-R-1 4/10	FRS-R-6 1/4	FRS-R-60
FRS-R-1 1/2	FRS-R-7	—
FRS-R-1 6/10	FRS-R-7 1/2	—

Carton Quantity and Weight

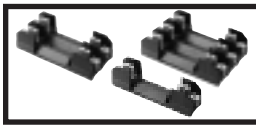
Ampere Ratings	Carton Qty.	Weight* Lbs.	Weight* Kg.
1/10–15	10	0.40	0.181
17.5–30	10	0.50	0.277
35-60	10	3.10	1.406

*Weight per carton.

General Information:
- Provides motor overload, ground fault and short-circuit protection. When used in circuits subject to surge currents such as those caused by motors, transformers and other inductive components, these fuses can be sized close to full-load amperes to give maximum overcurrent protection.
- Permits the use of smaller and less costly switches. The time-delay feature makes it possible to use fuse ampere ratings which are much smaller than those of non-time-delay fuses. Considerable cost saving occurs by permitting the use of smaller size switches, panels and fuses themselves.
- Provides a higher degree of short-circuit protection (greater current-limitation) in circuits in which surge currents or temporary overloads occur.
- Helps protect motors against burnout from overloads.
- Gives motor running back-up protection to motors without extra costs.
- Helps protect motors against burnout from single phasing on three phase systems.
- Simplifies and improves blackout prevention (selective coordination).
- Dual-element fuses can be applied in circuits subject to temporary motor overloads and surge currents to provide both high-performance, short-circuit and overload protection.
- The overload element provides protection against low level overcurrent of overloads and will hold an overload which is five times greater than the ampere rating of the fuse for a minimum of ten seconds.

Fuse Reducers For Class R Fuses

Equipment Fuse Clips	Desired Fuse (Case) Size	Catalog Number (Pairs) 600V
60A	30A	No. 663-R
100A	30A	No. 216-R
	60A	No. 616-R
200A	60A	No. 626-R



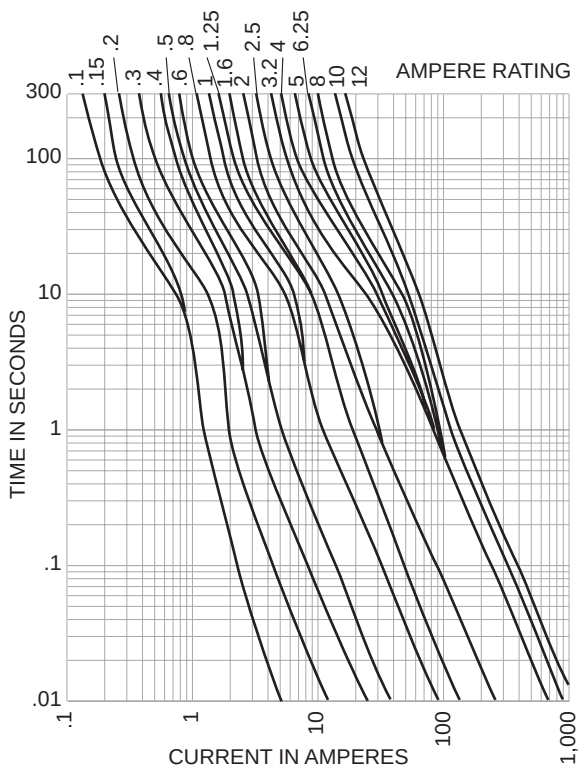
Recommended fuseblocks for Class R 600V fuses
See Data Sheet: 1111

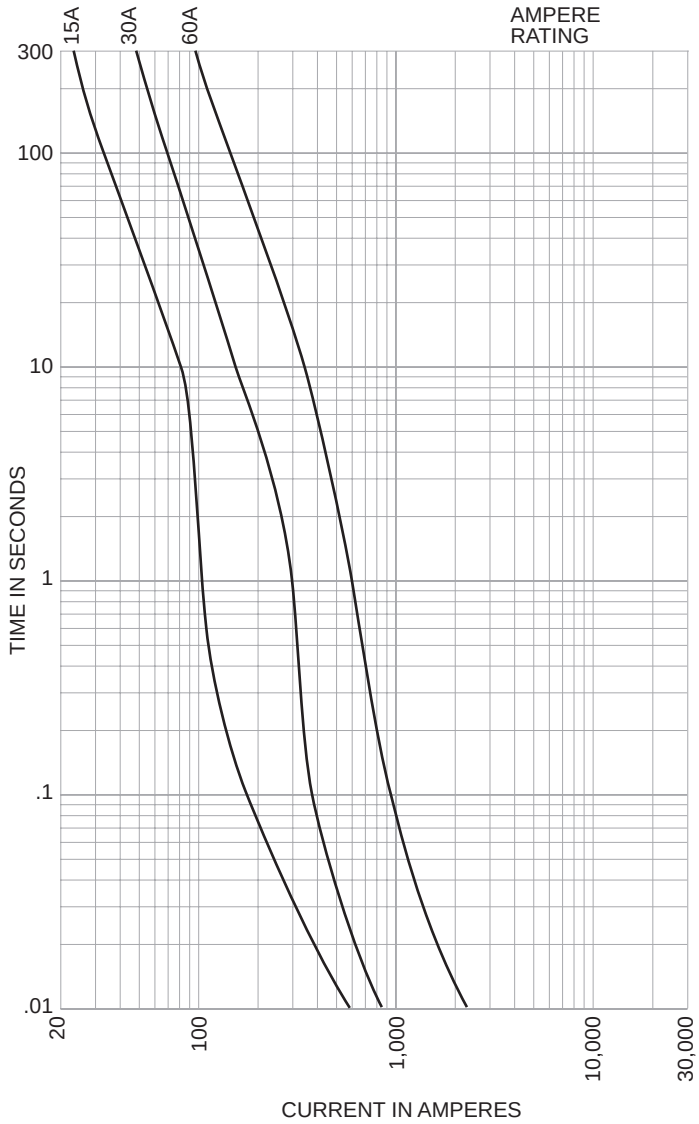
CE CE logo denotes compliance with European Union Low Voltage Directive (50-1000Vac, 75-1500Vdc). Refer to Data Sheet: 8002 or contact Bussmann Application Engineering at 314-527-1270 for more information.

Fusetron®
Dual-Element, Time-Delay Fuses
Class RK5 – 600 Volt

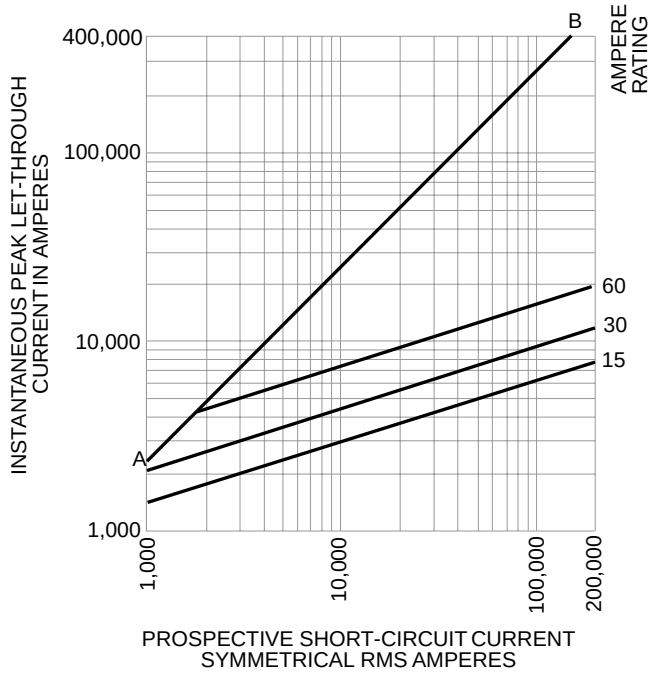
FRS-R
1/10-60A

Time-Current Characteristic Curves–Average Melt





Current-Limitation Curves



Fusetron®
Dual-Element, Time-Delay Fuses
Class RK5 — 600 Volt

FRS-R
65-600A

Catalog Symbol: FRS-R

Dual-Element, Time-Delay – 10 seconds (minimum) at 500% rated current

Current-Limiting

Ampere Rating: 65 to 600A †

Voltage Rating: 600Vac (or less)

Interrupting Rating: 200,000A RMS Sym.

dc Ratings (20,000AIC @ 300Vdc)

Agency Information:

UL Listed, Std. 248-12, Class RK5, Guide JDDZ, File E4273

CSA Certified, C22.2 No. 248.12, Class 1422-01, File 53787

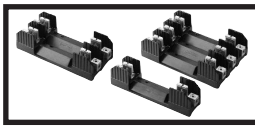
Catalog Numbers

FRS-R-65	FRS-R-135	FRS-R-325
FRS-R-70	FRS-R-150	FRS-R-350
FRS-R-75	FRS-R-175	FRS-R-400
FRS-R-80	FRS-R-200	FRS-R-450
FRS-R-90	FRS-R-225	FRS-R-500
FRS-R-100	FRS-R-250	FRS-R-600
FRS-R-110	FRS-R-275	—
FRS-R-125	FRS-R-300	—

Carton Quantity and Weight

Ampere Ratings	Carton Qty.	Weight* Lbs.	Weight* Kg.
65–100	1	0.54	0.245
101–200	1	1.22	0.544
201–400	1	3.00	1.359
401–600	1	5.00	2.268

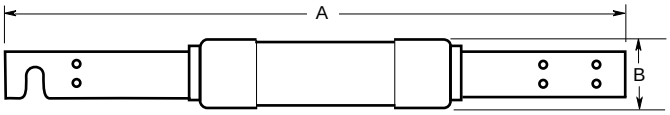
*Weight per carton.



Recommended fuseblocks for Class R 600V fuses
See Data Sheet: 1111

† To obtain information for 0-60A, access Data Sheet: 1017

Dimensional Data



Dimensions (inches)

Ampere Ratings	A	B
65-100	7.88 (± 0.062)	1.11 (± 0.020)
110-200	9.63 (± 0.062)	1.61 (± 0.020)
225-400	11.63 (± 0.094)	2.34 (± 0.020)
450-600	13.38 (± 0.094)	2.88 (± 0.020)

General Information:

- Provides motor overload, ground fault and short-circuit protection. When used in circuits subject to surge currents such as those caused by motors, transformers and other inductive components, these fuses can be sized close to full-load amperes to give maximum overcurrent protection.
- The time-delay feature makes it possible to use fuse ampere ratings which are much smaller than those of non-time-delay fuses. Considerable cost saving occurs by permitting the use of smaller size switches, panels and fuses themselves.
- Provides a good degree of short-circuit protection (greater current-limitation) to help protect downstream components from high fault currents.
- Gives motor running back-up protection to motors without extra costs.
- Helps protect motors against burnout from overloads and single phasing when sized properly.
- Simplifies and improves blackout prevention (selective coordination ratios).
- Dual-element fuses can be applied in circuits subject to temporary motor overloads and surge currents to provide both high-performance, short-circuit and overload protection.

Fuse Reducers For Class R Fuses

Equipment Fuse Clips	Desired Fuse (Case) Size	Catalog Number (Pairs) 600V
200A	100A	No. 2621-R
400A	100A	No. 2641-R
	200A	No. 642-R
600A	100A	No. 2661-R
	200A	No. 2662-R
	400A	No. 2664-R*

*Single reducer only (pair not required).

For additional information, see Data Sheet: 1118.

CE CE logo denotes compliance with European Union Low Voltage Directive (50-1000Vac, 75-1500Vdc). Refer to Data Sheet: 8002 or contact Bussmann Application Engineering at 636-527-1270 for more information.

Fusetron®
Dual-Element, Time-Delay Fuses
Class RK5 — 600 Volt

FRS-R
65-600A

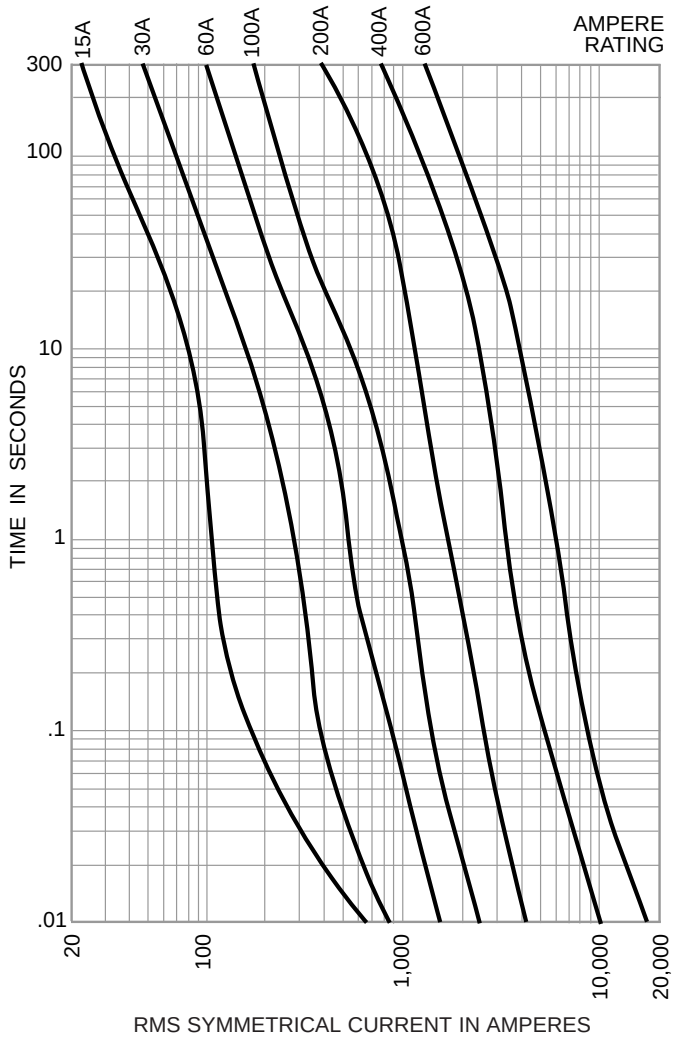
Current-Limiting Effects

FRS-R Apparent RMS Symmetrical Let-Through Current

Prospective SCC	30A	60A	100A	200A	400A	600A
5,000	1,400	2,000	2,900	3,950	5,000	5,000
10,000	1,850	2,650	3,600	5,100	8,550	10,000
15,000	2,200	3,200	4,100	5,950	9,750	13,700
20,000	2,450	3,550	4,500	6,600	10,700	15,000
25,000	2,700	3,900	4,850	7,150	11,500	16,100
30,000	2,900	4,280	5,150	7,650	12,200	17,050
35,000	3,100	4,400	5,400	8,100	12,800	17,900
40,000	3,300	4,760	5,600	8,500	13,400	18,700
50,000	3,550	5,150	6,050	9,250	14,400	20,050
60,000	3,800	5,500	6,400	9,850	15,250	21,250
80,000	4,300	6,100	7,000	10,950	16,750	23,300
100,000	4,500	6,600	7,550	11,900	18,000	25,000
150,000	5,200	8,000	8,600	13,800	20,550	28,450
200,000	5,800	8,500	9,400	15,350	22,550	31,200

For information on previous design FRS-R, 70-600, see Data Sheet: 1153.

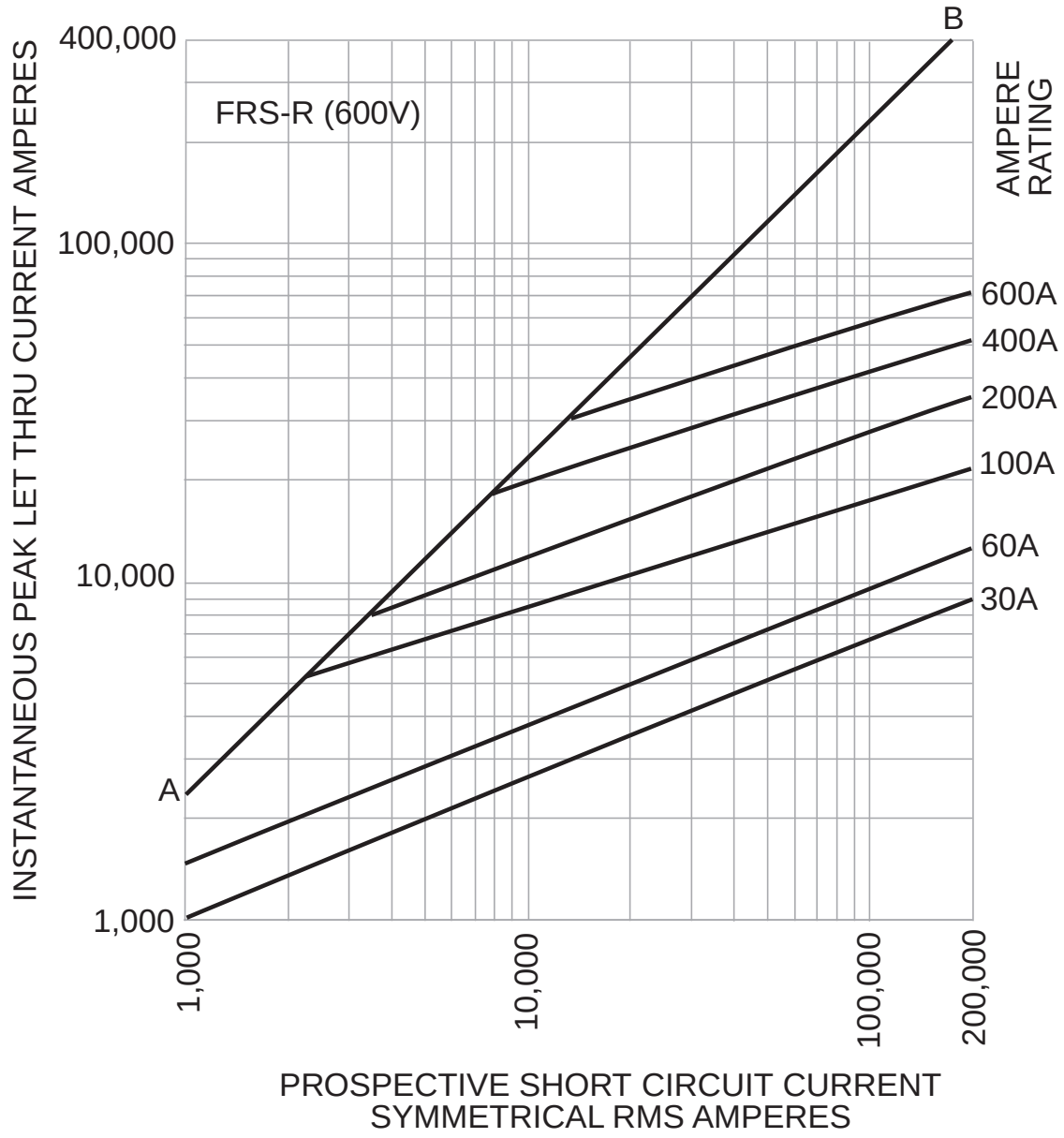
Time-Current Characteristic Curves–Average Melt



Fusetron®
Dual-Element, Time-Delay Fuses
Class RK5 — 600 Volt

FRS-R
65-600A

Current-Limitation Curves



Series 50 Industrial Control Transformers

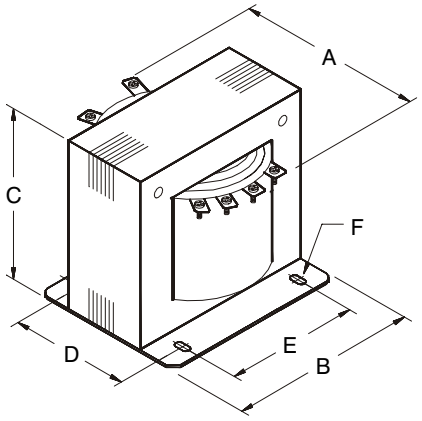
DONGAN ELECTRIC MANUFACTURING CO. • 2987 FRANKLIN • DETROIT, MI 48207
800.428.2626 • 313.567.8500 • FAX 313.567.8828 • www.dongan.com

Series 50 Industrial Control Transformers are designed to the highest NEMA and industrial standards. Series 50 offer compact designs for ease of installation in hundreds of control panel and automation applications.

All Series 50 transformers are UL approved and CSA certified.

Series 50 are available in both domestic and export voltage combinations. Other voltage, frequency and size requirements are readily manufactured by consulting the factory or your Dongan representative.

CE Marked, TÜV Licensed Industrial Control Transformers are featured on pgs. 82-83 in this section.



Domestic Series:

Features

- **UL Listed, File E3210.**
- **CSA Certified, File LR 560.**
- **All copper windings.**
- **All designs are rated 50 / 60 Hertz.**
- **Rugged coil mounted screw terminals.**
- **Primary fuse blocks and secondary fuse holders** are available and are easily installed.
- **Regulation characteristics** equal or exceed the highest industry standards.
- **Transformers .750 kVA and below employ a UL Class 105°C insulation system** with 55°C temperature rise at a maximum ambient of 40°C.
- **Transformers 1.0 kVA and above are designed with a UL Class 180°C insulation system** with 115°C temperature rise at a maximum ambient of 40°C.
- **Nonstandard designs are available** by consulting the factory or your Dongan Representative.

Voltage Combinations:

Suffix	Primary	Secondary
-052	120 x 240	24
-053	240 x 480	120
-054	208	120
-056	600	120
-134	240 x 480	120 / 240

SUFFIX -052, 50 / 60 HZ

Primary Volts 120 X 240, Secondary Volts 24

General Information			Dimensions (inches)						Primary		Secondary		
kVA Cap.	Catalog Number	Wgt. Lbs	Height A	Width B	Depth C	Mounting D	Mounting E	Mounting F	Pri. Max. Amps 120V / 240V	Pri. Fuse Kit	Sec. Max. Amps	Sec. Fuse Kit	Sec. Fuse Size
.050	50-0050-052	3	3.00	3.00	2.50	2.00	2.50	.203 x .375	.42 / .21	BR-734-1	2.08	GLF 1¼	2.25
.075	50-0075-052	3	3.38	3.00	2.50	2.50	2.50	.203 x .375	.63 / .31	BR-734-1	3.13	GLF 1¼	3.2
.100	50-0100-052	4	3.38	3.38	2.81	2.38	2.81	.203 x .375	.83 / .42	BR-734-2	4.17	GLF 1¼	4.5
.150	50-0150-052	6	3.90	3.75	3.13	2.63	3.13	.203 x .375	1.25 / .63	BR-734-3	6.25	GLF 1¼	6.25
.200	50-0200-052	8	4.12	4.50	3.75	2.50	3.75	.203 x .375	1.67 / .83	BR-734-4	8.33	GLF 1¼	9
.250	50-0250-052	9	4.25	4.50	3.75	2.75	3.75	.203 x .375	2.08 / 1.04	BR-734-4	10.42	GLF 1¼	10
.300	50-0300-052	11	4.75	4.50	3.75	3.13	3.75	.203 x .375	2.50 / 1.25	BR-734-4	12.50	GLF 1¼	15
.375	50-0375-052	12	5.25	4.50	3.75	3.63	3.75	.203 x .375	3.13 / 1.56	BR-734-4	16.63	GLF 1¼	20
.500	50-0500-052	17	5.88	5.25	4.38	3.63	4.38	.281 x .562	4.17 / 2.08	BR-734-6	20.83	265 B	25
.750	50-0750-052	25	7.50	5.25	4.38	5.25	4.38	.281 x .562	6.25 / 3.13	BR-734-6	31.25	265 B	30
1.0	50-1000-052	26	7.50	5.25	4.38	5.25	4.38	.281 x .562	8.33 / 4.17	BR-734-6	41.67	--	--

Series 50 Industrial Control Transformers

Export Series:

Features

- **UL Listed, File E3210.**
- **CSA Certified, File LR 560.**
- **All copper windings.**
- **All designs are rated 50 / 60 Hertz.**
- **Rugged coil mounted screw terminals.**
- **Primary fuse blocks and secondary fuse holders** are available and are easily installed.
- **Regulation characteristics** equal or exceed the highest industry standards.
- **Transformers .750 kVA and below employ a UL Class 105°C insulation system** with 55°C temperature rise at a maximum ambient of 40°C.
- **Transformers 1.0 kVA and above are designed with a UL Class 180°C insulation system** with 115°C temperature rise at a maximum ambient of 40°C.
- **Nonstandard designs are available** by consulting the factory or your Dongan Representative.

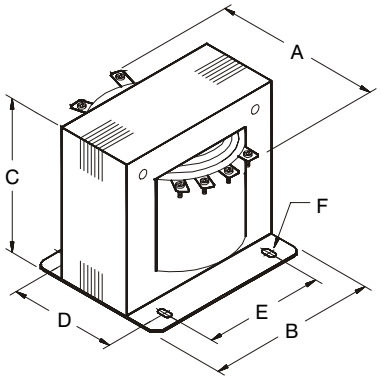
Voltage Combinations:

Suffix	Primary	Secondary
-058	220/380/415	95/115
-059	208 or 500	85/100/110
	220/380/440/550	91/110/120
	230/400/460/575	95/115/125
	240/416/480/600	99/120/130

Connection Diagrams may be found on Pg. 74

Note: Dimension C increases approximately 1 3/8" when Primary Fuse Kit BR-734-X is installed. Drawing is for dimensional purposes only. Actual terminal arrangements may vary.

Dimensions & weights may change.
Consult factory for certified drawings.



