Acromag®

Series 657T/658T
Single/Dual Channel Two-Wire Transmitters
RTD Input

USER'S MANUAL

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Safety Summary - Symbols on equipment:

Means "Caution, refer to this manual for additional information".

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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.

1.0 INTRODUCTION

These instructions cover the hardware functionality of the transmitter models listed in Table 1. Supplementary sheets are attached for units with special options or features.

Table 1: Models Covered in This Manual

Series/ Input/Type	-Options/Output/ Enclosure/Approvals[1]	-Factory Configuration[2]
657T	-0600[3]	-C
658T	-0600[3]	-C

Notes (Table 1):
1. Approvals cULus Listed.
   Hazardous Locations: Class I; Division 2; Groups A,B,C,D. (See specifications).
2. Include the "-C" suffix to specify factory configuration option. Otherwise, no suffix is required for standard configuration.
3. Model 657T-0600 units have one I/O channel, while 658T-0600 transmitters provide two independent I/O channels.

DESCRIPTION

Series 657T/658T Transmitters are members of the popular Acromag transmitter, isolator, and alarm family. These models are simple, low cost, non-isolated, two-wire transmitters for multi-range Resistance Temperature Detector (RTD) input signals, in single (657T), and dual (658T) channel configurations. Units are fully reconfigurable via external DIP and toggle switches on the module.

These models provide one or two inputs for RTD or resistance input signals. The dual channels of Model 658T units operate independent of one another and are isolated from each other. RTD sensor excitation, linearization, lead-wire compensation, and lead break detection are included. Front panel toggle switches are used to facilitate field calibration of zero and full-scale. Side access DIP switches select the input type/range, connection type, upscale/ down-scale lead break detection, linearization on/off, and configuration lock/unlock. The unit may also be calibrated for a normal or reverse acting output response.

The module uses a high resolution, low noise, Sigma-Delta, Analog to Digital Converter (Σ-Δ ADC) to accurately convert the input signal into a digitized value. An optically isolated PWM circuit provides the corresponding process current output. These units contain an advanced technology microcontroller with integrated downloadable flash memory and EEPROM for non-volatile program, configuration, calibration, and parameter data storage. Flexible transmitter functionality, variable range inputs, plus convenient switch programming makes this instrument extremely versatile over a broad range of applications.

These modules are designed to withstand harsh industrial environments. They feature RFI, EMI, ESD, EFT, and surge protection, plus low temperature drift and wide ambient temperature operation. They also have low radiated emissions per CE requirements.

Units are DIN-rail mounted and removable terminal blocks facilitate ease of installation and replacement, without having to remove wiring. Connectors are an industry standard screw clamp type and accept a wide range of wire sizes.

The safe, compact, rugged, reconfigurable, and reliable design of this transmitter makes it an ideal choice for control room and field applications. Custom module configurations are also possible (please consult the factory).

Key 658T Features

- **Easy Switch Configuration** - The unit is fully configurable via nine DIP switches. Scaling of the zero and full-scale I/O points is accomplished via two front-panel toggle switches. No additional software, adapters, or host computer are required to program this transmitter.
- **Convenient Two-Wire Loop Power** - The output signal and power share the same two-wire connections.
- **Linearized or Non-Linearized Output Response** - A DIP switch is used to enable/disable RTD linearization.
- **Normal Or Reverse Acting Output Direction** - The output of this transmitter may be calibrated for a normal acting (ascending), or reverse acting (descending) response.
- **Configuration Lock** - A DIP switch is used to lock and unlock reconfiguration capability of zero and full-scale and help prevent inadvertent reconfiguration or tampering in the field. Plastic covers (packaged separately) are also provided to conceal the DIP switches.
- **Flexible Multi-Range RTD or Resistance Inputs** - Accepts copper, nickel, or platinum RTD types, or linear resistance. Sensor excitation, linearization, lead break detection, and lead-wire compensation are included.
- **True 4-Wire Kelvin Measurement** - Improves performance of 4-wire RTD measurements.
- **High-Resolution Precise A/D Conversion** - Transmitters include a high-resolution, low noise, Sigma-Delta Analog to Digital Converter (Σ-Δ ADC) for high accuracy and reliability.
- **Automatic Self-Calibration** - Self-calibration is built-in to correct for temperature drift of the input circuit.
- **Wide Ambient Operation** - The unit is designed for reliable operation over a wide ambient temperature range.
- **Hardened For Harsh Environments** - The unit will operate reliably in harsh industrial environments and includes protection from RFI, EMI, ESD, EFT, and surges, plus low radiated emissions per CE requirements.
- **Convenient Mounting, Removal, & Replacement** - The DIN-rail mount and plug-in type terminal blocks make module removal and replacement easy.

2.0 PREPARATION FOR USE

UNPACKING AND INSPECTION

Upon receipt of this product, inspect the shipping carton for evidence of mishandling during transit. If the shipping carton is badly damaged or water stained, request that the carrier's agent be present when the carton is opened. If the carrier's agent is absent when the carton is opened and the contents of the carton are damaged, keep the carton and packing material for the agent's inspection. For repairs to a product damaged in shipment, refer to the Acromag Service Policy to obtain return instructions. It is suggested that salvageable shipping cartons and packing material be saved for future use in the event the product must be shipped.

This module is physically protected with packing material and electrically protected with an anti-static bag during shipment. However, it is recommended that the module be visually inspected for evidence of mishandling prior to applying power.

This circuit utilizes static sensitive components and should only be handled at a static-safe workstation.

INSTALLATION

The transmitter module is packaged in a general purpose plastic enclosure. Use an auxiliary enclosure to protect the unit in unfavorable environments or vulnerable locations, or to maintain conformance to applicable safety standards. Stay within the specified operating temperature range. As shipped from the factory, the unit is factory calibrated for all valid input ranges, the full input range is scaled to 4 to 20mA at the output, and the transmitter has the default configuration shown in Table 2 below:

WARNING: Applicable IEC Safety Standards may require that this device be mounted within an approved metal enclosure or sub-system, particularly for applications with voltages greater than or equal to 75VDC or 50VAC.

