Acromag®

User's Manual: Series 350T
Model 350T Resistance Bulb, RTD, DC-Powered Transmitters

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IMPORTANT SAFETY CONSIDERATIONS

It is very important for the user to consider the possible adverse effects of power, wiring, component, sensor, or software failures in designing any type of control or monitoring system. This is especially important where economic property loss or human life is involved. It is important that the user employ satisfactory overall system design. It is agreed between the Buyer and Acromag, that this is the Buyer's responsibility.

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INTRODUCTION:

These instructions cover the model types listed in Table 1 below. Supplementary sheets are attached for units with special options or features.

Table 1:

A. Model Number Format:
350T-Input-Output-Mounting/Display-Certification[1]
B. Typical Model Number: 350T-RBP1-Y-DIN-NCR-C

Series	Input	Output	Mtg/ Display	Cert.	Calib
350T	-RBP1	-Y	-DIN	-NCR	Blank
	-RBP2	-V0		-Approval[2]	-C
	-RBP3	-V5			
	-RBC1				
	-RBC2				

Notes (Table 1):

1. Models RBP1, RBP2, and RBP3, and Models RBC1 and RBC2 can be ordered with or without factory calibration (-C option). All other input types automatically include calibration to the customer's specification (no "-C" needed). Any customer specified calibration information will be included on a separate calibration label on the unit.
2. Consult the factory for current information on agency (e.g. Canadian Standards Association, etc.) approvals.

DESCRIPTION:

These DC-powered transmitters condition either a 2, 3, or 4 wire, 100 ohm Platinum Resistance Temperature Sensor (RTD), or a 2 or 3 wire Copper RTD input, and convert the signal to a process current or voltage output. Input circuit isolation is standard. The unit provides excitation to the sensor, lead-wire compensation, linearization, and wide-range zero and span adjustments. These transmitters are RFI and EMI protected, operate over large temperature ranges, and feature excellent temperature coefficients, which minimize the effects from the plant environment.

The 350T Series are DIN-rail mounted transmitters designed to be used as functional components that provide the user with a modular approach to the varied applications in the field. The Series 350T complements the Acromag Series 250T two-wire transmitter line, providing the same input conditioning for three-wire applications. That is, Series 350T transmitters require a separate power supply connection, while the output signal and DC power share a common lead. The small package size, low power requirements, and wide supply range offers maximum flexibility to the system designer. As a three-wired DC powered device, it can also be used in critical applications that require the use of redundant supplies.

The Series 350T includes reverse polarity protection, current limiting, and operates from a single 10V to 36V DC supply. In applications requiring only a single transmitter, the 350T can use available DC power, or it can be wired to an optional Series 35PS power supply module. The Series 35PS power supply module receives it's power from either 115V AC or 230V AC. Applications requiring multiple transmitters at a single location can more efficiently share a single DC supply. The modular approach of this design and companion Acromag flat-pack modules allows additional transmitters, input modules, isolators, and alarms to be easily integrated, as required. See Drawing 4501-292 for a simplified Series 350T schematic.

Input wiring is inserted in the bottom of the unit, while output and power wiring is inserted at the top of the unit. Screws to secure the wiring are located on the front panel. Connectors are screw-clamp type and accept wire size up to 14 AWG.

SPECIFICATIONS:

Function: This family of isolated, DC Voltage powered, transmitters condition either a 100 ohm Platinum RTD, or a 10 ohm Copper RTD input. The unit converts the input signal to a process current or voltage output and provides RTD excitation, lead-wire compensation, linearization, and isolation. The output and DC power share a common terminal (3-Wire connection). Wide-range zero and span adjustments utilize 22-turn potentiometers which are accessible from the front of the unit. This transmitter is DIN-rail mounted.

MODEL/SERIES: 350T- (Color coded with a white label)

INPUT: Platinum RTD, 100 ohm (-RBPx): - 100 ohm (Ro) Platinum Resistance Temperature Sensor (RTD), 2, 3, or 4 wire connection. Standard calibration is based on the international R versus T curve having an alpha of 0.00385 ohms/ohm/^{o}C (Pt-385). The unit can also be calibrated for sensors having an alpha of 0.003925 ohms/ohm/^{o}C (Pt-392). Maximum excitation current is 1.0mA DC (0.5mA for RBP3). The span and zero adjustment is a function of the RTD range. NOTE: Linearization is maintained for any calibration within defined range.

For Platinum units, the input range is field selected by means of an internal field configurable jumper. Input span and zero ranges are adjustable as specified below. NOTE: Accuracy is in percent of Input Temperature Span.

-RBP1: Platinum RTD, 100Ω	Accuracy
Range A: Span: 25-100°C, Zero: -50 to +50°C	± 0.1%
Range B: Span: 25-100°C, Zero: +50 to +150°C	± 0.1%
Range C: Span: 25-100°C, Zero: -150 to -50°C	± 0.2%

-RBP2: Platinum RTD, 100Ω	Accuracy
Range A: Span: 50-200°C, Zero: -50 to +50°C	± 0.1%
Range B: Span: 50-200°C, Zero: +50 to +150°C	± 0.1%
Range C: Span: 50-200°C, Zero: -150 to -50°C	± 0.2%

-RBP3: Platinum RTD, 100Ω	Accuracy
Range A: Span: 200-800°C, Zero: -50 to + 50°C	
Accuracy: 200-400°C Spans	±0.1%
Accuracy: 400-800°C Spans	±0.5%
Range B: Span: 200-800°C, Zero: +50 to +150°C	
Accuracy: 200-400°C Spans	±0.2%
Accuracy: 400-800°C Spans	±0.7%

-RBP3: Platinum RTD, 100Ω	Accuracy
Range C: Span: 200-800°C, Zero: -150 to -50°C	
Accuracy: 200-400°C Spans	±0.2%
Accuracy: 400-800°C Spans	±0.3%

Transmitter performance is per the temperature range specified (see specifications for temperature ranges above).

