INSTALLATION PACKAGE FOR A SOLAR HEATING SYSTEM

Prepared from documents furnished by

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George C. Marshall Space Flight Center, Alabama 35812

For the U. S. Department of Energy

U.S. Department of Energy
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**SYSTEM OPERATION & MAINTENANCE**

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Appendix A - Detailed Drawings

Index of Drawings
A. GENERAL

This is an air type solar system designed for heating during the winter and is very simple to operate. Basically the system is completely automatic and will function without further adjustment when the control switch is in the "Winter Mode" and the manual override switch is in the automatic position. NOTE: This switch must be left in the automatic position and should only be changed by an authorized serviceman. Upon conclusion of the heating season, the control switch is placed in the Summer Mode which activates the attic fan and ventilates the collector and attic. NOTE: The soffit vents located above the front door must be opened in this Mode to insure adequate ventilation. If the vent mode is not operating properly, an alarm has been provided which guards against inadequate ventilation and warns the occupant of this fact. A local serviceman should then be called to rectify said problem. A third switch has been provided to manually turn off the attic fan during overcast days or night time and is clearly marked as such. There is also a system On-Off switch which controls the power to the entire system and is provided for servicing the system.

The moving parts consist of Fans No. 1, No. 2, the attic fan, dampers and damper motors 1 - 5. Normally the only reason why the system will not operate will be because of the lack of
electricity caused by a burned out fuse, or because the driving belts have parted or slipped. These two faults can easily and quickly be determined.

If the system does not shift to the proper operating mode it may be because of lack of power to the damper control systems and this should be checked. (See damper maintenance section). Failure of sensors or jamming of operating motors or solenoids may make the dampers and the control system inoperative and the serviceman should be called. (see list of authorized servicemen).
B. FILTERS

Fan No. 2 is equipped with a standard fiberglass air filter which should be routinely checked and replaced when dirty. (see M-4 of working drawings for filter placement). This will normally be about once each month. Naturally, the air filters on the conventional unit should be checked and replaced, as per usual operation. Large mesh screening filters will be installed on the inlet and outlet to the rock storage pit and these should be checked occasionally to remove any insects or other material which may have accumulated.

C. COLLECTORS

The collectors should be self cleaning if there is normal rainfall. However, during extended dry periods it may be necessary to hose down the tops to remove accumulated dust. In all events, the local serviceman should check collector cleanliness at least once per month to ensure efficient operation. Periodic checks for water leaks evidenced by obvious rusting and caused by Tedlar damage should be conducted. New Tedlar should be ordered (see collector manufacturer) and rusted areas properly cleaned and repainted. Other than this, there is very little that should go wrong with the collector, although an annual inspection by the local serviceman is advisable to see if anything inordinate has happened.
D. **DUCTS**

Ducts should be checked for air leaks, cracks, or separations. Duct insulation should also be checked and repaired or replaced as necessary.

E. **SITE DATA ACQUISITION**

The Site Data Acquisition system should not be touched in any way. This has nothing to do with the actual operation of the SEEKO heating system but merely consists of a series of temperature and flow sensors which collect and transmit data to a general computer processing and recording point by a private telephone line which is connected to the transmitter in the house.

Maintenance to dampers, damper motors, fans and the control panel is explained in detail in the following pages. Control diagrams showing the various operating modes are also provided as well as a list of servicemen to contact in the event any complications should develop.
36" VERTICAL BELT-DRIVE POULTRY FAN

AMCA Certified Air Deliveries. 1/3 HP, Ball Bearing, TE Motor Included
Shipping Crate Can Serve as Installation Frame. Shipped Completely Assembled

Completely assembled 36" belt-drive exhaust fan with certified air delivery licensed by AMCA. Shipped in a wood crate which is specially designed for fast, easy installation in farm buildings, such as poultry and livestock houses, as shown in illustration at left. Can be easily removed from crate for installation in factories, warehouses, greenhouses, laundries, etc. Rugged construction throughout. Deep-drawn venturi frame has heavy-gauge tubular supports for vibration-free performance. Balanced six-wing blade is embossed for strength and rigidity. Self-aligning, sealed, ball bearing pillow blocks. Fan has 1/3 HP, 1725 RPM. 115/230V, 60 Hz, totally enclosed, ball bearing, split phase, Dayton motor with automatic reset thermal protection. Cast-iron drive sheaves with belt installed. Sturdy motor base has slotted holes to allow proper belt adjustment when necessary. Venturi frame is gray enamel, blade is red finish. Shpg wt. 103 lbs.

Dayton Electric Mfg. Co. certifies that the fan shown here is licensed to bear the AMCA seal. The ratings given are based on tests made in accordance with AMCA Standard 210 and comply with the requirements of the AMCA Certified Ratings Program.

No. 3G270 Fan. Retail $231.20. Each $138.45

MAINTENANCE

MOTOR - Check wiring for secure connections. Oiling is not required as this motor has sealed bearings.

PULLEY - Check pulleys for secure fit and alignment.

BELT - Check belt for wear and replace as necessary. Adjust belt tension making sure all motor mounting bolts are secure upon completion of maintenance inspection.

FAN HOUSING - Check housing for secure wall attachment.
F-2 FAN MOTOR

1/8 to 3/4 HP FURNACE & BELT-DRIVE BLOWER MOTORS


Built for quiet, dependable service on warm air furnaces, belt-driven fans and blowers, air conditioners, air coolers, and wherever a motor having a low noise level, reduced starting torque and low starting current is required. Low starting current reduces light flicker. Dynamically balanced rotor assembly and resilient mounting reduce vibration and electrical noise. Starting winding designed to bring load to speed at a uniform rate. 1725 RPM, 60 Hz, 40°F rise, continuous duty. Automatic-reset thermal protection. All angle mounting sleeve bearings. Rotation easily reversed by electrical connection. Gray finish. Recogized by UL under the Motor Component Recognition Program.

NEMA 48 Frame

<table>
<thead>
<tr>
<th>HP</th>
<th>RPM</th>
<th>Volts</th>
<th>Bearing Size</th>
<th>Full-Loaded Thermal Prot. (See Chart)</th>
<th>NEMA Frame</th>
<th>Weights</th>
<th>Stock No.</th>
<th>Retail</th>
<th>Each</th>
<th>Shop Wh.</th>
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<tbody>
<tr>
<td>1/8</td>
<td>1725</td>
<td>115</td>
<td>Siv Real Auto 48F</td>
<td>2.4</td>
<td>316F003</td>
<td>6K109</td>
<td>$24.71</td>
<td>13</td>
<td></td>
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<tr>
<td>1/6</td>
<td>1725</td>
<td>115</td>
<td>Siv Real Auto 48F</td>
<td>4.0</td>
<td>316F006</td>
<td>5K215</td>
<td>35 82</td>
<td>24.80</td>
<td>12</td>
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<td>1725</td>
<td>115</td>
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<td>316F006</td>
<td>5K215</td>
<td>39 56</td>
<td>26.71</td>
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<tr>
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<td>1725</td>
<td>115</td>
<td>Siv Real Auto 48F</td>
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<td>39 56</td>
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<tr>
<td>1/2</td>
<td>1725</td>
<td>115</td>
<td>Siv Real Auto 48F</td>
<td>7.2</td>
<td>316F006</td>
<td>6K106</td>
<td>39 56</td>
<td>26.71</td>
<td>14</td>
<td></td>
</tr>
</tbody>
</table>

(*) Nos. 6K463, 6K362 have NEMA 48 frame body mounted on NEMA 56 frame cradle base, have 1 1/2" long, 1/2" dia. shaft and are supplied with 3/4" split steel shaft bushing.
(t) Mating base has 56 and 58 frame mounting holes. Motor shaft height 2: 1 1/2" long, 3/4" dia. shaft, supplied with 3/4" split steel shaft bushing.

MAINTENANCE

MOTOR - Check wiring for secure connections. Oiling is not required as this motor has sealed bearings.

PULLEY - Check pulley for secure fit and alignment.

BELT - Check belt for wear and replace as necessary. Adjust belt tension making sure all motor mounting bolts are secure upon completion of maintenance inspection.

ORIGINAL PAGE IS OF POOR QUALITY
SINGLE INLET BELT-DRIVE DUCT BLOWERS
Air Deliveries Based on Standard Test Codes of AMCA

9, 10½ & 12½", Single-Width, Multi-Vane Wheels
Adjustable on-the-Job to Any Discharge Position
Very Quiet. Adapts to Many General Applications

Economical single-inlet blowers with inlet unobstructed, for general duct ventilation, exhausting, air conditioning; processing and industrial use. Comes with bottom horizontal discharge which can be altered on the job to any required discharge position by drilling new holes and rotating blower housing on base and bolting in position. Adjustable top motor mount quickly changed from top to rear mounting.


Air deliveries of blowers listed below are based on standard test codes of AMCA.

<table>
<thead>
<tr>
<th>Model No.</th>
<th>1/8&quot; SP</th>
<th>1/4&quot; SP</th>
<th>3/8&quot; SP</th>
<th>1/2&quot; SP</th>
<th>3/4&quot; SP</th>
<th>1&quot; SP</th>
<th>RPM</th>
<th>HP</th>
<th>Snub. Wt.</th>
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<tbody>
<tr>
<td>2C887</td>
<td>1100</td>
<td>1000</td>
<td>900</td>
<td>800</td>
<td>700</td>
<td>600</td>
<td>1000</td>
<td>1/4</td>
<td>25</td>
</tr>
<tr>
<td>2C888</td>
<td>1690</td>
<td>1600</td>
<td>1480</td>
<td>1370</td>
<td>1260</td>
<td>1140</td>
<td>1000</td>
<td>1/2</td>
<td>36</td>
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<tr>
<td>2C800</td>
<td>2100</td>
<td>1980</td>
<td>1600</td>
<td>1460</td>
<td>1370</td>
<td>1270</td>
<td>1100</td>
<td>1/2</td>
<td>60</td>
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</table>

(*) Overloaded below 1/8" SP (1) Overloaded at this SP at specified HP.

BLbwer DIMENSIONS

<table>
<thead>
<tr>
<th>Model No.</th>
<th>Wheel Size</th>
<th>Shaft Dia.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2C887</td>
<td>9 ½ ¾</td>
<td>10 ¾ 10 3/4</td>
</tr>
<tr>
<td>2C888</td>
<td>10 ¾ 5/8 5/8</td>
<td>12 ¾ 11 ¾ 8 11 ½ 7 ¾ 6 ½ 6 ½ 9/36 8/36 7 ¼ 5 ½ 9/36 9/36 10 ¾ 10 ¾ 3/8 11 ½</td>
</tr>
<tr>
<td>2C800</td>
<td>12 ½ 7/8 7/8</td>
<td>16 ¾ 13 ¾ 9 ¾ 14 ¾ 10 ¾ 8 ¾ 11 ½ 10 ½ 8 ¾ 6 ¾ 13 ¾ 11 ½ 12 ¾ 2 ¾ 17 ¾</td>
</tr>
</tbody>
</table>

ORIGINAL PAGE IS OF POOR QUALITY.
F-3 BOOSTER FAN

SINGLE-INLET, 4-WAY DISCHARGE BLOWERS
Adaptable to 4 Discharge Positions on the Job
9½ to 10½" Dia. Single-Width Wheels


4 BASIC DISCHARGES SERVED

SINGLE-INLET BLOWERS WITH MOTOR AND DRIVE

MAINTENANCE

MOTOR - Check wiring for secure connections. Oiling is not required as this motor has sealed bearings.

PULLEY - Check pulley for secure fit and alignment.