Table 2: 657T/658T Default Configuration (Each I/O Channel)

PARAMETER	CONFIGURATION/CALIBRATION
Input RTD Type	Pt385 RTD Type (α=0.00385)
Input Connection	4-Wire Kelvin
Input Wiring	4-Wire Kelvin
Break Detect	Upscale
Linearization	Enabled
Reconfiguration Lock	Enabled (Locked)
I/O Scaling (Zero/Full-Scale Configuration)	Input for 4mA Output = -200°C, Input for 20mA Output = 850°C.

Note: The default configuration noted above corresponds to all DIP switches set to their OFF (open circuit) positions.

Your application may differ from the default configuration noted above and will require that the transmitter be reconfigured to suit your needs. This is accomplished by first setting the DIP switches, then optionally re-scaling your input range to the 4mA and 20mA output range endpoints as described in Section 3.0.

It is generally more convenient to set the DIP switches and configure zero and span prior to completing the installation as described below. Plastic covers (packaged separately) are provided to shield the DIP switches and internal circuit from damage due to electrostatic discharge, debris, or tampering in the field. These covers should be installed after setting the DIP switches and configuring zero and span per your application. As such, you may wish to refer to Section 3.0 at this point to configure the module per your application.

Mounting

Refer to Enclosure Dimensions Drawing 4501-780 for mounting and clearance dimensions.

DIN Rail Mounting: This module can be mounted on "T" type DIN rails. Use suitable fastening hardware to secure the DIN rail to the mounting surface. Units may be mounted side-by-side on 1-inch centers for limited space applications.

"T" Rail (35mm), Type EN50022: To attach a module 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 module, first separate the input terminal block(s) from the bottom side of the module to create a clearance to the DIN mounting area. Next, insert a screwdriver into the lower arm of the DIN rail connector and use it as a lever to force the connector down until the unit disengages from the rail.

Electrical Connections

Terminals can accommodate wire from 14-24 AWG, solid or stranded. Since common mode voltages can exist on signal wiring, adequate wire insulation should be used and proper wiring practices followed. Input wiring may be shielded or unshielded twisted-pair. Output wires should be twisted pair. Strip back wire insulation 1/4-inch on each lead before installing into the terminal block. It is recommended that output wiring be separated from input wiring for safety, as well as for low noise pickup. Each channel's terminal block is of a plug-in type that can be easily removed to facilitate module removal or replacement, without removing individual wires. To prevent electric shock, be sure to remove the I/O signal before unplugging the terminals to uninstall the module or before attempting service. All connections should be made with I/O signals removed.

> **CAUTION:** Risk of Electric Shock - More than one disconnect switch may be required to de-energize the equipment before servicing.

1. **Input (Each Input):** Connect input(s) per Electrical Connections Drawing 4501-783. Observe proper polarity when making connections. Be sure that the DIP switches are set properly to match your input wiring (i.e. 2-Wire, 3-Wire, 4-Wire Kelvin, or 4-Wire Compensation Loop).

2. **Output/Power Connections (Each Output)**: Connect a DC power supply and load in a two-wire configuration as shown in Electrical Connections Drawing 4501-783. These transmitters operate from DC supplies only. Loop current is input to the OUT+ lead and returned via the OUT- lead. Supply voltage is not critical and should be from 12-36V DC. The power supply voltage must be adequate to supply full-scale current to the load, plus 12V to the transmitter terminals, plus any transmission line drop. Variations in power supply voltage or load resistance within rated limits has negligible effect on transmitter accuracy.

   Ripple & Noise: Power supply ripple at 60Hz/120Hz is reduced at the load by the transmitter. The ripple at the load will generally be less than 0.02% of span per volt peak-to-peak of power supply ripple. Connect an external 1uF capacitor across the load to reduce ripple further, if desired. For sensitive applications with high-speed acquisition rates, high frequency noise may be reduced by placing a 0.1uF capacitor directly across the load.

   Inductive Loads: If the two-wire current loop includes a highly inductive load (such as an I/P transducer), this may reduce output stability. In this case, place a 0.1uF capacitor directly across the inductive load and this will typically cure the problem.

3. **Grounding:** See Electrical Connections Drawing 4501-783. The module housing is plastic and does not require an earth ground connection. If the transmitter is mounted in a metal housing, a ground wire connection is typically required. Connect the metal enclosure's ground terminal (green screw) to earth ground using suitable wire and per applicable codes.

> **WARNING:** For compliance to applicable safety and performance standards, the use of twisted pair wiring is recommended as shown in Drawing 4501-783. Failure to adhere to sound wiring and grounding practices as instructed may compromise safety and performance.

3.0 MODULE CONFIGURATION

This transmitter module needs to be configured for your application. Configuration is accomplished by first setting the DIP switches as required, then optionally re-scaling the input range to the 4-20mA output range endpoints.

All valid input ranges have been calibrated at the factory. By default, the output 4mA and 20mA range end points are factory set to correspond to the full input range endpoints, but may be optionally adjusted to correspond to a portion of the input range as described below. Reconfiguration of the transmitter zero and full-scale endpoints is accomplished via momentary toggle switches on the front of the module.

DIP SWITCH SETTINGS

Adjacent to the I/O channel terminals are a bank of 12 DIP switches used to select the input type/range, input RTD connection type, wiring, break upscale or down-scale, linearization enable or disable, and reconfiguration lock for the adjacent I/O channel. DIP switch 12 is used to optionally lockout the Z/FS Up/Down toggle switches and must be set ON to reconfigure zero and full-scale. Refer to Drawing 4501-784 and Table 3 below to locate and set these switches as required for your application (shaded entries refer to the factory default configuration of all switches OFF). After setting these switches, you will need to configure the zero and full-scale input points via the front panel toggle switches as described in Module Configuration Section 3.0. You should also install the plastic covers (packaged separately) over the DIP switch openings after making your settings (partial enclosure disassembly is required). This helps protect the circuit from penetration by ESD or debris, and prevents tampering in the field.

