System 350™
A350S Electronic Temperature Reset Module (without Relay)

The A350S Electronic Temperature Reset Module is designed to raise or lower the setpoint of supply water or supply air temperature based upon a proportional change in temperature at the master sensor. The A350S module has no relay output and must be used with S350 Stage Modules to operate the equipment.

As are all System 350™ products, the A350S module is housed in a NEMA 1, high-impact plastic enclosure. The modular design provides easy, plug-together connections for quick installation and future expandability.

Figure 1: A350S Electronic Temperature Reset Module

Features and Benefits

❑ **Modular Design**	Enables stage, display, and transformer modules to be purchased and installed as necessary
❑ **Plug-together Connectors and 35 mm DIN Rail Mountability**	Eliminates wiring between modules and reduces installation costs
❑ **Field-Selectable Reset Direction**	Works in direct or reverse reset applications
❑ **Adjustable Reset Ratio**	Adapts to a variety of weather zones and to the specific heat loss characteristics of most buildings
❑ **Adjustable Master Reset Setpoint (M.R.S.)**	Enables the user to select a master (outdoor) sensor temperature starting point for the supply reset ramp
❑ **Adjustable Minimum and Maximum Supply Temperature**	Permits compliance with equipment manufacturer's specifications

Part No. 24-7664-1261, Rev. A
Code No. LIT-930035

Application

The A350S Temperature Reset Module has no output and must be used in conjunction with S350 Stage Modules. Use the S350A or S350C for on/off output or an S350P for proportional or proportional plus integral output. An A350S system controls a variety of single or multiple stage Heating, Ventilation, Air Conditioning, and Refrigeration (HVAC/R) applications.

Typical A350S applications include:

- resetting chilled water supply temperature setpoint
- resetting discharge air temperature setpoint
- resetting zone temperature setpoint

Operation

IMPORTANT:	All System 350 controls are designed for use **only** as operating controls. Where an operating control failure would result in personal injury and/or loss of property, it is the responsibility of the installer to add devices (safety, limit controls) or systems (alarm, supervisory systems) that protect against, or warn of, control failure.

The A350S module operates on 24 VAC/VDC provided by either an external transformer or a Y350R Power Module. The module receives temperature inputs from a master sensor and a supply sensor. The A350S module calculates the supply temperature setpoint as a function of the master temperature sensor input. A rise in master sensor temperature, for example, causes a proportional rise (direct acting reset) or drop (reverse acting reset) in the supply temperature setpoint.