INPUT: Copper RTD, 10 ohm (-RBCx):
10 ohm (R_0) Copper Resistance Temperature Sensor (RTD), 2 or 3 wire connection. Standard calibration is based on a Copper RTD, 9.035 ohms at 0^{o}C. Maximum excitation is 1.5mA DC. The span and zero adjustment range is a function of the RTD range code.

The input span and zero ranges are adjustable as specified below, except for special ranges which are factory calibrated per customer requirements. NOTE: Accuracy is in percent of input temperature span.

	Accuracy
-RBC1: Span: 50-100°C, Zero: -50 to + 50°C	±0.25%
-RBC2: Span:100-200°C, Zero: -50 to + 50°C	±0.25%

Transmitter performance is per the temperature range specified (see specifications for temperature ranges above).

Isolation: The input circuit is electrically isolated from the output and power circuits, allowing the input to operate at up to 250V AC, or 354V DC off ground, on a continuous basis (will withstand 1500V AC dielectric strength test for one minute without breakdown). This complies with test requirements outlined in ANSI/ISA-S82.01-1988 for the voltage rating specified.

Lead Wire Compensation:
A. 100 ohm, Platinum RTD: Zero shift is less than 0.01% per ohm of lead resistance, for up to 10 ohms per leg, with a total maximum shift of 0.1%.
B. 10 ohm Copper RTD: Zero shift is less than 0.05% per ohm of lead resistance, for up to 10 ohms per leg, with a total maximum shift of 0.5%.

OUTPUT: Process Current or Voltage output. The output shares a common with the power supply. Voltage outputs are designed to provide true voltage output, with zero volts included, and to be stable with capacitive loads.
-Y : 4 to 20mA DC (see Load Resistance Range Equation of the following page)
-V0: 0 to 10V DC into 10,000 ohms or greater
-V5: 0 to 5V DC into 5,000 ohms or greater

Load Resistance Range Equation (-Y output option): The maximum load resistance for 20mA compliance is a function of input supply voltage as follows:

R-Load (Maximum) = (Minimum VDC supply - 2.5V) / 0.02A
At 10.0V DC supply, R-Load = 0 to 375 ohms
At 12.5V DC supply, R-Load = 0 to 500 ohms
At 15.0V DC supply, R-Load = 0 to 625 ohms
At 24.0V DC supply, R-Load = 0 to 1075 ohms

Output Limiting: Voltage units: 150% of full scale output, nominal; Current units; 125% of full-scale output, nominal.

Output Ripple: Less than +/-0.1% of the maximum output span.

Power: An external DC power supply is required between the output (P) and (-) terminals. Transmitter current is for rated supply inputs, full-scale output, and no-load on voltage output units. Diode on transmitter provides reverse polarity protection. CAUTION: Do not exceed 36V DC peak, to avoid damage to the transmitter.

A. Process Current Output (-Y): +10.0V to 36.0V DC, 30mA (35mA at current limit).
B. Voltage Output (-V0): +12.5V to 36.0V DC, 9mA maximum.
C. Voltage Output (-V5): +10.0V to 36.0V DC, 9mA maximum.

Power Supply Effect:
DC Volts: less than ±0.001% of output span per volt DC, for rated power supply variations.
60/120 Hz ripple: less than ±0.01% of span per volt peak-to-peak of power supply ripple.

RTD Break Detection: Upscale RTD break detection is standard.

Reference Test Conditions:
A. 100 ohm, 3-wire Platinum, 0-100^{O}C, (Alpha = 0.00385); Output (-Y units): 4-20mA DC (500 Ohm load); Output (-Vx units): 0-10V DC into 10K ohms or greater; Ambient 77^{O}F (25^{O}C); +15V DC supply.
B. 10 ohm, 3-wire Copper (9.035 ohms at 0^{O}C), 0 to 100^{O}C; Output (-Y units): 4-20mA DC (500 Ohm load); Output (-Vx units): 0-10V DC into 10K ohms or greater; Ambient 77^{O}F (25^{O}C); +15V DC supply.

Accuracy: A function of input range. Accuracy is listed adjacent to range specification and includes the combined effects of transmitter repeatability, hysteresis, terminal point linearity, and adjustment resolution. Does not include sensor error.

Linearization: The unit linearizes the Platinum RTD signal to provide an output signal that represents the percent-of-span value of the measured temperature. The linearization circuit is universal for the model type ordered, it allows freedom to calibrate to any input range and linearization will be functional. Per manufacturers tables, the Copper sensor is linear between -50°C and 150°C.

Ambient Temperature Range: -13°F to 185°F (-25°C to 85°C).

Ambient Temperature Effect: (Combined effects of zero/span over temperature).

-RBP Less than ±0.01 % of output span per $^{\circ}$F (±0.018% per $^{\circ}$C) over ambient temperature range for reference test conditions.
-RBC Less than ±0.025% of output span per $^{\circ}$F (±0.045% per $^{\circ}$C) over ambient temperature range for reference test conditions.