Table 3A: Input Type/Range/Connection - DIP Switches

	S1	S2	S3	S4	S5,6,7
INPUT TYPE/RANGE					
Pt385 RTD	0	0	0	X	X
Pt3911 RTD	1	0	0	X	X
Ni 120Ω (Minco 7-120)	0	1	0	X	X
Cu 10Ω (Minco 16-9)	1	1	0	X	X
Resistance (Linear)	0	0	1	X	X
CONNECTION TYPE					
2-Wire or 4-wire Kelvin	X	X	X	0	X
3-Wire or 4-Wire With Loop Compensation	X	X	X	1	X

Table 3B: Miscellaneous Options - DIP Switch Settings

	S8	S9	S10	S11	S12
WIRING					
2-Wire Connection	1	1	X	X	X
3-Wire Connection OR 4-Wire With Loop Comp.	1	0	X	X	X
Not Used	0	1	X	X	X
4-Wire Kelvin Connection	0	0	X	X	X
OPTIONS					
Lead Break Downscale	X	X	1	X	X
Lead Break Upscale	X	X	0	X	X
Linearization OFF	X	X	X	1	X
Linearization ON	X	X	X	0	X
Configuration Lock OFF	X	X	X	X	1
Configuration Lock ON	X	X	X	X	0

Notes (Tables 3A & 3B):

1. X = Don't Care; 0 = Switch Open/OFF; 1 = Switch Closed/ON.
2. Factory Default Configuration is all switches OFF (0) and corresponds to a Pt385 input, 4-Wire Kelvin Connection, Scaling of -200 to +850°C for 4 to 20mA, Break Upscale, Linearization Enabled, and Reconfiguration Locked Out.
3. Note that switches SW5, SW6, & SW7 have no function and are reserved for future use.

These units were packaged with one or more plastic covers for installation over the DIP switch openings. Do not install the DIP switch cover(s) until you have completed the zero and span configuration procedure outlined in the following section. This is done to maintain access to the Configuration Lock switch (SW12), which should be locked following zero and span reconfiguration to help prevent inadvertent miscalibration or tampering in the field.

ZERO AND SPAN CONFIGURATION

IMPORTANT: You must set your DIP switches according to your application prior to configuring the zero and full-scale input points as described below (see Table 3).

UNLOCK RECONFIGURATION: Reconfiguration of zero and full-scale is locked out by default and must be unlocked before making adjustments to zero and full-scale--DIP switch 12 must be set ON to unlock the front-panel Z/FS toggle switches.

After setting the DIP switches as required by your application, you may optionally re-scale your input range to the output 4mA and 20mA endpoints as described here. Configuration of the zero & full-scale I/O points (essentially input to output scaling) is accomplished via the transmitter module's Zero (Z) and Full-Scale (FS) Up/Down toggle switches located on the front panel (see Drawing 4501-784).

Note that a normal acting (ascending), or reverse acting (descending) output response may be configured by swapping the full-scale and zero output adjustment levels during configuration.

Equipment Required

An accurate input source adjustable over the range desired for zero and full-scale is required. An RTD calibrator or precision resistance decade box may also be used. An accurate current or voltage meter is also required to monitor the output level. For best results, the input source and output meter must be accurate beyond the required specifications.

Transmitter Zero/Full-Scale Configuration Procedure

CAUTION: Input levels outside of the nominal input range of the configured input type will not be accepted for configuration of zero or full-scale. Since input levels cannot be validated during field programming, entering incorrect signals may produce an undesired output response.

Note: The transmitter's input type, connection type, wiring, lead break direction, and linearization is set via the DIP switches. Each input type/range is already factory calibrated and scaled to the 4 to 20mA output by default. However, you may use the front panel toggle switches to scale virtually any part of the input range to the 4-20mA output range. For our example, we will use the 0 to 100°C portion of the Pt385 RTD type to drive the 4 to 20mA output range.

Transmitter Zero/Full-Scale Configuration Procedure

1. Set DIP switch 12 of the channel to the up/ON or "Unlock" position to allow the front panel toggle switches to make adjustments to zero and full-scale.
2. Connect a precision resistance source or RTD calibrator to the input, as required (refer to Electrical Connections Drawing 4501-783). Connect a current milliampmeter (in series with the loop), or voltmeter (across a precision load resistor), to accurately read the output signal. Apply power to the transmitter.
3. Adjust the input source to the zero level (this level must be within the input range selected). For our example: use 0°C (100.00Ω).
4. If the measured output is not precisely at zero (4.000mA), depress the **Zero** "Z" toggle switch to the **"UP"** or "**DN**" position as required, to precisely adjust the output current to 4.000mA.
   Note: *The Zero Up/Down toggle functions as a trim adjustment for the zero output loop current level. Successive depressions of the "UP" or "DN" toggle positions will increment or decrement the output current by a small amount, while holding the toggle switch in the "UP' or "DN" position will increase the amount of increment or decrement.*

Zero/Full-Scale Configuration Procedure…Continued

Reverse Acting Outputs: A reverse acting output can be easily obtained by using the Up/Down toggle to adjust the output level accordingly. For a reverse acting output, you would adjust the zero output level to a higher level here (20.000mA) in response to the zero input, and a lower level (4.000mA) in response to a full-scale input signal (step 6).

5. Adjust the input source to the full-scale level (the input value must be within the input range selected). For our example: use 100°C (138.50Ω).
   Note: *The full-scale input value must be greater than the zero input value. If the zero and full-scale points are too close together, performance will be degraded.*
6. If the output is not exactly at the full-scale level (20.000mA), press the **Full-Scale** "FS" Up/Down toggle to the **"UP"** or **"DN"** position, as required to precisely adjust the output current to 20.000mA.
   Note: *The FS Up/Down toggle functions as a trim adjustment for the full-scale output loop current level. Successive depressions of the "UP" or "DN" toggle positions will increment or decrement the output current by a small amount, while holding the toggle switch in "UP' or "DN" position will increase the amount of increment or decrement.*
   Reverse Acting Outputs: A reverse acting output can be easily obtained by using the Up/Down toggle to adjust the output level accordingly. For a reverse acting output, you would adjust the output level to a lower level (4.000mA) in response to the full-scale input here, and a higher level (20.000mA) in response to a zero input signal (step 4).
7. After completing zero and full-scale adjustment, be sure to return DIP switch 12 to the down or "Lock" position after waiting at least 15 seconds. This will help prevent inadvertent reconfiguration or tampering in the field by locking out adjustment via the front panel zero and full-scale toggle switches.