SUFFIX -053, 50 / 60 HZ

Primary Volts 240 X 480, 230 X 460, 220 X 440, Secondary Volts 120/115/110

General Information			Dimensions (inches)						Primary		Secondary		
kVA Cap.	Catalog Number	Wgt. Lbs	Height A	Width B	Depth C	Mounting D	Mounting E	Mounting F	Pri. Max. Amps 240V / 480V	Pri. Fuse Kit	Sec. Max. Amps	Sec. Fuse Kit	120 V Fuse Size
.050	50-0050-053	3	3.00	3.00	2.50	2.00	2.50	.203 x .375	.21 / .10	BR-734-1	.42	GLF 1¼	.5
.075	50-0075-053	3	3.38	3.00	2.50	2.50	2.50	.203 x .375	.31 / .16	BR-734-1	.63	GLF 1¼	.6
.100	50-0100-053	4	3.38	3.38	2.81	2.38	2.81	.203 x .375	.42 / .21	BR-734-2	.83	GLF 1¼	1
.150	50-0150-053	6	3.90	3.75	3.13	2.63	3.13	.203 x .375	.63 / .31	BR-734-3	1.25	GLF 1¼	1.25
.200	50-0200-053	8	4.12	4.50	3.75	2.50	3.75	.203 x .375	.83 / .42	BR-734-4	1.67	GLF 1¼	2
.250	50-0250-053	9	4.25	4.50	3.75	2.75	3.75	.203 x .375	1.04 / .52	BR-734-4	2.08	GLF 1¼	2.25
.300	50-0300-053	11	4.75	4.50	3.75	3.13	3.75	.203 x .375	1.25 / .63	BR-734-4	2.50	GLF 1¼	2.5
.375	50-0375-053	12	5.25	4.50	3.75	3.63	3.75	.203 x .375	1.56 / .78	BR-734-4	3.13	GLF 1¼	3.2
.500	50-0500-053	17	5.88	5.25	4.38	3.63	4.38	.281 x .562	2.08 / 1.04	BR-734-6	4.17	265 B	4.5
.750	50-0750-053	25	7.50	5.25	4.38	5.25	4.38	.281 x .562	3.13 / 1.56	BR-734-6	6.25	265 B	6.25
1.0	50-1000-053	26	7.50	5.25	4.38	5.25	4.38	.281 x .562	4.17 / 2.08	BR-734-6	8.33	265 B	9
1.5	50-1500-053	32	7.00	6.38	5.62	4.50	5.31	.312 x .625	6.25 / 3.13	BR-734-7	12.50	265 B	15
2.0	50-2000-053	38	7.62	6.38	5.62	5.00	5.31	.312 x .625	6.25 / 3.13	BR-734-7	16.67	265 B	20
3.0	50-3000-053	50	7.75	7.50	6.62	4.75	6.75	.312 x .625	12.50 / 6.25	BR-734-8	25.00	265 B	25
5.0	50-5000-053	70	10.25	7.50	6.62	6.88	6.75	.312 x .625	20.83 / 10.42	BR-734-8	41.67	--	--

Dongan Electric Manufacturing Co. • 2987 Franklin • Detroit, MI 48207
800.428.2626 • 313.567.8500 • Fax 313.567.8828 • www.dongan.com

DONGAN ELECTRIC MANUFACTURING CO. • 2987 FRANKLIN • DETROIT, MI 48207
800.428.2626 • 313.567.8500 • FAX 313.567.8828 • www.dongan.com

SUFFIX -054, 50 / 60 HZ

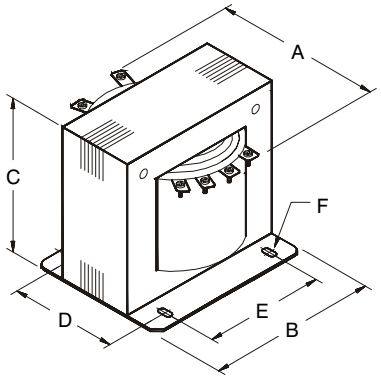
Primary Volts 208, Secondary Volts 120

General Information			Dimensions (inches)						Primary		Secondary		
kVA Cap.	Catalog Number	Wgt. Lbs	Height A	Width B	Depth C	Mounting D	Mounting E	Mounting F	Pri. Max. Amps 208V	Pri. Fuse Kit	Sec. Max. Amps	Sec. Fuse Kit	Sec. Fuse Size
.050	50-0050-054	3	3.00	3.00	2.50	2.00	2.50	.203 x .375	.24	BR-734-1	.42	GLF 1¼	.4
.075	50-0075-054	3	3.38	3.00	2.50	2.50	2.50	.203 x .375	.36	BR-734-1	.63	GLF 1¼	.6
.100	50-0100-054	4	3.38	3.38	2.81	2.38	2.81	.203 x .375	.48	BR-734-2	.83	GLF 1¼	1
.150	50-0150-054	6	3.90	3.75	3.13	2.63	3.13	.203 x .375	.72	BR-734-3	1.25	GLF 1¼	1.25
.200	50-0200-054	8	4.12	4.50	3.75	2.50	3.75	.203 x .375	.96	BR-734-4	1.67	GLF 1¼	2
.250	50-0250-054	9	4.25	4.50	3.75	2.75	3.75	.203 x .375	1.20	BR-734-4	2.08	GLF 1¼	2.25
.300	50-0300-054	11	4.75	4.50	3.75	3.13	3.75	.203 x .375	1.44	BR-734-4	2.50	GLF 1¼	2.5
.375	50-0375-054	12	5.25	4.50	3.75	3.63	3.75	.203 x .375	1.80	BR-734-4	3.13	GLF 1¼	3.2
.500	50-0500-054	17	5.88	5.25	4.38	3.63	4.38	.281 x .562	2.40	BR-734-6	4.17	265 B	4.5
.750	50-0750-054	25	7.50	5.25	4.38	5.25	4.38	.281 x .562	3.61	BR-734-6	6.25	265 B	6.25
1.0	50-1000-054	26	7.50	5.25	4.38	5.25	4.38	.281 x .562	4.81	BR-734-6	8.33	265 B	9
1.5	50-1500-054	32	7.00	6.38	5.62	4.50	5.31	.312 x .625	7.21	BR-734-7	12.50	265 B	15
2.0	50-2000-054	38	7.62	6.38	5.62	5.00	5.31	.312 x .625	9.62	BR-734-7	16.67	265 B	20
3.0	50-3000-054	50	7.75	7.50	6.62	4.75	6.75	.312 x .625	14.42	BR-734-8	25.00	265 B	25

Connection Diagrams may be found on Pg. 74

Note: Dimension C increases approximately 1 3/8" when Primary Fuse Kit BR-734-X is installed. Drawing is for dimensional purposes only. Actual terminal arrangements may vary.

Dimensions & weights may change.
Consult factory for certified drawings.



SUFFIX -056, 50 / 60 HZ

Primary Volts 600/575/550, Secondary Volts 120/115/110

General Information			Dimensions (inches)						Primary		Secondary		
kVA Cap.	Catalog Number	Wgt. Lbs	Height A	Width B	Depth C	Mounting D	Mounting E	Mounting F	Pri. Max. Amps 600V	Pri. Fuse Kit	Sec. Max. Amps	Sec. Fuse Kit	120 V Fuse Size
.050	50-0050-056	3	3.00	3.00	2.50	2.00	2.50	.203 x .375	.08	BR-734-1	.42	GLF 1¼	.4
.075	50-0075-056	3	3.38	3.00	2.50	2.50	2.50	.203 x .375	.13	BR-734-1	.63	GLF 1¼	.6
.100	50-0100-056	4	3.38	3.38	2.81	2.38	2.81	.203 x .375	.17	BR-734-2	.83	GLF 1¼	1
.150	50-0150-056	6	3.90	3.75	3.13	2.63	3.13	.203 x .375	.25	BR-734-3	1.25	GLF 1¼	1.25
.200	50-0200-056	8	4.12	4.50	3.75	2.50	3.75	.203 x .375	.33	BR-734-4	1.67	GLF 1¼	2
.250	50-0250-056	9	4.25	4.50	3.75	2.75	3.75	.203 x .375	.42	BR-734-4	2.08	GLF 1¼	2.25
.300	50-0300-056	11	4.75	4.50	3.75	3.13	3.75	.203 x .375	.50	BR-734-4	2.50	GLF 1¼	2.5
.375	50-0375-056	12	5.25	4.50	3.75	3.63	3.75	.203 x .375	.63	BR-734-4	3.13	GLF 1¼	3.2
.500	50-0500-056	17	5.88	5.25	4.38	3.63	4.38	.281 x .562	.83	BR-734-6	4.17	265 B	4.5
.750	50-0750-056	25	7.50	5.25	4.38	5.25	4.38	.281 x .562	1.25	BR-734-6	6.25	265 B	6.25
1.0	50-1000-056	26	7.50	5.25	4.38	5.25	4.38	.281 x .562	1.67	BR-734-6	8.33	265 B	9
1.5	50-1500-056	32	7.00	6.38	5.62	4.50	5.31	.312 x .625	2.50	BR-734-7	12.50	265 B	15
2.0	50-2000-056	38	7.62	6.38	5.62	5.00	5.31	.312 x .625	3.33	BR-734-7	16.67	265 B	20
3.0	50-3000-056	50	7.75	7.50	6.62	4.75	6.75	.312 x .625	5.00	BR-734-8	25.00	265 B	25

Series 50 Industrial Control Transformers

DONGAN TRANSFORMERS

DONGAN ELECTRIC MANUFACTURING CO. • 2987 FRANKLIN • DETROIT, MI 48207
800.428.2626 • 313.567.8500 • FAX 313.567.8828 • www.dongan.com

SUFFIX -058, 50 / 60 HZ

Primary Volts 220 / 380 / 415, Secondary Volts 95 / 115

General Information			Dimensions (inches)						Primary		Secondary		
kVA Cap.	Catalog Number	Wgt. Lbs	Height A	Width B	Depth C	Mounting D	Mounting E	Mounting F	Pri. Max. Amps 220V / 380V / 415	Pri. Fuse Kit	Sec. Max. Amps	Sec. Fuse Kit	115 V Fuse Size
.250	50-0250-058	11	4.81	4.50	3.75	3.38	3.75	.203 x .375	1.14 / .66 / .60	BR-734-4	2.17	GLF 1¼	2.25
.500	50-0500-058	22	6.63	5.25	4.38	4.60	4.38	.281 x .406	2.27 / 1.32 / 1.20	BR-734-6	4.35	265 B	4.5
.750	50-0750-058	23	7.38	5.75	4.25	4.38	4.94	.281 x .406	3.41 / 1.97 / 1.81	BR-734-5	6.52	265 B	7
1.0	50-1000-058	32	6.75	6.38	5.31	4.50	5.31	.312 x .625	4.55 / 2.63 / 2.41	BR-734-7	8.70	265 B	9
1.5	50-1500-058	41	6.25	7.50	6.25	4.00	6.75	.312 x .625	6.82 / 3.95 / 3.61	BR-734-8	13.04	265 B	15
2.0	50-2000-058	49	7.80	7.50	6.25	4.75	6.75	.312 x .625	9.09 / 5.26 / 4.82	BR-734-8	17.39	265 B	20
3.0	50-3000-058	75	9.88	7.50	6.25	4.62	6.75	.312 x .625	13.64 / 7.89 / 7.23	BR-734-8	26.09	265 B	30
5.0	50-5000-058	113	9.12	9.00	7.50	6.93	7.50	.437 x .750	22.73/ 13.16/ 12.05	BR-734-9	43.48	--	--

SUFFIX -059, 50 / 60 HZ

Primary Volts 208/500
220/380/440/550
230/400/460/575
240/416/480/600

Secondary Volts 85/100/110
91/110/120
95/115/125
99/120/130

General Information			Dimensions (inches)						Primary	Secondary		
kVA Cap.	Catalog Number	Wgt. Lbs	Height A	Width B	Depth C	Mounting D	Mounting E	Mounting F	Pri. Fuse Kit	Sec. Max. Amps	Sec. Fuse Kit	120 V Fuse Size
.150	50-0150-059	11	4.57	5.25	4.38	2.63	4.38	.281 x 406	BR-734-6	1.25	265 B	1.25
.250	50-0250-059	15	5.25	5.25	4.38	3.38	4.38	.281 x 406	BR-734-6	2.08	265 B	2.25
.375	50-0375-059	18	6.25	5.75	4.25	3.44	4.94	.281 x .406	BR-734-5	3.13	265 B	3.2
.500	50-0500-059	22	6.68	5.75	4.25	4.38	4.94	.281 x .406	BR-734-5	4.17	265 B	4.5
.750	50-0750-059	32	6.75	6.38	5.31	4.63	5.31	.312 x .625	BR-734-7	6.25	265 B	6.25
1.0	50-1000-059	35	7.25	6.38	5.31	5.10	5.31	.312 x .625	BR-734-7	8.33	265 B	9
1.5	50-1500-059	53	8.63	7.50	6.25	5.38	6.75	.312 x .625	BR-734-8	12.5	265 B	15
2.0	50-2000-059	60	8.75	7.50	6.25	5.80	6.75	.312 x .625	BR-734-8	16.67	265 B	20
3.0	50-3000-059	74	10.25	7.50	6.25	6.88	6.75	.312 x .625	BR-734-8	25.00	265 B	25

SUFFIX -134, 50 / 60 HZ

Primary Volts 240 X 480, 230 X 460, 220 X 440, Secondary Volts 120/240,115/230,110/220

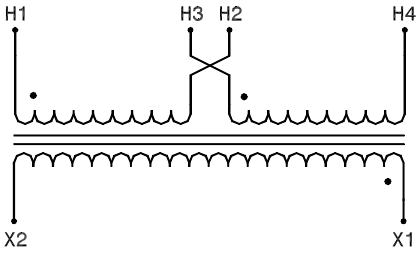
General Information			Dimensions (inches)						Primary		Secondary		
kVA Cap.	Catalog Number	Wgt. Lbs	Height A	Width B	Depth C	Mounting D	Mounting E	Mounting F	Pri. Max. Amps 240V / 480V	Pri. Fuse Kit	Sec. Max. Amps 120V / 240V	Sec. Fuse Kit	120 V Fuse Size
.050	50-0050-134	3	3.00	3.00	2.50	2.00	2.50	.203 x .375	.21 / .10	BR-734-1	.42 / .21	GLF 1¼	.5
.075	50-0075-134	3	3.38	3.00	2.50	2.50	2.50	.203 x .375	.31 / .16	BR-734-1	.63 / .31	GLF 1¼	.6
.100	50-0100-134	4	3.38	3.38	2.81	2.38	2.81	.203 x .375	.42 / .21	BR-734-2	.83 / .42	GLF 1¼	1
.150	50-0150-134	6	3.90	3.75	3.13	2.63	3.13	.203 x .375	.63 / .31	BR-734-3	1.25 / .63	GLF 1¼	1.25
.200	50-0200-134	8	4.12	4.50	3.75	2.50	3.75	.203 x .375	.83 / .42	BR-734-4	1.67 / .83	GLF 1¼	2
.250	50-0250-134	9	4.25	4.50	3.75	2.75	3.75	.203 x .375	1.04 / .52	BR-734-4	2.08 / 1.04	GLF 1¼	2.25
.300	50-0300-134	11	4.75	4.50	3.75	3.13	3.75	.203 x .375	1.25 / .63	BR-734-4	2.50 / 1.25	GLF 1¼	2.5
.375	50-0375-134	12	5.25	4.50	3.75	3.63	3.75	.203 x .375	1.56 / .78	BR-734-4	3.13 / 1.56	GLF 1¼	3.2
.500	50-0500-134	17	5.88	5.25	4.38	3.63	4.38	.281 x .562	2.08 / 1.04	BR-734-6	4.17 / 2.08	265 B	4.5
.750	50-0750-134	25	7.50	5.25	4.38	5.25	4.38	.281 x .562	3.13 / 1.56	BR-734-6	6.25 / 3.13	265 B	6.25
1.0	50-1000-134	26	7.50	5.25	4.38	5.25	4.38	.281 x .562	4.17 / 2.08	BR-734-6	8.33 / 4.17	265 B	9
1.5	50-1500-134	32	7.00	6.38	5.62	4.50	5.31	.312 x .625	6.25 / 3.13	BR-734-7	12.50 / 6.25	265 B	15
2.0	50-2000-134	38	7.62	6.38	5.62	5.00	5.31	.312 x .625	6.25 / 3.13	BR-734-7	16.67 / 8.33	265 B	20
3.0	50-3000-134	50	7.75	7.50	6.62	4.75	6.75	.312 x .625	12.50 / 6.25	BR-734-8	25.00 / 12.50	265 B	25

Series 50 Industrial Control Transformers
Connection Diagrams

DONGAN ELECTRIC MANUFACTURING CO. • 2987 FRANKLIN • DETROIT, MI 48207
800.428.2626 • 313.567.8500 • FAX 313.567.8828 • www.dongan.com

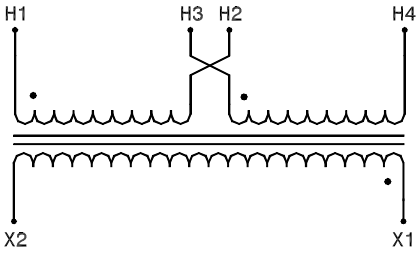
Suffix -052

Primary			Secondary	
Voltage	Jumper	Connect Incoming Lines To	Voltage	Connect Load To
120	H1 to H3 & H2 to H4	H1 & H4	24	X1 & X2
240	H2 to H3	H1 & H4	24	X1 & X2



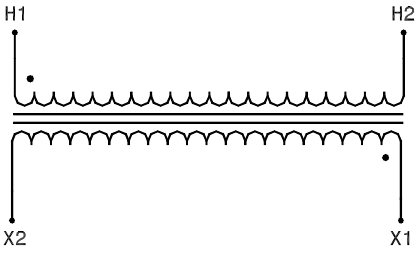
Suffix -053

Primary			Secondary	
Voltage	Jumper	Connect Incoming Lines To	Voltage	Connect LoadTo
480 460 440	H2 to H3	H1 & H4	120 115 110	X1 & X2
240 230 220	H1 to H3 H2 to H4	H1 & H4	120 115 110	X1 & X2



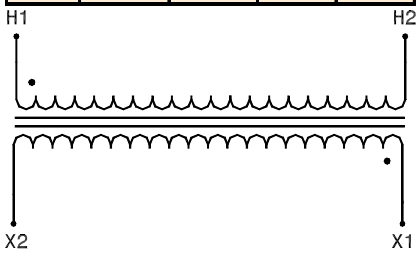
Suffix -054

Primary			Secondary	
Voltage	Jumper	Connect Incoming Lines To	Voltage	Connect Load To
208	---	H1 & H2	120	X1 & X2



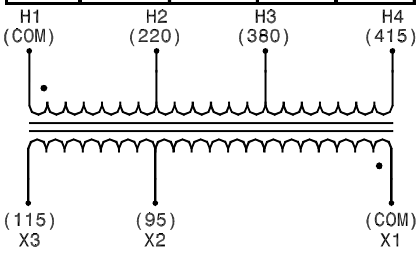
Suffix -056

Primary			Secondary	
Voltage	Jumper	Connect Incoming Lines To	Voltage	Connect Load To
600	---	H1 & H2	120	X1 & X2



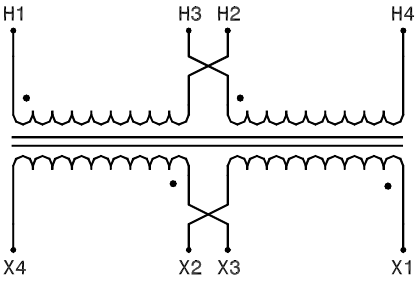
Suffix -058

Primary			Secondary	
Voltage	Jumper	Connect Incoming Lines To	Voltage	Connect Load To
220	---	H1 & H2	95	X1 & X2
380	---	H1 & H3		
415	---	H1 & H4	115	X1 & X3



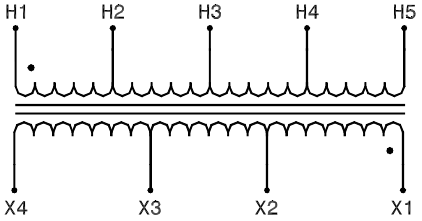
Suffix -134

Primary			Secondary		
Voltage	Jumper	Connect Incoming Lines To	Voltage	Jumper	Connect Load To
240 230 220	H1 to H3 & H2 to H4	H1 & H4	120 115 110	X1 to X3 & X2 to X4	X1 & X4
480 460 440	H2 to H3	H1 & H4	120 115 110	X1 to X3 & X2 to X4	X1 & X4
240 230 220	H1 to H3 & H2 to H4	H1 & H4	240 230 220	X2 to X3	X1 & X4
480 460 440	H2 to H3	H1 & H4	240 230 220	X2 to X3	X1 & X4



Suffix -059

Primary				Secondary		
Connect Incoming Lines To H1 & H2	Connect Incoming Lines To H1 & H3	Connect Incoming Lines To H1 & H4	Connect Incoming Lines To H1 & H5	Connect Load To X1 & X2	Connect Load To X1 & X3	Connect Load To X1 & X4
208			500	85	100	110
220	380	440	550	91	110	120
230	400	460	575	95	115	125
240	416	480	600	99	120	130



DONGAN TRANSFORMERS

DONGAN ELECTRIC MANUFACTURING CO. • 2987 FRANKLIN • DETROIT, MI 48207
800.428.2626 • 313.567.8500 • FAX 313.567.8828 • www.dongan.com

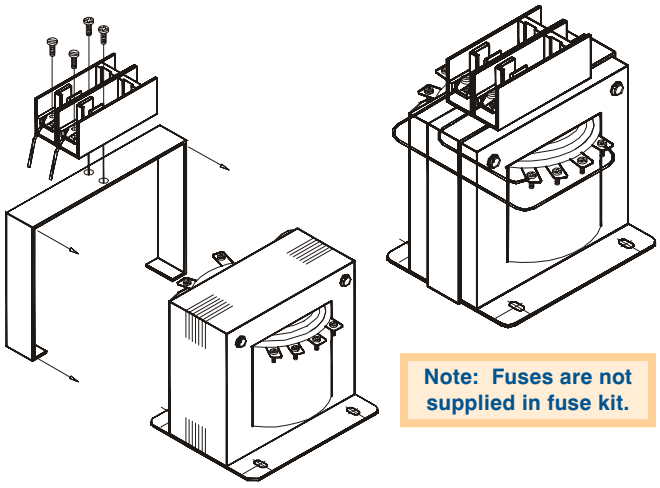
SERIES 50 PRIMARY FUSE KIT

Fuse Kit BR-734

- Meets UL 508
- Meets NEC Article 450
- Uses Class CC Fuses

Installation Procedure

- Loosen bolts holding transformer to the panel backplate.
- Slide the BR-734 bracket over the transformer.
- Retighten mounting bolts.
- Connect the fuse holder leads to the transformer terminals with the jumper leads furnished.



Note: Fuses are not supplied in fuse kit.

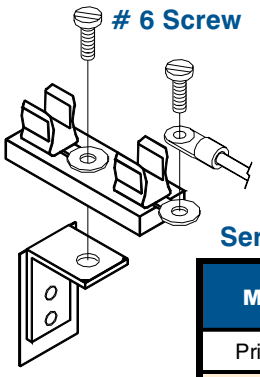
SERIES 50 SECONDARY FUSE KITS

Fuse Kit GLF 1¼

- Meets UL 508
- Meets NEC Article 450
- Uses ¼" x 1¼" Fuses

Installation Procedure

- Remove #6 screw in the transformer terminal to be fused.
- Fasten GLF 1¼ fuse holder to transformer terminal with the longer #6 screw provided, as shown in the diagram.
- Connect the load lead to the terminal provided on the GLF 1¼ fuse holder.



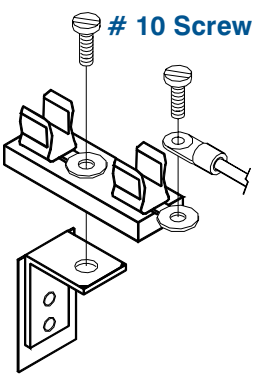
Fuse Kit 265B

- Meets UL 508
- Meets NEC Article 450
- Uses 13/32" x 1½" Fuses

Installation Procedure

- Remove #10 screw in the transformer terminal to be fused.
- Fasten 265B fuse holder to transformer terminal with the longer #10 screw provided, as shown in the diagram.
- Connect the load lead to the terminal provided on the 265B fuse holder.

Note: Fuses are not supplied in fuse kit.



Series 50 Recommended Fuse Type By Manufacturer

Manufacturer	Bussman	Gould	Littlefuse
Primary Fuse Type	FNQ-R	ATQR / ATDR	KLDR / CCRM
Secondary Fuse Type Fuse Holder 265-B	FNM / FNQ (250V) (500V)	TRM / ATQ (250V) (500V)	FLM / FLQ (250V) (500V)
Secondary Fuse Type Fuse Holder GLF-1 1/4	MDQ (250V)	GDL (250V)	3AB (250V)

DONGAN TRANSFORMERS

DONGAN ELECTRIC MANUFACTURING CO. • 2987 FRANKLIN • DETROIT, MI 48207
800.428.2626 • 313.567.8500 • FAX 313.567.8828 • www.dongan.com

Industrial Ignition Transformers

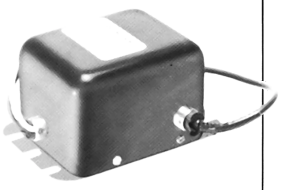
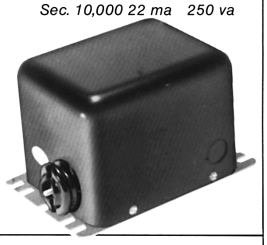
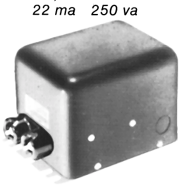
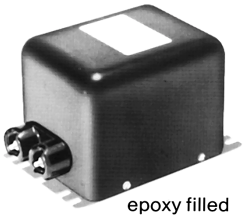
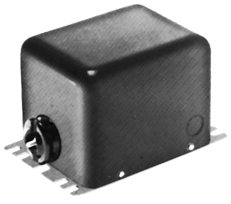
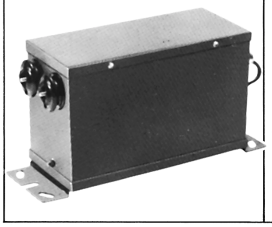
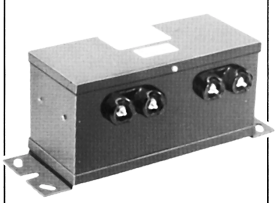
Dongan Industrial Ignition transformers are used in a wide variety of commercial and industrial heating applications. Their uses include commercial heat treating installations, bakeries, grain dryers, and industrial ovens.