Bandwidth: -3dB at 3 Hz, typical.

Response Time: For a step input, the output reaches 98% of output span in 350ms, typical.

Noise Rejection:
Common Mode: 120dB @ 60 Hz, 100 ohm unbalance, typical.
Normal Mode: 26dB @ 60 Hz, 100 ohm source; 20dB @ 60 Hz, 10 ohm source.

RFI Resistance: Less than ± 0.5% of output span effect with RFI field strengths of up to 10V/meter at frequencies of 27MHz, 151MHz, and 467 MHz per SAMA PMC 33.1 Test Procedures.

EMI Resistance: Less than ±0.25% of output span effect with switching solenoids or commutator motors.

Surge Withstand Capability (SWC): Input/Output terminations are rated per ANSI/IEEE C37.90-1978. Unit is tested to a standardized test waveform that is representative of surges (high frequency transient electrical interference), observed in actual installations.

Construction:
Printed Circuit Boards: Military grade FR-4 epoxy glass circuit board. Terminals: Compression type, wire size 14 AWG maximum. Case: Self-extinguishing NYLON Type 6.6 polyamide thermoplastic UL94 V-2, color black. General Purpose, NEMA Type 1 enclosure. Printed Circuit Board Coating: Fungus resistant acrylic conformal coat. Mounting Position: Position insensitive.

MOUNTING:

-DIN: General Purpose Housing, DIN-Rail Mount - "G" & "T" rails. "G" Rail (32mm), Type EN50035; "T" Rail (35mm), Type EN50022. Refer to Drawing 4501-252 for outline and clearance dimensions. Shipping Weight: 1 pound (0.45 Kg) packed.

CERTIFICATION: Consult the factory for current information on the availability of agency (e.g. Canadian Standards Association, Factory Mutual, etc.) approvals.

-NCR: No Certification Required.

INSTALLATION:

The transmitter is packaged in a general purpose type of enclosure. Use an auxiliary enclosure to protect against unfavorable environments and locations. Maximum operating ambient temperatures should be within -13 to 185^{O}F (-25 to 85^{O}C) for satisfactory performance. If the unit is factory calibrated, it is ready for installation. Connect as shown in the connection diagram of Drawing 4501-292. If the unit is not factory calibrated, refer to the "CALIBRATION" section.

Mounting: Mount transmitter assembly - refer to Drawing 4501-252 for mounting and clearance dimensions.

DIN Rail Mounting: Using suitable fastening hardware, secure the DIN rail to the designated mounting surface. A transmitter, can be mounted to either the "T" or "G" Rail. Installation of the transmitter to the rail depends on the type of DIN rail used. Units can be mounted side by side on 1.0 inch centers, if required.

"T" Rail (35mm), Type EN50022: To attach a transmitter to this style of DIN rail, angle the top of the unit towards the rail and locate the top groove of the adapter over the upper lip of the rail. Firmly push the unit towards the rail until it snaps solidly into place. To remove a transmitter, insert a screwdriver into the lower arm of the connector and pull downwards while applying outward pressure to the bottom of the unit.

"G" Rail (32mm), Type EN50035: To attach a transmitter to this style of DIN rail, angle the unit so that the upper groove of the adapter hooks under the top lip of the rail. Firmly push the unit towards the rail until it snaps solidly into place. To remove a transmitter, pull the lower part of the unit outwards until it releases from the rail, lift unit from rail.

Electrical Connections:

The wire size used to connect the unit to the control system is not critical. All terminal strips can accommodate wire from 14 to 26 AWG. Strip back the insulation 1/4-inch on each lead before installing it into the terminal block. Input wiring may be either shielded or unshielded twisted pair. Output wires should be twisted pair. Since common mode voltages can exist on signal wiring, adequate wire insulation should be used and proper wiring practices followed. It is recommended that output and power wiring be separated from the signal wiring for safety as well as for low noise pickup.

1. **Power:** Connect DC power supply per connection diagram (refer to Drawing 4501-292). These transmitters operate from DC power supplies only. Power supply voltage is not critical and normally should be from 10.0V to 36V DC. The supply voltage must not exceed 36 Volts, even instantaneously, and must be adequate to furnish full-scale current or voltage to the load. Variations in power supply voltage, above the minimum required, or load resistance have negligible effect on transmitter accuracy. Refer to "POWER" in the preceding SPECIFICATIONS section for current requirements. The minus (-) power supply lead and the minus (-) output lead share a common terminal. This device includes input current limiting and reverse polarity protection. Refer to Drawing 4501-254 for other power supply configurations.

2. **Output:** Connect output per connection diagram, refer to Drawing 4501-292. Load range is a function of the module's output type; refer to "Output" in the preceding "SPECIFICATIONS" section. The output shares a common with the power supply.

3. **Grounding:** The transmitter in the General Purpose Housing is plastic and does not require an earth ground connection.

4. **Input:** Connect input per connection diagram (refer to Drawing 4501-292). Be sure to observe proper polarity, see label for input type. If unit is factory calibrated, the calibration label indicates range of input. NOTE: The input circuit is electrically isolated from the output and power circuits allowing the input to operate up to 250V AC, or 354V DC off ground, on a continuous basis.

CALIBRATION:

A. TRANSMITTER

This section provides information for unit configuration and calibration. If the unit was factory calibrated, jumpers have been placed in their proper positions and verification of the calibration can be made per the Adjustment Procedure. If the calibration of the unit is to be changed, first go to the "Shunt Block Configuration Procedure" (Platinum units only--not required for Copper units) before going to the Transmitter Adjustment Procedure.

1. Transmitter - Shunt Block Configuration Procedure (Platinum Units Only):

The Platinum RTD transmitter is quite universal in that it can be configured for any of three adjustment ranges with a single jumper. Before proceeding with the adjustment procedure, this jumper must be configured for the requirements of the application (refer to Drawing 4501-293 for details). To gain access to the Configuration Jumper, first remove the transmitter from the installation. Second, remove the circuit boards from the plastic enclosure as described in the Disassembly Procedure below. Third, configure the jumper (shunt block) as described in the Jumper Configuration procedure below. NOTE: calibration per the Adjustment Procedure should be performed before the circuit boards are reassembled within the plastic enclosure.

Disassembly Procedure for the 350T Plastic Housing:

The plastic housing has no screws, it "snaps" together. A flat-head screwdriver (Acromag 5021-216 or equivalent) is needed to pry the housing apart as described in the following steps.

CAUTION: Do not push the screwdriver blade into the housing more than approximately 0.1 inches while prying it apart. Handling of the printed circuit boards should only be done at a static-free workstation, otherwise, damage to the electronics could result.

1. To begin disassembly (refer to Drawing 4501-293) place the screwdriver at point A (left side of the transmitter). While pressing the blade into the seam, use a twisting motion to separate the sides slightly. Repeat this operation at point B.
2. Now that the two pieces have been partially separated, use the screwdriver blade to work the left side of the package loose by working around the transmitter and carefully prying the sides further apart. Repeat this action until it is easy to remove the left side from the plastic pins holding the pieces together.
3. Repeat this operation for the right side starting at points C & D.

CAUTION: If the two pc boards become separated while taking the package apart, re-align the boards making sure that the two headers (pins) and sockets at locations E and F are properly aligned and carefully push the boards back together.

Jumper Configuration (Shunt Block):

A shunt block is provided to accommodate in-field configuration changes for the Platinum unit. In case of misplacement, additional shunt blocks may be ordered from the factory. When ordering additional shunt blocks, refer to Acromag Part Number 1004-332.

1. Zero Range: Determine the Zero Range that is required by your application, refer to the table on Drawing 4501-293 for proper jumper (shunt) position. Jumper positions are marked A, B, and C on the circuit board corresponding to sub-range A, B, and C.
2. Important: Mark the Transmitter's Configuration on the calibration label located on the enclosure. Example: IN: RBP1, Range B, 0-100^{O}C

Jumper Configuration Example:

The following is the configuration for the example below, configure your module as required by your application:

Configure internal jumper as follows:

A. RBP1 sub-range A: Zero: -50 to +50^{O}C (Span: 25 to 100^{O}C).
B. Mark label with range selected.

2. Transmitter - Adjustment Procedure:

The calibration example below is used for reference only. Calibration is essentially the same for units with other inputs. Connect the transmitter as shown in the Connection diagram (Drawing 4501-292). The resistance decade box must be adjustable over the entire input range of the unit and settable to an accuracy of 0.1% or better. The power supply voltage must be between 8 and 36 VDC at the terminals of the transmitter. The output voltage must be measured to 0.1% accuracy or better for proper results.

The Zero and Span adjustments are accessible on the front panel of the transmitter, see Drawing 4501-292 for their location. The screwdriver blade used to adjust the potentiometers should not be more than 0.1 inch (2.54mm) wide.

The resistance representing the temperatures at Zero and at Full-Scale are set on the resistance source to obtain the two calibration points. Use Table 2 to convert each temperature to its equivalent resistance for the RTD type used.

Transmitter - Calibration Example:

MODEL : 350T-RBP1-Y-DIN-NCR
Input : 0 to 100^{O}C (100.0Ω to 138.5Ω), Platinum RTD, PT-385.
Output: 4 to 20mA DC

1. Set the input resistance decade to 100.0 ohms (0.0^{O}C). Adjust the Zero (Z) pot until the output reads 4.000mA.
2. Set the input resistance decade to 138.5 ohms (100^{O}C). Adjust the Span (S) pot until the output reads 20.000mA.
3. Repeat steps 1 and 2 above until the readings converge. The instrument is now calibrated. Several mid-point values should be checked to verify proper operation of the transmitter.
4. After the above calibration procedure is complete, install the transmitter PC Board assembly back into its case as described in the assembly procedure below.

Assembly Procedure for the 350T Plastic Housing:
(Note: The Model/Serial Number is attached to the left side)

1. Refer to drawing 4501-088 and line up the left plastic side with the board and terminal assembly Carefully but firmly press the pieces together.
2. Before installing the right side, place the mounting bracket unique to the mounting type you have , around the pins at the back of the housing.
3. Line up the right side of the housing with the assembly and carefully but firmly press the pieces together.

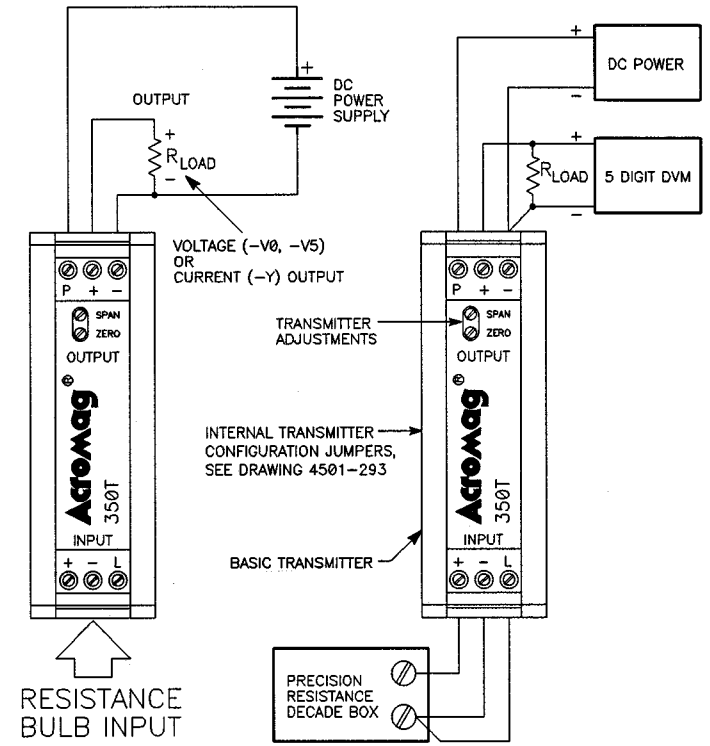
Table 2: Temperature Versus Resistance

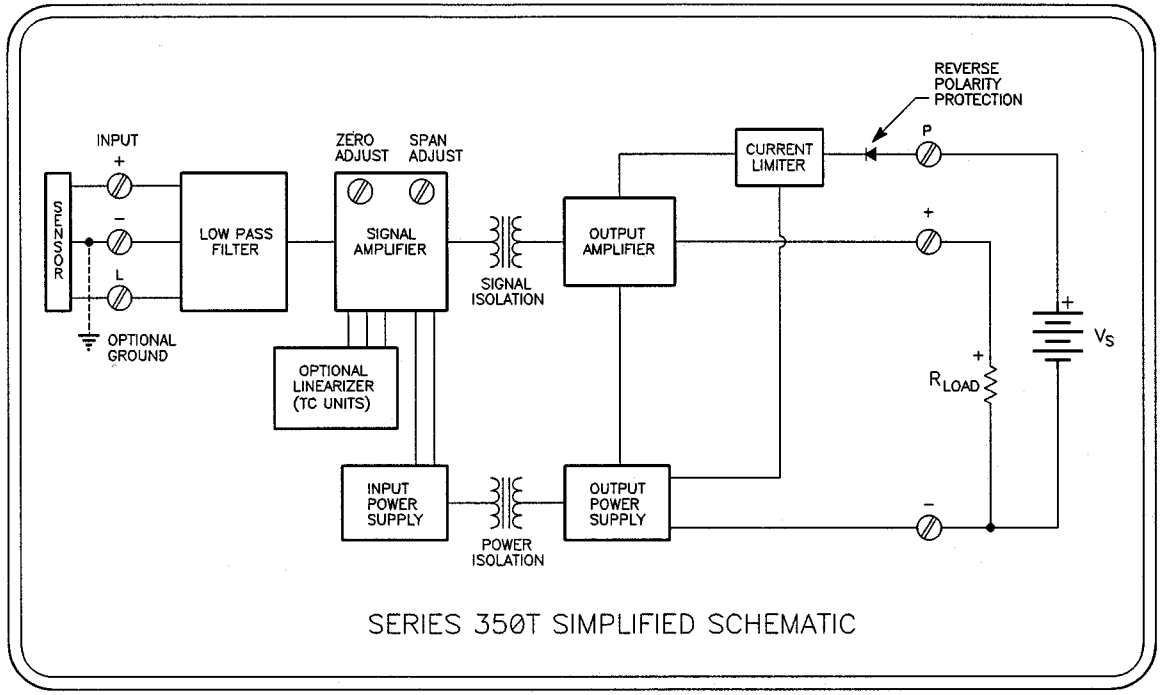
Temperature	Temperature in Ω		
	100Ω Platinum		10Ω Copper
	Pt385	Pt392	9.035 Ω @ 0^{O}C
-150 ^{O}C	39.71	38.68	---
-100 ^{O}C	60.25	59.57	---
-50 ^{O}C	80.31	79.96	7.104
0 ^{O}C	100.00	100.00	9.035
+50 ^{O}C	119.40	119.73	10.966
+100 ^{O}C	138.50	139.16	12.897
+150 ^{O}C	157.31	158.29	14.828
+200 ^{O}C	175.84	177.13	16.776
+250 ^{O}C	194.07	195.67	18.726
+300 ^{O}C	212.02	213.93	---
+350 ^{O}C	229.67	231.89	---
+400 ^{O}C	247.04	249.56	---
+450 ^{O}C	264.11	266.94	---
+500 ^{O}C	280.90	284.02	---
+550 ^{O}C	297.39	300.80	---
+600 ^{O}C	313.59	317.28	---
+650 ^{O}C	329.51	---	---
+700 ^{O}C	345.13	---	---
+750 ^{O}C	360.47	---	---
+800 ^{O}C	375.51	---	---
+850 ^{O}C	390.26	---	---

Note: Pt385 (Platinum): Alpha = 0.00385 Ω/ohm/^{O}C, Pt392 (Platinum): Alpha = 0.00392 Ω/ohm/^{O}C.

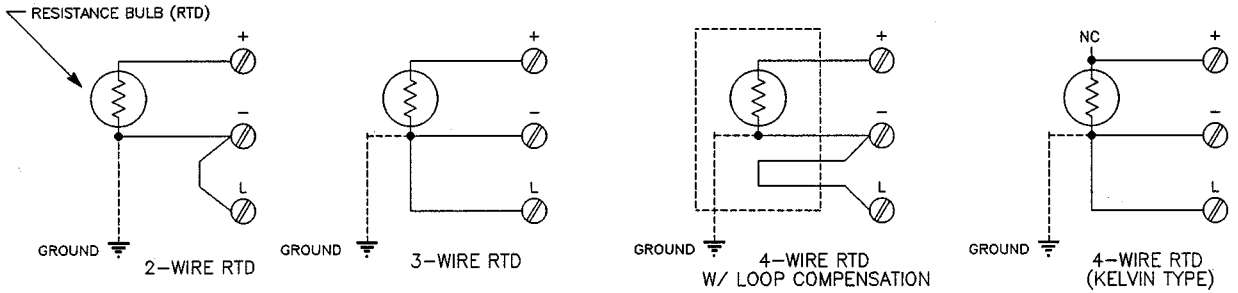
GENERAL MAINTENANCE:

The transmitter contains solid-state components and requires no maintenance, except for periodic cleaning and calibration verification. When a failure is suspected, a convenient method for identifying a faulty transmitter is to exchange it with a known good unit. It is highly recommended that a non-functioning transmitter be returned to Acromag for repair, since Acromag makes use of tested and burned-in parts, and in some cases, parts that have been selected for characteristics beyond that specified by the manufacturer. Further, Acromag has automated test equipment that thoroughly checks the performance of each transmitter.





SERIES 350T SIMPLIFIED SCHEMATIC



RTD TRANSMITTER INPUT CONNECTIONS

SERIES 350T RTD ELECTRICAL CONNECTIONS

Acromag WIXOM, MICH.							
17-DEC-92	A		BC	BC			
DATE	REV	ECN	DR	ENG	CLP		
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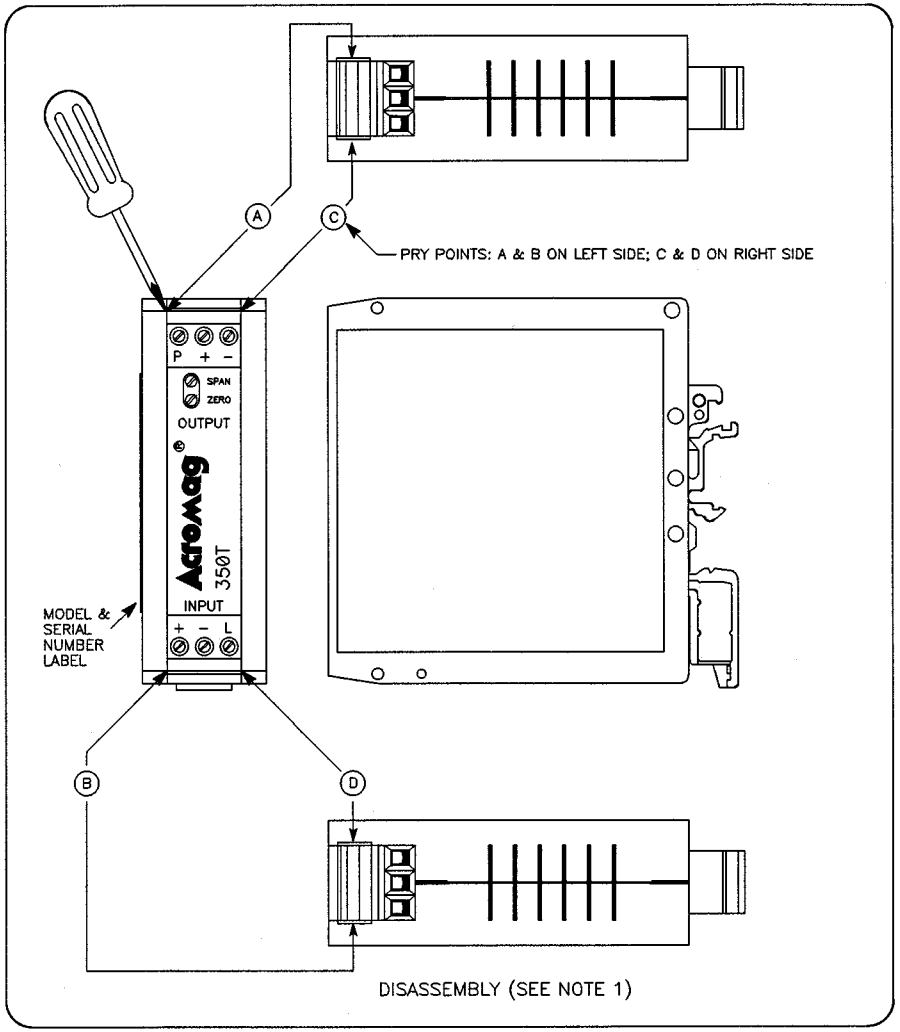
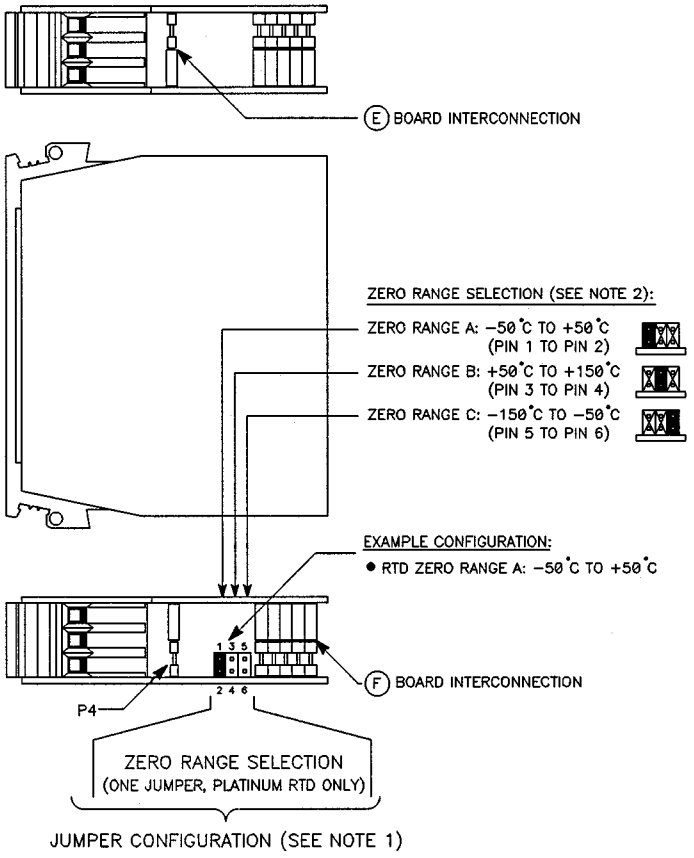
D	SERIES: 350T	1 OF 1	DWG NO. 4501-292	A			





NOTE: 1. REFER TO THE CALIBRATION SECTION OF THE MANUAL FOR DETAILED INSTRUCTIONS.
2. MODULE MUST BE RECALIBRATED WHEN ZERO JUMPER IS MOVED.

SERIES 350T RTD JUMPER CONFIGURATION

Acromag WIXOM, MICH.		17-DEC-92	A		BC	BC	
		DATE	REV	ECN	DR	ENG	CLP
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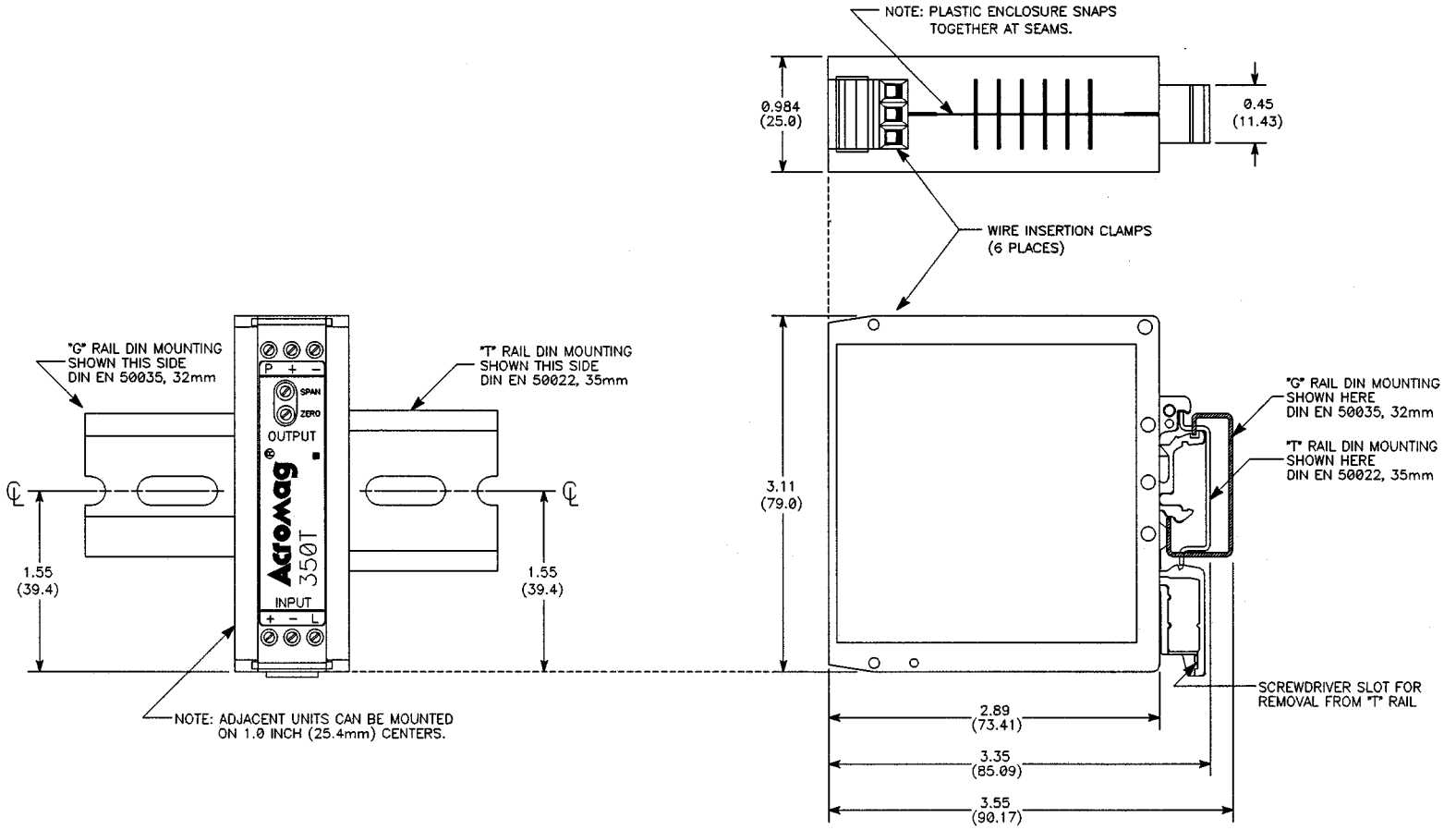
D	SERIES: 350T	1 OF 1	DWG NO. 4501-293	A			



ENCLOSURE DIMENSIONS FOR DIN RAIL MOUNTING

NOTE: ALL DIMENSIONS ARE IN INCHES (MILLIMETERS).

Acromag WIXOM, MICH.	DATE	REV	ECN	DR	ENG	CLP
	12-FEB-93	B	93801	BC	BC	TH
	27-JAN-93	A	———	BC	BC	

TITLE: 350T HOUSING: DIN RAIL MOUNT

SIZE	SERIES		DWG NO.	REV
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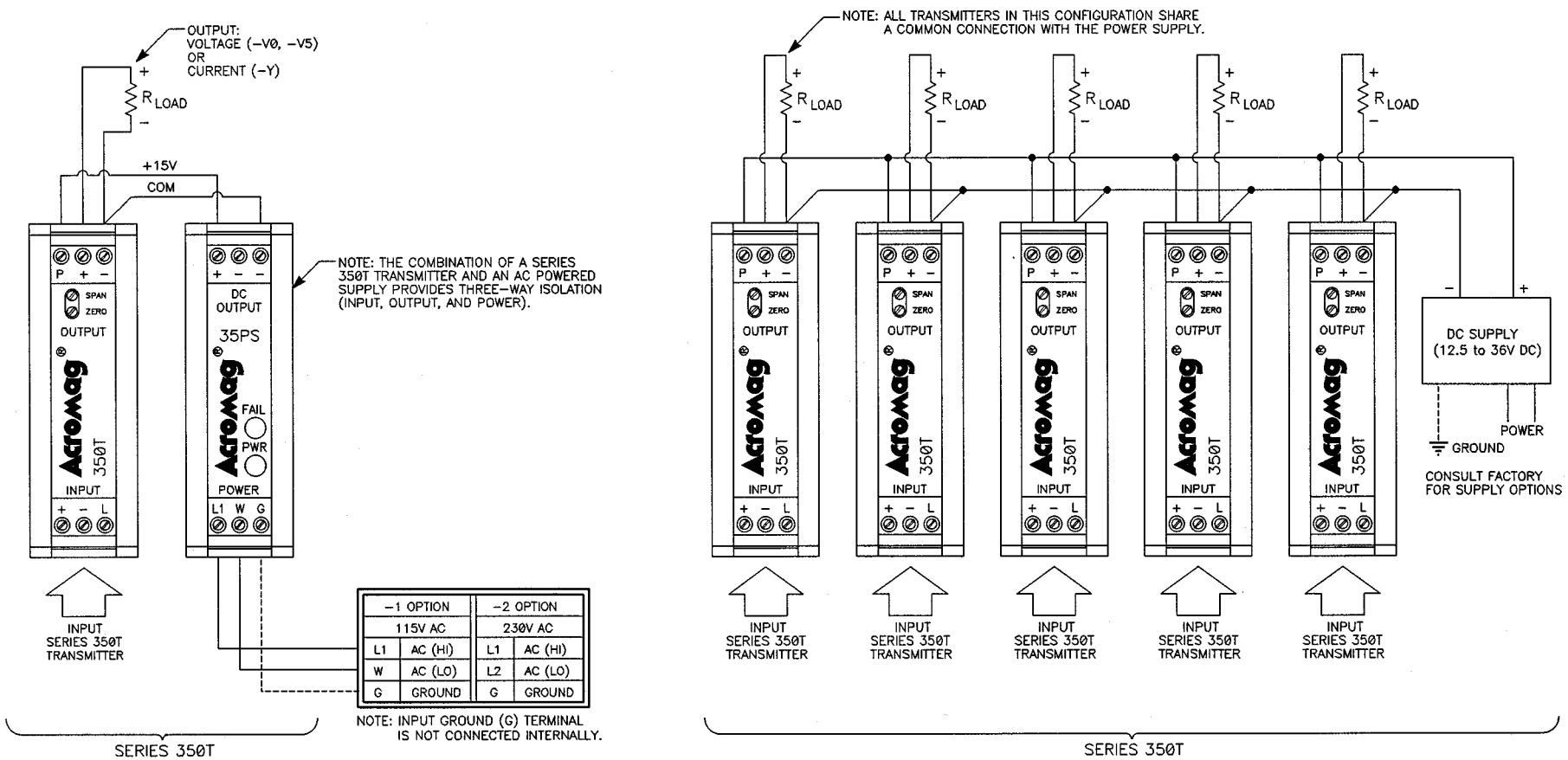

POWER SUPPLY CONFIGURATIONS

Acromag WIXOM, MICH.							
	11–JAN–93	A		BC	BC		
	DATE	REV	ECN	DR	ENG	CLP	
TITLE: ELECTRICAL CONNECTIONS							
D	SERIES: 350T	1 of 1	DWG NO. 4501–254	A	REV		