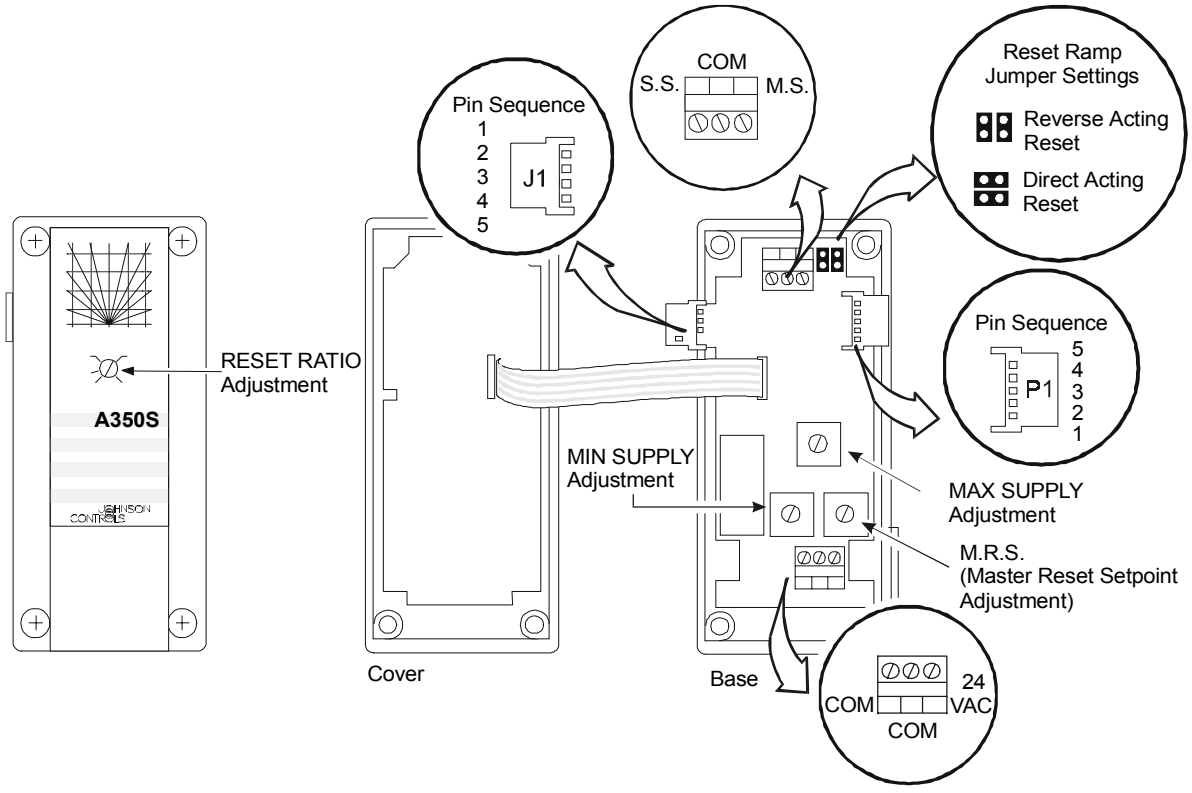


Figure 2: Interior View Illustrating A350S Module Features

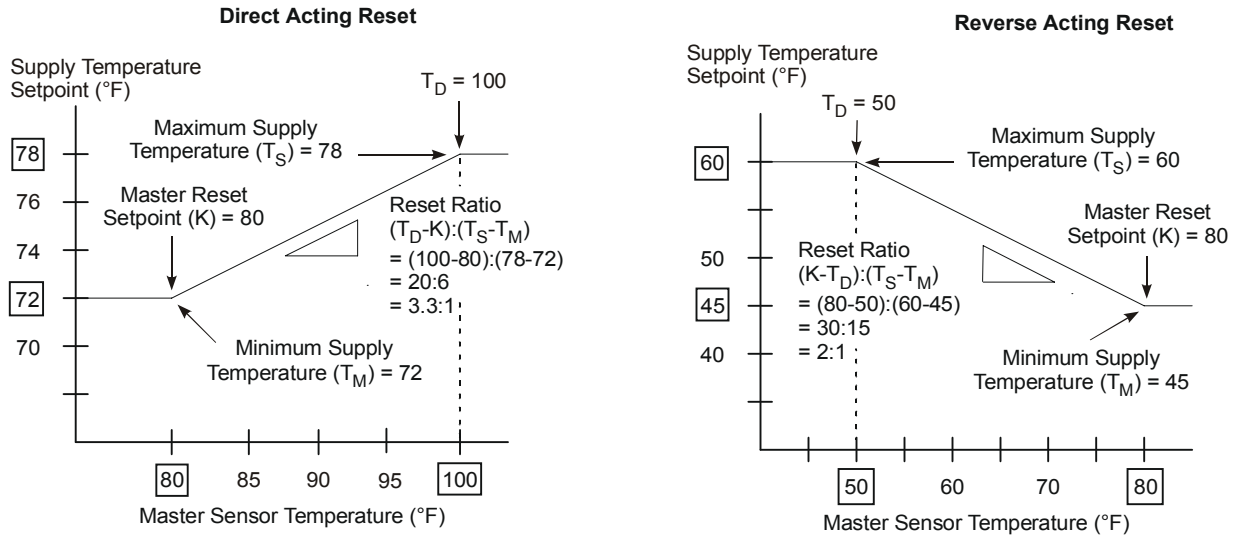


Figure 3: Example of Reset Action, Reset Ratio, Minimum and Maximum Supply Temperature, and Master Reset Setpoint

When connected to the A350S module, the S350 Stage Module receives the supply temperature sensor and setpoint signals. The S350 operates the equipment according to selected offset and differential (S350A) or selected offset and throttling range (S350P).

A350S features include:

- selectable direct or reverse acting reset
- adjustable reset ratio
- adjustable master reset setpoint
- adjustable minimum and maximum supply temperature

Celsius Scale Conversion

Each A350S is labeled to show the Fahrenheit temperature scale. If the Celsius scale is desired, see the *Installation and Wiring* section.

Reset Action

When configured for direct acting reset, the A350S module raises the supply temperature setpoint in response to a rise in master sensor temperature.

When configured for reverse acting reset, the A350S module lowers the supply temperature setpoint in response to a rise in master sensor temperature. Refer to Figure 3.

Select the Direct Acting/Reverse Acting (DA/RA) reset by positioning the reset ramp jumpers vertically or horizontally as shown in Figure 2. Position the reset ramp jumpers horizontally for direct and vertically for reverse. As shipped from the factory, the reset jumpers are installed in the vertical or reverse acting reset position.

Reset Ratio Adjustment

Reset ratio is defined as the ratio of the change in master sensor temperature to the change in supply setpoint temperature.

For a direct acting reset application with a ratio of 3.3:1, a 3.3°F rise in master sensor temperature causes a 1°F rise in the supply setpoint temperature.

For a reverse acting reset application with a ratio of 2:1, a 2°F rise in master sensor temperature causes a 1°F drop in the supply setpoint temperature. Refer to Figure 3 for an example.

Adjust the reset ratio using the potentiometer on the face of the module. (Refer to Figure 2 for location.) See the *Adjustments* section for the determination of the reset ratio.