IMPORTANT: Note that the zero and full-scale adjustments take effect immediately and are saved to non-volatile memory after 15 seconds of toggle switch inactivity. Please wait at least 15 seconds following adjustment before powering down or setting Dip switch 12 to the "Lock" position or your new configuration settings will be lost.

After setting the DIP switches as required by your application and configuring zero and span, be sure to install the plastic cover(s) over the DIP switch openings. To install these covers, you will have to remove the left side cover by prying at each corner with a screwdriver, then sliding the DIP switch covers into the switch opening. Replace the left side cover by snapping it into place and applying pressure at each corner to secure.

Refer to Table 4 when using a resistance substitution box to configure zero and full-scale.

Table 4: RTD Resistance Versus Temperature[1]

	Temperature in Ohms			
TEMP	**100Ω Platinum**		**10Ω Cu**	**Nickel**
°C	**Pt385**	**Pt3911**	**9.035Ω/0°C**	**Note 2**
- 200	18.52	17.26	1.058	---
- 150	39.72	38.79	3.113	---
- 100	60.26	59.64	5.128	---
- 50	80.31	80.00	7.104	86.17
0	100.00	100.00	9.035	120.0
+ 50	119.40	119.70	10.966	157.74
+ 100	138.51	139.11	12.897	200.64
+ 150	157.33	158.22	14.828	248.95
+ 200	175.86	177.04	16.776	303.46
+ 250	194.10	195.57	18.726	366.53
+ 300	212.05	213.81	---	439.44
+ 350	229.72	231.76	---	---
+ 400	247.09	249.41	---	---
+ 450	264.18	266.77	---	---
+ 500	280.98	283.84	---	---
+ 550	297.49	300.61	---	---
+ 600	313.71	317.09	---	---
+ 650	329.64	333.29	---	---
+ 700	345.28	349.18	---	---
+ 750	360.64	364.79	---	---
+ 800	375.70	380.10	---	---
+ 850	390.48	395.12	---	---

Notes (Table 4):

1. For Pt385 (Platinum), Alpha = 0.00385 Ohms/ohm/°C. For Pt3911 (Platinum), Alpha = 0.003911 Ohms/ohm/°C. 1. Alpha (α) is used to identify the particular RTD curve. The value of alpha is derived by dividing the resistance of the sensor at 100°C by the resistance at 0°C ($\alpha = R_{100°C}/R_{0°C}$). For Pt 100Ω, this is 138.5Ω/100.0Ω, or 1.385 (also shown as 0.00385Ω/Ω/°C).
2. For Nickel RTD, range endpoints are not shown in table, but given here: Nickel is 66.60Ω at -80°C and 471.20Ω at +320°C.

4.0 THEORY OF OPERATION

Refer to Simplified Schematic 4501-782 to gain a better understanding of the circuit. The 4-20mA current loop is routed through current steering circuitry that splits it into a fixed portion (less than 4mA), and a variable portion. The fixed portion is used to generate power to run the circuit, while the variable portion of the loop current is pulled through a circuit that regulates the current based on a pulse-width modulated input signal from the microcontroller. The transmitter will accept an RTD input, and condition it to a voltage signal for the A/D converter. The A/D converter stage then applies appropriate gain to these signals, performs analog-to-digital conversion, and digitally filters the signals. The digitized signals are then transmitted serially to a microcontroller. The microcontroller completes the transfer function according to the input type and configuration, and sends a corresponding output pulse to a filter circuit. The corresponding analog output voltage is used to drive an amplifier that modulates the loop current. Embedded configuration and calibration parameters are stored in non-volatile memory integrated within the microcontroller.

5.0 SERVICE AND REPAIR

CAUTION: Risk of Electric Shock - More than one disconnect switch may be required to de-energize the equipment before servicing.

SERVICE AND REPAIR ASSISTANCE

This module contains solid-state components and requires no maintenance, except for periodic cleaning and transmitter configuration parameter (zero and full-scale) verification. Since Surface Mounted Technology (SMT) boards are generally difficult to repair, it is highly recommended that a non-functioning module be returned to Acromag for repair. The board can be damaged unless special SMT repair and service tools are used. Further, Acromag has automated test equipment that thoroughly checks and calibrates the performance of each module. Please refer to Acromag's Service Policy Bulletin or contact Acromag for complete details on how to obtain service parts and repair.

PRELIMINARY SERVICE PROCEDURE

Before beginning repair, be sure that all installation and configuration procedures have been followed and that the unit is wired properly. Verify that power is applied and that your power supply voltage is sufficient to supply full-scale current into the load (0.020*R), plus 12V at the module terminals, plus any line drop. If you continue to have a problem with the unit after making these checks, then an effective and convenient fault diagnosis method is to exchange the questionable module with a known good unit.

Acromag's Application Engineers can provide further technical assistance if required. When needed, complete repair services are available from Acromag.

6.0 SPECIFICATIONS

657T-0600, Single, 2-Wire, Non-Isolated RTD Channel
658T-0600, Dual, Independent 2-Wire, RTD Channels

General: The Model 657T/658T-0600 Two-Wire Transmitters accept Resistance Temperature Detector (RTD) input(s) and generate 4 to 20mA two-wire output signal(s). The 657T-0600 unit provides a single I/O channel, while the 658T-0600 unit provides two independent I/O channels. These transmitters are connected in two-wire fashion with the output signal and power sharing the same leads. These transmitters are DIN-rail mounted with plug-in type terminal blocks. Units are fully configured via nine external DIP switches and two toggle switches. Non-volatile reprogrammable memory within the module stores calibration and configuration information.

MODEL NUMBER DEFINITION

Transmitters are color coded with a white label. The prefix "6" denotes the Series 600 family of transmitters and isolators, while the "T" suffix specifies that this device is primarily a process transmitter.

65xT: Two-wire, single channel (657T), or dual channel (658T) transmitters for RTD inputs.

-0600: The four digits of this model suffix represent the following options, respectively:

0 = Option specifier - no option for this model;
6 = Output is DC current;
0 = Enclosure is DIN rail mounted;
0 = Approvals: cULus Listed, UL file E199702 & E202242. Hazardous Locations: Class I; Division 2; Groups A,B,C,D.