BELT - Check belt for wear and replace as necessary. Adjust belt tension making sure all motor mounting bolts are secure upon completion of maintenance inspection.
CONCHO INDIAN SCHOOL

SOLAR PROJECT

TC77-13

OPERATIONS & MAINTENANCE MANUAL
This page is copyrighted. For information on the Control Damper contact Ruskin Mfg Co, P.O. Box 129, Grandview, MO 64030.
GENERAL INSTRUCTIONS

TECHNICAL INSTRUCTIONS

Solid State Thermostats
Proportional Controlling

GENERAL INFORMATION: The TP-8101 design is such that it can be mounted directly to a 2x4 handy box located on the wall. It is a self-contained unit which includes a sensing element and amplifier. The unit has three pigtails for connection of the power supply and control signal to the given controlled device, such as a solid state actuator drive. The red and blue wires are used to supply the 20 VDC to the controller. The yellow and blue wires are used to connect the variable output signal from the controller to the input of the controlled device. It is capable of operating several controlled devices.

The room controller is completely factory calibrated and requires no field calibration. The throttling range is adjustable from 2-20°F by selecting the proper throttling range pin. The unit contains a combination setpoint and calibration potentiometer with a range of 55-85°F.

Terminals are available on the back of the unit to accomplish the following options: remote setpoint, remote sensing, summer-winter changeover and auxiliary selective ratio elements.

ACCESSORIES:

1. The AD-8951 mounting assembly is an accessory provided to permit easy panel mounting and wiring of the TP-8101 room controller. It includes a 11" x 4" piece of vinyl mounting track. See Figure 4 for wiring information.

2. Remote setpoint adjuster (AT-8158), see Figure 2 for wiring.

3. Auxiliary selective ratio element (TS-8601), see Figure 3 for wiring.

INSTALLATION INFORMATION:

Location: Locate the controller where it will be exposed to unrestricted natural air circulation and to the average conditions of the controlled space. Do not locate it near sources of heat or cold (such as lamps, motors, sunlight, radiators, and concealed pipes or ducts within the wall) which might affect the control point.

Ambient Temperature Limits:
- Maximum +135°F
- Minimum + 40°F

Wiring: Pigtails are provided for wiring to the controlled device. Large, coded, screw type terminals are provided for all other electrical connections. Make all electrical connections to the element in accordance with installation wiring diagrams for the job. Comply with National and Local Electrical Codes. No. 18 3-conductor thermostat cable may be used. Low voltage Class 2 wire is acceptable but No. 18 or larger 600 V wire should be used if splices are to be made in the same junction box with line voltage wiring.

The controller may be installed on either a flush switch box or surface switch box. To install, proceed as follows:

1. "Pull" all wires that are required.

2. Connect all control wiring to thermostat terminals.

3. Make electrical connections to any remote sensing elements with a conductor cable.

4. Remove the thermostat cover. To do so, loosen the screw at the bottom of the cover, pull the cover out from the bottom and up to disengage from the base.

5. Fasten the base to the box with the provided captive screws.

6. Replace cover and tighten cover screw.
1. **Remote Setpoint**: Remove dial knob from the TP-8101, Figure 1, and install the AT-8158 remote setpoint adjustor between terminals 1, 2 & 7. This is used for applications where the setpoint adjustment is mounted remote from the TP 8101 controller.

2. **Remote Sensing**: Remove the internal 1000 ohm sensor, Figure 1, and install the remote sensor (TS-8000 series) between terminals 7 & 8. This is used for applications where the sensor is mounted remote from the TP-8101 controller.

3. **Summer-Winter Changeover**: The controller operates in either the DA or RA mode.

   - Jumper 4 to 5 - DA (Direct Acting) = temperature increase causes output voltage increase
   - Jumper 3 to 4 - RA (Reverse Acting) = temperature increase causes output voltage decrease

   ![Diagram](image1)

   Fig. 1 - TP-8101 Component Locations

   ![Diagram](image2)

   Fig. 2 - TP-8101 Terminal Arrangement Etc.

   ![Diagram](image3)

   Fig. 3 - Wiring Schematic

**Adjustments:**

The TP-8101 has been factory calibrated to produce a 7.5 VDC output signal when the setpoint and the temperature at the sensing element agree.

Throttling range settings of 2, 3, 6 & 20 are available by placing the T.R. jumper on the proper selector pin, see Figure 1.

**Service:**

1. Check wiring per job wiring diagram
2. Measure with VOM
   - Power Supply 20 VDC - Red (+) to Blue (-) wire
   - Output 1-15 VDC - Yellow (+) to Blue (-) wire
   - Sensor 1000 ohm remote or internal
3. Consult EN III for additional service information

**Fig. 4 - TP-8101 Mounting on AD-8951**

**Fig. 5 - TS-8601 Ratio Discharge Sensor**
General Instructions

SOLID STATE ADAPTORS
Seq./Par./Rev. Module
Hi-Lo Selector Module

General Information: Specific adaptor modules are designed to meet system applications such as sequencing/paralleling/reversing, and high-low signal selection. By placing these modules between the controller and the controlled device, complex cycles of operation can be accomplished. The design of the module centers around the use of integrated circuits and discrete type components arranged on printed circuit boards and snapped into vinyl track for mounting in a local control panel.

The high-low signal selector module, Figure 1, is designed to accomplish either high or low signal selection, depending on the pin arrangement underneath the cover, Figure 3. The device is calibrated at the factory and requires no field calibration. It has the capability of selecting either the highest or lowest signal from up to six zones. The output signal then responds to either the highest or lowest zone thermostat, depending on the application.

The sequencing/paralleling/reversing module, Figure 2, is a device which conditions the signal supplied by the controller and provides sequencing, reversing, or parallel operation to the controlled device. In the sequencing mode, the output is adjustable above or below the output voltage of the controller, permitting sequencing of two controlled devices. In the reversing mode, the output of the module is reversed with respect to the input, i.e., a 1-15 volt input provides a 15-1 volt output. In the paralleling mode, several controlled devices can be operated in parallel from the signal produced by the sequencing/paralleling/reversing module.

Installation Information: The module is designed to be track mounted and located in a local control panel. The unit is provided with a 7-1/2" piece of mounting track to permit quick and easy panel mounting, in a horizontal or vertical position. Location should be such that the unit is not subjected to severe vibration, shock, or ambient temperature conditions.

Make all connections in accordance with job wiring diagrams, complying with all national electrical codes. Wiring terminations are made at screw terminals located on the end of the printed circuit board, Figures 4 and 6.

Type
AD 8101
AD 8201

Ambient Temperature Limits:
Minimum = +40°F
Maximum = +135°F

Construction: The AD 8101, and 8201 adaptor modules are designed primarily for track mounting in a local or central control panel. However, they can also be located inside the AD 8910 enclosure for remote field mounted installations.
Adjustments: High-low selector module – this module is factory calibrated to provide a 1:1 ratio so that with a 6-9 volt input a 6-9 volt output is obtained. An adjustment is available so that the output of the high-low selector module can be changed ± 4 volts DC with respect to the input signal, Figure 3.

Adjustments: Sequencing/paralleling/reversing module is calibrated at the factory to provide a 1:1 ratio so that with a 6-9 volt input, a 6-9 volt output can be obtained. The sequencing/paralleling/reversing module has an adjustment so that the output signal may be changed ± 5 volts with respect to the input signal, Figure 5.

Service:
1. Check wiring per job wiring diagram.
2. Measure with VOM:
   A. Power supply 20 VDC, terminals +20 and COM.
   B. Output 1-15 VDC terminals OP1 and COM.
   C. Input 1-15 VDC terminals IV1 through IV6 and COM.
3. Consult EN 111 for additional service information.
Solid State Controlled Device
Single Stage Relay
Two Stage Relay
Time Proportioning Relay

General Information: Staging relays, Figure 1, are offered in various configurations which include single stage, dual stage, and dual stage with one stage containing heat anticipation. These staging relays require 120 volts AC for power source and contain a 20 volt DC regulated power supply which is used to supply power to other modules, such as controllers and adaptors. The staging relay receives a 1-15 volt DC input signal and by means of adjusting the drop-out voltage of each stage, the relays may be made to operate at any voltage in this 1-15 volt span. The differential of the relay is adjustable by selecting the proper pin on the printed circuit board.

The time proportioning version of the staging relays can be used to control heating-cooling applications. The heating side is built with a heat anticipation circuit which provides time proportioned control of electric heat. The second relay in the module can be used for cooling which would be connected to a single stage DX coil.

Adjustments: The staging relay has a potentiometer which will set the drop-out point of each relay between 2 - 12 volts DC. It also contains fixed deadband (pull-in to drop-out) of 1/2, 1, 2, and 4 volts DC, Figure 2. Pull-in point represents drop-out voltage plus deadband voltage setting.

Ambient Temperature Limits:
Minimum +40°F; Maximum +135°F.

Installation Information: The module is designed to be track mounted and located in a local control panel. The unit is provided with a 7-1/2" piece of mounting track to permit quick and easy panel mounting, in a horizontal or vertical position. Location should be such that the unit is not subjected to severe vibration, shock, or ambient temperature conditions.

Make all connections in accordance with job wiring diagrams, complying with all national electrical codes. Wiring terminations are made on screw terminals located on the end of the printed circuit board. See Figure 3, 4, 5 for module wiring.

Construction: The CC 8101, 8102, and 8103 relays are designed primarily for track mounting in a local or central control panel. However, they can also be located inside the AD 8910 enclosure for remote field mounted installations.
Calibration:

1. Apply power to relay module.
2. Connect VOM to input terminals IV1, IV2 and COM.
3. Set input voltage to desired drop-out voltage (IV1).
4. Adjust stage one for relay drop-out (R1).
5. Repeat steps 3 and 4 for stage two (R2).
6. Set differential to desired setting.

Service:

1. Check wiring per job wiring diagram.
2. Measure with VOM
   A. Power 120 VAC terminal L1 and L2.
   B. Power supply 20 VDC terminal +20 and COM.
   C. Input 1-15 VDC terminal IV1, IV2 and COM.
3. Consult EN 111 for additional service information.
ENVIRONMENTAL SYSTEMS

GENERAL INSTRUCTIONS

Proportional and Two-Position Hydraulic
Actuators for Dampers and Valves

DEVICE INFORMATION

Identification

Members of this group may be easily identified by referring to the part number displayed around the center of the cylinder. The date of manufacture (numerically, the week followed by the year) is stamped in ink on every actuator.

This General Instruction Sheet is concerned with all MP-5200 Series actuators bearing the part number suffix "-0-0-1" and all MA-5200 Series actuators. Actuators with the part number suffix "-500" have a built-in adjustable SPDT switch. When working with actuators manufactured before this series, refer to your obsolete literature file for previous Gl's. F-11943-3 deals with the obsolete MP-5200 Series. F-12766-1 is the previous sheet on MA-5200 Series actuators.

MA and MP-5210 Series: These actuators are two position and proportional valve actuators, respectively.

MA and MP-5220 Series: These actuators are two position and proportional damper actuators, respectively.

Pre-Installation

MA and MP-5210 Series: These valve actuators are supplied without additional linkage or hardware. Valve bodies or linkage must be ordered separately.

MA and MP-5220 Series: These damper actuators are supplied with mounting bracket, and integral damper linkage. Also required for installation will be three 1/4-inch diameter bolts or other fasteners to mount the actuator. Additional hardware normally, required for linking the damper would be:

- AM-132-0-0-1 - balljoint connector
- AM-122-0-0-1 - straight connector
- AM-125 - 5/16-inch link rod
- AM-111 thru 115 - damper shaft crank arms

When actuators have the optional auxiliary switch, an XDDH-132 adjusting wrench is available for adjustment.