Minimum Supply Temperature and Master Reset Setpoint (M.R.S.) Adjustments

The minimum supply temperature and the master reset setpoint adjustments determine the starting point for the reset ramp.

In a direct acting reset application, as the master sensor temperature rises above the master reset setpoint, the supply setpoint rises according to the reset ratio. As the master sensor temperature drops below the master reset setpoint, the supply setpoint is maintained at the selected minimum supply temperature.

In a reverse acting reset application, as the master sensor temperature drops below the master reset setpoint, the supply setpoint temperature rises according to the reset ratio. As the master sensor temperature rises above the master reset setpoint, the supply setpoint will be maintained at the selected minimum supply temperature. Refer to Figure 3.

Adjust the minimum supply temperature using the potentiometer marked MIN SUPPLY, and master reset setpoint using the potentiometer marked M.R.S. Refer to Figure 2 for locations.

Maximum Supply Temperature Adjustment

The maximum supply adjustment determines an end point for the reset ramp. Refer to Figure 3 for an example.

In a direct acting reset application, as the master sensor temperature rises above the master reset setpoint, the supply setpoint temperature rises according to the reset ratio. Upon a further rise in master sensor temperature, the supply setpoint temperature continues to rise until it reaches the selected maximum supply temperature. The supply temperature is maintained at the selected maximum supply temperature despite a further increase in master sensor temperature.

In a reverse acting reset application, as the master sensor temperature drops below the master reset setpoint, the supply setpoint temperature rises according to the reset ratio. Upon a further reduction in master sensor temperature, the supply setpoint temperature continues to rise until it reaches the selected maximum supply temperature. The supply temperature is maintained at the selected maximum supply temperature even with a further decrease in master sensor temperature. Refer to Figure 3.

Adjust the potentiometer marked MAX SUPPLY for maximum supply temperature. Refer to Figure 2 for location.

Add-on Modules

The S350 Stage Modules, D350 Digital Temperature Display Module, and Y350R Power Module connect together and plug into the A350S via female connectors located on the left side and male connectors located on the right side of each module. The maximum number of add-on modules is listed in Table 1.

Table 1: Maximum Number of S350 Stage Modules per A350S

Power Source	Number of S350A or S350C Modules Allowed	Number of S350A or S350C Modules (with 1 S350P) Allowed)	Number of S350A or S350C Modules (with 2 S350Ps) Allowed)
Y350R	9	6	4
External Class 2 Transformer	9	8	7

S350A On-Off Stage Modules

S350A On-Off Stage Modules receive power, setpoint, and sensor input from the A350S Reset Module. S350A Stage Modules perform switching functions based on the A350S's calculated supply setpoint and sensor temperature, with the offset and differential selected at the S350A.

Note: Plug the S350As only into the right side of the A350S module. Plugging the S350A into the left side of the control results in improper operation.

For more information on these modules, refer to *System 350™ S350 Temperature, S351 Humidity, and S352 On/Off Pressure Stage Modules Product/Technical Bulletin (LIT-930080*)

S350C Slave Stage Modules

S350C Slave Stage Modules receive power and sensor input from the A350S Reset Module. S350C Slave Stage Modules perform switching functions based on the A350S's sensor temperature, but the setpoint and differential are selected within the S350C.

Note: Unlike the S350A, the S350C can plug into either side of the A350S. When the S350C is plugged into the **left** side of the A350S, it controls to the S350C setpoint based on the master sensor temperature. When the S350C is plugged into the **right** side of the A350S, it controls to the S350C setpoint based on the supply sensor temperature.

For more information on these modules, refer to *System 350™ S350C Temperature Slave Stage Module Product/Technical Bulletin (LIT-930084)*.

S350P Proportional Stage Modules

S350P Proportional Stage Modules receive power, setpoint, and sensor input from the A350S Reset Module. The S350P Proportional Stage Module responds with an analog output of 0 to 10 VDC and 0 to 20 mA signal based on the A350S's calculated supply setpoint and sensor temperature, with the offset and throttling range selected at the S350P.

Note: Plug the S350P only into the right side of the A350S. Plugging the S350P into the left side of the control results in improper operation.

For more information on these modules, refer to *System 350™ S350P Proportional Plus Integral Temperature Stage Module Product/Technical Bulletin (LIT-930086)*.

D350 Temperature Display Module

The D350 receives power, sensor, and setpoint information from the A350S. This module may be connected to either the left or right side of the A350S. Sensor and setpoint temperature information will differ depending on which side of the A350S the D350 is connected to.

When the D350 is plugged into the **left** side of the A350S, it continuously displays the master sensor temperature. When the PRESS FOR SETPOINT button is pressed, the A350S's supply sensor temperature is displayed.

When the D350 is plugged into the **right** side of the A350S, it continuously displays the supply sensor temperature. When the PRESS FOR SETPOINT button is pressed, the A350S's supply setpoint is displayed.