INPUT SPECIFICATIONS

Unit must be wired and configured for the intended input type and range (see Installation Section for details). The unit can be configured to accept any one of the input types described below via the DIP switches. The toggle switches are used to scale the input range to the 4-20mA output. The following paragraphs summarize this module's input types, ranges, and applicable specifications.

RTD: User configured to one of four RTD types noted in Table 4 below. Module provides sensor excitation, linearization, lead-wire compensation, and sensor break detection.
Input Reference Test Conditions: Pt RTD 0°C to 200°C, Ni RTD 0 to 100°C, Cu RTD 0 to 250°C, or Resistance 0-500Ω; Ambient Temperature = 25°C; Power Supply = 24V DC; R-Load = 500Ω.
Input Configuration: Two, three, or four-wire (Kelvin or compensation loop). Set via DIP switches.
Excitation Current: 0.5mA DC typical, all types.
Linearization: Better than ±0.25°C, typical. Enabled/ disabled via DIP switch.
Lead-Wire Compensation: Inherent for 3 wire and 4 wire RTD's. The maximum lead resistance is 25Ω per lead (Pt),

20Ω per lead (Ni), 10Ω per lead (Cu). All lead wires must be of equal size and length.

Lead Resistance Effect: 3.5°C per Ω of unbalance, typical (Pt), 1.4°C per Ω of unbalance, typical (Ni), 25.5°C per Ω of unbalance, typical (Cu).
Break Detection: RTD sensor failure can be configured for either upscale or downscale detection.

Table 5: RTD Types, Ranges, and Accuracy

RTD Type	α[1] Alpha	°C Range	Typical Accuracy
Pt385 100Ω (IEC751 Amendment 2:1995)	1.385	-200 to +850°C	±0.25°C
Pt3911 100Ω (Old JIS 1981)	1.3911	-200 to +850°C	±0.25°C
Ni 120Ω (Minco 7-120)	1.6720	- 80 to +320°C	±0.25°C
Cu 10Ω (Minco 16-9)	1.4272	-200 to +260°C	±1.00°C
Resistance (Linear)[2]	1.000	0-500Ω[2]	±0.05 Ω

Notes (Table 5):
1. Alpha (α) is used to identify the particular RTD curve. The value of alpha is derived by dividing the resistance of the sensor at 100°C by the resistance at 0°C ($\alpha = R_{100°C}/R_{0°C}$). For Pt 100Ω, this is 138.5Ω/100.0Ω, or 1.385 (also shown as 0.00385Ω/Ω/°C).
2. The linear resistance input range approaches 0Ω, but does not include 0Ω. If exactly 0Ω is measured, the selected break detection is triggered.

General Input Specifications
Input Filter Bandwidth: -3dB at 3Hz, typical.
Input Bias Current: 25nA typical.
Noise Rejection (Normal Mode): Better than 40dB @ 60Hz, typical with 100Ω input unbalance.
Analog to Digital Converter (A/D): A 16-bit Σ-Δ converter.
Input Filter: Normal mode filtering, plus digital filtering optimized and fixed per input range within the Σ-Δ ADC.

OUTPUT SPECIFICATIONS

DC Process Current Output Specifications:
Output Range: 4 to 20mA DC, 3.7 to 23.3mA range typical.
Output Ripple: Less than ±0.1% of output span.
Output Limiting: Output current is limited to less than 25mA.
Output Maximum Current: 23.3mA typical, 25mA maximum.
Output Compliance: 12V Minimum, 17V Typical, with 24V supply and 20mA loop current.
Output Resolution: The output stage resolves to 1 part in 6546 for a 4 to 20mA output span. Note that input resolution is limited to 0.1°C (RTD), or 0.015625Ω (resistance). The effective resolution is controlled by the output stage for RTD input spans greater than 655°C (resolves 1 part in 6546) and resistance input spans greater than 16Ω (resolves to 1/64 ohm). The effective resolution is controlled by the input stage for RTD input spans less than 655° (resolves to 0.1°C), or resistance input spans less than 16Ω (resolves to 1/64 ohm).

General Output Specifications:
Accuracy: Typical accuracy is listed in Table 5 for reference test conditions. Linear resistance accuracy is better than ±0.1% of span. This includes the effects of repeatability, terminal point conformity, & linearization, but does not include sensor error. Relative accuracy will vary with calibrated input span and effective resolution.
Accuracy Versus Temperature: Better than ±0.010% of input span per °F (±0.018% per °C or ±180ppm/°C) over the ambient temperature range for reference test conditions. This specification includes the combined effects of zero and span drift over temperature.
Response Time: For a step change in input signal, the output reaches 98% of final value in less than 1500ms typical, with 500Ω load. Response time will vary with load resistance.
Output Power Supply: 12-36V DC Class 2, 24mA. The supply voltage must be chosen to provide full-scale current to the load (0.020*R), plus 12V to the isolator terminals, plus any line drop. Reverse polarity protection is included.
Power Supply Effect: Less than ±0.001% of output span effect per volt DC change, or ±0.015% of output span effect per volt peak-to-peak of 60Hz/120Hz power supply ripple.
Output Load Resistance Effect: Less than ±0.01% of output span effect for ±100Ω change in load resistance.
Load Resistance Range Equation: R_{load} (Maximum) = (V_{supply} - 12V)/0.020A (assuming negligible line drop). At a 24V DC supply, R_{load} = 0-600Ω.
Note: For sensitive applications with high-speed acquisition rates, high frequency noise may be reduced by placing a 0.1uF capacitor directly across the load.
Output Conversion Rate: Every 460ms or 2 conversions per second.

APPROVALS (-xxx0)

0:
cULus Listed.
Hazardous Locations: Class I; Division 2; Groups A, B, C, D.

ENCLOSURE/PHYSICAL SPECIFICATIONS

Unit is packaged in a general purpose plastic enclosure that is DIN rail mountable for flexible, high density (approximately 1" wide per unit) mounting. See Enclosure Dimensions Drawing 4501-780 for details.