Before mounting the device check for dents, bent parts and signs of oil leakage. Also check supply voltage against requirements, shown below:

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Voltage Requirements (VAC)</th>
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<tbody>
<tr>
<td>MA-MP-5XX0</td>
<td>120</td>
</tr>
<tr>
<td>MA-MP-5XX1</td>
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<td>208</td>
</tr>
<tr>
<td>MA-MP-5XX3</td>
<td>24</td>
</tr>
</tbody>
</table>

BARBER-COLMAN COMPANY ROCKFORD, ILL. 61101
INSTALLATION

Requirements

These actuators will operate correctly in any position and are unaffected by normally encountered environmental conditions. Ambient temperature limitations: For MA Series, minimum is zero and maximum is 140°F. For MP-5220 Series, minimum is minus 20°F and maximum is 135°F. Power required is 10 watts.

Procedure

1. Before installing the device, check to be sure that it operates properly.

   MA (two position) actuators: When the proper AC voltage (Figure 4) is applied, the actuator motor should run causing the actuator to extend.

   MP (proportional) actuators: These actuators require the proper input voltage (Figure 3) and a control voltage of 1 to 15 VDC. As the control voltage goes through a nominal 6 to 9 VDC range, the actuator should travel through its stroke with the proper valve or damper linkage. For this checkout step, the AD-8301 manual positioner may be used to supply the control voltage.

2. Install and connect the device physically.

   Damper actuators: Position actuator and mark mounting holes using the actuator bracket as a template. When mounting the actuator allow 10 inches space for wiring, and leave adequate room for linkage. Allow 2-1/4 inches to remove actuator from integral linkage.

   The best position for the actuator is with the actuator crank arm and the crank arm on the driven shaft, at a 90° angle to the linkrod at midstroke. It may be necessary to swivel the actuator linkage to arrive at the best mounting location.

   Allow adequate working space to wire the actuator into the system.

   Drill mounting holes for the appropriate 1/4-inch diameter mounting fasteners and mount the actuator. The actuator must be mounted firmly enough to prevent excessive actuator movement under normal damper loading. If there is excessive actuator movement, the damper may not fully open or fully close.

   Valve actuators: Remove the valve body from the actuator by loosening the 1-5/8-inch flange nut.

   Pipe the valve body into the system. Note: Be sure that the actual flow is in the same direction as the arrows on the valve body indicate. Allow 3 inches above the actuator case for reattachment and removal.

3. Wire the actuator into the system.

   Low voltage units wired to NEC codes may use Class Two wiring. Wire line voltage units wired to NEC codes, A maximum of 12 inches of 1/2-inch flexible conduit between the actuator and conduit box with standard 18-inch actuator leads. All actuator wires must be contained in the conduit.

   **POWER WIRE SIZE PER ACTUATOR**

<table>
<thead>
<tr>
<th>Actuator Voltage (VAC)</th>
<th>Wire Size (Ga)</th>
<th>Maximum Two Wire Run (Feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
<td>14</td>
<td>300</td>
</tr>
<tr>
<td>120</td>
<td>14</td>
<td>480</td>
</tr>
<tr>
<td>240</td>
<td>14</td>
<td>7000</td>
</tr>
</tbody>
</table>

   To determine the allowable maximum run for multiple actuator wiring, divide the maximum run shown above for a given wire size and voltage by the number of actuators on that run.

   Use wire nuts on power leads from a Class A power source. Power lead colors are shown as follows: Black — common to all voltages that follow. White — for 120 VAC. Black with blue tracer — for 24 VAC. Black with brown tracer — 208 VAC. Black with yellow tracer — 240 VAC. All leads 18 inches except 24 VAC units which are 48 inches.

   MP (proportional) actuators: Actuator wires are connected as shown in Figure 3. Barber-Colman approved, three conductor twisted 18 AWG wire has 600 volt PVC insulation and should be used from the controller. Also acceptable is any three wire (18 ga.) cable with Class I lead insulation insulated in conduit separate from line voltage (Figure 3).

   MA (two position) actuators: These are wired as shown with the thermostat or switching device controlling the off-on status of the actuator motor (Figure 4).
4. Finish the damper actuator mechanical hook-up.

After wiring, assemble the straight connector, linkrod, balljoint connector, and damper shaft crank arm as shown (Figure 5).

Tighten both the actuator connector to the linkrod and the damper crank arm to the damper shaft. Both crank arms should be approximately 90° to the linkrod at midstroke. Normally dampers are linked to full heat with the actuator retracted.

Extend and retract the actuator by applying approximately a 6 to 9 VDC control signal and required voltage. The actuator crank arm will rotate 80°.

Determine the proper radius on the damper shaft crank arm to fully open and close the damper.

Tighten down the connector to the damper crank arm and the linkrod.

The installation is now complete.

Auxiliary Switch

Hydraulic actuators may be ordered with a built-in adjustable SPDT auxiliary switch (Figures 6 and 7). This switch must be ordered as part of the actuator and cannot be field installed. Note: For MP Series actuators only, the switch common wire is internally connected to the black power lead. Because of this, the switch must be wired to control the same voltage as the actuator itself. Switch rating is 10 amperes at 120/240 VAC. Leads are 18 inches except 24 VAC units which are 48 inches.

The switch’s brown wire is normally open and the orange wire is normally closed. The switching point is adjustable over the entire actuator stroke and is factory set to occur at the retracted end. Use XDDA-132 to adjust the switch point.

CHECKOUT

The actuator is now installed and should run properly when the system is energized. The following checks can be easily performed to see if the device is operational.

MP Series Actuators: First, the actuator motor should run continually when power is applied. If the motor is not running, something is wrong with either actuator or the supply voltage. Second, the damper or valve should go from full heat to full cool as the control signal goes approximately from 6 to 9 VDC.

NOTE

At very low ambient temperatures (around minus 20°F) the actuator may run slowly until the oil warms up. This condition may exist for 30 minutes.

MA Series Actuators: When the proper voltage is supplied to the actuator terminals the actuator motor should run, causing the actuator to extend.

If the actuator fails to function properly, refer to the section on repairs.

RUN/ADJUST

No adjustments are made at the actuator. All adjustments are made at the controller.

Theory of Operation

See Figures 6 and 7. The permanently sealed oil filled case (1) contains a movable hydraulic piston assembly (2) and an electric pump (3) for the hydraulic system. The pump generates a fluid pressure which is transmitted to the top of the piston. Opposing the hydraulic force is the spring of the valve or damper linkage.

MA Series Actuators: The electric pump (3) is powered by the input supply voltage and runs whenever the voltage is applied. When power is removed, the oil flows back through the pump by means of check valve (6) and the actuator retracts.

MP Series Actuators: The electric pump (3) is powered by the input supply voltage, and runs continuously. An unregulated power supply (4) is powered by a transformer winding from the pump motor winding. The power supply produces 20 VDC which powers the controller. The controller returns a 1 to 15 VDC control voltage to the actuator transducer (5). This controls the internal pressure and the resultant actuator action.
MAINTENANCE

The power unit of the actuator is sealed in oil and requires no maintenance.

REPAIR

MA Series Actuators:

1. Check the actuator by applying the proper supply voltage.
2. The motor should run when power is applied, if not, the actuator is defective and should be replaced.
3. The actuator should extend, if it does not, check the mechanical linkage. Either the mechanical linkage prevents proper action or the actuator is defective.
4. If the linkage moves properly, but the actuator does not extend, replace the actuator.
5. If applying power causes the actuator to perform correctly, the actuator and linkage are functional and the wiring and thermostat should be checked.

MP Series Actuators: Repairs to this device consist mainly of checking the unit wiring and replacement of the power supply. Other field repairs are not recommended. Use the procedure below to locate a malfunction.

1. The actuator motor should run continually. If it does not run, check the supply voltage and the unit wiring.
2. Voltage between the blue (−) and red (+) leads should be 20±1 VDC.
3. Input voltage on the blue (−) and yellow (+) wires should be between 1 and 15 VDC. If it is not, refer to EN-111 3.1.2 for service information.
Seven Day Time Clock

For automatic switching of a building control system from "Day" to "Night" and then back to "Day" on a selectable program. Device: Heavy-duty, sealed, permanently lubricated, synchronous timing motor drives a large seven day dial. Graduation of dial at 30 minute intervals enables accurate setting of switch tripers. Switch tripers (7 on and 7 off) may be easily installed around the outer rim of the dial to provide various (on and off) timings. By not installing tripers for a specific day of the week, that day "on" operation is automatically omitted. Entire mechanism can be snapped out of case for installation in a central control center. Unit has large, coded, screw-type terminals. Case is 187mm wide, 276mm high and 92mm deep (7-3/8 inches wide, 10-7/8 inches high and 3-5/8 inches deep). Three 6mm [1/4-inch] diameter mounting holes in back of case. Top mounting hole centered 203mm [8 inches] above two bottom holes which are 127mm (5 inches) apart. Combination 13mm (1/2-inch), 19mm (3/4-inch) knockouts provided. AE-178: This device includes a battery driven 8 hour carryover feature. The Ni-cad battery charge is continuously maintained by a built-in charger. Initial charge time is 48 hours. Upon power interruption a battery driven motor maintains clock operation. The battery is automatically recharged upon power resumption. **Input**: 120 volts, 60 Hz. **Output**: Four single-pole, single throw switches. Snap-acting. Two normally open; two normally closed. Formed brass jumpers included readily permit modifying switch action to SPDT, DPST and DPDT.

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Clock Motor</th>
<th>Switch Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>AE-174</td>
<td>120V., 60 Hz</td>
<td>1 hp at 120/240 Volts, a.c. only.</td>
</tr>
<tr>
<td>AE-178</td>
<td>120V., 60 Hz</td>
<td>Pilot Duty 690 VA. Non-Inductive 40 amps at 120 or 240 volts. a.c. only.</td>
</tr>
</tbody>
</table>

Interval Timer

SPST, N.O., 6 hr., spring operated; for standard outlet box mounted. Includes wall plate and knob. Electrical rating: 20 amps at 120 volts, 1/3 hp.
Transformers

AE-200 and 300 Series Transformers, Power Boxes, Power Relays, Time Relay

For supplying low voltage power to operate control equipment. Primarily for mounting in control centers in conjunction with disconnect switch and overload circuit breaker. Device: AE-206 and AE-249 are provided with a plate on the primary side for mounting on standard 4-inch outlet box. Secondary connection is screw terminals for AE-206 and provision for flexible conduit connection on the AE-249. All 170 VA transformers are provided with mounting feet for panel mounting, and wire leads.

Power Relays DPDT

Clapper type with screw terminals. Contact Rating: 1 hp, 16 amps at 120 volts, 8 amps at 240 Vac; 25 amps noninductive at 120/240 Vac. Optional enclosure available. Order AE-300 separately.

Time Delay Relay

For control of circuits requiring 3 to 5 second time delay. Device: Two single pole double break relays having separate electronic time delay circuitry. All components mounted on a printed circuit board which includes screw type terminals. Complete with screws and spacers for panel mounting (not illustrated). Coil: 24 Vac Contacts rated at 5A/120 Vac, 2.5A/240 Vac.

Power Boxes

For supplying an electrically protected and enclosed low voltage power supply to operate control equipment. Device: A step-down transformer with a disconnect switch in the primary side and a manually reset circuit breaker in the secondary side. Mounted in a surface type steel cabinet with four convenient 13mm (1/2 inch) conduit knockouts and painted finish 203mm (8 inches) wide, 152mm (6 inches) high 89mm (3-1/2 inches) deep. Installation: Surface mount through four holes in the back of the cabinet.

Barber-Colman Company

CONTROLS DIVISION

1300 Rock Street, Rockford, Illinois, U.S.A., 61101
For convenient mounting of pre-assembled or field assembled control panels. Cabinets may be used for pneumatic or electric controls. **Device:** SYZE-630 and SYZE-631 are 18 gage steel. SYZE-632 is 16 gage steel. All size cabinets have knockouts for 3/4-inch and 1-inch conduit. Knockouts are aligned so that a short nipple may be used to couple the panels together, and also for interconnecting wire. The door(s) consist basically of a frame and insert. The frame is made of extruded aluminum and comes mounted with six self-tapping screws. Door(s) supplied with key lock. Standard cabinets are painted steel with beige finish. **Installation:** Cabinets are shipped from the factory completely assembled and ready for mounting. They may be installed flush or surface mounted. Legs are available for floor mounting. **Options:** See charts for equipment description and proper part number. **Ordering:** See chart for cabinet sizes available and part numbers. Sub-panels must be supplied locally.

### Dimensions (Inches)

<table>
<thead>
<tr>
<th>Description</th>
<th>Cabinet Size</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Complete Cabinet (without sub-panel)</td>
<td><strong>SYZE-630</strong></td>
<td><strong>SYZE-631</strong></td>
<td><strong>SYZE-632</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Painted Steel Legs for floor mounting</td>
<td><strong>SYZE-633</strong></td>
<td><strong>SYZE-633</strong></td>
<td><strong>SYZE-634</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bracket to accommodate light fixture</td>
<td>N/A</td>
<td><strong>SYZE-600</strong></td>
<td><strong>SYZE-600</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18&quot; Fluorescent Fixture</td>
<td>N/A</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*UB 115, SIM/KAR light fixture Purchase from local distributor, or direct from SIM/KAR Lighting Fixture Co., Philadelphia, Pa 19134 Phone 215-425-7200*
### Accessories

**Miscellaneous Electrical Components**

**Switches, Mounting and Position Indicating Plates**
(Order All Parts Separately)

<table>
<thead>
<tr>
<th>Switch Action</th>
<th>AC Rating</th>
<th>Switch Type</th>
<th>Switch Part No.</th>
<th>Indicating Plate</th>
</tr>
</thead>
<tbody>
<tr>
<td>DPDT</td>
<td>10</td>
<td>Toggle 2 Position</td>
<td>CYZP-11-1</td>
<td>SYZE-74-1 On-Off</td>
</tr>
<tr>
<td></td>
<td>250</td>
<td></td>
<td></td>
<td>SYZE-75-1 Summer-Winter</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SYZE-76-1 None</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>SYZE-102-1 Day-Night</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>SYZE-189-1 Open-Close</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>SYZE-300-1 Occupied-Unoccupied</td>
<td></td>
</tr>
<tr>
<td>4PDT</td>
<td>5</td>
<td>Toggle 2 Position</td>
<td>CYZP-105</td>
<td>SYZE-212-1 On-Off-Automatic</td>
</tr>
<tr>
<td></td>
<td>24</td>
<td></td>
<td></td>
<td>SYZE-255-1 Summer-Off-Winter</td>
</tr>
<tr>
<td>DPDT (Center Off)</td>
<td>10</td>
<td>Toggle 3 Position</td>
<td>CYZP-269</td>
<td></td>
</tr>
<tr>
<td></td>
<td>250</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4PDT (Center Off)</td>
<td>5</td>
<td>Toggle 3 Position</td>
<td>CYZP-427</td>
<td></td>
</tr>
<tr>
<td></td>
<td>24</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPST N.O.</td>
<td>5</td>
<td>Push Button 3 Position</td>
<td>CYZP-346</td>
<td></td>
</tr>
<tr>
<td></td>
<td>125</td>
<td>Momentary Contact</td>
<td>CYZP-347</td>
<td></td>
</tr>
<tr>
<td>SPST N.C.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NOTE:** All switches mount to standard switch box. 1/2" mounting hole required.

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AYZP-43-2</td>
<td>Circuit Breaker 10 Amp (Illustrated)</td>
</tr>
<tr>
<td>BYZP-145</td>
<td>12 Circuit Terminal Block (Illustrated)</td>
</tr>
<tr>
<td>BYZP-146</td>
<td>Marker Strip #1—12</td>
</tr>
<tr>
<td>BYZP-252</td>
<td>Marker Strip #13—24</td>
</tr>
<tr>
<td>BYZP-253</td>
<td>Marker Strip #25—36</td>
</tr>
<tr>
<td>BYZP-269-2</td>
<td>Mtg. Bracket for Circuit Breaker &amp; Switch (Illustrated)</td>
</tr>
<tr>
<td>BYZP-599</td>
<td>Terminal End (Illustrated)</td>
</tr>
<tr>
<td>BYZP-600</td>
<td>Terminals (Approx. 4 per inch) (Illustrated)</td>
</tr>
<tr>
<td>BYZP-601</td>
<td>Terminal Channel (3') (Illustrated)</td>
</tr>
<tr>
<td>BYZP-602</td>
<td>Terminal Clamp (Illustrated)</td>
</tr>
<tr>
<td>BYZP-603</td>
<td>Terminal Marker (25') (Illustrated)</td>
</tr>
<tr>
<td>CYZP-181-3</td>
<td>Burnishing tool for Electric Contacts</td>
</tr>
<tr>
<td>CYZP-319-2</td>
<td>Arc Suppressor for SPDT Floating Switching</td>
</tr>
<tr>
<td>EYZP-504-1</td>
<td>Lamp, 24V, 0.073 Amp, 1.7 Watts</td>
</tr>
<tr>
<td>EYZP-504-2</td>
<td>Lamp, 120V, 0.025 Amp, 30 Watts</td>
</tr>
<tr>
<td>EYZP-504-3</td>
<td>Lamp, 48V, 0.053 Amp, 2.5 Watts</td>
</tr>
<tr>
<td>EYZP-721</td>
<td>Lamp Socket with Clip</td>
</tr>
<tr>
<td>EYZP-723-1</td>
<td>Lens, Red</td>
</tr>
<tr>
<td>EYZP-723-2</td>
<td>Lens, Green</td>
</tr>
<tr>
<td>EYZP-723-3</td>
<td>Lens, Amber</td>
</tr>
<tr>
<td>EYZP-723-4</td>
<td>Lens, Blue</td>
</tr>
<tr>
<td>EYZP-723-5</td>
<td>Lens, White</td>
</tr>
<tr>
<td>SYZE-81-1</td>
<td>Blank Nameplate 1-7/8&quot; x 9/16&quot;</td>
</tr>
<tr>
<td>SYZE-82-1</td>
<td>Blank Nameplate 2-1/2&quot; x 3/4&quot;</td>
</tr>
<tr>
<td>SYZE-83-1</td>
<td>Blank Nameplate 4&quot; x 1-1/4&quot;</td>
</tr>
<tr>
<td>SYZE-299-1</td>
<td>Tie Strap, plastic, for lacing wires, 4&quot; long</td>
</tr>
</tbody>
</table>
Ben urainstructions

Bulb Thermostats

Two Position

Type: Single Stage  TC-4100 Series
Two Stage  TC-4211
Dual Bulb  TC-4151
TC-4152

DEVICE INFORMATION

Identification

Two position bulb thermostats are for on-off control of media temperature in ducts, tanks, liquid lines, etc.

TC-4100 Series one stage units control one electrical circuit.

TC-4211 two stage units control two electrical circuits in sequence.

TC-4151 and TC-4152 dual bulb units vary the control point of the controlled media as function of outside air temperature. One bulb senses the controlled media, the second bulb senses the outside air temperature.

Pre-installation — All Devices

Refer to the INSTALLATION and Performance Data applicable to the part number of the device being installed. Make a visual inspection of the device for obvious signs of damage. Avoid locations where excessive moisture, corrosive fumes, vibration or high ambient exists.

INSTALLATION

Requirements

Locate the device allowing proper distance to the bulb location. The case can be mounted in any position. Refer to Figure 1 for case dimensions.

Procedure

Case Mounting

Ambient Rating: $-40^\circ$ to $60^\circ$C ($-40^\circ$ to $140^\circ$F)

1. Remove cover and provide 2 holes for #10 round head screws using the housing as the template or by using the dimensions shown in Figure 1.

2. Partially insert the mounting screws in the screw holes. Fit the housing over the screws, slide housing down on the screws and tighten the screws.

Wiring: The thermostat has one 1/2-inch to 3/4-inch conduit opening in bottom of housing. Make all electrical connections in accordance with the job wiring diagram and in compliance with national and local electrical codes. Terminal coding and switch action is shown in Figure 2, and Figure 3 shows two stage switching sequence.
Liquid Line and Tank

Install with AT-209 kit as shown in Figure 6. A bulb well is recommended, see Figure 7 for preferred installation and limitations. The thermal bulb is suitable for immersion mounting with 150 psig maximum pressure and/or 4 fps fluid velocity.

1. A 3/4-inch NPT hole is required.
2. Place packing nut, washers and packing over bulb support section as shown in Figure 6.
3. Install bulb well or adaptor from AT-209 kit into the 3/4-inch NPT opening.
4. Insert bulb into well or adaptor.
5. Push interlocking washers and packing into well or adaptor and tighten packing nut until firmly seated.

Bulb Mounting

Maximum insertion length 152 mm (6 inches). Maximum safe bulb temperature 26°C (50°F) above scale range. For dual bulbs, total of indoor and outdoor bulb temperatures must not exceed 138°C (280°F).

Duct: Install bulb with AT-208 kit as shown in Figure 4

Outdoor:
Install with AT-211 kit as shown in Figure 5.
1. Mount bulb to outside wall or surface with bulb clip.
2. Place shield over bulb and fasten to mounting surface.

Electrical Rating: All Units Except TC-4115

<table>
<thead>
<tr>
<th>Switch Rating (50/60 Hz)</th>
<th>24V</th>
<th>120V</th>
<th>240V</th>
<th>277V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Load Amps</td>
<td>-</td>
<td>9.8</td>
<td>8.0</td>
<td>-</td>
</tr>
<tr>
<td>Locked Rotor Amps</td>
<td>-</td>
<td>56.8</td>
<td>48.0</td>
<td>-</td>
</tr>
<tr>
<td>Pilot Duty</td>
<td>60</td>
<td>360</td>
<td>360</td>
<td>-</td>
</tr>
<tr>
<td>Non-inductive Amps (Resistive)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Single Stage</td>
<td>22</td>
<td>22</td>
<td>22</td>
<td>22</td>
</tr>
<tr>
<td>Two Stage</td>
<td>16</td>
<td>16</td>
<td>8.3</td>
<td>7.2</td>
</tr>
</tbody>
</table>

Application Limitations at 250°F
Fluid Temp. (Max. 350°F)

<table>
<thead>
<tr>
<th>Bulb Well Part No.</th>
<th>Max. Recommended Velocity (FPS)</th>
<th>Max. Recommended Static Pressure (psig)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT-201</td>
<td>11</td>
<td>250</td>
</tr>
<tr>
<td>AT-203</td>
<td>20</td>
<td>500</td>
</tr>
</tbody>
</table>

Figure 2. Terminal Coding and Switch Action

Figure 3. Two Stage Switch Sequence

Figure 4. Duct Mounting With AT-208

Figure 5. Outdoor Mounting With AT-211

Figure 6. Liquid Line or Tank Mounting With AT-209

Figure 7. Bulb Well Installation
CHECKOUT

After installing a thermostat, make an initial check of the switching action. Verify the switch action by listening to the switch contacts.