For more information on these modules, refer to *System 350™ Display Modules Product/Technical Bulletin (LIT-930070)*.

Y350R Power Module

The Y350R provides a convenient method of powering System 350 modules from a 120 or 240 VAC power source. The Y350R can be plugged into either the right (the preferred location) or left side of the A350S module or any of the accessory modules.

For more information on this module, refer to *System 350™ Y350R Power Module Product/Technical Bulletin (LIT-930090)*.

Dimensions

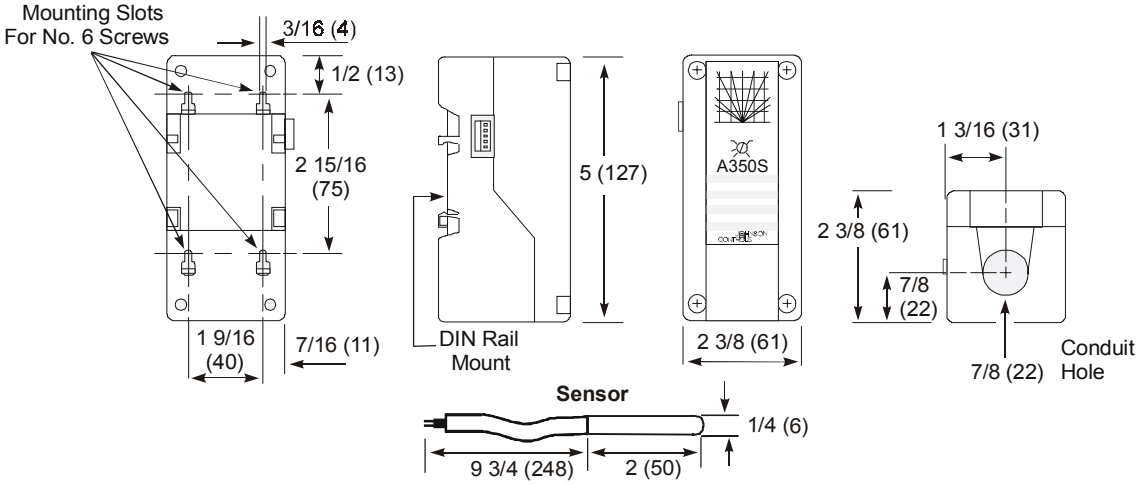


Figure 4: A350S and Sensor Dimensions, in. (mm)

Installation and Wiring

Celsius Scale Conversion

Each A350S module is labeled to show the Fahrenheit temperature scale. A Celsius temperature scale decal is provided under the cover of the A350S. If the Celsius scale is desired:

1. Carefully remove the three red potentiometer knobs.
2. Peel off the existing Fahrenheit scale decal.
3. Apply the Celsius scale to where the Fahrenheit scale was previously.
4. Rotate all knob stems completely counterclockwise.
5. Re-install the three potentiometer knobs so the arrows point to the minimum scale temperature.

Mounting the A350S

The A350S Reset Module is housed in a compact NEMA 1 plastic enclosure designed for standard 35 mm DIN rail mounting. It should be mounted for convenient wiring and adjustment. Use the key-slot mounting holes on the back of the control for surface mounting. If a Y350R is used, it should be mounted immediately to the right of the A350S. Any S350 controls would follow on the right, with the D350 being the last control mounted. (D350 and S350C modules may also be mounted to the left of the A350S.)

Note: When mounting the A350S (or any System 350 module) to rigid conduit, attach the hub to the conduit before securing the hub to the control enclosure.

WARNING: **Risk of Electrical Shock.** Disconnect power supply before making electrical connections to avoid possible electrical shock or equipment damage.

Install all wiring to conform to the National Electrical Code and local regulations. For maximum electrical rating of control, refer to the label inside the control cover. Use only copper conductors.

Consult Figures 2, 5, and 6 for proper wiring and terminal designations.

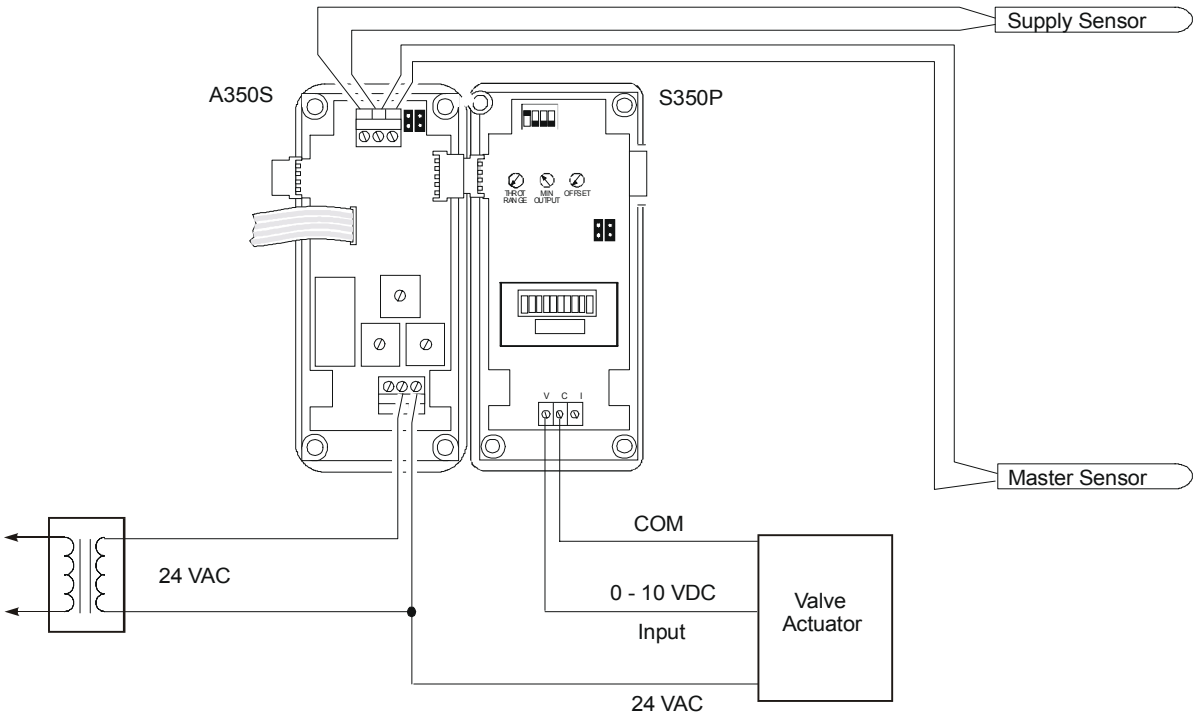
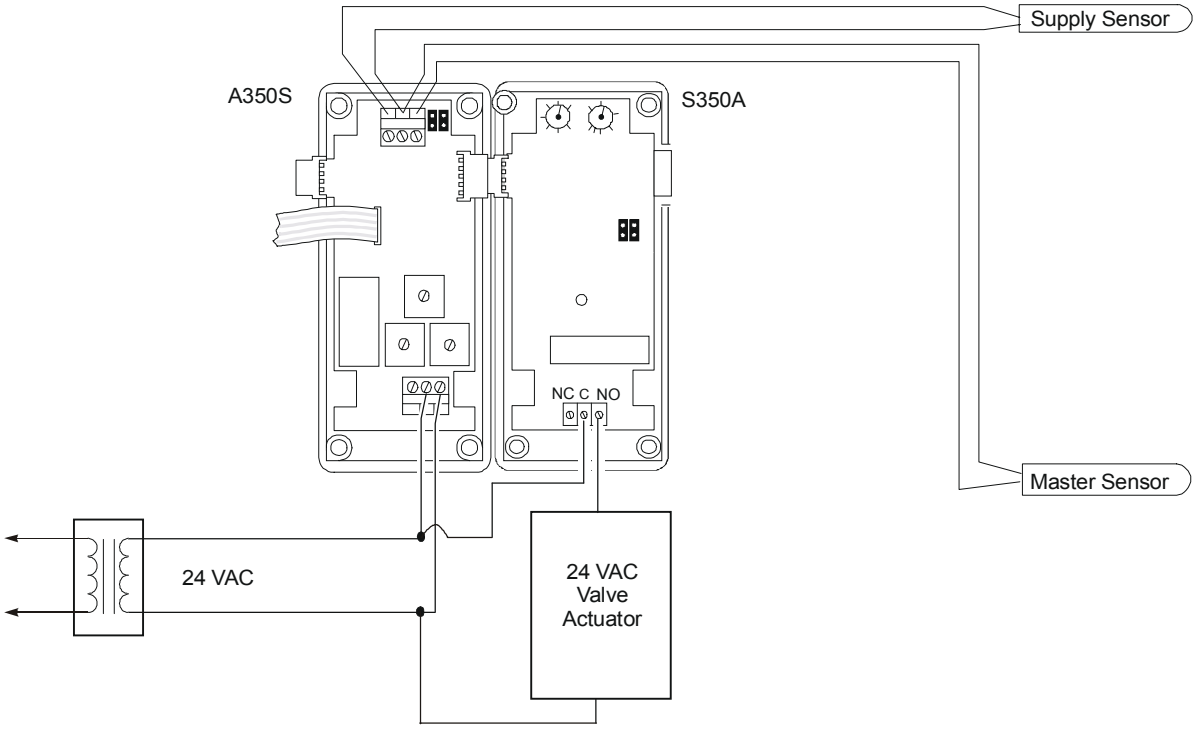


Figure 5: Typical Wiring Diagram of A350S and S350P Powered by an External Transformer



Note: Actuator must include a spring return for proper operation.

Figure 6: Typical Wiring Diagram of an A350S and S350A Powered by an External Transformer

Sensor Connections

The A350S module uses two sensors, which are included:

- The master sensor is the A99BC-25.
- The supply sensor is the A99BC-300.

(Refer to Table 3 for further information about these sensors.)

- Also included is assembly BOX10A-600R, a PVC enclosure which includes two wire nuts, a high-temperature cable tie, and a conduit connector.

The master and supply sensors must be connected to the three position terminal block located at the top of the base-mounted circuit board. (Refer to Figures 2, 5, and 6.) The supply sensor connects to the S.S. and COM terminals. The master sensor connects to the COM and M.S. terminals. The sensors are not polarity sensitive.

Master Sensor Installation

The master sensor must be mounted so that it can accurately sense the temperature driving the reset strategy.

For discharge air reset from return air applications, remove the master sensor from the PVC enclosure and secure it in the return air duct using a DUCT temperature element holder.

For outdoor applications, locate the sensor where it is not exposed to direct sunlight, preferably on the north side of the building. Enclose the sensor in a BOX10A-600R,a PVC enclosure designed to protect the sensor. If required, a metal sun shield (SHL10A-603) is also available.

Mount the enclosure so moisture cannot enter through the conduit connection. Block the conduit hole with foam packing or similar material to prevent air movement through the conduit opening, which could cause false readings of the master sensor.

Supply Sensor Installation

Supply sensor must be mounted so it can accurately sense the temperature of the controlled medium.

For water applications, the preferred method is to install an immersion well (WEL11A-601R or equivalent). If use of an immersion well is not possible and the temperature does not exceed 212°F (100°C), the sensor can be secured directly to a water pipe with the cable tie provided.

In addition, clip A99-CLP-1 is available for surface mounting the sensor. To minimize the effect of ambient air temperature, wrap insulation around both the sensor and pipe.

Shielded cable is not generally required for sensor wiring on runs of less than 50 feet. When using shielded cable, isolate and tape the shield at the sensor. Connect the shield to the COM terminal on the A350S. Sensor A99BA-200, which includes a shielded cable, is available if needed.

Refer to Table 2 for the maximum recommended cable lengths for particular sizes of wire.

Note: At the maximum cable lengths listed in Table 2, no more than 1F° (0.6C°) error in the sensed temperature will result due to wire resistance.

Table 2: Maximum Recommended Sensor Cable Lengths

Wire Gauge	Shielded Cable Length	
	Feet	Meters
14 AWG	800	244
16 AWG	500	152
18 AWG	310	94
20 AWG	200	61
22 AWG	124	38

* Values provided are for 2-wire stranded cable.

- Various A99B Series Temperature Sensors and mounting hardware are available for use with A350 Series Controls. Refer to Tables 3 and 5 for further information. The sensors must be connected to the appropriate terminals on the terminal strip located at the top of the printed circuit board. (See Figures 2, 5, and 6.) The sensors are not polarity sensitive.

Table 3: A350S Controls And Sensors

Controls	Description of Sensors
A350SS-1C and A350SS-2C	Master: A99BC-25C; Range: -40 to 248°F (-40 to 120°C); Length: 9-3/4 in. (0.25 m) Supply: A99BC-300C; Range: -40 to 248°F (-40 to 120°C); Length: 9-3/4 ft (3 m)

- For more information regarding sensor options and installation, refer to the *A99B Series Temperature Sensors Product/Technical Bulletin (LIT-125186).*

Adjustments

Follow this procedure to set up the A350S module for the types of operation desired.

1. Remove the A350S module's cover by loosening the four captive cover screws.

Note: The cover is permanently attached to the base by a ribbon cable. Remove cover carefully to avoid breaking the ribbon cable or its connections.

2. Select the desired reset action by positioning the reset jumpers horizontally for direct acting and vertically for reverse acting.
3. Set the minimum supply temperature potentiometer (MIN SUPPLY) to the manufacturer's recommendations.
4. Adjust the master reset setpoint potentiometer (M.R.S.) to the desired setting. Clockwise (CW) rotation increases the setpoint.
5. Set the maximum supply temperature potentiometer (MAX SUPPLY) to the manufacturer's recommendations.
6. Reinstall the cover and secure in place with the four captive cover screws.
7. Determine the proper reset ratio for the application by using one of the following formulas:

   Reset Ratio (master : supply) =

   $(T_D - K):(T_S - T_M)$ for Direct Acting Reset
   $(K - T_D):(T_S - T_M)$ for Reverse Acting Reset

   Where:
   K = master reset setpoint (M.R.S.)
   T_D = design temperature
   T_S = maximum supply temperature of building
   T_M = minimum supply temperature

   Example:
   M.R.S. = 80°F
   T_D = 50°F
   maximum supply temperature = 60°F
   minimum supply temperature = 45°F
   reset ratio = (80 - 50):(60 - 45)
   30:15
   2:1

   (See Figure 3 for illustrations.)