Dimensions: Width = 1.05 inches, Height = 4.68 inches, Depth = 4.35 inches (see Drawing 4501-780).
DIN Rail Mounting (-xx0x): DIN rail mount, Type EN50022; "T" rail (35mm).
Connectors: Removable plug-in type terminal blocks; Current/ Voltage Ratings: 15A/300V; Wire Range: AWG #14-24 solid or stranded; Separate terminal blocks are provided for each I/O channel.

Case Material: Self-extinguishing NYLON type 6.6 polyamide thermoplastic, UL94 V-2, color beige; general purpose NEMA Type 1 enclosure.
Printed Circuit Boards: Military grade FR-4 epoxy glass.
Shipping Weight: 1 pound (0.45 Kg) packed.

ENVIRONMENTAL SPECIFICATIONS

Operating Temperature: -25°C to +75°C (-13°F to +167°F), Temperature Code: T4.
Storage Temperature: -40°C to +85°C (-40°F to +185°F).
Relative Humidity: 5 to 95%, non-condensing.
Isolation: Input and output are not isolated from each other. Dual channel units are isolated channel-to-channel for common-mode voltages up to 250VAC, or 354V DC off DC power ground, on a continuous basis (will withstand 1500VAC dielectric strength test for one minute without breakdown). This complies with test requirements outlined in ANSI/ISA-82.01-1988 for the voltage rating specified..
Installation Category: Designed to operate in an Installation Category for use in pollution degree 2.
Radiated Field Immunity (RFI): Designed to comply with IEC1000-4-3 Level 3 (10V/M, 80 to 1000MHz AM & 900MHz keyed) and European Norm EN50082-1.
Electromagnetic Interference Immunity (EMI): No output shift will occur beyond ±0.25% of span, under the influence of EMI from switching solenoids, commutator motors, and drill motors.
Electrical Fast Transient Immunity (EFT): Complies with IEC1000-4-4 Level 3 (2KV) and European Norm EN50082-1.
Electrostatic Discharge (ESD) Immunity: Complies with IEC1000-4-2, Level 3 (8KV/4KV air/direct discharge) to the enclosure port and European Norm EN50082-1.
Surge Immunity: Complies with IEC1000-4-5 Level 3 (2.0KV) and European Norm EN50082-1.
Radiated Emissions: Meets or exceeds European Norm EN50081-1 for class B equipment.

IMPORTANT: Power, input, and output (I/O) wiring must be in accordance with Class I, Division 2 wiring methods Article 501-4(b) of the National Electrical Code, NFPA 70 for installations in the U.S., or as specified in section 18-1J2 of the Canadian Electrical Code for installations within Canada and in accordance with the authority having jurisdiction.

This equipment is suitable for use in Class I, Division 2, Groups A, B, C, and D, or non-hazardous locations only.

WARNING – EXPLOSION HAZARD – Substitution of components may impair suitability for Class I, Division 2.

WARNING – EXPLOSION HAZARD – Do not disconnect equipment unless power has been switched off or the area is known to be non-hazardous.

CAUTION – To reduce the risk of fire or electric shock, do not interconnect the outputs of different class 2 circuits.\

CONFIGURATION CONTROLS

Configuration of this transmitter is accomplished via nine DIP switches and two toggle switches provided for each channel and described below:

Toggle Switches (Each Channel, See Drawing 4501-784):

The following SPDT toggle switches are used to configure the transmitter’s zero and full-scale end points (input to output scaling) and are located on the front-panel. Adjustment via these switches may be locked out via DIP switch 12 (see below).

Z (Zero) Up/Down - Used to adjust the **Zero** endpoint during field configuration. With a zero input signal applied, depress this toggle to the UP direction to raise the output zero level, or DN to lower the output zero level.
FS (Full-Scale) Up/Down - Used to adjust the **Full-Scale** endpoint during field configuration. With the full-scale input signal applied, depress this toggle to the UP direction to raise the full-scale output level, or DN direction to lower the full-scale output level.

DIP Switches (See Drawing 4501-784 For Location):

Options Configuration - Used to select the input range/type, RTD connection type, set upscale or downscale lead break detection, enable or disable linearization, and lock/unlock reconfiguration. Refer to Drawing 4501-784 and INSTALLATION to set switches. Note that switches 5, 6, and 7 are not used.

Input - RTD Type/Range (Switches 1, 2, & 3): The transmitter can be configured to accept any one of five RTD types: Pt385, Pt3911, Ni 120Ω, Cu 10Ω, and linear resistance.

Input - RTD Connection Type (Switch 4): Used to select 2-Wire/4-wire Kelvin, or 3-Wire/4-Wire Compensation Loop RTD connection types.

Input - Wiring (Switches 8 & 9): Used to select 4-Wire Kelvin, 3-Wire/4-Wire with loop compensation, or 2-Wire RTD wiring.

Input - Lead Break (Switch 10): The signal detent for detection of a sensor failure or lead break can be set to upscale or downscale.

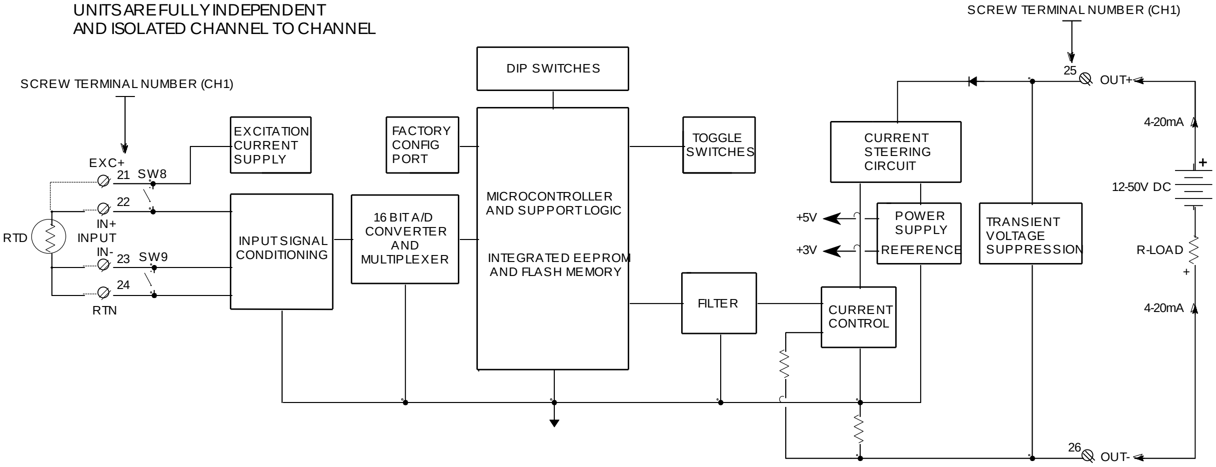
Input - Linearization (Switch 11): Linearization can be turned off for an output response that is linear with resistance, or ON for a response that is linear with temperature.