Primary voltages include 110,120, 208, 220, 240, and 480. Secondary voltages include 5,000, 6,000, 7,500, 8,500, and 10,000. The 10,000 volt models come in either an end grounded 10,000 volt configuration or a twin 5,000 volt version.

Epoxy filled variations complete the line, providing solutions for higher ambient temperature applications. Additionally, a liquid filled model, the LFI Series is available for the harsh conditions found with ozone generation installations. LFI Series literature may be ordered by requesting Transfax 111.

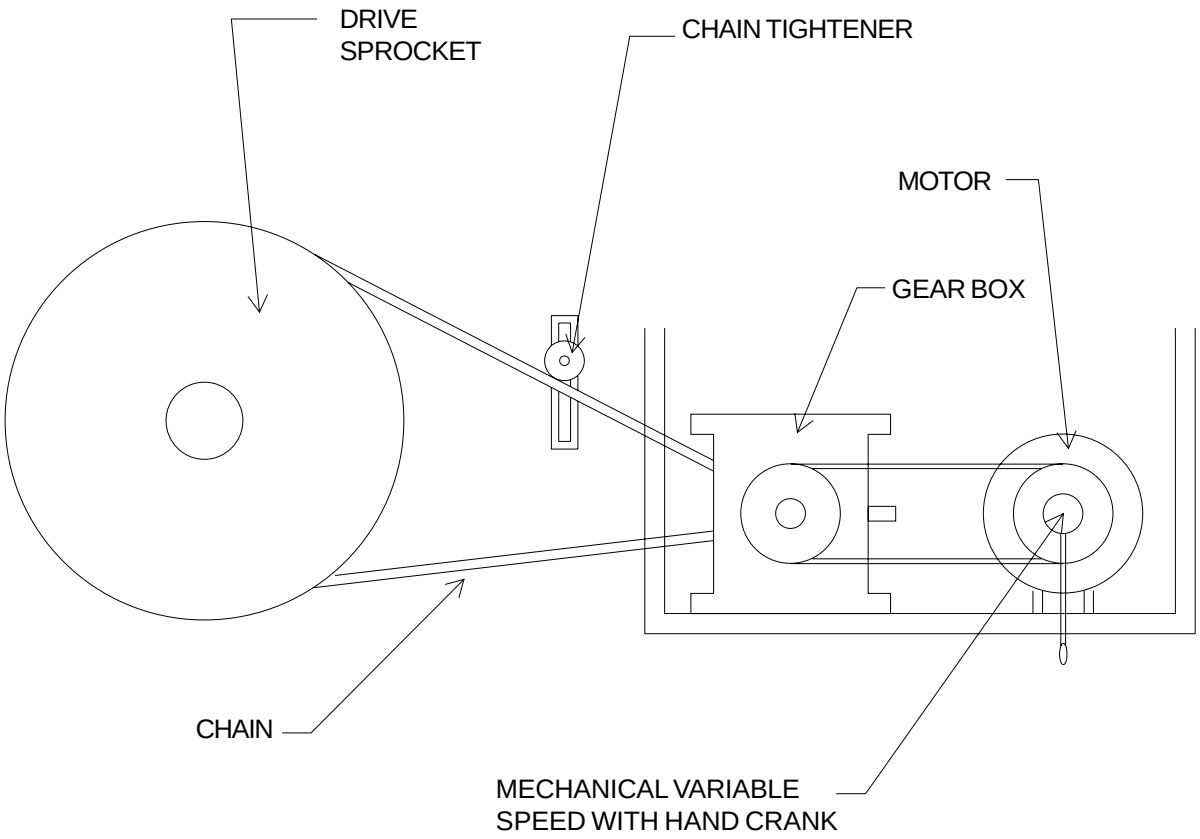
INDUSTRIAL OIL AND GAS IGNITION

UL Listed File E12339. CSA Certified LR560.

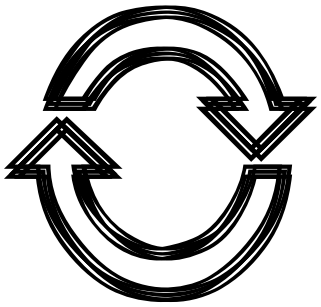
AO5-SA6 *120 V Pri 60 Hz* EO5-SA6 *110 V Pri 50 Hz* *5000 V Sec. 20 ma 115 va* 	AO5-SC7 *120 V Pri 60 Hz* *Sec. 5000 V 20 ma 115 va* 	A06-SA6 *120 V Pri 60 Hz* C06-SA6 *240 V Pri 60 Hz* F06-SA6 *220 V Pri 50 Hz* *Sec. 6000 V 20 ma 175 va* 	A06-SA6X *120 V Pri 60 Hz* *Sec. 6000 V 20 ma 175 va*  epoxy filled
A06-SD7 *120 Pri 60 Hz* *6000 V Sec. 20 ma 175 va* 	A06-SA21 *120 V Pri 60 Hz* *Sec. 6000 V 20 ma 175 va* 	A08-SA1 *120 V Pri 60 Hz* *Sec. 8500 V 20 ma 230 va* 	A10-LA2 *120 V Pri 60 Hz* C10-LA2 *240 V Pri 60 Hz* *Sec. 10,000 22 ma 250 va* 
A10-LF3 *120 V Pri 60 Hz* C10-LF3 *240 V Pri 60 Hz* N10-LF3 *480 V Pri 60 Hz* *Sec. 10,000 or 2×5000 V* *22 ma 250 va* 	A10-LF3X *120 V Pri 60 Hz* *Sec. 10,000 or 2×5000* *22 ma 250 va*  epoxy filled	A10-LA22 *120 V Pri 60 Hz* *Sec. 10,000 22 ma 250 va* 	A10-LA2X *120 V Pri 60 Hz* *Sec. 10,000 22 ma 250 va*  epoxy filled
A15-LA61 *120 Pri 60 Hz* *Sec. 2×7500 30 ma 560 va* 	A15-LA6 *120 V Pri 60 Hz* *Sec. 3×5000 22 ma 375 va* 	A20-LA7 *120 V Pri 60 Hz* *Sec. 4×5000 22 ma 500 va* 	A10-LN2X *Pri 120 V 60 Hz* *Sec. 10,000 22 ma 250 va*  epoxy filled

Drive Plate & Chain Tightener

Frame 431 lower and
Explosion proof drives



Adjust chain tightener to keep tension on chain



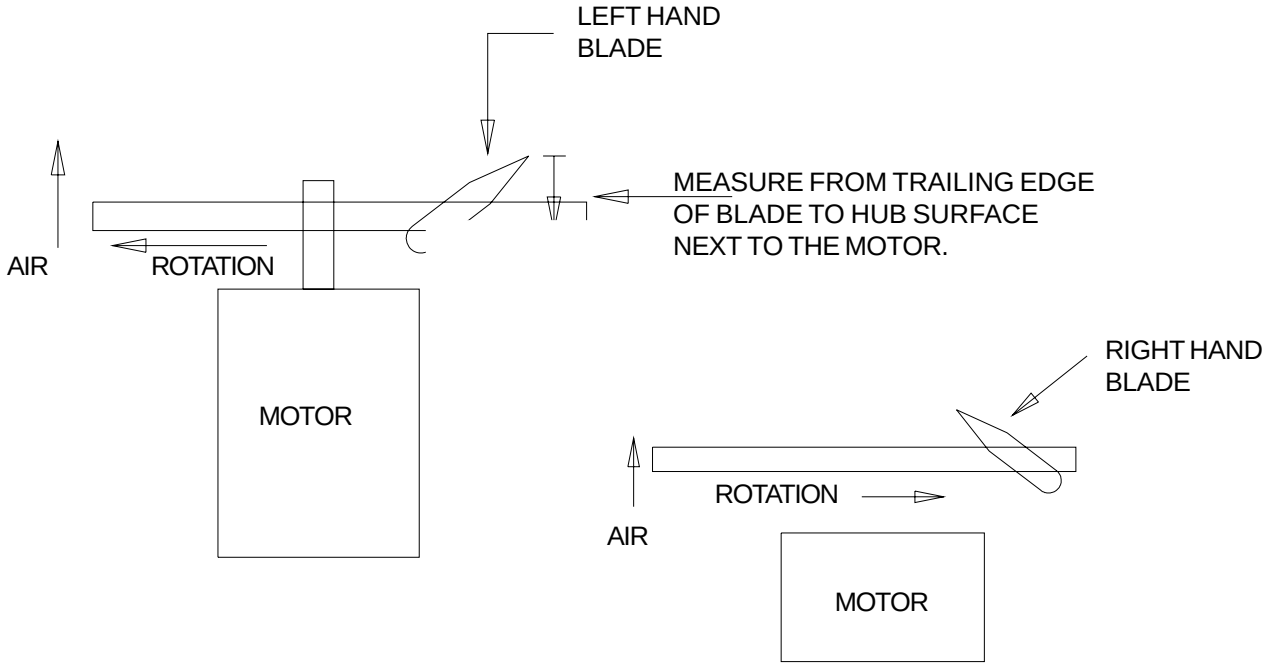
Rotation of hand crank (more speed)

Setting the Fan Blade Pitch

38” Fan Blade Setting with Steel Hub
(Add 3/16” for Aluminum Hub)

30HP	3”
25HP	2-7/8”
20HP	2-3/4”
15HP	2-5/8”
10HP	2-1/2”

CAUTION: Settings can vary under different conditions. Always check motor amp. draw.



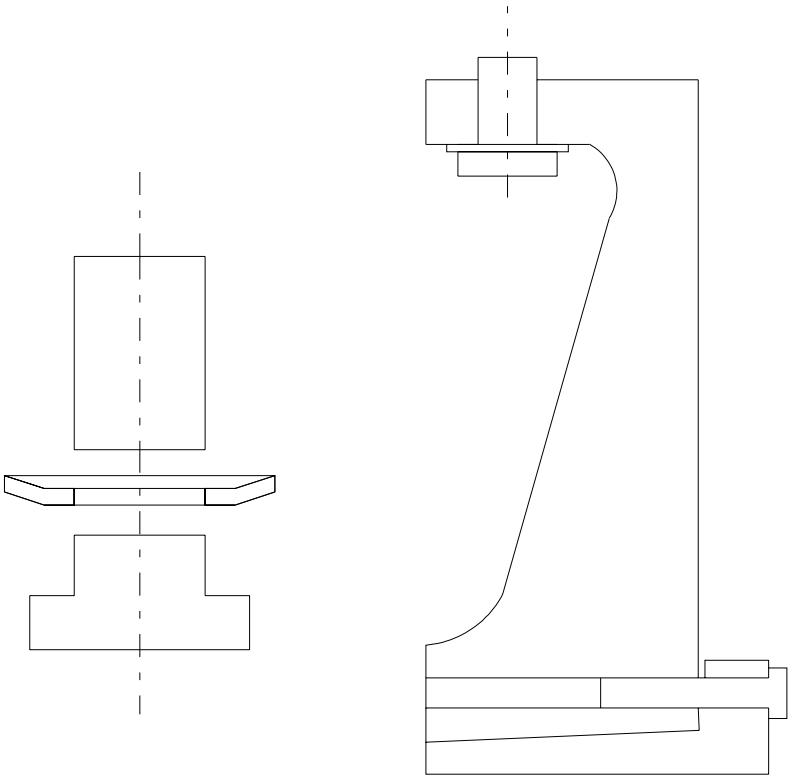
1. Get correct blade next to air straightener CCR looking from motor.
2. Set blades before installing in housing. Set a bolt or something as a caliper.
3. Always check amp draw on motors after changing the blades.

Installation of and Use of Special Fan Blade Washers

(Note: Torque 3/4” Fan Bolts to 135 FT/LBS)

Bolts are to be lubricated with SAE 30 non-detergent motor oil.

THIS INFORMATION APPLIES TO: 12" & 16" DIAM HUBS



Typical special washer, slightly deformed not tumbled.

Place on bolt with outside burr/ deflection away from the head of bolt.

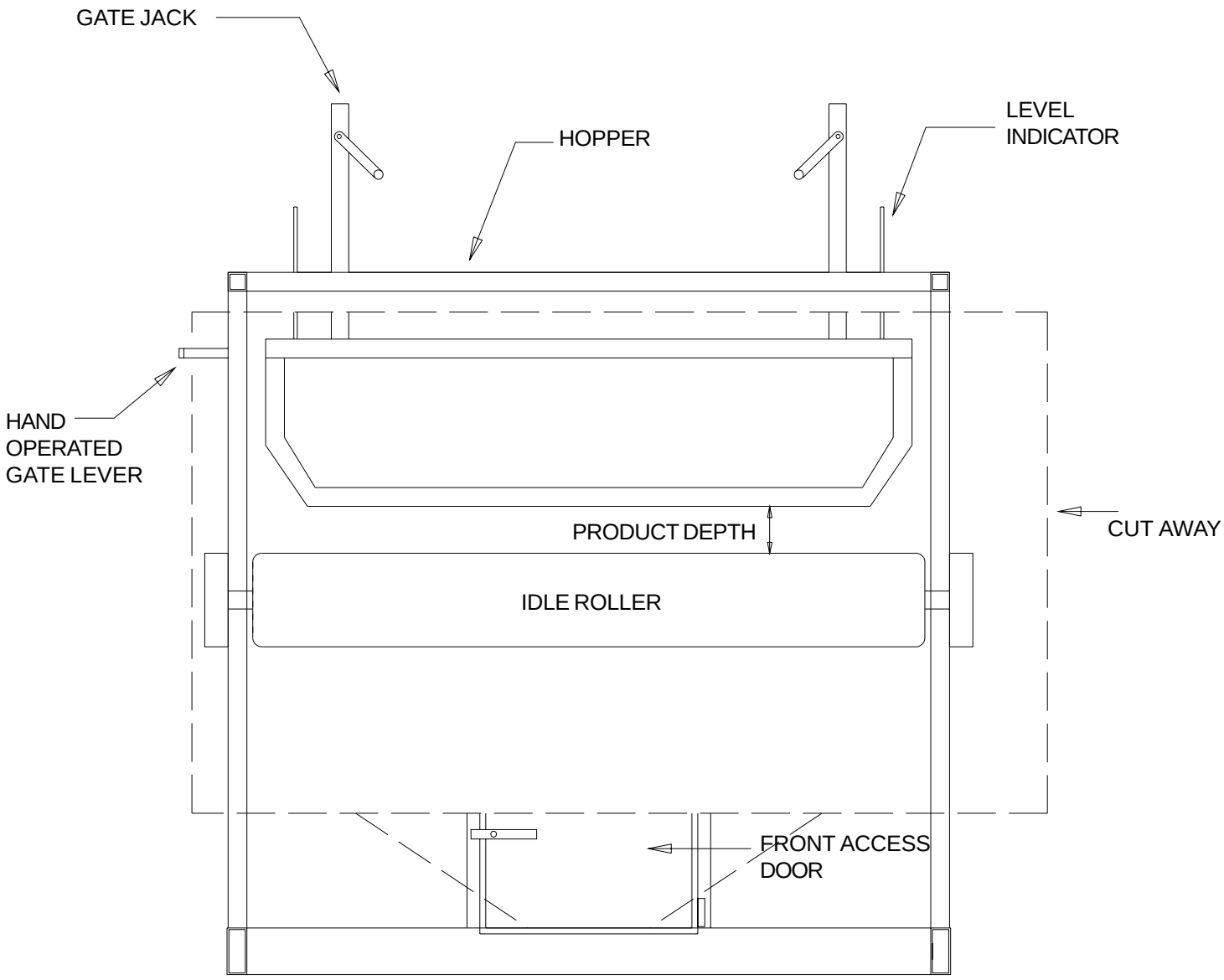
Thus providing extra cushion, tension and locking action.

When installing the fan use 30 motor oil on the outside of the browning bushing and on the inside of the fan hub.

Lubricate the bolts, draw up the bolts evenly; after reasonable tension use hammer to tap on bushing and then redraw the bolts thus assuring a good set on the shaft.

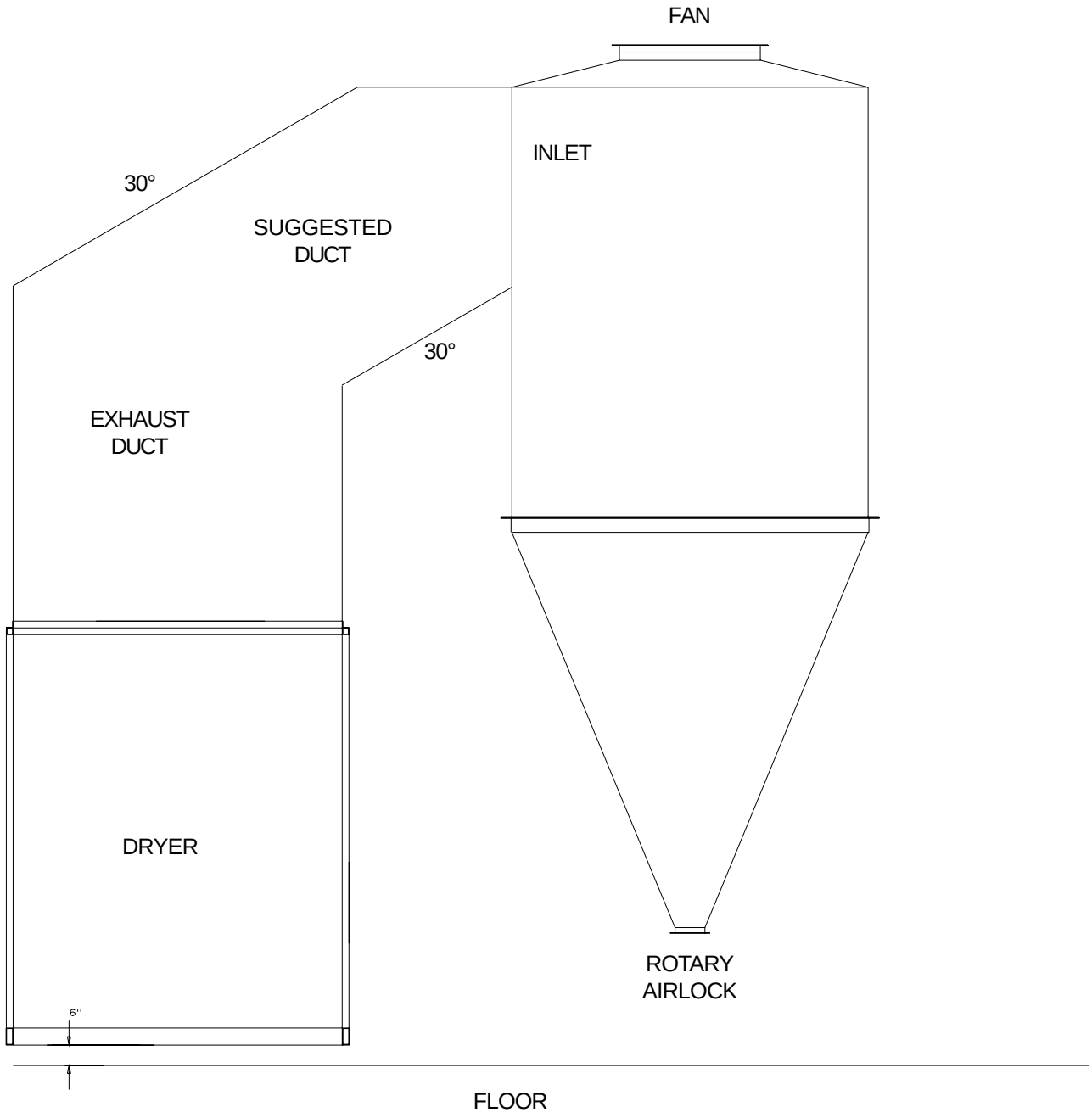
In disassembly after putting tension on bolts in removal position again use hammer and tap to loosen taper bushing from shaft.

Leveling Gate Adjustment for Product Depth



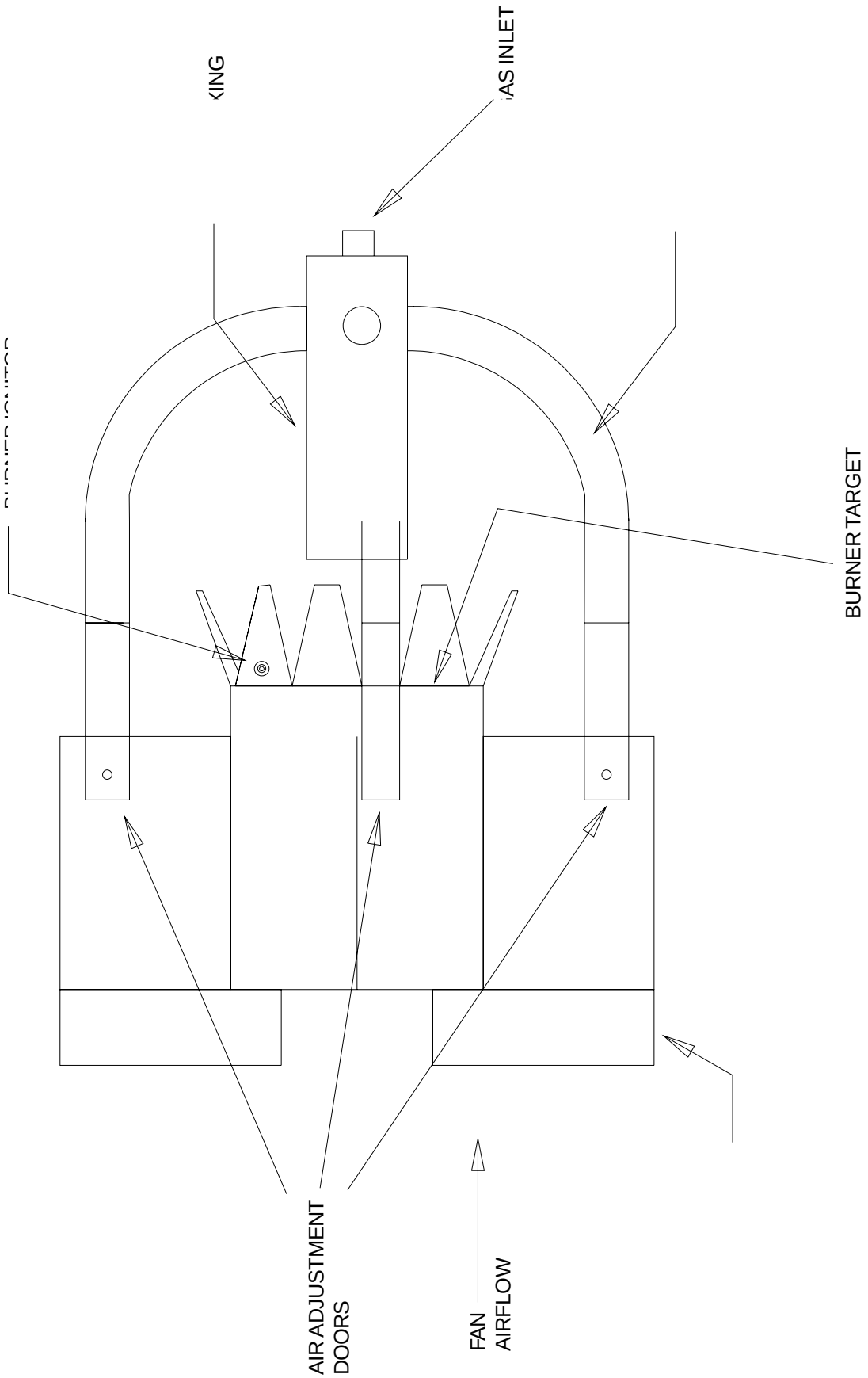
Dotted line indicates a cut away section.
Either the top jacks or the hand operated lever are used.
The hand operated level is used in smaller units.

Air Duct to Cyclone Transition Drawing



Drawing shows the suggested transition from dryer or cooler to cyclone. The dimension will be different with different size cyclones. The two fans that sit on top are counter rotating. Looking from the motor side the top one is L.H. (counter clockwise) and the bottom one next to the cyclone is R.H.. (clockwise) See pages J-1 and J-2a in the manual about blade adjustment. Always check rotation of fans and amp draw of the motors. An overloaded motor will burn up.