8. Set the RESET RATIO adjustment to the desired ratio as determined in Step 7.

Checkout Procedure

Follow this procedure to ensure the A350S module is connected and functioning properly.

1. Before applying power, verify that the installation and wiring connections comply with job specifications.
2. After making adjustments and electrical connections, put the system into operation and observe at least three complete operating cycles before leaving the installation.

Troubleshooting

If the control system does not function properly, use these steps to determine the cause of the problem:

1. Check for proper voltages on the A350S module.
   a. Connect a digital voltmeter (DVM) between the 24 VAC (+) and COM (-) terminals located at the bottom right side of the A350S. Refer to Figure 2.
      - If an external transformer is used, select AC volts on the DVM and verify that the voltage is between 20 and 30 VAC.
      - If a Y350R Power Module is used, select DC volts on the DVM and verify that the voltage is between 16 and 38 VDC.
      - If an external DC power supply is used, select DC volts on the DVM and verify the voltage is between 22 and 29 VDC.
2. Check temperature sensors for proper resistance.
   a. Remove power and disconnect both sensors from the A350S.
   b. Take accurate, independent temperature readings at the sensor locations.
   c. Using an ohmmeter, measure the resistance across the two leads of each sensor.
   d. Refer to Figure 7 to determine the optimal resistance for the measured temperature.
   e. If the measured resistance varies substantially from the optimal resistance for that temperature, replace the sensor or wiring.
   f. If the sensor's resistance conforms to the chart in Figure 7, reconnect the sensor to the control.
   g. Reconnect power to the control.

Note: The sensor readings indicated by the D350 may differ from thermometer readings due to sensor tolerances, time constants, thermometer accuracy, and other factors.

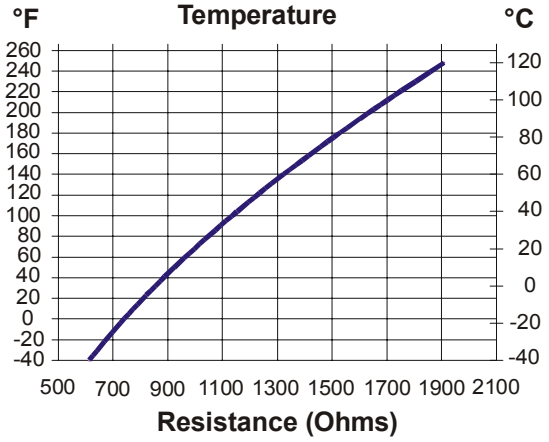


Figure 7: Temperature vs. Resistance Chart for the A99B Series Sensor

3. Check the A350S for proper operation.

Note: Perform Steps 1 and 2 first.

a. Reconnect the sensors to the A350S module and re-apply power.

b. Verify the MIN SUPPLY adjustment is not too high and the MAX SUPPLY adjustment is not too low. Either condition could limit the active range of the supply setpoint to just a few degrees.

c. Connect the negative lead of a DVM to any COM terminal, and place the positive lead onto P1 Pin 3 (see Figure 2). This reading is the voltage corresponding to the master sensor temperature.

d. Consult Figure 8 to verify master sensor voltage conformance.

e. Knowing the approximate sensor temperature, if the sensor's actual voltage deviates substantially from the voltage represented on the chart, replace the A350S.

f. Place the positive DVM lead onto J1 Pin 3 (see Figure 2). This is the voltage corresponding to the supply sensor temperature.

g. Consult Figure 8 to verify supply sensor temperature. If the sensor's actual temperature varies substantially from the temperature represented on the chart, replace the A350S module.

h. Connect the positive DVM lead onto P1 Pin 2. This is the voltage corresponding to the supply setpoint temperature. See Figure 2.

i. If the master sensor is between 1.33 and 1.60 VDC and the A350S module is in the reverse acting mode, adjust the M.R.S. to 90°F. The DVM should correspond to a temperature equal to the MIN SUPPLY setting. To confirm this, convert the DVM voltage to temperature using Figure 8.

j. If the master sensor is between 1.33 and 1.60 VDC and the module is in the direct acting mode, adjust the M.R.S. to 30°F. The DVM should correspond to a temperature equal to the MIN SUPPLY setting. To confirm this, convert the DVM voltage to temperature using Figure 8.

k. Adjust the M.R.S. counterclockwise if in the reverse acting mode, or clockwise if in the direct acting mode. Supply setpoint voltage should remain at the MIN SUPPLY level until the M.R.S. is adjusted beyond the master sensor voltage. The supply setpoint voltage should increase linearly as the M.R.S. is adjusted in the same rotational direction until the voltage level is clamped by the MAX SUPPLY circuit. To confirm this, convert the DVM voltage to temperature using Figure 8.

l. If the setpoint voltage does not reach the MAX SUPPLY level, adjust the Reset Ratio to 1:5 and convert the DVM voltage to temperature to confirm that it is now at the MAX SUPPLY level. If the supply setpoint's actual performance deviates substantially from this, replace the A350S module.