1. Turn the setpoint dial to a temperature above ambient. This should cause the thermostat to switch, making orange to brown.
2. Turn the setpoint dial settling down gradually. Orange to brown must break, making orange to red.
3. Compare the differential of the device to the differential shown on the performance charts by turning the dial. The differential is the difference in dial reading between the make of orange to brown and the make of orange to red on single switch units.

CALIBRATION

1. With all power disconnected, soak bulb(s) for 10 minutes at known temperature (must be 70°F for dual bulb).
2. Turn dial and note where switch contacts make.
3. Turn dial midway between click points.
4. Turn the calibration nut (located under dial) until the temperature of the bulb is indicated on the dial.
Note: On two-stage units follow above procedure on "LO" switch.

REPAIR

Field repair is not recommended. Replace defective device.

DIFFERENTIAL

The differential is adjustable by turning the adjustor located on side of device.

Single stage: Each line represents approximately 1.6°C (3°F) change.
### Performance and Selection Table

<table>
<thead>
<tr>
<th>Type</th>
<th>Part Number</th>
<th>Setpoint Adjustment Range °C (°F)</th>
<th>Part of Range</th>
<th>Ratio</th>
<th>Capillary Copper</th>
<th>Bulb Copper</th>
<th>Factory Set</th>
<th>Adjustable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Stage</td>
<td>TC-4111</td>
<td>-40 to 49 (40 to 120)</td>
<td></td>
<td></td>
<td>1.5M (6&quot;)</td>
<td></td>
<td>1.6°C (3°F)</td>
<td>1.6 to 8.5°C (3 to 16°F)</td>
</tr>
<tr>
<td></td>
<td>TC-4111-020</td>
<td>-40 to 49 (-40 to 120)</td>
<td></td>
<td></td>
<td>6M (2&quot;)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>TC-4115</td>
<td>38 to 127 (100 to 260)</td>
<td></td>
<td></td>
<td>1FM (6&quot;)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>TC-4121</td>
<td>38 to 127 (100 to 260)</td>
<td></td>
<td></td>
<td>3M (10&quot;)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>TC-4122</td>
<td>38 to 127 (100 to 260)</td>
<td></td>
<td></td>
<td>3M (10&quot;)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>TC-4123</td>
<td>38 to 127 (100 to 260)</td>
<td></td>
<td></td>
<td>3M (10&quot;)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dual Bulb</td>
<td>TC-4151</td>
<td>21 to 49 (70 to 120)</td>
<td>1 1½</td>
<td>9M (30&quot;) Each Bulb</td>
<td>10 x 100 mm (3/8 x 4&quot;)</td>
<td>10 x 140 mm (3/8 x 5½&quot;)</td>
<td>1.0°C (5°F)</td>
<td>1.5 to 5.5°C (1½ to 10°F)</td>
</tr>
<tr>
<td></td>
<td>TC-4152</td>
<td>21 to 49 (70 to 120)</td>
<td>1 1½</td>
<td>9M (30&quot;) Each Bulb</td>
<td>10 x 100 mm (3/8 x 4&quot;)</td>
<td>10 x 100 mm (3/8 x 4&quot;)</td>
<td>1.0°C (5°F)</td>
<td>1.5 to 5.5°C (1½ to 10°F)</td>
</tr>
<tr>
<td>Two Stage</td>
<td>TC-4211</td>
<td>-40 to 49 (-40 to 120)</td>
<td>1 8M (6&quot;)</td>
<td></td>
<td>10 x 100 mm (3/8 x 4&quot;)</td>
<td></td>
<td>1.6°C (3°F)</td>
<td>Between Stages 1.1 to 3.5°C (2 to 10°F)</td>
</tr>
</tbody>
</table>

*TC-4115 for System 8000 and dry circuit switching Electrical Rating: 1.0 amp at 24 Vac, 2.0 amp at 24 Vdc
**TC-4151 — For 1 1½:1 ratio reverse bulbs and use extra dial supplied with unit

### Dual Bulb Selection

To select Ratio it is necessary to know only: (1) Outdoor design temperature, (2) Maximum water temperature at outdoor design temperature, and (3) Desired water temperature at 70 F outdoors.

Example Select ratio for panel installation with a -10 F design temperature and estimated supply water temperatures of 75 F at 70 F outdoors, and 125 F at -10 F outdoors.

From chart below, -10 F for 1 1½ to 1 ratio, note by interpolation (70 F to 123 F with dial at 70 F; 80 F to 133 F with dial at 80 F) that water temperature varies from 75 F to 126 F as outdoor temperature drops from 70 F to -10 F, when dial is set at 75 F.

By similar means, note that a control with 1 to 1 ratio would result in water temperatures varying from 75 F to 155 F. For this application the 1½ to 1 ratio should be selected.

### Change in Water Temperature for Different Ratios as Outdoor Temperature Drops from 70°F to Design Temperature

<table>
<thead>
<tr>
<th>Outdoor Temperature (°F)</th>
<th>Ratio</th>
<th>Change in Water Temperature for Different Ratios as Outdoor Temperature Drops from 70°F to Design Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>-30</td>
<td>1 to 1½</td>
<td>Dial Set at 70°F: 70°F to 220°F, Dial Set at 80°F: 80°F to 230°F, Dial Set at 90°F: 90°F to 240°F, Dial Set at 100°F: 100°F to 250°F, Dial Set at 110°F: 110°F to 260°F, Dial Set at 120°F: 120°F to 270°F</td>
</tr>
<tr>
<td>-20</td>
<td>1 to 1 ½</td>
<td>Dial Set at 70°F: 70°F to 170°F, Dial Set at 80°F: 80°F to 180°F, Dial Set at 90°F: 90°F to 190°F, Dial Set at 100°F: 100°F to 200°F, Dial Set at 110°F: 110°F to 210°F, Dial Set at 120°F: 120°F to 220°F</td>
</tr>
<tr>
<td>-10</td>
<td>1 to 1 ½</td>
<td>Dial Set at 70°F: 70°F to 150°F, Dial Set at 80°F: 80°F to 160°F, Dial Set at 90°F: 90°F to 170°F, Dial Set at 100°F: 100°F to 180°F, Dial Set at 110°F: 110°F to 190°F, Dial Set at 120°F: 120°F to 200°F</td>
</tr>
<tr>
<td>0</td>
<td>1 to 1 ½</td>
<td>Dial Set at 70°F: 70°F to 137°F, Dial Set at 80°F: 80°F to 143°F, Dial Set at 90°F: 90°F to 149°F, Dial Set at 100°F: 100°F to 153°F, Dial Set at 110°F: 110°F to 157°F, Dial Set at 120°F: 120°F to 160°F</td>
</tr>
<tr>
<td>+10</td>
<td>1 to 1 ½</td>
<td>Dial Set at 70°F: 70°F to 117°F, Dial Set at 80°F: 80°F to 127°F, Dial Set at 90°F: 90°F to 137°F, Dial Set at 100°F: 100°F to 147°F, Dial Set at 110°F: 110°F to 157°F, Dial Set at 120°F: 120°F to 160°F</td>
</tr>
<tr>
<td>+20</td>
<td>1 to 1 ½</td>
<td>Dial Set at 70°F: 70°F to 103°F, Dial Set at 80°F: 80°F to 113°F, Dial Set at 90°F: 90°F to 123°F, Dial Set at 100°F: 100°F to 133°F, Dial Set at 110°F: 110°F to 143°F, Dial Set at 120°F: 120°F to 153°F</td>
</tr>
<tr>
<td>+30</td>
<td>1 to 1 ½</td>
<td>Dial Set at 70°F: 70°F to 97°F, Dial Set at 80°F: 80°F to 107°F, Dial Set at 90°F: 90°F to 117°F, Dial Set at 100°F: 100°F to 127°F, Dial Set at 110°F: 110°F to 137°F, Dial Set at 120°F: 120°F to 147°F</td>
</tr>
</tbody>
</table>

Barber-Colman Company

CONTROLS DIVISION

1300 Rock Street, Rockford, Illinois, U.S.A. 61101
AIR FLOW CONTROL

APPLICATION
This control detects air flow or the absence of air flow in ducts, responding only to velocity of air movement. It can be wired to open one circuit and close a second circuit (SPDT) for either safety or interlock purposes.

INSTALLATION
The F62AA can be mounted on top, side or bottom of a duct. Mount so the paddle weight does not assist or oppose the spring force which sets the CFM flow required to activate the switch.

Install in a horizontal duct whenever possible and where ambient temperatures do not exceed 180°F. Avoid locations close to elbows, dampers, fans and duct openings or other areas where excessive turbulence occurs. Control should be mounted away from such areas at least five times the distance of the smallest duct dimension. Example: 3" x 8" duct mount at least 15" from the nearest bend. The standard paddle fits into ducts of 3" x 8" minimum. The paddle may be trimmed for installing in ducts as small as 3" x 6".

To install proceed as follows:
1. Select the proper location.
2. Use the mounting plate gasket as a template and mark hole positions.
3. Drill or punch screw holes.
4. Cut center hole large enough for the paddle to pass through.
5. In horizontal duct the case must be level with the paddle at approximately a right angle to the air flow.
6. When the horizontal duct is not horizontally true, check with a level and place a shim under the control mounting plate (see sketch.)

CAUTION: If necessary to install in a vertical duct with downward air flow, the control must be readjusted. To readjust, turn the range screw clockwise until switch operates with no air flow. Then, adjust screw one additional turn clockwise.

Wiring
All wiring should conform to the National Electrical Code and local regulations. The Pennswitch terminals are color coded as follows: Red is common, Red closes to Yellow on air flow increase, Red closes to Blue on air flow decrease (no flow).

The circuit between the red and yellow terminals will close when the required air flow velocity is reached in the duct where the control is installed. The warning light or signal, when used, will be activated when the air flow decreases or ceases.

ADJUSTMENT
The flow control is factory set at the minimum flow rate shown in the graph. To adjust:
1. Remove control cover.
Air flow velocities in FPM required to actuate switch for any given duct size are shown in the graph curves. (Based on standard air density of 0.075 pounds per cubic foot.)

CHECKOUT PROCEDURE

Before leaving the installation, a complete operating cycle should be observed to see that all components are functioning properly.

REPAIR AND REPLACEMENT

Field repairs are not recommended. Flow control requiring attention should be returned to the nearest Penn-Baso Counterline Wholesaler or the factory.
versatile, low cost relays with many optional features

ENGINEERING DATA
KU, KUP and KUB Series relays have been engineered for reliability, ease of installation and an excellent cost-to-quality relationship. An exceptionally wide choice of optional features is available with each Series. Their quick-connect/solder terminals are a substantial cost saver on modern production lines. KU and KUP Series fit four types of custom nylon sockets, making the series convenient plug-in relays.

Three general types, the KU open series, the KUP enclosed series and the KUB dual coil latching relays are available. Standard relays are furnished with .187" terminals; 205" terminals are available upon request. The KU open series can be furnished with either a .218" or a .125" long locating tab and with or without a mounting stud.

Two styles of clear polycarbonate dust covers are available for the KUP Series relays. One is plain, for use when the relay is mounted in a socket. This case also can be furnished with a stud-and-locating-tab plate mounted on the end opposite the terminals. The other case has two slotted flanges for bracket mounting the relay directly to a chassis. The bracket-mount case is not suitable for socket mounting.

Relays with either type of dust covers (except the model with stud on end of case) can be furnished with a handy external push-button for checking circuits by manually operating the movable contacts. A hold-down spring can be furnished for socket-mounted KUP Series (not applicable to screw terminal sockets). When desired, the KUP 120V and 240V AC types can be supplied with a neon lamp wired in parallel with their coils to indicate power is reaching the relay. All optional features are listed on Page 8.

Reliability and long life of the KU/KUP/KUB Series are enhanced by long contact arms and a unique method of staking the stationary contacts, as well as barriers molded into the front.

Several types of custom nylon sockets are available. They accommodate all open KU* Series and plain case KUP Series when these relays have .187" terminals. These socket types are: solder, printed circuit, quick-connect, quick-connect with terminal barriers, and screw terminals (DPDT only). All are rated 10 amperes. Chassis layouts for these types of sockets are shown in the outline drawings on Page 6.

KU and KUP series are recognized under the Component Program of Underwriters' Laboratories, Inc., File No. E22575. Only standard KU and KUP series are included. Any electrical or mechanical deviations from standard relays are subject to reexamination by U/L.

*Caution should be exercised in handling socket-mounted open relay's due to the inherent shock hazard.

AVAILABLE WITH A WIDE CHOICE OF OPTIONAL FEATURES

KU-KUP-KUB series are equipped with quick-connect terminals punched for soldering. .187" terminals are standard but .205" are available. Molded barriers meet U/L and CSA requirements.

All KUP relays (except with stud on end of case) are available with push-to-test button which operates the movable contacts for manually checking circuits.

A neon lamp wired in parallel with its coil to indicate that power is reaching the relay is available on KUP 120V and 240V AC types.

Two styles of heat and shock resistant polycarbonate dust covers can be furnished. One-plain, the other with slotted flanges for direct-to-chassis mounting.

Several socket types can be supplied for the KU and KUP (plain case) series making them plug-in relays. See page 8.
SPECIFICATIONS

GENERAL:
Description: Versatile, low cost 5 or 10 amperes general purpose relays with many optional features.
Insulating Materials: Molded phenolic.
Insulation Resistance: 100 megohms minimum.
Expected Life: Mechanical: 10 million operations.
Electrical: 100,000 operations min. @ rated load.
Breakdown Voltage: 1500 volts rms 60 Hz between all elements; 500 volts rms 60 Hz between open contacts.

Temperature Range:
· KU open relays: AC:
  1 and 2 poles -45°C to +70°C
  3 poles -45°C to +60°C
  DC: -45°C to +65°C
KUP enclosed: AC:
  1 and 2 poles -45°C to +55°C
  3 poles -45°C to +45°C
  DC: -45°C to +70°C

Time Values: (approx.): Operate: 15 milliseconds
Release: 10 milliseconds

Weights: KU open relay: 2.3 ozs. KUP enclosed relay 3.0 ozs

Operate: AC: 85% of nominal voltage @ 25°C.
DC: 75% of nominal voltage @ 25°C.

Enclosures: Two styles of heat and shock resistant, clear plastic polycarbonate. Please see Page 7.
Terminals: .187" standard, or .205" quick-connect. Both are punched for solder-connecting.

CONTACTS:
Arrangements: Please see chart, Page 4.
Material: Gold-flashed fine silver and silver-cadmium-oxide is standard. Tungsten and 2.5% gold alloy available.
Ratings: 5 or 10 amps @ 28 volts DC resistive, or 240 volts AC. 80% PF.

COILS:
Voltage: DC: to 110 volts. AC: to 240 volts 60 Hz.
Power: DC: 1.2 watts. AC: 1 and 2 poles 2.0 VA; 3 poles 2.7 VA.
Resistance: Please see coil data table below.
Duty: Continuous.
Treatment: Centrifugally impregnated with high quality electrical varnish.

CUSTOM SOCKETS:
Standard: All are rated 10 amperes. Will accept .187" terminals of all KU and plain case KUP relays. Please see Page 6.

COIL DATA FOR STANDARD KU AND KUP RELAYS

<table>
<thead>
<tr>
<th>DC COILS</th>
<th>AC COILS—1 &amp; 2 POLE [50 60 Hz]</th>
<th>AC COILS—3 POLE [50 60 Hz]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage</td>
<td>DC Resistance In Ohms</td>
<td>Nominal Current In Milliamperes</td>
</tr>
<tr>
<td>6</td>
<td>32.1</td>
<td>188</td>
</tr>
<tr>
<td>12</td>
<td>120</td>
<td>100</td>
</tr>
<tr>
<td>24</td>
<td>472</td>
<td>91</td>
</tr>
<tr>
<td>48</td>
<td>1,400</td>
<td>28</td>
</tr>
<tr>
<td>110</td>
<td>10,000</td>
<td>11.5</td>
</tr>
<tr>
<td>220</td>
<td>Use 110V relay with a 10,000 OHM 5W wire-wound resistor in series.</td>
<td></td>
</tr>
</tbody>
</table>

OPTIONAL FEATURES FOR KU/KUP RELAYS

SCREW TERMINAL SOCKET*
*Will accept 2 pole relay only.

CHOICE OF NYLON SOCKETS

27E043 with Solder Terminals
27E040 with Printed Circuit Term.
27E067 with Quick-Connect Term.
27E088 with Terminal Barriers
27E097 with Screw Terminals

20C228 KUP HOLDDOWN SPRING**
**Not designed for KUL.
### Engineering Data

Especially designed for overload or memory work, the KUB Series is a dual coil mechanical latching relay. A momentary impulse to one of the coils operates the relay to set the latch; a second pulse to the other coil releases it. Coils may be specified to operate on the same or different voltages. (See Coil Data chart for latch and release voltages.)

These positive-latching relays are mounted on a rigid zinc-alloy die-cast base to protect the relay adjustment during wiring and to provide for stable alignment of the latch bars. Relays can be furnished with contact arrangements to 6PDT (3PDT each coil).

#### General
- Insulating Material: Molded and laminated phenolic.
- Insulation Resistance: 100 megohms.
- Expected Life: Mechanical: 500,000 operations.
- Electrical: 50,000 operations min. @ rated load.
- Breakdown Voltage: 1,500 volts rms between all elements.
- 50 volts rms between open contacts.
- Temperature Range: AC and DC: -45°C min. +85°C max. (intermittent duty).
- Time Values: Operate: 25 milliseconds.

#### Contact Arrangements for KU, KUP, KUB and KUL Relays

<table>
<thead>
<tr>
<th>Designator</th>
<th>Form</th>
<th>Arrangement</th>
<th>KU/KUP</th>
<th>KUB</th>
<th>KUL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1 Form A</td>
<td>SPST-NO</td>
<td>✘</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>1 Form B</td>
<td>SPST-NC</td>
<td>✘</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>1 Form C</td>
<td>SPDT</td>
<td>✘</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>2 Form A</td>
<td>DPST-NO</td>
<td>✘</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>2 Form B</td>
<td>DPST-NC</td>
<td>✘</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>2 Form C</td>
<td>DPDT</td>
<td>✘</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>3 Form A</td>
<td>3PST-NO</td>
<td>✘</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>3 Form B</td>
<td>3PST-NC</td>
<td>✘</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>3 Form C</td>
<td>3PDT</td>
<td>✘</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>4 Form A</td>
<td>4PST-NO</td>
<td>✘</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>4 Form B</td>
<td>4PST-NC</td>
<td>✘</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>4 Form C</td>
<td>4PDT</td>
<td>✘</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>5 Form A</td>
<td>5PST-NO</td>
<td>✘</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>5 Form B</td>
<td>5PST-NC</td>
<td>✘</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>5 Form C</td>
<td>5PDT</td>
<td>✘</td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>(2) 3 Form C</td>
<td>6PDT</td>
<td>✘</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Coils Data for KUB Series

Please specify coil voltage for both latch and release coils.

<table>
<thead>
<tr>
<th>DC Coils</th>
<th>AC Coils (50/60 Hz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 8 Pole Relays</td>
<td>Up to 4 Pole Relays</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>13.1</td>
</tr>
<tr>
<td>12</td>
<td>52.0</td>
</tr>
<tr>
<td>24</td>
<td>230</td>
</tr>
<tr>
<td>48</td>
<td>650</td>
</tr>
<tr>
<td>110</td>
<td>4560</td>
</tr>
</tbody>
</table>

220 Use 110 volt relay with 5000 ohms, 5 watt resistor in series

For 5 and 6 pole relays

| Volts | Resistance in Ohms | Av. Current Milliamperes |
| 6 | 1.8 | 1300 |
| 12 | 3.2 | 650 |
| 24 | 27 | 325 |
| 120 | 700 | 69 |
| 240 | 3750 | 34 |
ENGINEERING DATA

The KUL is a small, commercial, magnetic latching relay that occupies approximately half the space of mechanically interlocking latching relays. The use of a permanent-magnet in parallel with the normal magnetic circuit accounts for the relay's small size.

Reset is accomplished by reversing the voltage polarity in a single coil relay or by energizing the reset winding in a dual-wound coil relay. If overvoltage should occur during reset, the magnetic circuit is designed to prevent false operation of the contacts.

Relays with single or dual-wound coils are available for either AC or DC operation with contact arrangements up to 3 Form C rated 5 or 10 amperes at 28 volts DC, resistive, or 120 volts AC; 80% P. F.

A variety of nylon sockets is available that includes a choice of solder, printed circuit, quick-connect or screw terminals. All sockets are rated at 10 amperes.

A good memory stability is offered by the KUL relay which will provide a continuous latch condition during loss of power.

Continuous duty coil operation is practical because of the relay's low power requirements. This feature provides for the coil to remain energized in the latch position without damage to the relay.

The various features designed into the KUL Series make it ideal for applications as diverse as alarm systems and machine tools, battery chargers and protective devices, process controls and business machines.

GENERAL:
Description: Small, commercial magnetic latching relay.
Insulating Material: Molded phenolic.
Insulation Resistance: 100 megohms minimum.
Expected Life: Mechanical: 10 million operations.
Electrical: 100,000 operations minimum @ rated load.
Breakdown Voltage:
1500 volts rms 60 Hz between all elements.
500 volts rms 60 Hz between open contacts.
Temperature Range: AC and DC: -45°C to +70°C.

Time Values:
Operate: 25 ms max. @ nominal voltage @ 25°C.
Reset: 10 ms max. @ nominal voltage @ 25°C.
Weight: 3.4 ozs. approximately.
Operate: AC: 85% of nominal voltage @ 25°C.
DC: 75% of nominal voltage @ 25°C.
Enclosures: Clear plastic polycarbonate heat and shock resistant case.
Terminals: .187" standard, or .205" connect.
Both are punched for solder-connecting.

CONTACTS:
Arrangements:
DC single coil: 1 Form C, 2 Form C and 3 Form C.
DC dual coil: 1 Form C and 2 Form C.
AC single coil: 1 Form C, 2 Form C and 3 Form C.
Material: Gold-plated fine silver and silver-cadmium-oxide.
Ratings:
5 or 10 amps @ 28 volts DC resistive,
or 120 volts AC, 80% P. F.

COILS:
Voltage: To 110 volts DC; 120 volts AC.
Resistance: Please see Coil Data chart.
Duty: Continuous

COIL DATA FOR KUL SERIES

<table>
<thead>
<tr>
<th>DC Single Coil</th>
<th>DC Dual Coil*</th>
<th>AC 50/60 Hz AC coil with diodes**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal Voltage</td>
<td>Coil Resistance @ 10% @ 25°C</td>
<td>Nominal Voltage</td>
</tr>
<tr>
<td>6</td>
<td>32.1</td>
<td>6</td>
</tr>
<tr>
<td>12</td>
<td>120</td>
<td>12</td>
</tr>
<tr>
<td>24</td>
<td>472</td>
<td>24</td>
</tr>
<tr>
<td>48</td>
<td>1,800</td>
<td>48</td>
</tr>
<tr>
<td>110</td>
<td>10,000</td>
<td></td>
</tr>
</tbody>
</table>

*Dual coil available only with 1 or 2 Form C contacts. On standard dual coil relays, the latch and unlatch voltage must be the same. For unlike voltages, please consult factory.
**Diodes included inside relay for 1 or 2 Form C contacts. For 3 Form C, the customer must wire diodes and resistor outside relay.
SOCKETS FOR KU/KUP
WITH SOLDER TERMINALS—27E043

The chassis layout for sockets with solder terminals (27E043) is identical with the chassis layout for quick-connect terminals (No. 27E097), shown.

Socket Punch: Greenlee Part No. 301-8555.0 socket punch for either P&B socket No. 27E043 or No. 22E067 is available from Greenlee Tool Co., Rockford, Illinois.

WITH QUICK-CONNECT TERMINALS—27E067 AND 27E097

WITH PRINTED CIRCUIT TERMINALS—27E046

WITH SCREW TERMINALS—27E049

Tolerances on this page unless otherwise specified:
0.XX = ± .03"  
0.XXX = ± .010"
KUP SERIES ENCLOSED RELAYS

KUP PLAIN, OR STUD-ON-END RELAYS

KU BRACKET TYPE

KU STUD TYPE

KUB SERIES LATCHING RELAYS

CIRCUIT DIAGRAMS

TERMINAL DIMENSIONS

SEATED HEIGHTS:

1.391" FOR #6-32 STUD WITH .218" LOCATING TAB.
1.52 FOR 2-BRACKET WITH #6-32 TAPPED CORE.
1.282" FOR #6-32 TAPPED CORE WITH .125" LOCATING TAB OR .218" LOCATING TAB.
KUL LATCHING RELAYS

MOUNTINGS

KUL CIRCUIT DIAGRAMS

DC SINGLE COIL
1 FORM C

DC DUAL COIL
1 FORM C

AC COIL
1 FORM C

KUL

CIRCUIT DIAGRAMS

DC SINGLE COIL
DC DUAL COIL
AC COIL

I
FORM
C
I
FORM
C
I
FORM
C

2
f
2
REE
A~ Ai
-K
LATCH+
SRSET.
LATCH
z FORM
C
2 FORM
C
3 FORM
C

OPTIONAL FEATURES AND CODE EXPLANATION OF KU/KUP/KUB/KUL

<table>
<thead>
<tr>
<th>Type</th>
<th>Contact Arrang.</th>
<th>Coil Power</th>
<th>Mountings (Drawings on page 5)</th>
<th>Terminals &amp; Contact Material</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>KU Basic Open Relay</td>
<td>Please see A=AC</td>
<td>D=DC</td>
<td>on Page 4</td>
<td>1 = Plain case: 2 = with test button. 3 = with neon light. 4 = with test button &amp; neon light 5 = Bracket-mount case: 6 = with test button 7 = with neon light 8 = with test button &amp; Neon light. 9 = Stud on end of case.</td>
<td>1 = .187 quick-connect/solder, silver, 5 amps 2 = .205 quick-connect/solder, silver, 5 amps. 5 = .187 quick-connect/solder, silver-cad-oxide, 10 amps</td>
</tr>
<tr>
<td>KUP Basic Enclosed Relay</td>
<td>Table D=DC</td>
<td>A=AC</td>
<td>on Page 4</td>
<td>1 = Plain case: 2 = with test button. 3 = with neon light. 4 = with test button &amp; neon light 5 = Bracket-mount case: 6 = with test button 7 = with neon light 8 = with test button &amp; neon light.</td>
<td>1 = .187 quick-connect/solder, silver, 5 amps 2 = .205 quick-connect/solder, silver, 5 amps. 5 = .187 quick-connect/solder, silver-cad-oxide, 10 amps</td>
</tr>
<tr>
<td>KUR Basic Latching Relay</td>
<td>Table D=DC</td>
<td>A=AC</td>
<td>on Page 4</td>
<td>1 = Standard Mounting plate 2 5/8&quot; long, 1.781&quot; wide with two .156&quot; dia holes on 1.275&quot; centers.</td>
<td>1 = .187 quick-connect/solder, silver, 5 amps 2 = .205 quick-connect/solder, silver, 5 amps. 5 = .187 quick-connect/solder, silver-cad-oxide, 10 amps</td>
</tr>
<tr>
<td>KUL Basic Enclosed Magnetic Latching Relay</td>
<td>Table D=DC</td>
<td>A=AC</td>
<td>on Page 4</td>
<td>1 = Plain case: 2 = With neon light. (Sockets required)</td>
<td>1 = .187 quick-connect/solder, silver, 5 amps 2 = .205 quick-connect/solder, silver, 5 amps. 5 = .187 quick-connect/solder, silver-cad-oxide, 10 amps</td>
</tr>
</tbody>
</table>

(Drawings on pages 7 and 8)

(Add XX Coil Voltage)

(For KUL add: S—Single coil D—Dual coil XX—Coil voltage.)

AMF | POTTER & BRUMFIELD

DIVISION OF AMERICAN MACHINE & FOUNDRY COMPANY • PRINCETON, INDIANA 47570 • Phone: Area Code 812 – 385-52
PRINTED IN U.S.A.

FORM 13C199 3-69
SPECIFICATIONS

TRADELINE MODELS

Tradeline models are selected and packaged for ease of stocking, ease of handling, and maximum replacement value. Tradeline specifications are the same as those of standard models except as noted below.

TRADELINE MODELS AVAILABLE:

R7412F Differential Temperature Controller.

TRADELINE FEATURES:

Includes freeze and overtemperature protection and an auxiliary relay driver.

Tradeline pack with cross reference label.

STANDARD MODELS

<table>
<thead>
<tr>
<th>MODEL</th>
<th>DIFFERENTIAL TEMPERATURE CONTROL</th>
<th>FREEZE PROTECTION</th>
<th>OVERTEMPERATURE PROTECTION</th>
<th>AUXILIARY RELAY DRIVER</th>
</tr>
</thead>
<tbody>
<tr>
<td>R7412A</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R7412B</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>R7412C</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R7412D</td>
<td>Yes</td>
<td></td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>R7412E</td>
<td>Yes</td>
<td></td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>R7412F</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>
TEMPERATURE SETTING RANGES:

Operating Range (as defined by the temperature of the low temperature sensor)--
0 to plus 210 F [minus 18 to 99 C].

Differential Temperature Controller--
Adjustable ON and OFF differentials from minus 10 to plus 40 F [minus 5.6 to plus 22.2 C]. Factory-set at 16 F [10 C] temperature difference ON and 3 F [1.7 C] temperature difference OFF. Plug-in resistors vary settings (see Table 1, page 6).

Freeze Protection
Adjustable settings at 37, 42, or 47 F [3, 6, or 8 C].
Factory-set at 37 F [3 C].

Overtemperature
Adjustable in 5 F [3.2 C] increments from 140 to 190 F [57 to 89 C].
Factory-set at 140 F [66 C].

ELECTRICAL RATINGS:

Input Voltage--120 V ac, 60 Hz; at 220/240 Volts, 50 Hz.

Load Relay Contacts--
1 N.O. Pole--12 AFL/72 ALR at 120 V ac.
1 N.C. Pole--125 VA at 120 V ac.

Auxiliary Relay Drive--5 VA max at 24 V ac, 60 Hz.

Power consumption--7 watts maximum.

AMBIENT TEMPERATURE RANGE:

Controller--20 to 115 F [minus 7 to plus 46 C].

Temperature Sensor--
minus 50 to plus 450 F [minus 46 to plus 232 C].

MOUNTING:

Controller--two screw holes in opposite corners of case.
Mounting screws not included.

Temperature Sensor--High temperature sensor either mounts with an accessory clip or sensor has a flattened end with a mounting hole.
DIFFERENTIAL TEMPERATURE SELECTION

The control settings may be adjusted by changing the ON and OFF plug-in resistors (see Fig. 8). The R7412 is factory-set for pull-in at 18 °F [10 °C] temperature difference with a 4750 ohm ON resistor. Dropout is set for 3 °F [1.7 °C] temperature difference with a 9760 ohm OFF resistor.

To change the setting, refer to Table 1 to select the resistors needed. See Fig. 9 to prepare resistor for installation. Remove the old ON resistor and plug in the replacement. Repeat for the OFF resistor. Be sure the correct resistor is inserted in the proper position. Use 1/8 watt, 1 percent resistors, available locally.

FREEZE PROTECTION TEMPERATURE SELECTION

On models with adjustable freeze protection, the setting may be adjusted by changing the freeze protection plug-in resistor R23 (see Fig. 8). The R7412 freeze protection is factory-set at 37 °F [3 °C].

To change the setting to 37 °F [3 °C], simply remove the freeze protection resistor and leave it open circuited. For a setting of 42 °F [6 °C], install a 110 kilohm resistor using the resistor preparation indicated in Fig. 9. Use a 48.7 kilohm resistor to change the freeze protection setting to 47 °F [8 °C].

OVERTEMPERATURE SETTING SELECTION

On models with adjustable overtemperature protection, the setting may be adjusted by changing the overtemperature protection resistors, OT1 (R41) and OT2 (R26). The R7412 overtemperature limit is factory-set at 140 °F [66 °C].

To change the setting, refer to Table 2 to select the resistors needed. See Fig. 9 to prepare resistor for installation. Remove the old overtemperature resistors and insert the correct resistor in the proper position. Use 1/8 watt, 1 percent resistors, available locally.
FIG. 8--ADJUSTMENT COMPONENTS OF THE R7412.

FIG. 9--PLUG-IN RESISTOR PREPARATION. DIMENSIONS IN INCHES [MILLIMETRES IN BRACKETS].
<table>
<thead>
<tr>
<th>FOR TEMPERATURE DIFFERENCE OF:</th>
<th>USE RESISTANCES BELOW FOR BOTH ON AND OFF RESISTORS (IN OHMS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>°F</td>
<td>°C</td>
</tr>
<tr>
<td>-10</td>
<td>-6</td>
</tr>
<tr>
<td>-5</td>
<td>-3</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>0.6</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>1.7</td>
</tr>
<tr>
<td>4</td>
<td>2.2</td>
</tr>
<tr>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>3.3</td>
</tr>
<tr>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>8</td>
<td>4.4</td>
</tr>
<tr>
<td>9</td>
<td>5</td>
</tr>
<tr>
<td>10</td>
<td>6</td>
</tr>
<tr>
<td>12</td>
<td>7</td>
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<tr>
<td>14</td>
<td>8</td>
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<tr>
<td>16</td>
<td>9</td>
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<tr>
<td>18</td>
<td>10</td>
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<tr>
<td>20</td>
<td>11</td>
</tr>
<tr>
<td>25</td>
<td>14</td>
</tr>
<tr>
<td>30</td>
<td>17</td>
</tr>
<tr>
<td>35</td>
<td>19</td>
</tr>
<tr>
<td>40</td>
<td>22</td>
</tr>
</tbody>
</table>
**SEQUENCE OF OPERATION**

**Damper Normal Position:** With panel power switch S-1 in the off position all damper actuators assume the following position.

<table>
<thead>
<tr>
<th>Damper</th>
<th>Actuator Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>H-1</td>
<td>1</td>
</tr>
<tr>
<td>H-1A</td>
<td>3</td>
</tr>
<tr>
<td>M-2</td>
<td>2</td>
</tr>
<tr>
<td>M-2A</td>
<td>1</td>
</tr>
<tr>
<td>H-3</td>
<td>1</td>
</tr>
<tr>
<td>M-4</td>
<td>2</td>
</tr>
<tr>
<td>M-5</td>
<td>1</td>
</tr>
</tbody>
</table>

**Position**
- Closed - linked
- Open
- Closed
- Closed
- Closed - linked
- Open
- Closed
- Open

---

**Solar Heat (Auto Winter):** With manual override switch SW-3 in "auto" position and the summer-winter switch SW-2 in winter position the following sequence will take place.

Solar sent: System is indexed to solar heat by differential thermostat DT-1 actuated by sensor S-1 in collector (roof) and sensors S-2 at top of rock storage or low limit thermostat T-5 with sensing bulb in collector discharge. When temperature difference between S-1 and S-2 exceeds 18°F and collector discharge temperature rises above 120°F. When indexed to solar heat as per above solar heat relay KS will be energized causing the following:

A) Apply power to H-1 to open damper #1 and close damper #3.
B) Apply power to H-1 to open damper #2.
C) Apply power to M-2 and M-2A. See below for damper sequence.
D) Apply power to M-3 to open damper #1 and close damper #2.
E) Apply power to M-2 to close damper.
F) Start solar circulating fan F-2.

Room thermostat T-1 modulates M-2 and M-2A, also cycles furnace fan F-1 and return air fan F-3 through electronic relay R-1 to maintain desired room temperature.
**SEQUENCE OF OPERATION**

**Damper Normal Position:** With panel power switch S-9 in the off position all damper actuators will assume the following position.

**Position**
- Closed - linked
- Open
- Closed
- Closed
- Closed - linked
- Open
- Closed
- Open

**Rock Storage (Auto Winter)**: The system is indexed to rock storage when the temperature difference between S-1 and S-2 is less than 10°F or collector discharge temperature is less than 100°F as sensed by thermostat T-4. Also differential thermostat DT-2 actuated by sensor S-3 in collector discharge and S-4 in rock storage or low-limit thermostat T-5 with sensing bulb in rock storage discharge. If the temperature difference between S-3 and S-4 is above 10°F and rock storage discharge is above 90°F then the system will remain in rock storage mode energizing relay R-1 causing the following:
  A) Apply power to R-3 to closing damper. Rock thermostat T-1 through electronic relay R-1 will cycle furnace fan F-1 and return air fan F-3 to maintain desired room temperature.

**Actuator Number**
- H-1
- H-1A
- H-2
- H-2A
- H-3
- H-4
- M-5
- T-1
- DT-2
- R-A

**Damper**
- 7
- 3
- 2
- 1
- 1
- 2
- 1
- 1
- 1
- 1
- 1
- 1

**THERMOSTAT**

**ADJUNCTS**
- DT-1
- DT-2
- T-1
- F-1
- F-3
- R-1
- R-3
- R-A
- F-4
- F-5
- F-6
SEQUENCE OF OPERATION

DAMPER NORMAL POSITION: With panel power switch S-1 in the off position all damper actuators are in the following position.

- In the Off Position: all damper actuators are in the following position.

HOT AIR PLENUM

Actuator Number

<table>
<thead>
<tr>
<th>Actuator</th>
<th>Number</th>
<th>Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>M-1</td>
<td>1</td>
<td>Closed</td>
</tr>
<tr>
<td>M-2</td>
<td>1</td>
<td>Open</td>
</tr>
<tr>
<td>M-3</td>
<td>2</td>
<td>Closed</td>
</tr>
<tr>
<td>M-4</td>
<td>2</td>
<td>Open</td>
</tr>
<tr>
<td>M-5</td>
<td>1</td>
<td>Open</td>
</tr>
</tbody>
</table>

ATTIC FAN

ROCK STORAGE

Aux. Heat (Auto Winter): The system is indexed to aux. heat when the temperature difference between S-3 and S-4 is less than 3°F or rock storage discharge is less than 90°F as sensed by thermostat T-4.

Also: If the temperature difference between S-1 and S-2 is less than 3°F or low limit stat T-4 is less than 10°F then the system will remain in aux. heat mode causing the following:

- Room thermostat T-1 will cycle the furnace gas as per conventional furnace operation.

Note: The furnace 24V control voltage is off when panel power switch S-1 is turned off or summer-winter switch S-2 is in off or summer position.
Amper Normal Position: With panel power switch S-1 in the off position all damper actuators will assume the following position.

Power switch 5-I in the off position all damper actuators.

<table>
<thead>
<tr>
<th>Actuator Number</th>
<th>Damper</th>
</tr>
</thead>
<tbody>
<tr>
<td>H-1</td>
<td>1</td>
</tr>
<tr>
<td>H-1A</td>
<td>2</td>
</tr>
<tr>
<td>H-2</td>
<td>2</td>
</tr>
<tr>
<td>H-2A</td>
<td>1</td>
</tr>
<tr>
<td>H-3</td>
<td>1</td>
</tr>
<tr>
<td>H-4</td>
<td>1</td>
</tr>
<tr>
<td>H-5</td>
<td>1</td>
</tr>
</tbody>
</table>

Position
Closed - linked
Open
Closed
Closed
Closed - linked
Open
Closed
Open

Vent (Auto Summer): With manual override switch SW-2 in "auto" position and the summer-winter switch SW-1 in Summer position the following sequence will take place.

Vents: The vent relay KV will be energized causing the following:
A) Apply power to H-1 to open damper #1 and close damper #3.
B) Apply power to H-4 to open vent damper.
C) Apply power to H-5 to close damper.
D) Start exhaust fan in attic.
E) Solar heat: System is inoperative.
F) Rock storage: System is inoperative.
G) Aux. heat: System is inoperative.

Collector Overtemperature Alarm
When collector temperature exceeds the setpoint of thermostat T-3, the system is indexed to vent cycle regardless of the position of manual override switch SW-2 and summer-winter switch SW-1. Should exhaust fan fail to start, air flow switch will activate a pilot alarm on panel face. The alarm circuit can be activated manually by override switch SW-2.

All modes can be activated manually by selecting modes required with override switch SW-2.
LIST OF SERVICEMEN

ELECTRICAL CONTRACTOR

BELCO INC.
10450 Shields
Oklahoma City, OK  Phone 405/794-4435

CONTROL CONTRACTOR - BARBER COLEMAN CONTROL

R & B Temperature Controls Inc.
7321 Broadway Extension
Oklahoma City, OK  Phone 405/848-8573

HONEYWELL

Honeywell Service Line Center
6600 N. Broadway Extension
Oklahoma City, OK  Phone 405/848-2811

COLLECTOR HARDWARE

The Binkley Company
Building Products Division
Warrenton, Missouri 63383  Phone 314/456-3455

SOLAR CONTRACTOR

Solar Engineering & Equipment Co. Inc.
3305 Metairie Road
Metairie, Louisiana 70001  Phone 504/837-7313
Appendix A

SOLAR HEATING

DESIGN DRAWINGS

FOR

CONCHO SCHOOL BUILDING

EL RENO, OKLAHOMA

CONTRACT NAS 8 32247

SOLAR ENGINEERING & EQUIPMENT CO. II
INDEX OF DRAWINGS

DWNG. CO.           T I T L E

S-1    Module Cross Section
S-2    Installation Details
S-3    Collector Installation Details
M-4    Ductwork in Attic
M-5    Ductwork in Crawl Space
M-6    Air Distribution Details
M-7    Details - Duct Connections
C-8    Storage Design & Air Distribution
I-9    Instrumentation - Storage
I-10   Instrumentation Schematic
I-11   Instrumentation - Lower Attic
I-12   Instrumentation - Crawl Space
I-13   Typical SDAS Sensor Connection Details
I-14   SDAS Installation Details
C-15   Control Diagram - Solar Heating Mode
C-16   Control Diagram - Storage Mode
C-17   Control Diagram - Auxiliary Heat Mode
C-18   Control Diagram - Summer Operations Mode
C-19   Typical Control Wiring
C-20   COLLECTOR BALANCING DETAIL
C-21   Service Rig for Access to Collector Area
NOT TO SCALE

DUCT CONNECTIONS TO AIR UNIT NO. 1
SCALE: 3'-0" / 1'-0"

(Reinstall all connections from heater to existing ductwork)
With manual override switch (SW-2) in "OFF" position and the attic vent manual-winter switch (SW-3) in the "ON" position, the following sequence will take place in the rock storage mode. The system is engaged in rock storage when the temperature of sensor (S-1) located in the collector is 70°F above the temperature of sensor (S-2) located in the rock storage, or the collector discharge temperature is less than 100°F as sensed by low limit thermostat (T-4). This assumes that the collector is cooling F. Differential controller (C-2) then takes over system operation for the rock storage mode; the system will remain in this mode as long as sensor (S-1) which is located in rock storage is 90°F above sensor (S-2), located in the collector discharge and the rock temperature is higher than 70°F C. After system is engaged and all previously mentioned conditions are met, the following will be energized causing the following:

A) Apply power to H-5 closing the damper
B) Room thermostat (T-1) through electronic relay (R-1) will cycle furnace fan (F-1) and booster fan (F-2) to maintain desired room temperature
C) All other dampers and fans will return to their normal "off" position (see above sequence of operation)
DANGER NORMAL POSITION: With panel power switch 5-1 in the "off" position all damper actuators will assume the following position.

<table>
<thead>
<tr>
<th>Actuator Number</th>
<th>Dangers</th>
</tr>
</thead>
<tbody>
<tr>
<td>N-1</td>
<td>1</td>
</tr>
<tr>
<td>N-1A</td>
<td>2</td>
</tr>
<tr>
<td>N-1B</td>
<td>2</td>
</tr>
<tr>
<td>N-2</td>
<td>3</td>
</tr>
<tr>
<td>N-3</td>
<td>4</td>
</tr>
<tr>
<td>N-4</td>
<td>5</td>
</tr>
</tbody>
</table>

- Closed - "linked"
- Open

The vent cycle is designed to keep the collector free of overheating and thereby ensure the longevity of the cover material. This cycle can be achieved manually by:
1. Switching the manual override switch (SN-2) to the "auto" position and switching the attic fan manual switch (SN-3) to "vent" or by switching the manual override switch (SN-2) on the face of the control panel to the "on" position. The exhaust fan will run continuously in all three of the above cases which is undesirable for the operation of energy conservation. Therefore, a limit thermostat (T-3) located in the collector discharge has been incorporated into the vent cycle to provide automatic cycling of the attic fan. With attic vent manual switch (SN-3) in the "off" position and the manual override switch (SN-2) in the "auto" position the system is indexed in "summer vent mode". When (T-3) senses a temperature of 160°F or greater the vent relay (SN-4) will energize causing the following:
   a) Apply power to N-1 to open damper #1 and close damper #3
   b) Apply power to N-3 to open damper #3
   c) Start exhaust fan in attic

COLLECTOR OVERTEMPERATURE ALARM

When collector temperature exceeds the setpoint of thermostat T-3, the system is indexed in vent cycle regardless of the position of manual override switch 5-2 and manual switch 5-3. Should exhaust fan fail to start, air flow switch will activate a pilot alarm on panel face. The alarm circuit can be activated manually by override switch 5-4.
This report contains installation information for a solar heating system installed in Concho Indian School at El Reno, Oklahoma. This package includes a system Operation and Maintenance Manual, hardware brochures, schematics, system operating modes and drawings.

The Solar Engineering and Equipment Company (SEECO), under NASA/MSFC Contract NAS8-32247, developed this prototype solar heating system consisting of the following subsystems: solar collectors, control and storage.

This work was done under the technical management of Mr. Ralph Cole, George C. Marshall Space Flight Center.