Gun Style Burner



FOOT PER MINUTE WEB TRAVEL CHART

OVERALL REDUCTION RATIO

	250	500	600	750	1000	1250	1500	1800	2000	2250	2500	3000	3200	3750	4000	5000	6250
60HZ	20.60	10.30	8.40	6.88	5.16	4.12	3.44	2.86	2.58	2.29	2.06	1.72	1.61	1.37	1.29	1.04	0.82
57HZ	19.57	9.79	7.98	6.54	4.90	3.91	3.27	2.72	2.45	2.18	1.96	1.63	1.53	1.30	1.23	0.99	0.78
54HZ	18.54	9.27	7.56	6.19	4.64	3.71	3.10	2.57	2.32	2.06	1.85	1.55	1.45	1.23	1.16	0.94	0.74
51HZ	17.51	8.76	7.14	5.85	4.39	3.50	2.92	2.43	2.19	1.95	1.75	1.46	1.37	1.16	1.10	0.88	0.70
48HZ	16.48	8.24	6.72	5.50	4.13	3.30	2.75	2.29	2.06	1.83	1.65	1.38	1.29	1.10	1.03	0.83	0.66
45HZ	15.45	7.73	6.30	5.16	3.87	3.09	2.58	2.15	1.94	1.72	1.55	1.29	1.21	1.03	0.97	0.78	0.62
42HZ	14.42	7.21	5.88	4.82	3.61	2.88	2.41	2.00	1.81	1.60	1.44	1.20	1.13	0.96	0.90	0.73	0.57
39HZ	13.39	6.70	5.46	4.47	3.35	2.68	2.24	1.86	1.68	1.49	1.34	1.12	1.05	0.89	0.84	0.68	0.53
36HZ	12.36	6.18	5.04	4.13	3.10	2.47	2.06	1.72	1.55	1.37	1.24	1.03	0.97	0.82	0.77	0.62	0.49
33HZ	11.33	5.67	4.62	3.78	2.84	2.27	1.89	1.57	1.42	1.26	1.13	0.95	0.89	0.75	0.71	0.57	0.45
30HZ	10.30	5.15	4.20	3.44	2.58	2.06	1.72	1.43	1.29	1.15	1.03	0.86	0.81	0.69	0.65	0.52	0.41
27HZ	9.27	4.64	3.78	3.10	2.32	1.85	1.55	1.29	1.16	1.03	0.93	0.77	0.72	0.62	0.58	0.47	0.37
24HZ	8.24	4.12	3.36	2.75	2.06	1.65	1.38	1.14	1.03	0.92	0.82	0.69	0.64	0.55	0.52	0.42	0.33
21HZ	7.21	3.61	2.94	2.41	1.81	1.44	1.20	1.00	0.90	0.80	0.72	0.60	0.56	0.48	0.45	0.36	0.29
18HZ	6.18	3.09	2.52	2.06	1.55	1.24	1.03	0.86	0.77	0.69	0.62	0.52	0.48	0.41	0.39	0.31	0.25
15HZ	5.15	2.58	2.10	1.72	1.29	1.03	0.86	0.72	0.65	0.57	0.52	0.43	0.40	0.34	0.32	0.26	0.21
12HZ	4.12	2.06	1.68	1.38	1.03	0.82	0.69	0.57	0.52	0.46	0.41	0.34	0.32	0.27	0.26	0.21	0.16
9HZ	3.09	1.55	1.26	1.03	0.77	0.62	0.52	0.43	0.39	0.34	0.31	0.26	0.24	0.21	0.19	0.16	0.12
6HZ	2.06	1.03	0.84	0.69	0.52	0.41	0.34	0.29	0.26	0.23	0.21	0.17	0.16	0.14	0.13	0.10	0.08

Exhibit N

LEESON®

TECHNICAL INFORMATION

MOTOR SELECTION

Electric motors are the workhorses of industry. Many applications exist where more than one motor can be used and/or the exact replacement is not available. LEESON makes every effort to maximize interchangeability, mechanically and electrically, where compromise does not interfere with reliability and safety standards. If you are not certain of a replacement condition, contact any LEESON Authorized Distributor or the LEESON District Sales Office.

SELECTION

Identifying a motor for replacement purposes or specifying a motor for new applications can be done easily if the following information is known:

1. Nameplate Data
2. Motor Type
3. Electrical and Performance Characteristics
4. Mechanical Construction

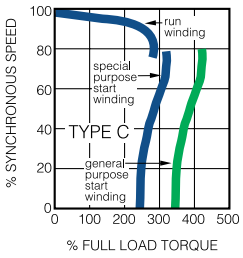
NAMEPLATE DATA

Nameplate data is the most important first step in determining motor replacement. Much of the information needed can generally be obtained from the nameplate of the motor to be replaced. Take time to record all the nameplate information because it can save time, avoid confusion and MISAPPLICATION.

MOTOR TYPE

Alternating current (AC) induction motors are divided into two electrical categories, based on power source—single phase and polyphase (three phase). Direct current (DC) motors are used in applications where precise speed control is required or when battery or generated direct current is the available power source.

TYPICAL SPEED TORQUE CURVES



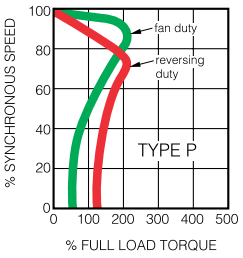
Capacitor Start/Induction Run

A single phase general purpose design, with an electrolytic capacitor in series with the start winding, offering maximum starting torque per ampere.

A centrifugal switch removes the auxiliary winding and capacitor when the motor approaches full load speed. The design is a heavy-duty unit which has approximately 300% (of full load) starting torque. Common applications include compressors, pumps, conveyors and other "hard-to-start" applications.

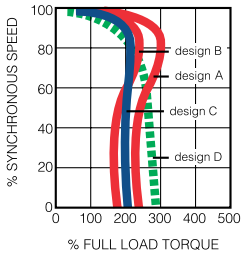
Capacitor Start/Capacitor Run

This design has two capacitors of different values. A centrifugal switch is used to remove the electrolytic capacitor when the motor approaches full load speed. A second run capacitor remains in series with the auxiliary winding during full load operation. This type of design has lower full-load amps as a result of the run capacitor and is consequently used on most higher horsepower single phase motors.



Permanent Split Capacitor (PSC)

This design has an auxiliary winding with a "run" capacitor, but unlike the capacitor start/induction run motor, the capacitor and auxiliary winding remain in the circuit under running conditions. (There is no centrifugal switch on this type motor.) A permanent split capacitor design has low starting torque and low starting current. They are generally used on direct-drive fans and blowers. They can also be designed for higher starting torque and intermittent applications, where rapid reversing is desired.

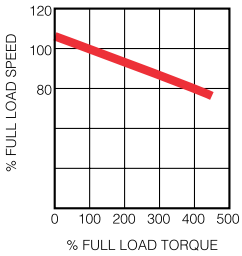


Three Phase or Polyphase

General purpose three phase motors have different electrical design classifications as defined by NEMA. NEMA Design A and B motors are of normal starting torque with normal starting current. NEMA Design C motors have higher starting torque with normal starting current. All three types have slip of less than 5%. ("Slip" being a term which expresses, as a percentage, the difference between synchronous motor speed and full load motor speed, for example, 1800 rpm synchronous versus a full load speed of 1740 rpm.

NEMA's Design B and C standards are minimum performance standards. In practice, some manufacturers (including LEESON) build small integral HP Design B motors with locked rotor and breakdown torque levels equalling NEMA Design C standards.

NEMA T frame motors 1 through 200 HP *covered* by EPACT (identified with a "G" catalog prefix) are labeled Design B, exceed NEMA Design B performance levels, and have efficiencies equal to EPACT mandated levels. EPACT *exempt* three phase, base-mounted motors are labeled Design C and have performance characteristics meeting NEMA's Design C standards, with standard motor efficiencies. Motors 250 HP and larger are exempt from EPACT legislation.



Permanent Magnet DC

This design has linear speed/torque characteristics over the entire speed range. SCR rated motor features include high starting torque for heavy load applications and dynamic braking, variable speed and reversing capabilities. Designs are also available for use on generated low voltage DC power or remote applications requiring battery power.

ELECTRICAL AND PERFORMANCE CHARACTERISTICS

One of the best ways to guarantee economical performance and long motor life is to make sure your motors operate at nameplate voltage. Applying too high a voltage may reduce the motor's efficiency and increase operating temperatures. The net result is shorter motor life.

Under-voltage can also shorten motor life. Operating on too low a voltage reduces the motor's effective horsepower. The motor will attempt to drive the load it was intended to drive, become overloaded, draw more current than normal, and overheat. Again, the result will be premature failure.

ENCLOSURES AND ENVIRONMENT

DRIP-PROOF: Venting in end frame and/or main frame located to prevent drops of liquid from falling into motor within a 15˚ angle from vertical. Designed for use in areas that are reasonably dry, clean, and well ventilated (usually indoors). If installed outdoors, it is recommended that the motor be protected with a cover that does not restrict the flow of air to the motor.

TOTALLY ENCLOSED AIR OVER (TEAO): Dust-tight fan and blower duty motors designed for shaft mounted fans or belt driven fans. The motor must be mounted within the airflow of the fan.

TOTALLY ENCLOSED NON-VENTILATED (TENV): No vent openings, tightly enclosed to prevent the free exchange of air, but not airtight. Has no external cooling fan and relies on convection for cooling. Suitable for use where exposed to dirt or dampness, but not for hazardous (explosive) locations.

TOTALLY ENCLOSED FAN COOLED (TEFC): Same as the TENV except has external fan as an integral part of the motor, to provide cooling by blowing air around the outside frame of the motor.

TOTALLY ENCLOSED, HOSTILE AND SEVERE ENVIRONMENT MOTORS: Designed for use in extremely moist or chemical environments, but not for hazardous locations.

TOTALLY ENCLOSED BLOWER COOLED MOTORS (TEBC): Used to extend the safe speed range of inverter-fed motors. Similar to TEFC except a small, constant-speed fan provides uniform airflow regardless of the drive motor's operating speed.

EXPLOSION-PROOF MOTORS: These motors meet Underwriters Laboratories and Canadian Standards Association standards for use in hazardous (explosive) locations, as indicated by the UL label affixed to the motor. Locations are considered hazardous because the atmosphere does or may contain gas, vapor, or dust in explosive quantities.

NEMA SERVICE FACTORS

HP	ENCLOSURE	RPM 3600	1800	1200
1/4-1/3	Open	1.35	1.35	1.35
1/2-3/4	Open	1.25	1.25	1.25
1 & Larger	Open	1.15	1.15	1.15
All	Totally Enclosed	1.00	1.00	1.00

Most LEESON Totally Enclosed Motors have 1.15 Service Factor. Refer to the Service Factor information on each page to identify specific totally enclosed motors with NEMA 1.00 Service Factor or LEESON 1.15 Service Factor. All drip-proof motors have NEMA Service Factors of 1.15 or higher. All three phase totally enclosed motors have NEMA Service Factors of 1.15 except when noted (♣).

SCR PM DC MOTORS ON PWM POWER SUPPLIES

Pulse width modulated DC controls have a voltage output similar to pure direct current which has a form factor of 1.00. SCR thyristor drives, such as the SPEEDMASTER® controls listed on page 83, have a form factor of 1.4.

LEESON stock SCR rated motors can also be used with PWM controls. In fact, the motor's HP rating can be increased because of less heating in the motor. In addition, the motor will operate quieter and the brush life will be extended.

Rated HP 1.40 FF	Rated RPM	Rated Volts	Catalog Number	Rated HP 1.05 FF
1/4	1750	90	**098002**	0.40
	1750	180	**098003**	0.50
1/3	1750	90	**098004**	0.50
	1750	90	**108424**	0.56
	1750	180	**098005**	0.50
1/2	2500	90	**098006**	0.75
	2500	180	**098007**	0.70
	1750	90	**098000**	0.70
	1750	90	**108014**	0.75
	1750	90	**108226**	0.75
	1750	180	**098008**	0.56
	1750	180	**108015**	0.70
	1750	180	**108227**	0.70
3/4	2500	90	**098009**	1.00
	2500	90	**108016**	1.00
	2500	180	**098010**	1.00
	2500	180	**108017**	0.86
	1750	90	**098032**	1.00
	1750	90	**108018**	1.00
	1750	90	**108228**	1.25
	1750	180	**098069**	1.00
	1750	180	**108019**	1.00
	1750	180	**108229**	1.25
1	2500	90	**108020**	1.50
	2500	180	**108021**	1.50
	1750	90	**108022**	1.25
	1750	90	**108230**	1.25
	1750	180	**108023**	1.25
	1750	180	**108231**	1.25
1½	2500	180	**108265**	2.00
	1750	180	**108092**	1.75
	1750	180	**108262**	1.75
	1750	180	**108232**	1.75
	1750	180	**128000**	--
2	2500	180	**108266**	3.00
	1750	180	**128001**	--
	1750	180	**128010**	--
3	2500	180	**128008**	--
	1750	180	**108502**	--

METRIC (IEC) DESIGNATIONS

The International Electrotechnical Commission (IEC) is a European-based organization that publishes and promotes worldwide mechanical and electrical standards for motors, among other things. In simple terms, it can be said that IEC is the international counterpart to the National Electrical Manufacturers Association (NEMA), which publishes the motor standards used in the United States.

IEC standards are expressed in metric units.

IEC ENCLOSURE PROTECTION INDEXES

Like NEMA, IEC has designations indicating the protection provided by a motor's enclosure. However, where NEMA designations are word descriptive, such as Open Drip-Proof or Totally Enclosed Fan Cooled. IEC uses a two-digit Index of Protection (IP) designation. The first digit indicates how well-protected the motor is against the entry of solid objects, the second digit refers to water entry.

By way of general comparison, an IP22 motor relates to Open Drip-Proof, IP54 to totally enclosed.

Protection Against Solid Objects		Protection Against Liquids	
Number	Definition	Number	Definition
0	No protection	0	No protection
1	Protected against solid objects of over 50 mm (e.g. accidental hand contact)	1	Protected against water vertically dripping (condensation)
2	Protected against solid objects of over 12 mm (e.g. finger)	2	Protected against water dripping up to 15° from the vertical
3	Protected against solid objects of over 2.5 mm (e.g. tools, wire)	3	Protected against rain falling at up to 60° from the vertical
4	Protected against solid objects of over 1 mm (e.g. thin wire)	4	Protected against water splashes from all directions
5	Protected against dust	5	Protected against jets of water from all directions
6	Totally protected against dust. Does not involve rotating machines	6	Protected against jets of water comparable to heavy seas
		7	Protected against the effects of immersion to depths of between 0.15 and 1m
		8	Protected against the effects of prolonged immersion at depth

IEC DESIGN TYPES

The electrical performance characteristics of IEC Design N motors in general mirror those of NEMA Design B—the most common type of motor for industrial applications. By the same token, the characteristics of IEC Design H are nearly identical to those of NEMA Design C. There is no specific IEC equivalent to NEMA Design D.

MOTOR EFFICIENCY TEST METHODS

Performance data of single phase motors is determined by using I.E.E.E. Std. 114 (Method B), three phase motors by I.E.E.E. Std. 112 (Method B). Motor efficiency is calculated using CSA C390. These testing methods meet the requirements of EPACT of 1992 and most utility companies.

For complete performance data on all LEESON motors, please review the Find-A-Product section on *www.leeson.com*.

U.L., CSA, ISO AND OTHER STANDARDS & APPROVALS – MOTORS

UNDERWRITERS LABORATORIES INC.

1. All motor models listed with prefix "C" have U.L. component recognition (without thermal overload). File Number E57948, Guide Number PRGY2.
2. All units have U.L. recognized Class B, F or H insulation systems unless otherwise noted. File Number E55555, Guide Number OBJY2.
3. Single phase motors with a model number prefix of "A" or "M" (automatic or manual protectors) have U.L. recognized protector winding combinations and component recognition. File Number E57955, Guide Number XEWR2.
4. Three phase motors with a model number prefix of "A" or "M" (automatic or manual protectors) have U.L. recognized protector winding combinations plus have capability of providing U.L. recognized primary single phasing which is included in our U.L. file E57955, Guide Number XEWR2.
5. Explosion-Proof, single and three phase for 56, 143T and 145T frames: File Number E75276, Guide Number PTDR.

   Explosion-Proof motors 182T and larger: File Number E12044, Guide Number PTDR.

   Explosion-Proof motors DC motors 48 frame: File Number E75276, Guide Number PTDR..
6. Permanent Magnet DC motors except PZ and P300 gearmotors are recognized components under File Number E57948, Guide Number PRGY2.
7. PZ and P300 Permanent Magnet DC gearmotors: File number E49849 or E49747, Guide Number PRGY2.
8. Speedmaster SCR Drives, Component Recognition, File E132235, Guide Number NMMS2, except catalog numbers 174902 and 174903.
9. Speedmaster SCR Drives, catalog numbers 174902 and 174903. File Number E154901, Guide Number NMFT2.
10. Speedmaster AC Adjustable Speed Drives, File Number E161242. Canadian UL covered by File Number E161242 also, Guide Number NMMS.

CANADIAN STANDARDS ASSOCIATION

1. Motor construction for all single and three phase NEMA 42 through S254T frame, IEC/metric 63 through 90L frame, and all sub-fractional horsepower motors: Report Number LR33543, Guide Number 260-0-0..
2. Motor construction for all steel or cast iron three phase NEMA 182T through 447T frame and IEC/metric 100L through 250M frame motors: Report Number LR62104.
3. Thermally protected single phase motors through 7½ HP, Report Number LR33543.
4. All Farm Duty motors 1/3 HP through 7½ HP, Report Number LR33543
5. Explosion proof single and three phase for 56, 143T and 145T frames: File Number LR47667.

   Explosion-Proof motors 182T and larger: File Number LR21839 and LR47504.

   Explosion-Proof DC motors 48 frame: File Number LR701080.
6. Permanent Magnet DC motors are listed under File Number LR33543.
7. Multi-Speed Motors, steel or cast iron, 182T through 447T frames are listed under file number LR33543.
8. Speedmaster SCR Drives, catalog numbers 174902 and 174903. File Number LR75790.

MOTOR EFFICIENCY VERIFICATION

Energy Efficiency Verification - Full load efficiency ratings of three phase, single speed, NEMA/EEMAC Design A or B squirrel cage induction motors, 1 through 200 HP, 230, 460 or 575 volts, 60 Hz, in totally enclosed and open, drip-proof enclosures for non-hazardous applications, CSA Report Number EEV 78720-1. Tested to CSA 390 (IEEE 112B) Standards. The Grafton testing facility is qualified for CSA energy efficiency performance testing of polyphase induction motors. The Grafton Testing Facility is NVLAB recognized for energy efficiency testing of electric motors to EPACT requirements of the Department of Energy.

ISO QUALITY CERTIFICATION

Grafton and Saukville, Wisconsin administrative, design and manufacturing facility, ISO 9001, Certificate Number RvC #93-102. EN29001, BS5750: Part 1 and ANSI/ASQC Q91-19.

Black River Falls, Wisconsin manufacturing facility, ISO 9002, Certificate Number RvC #93-090.

Mississauga (Toronto), Ontario, administrative, distribution facility, ISO 9002, Certificate Number QMI #003027.

Hanover, Ontario, manufacturing facility, ISO 9002, Certificate Number QMI #003028.

BAKING INDUSTRY SANITATION STANDARDS COMMITTEE

WASHGUARD® II, stainless steel washdown duty motors, NEMA frames 56, 143T, 145T, 182T and 184T are certified to Standard No. 29 for Electric Motors and Accessory Equipment, authorization number 769. The WBMQ Series of gear reducers are BISSC certified to Standard No. 29 for Electric Motors and Accessory Equipment, authorization number 941.

SAUDI ARABIAN STANDARDS ORGANIZATION

SCCP Ref. No.: R-100157

The CE Mark

CE is an acronym for the French phrase *"Conformite Europeene"* and is similar to the UL or CSA marks of North America. However, unlike UL or CSA which require independent laboratory testing, the CE mark can be applied by the motor manufacturer through "self certifying" that its products are designed to the appropriate standards. The European Union has issued 24 directives related to the **CE** mark. Three Directives apply to electric motors.

Low Voltage Directive (73/23/EEC) This directive applies to electrical equipment operating in the voltage range of 50-1000 volts AC or 75-1500 volts DC. Virtually all LEESON motors (except low voltage DC) are included in this directive.

Based on our testing to the applicable electrical and mechanical standards EN60034 and IEC 34, LEESON certifies conformity to this directive. All three phase 50 Hz stock motors comply with the nameplate designations, lead markings and connection diagrams required. A "Declaration of Conformity" accompanies these motors and a CE label is applied.

Machinery Directive (89/3392/EEC) This directive applies to machinery that may contain certain motors. This is an issue with equipment manufacturers and requires the use of a motor meeting the Low Voltage Directive and requires a "Declaration of Incorporation" document which means that only the motor complies with the requirements of the Low Voltage Directive. A CE label is applied to the motor but it remains the responsibility of the equipment manufacturer to obtain certification for the finished product.

Electromagnetic Compatibility (EMC) Directive (89/336/EEC) This directive addresses the final product and is again a concern for the equipment manufacturer. Since this Directive addresses electromagnetic interference (EMI) concerns, it does not affect three phase AC motors because they do not produce EMI. DC motors, however, do produce EMI. How much of the "noise" is emitted outside the machine depends on a host of factors. LEESON's Engineering Department can assist OEM's in applying DC motors in machinery destined for Europe and requiring certification to the EMC Directive.

CE CONFORMITE EUROPEENE

INVERTER CAPABILITIES OF LEESON MOTORS

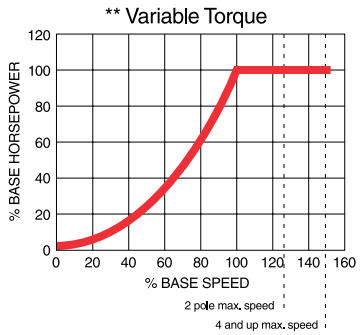
STEEL FRAME MOTORS	NEMA Frame	Variable Torque**	Constant Torque**	Notes
Standard General Purpose				
TEFC	56-210 frame	10-90* Hz	20-90* Hz	
ODP	56-210 frame	10-90* Hz	20-90* Hz	
WATTSAVER® Premium Efficiency				
TEFC	56-210 frame	6-90* Hz	20-90* Hz	CT: 10-90 Hz on some ratings
ODP	56-210 frame	6-90* Hz	20-90* Hz	CT: 10-90 Hz on some ratings
Special Purpose Motors				
WASHGUARD® motors				
TENV	56-140 frame	10-90* Hz	10-90* Hz	
TEFC	56-210 frame	10-90* Hz	20-90* Hz	

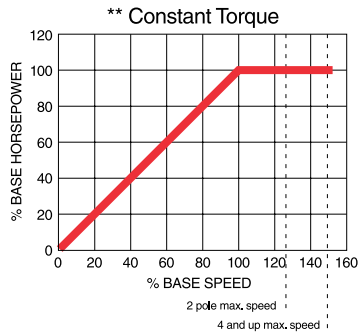
CAST IRON MOTORS	NEMA Frame	Variable Torque**	Constant Torque**	Notes
Standard General Purpose				
TEFC	180-440 frame	10-90* Hz	20-90* Hz	CT: 15-90 Hz on some ratings
ODP	180-440 frame	10-90* Hz	20-90* Hz	CT: 15-90 Hz on some ratings
TEFC with blower kit	180-320 frame	5-90* Hz	5-90* Hz	full torque at low speed with vector drive
WATTSAVER® Premium Efficiency				
TEFC	180-280 frame	6-90* Hz	6-90* Hz	
	320-440 frame	10-90* Hz	15-90* Hz	CT: 6-90 Hz on some ratings
ODP	180-280 frame	6-90* Hz	6-90* Hz	
	320-440 frame	10-90* Hz	15-90* Hz	CT: 6-90 Hz on some ratings
TEFC with blower kit	180-320 frame	0-90* Hz	0-90* Hz	full torque at zero speed with vector drive
SPEEDMASTER® Extreme-Duty Inverter Motors				
TENV	143TC-256TC	0-120 Hz	0-120 Hz	
TEBC	284T-449T	0-90 Hz	0-90 Hz	

* The maximum recommended frequency (speed) for 2 pole (3600 rpm) motor is Hz=75, rather that 90 Hz.
** Operation for variable or constant torque is up to a base frequency of 60 Hz only. Operation above 60 Hz to the maximum frequency listed is constant horsepower (horsepower equal to motor rated horsepower).

NOTES:

1. All motors are class F insulated, 40°C ambient, 3300 ft. and 1.0 service factor when used with an inverter.
2. Optimized voltage boost is required for continuous operation throughout the frequency range specified. (See operating curves.)
3. Motors with blower kits have continuous cooling and are capable of full rated torque at 0 speed with properly tuned vector drive.
4. Maximum recommended cable length for IGBT inverters is 250 ft. (longer cable lengths may require noise or voltage suppression).
5. All LEESON three phase stock motors (1 HP and larger) have the IRIS™ insulation system, which is designed to meet the NEMA requirements for peak voltages up to 1600 volts, and pulse rise time greater than or equal to 0.1 microseconds.
6. Operating curves are available for WATTSAVER® motors. Refer to curves for more details about frequency ranges.
7. Refer to Bulletin 1051 for performance data of WATTSAVER® motors fed by inverters.





LEESON MOTOR MODEL NUMBER NOMENCLATURE

All LEESON motors, both stock and custom, have a catalog number and a model number. The model number appears on the motor's nameplate and describes pertinent electrical and mechanical features of the motor. An example follows along with a listing of the various letters and positions used.

POSITION 1: U.L. PREFIX

A = Auto protector. U.L. recognized for locked rotor plus run, also recognized construction (U.L. 1004)*.
M = Manual protector. U.L. recognized for locked rotor plus run, also recognized construction (U.L. 1004)*.
L = Locked rotor protector (automatic). U.L. recognized for locked rotor only, also recognized construction (U.L. 1004)*.
C = Component recognition. (U.L. 1004) No protector.
U = Auto protector. Not U.L. recognized.
P = Manual protector. Not U.L. recognized.
T = Thermostat, not U.L. recognized.
N = No overload protection.

*This applies only to 48, S56, and 56 frame designs through 1 HP, Open & TENV.