Unlock Reconfiguration (Switch 12): This switch (SW12) is normally enabled (locked) and must be set ON to unlock reconfiguration capability of the front panel toggle switches. It is provided as an extra level of security to help prevent inadvertent reconfiguration of zero and full-scale or tampering in the field.

MODEL 657T-0600 UNITS CONTAIN A SINGLE CHANNEL AS SHOWN

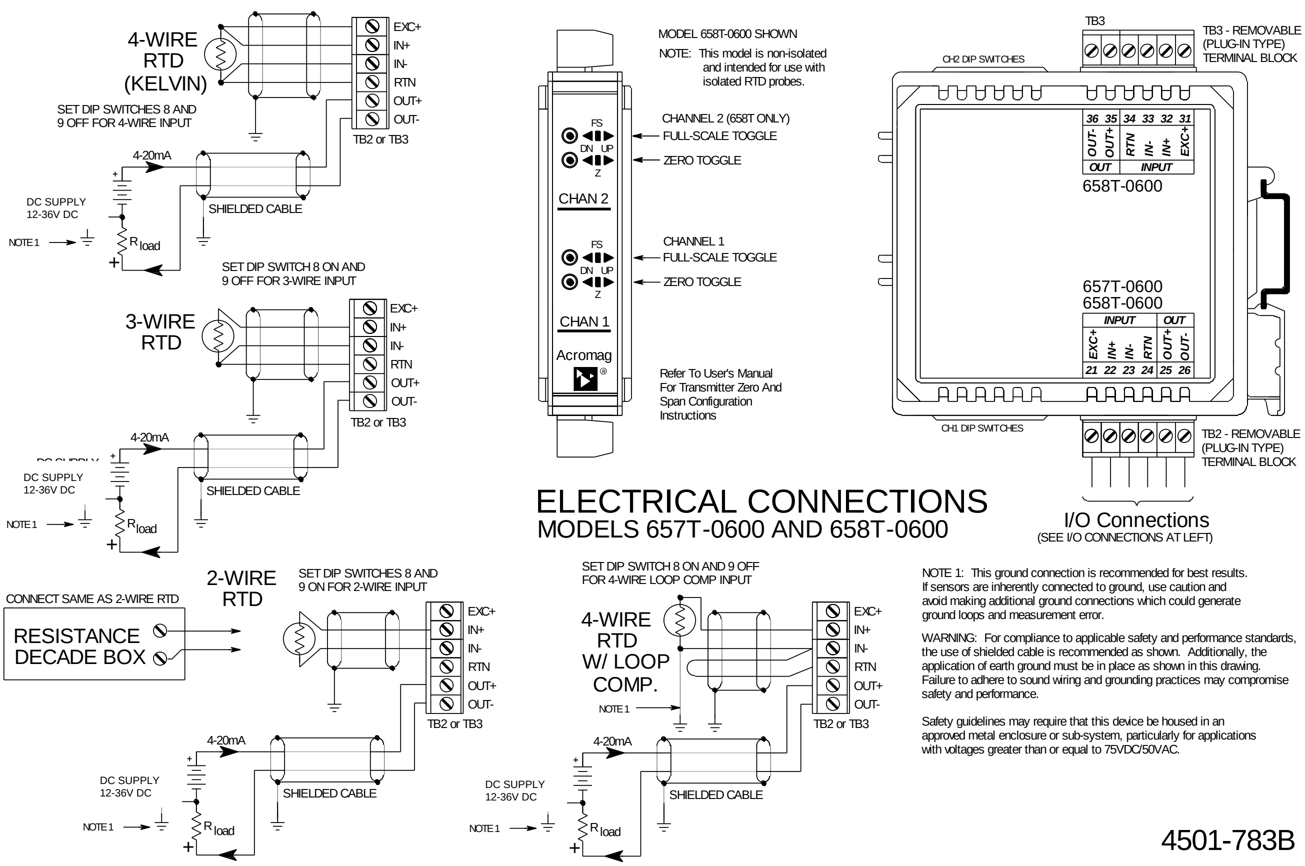
MODEL 658T-0600 UNITS CONTAIN TWO CHANNELS, EACH AS SHOWN

DUAL CHANNELS OF 658T UNITS ARE FULLY INDEPENDENT AND ISOLATED CHANNEL TO CHANNEL



SERIES 658T SIMPLIFIED SCHEMATIC (CHANNEL 1 OF 2 SHOWN)