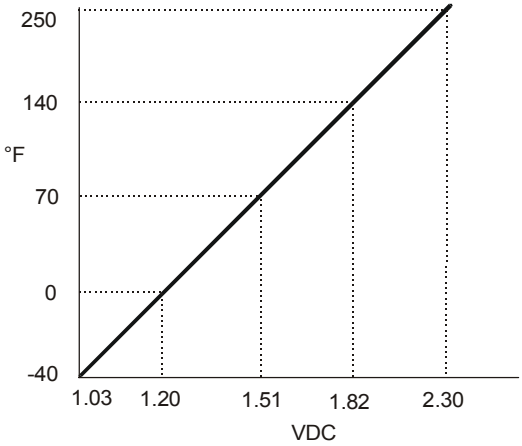


Figure 8: Voltage-to-Temperature Conversion

Repairs and Replacement

Do not attempt to repair or calibrate this control.

A99B Temperature Sensors and replacement controls are available through local Johnson Controls representatives.

Ordering Information

Table 4: System 350 Products

Item	Product Code Number	Description
A350S Temperature Reset Modules	A350SS-1C A350SS-2C	Dual scale; reset ratio adjustable from 1:5 to 10:1 (master:supply) Dual scale; reset ratio adjustable from 1:30 to 1:1 (master:supply)
Display Modules	D350AA-1C D350BA-1C	Fahrenheit scale Celsius scale
On/Off Stage Modules	S350AA-1C S350AB-1C	Fahrenheit Scale Celsius Scale
Slave Stage Module	S350CC-1C	Dual Scale (°F and °C)
Proportional Stage Module	S350PQ-1C	Dual Scale (°F and °C)
Power Module	Y350R-1C	120 or 240 VAC, 50/60 Hz input; rectified 24V Class 2 output

Table 5: System 350 Accessories

Item	Product Code Number	Description
Enclosure	BOX10A-600R	PVC enclosure; includes wire nuts
Immersion Well	WEL11A-601R	For liquid sensing applications
Duct Temperature Element Holder	TE-6001-1	Duct mounting hardware with handy box
Duct Mounting	TE-6001-11	Duct mounting hardware without handy box
Mounting Clip	A99-CLP-1	Surface mounting clip for the A99B Temperature Sensor
Room Temperature Element Holder	TE-6001-4	Room temperature element holder
Cover	T-4000-2139	Cover for room temperature element holder
Sun Shield	SHL10A-603R	For use with outside sensors in sunny locations
DIN Rail Sections	BKT287-1R BKT287-2R	12 in. (0.3 m) long 39-1/3 in. (1.0 m) long
DIN Rail End Clamp	PLT344-1R	Consists of two end clamps
Cables for Remote Mounting of D350 Display Module	WHA29A-600R* WHA29A-603R WHA29A-604R	3 ft (0.9 m) 25 ft (7.6 m) 50 ft (15.2 m)

* WHA29A-600R can also be used to daisy chain S350 Stage Modules together.

Specifications

Product	A350S Electronic Temperature Reset Module
Supply Voltage	Y350R Power Module: Input: 120/240 VAC 50/60 Hz Output: 24 VDC, unfiltered, 10 VA External Source: 24 VAC, 50/60 Hz Class 2 (20-30 VAC) Note: Only one supply voltage source may be used.
Power Consumption	2.5 VA Maximum
Ambient Temperature	Operating: -4 to 150°F (-20 to 66°C) Shipping: -40 to 185°F (-40 to 85°C)
Humidity	0 to 95% RH non-condensing, 85°F (29°C) maximum dew point
Reset Action	Selectable: Reverse or Direct Acting
Reset Ratio Adjustment Range	A350SS-1: 1:5 to 10:1 (master:supply) A350SS-2: 1:30 to 1:1
Master Reset Setpoint Adjustment Range	30 to 90°F (-1 to 32°C)
Minimum Supply Temperature Adjustment Range	35 to 80°F (2 to 27°C)
Maximum Supply Temperature Adjustment Range	45 to 140°F (7 to 60°C)
Material	Case, Cover: NEMA 1, High-impact thermoplastic
Agency Listings	UL Listed, CCN XAPX, File E27734 UL Listed for Canada, CCN XAPX7, File E27734

The performance specifications are nominal and conform to acceptable industry standards. For application at conditions beyond these specifications, consult Johnson Controls Application Engineering at (414) 274-5535. Johnson Controls, Inc. shall not be liable for damages resulting from misapplication or misuse of its products.

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