POSITION 2: (OPTIONAL)

This position is not always used.
M = Sub-Fractional HP Motors.
Z = BISSC Approved.
Other = Customer Code

POSITION 3: FRAME

4 = 48 Frame	23 = 23 Frame	40 = 40 Frame
6 = 56 Frame	30 = 30 Frame	43 = 43 Frame
42 = 42 Frame	34 = 34 Frame	44 = 44 Frame
143 = 143T Frame	36 = 36 Frame	53 = 53 Frame
145 = 145T Frame	38 = 38 Frame	65 = 65 Frame
182 = 182T Frame	39 = 39 Frame	
184 = 184T Frame		
213 = 213T Frame		
215 = 215T Frame		

POSITION 4: MOTOR TYPE

C = Cap. Start/Ind. Run	T = Three Phase
D = Direct Current	B = Brushless DC
K = Cap. Start/Cap. Run	H = Hysteresis Sync.
P = Permanent Split	R = Reluctance Sync.
S = Split Phase	

POSITION 5: RPM

RPM-Single Speed	RPM-Multi-Speed
34 = 3450 RPM 60 Hz 2 Pole	24 = 2 and 4 Poles
28 = 2850 RPM 50 Hz 2 Pole	26 = 2 and 6 Poles
17 = 1725 RPM 60 Hz 4 Pole	82 = 2 and 8 Poles
14 = 1425 RPM 50 Hz 4 Pole	212 = 2 and 12 Poles
11 = 1140 RPM 60 Hz 6 Pole	46 = 4 and 6 Poles
9 = 950 RPM 50 Hz 6 Pole	48 = 4 and 8 Poles
8 = 960 RPM 60 Hz 8 Pole	410 = 4 and 10 Poles
7 = 720 RPM 50 Hz 8 Pole	412 = 4 and 12 Poles
7 = 795 RPM 60 Hz 10 Pole	68 = 6 and 8 Poles
6 = 580 RPM 50 Hz 10 Pole	
6 = 580 RPM 60 Hz 12 Pole	

Odd frequencies other than 50 Hz show synchronous speed code.

DC and special motors may have one, two, or three digits indicating motor speed rounded to the nearest hundred RPM.

EXAMPLE:

Position No.	1	2	3	4	5	6	7	8	9	10
Sample Model No.	A	B	4	C	17	D	B	1	A	(A-Z)

POSITION 6: ENCLOSURE

D = Drip-Proof
E = Explosion-Proof TENV
F = Fan Cooled
N = TENV
O = Open
S = Splashproof
W = Weatherproof, Severe Duty, Chemical Duty, WASHGUARD™ - TEFC
X = Explosion-Proof TEFC
V = Weatherproof, Severe Duty, Chemical Duty, WASHGUARD™ - TENV

POSITION 7: MOUNTING

B = Rigid base standard
C = "C" face - no base - NEMA
D = "D" flange - no base - NEMA
H = 48 frame - 56 frame mounting/shaft rigid
J = 48 frame - 56 frame mounting/shaft resilient
K = Rigid mount with "C" flange
L = Rigid mount with "D" flange
M = Motor parts - rotor and stator
R = Resilient base
S = Shell motor
T = Round body
Z = Special mounting

POSITION 8: SEQUENCE NUMBER

Number assigned as required when new designs with new characteristics are needed.

POSITION 9: MODIFICATION LETTER

Major modification letter. Used when revisions made in existing model ***will*** affect service parts.

POSITION 10: (OPTIONAL)

A date code consisting of either A-Z, and two digits 00-99.

Letter when shown on nameplate indicates model has U.L. primary single phasing recognition. (Applies to 3 phase motors only.)

Code letters indicate manufacturing location:
A = Grafton, WI
B = Black River Falls, WI
C = Saukville, WI
E = Neillsville, WI
G = Lincoln, MO
P = West Plains, MO

Lubrication Instructions For Ball Bearing Motors

Lubrication
This motor is supplied with pre-lubrication ball bearings. No lubrication required before start up.

Relubrication Intervals
The following intervals are suggested as a guide:

SUGGESTED RELUBRICATION INTERVALS		
HOURS OF SERVICE PER YEAR	H.P. RANGE	RELUBE INTERVAL
5,000	Sub Fractional to 7 1/2 10 to 40 50-200	5 Years 3 Years 1 Year
Continuous Normal Applications	Sub Fractional to 7 1/2 10 to 40 50 to 200	2 Years 1 Year 9 Months
Season Service Motor Idle 6 Months or More	All	1 Year (Beginning of Season)
Continuous High Ambients Dirty or Moist Locations High Vibrations Where Shaft End is Hot (Pumps-Fans)	Sub Fractional to 40 50 to 200	6 Months 3 Months

Lubrication

Use high quality ball bearing lubricant. Use consistency of lubricant suitable for class of insulation stamped on nameplate as follows:

LUBRICATION CONSISTENCY				
INSULATION CLASS	CONSISTENCY	TYPE	TYPICAL LUBRICATION	FRAME TYPE
B & F F & H	Medium	Polyurea	Shell Dolium R and/or Chevron SR1 2	Sub Fractional to 447T All

Procedure

If motor is equipped with Alemite fitting, clean tip of fitting and apply grease gun. Use 1 to 2 full strokes on motors in NEMA 215T frame and smaller. Use 2 to 3 strokes on NEMA 254T thru NEMA 365 T frame. Use 3 to 4 strokes on NEMA 404T frames and larger. On motors having drain plugs, remove drain plug and operate motor for 20 minutes before replacing drain plug.

On motors equipped with slotted head grease screw, remove screw and apply grease tube to hole. Insert 2 to 3 inch length of grease string into each hole on motors in NEMA 215T frame and smaller. Insert 3 to 5 inch length on larger motors. For motors having drain plug and operate motor for 20 minutes before replacing drain plug.

CAUTION: Keep lubricant clean. Lubricate motors at standstill. remove and replace drain plugs at standstill. Do not mix petroleum lubricant and silicone lubricant in motor bearings.

LEESON®
ELECTRIC MOTORS, GEARMOTORS AND DRIVES
LEESON ELECTRIC
GRAFTON, WISCONSIN 53024-0241 U.S.A.
TEL (262)377-8810 FAX (262)377-9025 www.leeson.com
A Subsidiary of Regal-Beloit Corporation

Installation Maintenance Instructions AC Induction Motors

Installation

After unpacking, check for damage. Be sure that shaft rotates freely. Before making electrical power connections, check for proper grounding of motor and application. All electrical contacts and connections must be properly insulated and enclosed. Couplings, belts, chains or other mounted devices must be in proper alignment, balance and secure to insure safe motor operation.

Electrical Wiring

Prior to connecting to the power line, check nameplate for proper voltage and rotation connection. This motor should be installed in compliance with the National Electrical Code and any other applicable codes. Voltage at motor not to exceed + or -10% of nameplate. Authorized person should make all electrical connections.

Mounting

This motor should be securely mounted to the application. Sufficient ventilation area should be provided to insure proper operation.

RECOMMENDED COPPER WIRE & TRANSFORMER SIZE

SINGLE PHASE MOTORS - 230 VOLTS

H.P.	TRANSFORMER KVA	DISTANCE - MOTOR TO TRANSF. IN FT.				
		100	150	200	300	500
1 1/2	3	10	8	8	6	4
2	3	10	8	8	6	4
3	5	8	8	6	4	2
5	7 1/2	6	4	4	2	0
7 1/2	10	6	4	3	1	0

THREE PHASE MOTORS - 230 & 460 VOLTS

H.P.	VOLTS	TRANSFORMER KVA	DISTANCE - MOTOR TO TRANSF. IN FT.				
			100	150	200	300	500
1 1/2	230	3	12	12	12	12	10
1 1/2	460	3	12	12	12	12	12
2	230	3	12	12	12	10	8
2	460	3	12	12	12	12	12
3	230	5	12	10	10	8	6
3	460	5	12	12	12	12	10
5	230	7	10	8	8	6	4
5	460	1/2	12	12	12	10	8
7 1/2	230	7 1/2	8	6	6	4	2
7 1/2	460	10	12	12	12	10	8
10	230	10	6	4	4	4	1
10	460	15	12	12	12	10	8
15	230	15	4	4	4	2	0
15	460	20	12	10	10	8	6
20	230	20	4	2	2	1	000
20	460		10	8	8	6	4
25	230		2	2	2	0	000
25	460	Consult	8	8	6	6	4
30	230	Local	2	1	1	00	0000
30	460	Power	8	6	6	4	2
40	230	Company	1	0	00	0000	300
40	460		6	6	4	2	0
50	230		1	0	00	0000	300
50	460		4	4	2	2	0
60	230		1	00	000	250	500
60	460		4	2	2	0	00
75	230		0	000	0000	300	500
75	460		4	2	0	00	000

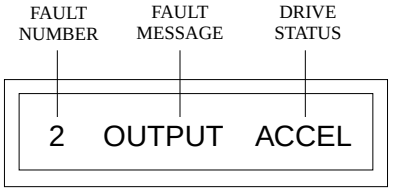
LEESON®

MC3000 FAULT MESSAGES

FAULT	DESCRIPTION
OUTPUT	Output Transistor fault. Output current exceeded 200%. May be ground fault or short circuit.
LO VOLTS	Low DC Bus Voltage fault. DC bus voltage dropped below 60% May be low line voltage.
HI VOLTS	High DC Bus Voltage fault. DC Bus voltage exceeded 120%. May be overhauling load .
HI TEMP	High Temperature fault. Heatsink or ambient temperature too high.
OVERLOAD	Current Overload fault. Output current exceeded 100% for too long. VFD may be undersized.
PWR TRAN	Power Transient fault.
PWR SAG	Power Sag fault: New control board installed. Perform factory reset using Parameter 65.
LANGUAGE	Language EEPROM fault.
EXTERNAL	External fault: TB-130 activated (Parameter 50).
DB ERROR	Dynamic Brake fault. DB Resistors overloaded.
CONTROL	Control Board fault. New solfware installed. Perform factory reset using Parameter 65.
INTERNAL	Internal fault
INTERN (#)	Internal fault.

MICRO SERIES FAULT HISTORY

Parameter 70 — FAULT HISTORY stores the last eight faults that tripped the drive. The FAULT HISTORY indicates the number of the fault (number 1 is the most recent fault), the fault message, and the status of the drive at the time of the fault. An example is shown below:



In the example above, the second fault is being viewed, which is an OUTPUT fault that occurred while the drive was accelerating.

MICRO SERIES PARAMETERS

NO.	PARAMETER NAME	FACTORY DEFAULT	NO.	PARAMETER NAME	FACTORY DAFAULT
0	LINE VOLTS	AUTO	29	MANUAL	KEYPAD
1	SPEED #1	20.00 Hz	30	CONTROL	LOCAL
2	SPEED #2	20.00 Hz	31	UNITS	HERTZ
3	SPEED #3	20.00 Hz	32	HZ MULT	1
4	SPEED #4	20.00 Hz	33	UNITS DP	XXXX
5	SKIP #1	.00 Hz	34	LOAD MLT	100%
6	SKIP #2	.00 Hz	35	CONTRAST	HIGH
7	BAND WID	1.00 Hz	39	TB5 MIN	.00 Hz
8	ACCEL	30.0 SEC	40	TB5 MAX	60.00 Hz
9	DECEL	30.0 SEC	42	TB10A OUT	NONE
10	MIN FRQ	.50 Hz	43	@TB10A	60.00 Hz
11	MAX FRQ	60.00 Hz	44	TB10B OUT	NONE
12	DC BRAKE	.0 VDC	45	@TB10B	125%
13	DC TIME	.0 SEC	47	TB13A	NONE
14	DYN BRAKE	OFF	48	TB13B	NONE
16	CURRENT	180%	49	TB13C	NONE
17	MOTOR OL	100%	50	TB13D	FAULT
18	BASE	60.00 Hz	52	TB14 OUT	NONE
19	FX BOOST	(NOTE 1)	53	TB15 OUT	NONE
20	AC BOOST	.0%	54	RELAY	NONE
21	SLIP COMP	.0%	58	ADDRESS	30
22	TORQUE	CONSTANT	61	PASSWORD	0019
23	CARRIER	2.5 kHz	63	SOFTWARE	(NOTE 2)
25	START	NORMAL	64	MONITOR	ON
26	STOP	COAST	65	PROGRAM	RESET 60
27	ROTATION	FORWARD	66	HISTORY	MAINTAIN
28	AUTO/MAN	BOTH	70	FAULT HIST.	(NOTE 2)

NOTE 1: REFER TO THE MICRO SERIES MANUAL.

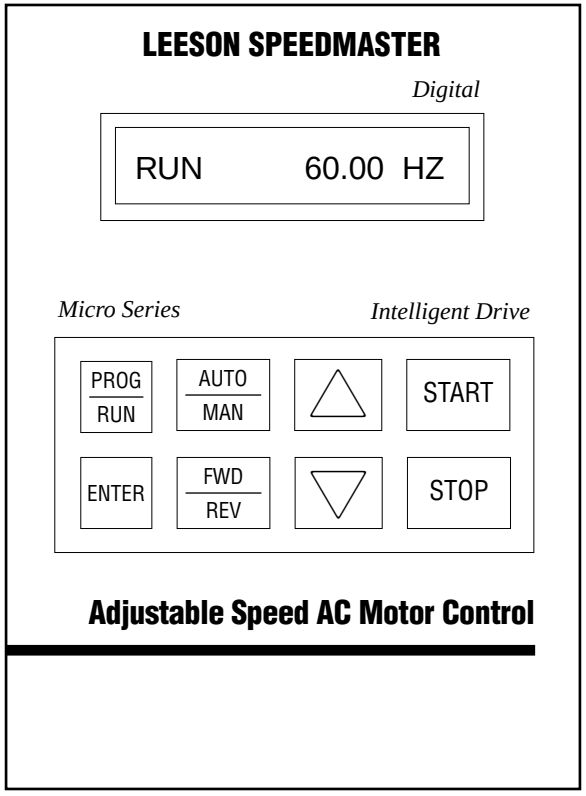
NOTE 2: THESE PARAMETERS ARE VIEW-ONLY.

BULLETIN #2452 3/98

Exhibit O-8

LEESON

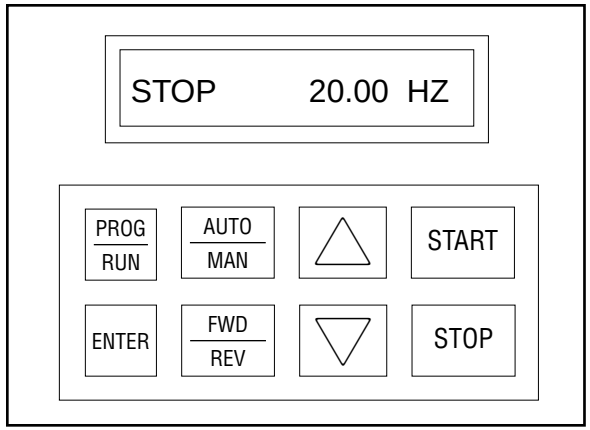
Variable Speed AC Motor Drives



Micro Series Quick Reference Guide

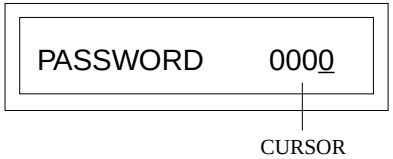
NOTE: Before installing and operating the MICRO SERIES drive, please read and become familiar with the MICRO SERIES Installation and Operation Manual.

MICRO SERIES KEYPAD



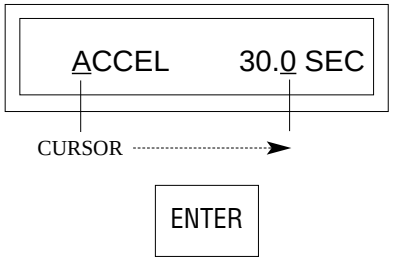
PROGRAMMING THE MICRO SERIES

1. Press the PROG/RUN key. This will cause the PASSWORD prompt to appear (unless the password protection has been disabled), as shown below:



2. Use the ARROW keys to scroll to the correct password value (the factory default password is 0019) and press ENTER. The PROGRAM mode will be entered at the start of the parameter menu. A cursor will highlight the parameter name.

3. Use the ARROW keys to scroll to the desired parameter and press ENTER. The cursor will shift from the parameter name to the parameter value, as the example below illustrates:



4. Use the ARROW keys to scroll to the desired parameter value, and press ENTER to store the new value.

5. Press PROG/RUN to exit the PROGRAM mode.

MICRO SERIES KEYPAD FUNCTIONS

START — Press the START key to start the drive. The START key is only active in LOCAL mode.

STOP — Press the STOP key to stop the drive.
NOTE: The STOP key is active in both LOCAL and REMOTE mode.

The STOP key is also used to reset faults. If the fault condition has passed, pressing the STOP key will clear the fault and return the drive to a STOP condition.

UP and DOWN ARROWS — Used to change the speed setpoint in MANUAL mode, scroll through the parameter menu, and change parameter values.

AUTO / MAN — Toggles between AUTOMATIC (terminal strip) and MANUAL (keypad) speed control.
NOTE: Parameter 28 — AUTO/MAN must be set to BOTH for this key to be active.

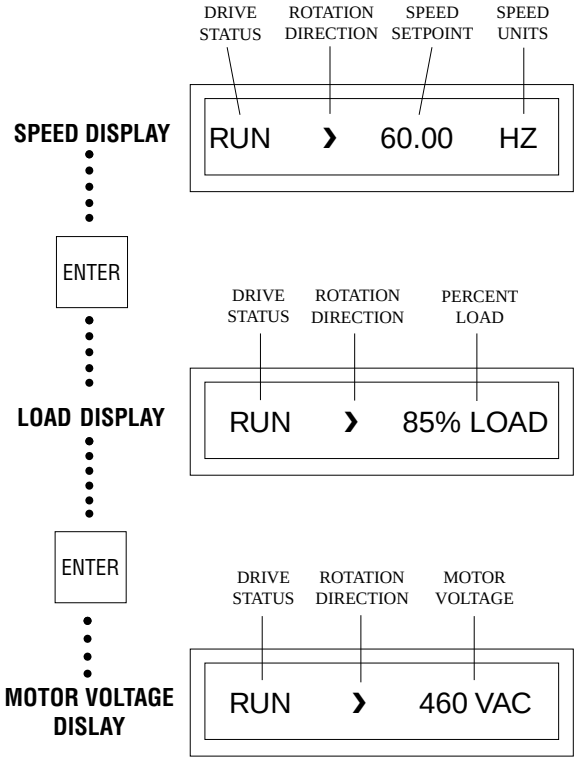
FWD / REV — Toggles between forward and reverse directions. ENTER key must pressed.

PROG / RUN — Used to enter and exit the PROGRAM mode to set the parameters.

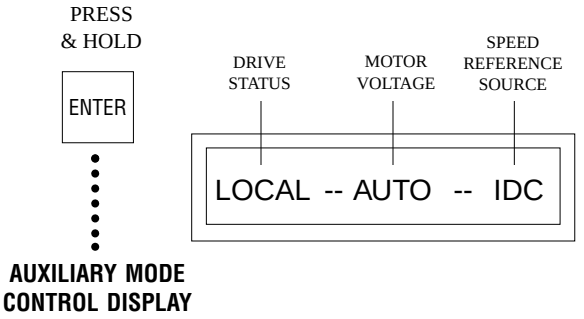
ENTER — Used for: toggling the display between SPEED, LOAD, and MOTOR VOLTAGE; confirming new parameter values; confirming AUTO and MANUAL speed control selections.

MICRO SERIES DISPLAYS

Shown below are examples of MICRO SERIES displays. To scroll through the SPEED, LOAD, and MOTOR VOLTAGE displays, press and release the ENTER key.



Press and hold the ENTER key to activate the AUXILIARY MODE, which will toggle to a CONTROL DISPLAY. An example is shown below:



LEESON®

OHIO GEAR™

TECHNICAL INFORMATION

IRONMAN BY OHIO GEAR™

CONDENSED GLOSSARY OF MOTOR AND GEARING TERMS

Axial Movement - Often called "endplay." The endwise movement of motor or gear shafts. Usually expressed in thousandths of an inch.

Back Driving - Driving the output shaft of a reducer — using it to increase speed rather than reduce speed. Worm gear reducers are not suitable for service as speed increasers.

Backlash - Rotational movement of the output shaft clockwise and counter clockwise, while holding the input shaft stationary. Usually expressed in thousandths of an inch and measure at a specific radius at the output shaft.

Center Distance - A basic measurement or size reference for worm gear reducers, measured from the centerline of the worm to the centerline of the worm wheel.

Drip-Proof - Venting in end frame and/or main frame located to prevent drops of liquid from falling into motor within 15 angle from vertical. Designed for use in areas that are reasonably dry, clean, and well ventilated (usually indoors). If installed outdoors, it is recommended that the motor be protected with a cover that does not restrict the flow of air to the motor.

Efficiency - A ratio of the input power compared to the output, usually expressed as a percentage.

Explosion-Proof Motors - These motors meet Underwriters Laboratories and Canadian Standards Association standards for use in hazardous (explosive) locations, as indicated by the UL label affixed to the motor. Locations are considered hazardous because the atmosphere does or may contain gas, vapor, or dust in explosive quantities.

Flanged Reducer - Usually used to refer to a reducer having provisions for close coupling of a motor either via a hollow (quill) shaft or flexible coupling. Most often a NEMA C face motor is used.

Gear+Motor™ - LEESON's registered trademark for a separable gear and NEMA C face motor as opposed to an integral gearmotor. Integral gearmotors suffer from lack of application and availability constraints as well as having inherent service issues when one or the other component needs replacement.

Input Horsepower - The power applied to the input shaft of a reducer. The input horsepower rating of a reducer is the maximum horsepower the reducer can safely handle.

Mechanical Rating - The maximum power or torque a reducer can transmit. LEESON reducers typically have a safety margin equal to 200% or more of its mechanical rating allowing momentary overloads during start-up or other transient overload conditions.

Motor Selection - See the technical section of LEESON's Stock Motor Catalog 1050, request LEESON's book, Practical Motor Basics or contact LEESON's District Office for expert assistance.

Mounting Position - The relationship of the input and output shafts of a reducer relative to horizontal.

Output Horsepower - The amount of horsepower available at the output shaft of the reducer. Output horsepower is always less than the input horsepower due to the efficiency of the reducer.

Overhung Load - A force applied at right angles to a shaft beyond the shaft's outermost bearing. This shaft-bending load must be supported by the bearing. Overhung load ratings are listed for each reducer size and should not be exceeded.

Prime Mover - In industry, the prime mover is most often an electric motor. Occasionally engines, hydraulic or air motors are used. Special application considerations are called for when other than an electric motor is the prime mover.

Self-Locking - The inability of a reducer to be driven backwards by its load. As a matter of safety, no LEESON reducer should be considered self-locking.

Service Factor for Gearing - A method of adjusting a reducer's load carrying characteristics to reflect the application's load characteristics. AGMA (American Gear Manufacturer's Association) has established standardized service factor information.

Service Factor for Motors - Refers to a motor's ability to handle a load greater than the motor's rated HP on a continuous basis. Most LEESON motors have a continuous duty service factor of 1.15 or higher. This ability of the motor is intended to handle momentary or transient overloads or unusual service conditions and should not be utilized when sizing motors for continuous service. For assistance in motor selection please contact your LEESON's District Office.

Thermal Rating - The power or torque a reducer can transmit continuously. This rating is based upon the reducer's ability to dissipate the heat caused by friction.

Thrust Load - Force imposed on a shaft parallel to a shaft's axis. Thrust loads are often induced by the driven machine. Take care to be sure the thrust load rating of the reducer is sufficient that it's shafts and bearings can absorb the load without premature failure.

Totally Enclosed Non-Ventilated (TENV) - No vent openings, tightly enclosed to prevent the free exchange of air, but not airtight. Has no external cooling fan and relies on convection for cooling. Suitable for use where exposed to dirt or dampness, but not for hazardous (explosive) locations.

Totally Enclosed Fan Cooled (TEFC) - Same as the TENV except has external fan as an integral part of the motor, to provide cooling by blowing air around the outside frame of the motor.

WORM GEAR REDUCER SERVICE FACTORS

Proper determination of an application's service factor characteristics is critical for maximum reducer life and trouble free service. See the definition of service factor in the glossary.

All worm reducers and LEESON Gear+Motor motorized reducers are sized for applications having an AGMA defined service of 1.0, unless otherwise stated. (Alternately, 1.0 service factor is sometimes expressed as "Class I Service".) Reducers in such applications operate on a continuous duty basis, for 10 hours per day or less, and are free of recurrent shock loads. When operating characteristics are different than noted, the input horsepower and torque ratings listed must be divided by the service factor selected from the table below. This table applies to reducers with an electric or hydraulic motor input.

SPECIAL APPLICATION CONSIDERATIONS

CAUTION: Please contact LEESON for assistance in applications not listed or for applications with unusual characteristics. Including the following:

- Input speeds not listed in catalog
- Frequent starting or repetitive shock applications
- Selection of reducers for man lifts or people moving equipment
- High energy loads, including stalling
- Starting or momentary overloads exceeding 200% of gear reducer mechanical capacity (100% overload)

SERVICE FACTOR TABLE

Duration of Service (Hours per day)	Uniform Load	Moderate Shock	Heavy Shock	Extreme Shock
Occasional 1/2 Hour	—*	—*	1.00	1.25
Less than 3 Hours	1.00	1.00	1.25	1.50
3 - 10 Hours	1.00	1.25	1.50	1.75
Over 10 Hours	1.25	1.50	1.75	2.00

* Unspecified service factors should be 1.00 or as agreed upon by the user and manufacturer.

When a single or multi-cylinder engine is the input power, the service factor selected from the table above should be increased by multiplying the value by the factor selected from the table below.

Service Factor Conversion Table for Engine Driven Applications.

Hydraulic or Electric Motor	Single Cylinder Engines	Multi-Cylinder Engines
1.00	1.50	1.25
1.25	1.75	1.50
1.50	2.00	1.75
1.75	2.25	2.00
2.00	2.50	2.25

On the next page, AGMA standardized service factor data is listed for a wide variety of applications operating 3 to 10 hours per day and for 10 hours or more per day.

TECHNICAL INFORMATION

LEESON IRONMAN BY OHIO GEAR

LEESON OHIO GEAR™

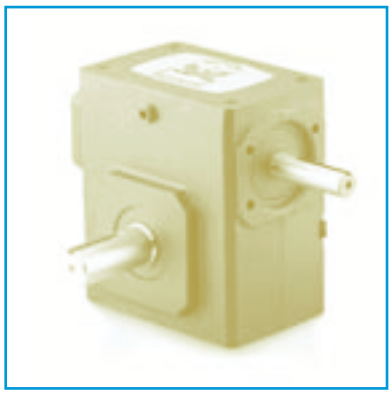
A.G.M.A. SERVICE FACTORS

Application	Service Factor 3-10 Hours	Over 10 Hours
AGITATORS		
Pure Liquids	1.00	1.25
Liquids & Solids	1.25	1.50
Liquids-Variable Density	1.25	1.50
APRON CONVEYORS		
Uniformly Loaded or Fed	1.00	1.25
Heavy Duty	1.25	1.50
APRON FEEDERS	1.25	1.50
ASSEMBLY CONVEYORS		
Uniformly Loaded or Fed	1.00	1.25
Heavy Duty	1.25	1.50
BARGE HAUL PULLERS	1.50	1.75
BARKING		
Drums (Coupling Connected)		1.75
Mechanical		1.75
BAR SCREENS (Sewage)	1.00	1.25
BELT CONVEYORS		
Uniformly Loaded or Fed	1.00	1.25
Heavy Duty	1.25	1.50
BELT FEEDERS	1.25	1.50
BLOWERS		
Centrifugal	1.00	1.25
Lobe	1.25	1.50
Vane	1.00	1.25
BOLTING MACHINERY	1.00	1.25
BREWING & DISTILLING		
Bottling Machinery	1.00	1.25
Brew Kettles, Cont. Duty	1.00	1.25
Can Filling Machines	1.00	1.25
Cookers-Cont. Duty	1.00	1.25
Mash Tubs-Cont. Duty	1.00	1.25
Scale Hoppers-Frequent Starts	1.25	1.50
BUCKET		
Conveyors Uniform	1.00	1.25
Conveyors Heavy Duty	1.25	1.50
Elevators Cont.	1.00	1.25
Elevators Uniform	1.00	1.25
Elevators Heavy Duty	1.25	1.50
CALENDARS		
Rubber		1.50
Textile	1.25	1.50
CANE KNIVES		1.50
CAN FILLING MACHINES	1.00	1.25
CAR DUMPERS	1.50	1.75
CAR PULLERS	1.25	1.50
CENTRIFUGAL		
Blowers, Compressors, Discharge Elevator, Fans or Pumps	1.00	1.25
CHAIN CONVEYORS		
Uniformly Loaded or Fed	1.00	1.25
Heavy Duty	1.25	1.50
CLARIFIERS	1.00	1.25
CLASSIFIERS	1.25	1.50
CLAY WORKING INDUSTRY		
Brick Press	1.75	2.00
Briquette Machines	1.75	2.00
Clay Working Machinery	1.25	1.50
Plug Mills	1.25	1.50
COMPRESSORS		
Centrifugal	1.00	1.25
Lobe	1.25	1.50
Reciprocating:		
Multi-Cylinder	1.25	1.50
Single Cylinder	1.50	1.75
CONCRETE MIXERS		
Continuous	1.25	1.50
Intermittent	1.25	1.50
CONVEYORS-Uniformly Loaded or Fed		
Apron, Assembly, Belt, Bucket, Chain, Flight, Oven, Screw	1.00	1.25
CONVEYORS-Severe Duty		
Live Roll		Contact Factory
Reciprocating, Shaker	1.50	1.75
COOLING TOWER FANS		Contact Factory
CRANES		
Dry Dock Cranes		Contact Factory
Main Hoist	1.00	1.25
Bridge and Trolley Travel		Contact Factory
CRUSHERS		
Ore or Stone	1.50	1.75
Sugar		1.50
DISC FEEDERS	1.00	1.25
DOUBLE ACTING PUMPS		
2 or more Cylinders	1.25	1.50
Single Cylinder		Contact Factory
DRAW BENCH (Metal Mills)		
Carriage & Main Drive	1.25	1.50
DREDGES		
Cable Reels, Conveyors	1.25	1.50
Cutter Head & Jig Drives	1.75	2.00
Maneuvering Winches, Pumps	1.25	1.50
Screen Drives	1.50	1.75
Stackers, Utility Winches	1.25	1.50
ELEVATORS		
Bucket-Uniform Load	1.00	1.25
Bucket-Heavy Duty	1.25	1.50
Bucket-Continuous	1.00	1.25
Centrifugal Discharge	1.00	1.25
Escalators		Not Approved
Freight		Not Approved
Gravity Discharge	1.00	1.25
Man Lifts, Passenger		Not Approved
EXTRUDERS (Plastic)		
Film Sheet, Coating, Rods, Pipe Tubing	1.25	1.25
Blow Molders, Pre-plasticizers		1.50
FANS		
Centrifugal	1.00	1.25
COOLING TOWERS		Contact Factory
Forced Draft		1.25
Induced Draft	1.25	1.50
Large (Mine, etc.)	1.25	1.50
Large Industrial	1.25	1.50
Light (Small Diameter)	1.00	1.25
FEEDERS		
Apron, Belt	1.25	1.50
Disc	1.00	1.25
Reciprocating	1.75	2.00
Screw	1.25	1.50
FLIGHT		
Conveyors, Uniform	1.00	1.25
Conveyors, Heavy	1.25	1.50
FOOD INDUSTRY		
Beet Slicers	1.25	1.50
Bottling, Can Filling Mach.	1.00	1.25
Cereal Cookers	1.00	1.25
Dough Mixers, Meat Grinders	1.25	1.50
HAMMER MILLS	1.50	1.75
HOISTS		
Heavy Duty	1.75	2.00
Medium Duty	1.25	1.50
Skip Hoist	1.25	1.50
INDUCED DRAFT FANS	1.25	1.50
LAUNDRY WASHERS AND TUMBLERS	1.25	1.50
LINE SHAFTS		
Driving Processing Equipment	1.25	1.50
Other Line Shafts, Light	1.00	1.25
LUMBER INDUSTRY		
Barkers-Spindle Feed	1.25	1.50
Barkers-Main Drive	1.75	1.75
Carriage Drive		Contact Factory
CONVEYORS		
Burner	1.25	1.50
Main or Heavy Duty	1.50	1.50
Main Log	1.75	2.00
Re-saw Merry-Go-Round	1.25	1.50
Slab	1.75	2.00
Transfer	1.25	1.50
Chains-Floor	1.50	1.50
Chains-Green	1.50	1.75
Cut-Off Saws-Chain & Drag	1.50	1.75
Debarking Drums	1.75	2.00
Feeds-Edger	1.25	1.50
Feeds-Gang	1.50	1.50
Feeds-Trimmer	1.25	1.50
Log Deck	1.50	1.50
Log Hauls-Incline Well Type	1.50	1.50
Log Turning Devices	1.50	1.50
Planer Feed	1.25	1.50
Planer Tilting Hoist	1.50	1.50
Rolls-Live-Off Bearing-Roll Cases	1.50	1.50
Sorting Table, Tipple Hoist	1.25	1.50
Transfers-Chain & Craneway	1.50	1.75
Tray Drives	1.25	1.50
Veneer Lathe Drives		Contact Factory
MACHINE TOOLS		
Auxiliary Drives	1.00	1.25
Bending Rolls	1.25	1.50
Main Drives	1.25	1.50
Notching Press (Belted)		Contact Factory
Plate Planers	1.50	1.75
Punch Press (Geared)	1.50	1.75
Tapping Machines	1.50	1.75
METAL MILLS		
Draw Bench Carriages & Main Drives	1.25	1.50
Pinch, Dryer and Scrubber Rolls Reversing		Contact Factory
Slitters	1.25	1.50
Table Conveyors Non-Reversing Group Drives	1.25	1.50
Individual Drives	1.50	1.75
Reversing Wire Drawing & Flattening Machines	1.25	1.50
Wire Winding Machines	1.25	1.50
MILLS, ROTARY		
Ball and Rod Mills with		
Spur Ring Gear		1.75
with Helical Ring Gear		1.50
Direct Connect		1.50
Cement Kilns, Dryers, Coolers, Pebble, Plain & Wedge Bar Mills		1.50
Tumbling Barrels	1.50	1.75
MIXERS (Also see Agitators)		
Concrete, Cont. & Int.	1.25	1.50
Constant Density	1.00	1.25
Variable Density	1.25	1.50
OIL INDUSTRY		
Chillers	1.25	1.50
Oil Well Pumping		Contact Factory
Paraffin Filter Press	1.25	1.50
Rotary Kilns	1.25	1.50
PAPER MILLS		Contact Factory
PASSENGER ELEVATORS		Contact Factory
PLATE PLANERS	1.50	1.75
PRINTING PRESSES		Contact Factory
PUMPS		
Centrifugal	1.00	1.25
Proportioning	1.25	1.50
Reciprocating		
Single Act, 3 or more Cyl.	1.25	1.50
Double Act, 2 or more Cyl.	1.25	1.50
Single Act, 1 or 2 Cyl		Contact Factory
Double Act, 1 Cyl.		Contact Factory
Rotary: Gear, Lobe, Vane	1.00	1.25
PUNCH PRESSES (Gear Driven)	1.50	1.75
RUBBER & PLASTIC INDUSTRIES		
Calendars		1.50
Crackers		1.75
Laboratory Equipment	1.25	1.50
Mills (2 on line)	1.50	
Mills (3 on line)	1.25	
Mixing Mills	1.50	1.50
Refiners		1.50
Sheeters		1.50
Tire Building & Machines		Contact Factory
Tire & Tube Press Openers		Contact Factory
Tubers & Strainers		1.50
Warming Mills		1.50
SCREENS		
Air Washing	1.00	1.25
Rotary-Sand or Gravel	1.25	1.50
Traveling Water Intake	1.00	1.25
SEWAGE DISPOSAL		
Bar Screens	1.00	1.25
Chemical Feeders	1.00	1.25
Collectors	1.00	1.25
Dewatering Screens	1.25	1.50
Scum Breakers	1.25	1.50
Slow or Rapid Mixers	1.25	1.50
Thickeners	1.25	1.50
Vacuum Filters	1.25	1.50
SKI TOWS & LIFTS		Not Approved
STOKERS	1.00	1.25
STONE CRUSHERS	1.50	1.75
SUGAR INDUSTRY		
Cane Knives, Crushers, Mills		1.50
TABLE CONVEYORS (Non-Reversing)		
Group Drives	1.25	1.50
Individual Drives	1.50	1.75
Reversing		Contact Factory
TEXTILE INDUSTRY		
Batchers, Calendars	1.25	1.50
Card Machines	1.25	1.50
Dry Cans, Dryers	1.25	1.50
Dyeing Machinery	1.25	1.50
Knitting Machinery		Contact Factory
Looms, Mangles, Nappers, Pads	1.25	1.50
Range Drives		Contact Factory
Slashers, Soapers, Spinners	1.25	1.50
Tenter Frames, Washers, Winders	1.25	1.50
TUMBLING BARRELS	1.50	1.75
VANE BLOWERS	1.00	1.25
WINDLASS		Contact Factory
WIRE		
Drawing Machines	1.25	1.50
Winding Machines	1.25	1.50

LEESON® OHIO GEAR™

ELECTRIC MOTORS, GEARMOTORS AND DRIVES

Speed Reducers Installation, Lubrication and Maintenance Instructions



IRONMAN BY OHIO GEAR™

Table of Contents

WARNING/CAUTION INFORMATION 2

General Operation 3

Installation 3

Lubrication
Oil Capacities 4
Mounting Positions 5

Maintenance 5-6

Instruction Manual

Selection Information

Read ALL instructions prior to operating reducer. Injury to personnel or reducer failure may be caused by improper installation, maintenance or operation.

Written authorization from LEESON ELECTRIC is required to operate or use reducers in man lift or people moving devices.

Check to make certain application does not exceed the allowable load capacities published in the current catalog.

Buyer shall be solely responsible for determining the adequacy of the product for any and all uses to which Buyer shall apply the product. The application by Buyer shall not be subject to any implied warranty of fitness for a particular purpose.

Safety Alert

⚠WARNING

- For safety, Buyer or User should provide protective guards over all shaft extensions and any moving apparatus mounted thereon. The User is responsible for checking all applicable safety codes in his area and providing suitable guards. Failure to do so may result in bodily injury and/or damage to equipment.
- Hot oil and reducers can cause severe burns. Use extreme care when removing lubrication plugs and vents.
- Make certain that the power supply is disconnected before attempting to service or remove any components. Lock out the power supply and tag it to prevent unexpected application of power.
- Reducers are not to be considered fail safe or self-locking devices. If these features are required, a properly sized, independent holding device should be utilized. Reducers should not be used as a brake.
- Any brakes that are used in conjunction with a reducer must be sized or positioned in such a way so as to not subject the reducer to loads beyond the catalog rating.
- Lifting supports including eyebolts are to be used for vertically lifting the gearbox only and no other associated attachments or motors.
- Use of an oil with an EP additive on units with backstops may prevent proper operation of the backstop. Injury to personnel, damage to the reducer or other equipment may result.
- Overhung loads subject shaft bearings and shafts to stress which may cause premature bearing failure and/or shaft breakage from bending fatigue, if not sized properly.

⚠CAUTION

- Test run unit to verify operation. If the unit tested is a prototype, that unit must be of current production.
- If the speed reducer cannot be located in a clear and dry area with access to adequate cooling air supply, then precautions must be taken to avoid the ingestion of contaminants such as water and the reduction in cooling ability due to exterior contaminants.
- Mounting bolts should be routinely checked to ensure that the unit is firmly anchored for proper operation.

Important Information

In the event of the resale of any of the goods, in whatever form, Resellers/Buyers will include the following language in a conspicuous place and in a conspicuous manner in a written agreement covering such sale:

> *The manufacturer makes no warranties or representations, express or implied, by operation of law or otherwise, as to the merchantability or fitness for a particular purpose of the goods sold hereunder. Buyer acknowledges that it alone has determined that the goods purchased hereunder will suitably meet the requirements of their intended use. In no event will the manufacturer be liable for consequential, incidental or other damages. Even if the repair or replacement remedy shall be deemed to have failed of its essential purpose under Section 2-719 of the Uniform Commercial Code, the manufacturer shall have no liability to Buyer for consequential damages.*

Resellers/Buyers agree to also include this entire document including the warnings above in a conspicuous place and in a conspicuous manner in writing to instruct users on the safe usage of the product.

This instructions manual should be read together with all other printed information such as catalogs, supplied by LEESON ELECTRIC.

LEESON
OHIO GEAR™

Instruction Manual

IRONMAN BY OHIO GEAR

General Operation

1. Run the motor which drives the reducer and check the direction of reducer output rotation. Consult motor nameplate for instructions to reverse the direction of rotation.
2. Attaching the load: On direct coupled installations, check shaft and coupling alignment between speed reducer and loading mechanism. On chain/sprocket and belt/pulley installation, locate the sprocket or pulley as close to the oil seal as possible to minimize overhung load. Check to verify that the overhung load does not exceed specifications published in the catalog.
3. High momentum loads: If coasting to a stop is undesirable, a braking mechanism should be provided to the speed reducer output or the driven mechanism.

⚠CAUTION The system of connected rotating parts must be free from critical speed, torsional or other type vibration, no matter how induced. The responsibility for this system analysis lies with the purchaser of the speed reducer.

Installation

1. Mount the unit to a rigid flat surface using grade 5 or higher fasteners. The mounting fasteners should be the largest standard size that will fit in the base mounting hole. Shim as required under flange or base feet which do not lie flat against the mounting surface.
2. For shipment, pipe plugs are installed in the unit and a vent plug is packed separately. After mounting the unit in position, remove the appropriate pipe plug and install the vent plug in the location shown on page 5. On double reduction units both the primary and the secondary must be vented. Failure to vent the unit can cause premature seal wear or loss of seal and oil. These conditions are not covered by warranty. Check for correct oil level. Contact the factory for level and vent recommendations on non-standard mounting positions. **WASHGUARD® (BISSC)** units with Enviro-Seal do not use vents. See (Enviro-Seal) under **Lubrication** for further information.
3. **WASHGUARD® (BISSC)** units include synthetic oil and an Enviro-Seal pre-installed at the factory. It is not necessary to vent these units, and they can be used as supplied from the factory. Do not loosen the nut holding the stem of the Enviro-Seal, and do not block the hole in the stem. Do not blow pressurized air into the hole, and avoid spraying washdown chemicals directly into the hole.
4. Connect motor to speed reducer.

⚠WARNING Depending upon gear geometry and operating conditions worm gear reducers may or may not backdrive. Special consideration should be given to high inertia loads connected to the output shaft. Consult the factory for further details.

⚠CAUTION DO NOT CHANGE MOUNTING POSITIONS WITHOUT CONTACTING FACTORY.
Altering the mounting position may require special lubrication provisions which must be factory installed.

⚠CAUTION Do not operate the reducer without making sure it contains the correct amount of oil. Do not overfill or underfill with oil, or injury to personnel, reducer or other equipment may result. **WASHGUARD®** units are lubed and sealed for life, so in most applications it will not be necessary to drain or re-fill the unit.

⚠CAUTION A unit cannot be used as an integral part of a machine superstructure which would impose additional loads on the unit other than those imposed by the torque being transmitted either through a shaft-mounted arrangement, and any shaft mounted power transmitting device. *(e.g., sprockets, pulleys, couplings)*

⚠CAUTION For safe operation and to maintain the unit warranty, when changing a factory installed fastener for any reason, it becomes the responsibility of the person making the change to properly account for fastener grade, thread engagement, load, tightening torque and the means of torque retention.

Lubrication - Standard Units

All standard reducers ordered from the factory are filled with synthetic lubricant to operate within a -10° to105° F ambient temperature range. Double reduction units have separate oil sumps and must be filled/checked independently. Prior to startup, verify that the oil is at the level shown on the drawings on page 5.

Enviro-Seal: WASHGUARD® (BISSC) and stainless steel reducers come standard with an Enviro-Seal and synthetic oil pre-installed at the factory. It is not necessary to vent these reducers, and they can be used as supplied from the factory.

⚠CAUTION In the Food and Drug Industry (including animal food), consult the lubrication supplier for recommendation of lubricants which are acceptable to the Food and Drug Administration and/or other authoritative bodies having jurisdiction.

⚠CAUTION Do not mix different oils in the reducer. Oils should be compatible with Viton® seal material.

Instruction Manual

Lubrication

The reducer is properly filled at the factory with sufficient lubricant per customer specified mounting position. If position is not specified by customer, reducer will be filled to level in mounting position 1 (worm over) Reducer ordered with a "MOD" will be filled based on the factory assumed mounting position, mounting position should be specified with order to assure proper lubrication.

Factory Assumed Mounting Orientation	Applicable Unit Styles*	
Worm Over	B, T, F, H, FH, C D, DT, DF, DH, DFH DX, DXT, DXH, DXFH	Single Reduction Double Reduction Worm-Worm Double Reduction Helical-Worm
Worm Under	U DU	Single Reduction Double Reduction Worm-Worm
Vertical Output	VL, VH DVL, DVH DXVL, DXVH	Single Reduction Double Reduction Worm-Worm Double Reduction Helical-Worm
Vertical Input	J DJ DXJ	Single Reduction Double Reduction Worm-Worm Double Reduction Helical-Worm

* INCLUDES MOTORIZED COUPLING AND QUILL INPUT VERSIONS OF ALL STYLES LISTED

All standard IRONMAN BY OHIO GEAR™ Worm Reducers are factory filled with MOBIL SHC-634 lubricant, a synthesized hydrocarbon formulated for long life and wide operating temperature range (-25°F to +220°F).
Change oil only when performing maintenance that requires gearbox disassembly.

If oil must be replaced, use only MOBIL SHC-634

Do not confuse MOBIL SHC-634 with MOBILGEAR 634. MOBILGEAR 634 is an EP type gear oil NOT suitable for use in the IRONMAN™ BY OHIO worm gear reducers.

SPECIAL LUBRICATION REQUIREMENTS - Size 830 & Larger
Please specify mounting position *with order* if any of the following applies:
1- Reducer is mounted with input or output shafts vertical
2- Input speed is less than 900 RPM
3- Reducer is mounted in inclined position
NOTE: The reducer may require modifications to assure proper lubrication in these applications.

For lubrication requirements of helical reducers (primaries of helical/worm reducers and ratio multipliers), contact factory.

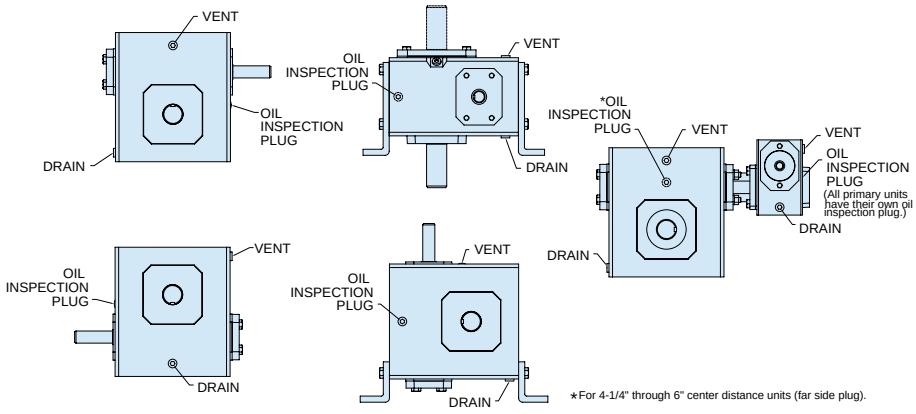
Oil Capacities (ounces) - Standard Units

Mounting Position	UNIT SIZE 813	815	818	821	824	826	830	832	842	852	860
1-Worm Over	4	12	12	20	24	40	56	72	112	188	312
2-Worm Under	8	16	20	28	40	60	84	108	152	304	328
3-Vertical Output	4	16	16	28	32	48	68	88	128	248	320
4-Vertical Input	4	16	16	24	32	48	72	92	128	248	325
5-Worm Over on Secondary Unit of Double Reduction	—	—	—	N/A	N/A	N/A	N/A	192	308	320	485

16 OZ.	**=**	**1 PINT**
2 PINTS	**=**	**1 QUART**
4 QUARTS	**=**	**1 GALLON**
1 GALLON	**=**	**128 OZ.**

CAUTION Always check for proper oil level after filling. Capacities vary somewhat with model and mounting position. Oil should rise to bottom edge of level hole. Do not overfill.

Standard Speed Reducer Mounting Positions & Vent Plug, Level and Drain Locations



Maintenance - Standard Units

Your IRONMAN BY OHIO GEAR™ reducer has been tested and adjusted at the factory. Dismantling or replacement of components must be done by LEESON to maintain the warranty.

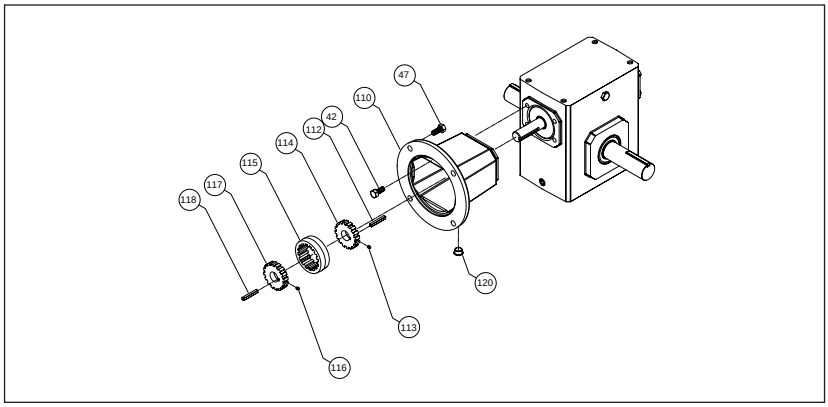
Inspect vent plug often to insure it is clean and operating.

CAUTION Mounting bolts should be routinely checked to ensure that the unit is firmly anchored for proper operation.

Seals: The IRONMAN BY OHIO GEAR™ line of speed reducers utilize premium quality seals which are the state-of-the-art in sealing technology. Seals are, however, a wear item and eventually need to be replaced. Replacement can be easily accomplished by following the steps below:

1. Remove the worn seal without damaging the shaft surface or the seal bore. This can be done by drilling a .062" diameter hole in the seal casing (being careful not to drill into the bearing behind the seal). Screw a #10 sheet metal screw into the hole and pry out the seal.
2. Clean the seal bore of sealant.
3. Before installing the new seal, use electrical tape to cover any keyways on the shaft to prevent seal lip damage.
4. Grease the seal lips with bearing grease and apply a sealant to the seal bore.
5. Slide the seal into the shaft being careful not to fold the inner lip over on any shaft steps.
6. Press the seal into its bore with a sleeve that presses on the seal casing, being careful to keep the seal square in its bore.

Installation Extended "C" Flange Adapter Kits With Flexible Couplings (BM Style)



These instructions must be followed for proper installation of "C" Flange Adapter and Motor onto IRONMAN BY OHIO GEAR™ Worm Reducers. These reducers have input ball bearings mounted directly in the housing, and no bearing cap on the input shaft side.

1. Make sure reducer pilot and face, and frame pilot and face are clean.
2. Install "C" Flange Adapter (ref. 110) onto reducer, being careful not to damage seal.
3. Install capscrews (ref. 42) and tighten to torque specified in tightening torque chart on page 6.
4. Install key (ref. 112) in the input shaft, key should be flush with shaft end. Install coupling hub (ref. 114) flush with end of reducer shaft.

LEESON
OHIO GEAR™

Instruction Manual

IRONMAN BY OHIO GEAR

5. Rotate input shaft of reducer to position the set screw (ref. 113) in line with access hole provided in the “C” flange adapter, tighten set screw (make sure key is properly in place under set screw).
6. Slide plastic sleeve (ref. 115) over reducer hub until it comes to a stop.
7. **Discard motor key** and install key supplied in kit (ref. 118) flush with motor shaft end. Install coupling hub (ref. 117) flush with end of motor shaft and tighten set screw (ref. 116), make sure key is under set screw.
8. Install motor by sliding hub into sleeve until it comes to a stop. Install capscrews (ref. 47) and tighten to torque specified on tightening torque chart.
9. **Install plastic plug (ref. 120) into the “C” Flange Adapter access hole.**

Items Included in “C” Flange Adapter Kit

1. One “C” Flange Adapter (ref. 110)
2. Four capscrews (ref. 42) adapter to reducer
3. One reducer coupling hub (ref. 114)
4. One reducer input key (ref. 112)
5. One reducer hub set screw (ref. 113)
6. Four capscrews (ref. 47), motor to adapter
7. One coupling sleeve (ref. 115)
8. One motor coupling hub (ref. 117)
9. One motor shaft key (ref. 118)
10. One motor hub set screw (ref. 116)
11. One access hole plug (ref. 120)

Capscrew Tightening Torque
Grade 5 Capscrews (dry, without lubricant)

Capscrew Size	Tightening Torque (lb.-in.)
1/4 UNC	75
5/16 UNC	155
3/8 UNC	275
1/2 UNC	780

Maintenance

Your **IRONMAN BY OHIO GEAR™** reducer has been tested and adjusted at the factory. Dismantling or replacement of components must be done by LEESON to maintain the warranty.

Inspect the stem of the Enviro-Seal often to ensure it is clean and operating properly.

CAUTION Mounting bolts should be routinely checked to ensure that the unit is firmly anchored for proper operation.

Seals: The **IRONMAN BY OHIO GEAR™** line of speed reducers utilize premium quality seals which are state-of-the-art in sealing technology. Seals are, however, a wear item and eventually need to be replaced. Replacement can easily be accomplished by following the procedure on page 5.

If seal leakage has resulted in the loss of a significant amount of oil, it may be necessary to add more lubricant. For normal ambient temperature conditions, LEESON recommends Mobil SHC 634 synthetic gear oil for worm drives, and Mobil SHC 150 for helical drives.

CAUTION Always check for proper oil level after filling. Do not overfill or underfill with oil, or injury to personnel, reducer, or other equipment may result.

CAUTION Do not mix different oils in the reducer.

Class of Service

All capacity ratings are based on proper application of American Gear Manufacturers Association (AGMA) service factors as given on page 174 of the IRONMAN BY OHIO GEAR™ 8050 Catalog. Load conditions must be within cataloged ratings published in the current LEESON Catalog (available upon request).

Warranty From LEESON Electric - See 8050 catalog pages 185-187 for warranty terms and conditions.

LEESON
LEESON ELECTRIC
GRAFTON, WISCONSIN 53024-0241 U.S.A.
TEL (262)377-8810 FAX (262)377-9025 www.leeson.com
A Subsidiary of REGAL-BELOIT CORPORATION

NEMA Member

9/02 REV. 01
Specifications and prices are subject to change without notice.
3395S/30M/9-02/SL/BH

Mobil SHC 600 Series

Supreme Performance Gear and Bearing Oils

Product Description

Mobil SHC 600 Series lubricants are supreme performance gear and bearing oils designed to provide outstanding service in terms of equipment protection, oil life and problem-free operation. They are formulated from synthesised, wax-free hydrocarbon base fluids. The combination of a naturally high viscosity index and a unique, proprietary, additive system enables these products to provide outstanding performance in extreme service applications at high and low temperatures, well beyond the capabilities of mineral oils. These products are resistant to mechanical shear, even in heavily loaded gear and high shear bearing applications, so that there is virtually no loss of viscosity.

The Mobil SHC 600 Series products have low traction coefficients, which derive from the molecular structure of the base stocks used. This results in low fluid friction in the load zone of non-conforming surfaces such as gears and rolling contact bearings. Low fluid friction produces lower operating temperatures and improved gear efficiency, which translates into reduced power consumption. It also results in extended parts life and allows for more economical equipment design. The base oils used in the Mobil SHC 600 Series have outstanding response to antioxidant additives resulting in superior resistance to oxidation and sludging, especially at high temperatures. The additive combination used in these oils also provides exceptional resistance to rusting and corrosion, very good antiwear, demulsibility, foam control and air release properties, as well as multimetal compatibility. The Mobil SHC 600 Series oils are also compatible with the same seal and other construction materials used in equipment normally lubricated with mineral oils.

The leading edge technology on which Mobil SHC 600 Series lubricants have always been based has made these the products of choice for operators of a wide range of equipment, worldwide. While initially recognised as a high temperature problem solver, these products are now used in many industrial applications because of the range of benefits they offer.

Features & Benefits

The Mobil SHC brand of lubricants are recognised and appreciated around the world for their innovation and outstanding performance. These molecular designed synthetic products, pioneered by our research scientists, symbolise the continuing commitment to using advanced technology to provide outstanding lubricant products. A key factor in the development of Mobil SHC 600 Series were the close contacts between our scientists and application specialists with key OEMs to ensure that our product offerings will provide exceptional performance in the continually evolving industrial equipment designs.

Our work with equipment builders has helped confirm the results from our own laboratory tests showing the exceptional performance of the Mobil SHC 600 Series lubricants. Not least among the benefits, shown in work with OEMs, is the potential for significant efficiency improvements in changing from mineral oil. These benefits are particularly evident in equipment which, by design, cannot avoid low overall efficiency, such as high ratio wormgears.

To combat high thermal exposure of the oil, our product formulation scientists chose proprietary base oils for Mobil SHC 600 Series oils because of their exeptional thermal/oxidative resistance potential. Our formulators chose specific additives which would maximize the

benefits of the base oils to provide exceptional oil life and deposit control and resistance to thermal/oxidative and chemical degradation, as well as the balance of the performance features. The wax-free nature of the base oil also provides low temperature fluidity characteristcs unmatched by mineral products and is a key benefit for remote, low ambient temperature applications. The Mobil SHC 600 Series oils offer the following features and potential benefits:

Features	Advantages and Potential Benefits
Superb high temperature thermal/oxidation resistance	Extends equipment high temperature operating capability
	Long oil life, reduced need and costs for oil change outs
	Minimises sludges and deposits for trouble-free operation and long filter life
High Viscosity Index and absence of wax	Maintains viscosity and film thickness at high temperatures
	Exceptional low temperature performance, including start-up
Low traction coefficient	Reduces overall friction and can increase efficiency in sliding mechanisms such as gearing, with potential for reduced power consumption and lower steady-state operating temperatures.
	Minimises effects of micro slip in rolling contact bearings for longer rolling-element life potential
High load carrying capability	Protects equipment and extends life; minimises unexpected downtime and extends service periods
Balanced additive combination	Provides excellent performance in terms of rust & corrosion prevention, water separability, foam control, air release performance ensuring problem-free operation in a wide range of industrial applications and reduced operating costs

Applications

While Mobil SHC 600 Series are compatible with mineral oil based products, admixture may detract from their performance. Consequently it is recommended that before changing a system to one of the Mobil SHC 600 Series, it should be thoroughly cleaned out and flushed to achieve the maximum performance benefits. The Mobil SHC 600 Series oils are compatible with the following seal materials: fluorocarbon, polyacrylate, polyurethane ether, some silicone, ethylene/acrylic, chlorinated polyethylene, polysulfide, and some nitrile rubbers. There is the potential for substantial variations in the elastomers being used today. For best results, consult your equipment supplier, seal manufacturer, or your local Mobil representative to verify compatibility.

Mobil SHC 600 Series lubricants are recommended for use in a wide variety of gear and bearing applications where high or low temperatures are encountered or where operating temperatures or bulk oil temperatures are such that conventional lubricants give unsatisfactory life, or where improved efficiency is needed. They are particularly effective in applications where the maintenance costs of component replacement, system cleaning and lubricant changes are high. Specific applications include:

- Filled for life gearboxes, especially high ratio/ low-efficiency worm gears
- Remotely located gearboxes, where oil change-out is difficult
- Low temperature applications, such as ski lifts where seasonal oil changes can be avoided
- Mixer roll bearings and roll neck bearings where high temperatures are encountered
- Plastic calendars
- Severe centrifuge applications, including marine centrifuges
- Railroad A/C Traction Drives
- Mobil SHC 625, 627, 629 and 630 are suitable for Oil Flooded Rotary Screw Compressors compressing natural gas, field gas gathering, CO2 and other process gasses used in the natural gas industry

Specifications & Approvals

Mobil SHC 600 Series has the following builder approvals	624	625	626	629	630	632	634	636	639
Cone Drive (US)							X		
Boston Gear (US)							X		

Typical Properties

Mobil SHC 600 Series	624	625	626	627	629	630	632	634	636	639
ISO Viscosity Grade	32	46	68	100	150	220	320	460	680	1000
Viscosity, ASTM D 445										
cSt @ 40° C	32.4	48.0	69.9	99.1	143	216	326	430	664	933
cSt @ 100° C	6.3	7.9	10.9	13.9	18.3	25.2	38.6	48.5	62.8	79.5
Viscosity Index, ASTM D 2270	148	135	146	143	144	152	169	173	165	164
Pour Point, °C, ASTM D 97	-54	-48	-48	-42	-45	-42	-39	-42	-42	-15
Flash Point, °C, ASTM D 92	240	252	236	248	228	235	250	262	236	270
Specific Gravity, ASTM D 4052, 15° C/15° C	0.85	.85	0.86	0.86	0.86	0.87	0.87	0.87	0.87	0.87
Appearance, visual	Orange	Orange	Orange	Orange	Orange	Orange	Orange	Orange	Orange	Orange
TOST, ASTM D 943, Hours to 2 NN	10,000+	10,000+	10,000+	10,000+	10,000+	10,000+	10,000+	10,000+	10,000+	10,000+
RBOT, ASTM D 2272, min.	1750	1750	1750	1750	1750	1750	1750	1750	1750	1750
Rust protection, ASTM D665, Sea Water	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Water Seperability, ASTM D 1401, Min. to 3 ml emulsion @ 54° C	10	10	10	-	-	-	-	-	-	-
Water Seperability, ASTM D 1401, Min. to 3 ml emulsion @ 82° C	-	-	-	15	15	15	25	25	30	40
Copper Corrosion, ASTM D130, 24 hrs @ 121° C	1B	1B	1B	1B	1B	1B	1B	1B	1B	1B
Foam Test, ASTM D 892, Seq I,II,III Tendency / Stability, ml/ml										
Seq I	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0
Seq II	20/0	0/0	0/0	0/0	0/0	0/0	0/0	20/0	0/0	0/0
Seq III	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0
FZG scuffing test, DIN 51534 (mod), A/16.6/90, Failure Stage	10	11	11	13	13	13+	13+	13+	13+	13+

Health & Safety

Based on available information, this product is not expected to produce adverse effects on health when used for the intended application and the recommendations provided in the Material Safety Data Sheet (MSDS) are followed. MSDS's are available upon request through your sales contract office, or via the Internet. This product should not be used for purposes other than its intended use. If disposing of used product, take care to protect the environment.

ExxonMobil

602912-00 MOBIL SHC 634
MATERIAL SAFETY DATA BULLETIN

---

1. PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME: MOBIL SHC 634
SUPPLIER: EXXONMOBIL OIL CORPORATION
3225 GALLOWS RD.
FAIRFAX, VA 22037

24 - Hour Health and Safety Emergency (call collect): 609-737-4411

24 - Hour Transportation Emergency:
CHEMTREC: 800-424-9300 202-483-7616
LUBES AND FUELS: 281-834-3296

Product and Technical Information:
Lubricants and Specialties: 800-662-4525 800-443-9966
Fuels Products: 800-947-9147
MSDS Fax on Demand: 613-228-1467
MSDS Internet Website: http://emmsds.ihssolutions.com/

2. COMPOSITION/INFORMATION ON INGREDIENTS

CHEMICAL NAMES AND SYNONYMS: SYN. HYDROCARBONS AND ADDITIVES

GLOBALLY REPORTABLE MSDS INGREDIENTS:

None.

See Section 8 for exposure limits (if applicable).

3. HAZARDS IDENTIFICATION

Under normal conditions of use, this product is not considered hazardous according to regulatory guidelines (See section 15).

EMERGENCY OVERVIEW: Orange Liquid. DOT ERG No. : NA

POTENTIAL HEALTH EFFECTS: Under normal conditions of intended use, this product does not pose a risk to health. Excessive exposure may result in eye, skin or respiratory irritation.

For further health effects/toxicological data, see Section 11.

---

4. FIRST AID MEASURES

EYE CONTACT: Flush thoroughly with water. If irritation occurs, call a physician.

SKIN CONTACT: Wash contact areas with soap and water. Remove and clean oil soaked clothing daily and wash affected area. (See Section 16 - Injection Injury)

INHALATION: Not expected to be a problem. However, if respiratory irritation, dizziness, nausea, or unconsciousness occurs due to excessive vapor or mist exposure, seek immediate medical assistance. If breathing has stopped, assist ventilation with a mechanical device or mouth-to-mouth resuscitation.

INGESTION: Not expected to be a problem. Seek medical attention if discomfort occurs. Do not induce vomiting.

---

5. FIRE-FIGHTING MEASURES

EXTINGUISHING MEDIA: Carbon dioxide, foam, dry chemical and water fog.

SPECIAL FIRE FIGHTING PROCEDURES: Water or foam may cause frothing. Use water to keep fire exposed containers cool. Water spray may be used to flush spills away from exposure. Prevent runoff from fire control or dilution from entering streams, sewers, or drinking water supply.

SPECIAL PROTECTIVE EQUIPMENT: For fires in enclosed areas, fire fighters must use self-contained breathing apparatus.

UNUSUAL FIRE AND EXPLOSION HAZARDS: None.

COMBUSTION PRODUCTS: Fumes, smoke, carbon monoxide, sulfur oxides, aldehydes and other decomposition products, in the case of incomplete combustion.

Flash Point C(F): > 93(200) (ASTM D-93).

Flammable Limits (approx.% vol.in air) - LEL: 0.9%, UEL: 7.0%

NFPA HAZARD ID: Health: 0, Flammability: 1, Reactivity: 0

---

6. ACCIDENTAL RELEASE MEASURES

NOTIFICATION PROCEDURES: Report spills/releases as required to appropriate authorities. U.S. Coast Guard and EPA regulations require immediate reporting of spills/releases that could reach any waterway including intermittent dry creeks. Report spill/release to Coast Guard National Response Center toll free number (800)424-8802. In case of accident or road spill notify CHEMTREC (800) 424-9300.

PROCEDURES IF MATERIAL IS RELEASED OR SPILLED:

LAND SPILL: Shut off source taking normal safety precautions. Take measures to minimize the effects on ground water. Recover by pumping or contain spilled material with sand or other suitable absorbent and remove mechanically into containers. If necessary, dispose of adsorbed residues as directed in Section 13.

WATER SPILL: Confine the spill immediately with booms. Warn other ships in the vicinity. Notify port and other relevant authorities. Remove from the surface by skimming or with suitable absorbents. If

permitted by regulatory authorities the use of suitable dispersants should be considered where recommended in local oil spill procedures.

ENVIRONMENTAL PRECAUTIONS: Prevent material from entering sewers, water sources or low lying areas; advise the relevant authorities if it has, or if it contaminates soil/vegetation.

PERSONAL PRECAUTIONS: See Section 8

---

7. HANDLING AND STORAGE

HANDLING: No special precautions are necessary beyond normal good hygiene practices. See Section 8 for additional personal protection advice when handling this product.

STORAGE: Keep containers closed when not in use. Do not store in open or unlabelled containers. Store away from strong oxidizing agents and combustible materials. Do not store near heat, sparks, flame or strong oxidants.

SPECIAL PRECAUTIONS: Prevent small spills and leakages to avoid slip hazard.

EMPTY CONTAINER WARNING: Empty containers retain residue (liquid and/or vapor) and can be dangerous. DO NOT PRESSURIZE, CUT, WELD, BRAZE, SOLDER, DRILL, GRIND OR EXPOSE SUCH CONTAINERS TO HEAT, FLAME, SPARKS, STATIC ELECTRICITY, OR OTHER SOURCES OF IGNITION; THEY MAY EXPLODE AND CAUSE INJURY OR DEATH. Do not attempt to refill or clean container since residue is difficult to remove. Empty drums should be completely drained, properly bunged and promptly returned to a drum reconditioner. All containers should be disposed of in an environmentally safe manner and in accordance with governmental regulations.

---

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

OCCUPATIONAL EXPOSURE LIMITS:

When mists/aerosols can occur, the following are recommended: 5 mg/m3 (as oil mist)- ACGIH Threshold Limit Value (TLV), 10 mg/m3 (as oil mist) - ACGIH Short Term Exposure Limit (STEL), 5 mg/m3 (as oil mist) - OSHA Permissible Exposure Limit (PEL)

VENTILATION: If mists are generated, use adequate ventilation, local exhaust or enclosures to control below exposure limits.

RESPIRATORY PROTECTION: If mists are generated, and/or when ventilation is not adequate, wear approved respirator.

EYE PROTECTION: If eye contact is likely, safety glasses with side shields or chemical type goggles should be worn.

SKIN PROTECTION: Not normally required. When splashing or liquid contact can occur frequently, wear oil resistant gloves and/or other protective clothing. Good personal hygiene practices should always be followed.

---

9. PHYSICAL AND CHEMICAL PROPERTIES

Typical physical properties are given below. Consult Product Data Sheet

for specific details.

APPEARANCE: Liquid
COLOR: Orange
ODOR: Mild
ODOR THRESHOLD-ppm: NE
pH: NA
BOILING POINT C(F): > 316(600)
MELTING POINT C(F): NA
FLASH POINT C(F): > 93(200) (ASTM D-93)
FLAMMABILITY (solids): NE
AUTO FLAMMABILITY C(F): NA
EXPLOSIVE PROPERTIES: NA
OXIDIZING PROPERTIES: NA
VAPOR PRESSURE-mmHg 20 C: < 0.1
VAPOR DENSITY: > 2.0
EVAPORATION RATE: NE
RELATIVE DENSITY, 15/4 C: 0.86-1
SOLUBILITY IN WATER: Negligible
PARTITION COEFFICIENT: > 3.5
VISCOSITY AT 40 C, cSt: > 20.0
VISCOSITY AT 100 C, cSt: NE
POUR POINT C(F): < -30(-22)
FREEZING POINT C(F): NE
VOLATILE ORGANIC COMPOUND: NE
DMSO EXTRACT, IP-346 (WT.%): <3, for mineral oil only
NA=NOT APPLICABLE NE=NOT ESTABLISHED D=DECOMPOSES

FOR FURTHER TECHNICAL INFORMATION, CONTACT YOUR MARKETING REPRESENTATIVE

---

10. STABILITY AND REACTIVITY

STABILITY (THERMAL, LIGHT, ETC.): Stable.
CONDITIONS TO AVOID: Extreme heat and high energy sources of ignition.
INCOMPATIBILITY (MATERIALS TO AVOID): Strong oxidizers.
HAZARDOUS DECOMPOSITION PRODUCTS: Product does not decompose at ambient temperatures.
HAZARDOUS POLYMERIZATION: Will not occur.

---

11. TOXICOLOGICAL DATA

---ACUTE TOXICOLOGY---

ORAL TOXICITY (RATS): Practically non-toxic (LD50: greater than 2000 mg/kg). ---Based on testing of similar products and/or the components.
DERMAL TOXICITY (RABBITS): Practically non-toxic (LD50: greater than 2000 mg/kg). ---Based on testing of similar products and/or the components.
INHALATION TOXICITY (RATS): Practically non-toxic (LC50: greater than 5 mg/l). ---Based on testing of similar products and/or the components.
EYE IRRITATION (RABBITS): Practically non-irritating. (Draize score: greater than 6 but 15 or less). ---Based on testing of similar products and/or the components.
SKIN IRRITATION (RABBITS): Practically non-irritating. (Primary

Irritation Index: greater than 0.5 but less than 3). ---Based on testing of similar products and/or the components.
OTHER ACUTE TOXICITY DATA: Although an acute inhalation study was not performed with this product, a variety of mineral and synthetic oils, such as those in this product, have been tested. These samples had virtually no effect other than a nonspecific inflammatory response in the lung to the aerosolized mineral oil. The presence of additives in other tested formulations (in approximately the same amounts as in the present formulation) did not alter the observed effects.

---SUBCHRONIC TOXICOLOGY (SUMMARY)---
No significant adverse effects were found in studies using repeated dermal applications of similar formulations to the skin of laboratory animals for 13 weeks at doses significantly higher than those expected during normal industrial exposure. The animals were evaluated extensively for effects of exposure (hematology, serum chemistry, urinalysis, organ weights, microscopic examination of tissues etc.).

---REPRODUCTIVE TOXICOLOGY (SUMMARY)---
No teratogenic effects would be expected from dermal exposure, based on laboratory developmental toxicity studies of major components in this formulation and/or materials of similar composition.

---CHRONIC TOXICOLOGY (SUMMARY)---
Repeated and/or prolonged exposure may cause irritation to the skin, eyes or respiratory tract. Overexposure to oil mist may result in oil droplet deposition and/or granuloma formation. For mineral base oils: Base oils in this product are severely solvent refined and/or severely hydrotreated. Chronic mouse skin painting studies of severely treated oils showed no evidence of carcinogenic effects. These results are confirmed on a continuing basis using various screening methods such as Modified Ames Test, IP-346, and/or other analytical methods. For synthetic base oils: The base oils in this product have been tested in the Ames assay and other tests of mutagenicity with negative results. These base oils are not expected to be carcinogenic with chronic dermal exposures.

---SENSITIZATION (SUMMARY)---
Not expected to be sensitizing based on tests of this product, components, or similar products.

---

12. ECOLOGICAL INFORMATION

ENVIRONMENTAL FATE AND EFFECTS:

In the absence of specific environmental data for this product, this assessment is based on information for representative products.

ECOTOXICITY: Available ectoxicity data (LL50 >1000 mg/L) indicates that adverse effects to aquatic organisms are not expected from this product.

MOBILITY: When released into the environment, adsorption to sediment and soil will be the predominant behavior.

PERSISTENCE AND DEGRADABILITY: This product is expected to be inherently biodegradable.

BIOACCUMULATIVE POTENTIAL: Bioaccumulation is unlikely due to the very low water solubility of this product, therefore bioavailability to aquatic organisms is minimal.

---

13. DISPOSAL CONSIDERATIONS

WASTE DISPOSAL: Product is suitable for burning in an enclosed, controlled burner for fuel value. Such burning may be limited pursuant to the Resource Conservation and Recovery Act. In addition, the product is suitable for processing by an approved recycling facility or can be disposed of at an appropriate government waste disposal facility. Use of these methods is subject to user compliance with applicable laws and regulations and consideration of product characteristics at time of disposal.

RCRA INFORMATION: The unused product, in our opinion, is not specifically listed by the EPA as a hazardous waste (40 CFR, Part 261D), nor is it formulated to contain materials which are listed hazardous wastes. It does not exhibit the hazardous characteristics of ignitability, corrosivity, or reactivity. The unused product is not formulated with substances covered by the Toxicity Characteristic Leaching Procedure (TCLP). However, used product may be regulated.

---

14. TRANSPORT INFORMATION

USA DOT: NOT REGULATED BY USA DOT.

RID/ADR: NOT REGULATED BY RID/ADR.

IMO: NOT REGULATED BY IMO.

IATA: NOT REGULATED BY IATA.

STATIC ACCUMULATOR (50 picosiemens or less): YES

---

15. REGULATORY INFORMATION

US OSHA HAZARD COMMUNICATION STANDARD: When used for its intended purposes, this product is not classified as hazardous in accordance with OSHA 29 CFR 1910.1200.

EU Labeling: Product is not dangerous as defined by the European Union Dangerous Substances/Preparations Directives. EU labeling not required.

Governmental Inventory Status: All components comply with TSCA, EINECS/ELINCS, and DSL.

U.S. Superfund Amendments and Reauthorization Act (SARA) Title III:
This product contains no "EXTREMELY HAZARDOUS SUBSTANCES".

SARA (311/312) REPORTABLE HAZARD CATEGORIES: None.

This product contains no chemicals subject to the supplier notification requirements of SARA (313) toxic release program.

THIS PRODUCT HAS BEEN AUTHORIZED BY USDA FOR USE UNDER THE FOLLOWING CATEGORY: This product is acceptable as a lubricant where there is no possibility of food contact (complies with earlier USDA guidelines for H-2 lubricant use).

The following product ingredients are cited on the lists below:

CHEMICAL NAME	CAS NUMBER	LIST CITATIONS *
NAPHTHALENE (COMPONENT ANALYSIS) (<0.01%)	91-20-3	16, 22

--- REGULATORY LISTS SEARCHED ---

1=ACGIH ALL	6=IARC 1	11=TSCA 4	16=CA P65 CARC	21=LA RTK
2=ACGIH A1	7=IARC 2A	12=TSCA 5a2	17=CA P65 REPRO	22=MI 293
3=ACGIH A2	8=IARC 2B	13=TSCA 5e	18=CA RTK	23=MN RTK
4=NTP CARC	9=OSHA CARC	14=TSCA 6	19=FL RTK	24=NJ RTK
5=NTP SUS	10=OSHA Z	15=TSCA 12b	20=IL RTK	25=PA RTK
				26=RI RTK

* EPA recently added new chemical substances to its TSCA Section 4 test rules. Please contact the supplier to confirm whether the ingredients in this product currently appear on a TSCA 4 or TSCA 12b list.
Code key:CARC=Carcinogen; SUS=Suspected Carcinogen; REPRO=Reproductive

16. OTHER INFORMATION

USE: LUBRICANT

NOTE: PRODUCTS OF EXXON MOBIL CORPORATION AND ITS AFFILIATED COMPANIES ARE NOT FORMULATED TO CONTAIN PCBS.

Health studies have shown that many hydrocarbons pose potential human health risks which may vary from person to person. Information provided on this MSDS reflects intended use. This product should not be used for other applications. In any case, the following advice should be considered:

INJECTION INJURY WARNING: If product is injected into or under the skin, or into any part of the body, regardless of the appearance of the wound or its size, the individual should be evaluated immediately by a physician as a surgical emergency. Even though initial symptoms from high pressure injection may be minimal or absent, early surgical treatment within the first few hours may significantly reduce the ultimate extent of injury.

INDUSTRIAL LABEL

Under normal conditions of intended use, this product does not pose a risk to health. Excessive exposure may result in eye, skin or respiratory irritation. Always observe good hygiene measures. First Aid: Wash skin with soap and water. Flush eyes with water. If overcome by fumes or vapor, remove to fresh air. If ingested do not induce vomiting. If symptoms persist seek medical assistance. Read and understand the MSDS before using this product.

****

For Internal Use Only: MHC: 1* 1* 1* 1* 1*, MPPEC: A, TRN: 602912-00, ELIS: 400007, CMCS97: 970321, REQ: US - MARKETING, SAFE USE: L
EHS Approval Date: 04APR2002

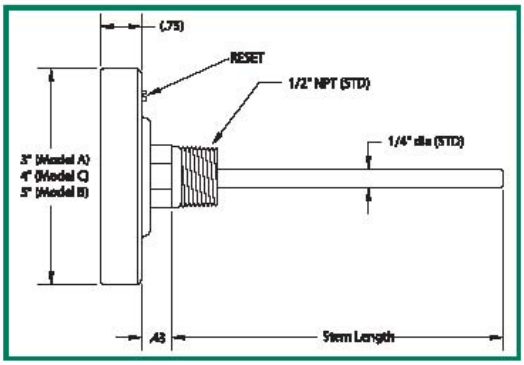
****

Prepared by: ExxonMobil Oil Corporation
Environmental Health and Safety Department, Clinton, USA

Bimetal Thermometers
Industrial 3", 4", 5" Dial

Back Connected (Angle Form)

REO*TEMP* Angle Form thermometers are ideal for local, eye-level temperature readings in most process applications.



Standard Features

- All Stainless Steel Construction
- Hermetically Sealed (ASME B40.3)
- Accurate to 1% of Full Scale
- Standard External Reset
- Silicone Fillable for Vibration

How to Order

AA ——— 060 ——— 1 ——— F43 ——— SF

Models	Stem Length	Connection	Temperature Ranges (See pg.13 for a full list.)	Options
Standard Models		**Standard Threaded***	**Fahrenheit Ranges**	
AA = Model A (3" dial, reset)	025 = 2.5"	1 = 1/2" NPT (std.)	F23 -40 TO 160°F F55* 25 TO 125°F	PS = Pointed Stem
BB = Model B (5" dial, reset)	040 = 4"	4 = 1/4" NPT	F43 0 TO 200°F F47 0 TO 250°F	SF = Silicone Fill (max temp 550°F)
CC = Model C (4" dial, reset)	060 = 6"	5 = 3/4" NPT adapter	F63 50 TO 300°F F67 50 TO 500°F	SS = 316 SS Stem
	090 = 9"	X = Plain Hex Bushing (no threads)	F81 150 TO 750°F F85 200 TO 1000°F	F3 = 3/8" dia. Stem
	120 = 12"		**Celsius Ranges**	
Non-Reset Models		B = 1/2" BSPT	C23 -40 TO 70°C C55* 0 TO 50°C	PC = Acrylic Window
RR = Model R (3" dial, no reset)	150 = 15"	**Sanitary***	C43 0 TO 100°C C47 -20 TO 120°C	PY = Polycarbonate Window
SS = Model S (5" dial, no reset)	180 = 18"	C = 1-1/2" Tri-Clamp	C59 0 TO 150°C C67 0 TO 250°C	TG = Tempered Glass Window
CN = Model CN (4" dial, no reset)	240 = 24"	L = 2" Tri-Clamp	C81 0 TO 400°C C85 100 TO 500°C	MM = Max/Min Pointer
	300 = 30"	M = 3/4" Tri-Clamp	**Dual F/C Ranges**	
	360 = 36"	For more information on Sanitary Thermometers see page 12	D23 -40 TO 160°F & -40 TO 70°C D55* 25 TO 125°F & 0 TO 50°C D43 0 TO 200°F & 0 TO 100°C D47 0 TO 250°F & -20 TO 120°C D63 50 TO 300°F & 10 TO 150°C D67 50 TO 500°F & 0 TO 250°C D81 150 TO 750°F & 0 TO 400°C D85 200 TO 1000°F & 100 TO 500°C	For Thermowells see pg. 14
	-Intermediate lengths available up to 80"			
	-Specify length in inches + tenths			
		*-Other sizes available	*-Not available in 2.5" stem.	

SERIES PD

GENERAL PURPOSE GAUGES (DRY)

- **Black Steel or Stainless Cases**
- **Copper Alloy Wetted Parts**
- **Cost Effective Design**
- **Standard 3-2-3% Accuracy**

PD40Y

PD60Y

PD25N

Specifications

Case: Black Painted Steel or Stainless Steel

Ring: Snap-In Window, Push-On Bezel, or Bayonet

Lens: Snap-In Plastic or Glass

Dial: Aluminum, Black Figures on White Background

Wetted Parts: Copper Alloy

Temperature: -10° to 140°F

Accuracy: 3-2-3% (1.6% Available)

Applications

The PD Series offers a wide variety of economical gauges for applications where ambient or process corrosion are not of concern. Suitable for non-vibrating applications. More economical movements are available where 1.6% accuracy is not required.

HOW TO ORDER

PD — 40 — Y — 2 — C — 2 — P23

Dial:

- **15** = 1.5”
- **20** = 2”
- **25** = 2.5”
- **30** = 3”
- **40** = 4”
- **60** = 6”

Case:

- **N** = Black Steel Snap-In Plastic Lens (1.5”, 2”,2.5” Dial)
- **X** = St. Steel Snap-In Plastic Lens (1.5”, 2”, 2.5” Dial)
- **B** = Blk Steel Push-On Bezel with glass window (1.5”, 2”, 2.5”, 3”, 4” Dial)
- **Z** = St. Steel Push-On Bezel with glass window (1.5”, 2”,2.5 Dial)
- **Y** = Blk Steel Bayonet Removable Glass Lens (4”, 6” Dial)
- **S** = St. Steel Bayonet Removable Glass Lens (4”, 6” Dial)

Tube & Socket:

- **2** = Copper Alloy

Mounting:

- **A** = Bottom
- **B** = Bottom/Rear Flange (2.5”, 3”, 4”, 6”)
- **C** = Back (1.5”, 2”, 2.5”) (4”, 6”)
- **D** = Back /“U” or “O” Clamp (not avail. on “y” case)
- **E** = Back/Front Flange (2.5”) (4”, 6”)

Connection:

- **8** = 1/8” NPT (1.5”, 2”, 2.5”)
- **4** = 1/4” NPT (All Sizes)
- **2** = 1/2” NPT (4”, 6”)

Range Code:

See Page 15 for Range Codes

Available Ranges:

All ranges from vacuum to 6,000 p.s.i. (1.5”, max = 600 p.s.i.) (2”, max = 3,000 p.s.i.)

Options:

- Custom / Logo Dials
- Restrictor Screw
- Silicone Dampened Movement
- High Temperatures (up to 380°F)

REOTEMP INSTRUMENT CORPORATION
10656 Roselle Street • San Diego, CA 92121 U.S.A. • Telephone: (800) 648-7737 FAX (858) 784-0720
sales@reotemp.com • www.reotemp.com

3F05-1

3L05-1

F6-1798 (1 per pack)

ADJUSTABLE SNAP DISC FAN & LIMIT CONTROLS

Adjustable Snap Disc Thermostat Allows You to Set the Temperature Set Point to Match Your Specific Needs Which Simplifies Inventory

FEATURES

- ¼″ quick connect terminals are standard.
- Reduces inventory while providing coverage for a wide range of temperature applications.
- Replaces the majority of fixed disc thermostats now on heating equipment and various appliances.
- 2 adjustable fan control models replace 7 fixed snap disc models.
- 4 adjustable limit control models replace 10 fixed snap disc models.

SPECIFICATIONS

ELECTRICAL RATINGS

VAC	Resistive (Non-Inductive)	Motor Rating (Inductive)		Pilot Duty
		Full Load	Locked Rotor	
120	25.0A	14.0A	72.0A	125 VA
240	25.0A	10.0A	60.0A	125 VA

PARTS AND ACCESSORIES

- F6-1798 Adapter plates (Order separately) — 1 per pack

Model Number	Temperature Range	Differential	Switch Action	Function	Accessories	Therm-O-Disc Part Number
3F05-1	90 to 130°F	20°F	SPST	Fan Controls	Includes thermostat	74T12-310708
3F05-2	140 to 180°F	20°F	SPST	(Close on Rise)	and tab-to-screw	74T12-310709
3L05-1	135 to 175°F	40°F	SPST	Limit Controls	terminals.	74T11-310710
3L05-2	175 to 215°F	40°F	SPST	(Open on Rise)		74T11-310711
3L05-3	210 to 250°F	40°F	SPST			74T11-310712
3L05-10	135 to 175°F	20°F	SPST			74T11-310724
3L05-13	250 to 290°F	40°F	SPST			74T11-310730
3F05-3	90 to 130°F	20°F	SPST	Fan Controls	Includes thermostat,	74T12-310708
3F05-4	140 to 180°F	20°F	SPST	(Close on Rise)	tab-to-screw	74T12-310709
3L05-4	135 to 175°F	40°F	SPST	Limit Controls	terminals, adapter	74T11-310710
3L05-5	175 to 215°F	40°F	SPST	(Open on Rise)	bracket and	74T11-310711
3L05-6	210 to 250°F	40°F	SPST		mounting screws.	74T11-310712

APPLIANCE

757-1

775-1

FLUSH MOUNT FAN OR LIMIT CONTROLS/ ATTIC FAN CONTROL

Ideal for Replacement of Similar Type Controls

FEATURES

- For use where space is limited.
- Small bimetal sensing element.
- Snap-Action switch.
- Fan control has adjustable range with direct reading temperature dial.
- **758** has adjustable limit setting.

SPECIFICATIONS

Dimensions for 757 & 758 . . . . . 1″H x 3″W x 1 1/4″D
Dimensions for 775 . . . . . 2.8″H x 3.59″W x 2.02″D

Model Number	Description	Range	Differential	Switch Action	Motor Rating – Full Load		Pilot Duty
					120 VAC	240 VAC	
757-1	Fan	70 to 160°F ① (21 to 71°C)	Fixed 25°F (14°C)	Close on Rise	8.0 A	4.0 A	125 VA
758-1	Limit	110 to 200°F ② (43 to 93°C)	Fixed 25°F (14°C)	Open on Rise	8.0 A	4.0 A	125 VA
NEW! **775-1**	Attic Fan Control with Thermal Limiter	60 to 120°F ③ (15 to 49°C)	Fixed 10°F (6°C)	Close on Rise	9.0 A	—	—

① Cut-in setting (cut-out is cut-in setting minus the differential)
② Cut-out setting (cut-in is cut-out setting minus the differential)
③ Thermal limiter opens at 183°F (84°C)

416-4

SINGLE FAN OR LIMIT CONTROL

Starts and Stops Fan Operation and the 416-4 Provides Positive Reliable High Limit Protection on Warm Air Furnaces

FEATURES

- Specially designed hydraulic action element can be bent to any position.
- Temperature dial calibrated in °F and °C and can be adjusted through cover.
- Easy to set cut-in and cut-out indicators on adjustable differential.
- Dustproof steel case has top and bottom knockouts.
- SPDT for use as fan or limit, also as fan “selector” on 2-speed blower application

SPECIFICATIONS

Dimensions . . . . . 5 3/8″H x 2 5/16″W x 1 7/8″D
Finish . . . . . Grey
Agency . . . . . U.L. listed and C.S.A. certified

Model Number	Range	Differential	Length	Switch Action	Full Electrical Rating	Motor Rating (Full Load)		Valves & Relays
						12 VAC	240 VAC	24 VAC
416-4 ① ②	100 to 350°F (38 to 177°C)	Fixed 20°F (11°C)	9″	SPDT	HH See page 219	7.4A	3.7A	2.9A

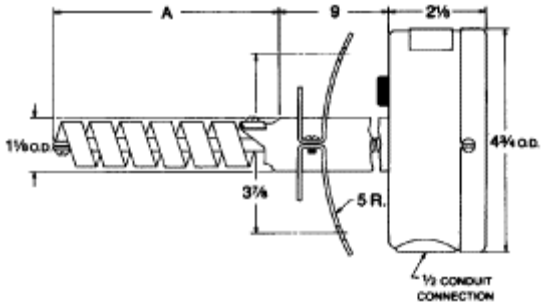
① Includes a standoff bracket for high temperature mounting.
② U.L. approved adjustable dial stop, factory set at 250°F maximum.

Mercoid®

Series M-51

Bi-Metal Air Temperature Switches

Double Adjustable, Heavy Duty, Automatic Reset



FEATURES

- UL Listed, CSA Certified.
- Automatic or Manual Reset.
- SPST Mercury Switch (SPDT Switches Available).
- Visible Dial Shows Duct Temperature.
- Two Adjustments: one sets high temperature set point, the other sets low temperature reset.

Designed for use as a limit switch, fan control, or alarm switch, Model M-51 is used on all types of air conditioning ducts, furnaces, ovens, dryers, etc. Unit may also be used with damper control system to prevent spread of fire through ducts. Adjustments for both set and reset points. Visible dial shows duct temperature and switch set points.

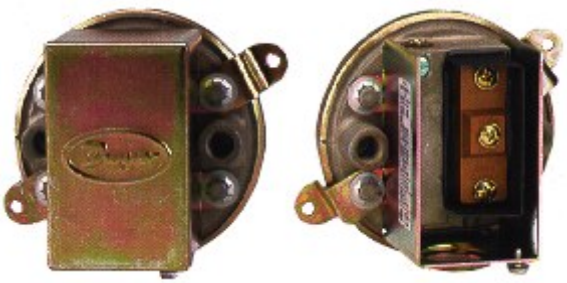
SPECIFICATIONS

Max. Ambient Temperature: 180°F (82°C).
Max. Bi-Metal Temperature: See chart.
Mounting: Reversible flange for flat or curved surfaces.
Dial Calibration: Degrees F.
Housing: Steel with glass fronted cover.
Electrical Rating: 10A @ 120V; 5A @ 240V. AC/DC. Motor Rating: 120/240V AC. Single phase, 3/4 HP, 120/240V DC, 1/3 HP. (SPST mercury switch).
Weight: 4 lbs. (1.8 kg).

Series 1900

Compact Low Differential Pressure Switches

Set Points from 0.07" to 20" w.c., Repetitive Accuracy within 3%



Series 1910 pressure switch. All pressure and electrical connections and set point adjustments are on one side for easy installation.
Series 1910 switch with conduit enclosure off. Shows electric switch and set point adjustment screw.

Our most popular series combines advanced design and precision construction to make these switches able to perform many of the tasks of larger, costlier units. Designed for air conditioning service, they also serve many fluidics, refrigeration, oven and dryer applications. For air and non-combustible compatible gases, Series 1900 switches have set points from 0.07 to 20" w.c. (1.8 to 508 mm). Set point adjustment is easy with range screw located inside conduit enclosure. Internal location helps prevent tampering. UL and CSA listed, FM and CENELEC approved.

SPECIAL MODELS AND ACCESSORIES

Manual Reset Model 1900 MR includes special snap switch which latches on pressure increase above the setpoint. Switch must be manually reset after pressure drops below the setpoint. To order, change base model to 1900 and add MR suffix after range number. Example: 1900-10-MR. Available on -1, -5, -10, or -20 ranges only. Option is not UL, CSA or FM listed.

SPECIFICATIONS

Service: Air and non-combustible, compatible gases.
Wetted Materials: Consult Factory.
Temperature Limits: -30 to 180°F (-34 to 82.2°C).
Pressure Limits: 45" w.c. (11.2 kPa) continuous, 10 psig (68.95 kPa) surge.
Switch Type: Single-pole double-throw (SPDT).
Repeatability: ±3%.
Electrical Rating: 15 A @ 120-480 VAC, 60 Hz. Resistive 1/8 HP @ 125 VAC, 1/4 HP @ 250 VAC, 60 Hz. Derate to 10 A for operation at high cycle rates.
Electrical Connections: 3 screw type, common, normally open and normally closed.
Process Connections: 1/8" female NPT.
Mounting Orientation: Diaphragm in vertical position. Consult factory for other position orientations.
Set Point Adjustment: Screw type inside conduit enclosure.
Weight: 1 lb 4.5 oz (581 g).
Agency Approvals: CE, UL, CSA, Cenelec, FM.

Weatherproof Housing
16-ga. steel enclosure with gasketed cover (NEMA 4) for wet or oily conditions. Withstands 200 hour salt spray test. Wt. 5 lbs. (2.3 kg). Switch must be factory installed. Change 1910 base number to 1911 and add -WP suffix. Example: 1911-1-WP.

Explosion-proof Housing
Cast iron base with brass cover. Rated Class I, Div. 1 & 2, Group D; Class II, Div. 1 & 2, Groups E, F, G; Class III, and NEMA 7, 9 NEMA 3. Wt. 7 lbs. Switch must be factory installed. Change base model to 1911 and add -EXPL suffix. Example: 1911-1-EXPL.

CENELEC Approved Housing, Model 1911-CN.
Explosion-proof housing, CENELEC approved, EExd II B T6 IP6S. Change base number to 1911 and add -CN suffix. Example: 1911-1-CN.

A-399 Duct Pressure Monitor Kit - For use with standard or manual reset model switches. Includes mounting flange, tubing and adaptors.

A-329 Street Ell - Brass adapter for applications requiring right angle connections. Two required for differential pressure.

CAUTION: FOR USE ONLY WITH AIR OR COMPATIBLE GASES.

POPULAR MODELS

Model Number	Operating Range, Inches W.C.	Approximate Dead Band At Min. Set Point	Approximate Dead Band At Max. Set Point
1910-00	0.07 to 0.15	0.04 min	0.04 max
1910-0	0.15 to 0.55	0.10 min	0.10 max
1910-1	0.40 to 1.6	0.15 min	0.16 max
1910-5	1.40 to 5.5	0.30 min	0.30 max
1910-10	3.0 to 11.75	0.40 min	0.40 max
1910-20	4.0 to 20.0	0.40 min	0.50 max

ACCESSORIES

Model Number	Description
A-399	Duct Pressure Monitor Kit, for use with standard or manual reset model switches.
A-329	1/8" NPT Close Coupled Street Ell, brass.

Exhibit T-1

Burner Controls:		Mfg. Number	BNW Ind. Number
	Partlow Gas Valve 3/4"	PA GC00101	GVL-01PAGV34
	Partlow Gas Valve 1 1/4"	PA GC00103	GVL-01PAGV114
	Partlow Sensor 5' PA	PA 106560516	GVL-01PAS05
	Partlow Sensor 15' PA	PA 106561516	GVL-01PAS15
	Partlow Sensor 25' PA	PA 106562516	GVL-01PAS25
	ASCO Solenoid Valve 1/2"		GVL-01ASGV12
	ASCO Solenoid Valve 1 1/4"	JB821460VI	GVL-01ASGV114-VI
	Feed Through Igniter	F-68	BRP-01AUFT
	Spark Plug		BRP-01CHI
	Pressure Gauge 30#		GVL-01VMPG30
	Vacuum Switch-Heavy	1910-5	GVL-01DWPSH
	Vacuum Switch-Medium	1910-1	GVL-01DWPSM
	Vacuum Switch-Light	1910-0	GVL-01DWPSL
	Vacuum Switch-Very Light	1910-00	GVL-01DWPSVL
	Thermometer	20.110.060.50-500F	GVL-01WETH
Fireye:	Programmer	MEP230	ELE-01MFIP
	Base	61-3060	ELE-01MFIB
	Scanner	UV1A3	ELE-01MFIS
	Amplifier	MEUV4	ELE-01MFIA-UV
	Chassis	MEC120RC	ELE-01MFIC-RC
	Remote Display	ED510	ELE-01FIRD
Honeywell:	7800 Safeguard Relay	RM7895A1014	ELE-01HWSR-7800
	7800 Amplifier Module	R7849A1023	ELE-01HWAM-7800
	7800 Purge Module	ST7800A1039	ELE-01HEPM-7800
	7800 Mounting Sub-base	Q7800A1005	ELE-01HWMB-7800
	7800 Display Module	S7800A1001	ELE-01HWDM-7800
	7800 UV Flame Detector	C7027A1049	ELE-01HWFD-UV-7800
	7800 Control Bus Module	S7810A1009	ELE-01HWCB-7800
	7800 Nema IV Cover	204718C	ELE-01HWC-N4-7800
Gas Train:	Temperature Controller	RFW40.000A97	Same
	Gas butterfly valve 1-1/4"	5BV-A 501202	Same
	Double gas valve body	VGG20.403U	Same
	Flange kit	AGA41U	Same
	Actuator w/POC switch	SKP10.191U17	Same
	Leak detection unit	LDU11.523A17	Same
	LDU base plate	AGM11	Same
	Control actuator	SQN&1.603R19	Same
	Control actuator	SQM50.460R1G3	Same
	Pressure switch	GAO-A4-4-8 (14599-1)	Same
	Thermocouple J type	S250JX12WLHB.5	GVL-01DWTC-J

Exhibit T-2

Power Drive:	Mfg. Number	BNW Ind. Number
1 15/16" Insert Bearing	210-31	BSC-01PEB1.94
1 15/16" Pillow Block Bearing	P210-31	BSC-01PEPBB156
1 15/16" Slot Take-Up Bearing	T210-31	BSC-01PEBM.69
1" Pillow Block Bearing	P205-16	BSC-01PEBPB1
1" Slot Take-Up Bearing	T205-16	BSC-01PESTU1
Gearbox Multiplier 5:1	TXQ1-5-56C-56C	GBM-01ALGB-HPF-5M
Gearbox Multiplier 4:1	TXQ1-4-56C-56C	GBM-01ALGB-HPF-4M
Gearbox Multiplier 3:1	TXQ1-3-56C-56C	GBM-01ALGB-HPF-3M
Gearbox Multiplier 2:1	TXQ1-2-56C-56C	GBM-01ALGB-HPF-2M
Conveyor Gearbox 30HWYF	30HWYF -2-1.9375-56C-(Ratio)	GBM-01ALGB30-(Ratio)
Conveyor Gearbox 32HWYF	32HWYF -2-1.9375-56C-(Ratio)	GBM-01ALGB32-(Ratio)
Conveyor Gearbox 42HWYF	42HWYF -2-1.9375-56C-(Ratio)	GBM-01ALGB42-(Ratio)
Auto Fines Clean Out Gearbox	26DYF-1-1.00-56C-400	GBM-01ALGB26-400
Stirrer Gearbox	30YF-2-1.9375-56C-(Ratio)	GBM-01ALGB30-YF(Ratio)
Conveyor Drive Motor	3/4 HP 56C INVERTER DUTY	GBM-01LEM.75-ID
Fan Motor	HP?	VARIOUS
Aux. Motor	HP?	VARIOUS
Conveyor Belting - Coarse-SS	B-60-48-16 SS	RWL-01PEN16WSS
Conveyor Belting - Coarse-Galv.	B-60-48-16 Galv.	RWL-01PEN16WG
Conveyor Belting - Compound-SS	CB2-120-96-18 SS	RWL-01IWCB218SS
Conveyor Belting - Compound-Galv.'	CB2-120-96-18 Galv.	RWL-01IWCB218G
Conveyor Belting - S Trays	Solid Tray	RWL-01BNWSIT
Lagging 6'___ 8'___		RWL-01BNHBL
Lagging Vulcanized 6'___ 8'___		RWL-01BNVL
Fan 24" Alum. Or Steel-Blades #____		FAR-01JLF24L
Fan 28" Alum. Or Steel-Blades #____		FAR-01JLF28L
Fan 34" Alum. Or Steel-Blades #____		FAR-01JLF34L
Fan 38" Alum. Or Steel-Blades #____		FAR-01JLF38L

Electrical:	Mfg. Number	BNW Ind. Number
Fuses	Type? Amp?	VARIOUS
Push Button NC/NO	ABW111 NC/NO	ELE-01VMPB
Hi Limit Snapdisc (250 F Max.)	3L05-3	GVL-01VMLCSD
Hi Limit Snapdisc (290 F Max.)	3L05-13	GVL-01VMLCSD-H
Hi Limit NC/NO contactor	416-4	GVL-01VMLCO
Hi Limit Bi-Metal (500 F Max.)	M-51-74	GVL-01VMLC-BM
Ignition Transformer	A06-SA6	ELE-01WEIT
Machine Tool Transformer	50-0150-053	ELE-01VMT
Fuse Block for Machine Tool	265B	ELE-01VMTFB
AC Relay		ELE-01DARAC
Panel Light-Amber	SL53416-6	ELE-01SSPLA
Panel Light-Red	SL53415-6	ELE-01SSPLR
Disconnect Pistol Handle	BDH47	ELE-01STDH
Disconnect Selector Handle	BDSL105	ELE-01STDSH

Exhibit T-3

Parts Order Form

From: _____ Date: _____

Address: _____ Serial No. _____

_____ Model No. _____

_____

1 Part Description: _____

BNW Number: _____ Amount: _____

2 Part Description: _____

BNW Number: _____ Amount: _____

3 Part Description: _____

BNW Number: _____ Amount: _____

4 Part Description: _____

BNW Number: _____ Amount: _____

Date Needed _____

All parts shipped FOB Factory Tippecanoe, IN 46570

Fax: 219-353-8152
Phone: 219-353-7855
Email: sales@belt-o-matic.com

Mail: BNW Industries
7930 N 700 E
Tippecanoe, IN 46570