4501-782A



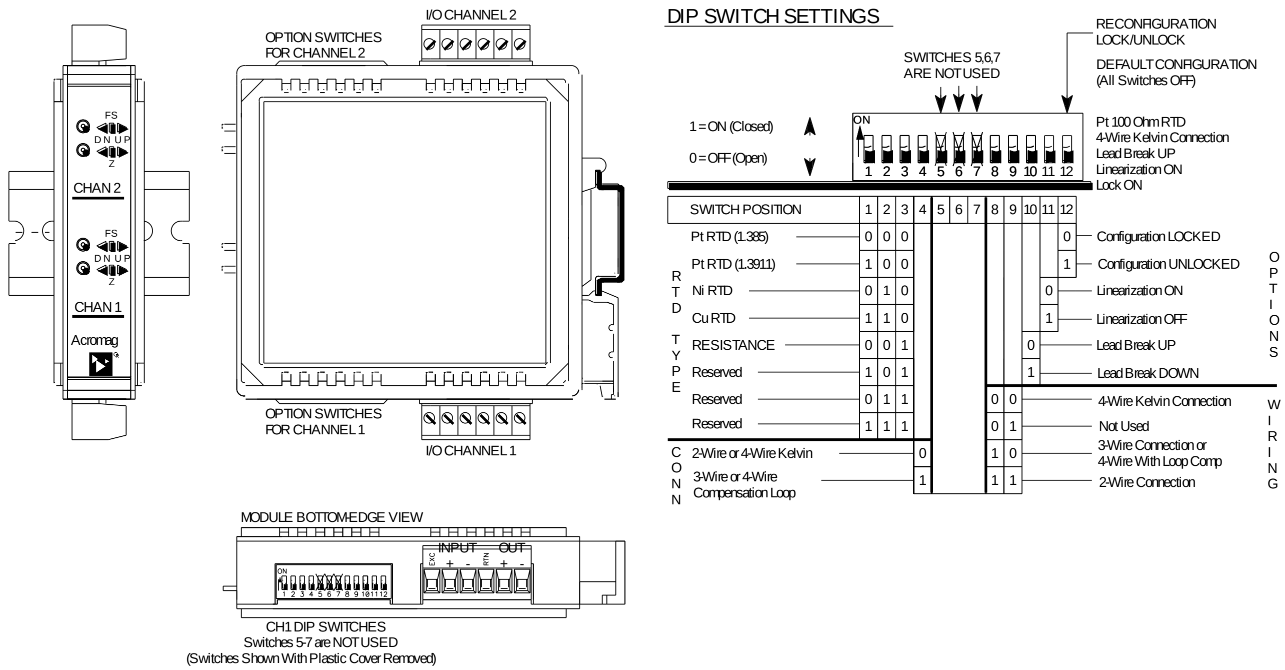
ELECTRICAL CONNECTIONS
MODELS 657T-0600 AND 658T-0600

NOTE 1: This ground connection is recommended for best results. If sensors are inherently connected to ground, use caution and avoid making additional ground connections which could generate ground loops and measurement error.

WARNING: For compliance to applicable safety and performance standards, the use of shielded cable is recommended as shown. Additionally, the application of earth ground must be in place as shown in this drawing. Failure to adhere to such wiring and grounding practices may compromise safety and performance.

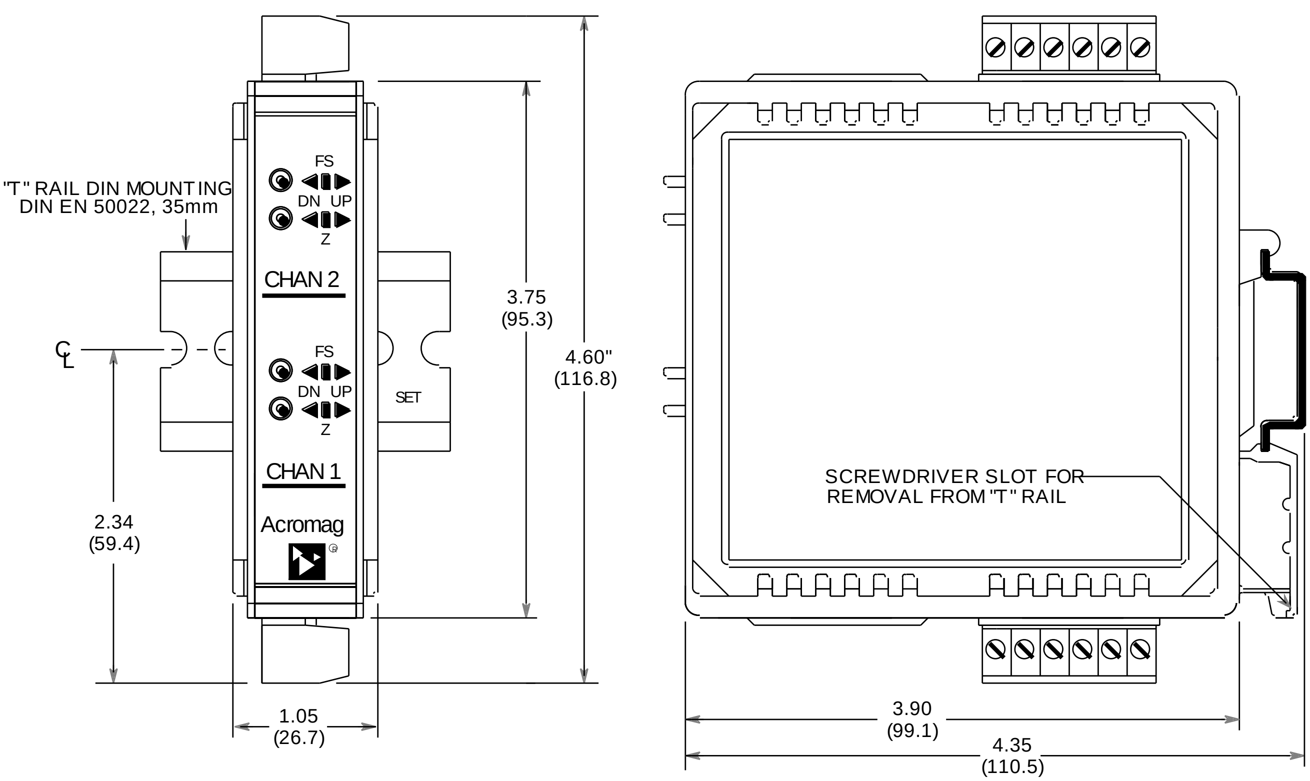
Safety guidelines may require that this device be housed in an approved metal enclosure or sub-system, particularly for applications with voltages greater than or equal to 75VDC/50VAC.

4501-783B



MODEL 658T-0600 DIP SWITCH SETTINGS

4501-784A



NOTE: ALL DIMENSIONS ARE IN INCHES (MILLIMETERS)

MODEL 65xT-0600 ENCLOSURE DIMENSIONS
(MODEL 655T-0600 & 657T-0600 ARE SIMILAR, BUT ONLY CHANNEL 1 IS PRESENT)

4501–780A

Revision History

The following table details the revision history for this document:

Release Date	Version	EGR/DOC	Description of Revision
3-AUG-2017	G	CAP/JAA	Remove CE Mark due to non-RoHS compliant part. Refer to ECN# 17G016.

Notes: