Reference Manual
00809-0100-4021, Rev BA
April 2003

Model 3144P Smart Temperature Transmitter

HART® FIELD COMMUNICATIONS PROTOCOL

ROSEMOUNT®

EMERSON™ Process Management

www.rosemount.com

Model 3144P Smart Temperature Transmitter

Model 3144P Revision: 5.3.4
HART Field Device Revision: Dev. v3, DD v2

NOTICE

Read this manual before working with the product. For personal and system safety, and for optimum product performance, make sure you thoroughly understand the contents before installing, using, or maintaining this product.

Within the United States, Rosemount Inc. has two toll-free assistance numbers:

Customer Central
Technical support, quoting, and order-related questions.
1-800-999-9307 (7:00 am to 7:00 pm CST)

North American Response Center
Equipment service needs.
1-800-654-7768 (24 hours)

International
(952)-906-8888

⚠CAUTION

The products described in this document are NOT designed for nuclear-qualified applications. Using non-nuclear qualified products in applications that require nuclear-qualified hardware or products may cause inaccurate readings.

For information on Rosemount nuclear-qualified products, contact your local Emerson Process Management Sales Representative.

Rosemount Model 3144P Smart Temperature Transmitter may be protected by one or more U.S. Patents Pending. Other foreign patents pending.

Table of Contents

APPENDIX C Safety Instrumented System (SIS)

Section 1 Introduction

OVERVIEW

Manual

This manual is intended to assist in the installation, operation, and maintenance of the Rosemount Model 3144P Smart Temperature Transmitter.

Section 1: Introduction

Section 2: Installation

Section 3: Commissioning

Section 4: Operation and Maintenance

Appendix A: Specifications and Reference Data

Appendix B: Hazardous Area Approvals

Appendix C: Safety Instrumented System (SIS)

Transmitter

The Rosemount Model 3144P Smart Temperature Transmitter is a microprocessor-based instrument that accepts input from a wide variety of sensors and transmits temperature data to a control system or transmitter interface. The transmitter combines Emerson Process Management reliability with the flexibility of digital electronics. The transmitter is ideal for applications that require high performance and/or remote communication.

The AMS software and Model 275 HART® Communicator use HART protocol to interrogate, configure, test, and format the Model 3144P transmitter. Communication can be made with the transmitter from the control room, transmitter site, or across any other two points in the loop provided the loop contains 250 to 1100 ohms of resistance.

Special dual-sensor features include Hot Backup®, sensor drift alert, first good, differential and average temperature measurements, and four simultaneous measurement variable outputs in addition to the analog output signal

CONSIDERATIONS

General

Electrical temperature sensors, such as resistance temperature detectors (RTDs) and thermocouples (T/Cs), produce low-level signals proportional to temperature. The Model 3144P transmitter converts low-level sensor signals to a standard 4–20 mA dc signal. This current signal is then transmitted to the control room via two power/signal wires.

Electrical

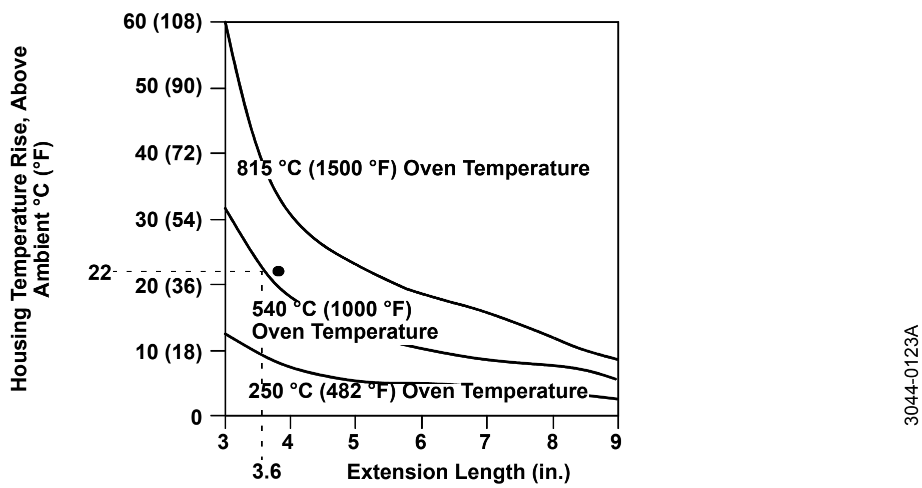
Proper electrical installation is essential to prevent errors due to sensor lead resistance and electrical noise. Shielded cable should be used for best results in electrically noisy environments. The current loop must have between 250 and 1100 ohms resistance for HART communications. Refer to Figure 2-10 on page 2-11 for sensor and current loop connections.

Environmental

Temperature Effects

The transmitter will operate within specifications for ambient temperatures between –40 and 185 °F (–40 and 85 °C). Heat from the process is transferred from the thermowell to the transmitter housing. If the expected process temperature is near or beyond specification limits, consider the use of additional thermowell lagging, an extension nipple, or a remote mounting configuration to isolate the transmitter from the process. Figure 1-1 describes the relationship between housing temperature rise and extension length.

Figure 1-1. Model 3144P Transmitter Housing Temperature Rise versus Extension Length for a Test Installation.



Example:
The maximum permissible housing temperature rise (T) can be calculated by subtracting the maximum ambient temperature (A) from the transmitter's ambient temperature specification limit (S). For instance, suppose A = 40 °C.

$$T = S - A$$
$$T = 85\ °C - 40\ °C$$
$$T = 45\ °C$$

For a process temperature of 540 °C (1004 °F), an extension length of 3.6 inches (91.4 mm) yields a housing temperature rise (R) of 22 °C (72 °F), which provides a safety margin of 23 °C (73 °F). A six-inch extension length (R = 10 °C (50 °F)) would offer a higher safety margin (35 °C (95 °F)) and would reduce temperature-effect errors but would probably require extra transmitter support. Gauge the requirements for individual applications along this scale. If a thermowell with lagging is used, the extension length may be reduced by the length of the lagging.

Moist or Corrosive Environments

The Model 3144P temperature transmitter has a highly reliable dual compartment housing designed to resist moisture and corrosion. The sealed electronics module is mounted in a compartment that is isolated from the terminal side conduit entries. O-ring seals protect the interior when the covers are properly installed. In humid environments, however, it is possible for moisture to accumulate in conduit lines and drain into the housing.

NOTE
Each transmitter is clearly marked with a tag indicating the approvals. Install the transmitter in accordance with all applicable installation codes and approval and installation drawings (see Appendix B: Product Certifications). Verify that the operating atmosphere of the transmitter is consistent with the hazardous locations certifications.

Once a device labeled with multiple approval types is installed, it should not be reinstalled using any of the other labeled approval types. To ensure this, the approval label should be permanently marked to distinguish the used from the unused approval type(s).

Mounting

Take into account the need for access to the transmitter when choosing an installation location and position.

Terminal Side of Electronics Housing

Mount the transmitter so the terminal side is accessible. Allow adequate clearance for cover removal. Make wiring connections through the conduit openings on the bottom of the housing.

Circuit Side of Electronics Housing

Mount the transmitter so the circuit side is accessible. Provide adequate clearance for cover removal. Additional room is required for LCD installation.

The transmitter may be mounted directly to or remotely from the sensor. Using optional mounting brackets, the transmitter may be mounted to a flat surface or to a two-inch diameter pipe (see “Optional Transmitter Mounting Brackets” on page A-8).

Software Compatibility

Replacement transmitters may contain revised software that is not fully compatible with the existing software in your HART communicator.

Model 275 HART Communicators and AMS software containing device descriptors for the Models 3144 and 3244MV before December 2001 do not fully support the new features of the Model 3144P. The HART Communicator Field Device Revisions Dev v3,DD v2 should be loaded into the Model 275 HART Communicator to communicate with the new features of the Model 3144P. The Device Descriptors (DD) are available with new communicators or can be loaded into existing communicators at any Emerson Process Management Service Center. See Section 3: Commissioning for more device revisions information.

MODEL 3144P AND MODELS 3144 / 3244MV DIFFERENCES

The following table identifies the differences between the Model 3144P and Models 3144 and 3244MV Temperature Transmitters.

Improved Model 3144P	Previous Model 3144 and 3244MV
Field Device Revision number 3	Field Device Revision number 2
Software Revision number 3	Software Revision number 1
Added sensor input types: DIN Type L, DIN Type U, and extended temperature range of Type N	NA
Uses custom-configurable alarm limits	Analog output and alarm levels can be ordered to be NAMUR-compliant with option codes A1 and CN
Improved 2- and 3-wire EMF compensation	NA
First Good Temperature is available as a device variable	NA
2-wire fixed lead correction is available	NA
Enhanced EMI rejection and filtering resulting in unmatched stability in process measurement	NA
Dual-sensor configuration is field selectable	Model 3144 – single sensor Model 3244MV – dual-sensor configuration

Section 2 Installation

SAFETY MESSAGES

Instructions and procedures in this section may require special precautions to ensure the safety of the personnel performing the operations. Information that potentially raises safety issues is indicated by a warning symbol (⚠). Please refer to the following safety messages before performing an operation preceded by this symbol.

Warnings

⚠WARNING

Explosions could result in death or serious injury:

- Do not remove the transmitter cover in explosive atmospheres when the circuit is live.
- Before connecting a HART communicator in an explosive atmosphere, make sure the instruments in the loop are installed in accordance with intrinsically safe or non-incendive field wiring practices.
- Verify that the operating atmosphere of the transmitter is consistent with the appropriate hazardous locations certifications.
- Both transmitter covers must be fully engaged to meet explosion-proof requirements.

Failure to follow these installation guidelines could result in death or serious injury:

- Make sure only qualified personnel perform the installation.

Process leaks could result in death or serious injury:

- Install and tighten thermowells or sensors before applying pressure, or process leakage may result.
- Do not remove the thermowell while in operation. Removing while in operation may cause process fluid leaks.

Electrical shock could cause death or serious injury. If the sensor is installed in a high-voltage environment and a fault or installation error occurs, high voltage may be present on the transmitter leads and terminals:

- Use extreme caution when making contact with the leads and terminals.

COMMISSIONING

The Model 3144P must be configured for certain basic variables to operate. In many cases, all of these variables are pre-configured at the factory. Configuration may be required if the transmitter is not configured or if the configuration variables need revision.

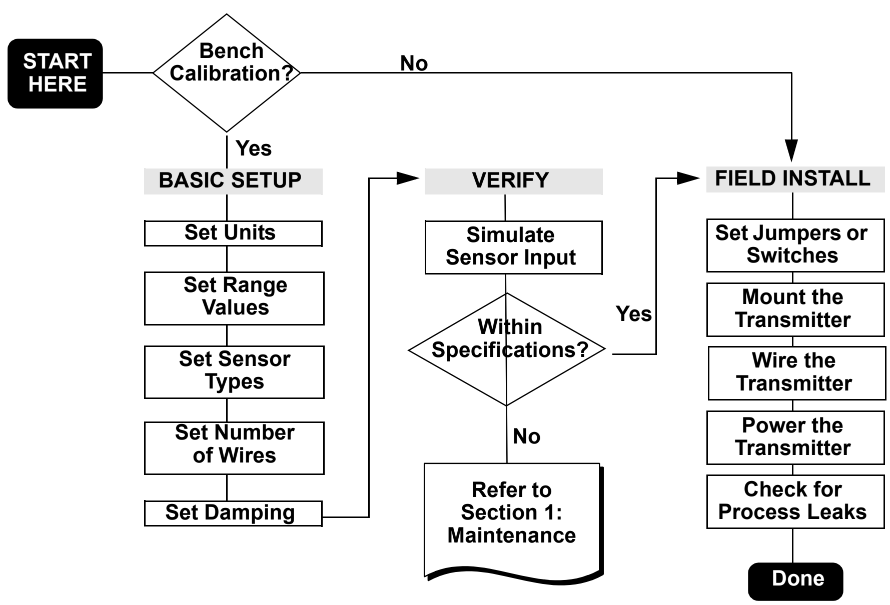
Commissioning consists of testing the transmitter and verifying transmitter configuration data. Model 3144P Series transmitters can be commissioned either before or after installation. Commissioning the transmitter on the bench before installation using a Model 275 HART Communicator or AMS ensures that all transmitter components are in working order.

⚠ To commission on the bench, connect the transmitter and the HART Communicator or AMS as shown in Figure 2-10 on page 2-11. Make sure the instruments in the loop are installed according to intrinsically-safe or non-incendive field wiring practices before connecting a communication in an explosive atmosphere. Connect HART Communication leads at any termination point in the signal loop. For convenience, connect them to the terminals labeled “COMM” on the terminal block. Connecting across the “TEST” terminals will prevent successful communication. Avoid exposing the transmitter electronics to the plant environment after installation by setting all transmitter jumpers during the commissioning stage on the bench.

When using a HART Communicator, any configuration changes made must be sent to the transmitter by using the “Send” key (F2). AMS configuration changes are implemented when the “Apply” button is clicked.

For more information on using the model 275 HART Communicator with the Model 3144P transmitter, see Section 3: Commissioning.

Figure 2-1. Installation Flowchart.



Setting the Loop to Manual

When sending or requesting data that would disrupt the loop or change the output of the transmitter, set the process application loop to manual. The HART Communicator or AMS will prompt you to set the loop to manual when necessary. Acknowledging this prompt does not set the loop to manual. The prompt is only a reminder; set the loop to manual as a separate operation.

Set the Switches

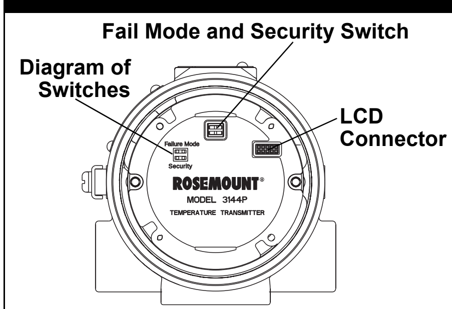
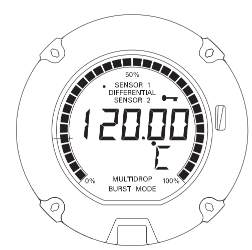
Without a LCD meter

1. If the transmitter is installed, set the loop to manual.
2. ⚠ Remove the housing cover on the electronics side of the transmitter. Do not remove the transmitter cover in explosive atmospheres when the circuit is live.
3. Set the switches to the desired position (see Figure 2-1).
4. ⚠ Replace the transmitter cover. Both transmitter covers must be fully engaged to meet explosion-proof requirements.
5. Set the loop to automatic control.

With a LCD meter

1. If the transmitter is installed, set the loop to manual.
2. ⚠ Remove the housing cover on the electronics side of the transmitter. Do not remove the transmitter cover in explosive atmospheres when the circuit is live.
3. Remove the housing cover, unscrew the LCD meter screws and gently slide the meter straight off.
4. Set the switches to the desired position (see Figure 2-1).
5. Gently slide the LCD meter back into place, taking extra precautions of the 10 pin connection.
6. Secure the LCD meter by replacing the LCD meter screws.
7. ⚠ Replace the transmitter cover. Both transmitter covers must be fully engaged to meet explosion-proof requirements.
8. Set the loop to automatic control.

Table 2-1. Transmitter Switch Locations.

Switch Location	LCD Meter Faceplate
	

3144- 0200G33A, 0001B01B

Transmitter Security Switch

The transmitter is equipped with a write-protect switch that can be positioned to prevent the accidental or deliberate change of configuration data.

Failure Mode Switch

The transmitter monitors itself during normal operation with an automatic diagnostic routine. If the diagnostic routine detects a sensor failure or a failure in the transmitter electronics, the transmitter goes into alarm (high or low, depending on the position of the failure mode switch).

The analog alarm and saturation values that the transmitter uses depend on whether it is configured to standard or NAMUR-compliant operation. These values are also custom-configurable in both the factory and the field using the HART Communications. The limits are

- 21.0 ≤ I ≤ 23 for high alarm
- 3.5 ≤ I ≤ 3.75 for low alarm

Table 2-2. Values for standard and NAMUR operation

Standard Operation (factory default)	
Fail High	21.75 mA ≤ I ≤ 23.0 mA
High Saturation	I ≥ 20.5 mA
Low Saturation	I ≤ 3.90 mA
Fail Low	I ≤ 3.75 mA

NAMUR-Compliant Operation	
Fail High	21 mA ≤ I ≤ 23.0 mA
High Saturation	I ≥ 20.5 mA
Low Saturation	I ≤ 3.8 mA
Fail Low	I ≤ 3.6 mA

MOUNTING

If possible, mount the transmitter at a high point in the conduit run so moisture from the conduits will not drain into the housing. The terminal compartment could fill with water If the transmitter is mounted at a low point in the conduit run. In some instances, the installation of a poured conduit seal, such as the one pictured in Figure 2-3, is advisable. Remove the terminal compartment cover periodically and inspect the transmitter for moisture and corrosion.

Figure 2-2. Incorrect Conduit Installation

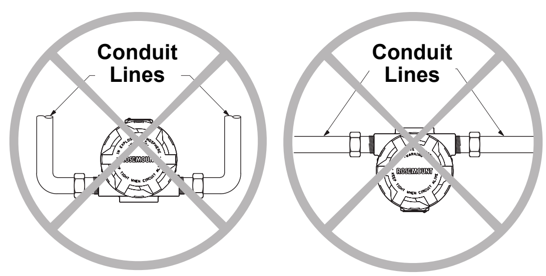
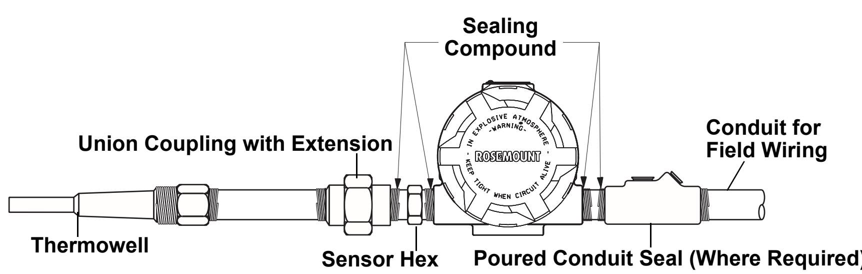


Figure 2-3. Recommended Mounting with Drain Seal



If mounting the transmitter directly to the sensor assembly, use the process shown in Figure 2-4. If mounting the transmitter apart from the sensor assembly, use conduit between the sensor and transmitter. The transmitter accepts male conduit fittings with $^1/_2$–14 NPT, M20 × 1.5 (CM 20), PG 13.5 (PG 11), or JIS G$^1/_2$ threads (M20 × 1.5 (CM 20), PG 13.5 (PG 11), or JIS G$^1/_2$ threads are provided by an adapter). Make sure only qualified personnel perform the installation.

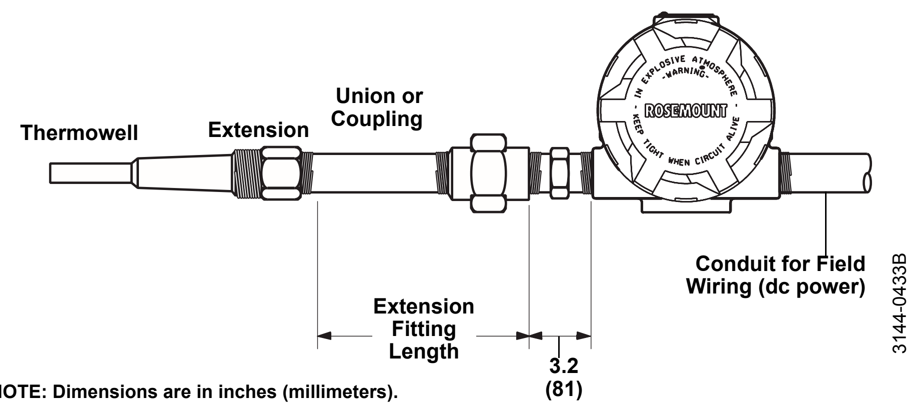
The transmitter may require supplementary support under high-vibration conditions, particularly if used with extensive thermowell lagging or long extension fittings. Pipe-stand mounting, using one of the optional mounting brackets, is recommended for use in high-vibration conditions.

INSTALLATION

Typical North American Installation

1. ⚠ Attach the thermowell to the pipe or process container wall. Install and tighten thermowells and sensors. Apply process pressure to perform a leak test.
2. Attach necessary unions, couplings, and extension fittings. Seal the fitting threads with teflon® (PTFE) tape (if required).
3. Screw the sensor into the thermowell or directly into the process (depending on installation requirements).
4. Verify all sealing requirements for severe environments or to satisfy code requirements.
5. Attach the transmitter to the thermowell/sensor assembly. Seal all threads with Teflon (PTFE) tape (if required).
6. Pull sensor leads through the extensions, unions, or couplings into the terminal side of the transmitter housing.
7. Install field wiring conduit to the remaining transmitter conduit entry.
8. ⚠ Pull the field wiring leads into the terminal side of the transmitter housing.
9. ⚠ Attach the sensor leads to the transmitter sensor terminals. Attach the power leads to the transmitter power terminals.
10. Attach and tighten both transmitter covers. Both transmitter covers must be fully engaged to meet explosion-proof requirements.

Figure 2-4. Typical North American Mounting Configuration.



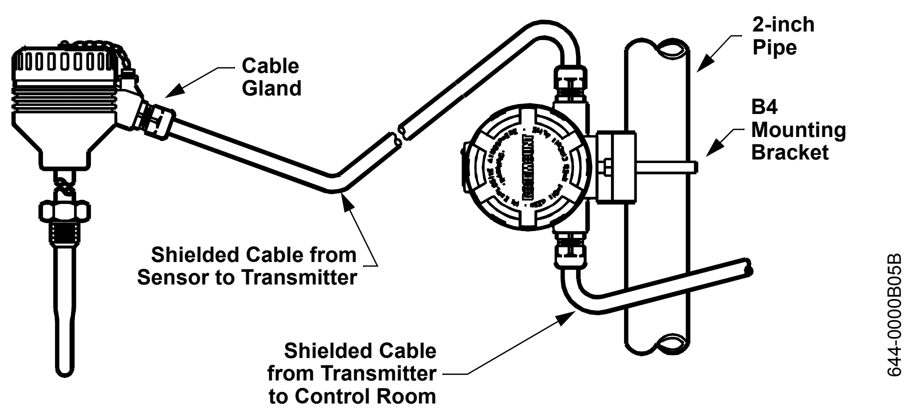
NOTE: Dimensions are in inches (millimeters).

NOTE
The National Electrical Code requires that a barrier or seal be used in addition to the primary (sensor) seal to prevent process fluid from entering the electrical conduit and continuing to the control room. Professional safety assistance is recommended for installation in potentially hazardous processes.

Typical European Installation

1. Mount the thermowell to the pipe or the process container wall. Install and tighten thermowells and sensors. Apply pressure and perform a leak check before starting the process.
2. Attach a connection head to the thermowell.
3. Insert the sensor into the thermowell and wire it to the connection head. The wiring diagram is located on the inside of the connection head.
4. Mount the transmitter to a 2-inch (50 mm) pipe or a suitable panel using one of the optional mounting brackets. The B4 bracket is shown in Figure 2-5.
5. Attach cable glands to the shielded cable running from the connection head to the transmitter conduit entry.
6. Run the shielded cable from the opposite conduit entry on the transmitter back to the control room.
7. Insert the shielded cable leads through the cable entries into the connection head and the transmitter. Connect and tighten the cable glands.
8. Connect the shielded cable leads to the connection head terminals (located inside of the connection head) and the sensor wiring terminals (located inside of the transmitter housing). Avoid contact with the leads and the terminals.

Figure 2-5. Typical European Process Mounting Configuration.



In Conjunction with a Model 333 HART Tri-Loop

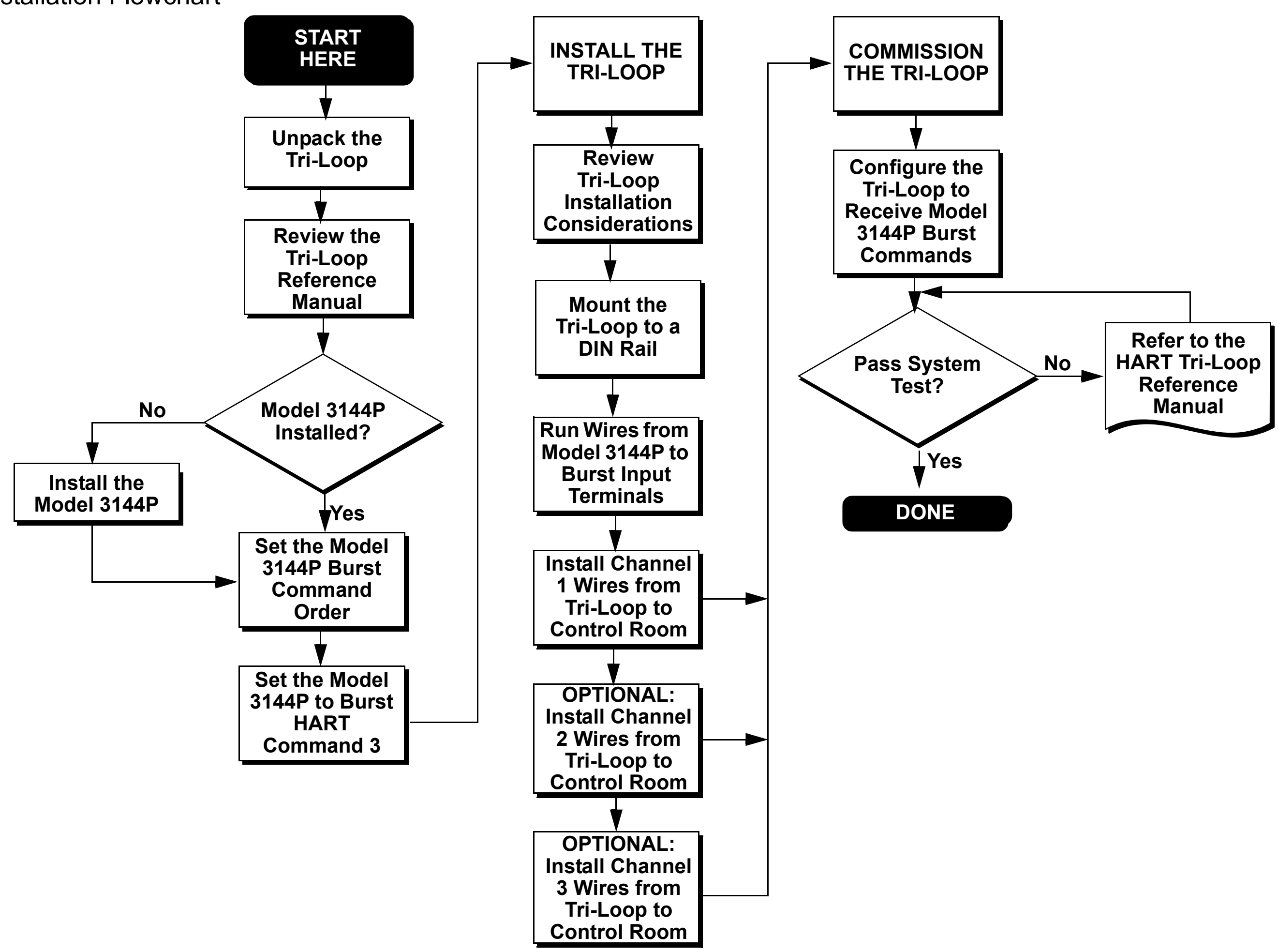
Use the dual-sensor option Model 3144P transmitter that is operating with two sensors in conjunction with a Model 333 HART Tri-Loop® HART-to-Analog Signal Converter to acquire an independent 4–20 mA analog output signal for each sensor input. The Model 3144P transmitter can be configured to output four of the six following digital process variables:

- Sensor 1
- Sensor 2
- Differential temperature
- Average temperature
- First good temperature,
- Transmitter terminal temperature.

The HART Tri-Loop reads the digital signal and outputs any or all of these variables into as many as three separate 4–20 mA analog channels.

Refer to Figure 2-6 for basic installation information. Refer to the Model 333 HART Tri-Loop HART-to-Analog Signal Converter Reference Manual (document number 00809-0100-4754) for complete installation information.

Figure 2-6. HART Tri-Loop Installation Flowchart(1)



(1) *See "Use with the HART Tri-Loop" on page 3-24 for configuration information.*

LCD Meter

Transmitters ordered with the LCD meter option (Option Code M5) are shipped with the LCD meter installed. After-market installation of the LCD meter on a conventional Model 3144P transmitter requires a small instrument screwdriver and the LCD meter kit, which includes:

- LCD meter assembly
- Extended cover with cover O-ring in place
- Captive screws (quantity 2)
- 10-pin interconnection header

Use the following procedure to install the LCD meter. Once the LCD meter is installed, configure the transmitter to recognize the meter option. Refer to “LCD Meter Options” on page 3-19.

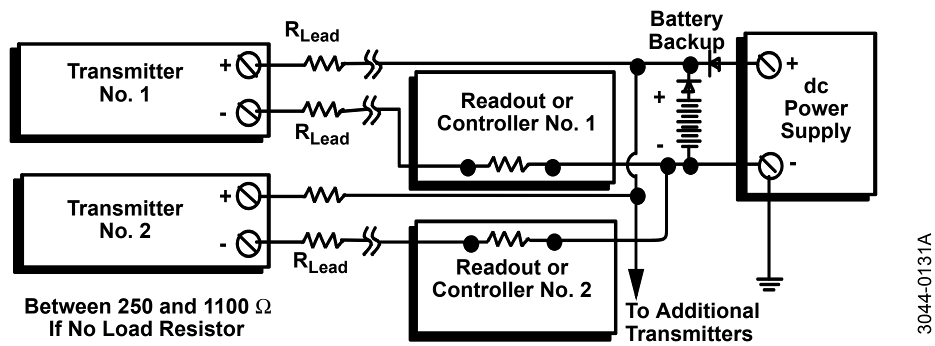
1. If the transmitter is installed in a loop, set the loop to manual and disconnect the power.
2. ⚠ Remove the housing cover from the electronics side of the transmitter. Do not remove the transmitter covers in explosive atmospheres if the circuit is live.
3. Ensure that the transmitter security mode switch is set to the **Off** position. If transmitter security is **On**, then you will not be able to configure the transmitter to recognize the LCD meter. If security **On** is desired, first configure the transmitter for the LCD meter and then install the meter.
4. Insert the interconnection header in the 10-pin socket on the face of the electronics module. Insert the pins into the electronics LCD interface.
5. Orient the meter. The meter can be rotated in 90-degree increments for easy viewing. Position one of the four 10-pin sockets on the back of the meter to accept the interconnection header.
6. Attach the LCD meter assembly to the interconnection pins. Thread and tighten the LCD meter screws into the holes on the electronics module.
7. ⚠ Attach the extended cover; tighten at least one-third turn after the O-ring contacts the transmitter housing. Both transmitter covers must be fully engaged to meet explosion proof requirements.
8. Apply power.

NOTE
Observe the following LCD meter temperature limits:
Operating:–4 to 185 °F (–20 to 85 °C)
Storage:–50 to 185 °F (–45 to 85 °C)

Multichannel Installations

You can connect several transmitters to a single master power supply (see Figure 2-7). In this case, the system may be grounded only at the negative power supply terminal. In multichannel installations where several transmitters depend on one power supply and the loss of all transmitters would cause operational problems, consider an uninterrupted power supply or a back-up battery. The diodes shown in Figure 2-7 prevent unwanted charging or discharging of the back-up battery.

Figure 2-7. Multichannel Installations.



WIRING

Field Wiring

All power to the transmitter is supplied over the signal wiring. Signal wiring does not need to be shielded, but twisted pairs should be used for the best results. Do not run unshielded signal wiring in conduit or open trays with power wiring or near heavy electrical equipment. High voltage may be present on the leads and may cause electrical shock. To wire the transmitter for power, follow the steps below.

1. Remove the transmitter covers. Do not remove the transmitter covers in an explosive atmosphere when the circuit is live.
2. Connect the positive power lead to the terminal marked "+" and the negative power lead to the terminal marked "–" as shown in Figure 2-8. Crimped lugs are recommended when wiring to screw terminals.
3. Tighten the terminal screws to ensure that good contact is made. No additional power wiring is required.
4. Replace the transmitter covers. Both transmitter covers must be fully engaged to meet explosion-proof requirements.

NOTE
Do not apply high voltage (e.g., ac line voltage) to the transmitter terminals. Abnormally high voltage can damage the unit.

Figure 2-8. Transmitter Terminal Block

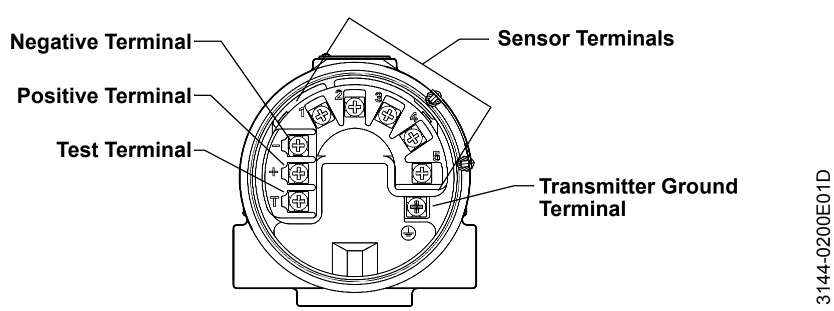
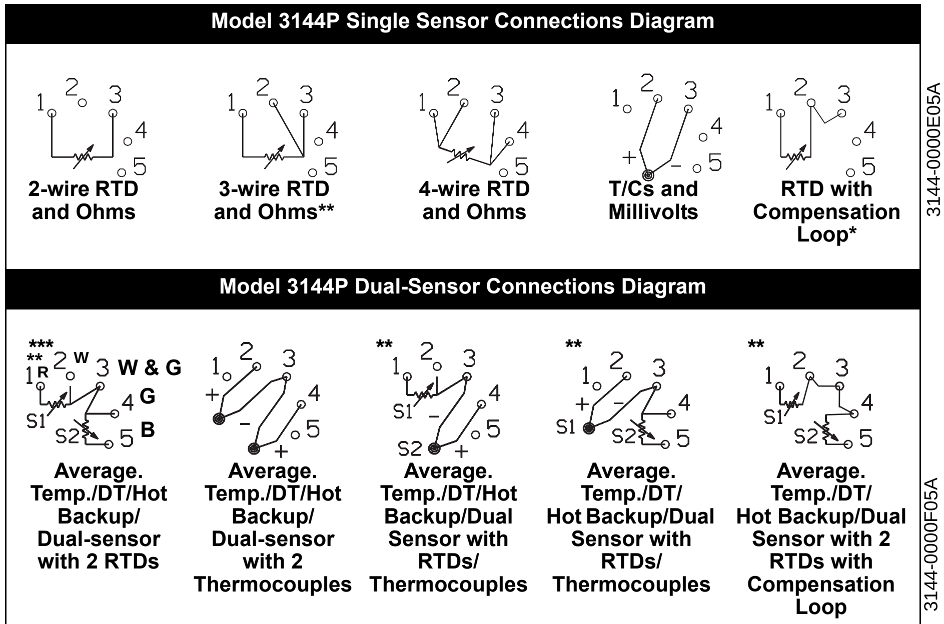


Figure 2-9. Sensor Wiring Diagram.



* *Transmitter must be configured for a 3-wire RTD in order to recognize an RTD with a compensation loop.*

** *Emerson Process Management provides 4-wire sensors for all single-element RTDs. You can use these RTDs in 3-wire configurations by leaving the unneeded leads disconnected and insulated with electrical tape.*

*** *Typical wiring configuration of a Rosemount dual-element RTD is shown (R=Red, W=White, G=Green, B=Black)*

Sensor Connections

⚠ Figure 2-9 on page 2-10 shows the correct sensor wiring connections to the transmitter sensor terminals. To ensure an adequate sensor connection, anchor the sensor lead wires beneath the flat washer on the terminal screw. Do not remove the transmitter cover in explosive atmospheres if the circuit is live. Both transmitter covers must be fully engaged to meet explosion-proof requirements. Use extreme caution when making contact with the leads and terminals.

RTD or Ohm Inputs

If the transmitter is mounted remotely from a 3- or 4-wire RTD, it will operate within specifications, without recalibration, for lead wire resistances of up to 10 ohms per lead (equivalent to 1,000 feet of 20 AWG wire). In this case, the leads between the RTD and transmitter should be shielded. If using only two leads (or a compensation loop lead wire configuration), both RTD leads are in series with the sensor element, so significant errors can occur if the lead lengths exceed one foot of 20 AWG wire. For longer runs, attach a third or fourth lead as described above. To eliminate 2-wire lead resistance error, the 2-wire offset command can be used. This allows the user to input the measured lead wire resistance, resulting in the transmitter adjusting the temperature to correct the error.

Thermocouple or Millivolt Inputs

For direct-mount applications, connect the thermocouple directly to the transmitter. If mounting the transmitter remotely from the sensor, use appropriate thermocouple extension wire. Make connections for millivolt inputs with copper wire. Use shielding for long runs of wire.

NOTE
The use of two grounded thermocouples with a dual option Model 3144P transmitter is not recommended. For applications in which the use of two thermocouples is desired, connect either two ungrounded thermocouples, one grounded and one ungrounded thermocouple, or one dual element thermocouple.

Power/Current Loop Connections

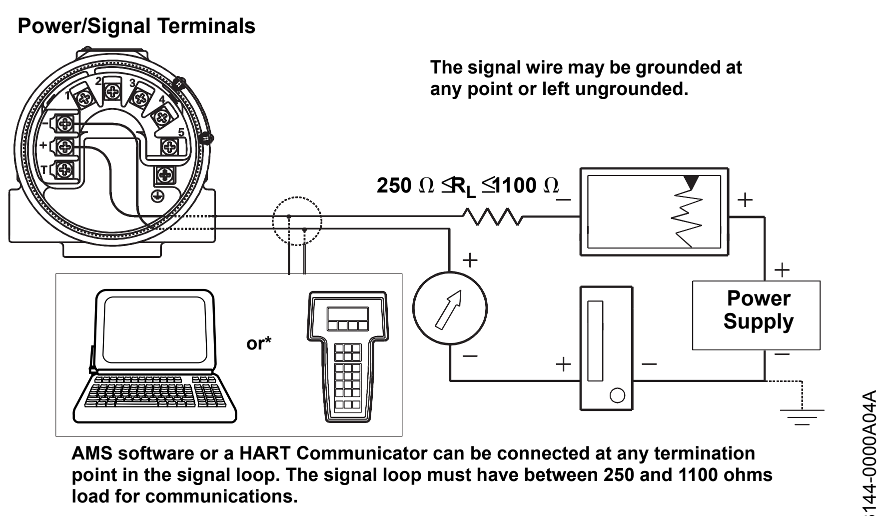
Use copper wire of a sufficient size to ensure that the voltage across the transmitter power terminals does not go below 12.0 V dc.

1. Connect the current signal leads as shown in Figure 2-10.
2. Recheck the polarity and correctness of connections.
3. Turn the power **ON**.

For information about multichannel installations, refer to page 2-14.

NOTE
Do not connect the power/signal wiring to the test terminal. The voltage present on the power/signal leads may burn out the reverse-polarity protection diode that is built into the test terminal. If the test terminal's reverse polarity protection diode is burned out by the incorrect power/signal wiring, the transmitter can still be operated by jumping the current from the test terminal to the "–" terminal. See "Test Terminal" on page 4-3 for use of the terminal.

Figure 2-10. Connecting a Communicator to a Transmitter Loop.



POWER SUPPLY

An external power supply is required to operate the Model 3144P (not included). The input voltage range of the transmitter is 12 to 42.4 V DC. This is the power required across the transmitter power terminals. The power terminals are rated to 42.4 V DC. With 250 ohms of resistance in the loop, the transmitter will require a minimum of 18.1 V DC for communication.

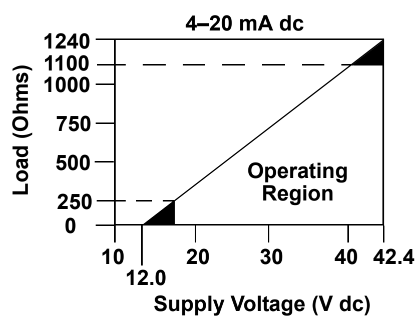
The power supplied to the transmitter is determined by the total loop resistance and should not drop below the lift-off voltage. The lift-off voltage is the minimum supply voltage required for any given total loop resistance. See Figure 2-11 to determine the required supply voltage. If the power drops below the lift-off voltage while the transmitter is being configured, the transmitter may output incorrect information.

The dc power supply should provide power with less than 2% ripple. The total resistance load is the sum of the resistance of the signal leads and the load resistance of any controller, indicator, or related piece of equipment in the loop. Note that the resistance of intrinsic safety barriers, if used, must be included.

NOTE
Do not allow the voltage to drop below 12.0 V dc at the transmitter terminals when changing transmitter configuration parameters, or permanent damage to the transmitter could result.

Figure 2-11. Load Limits.

Maximum Load = 40.8 X (Supply Voltage - 12.0)



Surges/Transients

The transmitter will withstand electrical transients of the energy level usually encountered in static discharges or induced switching. However, high-energy transients, such as those induced in wiring from nearby lightning strikes, can damage both the transmitter and the sensor.

To protect against high-energy transients, install the integral transient protection board (option code T1) or the Rosemount Model 470 Transient Protector. The integral transient protection board is available as an ordered option or as an accessory. Refer to “ Transient Protection (Option Code T1)” on page A-16 for more information. The Model 470 transient protector is available only as an accessory. Refer to the Model 470 Transient Protector Product Data Sheet (document number 00813-0100-4191) for more information.

Grounding

Shielding

The currents in the leads induced by electromagnetic interference can be reduced by shielding. Shielding carries the current to ground and away from the leads and electronics. If the ends of the shields are adequately grounded, little current will actually enter the transmitter.

If the ends of the shield are left ungrounded, a voltage is created between the shield and the transmitter housing and also between the shield and earth at the element end. The transmitter may not be able to compensate for this voltage, causing it to lose communication and/or go into alarm. Instead of the shield carrying the currents away from the transmitter, the currents will now flow through the sensor leads into the transmitter circuitry where they will interfere with the circuit operation.

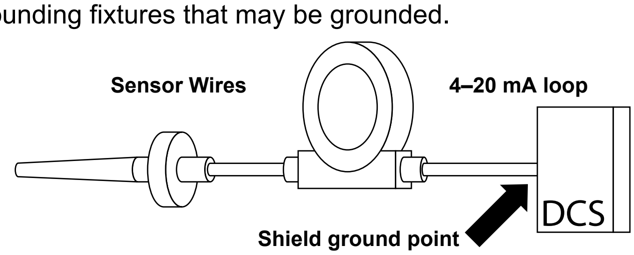
Shielding Recommendations

The following are recommended practices are from API Standard 552 (Transmission Standard) section 20.7 and from field and laboratory testing. If more than one recommendation is given for a sensor type, start with the first technique shown or the technique that is recommended for the facility by its installation drawings. If the technique does not eliminate the transmitter alarms, try another technique. If all techniques unsuccessfully prevent transmitter alarms due to high EMI, contact a Emerson Process Management representative.

Ungrounded Thermocouple, mV, and RTD/Ohm Inputs

Option 1: recommended for ungrounded transmitter housing

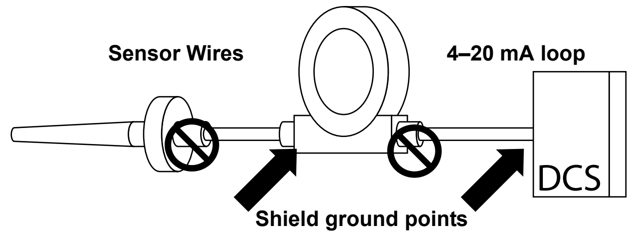
1. Connect the signal wiring shield to the sensor wiring shield.
2. Ensure the two shields are tied together and electrically isolated from the transmitter housing.
3. Ground the shield at the power supply end only.
4. Ensure the shield at the sensor is electrically isolated from the surrounding fixtures that may be grounded.



Connect shields together, electrically isolated from the transmitter

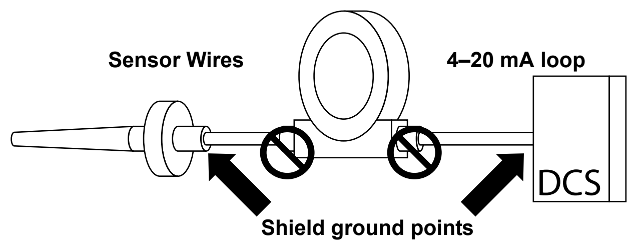
Option 2: recommended for grounded transmitter housing

1. Connect the sensor wiring shield to the transmitter housing, provided the transmitter housing is grounded (see "Transmitter Housing").
2. Ensure the shield at the sensor end is electrically isolated from surrounding fixtures that may be grounded.
3. Ground the signal wiring shield at the power supply end.



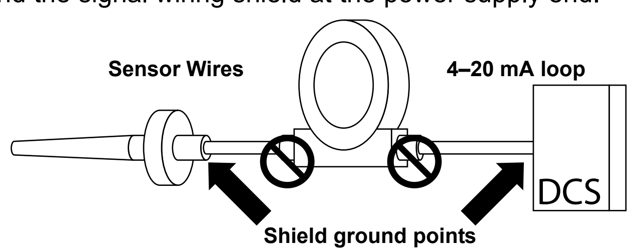
Option 3

1. Ground the sensor wiring shield at the sensor, if possible.
2. Ensure the sensor wiring and signal wiring shields are electrically isolated form the transmitter housing and other fixtures that may be grounded.
3. Ground the signal wiring shield at the power supply end.



Grounded Thermocouple Inputs

1. Ground the sensor wiring shield at the sensor.
2. Ensure the sensor wiring and signal wiring shields are electrically isolated form the transmitter housing and other fixtures that may be grounded.
3. Ground the signal wiring shield at the power supply end.



Transmitter Housing

Ground the transmitter housing in accordance with local electrical requirements. An internal ground terminal is standard. An optional external ground lug assembly (Option Code G1) can also be ordered if needed. Ordering certain hazardous approvals automatically includes an external ground lug (see Table A-5 on page A-16).

Section 3 Commissioning

OVERVIEW

This section contains information on commissioning and tasks that should be performed on the bench prior to installation. This section contains Model 3144P HART configuration only. HART Communicator and AMS instructions are given to perform configuration functions. For additional information, refer to the Model 275 HART Communication Reference Manual (document number 00809-0100-4275). AMS help can be found in the AMS on-line guides within the AMS system.

SAFETY MESSAGES

Instructions and procedures in this section may require special precautions to ensure the safety of the personnel performing the operations. Information that raises potential safety issues is indicated by a warning symbol (⚠). Please refer to the following safety messages before performing an operation preceded by this symbol.

Warnings

⚠WARNING

Explosions may result in death or serious injury.

- Do not remove the instrument cover in explosive atmospheres when the circuit is live.
- Before connecting a HART communicator in an explosive atmosphere, make sure the instruments in the loop are installed in accordance with intrinsically safe or non-incendive field wiring practices.
- Both covers must be fully engaged to meet explosion–proof requirements.

Electrical shock could cause death or serious injury. If the sensor is installed in a high-voltage environment and a fault or installation error occurs, high voltage may be present on transmitter leads and terminals.

- Use extreme caution when making contact with the leads and terminals.

MODEL 275 HART COMMUNICATOR

The HART Communicator exchanges information with the transmitter from the control room, the instrument site, or any wiring termination point in the loop. To facilitate communication, connect the HART Communicator in parallel with the transmitter (see Figure 2-11). Use the loop connection ports on the rear panel of the HART Communicator. The connections are non-polarized. Do not make connections to the serial port or the NiCad recharger jack in explosive atmospheres. Before connecting the HART communicator in an explosive atmosphere, make sure the instruments in the loop are installed in accordance with intrinsically safe or non-incendive field wiring practices

Updating the Model 275 HART Communication Software

You may need to upgrade the Model 275 HART Communicator software to take advantage of the additional features available in the Model 3144P (field device revision 3). Perform the following steps to determine if an upgrade is required.

1. Turn on your communicator and select *4 Utility*, then *5 Simulation*.
2. Choose “Rosemount” from the list of manufacturers and “3144 Temp” from the list of models.
3. If the **Fld Dev Rev** choices include “Dev v3, DD v2,” an upgrade is not required. If the only choice is “Dev v1” or “Dev v2” (with any DD version), than the communicator should be upgraded.

NOTE
If you initiate communication with an improved Model 3144P using a communicator that only has a previous version of the transmitter device descriptors (DDs), the communicator will display the following message:

NOTICE: Upgrade 275 software to access new XMTR functions.
Continue with old description?

If you select **YES**, the communicator will communicate properly with the transmitter using the existing transmitter DDs. However, new software features of the DD in the communicator will not be accessible. If you select **NO**, the communicator will default to a generic transmitter functionality.

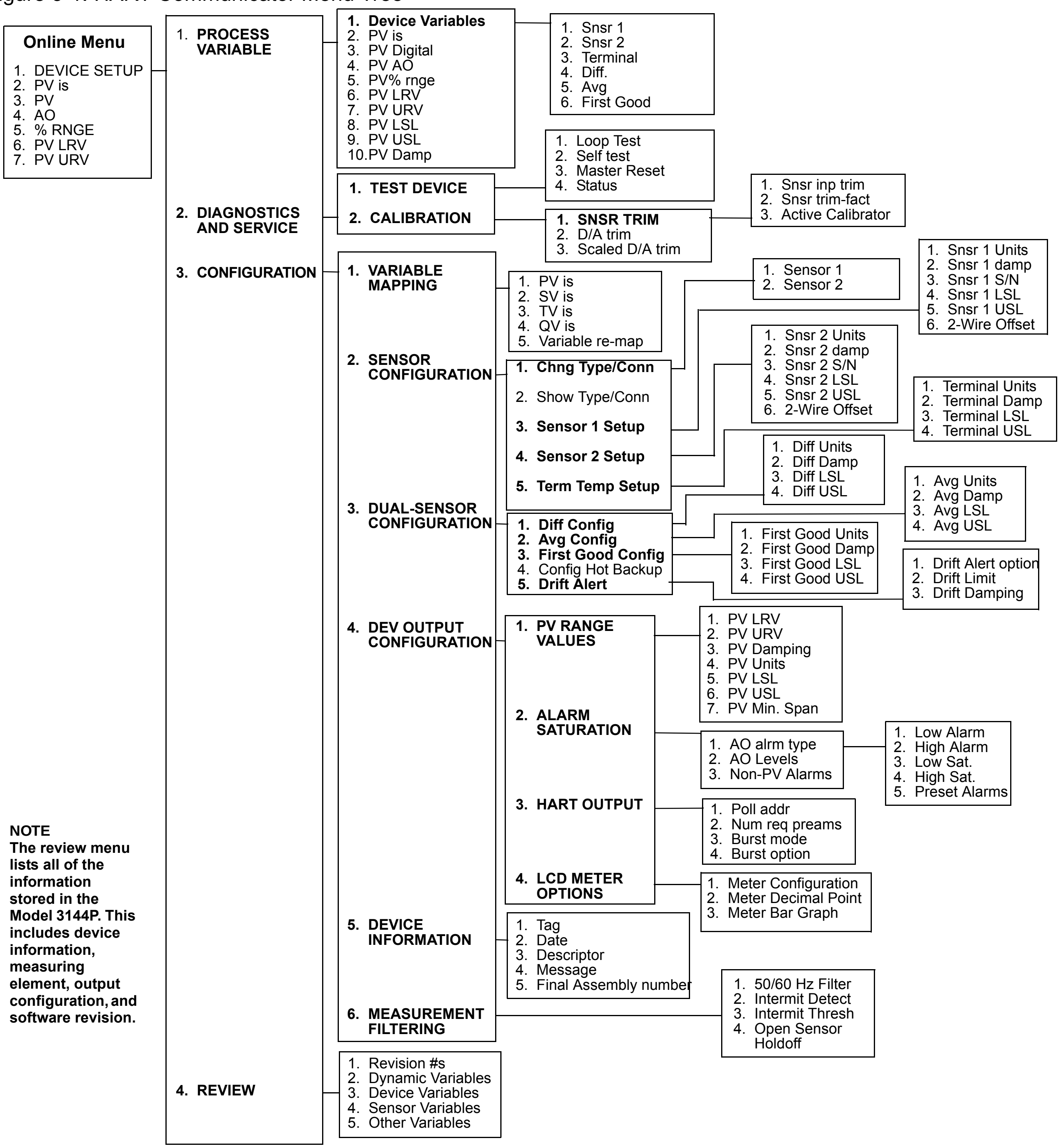
If **YES** is selected when the transmitter is already configured to utilize the new features of the improved transmitters (such as Dual Input configuration or one of the added sensor input types–DIN Type L or DIN Type U), the user will experience trouble communicating with the transmitter and will be prompted to turn the communicator off. To prevent this from happening, either upgrade the communicator to the latest DD or answer **NO** to the question above and default to the generic transmitter functionality.

To see a list of enhancements included in the improved transmitters, see “Model 3144P and Models 3144 / 3244MV Differences” on page 1-3.

Menu Tree

Figure 3-1 displays a complete Model 3144P menu tree for use with the Model 275 HART Communicator. Options listed in bold type indicate that a selection provides other options.

Figure 3-1. HART Communicator Menu Tree



Fast Key Sequences

Fast key sequences are listed below for common transmitter functions.

NOTE:
The fast key sequences assume that Device Descriptor Dev v3, DD v2 is being used. Table 3-1 provides alphabetical function lists for all Model 275 HART Communicator tasks as well as their corresponding fast key sequences.

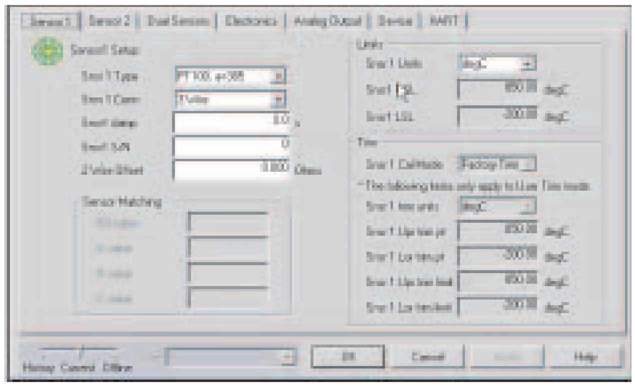
Table 3-1. Model 3144P Fast Key Sequence

Function	HART Fast Keys
Active Calibrator	1, 2, 2, 1, 3
Alarm Values	1, 3, 4, 2, 1
Analog Output	1, 1, 4
Average Temperature Setup	1, 3, 1, 5, 4
Average Temperature Configuration	1, 3, 3, 2
Burst Mode	1, 3, 4, 3, 3
Burst Option	1, 3, 4, 3, 4
Calibration	1, 2, 2
Configure *Hot Backup*	1, 3, 3, 4
Configuration	1, 3
D/A Trim	1, 2, 2, 2
Damping Values	1, 3, 4, 1, 3
Date	1, 3, 5, 2
Descriptor	1, 3, 5, 3
Device Information	1, 3, 5
Diagnostics and Service	1, 2
Differential Temperature Setup	1, 3, 1, 5, 3
Differential Temperature Configuration	1, 3, 3, 1
Drift Alert	1, 3, 3, 5
Filter 50/60 Hz	1, 3, 6, 1
First Good Temperature Setup	1, 3, 1, 5, 5
First Good Temperature Configuration	1, 3, 3, 3
Hardware Revision	1, 4, 1
Hart Output	1, 3, 4, 3
Intermittent Sensor Detect	1, 3, 6, 2
Intermittent Threshold	1, 3, 6, 3
Loop Test	1, 2, 1, 1
LRV (Lower Range Value)	1, 3, 4, 1, 1
LSL (Lower Sensor Limit)	1, 3, 4, 1, 5
Master Reset	1, 2, 1, 3
Message	1, 3, 5, 4
Meter Options	1, 3, 4, 4

Function	HART Fast Keys
Open Sensor Holdoff	1, 3, 6, 4
Percent Range	1, 1, 5
Poll Address	1, 3, 4, 3, 1
Process Temperature	1, 1
Process Variables	1, 1
Range Values	1, 3, 4, 1
Review	1, 4
Scaled D/A Trim	1, 2, 2, 3
Sensor 1 Configuration	1, 3, 2, 1, 1
Sensor 2 Configuration	1, 3, 2, 1, 2
Sensor Limits	1, 3, 2, 2
Sensor 1 Serial Number	1, 3, 2, 3, 3
Sensor 2 Serial Number	1, 3, 2, 4, 3
Sensor 1 Setup	1, 3, 2, 3
Sensor 2 Setup	1, 3, 2, 4
Sensor Trim	1, 2, 2, 1, 1
Sensor Type	1, 3, 2, 1
Sensor 1 Unit	1, 3, 2, 3, 1
Sensor 2 Unit	1, 3, 2, 4, 1
Software Revision	1, 4, 1
Status	1, 2, 1, 4
Tag	1, 3, 5, 1
Terminal Temperature Setup	1, 3, 2, 5
Test Device	1, 2, 1
Transmitter-Sensor Matching	1, 3, 2, 1, 1
URV (Upper Range Value)	1, 3, 4, 1, 2
USL (Upper Sensor Limit)	1, 3, 4, 1, 6
Variable Mapping	1, 3, 1
Wires	1, 3, 2, 1, 1
2-wire Offset Sensor 1	1, 3, 2, 3, 6
2-wire Offset Sensor 2	1, 3, 2, 4, 6

AMS

One of the key benefits of intelligent devices is the ease of device configuration. When used with AMS, the Model 3144P is easy to configure and provides instant and accurate alerts and alarms. The main configuration screen of the Model 3144P is the “Configuration Properties” screen. From this screen, the transmitter set-up can easily be viewed and edited.



The screens use a color-coding to give visual indication of the transmitter health and to indicate any changes that may need to be made or written to the transmitter.

- Gray screens: indicates that all information has been written to the transmitter
- Yellow on screen: changes have been made in the software but not sent to the transmitter
- Green on screen: all current changes on screen have been written to the transmitter
- Red on screen: indicates an alarm or alert that requires immediate investigation

Apply AMS Changes

Changes made in the software must be *sent* to the transmitter in order for the changes to take effect in the process.

1. From the bottom of the “Configuration Properties” screen, click **Apply**.
2. An “Apply Parameter Modification” screen appears, enter desired information and click **OK**.
3. After carefully reading the warning provided, select **OK**.

REVIEW CONFIGURATION DATA

Before operating the Model 3144P in an actual installation, review all of the factory-set configuration data to ensure that it reflects the current application.

Review

HART Fast Keys	1, 4

Review the transmitter configuration parameters set at the factory to ensure accuracy and compatibility with the particular application. After activating the *Review* function, scroll through the data list to check each variable. If changes to the transmitter configuration data are necessary, refer to “Configuration” below.

AMS
Right click on the device and select “Configuration Properties” from the menu. Select the tabs to review the transmitter configuration data.

CHECK OUTPUT

Before performing other transmitter online operations, review the configuration of the Model 3144P digital output parameters to ensure that the transmitter is operating properly.

Process Variables

HART Fast Keys	1, 1

The Model 3144P process variables provide the transmitter output. The PROCESS VARIABLE menu displays the process variables, including sensed temperature, percent range, and analog output. These process variables are continuously updated. The primary variable is 4–20 mA analog signal.

AMS
Right click on the device and select "Configuration Properties" from the menu. Select the Analog Output tab to review the transmitter Analog Output Range.

CONFIGURATION

The Model 3144P must be configured for certain basic variables to operate. In many cases, these variables are pre-configured at the factory. Configuration may be required if the configuration variables need revision.

Variable Mapping

HART Fast Keys	1, 3, 1

The Variable Mapping menu displays the sequence of the process variables. Select *5 Variable Re-Map* to change this configuration. With the Model 3144P single sensor input configuration, screens follow that allow selection of the primary variable (PV) and the secondary variable (SV). When the *Select PV* screen appears *Snsr 1* or *terminal temperature* must be selected.

With the Model 3144P dual-sensor option configuration, screens follow that allows selection of the primary variable (PV), secondary variable (SV), tertiary variable (TV), and quaternary variable (QV). Variable choices are *Sensor 1*, *Sensor 2*, *Differential Temperature*, *Average Temperature*, *First-Good Temperature*, T*erminal Temperature*, and *Not Used*. The primary variable is the 4–20 mA analog signal.

AMS
Right click on the device and select "Configuration Properties" from the menu. Select the Analog Output tab to review the Mapped Variable Output.

Apply changes made (see "Apply AMS Changes" on page 3-5).

Sensor Configuration

HART Fast Keys	1, 3, 2

Sensor configuration contains information for updating the sensor type, connections, units, and damping.

Change Type and Connections

HART Fast Keys	1, 3, 2, 1

The *Connections* command allows the user to select the sensor type and the number of sensor wires to be connected. Select from the following sensor types:

- 2-, 3-, or 4-wire Pt 100, Pt 200, Pt 500, Pt 1000 platinum RTDs (α = 0.00385 Ω/Ω/°C)
- 2-, 3-, or 4-wire Pt 100 (α = 0.003916 Ω/Ω/°C)
- 2-, 3-, or 4-wire Ni 120 nickel RTDs
- 2-, 3-, or 4-wire Cu 10 RTDs
- IEC/NIST/DIN Type B, E, J, K, R, S, T thermocouples
- DIN type L, U thermocouples
- ASTM Type W5Re/W26Re thermocouple
- –10 to 100 millivolts
- 2-, 3-, or 4-wire 0 to 2000 ohms

Contact a Emerson Process Management representative for information on the temperature sensors, thermowells, and accessory mounting hardware that is available through Emerson Process Management.

AMS
Right click on the device and select “Configuration.” Select “Sensor Connections,” then “Change type and connection.” The *wizard* will walk through the screens.

Output Units

HART Fast Keys	1, 3, 2, 3 or 4

The *Snsr 1 Unit* and *Snsr 2 Unit* commands set the desired primary variable units. Set the transmitter output to one of the following engineering units:

- Degrees Celsius
- Degrees Fahrenheit
- Degrees Rankine
- Kelvin
- Ohms
- Millivolts

AMS
Right click on the device and select “Configuration Properties” from the menu. Select the Sensor 1 (or Sensor 2) tab to configure the Sensor Ouput Units. Set the units to the desired output.

Apply changes made (see “Apply AMS Changes” on page 3-5).

Sensor 1 Serial Number

HART Fast Keys	1, 3, 2, 3, 3

The *Sensor 1 S/N* variable provides a location to list the serial number of the attached sensor. It is useful for identifying sensors and tracking sensor calibration information.

AMS
Right click on the device and select “Configuration Properties” from the menu. Select the Sensor 1 tab to configure the Sensor 1 Serial #.

Apply changes made (see “Apply AMS Changes” on page 3-5).

Sensor 2 Serial Number

HART Fast Keys	1, 3, 2, 4, 3

The *Sensor 2 S/N* variable provides a location to list the serial number of a second sensor.

AMS
Right click on the device and select “Configuration Properties” from the menu. Select the Sensor 2 tab to configure the Sensor 2 Serial #.

Apply changes made (see “Apply AMS Changes” on page 3-5).

2-Wire RTD Offset

HART Fast Keys	1, 3, 2, 3, 6

The *2-wire Offset* command allows the user to input the measured lead wire resistance, which will result in the transmitter adjusting its temperature measurement to correct the error caused by this resistance. Due to a lack of lead wire compensation within the RTD, temperature measurements made with a 2-wire RTD are often inaccurate.

To utilize this feature perform the following steps:

1. Measure the lead wire resistance of both RTD leads after installing the 2-wire RTD and the Model 3144P.
2. From the HOME screen, select 1 *Device Setup*, *3 Configuration*, *2 Sensor Configuration, 3 Sensor 1 Setup, 6 2-Wire Offset*.
3. Enter the total measured resistance of the two RTD leads at the *2-Wire Offset* prompt. Enter this resistance as a negative (–) value to ensure proper adjustment.The transmitter then adjusts its temperature measurement to correct the error caused by lead wire resistance.
4. Repeat Steps 1 through 3 for sensor 2, selecting 1 *Device Setup*, *3 Configuration*, *2 Sensor Configuration, 4 Sensor 2 Setup, 6 2-Wire Offset*.

AMS
Right click on the device and select “Configuration Properties” from the menu. Select the Sensor 1 (or Sensor 2) tab to configure the 2 Wire Offset.

Apply changes made (see “Apply AMS Changes” on page 3-5).

Terminal Temperature

HART Fast Keys	1, 3, 2, 5

The *Terminal Temp* command sets the terminal temperature units to indicate the temperature at the transmitter terminals.

AMS
Right click on the device and select "Configuration Properties" from the menu. Select the Electronics tab to configure the Terminal Temperature. In the Terminal Temperature box, Set the Termnl Units to the desired output.

Apply changes made (see "Apply AMS Changes" on page 3-5).

Dual-Sensor Configuration

HART Fast Keys	1, 3, 3

Dual-sensor configuration allows configuration of the functions that can be used with a dual-sensor configured transmitter. This includes Differential Temperature, Average Temperature, First Good Temperature, Hot Backup, and Sensor Drift Alert.

Differential Temperature

HART Fast Keys	1, 3, 1, 5, 3

The Model 3144P configured for a dual-sensor can accept any two inputs and display the differential temperature between them. Use the following procedure to configure the transmitter to measure differential temperature.

First, configure Sensor 1 and Sensor 2 appropriately. Select *1 Device Setup, 3 Configuration, 2 Sensor Configuration, 1 Change type/conn* to set the sensor type and number of wires for Sensor 1. Repeat for Sensor 2.

NOTE
This procedure reports the differential temperature as the primary variable analog signal. If this is not necessary, assign differential temperature to the secondary, tertiary, or quaternary variable.

1. From the HOME screen, select *1 Device Setup*, *3 Configuration, 1 Variable Mapping, 5 Variable Re-Map* to prepare to set the transmitter to display differential temperature. Set the control loop to manual and select **OK**.
2. Select *3 Diff* from the Primary Variable (PV) menu.
3. Select three of the five variables (average temperature, sensor 1, sensor 2, First-Good, and terminal temperature) for the Secondary Variable (SV), Tertiary Variable (TV), and Quaternary Variable (QV).

NOTE
The transmitter determines the differential temperature by subtracting Sensor 2 from Sensor 1 (S1 – S2). Ensure that this order of subtraction is consistent with the desired reading for the application. Refer to Figure 2-12 on page 2-16, or inside the transmitter terminal-side cover for sensor wiring diagrams.

4. Select **OK** after verifying the variable settings from the variable mapping menu.
5. Select OK to return the control loop to automatic control.
6. Select **HOME** to return to the Online menu.
7. Select *1 Device Setup, 3 Configuration, 3 Dual-sensor configuration, 1 Differential Config, 1 Differential Units* to set the desired differential units.
8. Select **HOME** to return to the Home screen.

If you are using a LCD meter for local indication, configure the meter to read the appropriate variables using the "LCD Meter Options" on page 3-17.

AMS

For AMS, configure each sensor as indicated above.

Right click on the device and select "Configuration Properties" from the menu. Select the Dual Sensor tab to configure the Differetial Temperature.In the Differential Temperature box, Set the Diff Units to the desired output. Set damping if applicable.

Apply changes made (see "Apply AMS Changes" on page 3-5).

Average Temperature

HART Fast Keys	1, 3, 1, 5, 4

The Model 3144P transmitter configured for dual-sensors can output and display the average temperature of any two inputs. Use the following procedure to configure the transmitter to measure the average temperature.

First, configure Sensor 1 and Sensor 2 appropriately. Select *1 Device Setup, 3 Configuration, 2 Sensor Configuration, 1 Change Type and Conn.* to set the sensor type and number of wires for Sensor 1. Repeat for Sensor 2.

NOTE
This procedure configures the average temperature as the primary variable analog signal. If this is not necessary, assign the average temperature to the secondary, tertiary, or quaternary variable.

1. From the Home screen, select *1 Device Setup, 3 Configuration, 1 Variable Mapping, 5 Variable Re-map* to set the transmitter to display the average temperature. Set the control loop to manual and select **OK**.
2. Select *4 Sensor Average* from the Primary Variable (PV) menu.
3. Select three of the five variables (differential temperature, sensor 1, sensor 2, First-Good, and terminal temperature) for the Secondary Variable (SV), Tertiary Variable (TV), and Quaternary Variable (QV).
4. Select **OK** after verifying the variable settings in variable mapping menu.
5. Select **OK** to return the control loop to automatic control.
6. Select **HOME** to return to the Online menu.
7. Select *1 Device Setup, 3 Configuration, 3 dual sensor configuration, 2 average, 1 avg units* to set the desired average temperature units.
8. Select **HOME** to return to the Home screen.

If using a LCD meter, configure it to read the appropriate variables using "LCD Meter Options" on page 3-17.

NOTE
If Sensor 1 and/or Sensor 2 should fail while PV is configured for average temperature and Hot Backup is ***not*** enabled, the transmitter will go into alarm. For this reason, when PV is Sensor Average it is recommended that Hot Backup be enabled when dual-element sensors are used or when two temperature measurements are taken from the same point in the process. If a sensor failure occures when Hot Backup is enabled while PV is Sensor Average, three scenarios could result:

- If Sensor 1 fails, the average will only be reading from Sensor 2, the working sensor.
- If Sensor 2 fails, the average will only be reading from Sensor 1, the working sensor.
- If both sensors fail simultaneously, the transmitter will go into alarm and the status available (via HART) states that both Sensor 1 and Sensor 2 have failed.

In the first two scenarios, where Hot Backup is enabled with PV set to Sensor Average, the 4-20 mA signal is not disrupted and the status available to the control system (via HART) specifes which sensor has failed.

AMS
For AMS, configure each sensor as indicated above.

Right click on the device and select "Configuration Properties" from the menu. Select the Dual Sensor tab to configure the Average Temperature.In the Average Temperature box, Set the Ave Units to the desired output. Set damping if applicable.

Apply changes made (see "Apply AMS Changes" on page 3-5).

First-Good Configuration

HART Fast Keys	1, 3, 1, 5, 5

The *First Good* device variable is useful for applications in which dual-sensors (or a single dual element sensor) are used in a single process. The first good variable will report the Sensor 1 value, unless Sensor 1 fails. When Sensor 1 fails, the Sensor 2 value will be reported as the first good variable. Once the first good variable has switched to Sensor 2, it will not revert back to Sensor 1 until a master reset occurs or "Suspend Non-PV alarms" is disabled. When the PV is mapped to first good and either Sensor 1 or Sensor 2 fails, the analog output will go to the alarm level, but the digital PV value read through the HART interface will still report the proper first good sensor value.

If it is desired that the transmitter not go into analog output alarm while having the PV mapped to first good and Sensor 1 fails, enable "Suspend Non-PV Alarm" mode. This combination will prevent the analog ouput from going to the alarm level unless BOTH sensors fail.

AMS
For AMS, configure each sensor as indicated above.

Right click on the device and select “Configuration Properties” from the menu. Select the Dual Sensor tab to configure the 1st Good. In the 1st Good box, set the 1st Good Units to the desired output. Set damping if applicable.

Apply changes made (see “Apply AMS Changes” on page 3-5).

Hot Backup Configuration

HART Fast Keys	1, 3, 3, 4

The *Config Hot BU* command configures the transmitter to automatically use Sensor 2 as the primary sensor if Sensor 1 fails. With Hot Backup enabled, the primary variable (PV) must either be First Good or Sensor Average (see “Average Temperature” on page 3-10 for details on using Hot Backup when PV is Sensor Average). You can map Sensors 1 or 2 as the secondary variable (SV), tertiary variable (TV), or quaternary variable (QV). In the event of a primary variable (Sensor 1) failure, the transmitter enters Hot Backup mode and Sensor 2 becomes the PV. The 4–20 mA signal is not disrupted and a status is available to the control system (via HART) that Sensor 1 has failed. An LCD meter, if attached, also displays the failed sensor status.

While configured to Hot Backup, if Sensor 2 fails while Sensor 1 is still operating properly, the transmitter continues to report the PV 4–20 mA analog output signal while a status is available to the control system (via HART) that Sensor 2 has failed. In Hot Backup mode, the transmitter will not revert back to Sensor 1 to control the 4–20 mA analog output until the Hot Backup mode is reset. Reset Hot Backup either by re-enabling via HART or by briefly powering down the transmitter.

To set up and enable the Hot Backup feature for the Model 3144P transmitter, perform the following procedure:

1. Attach any two sensors to the transmitter as shown in Figure 2-12 on page 2-16.
2. From the Home screen, select *1 Device Setup, 3 Configuration, 1 Variable Mapping, 5 Variable Re-map* to set primary, secondary, tertiary, and quaternary variables. The communicator displays the PV, SV, TV, and QV menus in succession.
3. Set PV as First Good or Sensor Average; set secondary, tertiary, and quaternary variables as desired.
4. Select **OK** after verifying the variable settings from the Variable Mapping menu.
5. Select **OK** to return the control loop to automatic control. Select **HOME** to return to the Home screen.
6. From the Home screen, select *1 Device Setup, 3 Configuration, 2 Sensor Configuration, 1 Change Type and Conn, 3 Sensor 1 Setup* to configure Sensor 1.
7. Set the sensor type, number of wires, damping, and units for Sensor 1.
8. Select **SEND** to download the new data to the transmitter. Select **HOME** to return to the Home screen.
9. Repeat Steps 5, 6, and 7 for Sensor 2 using *4 Sensor 2 Setup*.

10. From the Home screen, select *1 Device Setup, 3 Configuration, 3 Dual Sensor Configuration, 4 Configure Hot Backup* to prepare to configure the transmitter for Hot Backup.
11. Select yes to enable *Hot Backup.*
12. Select **OK** after you set the control loop to manual.
13. Select *1 Average* or *2 First Good* to set Hot Backup PV.
14. Select **OK** after you return the control loop to automatic control.

For information on using Hot Backup in conjunction with the HART Tri-Loop see "Use with the HART Tri-Loop" on page 3-24.

AMS
For AMS, configure each sensor as indicated above.

Right click on the device and select "Configuration." Select "Configure Hot Backup." The *wizard* will walk through the screens.

Drift Alert Configuration

HART Fast Keys	1, 3, 3, 5

The *Drift Alert* command allows the user to configure the transmitter to set a warning flag (via HART) or go into analog alarm when the temperature difference between Sensor 1 and Sensor 2 exceeds a user-defined limit. This feature is useful when measuring the same process temperature with two sensors, ideally when using a dual-element sensor. When Drift Alert mode is enabled, the user will set the maximum allowable difference, in engineering units, between Sensor 1 and Sensor 2. If this maximum difference is exceeded, a drift alert warning flag will be set.

When configuring the transmitter for Drift Alert the user also has the option of specifying that the analog output of the transmitter go into alarm when sensor drifting is detected.

NOTE
The Drift Alert alarm cannot be enabled while Hot Backup is enabled. The Drift Alert warning, however, can be used simultaneously with Hot Backup. For information on configuring the transmitter for Hot Backup see page 3-12.

To set up and enable the Drift Alert feature of the Model 3144P, perform the following procedure:

1. Attach any two sensors to the transmitter as shown in Figure 2-12 on page 2-16.
2. From the Home screen, select *1 Device Setup, 3 Configuration, 1 Variable Mapping, 5 Variable Re-map* to set primary, secondary, tertiary, and quaternary variables. The communicator displays the PV, SV, TV, and QV menus in succession.
3. Select primary, secondary, tertiary, and quaternary variables as desired.
4. Select **OK** after verifying the variable settings from the Variable Mapping menu.

5. Select **OK** to return the control loop to automatic control. Select **HOME** to return to the Home screen.
6. From the Home screen, select *1 Device Setup, 3 Configuration, 2 Sensor Configuration, 1 Change Type and Conn, 3 Sensor 1 Setup* to configure Sensor 1.
7. Set the sensor type, number of wires, damping, and units for Sensor 1.
8. Select **SEND** to download the new data to the transmitter. Select **HOME** to return to the Home screen.
9. Repeat steps 6 – 8 for Sensor 2 using *4 Sensor 2 setup*.
10. From the Home screen select *1 Device Setup, 3 Configuration, 3 Dual-Sensor Configuration, 5 Drift Alert* to prepare to configure the transmitter for Drift Alert.
11. Select *2 Drift Limit*. Enter the maximum acceptable difference between Sensor 1 and Sensor 2.
12. Select *3 Drift Damping* to enter a drift alert damping value. This value must be between 0 and 32 seconds.
13. Select *1 Drift Alert Option* and select *Enable Alarm* or *Warning* only.
14. Select **SEND** to download the alarm setting to the transmitters.

NOTE
Enabling Drift Alert Option Warning only (Step 13) will set a flag (via HART) whenever the maximum acceptable difference between Sensor 1 and Sensor 2 has been exceeded. If it is desired for the the transmitter’s analog signal to go into alarm when Drift Alert is detected, select **Alarm** in Step 13. The Drift Alert alarm cannot be enabled when Hot Backup is enabled; The Drift Alert alarm can only be enabled if Hot Backup is disabled.

AMS
For AMS, configure each sensor as indicated above.

Right click on the device and select “Configuration Properties” from the menu. Select the Dual Sensor tab to configure the Senosr Drift Alert. In the Drift Alert box, enable the Drift Alert Option. Enter the DrftLm limit and define the Drift Limit Units. Set damping if applicable.

Apply changes made (see “Apply AMS Changes” on page 3-5).

DEVICE OUTPUT CONFIGURATION

Device output configuration contains PV range values, alarm and saturation, HART output, and LCD meter options.

PV Range Values

HART Fast Keys	1, 3, 4, 1

The *PV URV* and *PV LRV* commands, found in the *PV Range Values* menu screen, allow the user to set the transmitter’s lower and upper range values using limits of expected readings. See Table A-2 on page A-5 for unit and range setting limits. The range of expected readings is defined by the Lower Range Value (LRV) and Upper Range Value (URV). The transmitter range values may be reset as often as necessary to reflect changing process conditions. From the *PV Range Values* screen select *1 PV LRV* to change the lower range value and *2 PV URV* to change the upper range value.

Reranging the transmitter sets the measurement range to the limits of the expected readings. Setting the measurement range to these limits maximizes transmitter performance; the transmitter is most accurate when operated within the expected temperature range for the application.

The rerange functions should not be confused with the trim function. Although reranging the transmitter matches a sensor input to a 4-20 mA output, as in conventional calibration, it does not affect the transmitter's interpretation of the input.

AMS

Right click on the device and select "Configuration Properties" from the menu. Select the Analog Output tab to define the upper and lower range values. From the Analog Input Range box, enter the URV and LRV.

Apply changes made (see "Apply AMS Changes" on page 3-5).

Process Variable Damping

HART Fast Keys	1, 3, 4, 1, 3

The *PV Damp* command changes the response time of the transmitter to smooth variations in output readings caused by rapid changes in input. Determine the appropriate damping setting based on the necessary response time, signal stability, and other requirements of the loop dynamics of the system. The default damping value is 5.0 seconds and can be reset to any value between 0 and 32 seconds.

The value chosen for damping affects the response time of the transmitter. When set to zero (i.e., disabled), the damping function is off and the transmitter output reacts to changes in input as quickly as the intermittent sensor algorithm allows. Increasing the damping value increases transmitter response time.

When damping is enabled, the transmitter will output a value at time (t) according to the following equation:

$$Output_{(t)} = Input_{(ts)} - De^{(-t/damping)}$$

D = input step change at time t = 0

At the time to which the damping time constant is set, the transmitter output is at 63 percent of the input change; it continues to approach the input according to the damping equation above.

For example, as illustrated in Figure 3-2, if the temperature undergoes a step change—from 100 degrees to 110 degrees, and the damping is set to 5.0 seconds, at 5.0 seconds, the transmitter outputs 106.3 degrees, or 63 percent of the input change, and the output continues to approach the input curve according to the equation above..

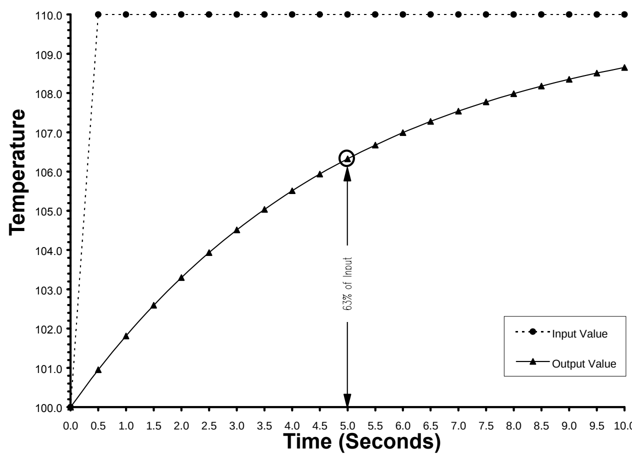


Figure 3-2. Change in Input versus Change in Output with Damping Enabled.

AMS

Right click on the device and select “Configuration Properties” from the menu. If Sensor 1 is mapped as your primary variable, select the Sensor 1 tab.

- Snr1 damp

Apply changes made (see “Apply AMS Changes” on page 3-5).

Alarm and Saturation

HART Fast Keys	1, 3, 4, 2

The *Alarm/Saturation* command allows the user to view the alarm settings (Hi or Low). With this command it is also possible to change the alarm and saturation values. To change the alarm values and saturation values, select the value to be changed, either *1 Low Alarm*, *2 High Alarm*, *3 Low Sat.*, *4 High Sat,* or *5 Preset Alarms*. Enter the desired new value. It must fall within the guidelines given below.

- The low alarm value must be between 3.50 and 3.75 mA
- The high alarm value must be between 21.0 and 23.0 mA

The low saturation level must be between the low alarm value plus 0.1 mA and 3.9 mA.

Example: The low alarm value has been set to 3.7 mA. Therefore, the low saturation level, S, must be as follows:
$3.8 \leq S \leq 3.9$ mA.

The high saturation level must be between 20.5 mA and the high alarm value minus 0.1 mA.

Example: The high alarm value has been set to 20.8 mA. Therefore, the low saturation level, S, must be as follows:
$20.5 \leq S \leq 20.7$ mA.

Preset alarms can either be *1 Rosemount* or *2 NAMUR-compliant*. Use the failure mode switch on the front side of the electronics (see “Switch Location” on page A-7) to set whether the output will be driven to high or low alarm in the case of failure.

AMS

For AMS, configure each sensor as indicated above.

Right click on the device and select "Configuration Properties" from the menu. Select the Analog Ouput tab to define the alarm and saturation levels. From the Alarm box, enter the low and high alarm and the low and high saturation.

Apply changes made (see "Apply AMS Changes" on page 3-5).

To preset to Rosemount standard or NAMUR NE43 comliant levels:

Right-click on the device and select "Configuration." Select "Alarm Configuration" then select "Alarm Configuration" then "Preset alarm levels." The *wizard* will walk through the configuration.

HART Output

HART Fast Keys	1, 3, 4, 3

The *HART Output* command allows the user to make changes to the multidrop address, initiate burst mode, or make changes to the burst options.

AMS

Right click on the device and select "Configuration Properties" from the menu. Select the HART tab to configure for mulidrop and Burst Mode.

Apply changes made (see "Apply AMS Changes" on page 3-5).

LCD Meter Options

HART Fast Keys	1, 3, 4, 4

The *LCD Meter Option* command sets the meter options, including engineering units and decimal point. Change the LCD meter settings to reflect necessary configuration parameters when adding a LCD meter or reconfiguring the transmitter. Transmitters without LCD meters are shipped with the meter configuration set to "Not Used."

To customize variables that the LCD meter displays, follow the steps below:

1. From the home screen select *1 Device Setup*, *3 Configuration*, *4 Dev Output Config*, *4 LCD Meter Options*, and *1 Meter Config*.
2. Select the appropriate variable configuration from the Meter Configuration screen.
3. Press F4, **ENTER**, and then F2, **SEND**, to send the information to the transmitter. The LCD meter will scroll through the outputs selected in step 2.

To change the decimal point configuration, perform the following steps:

1. From the home screen select *1 Device Setup*, *3 Configuration*, *4 Dev Output Config*, *4 LCD Meter Options*, and *2 Meter Decimal Pt*.
2. Choose from *Floating Precision* or *One-*, *Two-*, *Three-*, or *Four-Digit Precision* by pressing F4, **ENTER**. Press F2 to send the information to the transmitter.

To change the meter bar graph, perform the following steps:

1. From the home screen, select *1 Device Setup*, *3 Configuration, 4 Dev Output Configuration, 4 LCD Meter options, 3 Meter bar graph.*

2. Choose from Bar Graph offer, *Bar graph on* by pressing F4, Enter. Press F2 to send the information to the transmitter.

AMS
Right click on the device and select "Configuration Properties" from the menu. Select the Device tab to configure the LCD. From the LCD Meter box, define the Meter Config, Meter Decimal Pt, and Meter Bar Graph.

Apply changes made (see "Apply AMS Changes" on page 3-5).

DEVICE INFORMATION

Access the transmitter information variables online using the HART Communicator or other suitable communications device. The following is a list of transmitter information variables. These variables include device identifiers, factory-set configuration variables, and other information. A description of each variable, the corresponding fast key sequence, and a review of its purposes are provided.

Tag

HART Fast Keys	1, 3, 5, 1

The *Tag* variable is the easiest way to identify and distinguish between transmitters in multi-transmitter environments. Use it to label transmitters electronically according to the requirements of the application. The defined tag is automatically displayed when a HART-based communicator establishes contact with the transmitter at power-up. The tag may be up to eight characters long and has no impact on the primary variable readings of the transmitter.

Date

HART Fast Keys	1, 3, 5, 2

The *Date* command is a user-defined variable that provides a place to save the date of the last revision of configuration information. It has no impact on the operation of the transmitter or the HART-based communicator.

Descriptor

HART Fast Keys	1, 3, 5, 3

The *Descriptor* variable provides a longer user-defined electronic label to assist with more specific transmitter identification than is available with the tag variable. The descriptor may be up to 16 characters long and has no impact on the operation of the transmitter or the HART-based communicator.

Message

HART Fast Keys	1, 3, 5, 4

The *Message* variable provides the most specific user-defined means for identifying individual transmitters in multi-transmitter environments. It allows for 32 characters of information and is stored with the other configuration data. The message variable has no impact on the operation of the transmitter or the HART-based communicator.

AMS
Right click on the device and select "Configuration Properties" from the menu. Select the Device tab to enter alpahnumeric device information.

Apply changes made (see "Apply AMS Changes" on page 3-5).

MEASUREMENT FILTERING

50/60 Hz Filter

HART Fast Keys	1, 3, 6, 1

The *50/60 Hz Filter* command sets the transmitter electronic filter to reject the frequency of the ac power supply in the plant. The 60 Hz normal, 50 Hz normal, 60 Hz fast, and 50 Hz fast modes can be chosen (normal mode is the default mode). On software release 5.3.4, the fast mode cannot be enabled. If fast mode is selected it will display the normal mode.

NOTE
In high noise environments, normal mode is recommended.

Master Reset

HART Fast Keys	1, 2, 1, 3

Master Reset resets the electronics without actually powering down the unit. It does not return the transmitter to the original factory configuration.

AMS
Right click on the device and select “Diagnostics and Calibration” from the menu. Choose “test,” then “Master Reset.”

The *wizard* will perform the reset

Intermittent Sensor Detect

HART Fast Keys	1, 3, 6, 2

The following steps indicate how to turn the Intermittent Sensor Detect feature **ON** or **OFF**. When the transmitter is connected to a Model 275 HART Communicator, use the fast key sequence and choose **ON** or **OFF** (**ON** is the normal setting).

AMS
Right click on the device and select “Configuration Properties” from the menu. Select the Electronics tab. From the Measurement Filtering Box, configure the Intermit detect.

The *wizard* will perform the reset

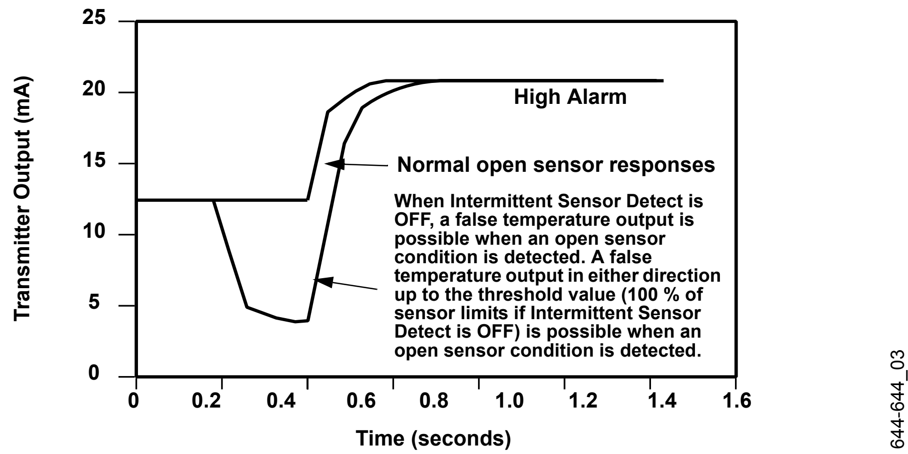
Apply changes made (see “Apply AMS Changes” on page 3-5).

Intermittent Threshold

HART Fast Keys	1, 3, 6, 3

The threshold value can be changed from the default value of 0.2%. Turning the Intermittent Sensor Detect feature **OFF** or leaving it **ON** and increasing the threshold value above the default does not affect the time needed for the transmitter to output the correct alarm signal after detecting a true open sensor condition. However, the transmitter may briefly output a false temperature reading for up to one update in either direction (see Figure 3-4 on page 3-23) up to the threshold value (100% of sensor limits if Intermittent Sensor Detect is **OFF)**. Unless rapid response rate is necessary, the suggested setting of the Intermittent Sensor Detect mechanism is **ON** with 0.2% threshold.

Figure 3-3. Open Sensor Response



Intermittent Sensor Detect (Advanced Feature)

The Intermittent Sensor Detect feature is designed to guard against process temperature readings caused by intermittent open sensor conditions (an *intermittent* sensor condition is an open sensor condition that lasts less than one update). By default, the transmitter is shipped with the Intermittent Sensor Detect feature switched **ON** and the threshold value set at 0.2% of sensor limits. The Intermittent Sensor Detect feature can be switched **ON** or **OFF** and the threshold value can be changed to any value between 0 and 100% of the sensor limits with a HART communicator.

Transmitter Behavior with Intermittent Sensor Detect ON

When the Intermittent Sensor Detect feature is switched **ON**, the transmitter can eliminate the output pulse caused by intermittent open sensor conditions. Process temperature changes (ΔT) within the threshold value will be tracked normally by the transmitter's output. A ΔT greater than the threshold value will activate the intermittent sensor algorithm. True open sensor conditions will cause the transmitter to go into alarm.

The threshold value of the Model 3144P should be set at a level that allows the normal range of process temperature fluctuations; too high and the algorithm will not be able to filter out intermittent conditions; too low and the algorithm will be activated unnecessarily. The default threshold value is 0.2% of the sensor limits.

Transmitter Behavior with Intermittent Sensor Detect OFF

When the Intermittent Sensor Detect feature is switched **OFF**, the transmitter tracks all process temperature changes, even if they are the consequence of an intermittent sensor. (The transmitter in effect behaves as though the threshold value had been set at 100%.) The output delay due to the intermittent sensor algorithm will be eliminated.

AMS
Right click on the device and select "Configuration Properties" from the menu. Select the Electronics tab. From the Measurement Filtering Box, configure the Intermit threshold.

Apply changes made (see "Apply AMS Changes" on page 3-5).

Open Sensor Holdoff

HART Fast Keys	1, 3, 6, 4

The *Open Sensor Holdoff* option, at the normal setting, enables the Model 3144P to be more robust under heavy EMI conditions. This is accomplished through the software by having the transmitter perform additional verification of the open sensor status prior to activating the transmitter alarm. If the additional verification shows that the open sensor condition is not valid, the transmitter will not go into alarm.

For users of the Model 3144P that desire a more vigorous open sensor detection, the Open Sensor Holdoff option can be changed to a fast setting. With this setting, the transmitter will report an open sensor condition without additional verification of the open condition.

AMS
Right click on the device and select “Configuration Properties” from the menu. Select the Electronics tab. From the Measurement Filtering Box box, configure the Open Snsr Holdoff.

Apply changes made (see “Apply AMS Changes” on page 3-5).

DIAGNOSTICS AND SERVICE

Test Device

HART Fast Keys	1, 2, 1

The *Test Device* command initiates a more extensive diagnostics routine than that performed continuously by the transmitter. The *Test Device* menu lists the following options:

- *1 Loop test* verifies the output of the transmitter, the integrity of the loop, and the operations of any recorders or similar devices installed in the loop. The ability to simulate an alarm is also available. See “Loop Test” below for more information.
- *2 Self Test* initiates a transmitter self test. Error codes are displayed if there is a problem.
- *3 Master Reset* sends out a command that restarts and tests the transmitter. A master reset is like briefly powering down the transmitter. Configuration data remains unchanged after a master reset.
- *4 Status* lists error codes. **ON** indicates a problem, and **OFF** means there are no problems.

AMS
Right click and select “Diagnostics and Calibration.” Choose “Test” and select “loop test,” “self test,” or “master reset.” Right-click on device and choose “status” to view errors.

Loop Test

HART Fast Keys	1, 2, 1, 1

The Loop Test command verifies the output of the transmitter, the integrity of the loop, and the operations of any recorders or similar devices installed in the loop. To initiate a loop test, perform the following procedure:

1. Connect an external ampere meter to the transmitter. To do so, shunt the power to the transmitter through the meter at some point in the loop.
2. From the **HOME** screen, select *1 Device Setup*, *2 Diag/Serv*, *1 Test Device*, *1 Loop Test* before performing a loop test. Select **OK** after you set the control loop to manual. The communicator displays the loop test menu.
3. Select a discreet milliampere level for the transmitter to output. At the **CHOOSE ANALOG OUTPUT** prompt, select *1 4mA*, *2 20mA*, or select *4 Other* to manually input a value between 4 and 20 milliamperes. Select **Enter**. It will indicate the fixed output. Select **OK**.
4. Check the installed transmitter in the test loop to verify that it reads the value that it was commanded to output. If the readings do not match, either the transmitter requires an output trim or the current meter is malfunctioning.

After completing the test procedure, the display returns to the loop test screen and allows the user to choose another output value. To end the Loop Test, Select *5 End* and **Enter**. The Test device screen will appear.

The transmitter can simulate alarm conditions based on the transmitter's current hardware and software alarm configurations.

To initiate Simulation Alarm, perform the following procedure:

1. From the Home screen, select *1 Device Setup, 2 Diag/Serv, 1 Test Device, 1 Loop Test, 3 Simulate Alarm*.
2. Based on the choosen alarm conditions, the transmitter will display an alarm.
3. To return the transmitter to normal conditions, select *5 End*.

AMS

Right click and select "Diagnostics and Calibration." Choose "Test" and select "Loop Test." The *loop test wizard* will walk through the process to fix the output for either sensor 1 or 2.

The trasmitter must be returned to normal conditions (turn off loop test) before placing back in process

Right click and select "Diagnostics and Calibration." Choose "Test" and select "Loop Test." The *loop test wizard* will walk through the process to fix the analog output. From the *loop test wizard* screen choose "END." A message will apppear indicating that it is OK to return to normal.

MULTIDROP COMMUNICATION

Multidropping refers to the connection of several transmitters to a single communications transmission line. Communication between the host and the transmitters takes place digitally with the analog output of the transmitters deactivated. Many of the Rosemount SMART FAMILY® transmitters can be multidropped. With the HART communications protocol, up to 15 transmitters can be connected on a single twisted pair of wires or over leased phone lines.

The application of a multidrop installation requires consideration of the update rate necessary from each transmitter, the combination of transmitter models, and the length of the transmission line. Each transmitter is identified by a unique address (1–15) and responds to the commands defined in the HART protocol.

Figure 3-4. Typical Multidropped Network

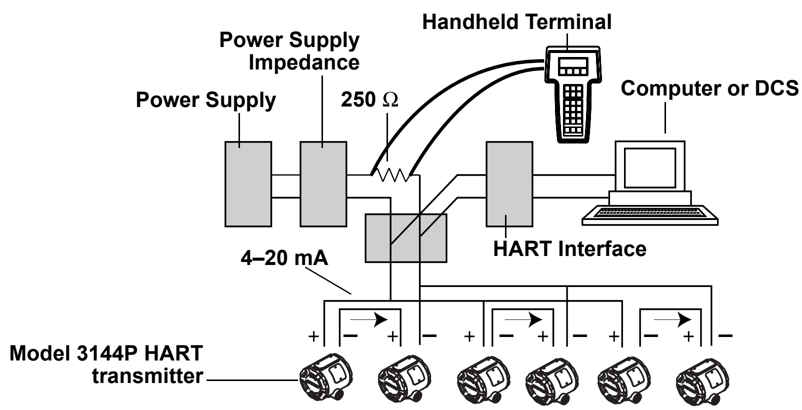


Figure 3-4 shows a typical multidrop network. Do not use this figure as an installation diagram. Contact Emerson Process Management product support with specific requirements for multidrop applications.

A HART-based communicator can test, configure, and format a multidropped Model 3144P transmitter the same as in a standard point-to-point installation.

NOTE
The Model 3144P is set to address 0 at the factory, allowing it to operate in the standard point-to-point manner with a 4–20 mA output signal. To activate multidrop communication, the transmitter address must be changed to a number between 1 and 15. This change deactivates the 4–20 mA analog output, sending it to 4 mA. The failure mode current also is disabled.

AMS
Right click and select “Configuration Properties” from the menu screen. Select the “HART” tab. From here, assign the polling address.

USE WITH THE HART TRI-LOOP

To prepare the Model 3144P transmitter with dual-sensor option for use with a Model 333 HART Tri-Loop, you must configure the transmitter to Burst Mode and set the process variable output order. In Burst Mode, the transmitter provides digital information for the four process variables to the HART Tri-Loop. The HART Tri-Loop divides the signal into separate 4–20 mA loops for up to three of the following choices:

- primary variable (PV)
- secondary variable (SV)
- tertiary variable (TV)
- quaternary variable (QV)

When using the Model 3144P transmitter with dual-sensor option in conjunction with the HART Tri-Loop, consider the configuration of the differential, average, first good temperatures, Sensor Drift Alert, and Hot Backup features (if applicable).

NOTE
These procedures assume that the sensors and the transmitter are connected, powered, and functioning properly, and that a Model 275 HART Communicator is connected to the transmitter control loop and is communicating successfully. For communicator usage instructions, see “Commissioning” on page 2-2.

Set the Transmitter to Burst Mode

To set the transmitter to burst mode, follow the steps below.

1. From the Home screen, select *1 Device setup*, *3 Configuration*, *4 Device output configuration*, *3 HART output*, *4 Burst option* to prepare to set the transmitter to burst command 3. The communicator displays the Burst option screen.
2. Select *Process vars/current*. The communicator returns to the HART output screen.
3. Select *3 Burst mode* to prepare to enable Burst Mode. The communicator displays the Burst Mode screen.
4. Select **On** to enable Burst Mode. The communicator returns to the HART output screen.
5. Select **Send** to download the new configuration information to the transmitter.

Set Process Variable Output Order

To set the process variable output order, follow the steps below.

1. From the Home screen, select *1 Device setup*, *3 Configuration*, *1 Variable Mapping*, *5 Variable Remapping*. Select **OK** to set the control loop to manual. The communicator displays the Primary Variable screen.
2. Select the item to be set as the primary variable at the **Select PV** prompt.
3. Repeat step 2 for the SV, TV, and QV. The communicator displays the Variable mapping screen.
4. Select **OK** to accept the order to which the variables are mapped, or **Abort** to abort the entire procedure.

NOTE
Take careful note of the process variable output order. You must configure the HART Tri-Loop to read the variables in the same order.

5. Select **OK** to return the control loop to automatic control.

AMS
Right click and select "Configuration" from the menu screen. Select "Set Variable Mapping" . The "*Set Variable Mapping wizard*" will go through the mapping procedure.

Special Considerations

To initiate operation between a Model 3144P transmitter with dual-sensor option and the HART Tri-Loop, consider the configuration of both the differential, average, first good temperatures, Sensor Drift Alert, and Hot Backup features (if applicable).

Differential Temperature Measurement

To enable the differential temperature measurement feature of a dual-sensor Model 3144P operating in conjunction with the HART Tri-Loop, adjust the range end points of the corresponding channel on the HART Tri-Loop to include zero. For example, if the secondary variable of the transmitter is to report the differential temperature, configure the transmitter accordingly (see "Set Process Variable Output Order" on page 3-24) and adjust the corresponding channel of the HART Tri-Loop so one range end point is negative and the other is positive.

Hot Backup

To enable the Hot Backup feature of a Model 3144P transmitter with dual-sensor option operating in conjunction with the HART Tri-Loop, ensure that the output units of the sensors are the same as the units of the HART Tri-Loop. Use any combination of RTDs or thermocouples as long as the units of both match the units of the HART Tri-Loop.

Using the Tri-Loop to Detect Sensor Drift Alert

The dual-sensor Model 3144P transmitter sets a failure flag (via HART) whenever a sensor failure occurs. If an analog warning is required, the HART Tri-Loop can be configured to produce an analog signal that can be interpreted by the control system as a sensor failure.

Use these steps to set up the HART Tri-Loop to transmit sensor failure alerts.

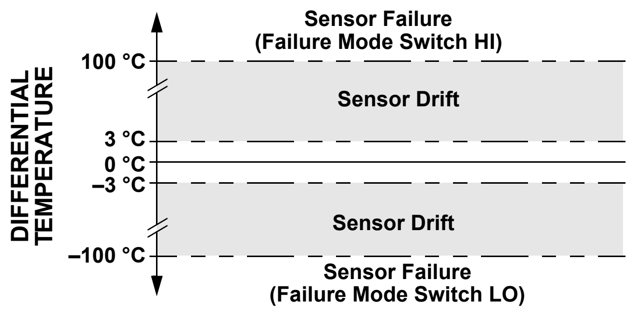
1. Configure the dual-sensor Model 3144P variable map as shown .

Variable	Mapping
PV	Sensor 1 or Sensor Average
SV	Sensor 2
TV	Differential Temperature
QV	As Desired

2. Configure Channel 1 of the HART Tri-Loop as TV (differential temperature). If either sensor should fail, the differential temperature output will be +9999 or –9999 (high or low saturation), depending on the position of the Failure Mode Switch (see "Failure Mode and Security Switch Locations" on page 2-5).

3. Select temperature units for Channel 1 that match the differential temperature units of the transmitter.
4. Specify a range for the TV such as –100 to 100 °C. If the range is large, then a sensor drift of a few degrees will represent only a small percent of range. If Sensor 1 or Sensor 2 fails, the TV will be +9999 (high saturation) or –9999 (low saturation). In this example, zero is the midpoint of the TV range. If a ΔT of zero is set as the lower range limit (4 mA), then the output could saturate low if the reading from Sensor 2 exceeds the reading from Sensor 1. By placing zero in the middle of the range, the output will normally stay near 12 mA, and the problem will be avoided.
5. Configure the DCS so that TV < –100 °C or TV > 100 °C indicates a sensor failure and, for example, TV ≤–3 °C or TV ≥ 3 °C indicates a drift alert. See Figure 3-5.

Figure 3-5. Tracking Sensor Drift and Sensor Failure with Differential Temperature



Section 4 Operation and Maintenance

SAFETY MESSAGES

Instructions and procedures in this section may require special precautions to ensure the safety of the personnel performing the operations. Information that raises potential safety issues is indicated by a warning symbol (⚠). Please refer to the following safety messages before performing an operation preceded by this symbol.

Warning

⚠WARNING

Explosions may result in death or serious injury.

- Do not remove the instrument cover in explosive atmospheres when the circuit is live.
- Before connecting a HART communicator in an explosive atmosphere, make sure the instruments in the loop are installed in accordance with intrinsically safe or non-incendive field wiring practices.
- Both transmitter covers must be fully engaged to meet explosion-proof requirements.

Electrical shock could cause death or serious injury. If the sensor is installed in a high-voltage environment and a fault or installation error occurs, high voltage may be present on transmitter leads and terminals.

- Use extreme caution when making contact with the leads and terminals.

Failure to follow these installation guidelines could result in death or serious injury:

- Make sure only qualified personnel perform the installation.

Process leaks could result in death or serious injury:

- Install and tighten thermowells or sensors before applying pressure, or process leakage may result.
- Do not remove the thermowell while in operation. Removing while in operation may cause process fluid leaks.

CALIBRATION

Calibrating the transmitter increases the precision of your measurement system. The user may use one or more of a number of trim functions when calibrating. To understand the trim functions, it is necessary to understand that smart transmitters operate differently from analog transmitters. An important difference is that smart transmitters are factory-characterized; they are shipped with a standard sensor curve stored in the transmitter firmware. In operation, the transmitter uses this information to produce a process variable output, dependent on the sensor input. The trim functions allow the user to make adjustments to the factory-stored characterization curve by digitally altering the transmitter's interpretation of the sensor input.

Calibration of the Model 3144P may include the following procedures:

- Sensor Input Trim: digitally alter the transmitter's interpretation of the input signal
- Transmitter Sensor Matching: generates a special custom curve to match that specific sensor curve, as derived from the Callendar-Van Dusen constants
- Output Trim: calibrates the transmitter to a 4–20 mA reference scale
- Scaled Output Trim: calibrates the transmitter to a user-selectable reference scale.

Trim the Transmitter

The trim functions should not be confused with the rerange functions. Although the rerange command matches a sensor input to a 4–20 mA output—as in conventional calibration—it does not affect the transmitter's interpretation of the input.

One or more of the trim functions may be used when calibrating. The trim functions are as follows

- Sensor Input Trim
- Transmitter Sensor Matching
- Output Trim
- Output Scaled Trim

Sensor Input Trim

HART Fast Keys	1, 2, 2, 1, 1

The *Sensor Trim* command allows the user to digitally alter the transmitter's interpretation of the input signal as shown in Figure 4-1 on page 4-3. The sensor trim command trims, in engineering (°F, °C, °R, K) or raw (Ω, mV) units, the combined sensor and transmitter system to a site standard using a known temperature source. Sensor trim is suitable for validation procedures or for applications that require profiling the sensor and transmitter together.

Perform a sensor trim if the transmitters digital value for the primary variable does not match the plant's standard calibration equipment. The sensor trim function calibrates the sensor to the transmitter in temperature units or raw units. Unless the site-standard input source is NIST-traceable, the trim functions will not maintain the NIST-traceability of your system

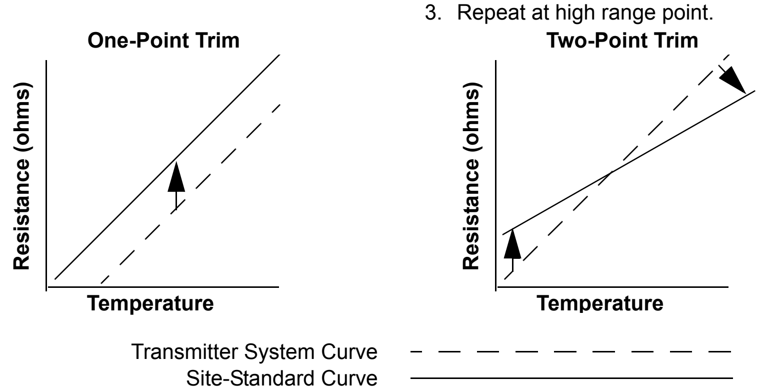
Figure 4-1. Trim

Application: Linear Offset
Solution: Single-Point Trim
Method:

1. Connect sensor to transmitter. Place sensor in bath between range points.
2. Enter known bath temperature using the Model 275 HART Communicator.

Application: Linear Offset and Slope Correction
Solution: Two-Point Trim
Method:

1. Connect sensor to transmitter. Place sensor in bath at low range point.
2. Enter known bath temperature using the Model 275 HART Communicator.
3. Repeat at high range point.



To perform a sensor trim, use the following procedure:

Single Sensor Trim

1. Connect the sensor or calibrator device to the transmitter.
2. Connect the communicator to the transmitter loop.
3. From the Home screen, select *1 Device Setup*, *2 Diag/Service*, *2 Calibration*, *1 Sensor Trim*, *1 Sensor Inp Trim* to prepare to trim the sensor. Select *1 Sensor 1.*
4. Select Sensor 1.

NOTE
A warning will appear reminding the user to Set the Control Loop to Manual” (see “Setting the Loop to Manual” on page 2-2.)

5. The communicator will ask “Are you using an active calibrator?”
   a. Select “No” if a sensor is connected to the transmitter
   b. Select “Yes” if using a calibration device. By selecting yes, the transmitter will be put into active calibration mode (see “Active Calibrator and EMF Compensation” on page 4-5). This is critical if the calibrator requires constant sensor current for calibration. If using a calibration device that can accept pulsed current, select “No.
6. Select the appropriate sensor trim units at the **ENTER SNSR 1 TRIM UNITS** prompt.
7. Select *1 Lower Only, 2 Upper Only* or *3 Lower and Upper* at the **SELECT SENSOR TRIM POINTS** prompt.
8. Adjust the calibration device to the desired trim value (must be within the selected sensor limits). If trimming a combined sensor and transmitter system, expose the sensor to a known temperature and allow the temperature reading to stabilize. Use a bath, furnace or isothermal block, measured with a site-standard thermometer, as the known temperature source.

9. Select **OK** once the temperature stabilizes.
10. Enter the lower or upper trim point, depending on your selection in Step 7.

The trim functions should not be confused with the rerange functions. Although the rerange command matches a sensor input to a 4–20 mA output—as in conventional calibration—it does not affect the transmitter's interpretation of the input.

Dual Sensor Trim

1. Connect the sensor or calibrator device to the transmitter.
   a. When using sensors, connect the two sensors or a dual element sensor
   b. When using a calibrator, connect the device to both sensor inputs.
2. Connect the communicator to the transmitter loop.
3. From the Home screen, select *1 Device Setup*, *2 Diag/Service*, *2 Calibration*, *1 Sensor Trim*, *1 Sensor Inp Trim* to prepare to trim the sensor. Select *1 Sensor 1.*
4. The Communicator will prompt the user to select either Sensor 1 or 2. The sensors can be trimmed in either order, but it is recommended to trim Sensor 1 first.

NOTE
A warning will appear reminding the user to Set the Control Loop to Manual" (see "Setting the Loop to Manual" on page 2-2.)

---

5. The communicator will ask "Are you using an active calibrator?"
   a. Select "No" if a sensor is connected to the transmitter
   b. Select "Yes" if using a calibration device. By selecting yes, the transmitter will be put into active calibration mode (see "Active Calibrator and EMF Compensation" on page 4-5). This is critical if the calibrator requires constant sensor current for calibration. If using a calibration device that can accept pulsed current, select "No.
6. Select the appropriate sensor trim units at the **ENTER SNSR 1 TRIM UNITS** prompt.
7. Select *1 Lower Only, 2 Upper Only* or *3 Lower and Upper* at the **SELECT SENSOR TRIM POINTS** prompt.
8. Adjust the calibration device to the desired trim value (must be within the selected sensor limits). If trimming a combined sensor and transmitter system, expose the sensor to a known temperature and allow the temperature reading to stabilize. Use a bath, furnace or isothermal block, measured with a site-standard thermometer, as the known temperature source.
9. Select **OK** once the temperature stabilizes.
10. Enter the lower or upper trim point, depending on your selection in Step 7.

To trim the second sensor, repeat the same procedure only in Step 4, select the sensor not yet calibrated (usually Sensor 2)

AMS

For AMS, configure each sensor as indicated above.

Right click on the device and select “Diagnostics and Calibration” from the menu. Select “Calibrate,” then “Sensor Trim,” then “Sensor Input Trim.”

The *wizard* will continue through the process.

The transmitter may be restored to the factory default by selecting: “Diagnostics and Calibration,” “Sensor Trim,” “Revert to Factory Trim.”

The *wizard* will recall the factory trim for a given sensor

Apply changes made (see “AMS” on page 3-5).

Active Calibrator and EMF Compensation

HART Fast Keys	1, 2, 2, 1, 3

The transmitter operates with a pulsating sensor current to allow EMF compensation and detection of open sensor conditions. Because some calibration equipment requires a steady sensor current to function properly, the “Active Calibrator Mode” feature should be used when an Active Calibrator, which requires a constant sensor current, is connected. Enabling this mode will temporarily set the transmitter to provide steady sensor current unless two sensor inputs are configured. Disable this mode before putting the transmitter back into the process. Disabling this mode will set the transmitter back to pulsating current. “Active Calibrator Mode” is volatile and will automatically be disabled when a Master Reset is performed (via HART) or when power is cycled.

EMF compensation allows the transmitter to provide sensor measurements that are not affected by unwanted voltages, which are typically due to thermal EMFs in the equipment connected to the transmitter or by some types of calibration equipment. If this equipment also requires steady sensor current, the transmitter must be set to “Active Calibrator Mode.” However, the steady current does not allow the transmitter to perform EMF compensation. As a result, a difference in readings between the Active Calibrator and actual sensor may exist.

If a reading difference is experienced and the difference is greater than the plant’s accuracy specification allows, perform a sensor trim with “Active Calibrator Mode” disabled. In this case, an active calibrator capable of tolerating pulsating sensor current must be used or the actual sensors must be connected to the transmitter. When the Model 275 HART Communicator or AMS asks if an Active Calibrator is being used when the sensor trim routine is entered, select **No**. This will leave the “Active Calibrator Mode” disabled.

Contact a Emerson Process Management representative for more information.

Transmitter-Sensor Matching

HART Fast Keys	1, 3, 2, 1, 1

The Model 3144P accepts Callendar-Van Dusen constants from a calibrated RTD schedule and generates a special custom curve to match that specific sensor Resistance vs. Temperature performance. Matching the specific sensor curve with the transmitter significantly enhances the temperature measurement accuracy. See the comparison below:

System Accuracy Comparison at 150 °C Using a PT 100 (α=0.00385) RTD with a Span of 0 to 200 °C			
Standard RTD		Matched RTD	
Model 3144P	±0.10 °C	Model 3144P	±0.10 °C
Standard RTD	±1.05 °C	Matched RTD	±0.18 °C
Total System(1)	±1.05 °C	Total System(1)	±0.21 °C

(1) Calculated using root-summed-squared (RSS) statistical method

$$TotalSystemAccuracy = \sqrt{(TransmitterAccuracy)^2 + (SensorAccuracy)^2}$$

The following input constants, included with specially-ordered Rosemount temperature sensors, are required:

R_0 = Resistance at Ice Point
Alpha = Sensor Specific Constant
Beta = Sensor Specific Constant
Delta = Sensor Specific Constant
Other sensor may have “A,B, or C” values for constants.

To input Callendar-Van Dusen constants, perform the following procedure:

1. From the **HOME** screen, select *1 Device Setup*, *3 Configuration*, *2 Sensor Config*, *1 Change Type/Conn., 1 Sensor 1*. Select **OK** after you set the control loop to manual.
2. Select *Cal VanDusen* at the **ENTER SENSOR TYPE** prompt.
3. Select the appropriate number of wires at the **ENTER SENSOR CONNECTION** prompt.
4. Enter the R_o, Alpha, Beta, and Delta values from the stainless steel tag attached to the special-order sensor when prompted.
5. Select **OK** after you return the control loop to automatic control.

To disable the transmitter-sensor matching feature from the **HOME** screen select *1 Device Setup*, *3 Configuration*, *2 Sensor Confi*g, *1 Change Type/Conn*. Choose the appropriate sensor type from the **ENTER SENSOR TYPE** prompt.

When using two sensors, repeat Steps 1 – 5 for the second sensor. In Step 1, select *Sensor 2* instead of *Sensor 1*.

NOTE
When you disable transmitter-sensor matching, the transmitter reverts to factory trim input. Make certain the transmitter engineering units default correctly before placing the transmitter into service.

Callendar Van-Dusen constants can be viewed anytime by making the following selections:

From the Home screen select *1 Device Setup*, *3 Configuration*, *2 Sensor Confi*g, *2 Show Type/Conn*.

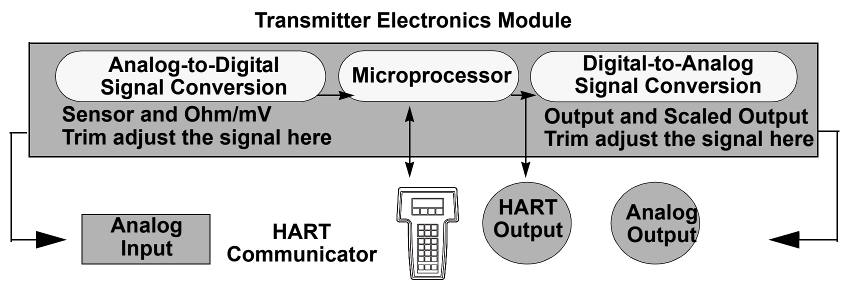
AMS
Right click on the device and select “Configuration” from the menu. Select the “Sensor connections.” Change the Type and Connection.

The *wizard* will go through the required changes. In the field, select “Cal VanDusen to enter the sensor type.

D/A Output Trim or Scaled Output Trim

Perform an D/A output trim (scaled output trim) if the digital value for the primary variable matches the plant standard but the transmitter's analog output does not match the digital value on the output device, such as the ampmeter. The output trim function calibrates the transmitter analog output to a 4–20 mA reference scale; the scaled output trim function calibrates to a user-selectable reference scale. To determine the need for an output trim or a scaled output trim, perform a loop test (see "Loop Test" on page 3-22).

Figure 4-2. Dynamics of Smart Temperature Measurement



Output Trim

HART Fast Keys	1, 2, 2, 2

The *D/A Trim* command allows the user to alter the transmitter's conversion of the input signal to a 4–20 mA output (see Figure 4-2 on page 4-7). Calibrate the analog output signal at regular intervals to maintain measurement precision. To perform a digital-to-analog trim, perform the following procedure:

1. From the **HOME** screen, select *1 Device setup*, *2 Diag/Service*, *2 Calibration*, *2 D/A trim*. Set the control loop to manual and select **OK**.
2. Connect an accurate reference meter to the transmitter at the **CONNECT REFERENCE METER** prompt. To do so, shunt the power to the transmitter through the reference meter at some point in the loop. Select **OK** after connecting the reference meter.
3. Select **OK** at the **SETTING FLD DEV OUTPUT TO 4 MA** prompt. The transmitter outputs 4.00 mA.
4. Record the actual value from the reference meter, and enter it at the **ENTER METER VALUE** prompt. The communicator prompts the user to verify if the output value equals the value on the reference meter.
5. If the reference meter value equals the transmitter output value, then select *1 Yes* and go to step 6. If the reference meter value does not equal the transmitter output value, then select *2 No* and go to step 4.
6. Select **OK** at the **SETTING FLD DEV OUTPUT TO 20 MA** prompt and repeat steps 4 and 5 until the reference meter value equals the transmitter output value.
7. Return the control loop to automatic control and select **OK**.

AMS
Right click on the device and select "Diagnostics and Calibration" from the menu. Select the "Calibrate" and choose the "D/A Trim."

This *wizard* will go through the required changes.

Scaled Output Trim

HART Fast Keys	1, 2, 2, 3

The *Scaled D/A Trim* command matches the 4 and 20 mA points to a user-selectable reference scale other than 4 and 20 mA (2–10 volts, for example). To perform a scaled D/A trim, connect an accurate reference meter to the transmitter and trim the output signal to scale as outlined in the "Output Trim" procedure.

AMS
Right click on the device and select "Diagnostics and Calibration" from the menu. Select the "Calibrate" and choose the "Scaled D/A Trim."

This *wizard* will go through the required changes.

HARDWARE

Diagnostics with HART Communicator

If a malfunction is suspected despite the absence of a diagnostics message on the HART communicator display, follow the procedures described in Table 4-1 to verify that transmitter hardware and process connections are in good working order. Under each of four major symptoms, specific suggestions are offered for solving problems. Always deal with the most likely and easiest-to-check conditions first.

Table 4-1. Troubleshooting.

SYMPTON	POTENTIAL SOURCE	CORRECTIVE ACTION
Transmitter Does Not Communicate with HART Communicator	Loop Wiring	• Check the revision level of the transmitter device descriptors (DDs) stored in your communicator. The communicator should report Dev v3, DD v2 (improved), or Dev v2, DD v1 (previous). Contact Emerson Process Management Customer Central for assistance. • Check for a minimum of 250 ohms resistance between the power supply and HART communicator connection. • Check for adequate voltage to the transmitter. If a HART communicator is connected and 250 ohms resistance is properly in the loop, then the transmitter requires a minimum of 12.0 V at the terminals to operate (over entire 3.90 to 20.5 mA operating range), and 17.5 V minimum to communicate digitally. • Check for intermittent shorts, open circuits, and multiple grounds.
High Output	Sensor Input Failure or Connection	• Connect a HART communicator and enter the transmitter test mode to isolate a sensor failure. • Check for a sensor open circuit. • Check if the process variable is out of range.
	Loop Wiring	• Check for dirty or defective terminals, interconnecting pins, or receptacles.
	Power Supply	• Check the output voltage of the power supply at the transmitter terminals. It should be 12.0 to 42.4 V dc (over entire 3.90 to 20.5 mA operating range).
	Electronics Module	• Connect a HART communicator and enter the transmitter test mode to isolate module failure. • Connect a HART communicator and check the sensor limits to ensure calibration adjustments are within the sensor range.
Erratic Output	Loop wiring	• Check for adequate voltage to the transmitter. It should be 12.0 to 42.4 V dc at the transmitter terminals (over entire 3.90 to 20.5 mA operating range). • Check for intermittent shorts, open circuits, and multiple grounds. • Connect a HART communicator and enter the loop test mode to generate signals of 4 mA, 20 mA, and user-selected values.
	Electronics Module	• Connect a HART communicator and enter the transmitter test mode to isolate module failure.

SYMPTON	POTENTIAL SOURCE	CORRECTIVE ACTION
Low Output or No Output	Sensor Element	• Connect a HART communicator and enter the transmitter test mode to isolate a sensor failure. • Check if the process variable is out of range.
	Loop Wiring	• Check for adequate voltage to the transmitter. It should be 12.0 to 42.4 V dc (over entire 3.90 to 20.5 mA operating range). • Check for shorts and multiple grounds. • Check for proper polarity at the signal terminal. • Check the loop impedance. • Connect a HART communicator and enter the loop test mode. • Check wire insulation to detect possible shorts to ground.
	Electronics Module	• Connect a HART communicator and check the sensor limits to ensure calibration adjustments are within the sensor range. • Connect a HART communicator and enter the transmitter test mode to isolate an electronics module failure.

Diagnostics with AMS

If a malfunction is suspected despite the absence of a diagnostics message, follow the procedures described in Table 4-2 to verify that transmitter hardware and process connections are in good working order. Under each of four major symptoms, specific suggestions are offered for solving problems. Always deal with the most likely and easiest-to-check conditions first.

Table 4-2. Troubleshooting.

SYMPTON	POTENTIAL SOURCE	CORRECTIVE ACTION
Transmitter Does Not Communicate with AMS Software	Loop Wiring	• Check the revision level of the transmitter device descriptors (DDs) stored in your software. The communicator should report Dev v3, DD v2 (improved), or Dev v2, DD v1 (previous). Contact Emerson Process Management Customer Central for assistance. • Check for a minimum of 250 ohms resistance between the power supply and AMS software. • Check for adequate voltage to the transmitter. If the AMS software is connected and 250 ohms resistance is properly in the loop, then the transmitter requires a minimum of 12.0 V at the terminals to operate (over entire 3.90 to 20.5 mA operating range), and 17.5 V minimum to communicate digitally. • Check for intermittent shorts, open circuits, and multiple grounds.

SYMPTON	POTENTIAL SOURCE	CORRECTIVE ACTION
High Output	Sensor Input Failure or Connection	• Using AMS, set the transmitter test mode to isolate a sensor failure. • Check for a sensor open circuit. • Check if the process variable is out of range.
	Loop Wiring	• Check for dirty or defective terminals, interconnecting pins, or receptacles.
	Power Supply	• Check the output voltage of the power supply at the transmitter terminals. It should be 12.0 to 42.4 V dc (over entire 3.90 to 20.5 mA operating range).
	Electronics Module	• Using AMS, set the transmitter test mode to isolate module failure. • Using AMS, check the sensor limits to ensure calibration adjustments are within the sensor range.
Erratic Output	Loop wiring	• Check for adequate voltage to the transmitter. It should be 12.0 to 42.4 V dc at the transmitter terminals (over entire 3.90 to 20.5 mA operating range). • Check for intermittent shorts, open circuits, and multiple grounds. • Using AMS, set the loop test mode to generate signals of 4 mA, 20 mA, and user-selected values.
	Electronics Module	• Using AMS, set the transmitter test mode to isolate module failure.
Low Output or No Output	Sensor Element	• Using AMS, set the transmitter test mode to isolate a sensor failure. • Check if the process variable is out of range.
	Loop Wiring	• Check for adequate voltage to the transmitter. It should be 12.0 to 42.4 V dc (over entire 3.90 to 20.5 mA operating range). • Check for shorts and multiple grounds. • Check for proper polarity at the signal terminal. • Check the loop impedance. • Set the loop test mode. • Check wire insulation to detect possible shorts to ground.
	Electronics Module	• Using AMS, check the sensor limits to ensure calibration adjustments are within the sensor range. • Using AMS, set the transmitter test mode to isolate an electronics module failure.

Maintenance

The Model 3144P transmitter has no moving parts and require a minimum amount of scheduled maintenance. The transmitter features a modular design for easy maintenance. If a malfunction is suspected, check for an external cause before performing the diagnostics as discussed in this section.

Test Terminal

The test terminal, marked as TEST or (“T”) on the terminal block, and the negative (-) terminal accept MINIGRABBER™, or alligator clips, and facilitate in-process checks (see Figure 2-8 on page 2-10). The test and the negative terminals are connected across a diode through which the loop signal current passes. The current measuring equipment shunts the diode when connected across the test (T) and negative (-) terminals; so as long as the voltage across the terminals is kept below the diode threshold voltage, no current passes through the diode. To ensure that there is no leakage current through the diode while making a test reading, or while an indicating meter is connected, the resistance of the test connection or meter should not exceed 10 ohms. A resistance value of 30 ohms will cause an error of approximately 1.0 percent of reading.

Sensor Checkout

⚠ If the sensor is installed in a high-voltage environment and a fault condition or installation error occurs, the sensor leads and transmitter terminals could carry lethal voltages. Use extreme caution when making contact with the leads and terminals.

To determine whether the sensor is at fault, either replace it with another sensor or connect a test sensor locally at the transmitter to test remote sensor wiring. Transmitters with Option Code C7 (Trim to Special Sensor), are matched to a specific sensor. Select any standard, off-the-shelf sensor for use with the transmitter, or consult the factory for a replacement special sensor/transmitter combination.

Disassembling the Electronics Housing

The transmitter is designed with a dual-compartment housing; one compartment contains the electronics module, and the other compartment contains all wiring terminals and the communication receptacles.

Removing the Electronics Module

The Model 3144P electronics module is located in the compartment opposite the wiring terminals.

Use the following procedure to remove the electronics module.

NOTE
The electronics are sealed in a moisture-proof plastic enclosure referred to as the electronics module. The module is a non-repairable unit; The entire unit must be replaced if a malfunction occurs.

---

1. Disconnect the power to the transmitter.
2. Remove the cover from the electronics side of the transmitter housing (see “ Transmitter Exploded View” on page A-7). Do not remove the covers in explosive atmospheres when the circuit is live. Remove the LCD meter, if applicable.
3. Loosen the two screws that anchor the electronics module assembly to the transmitter housing.
4. Firmly grasp the screws and assembly and pull it straight out of the housing, taking care not to damage the interconnecting pins.

NOTE
Note the transmitter’s security switch position (ON or OFF) and the failure mode switch position (LO or HI). If you are replacing the electronics module with a new one, make sure the security and alarm switch is set in the same position.

Transmitter Security and Failure Mode Switches

The transmitter security and failure mode switches are located on the front of the electronics module, as shown in “Switch Location” on page A-7. See “Mounting and Installation” on page 2-6 for more information.

ASSEMBLING THE ELECTRONICS HOUSING

Replacing the Electronics Module

Use the following procedure to reassemble the electronics housing for the Model 3144P transmitter:

1. Examine the electronics module to ensure that the failure mode and transmitter security switches are in the desired positions.
2. Carefully insert the electronics module to mate the interconnecting pins with the necessary receptacles on the electronics board.
3. Tighten the two mounting screws. Replace the LCD meter, if applicable.
4. Replace the cover. Tighten 1/6 of a revolution after the cover begins to compress the O-ring. Both transmitter covers must be fully engaged to meet explosion proof requirements.

LCD Meter Diagnostic Messages

The LCD meter displays abbreviated diagnostic messages for troubleshooting the transmitter. To accommodate two-word messages, the display alternates between the first and second word. Some diagnostic messages have a higher priority than others, so messages appear according to their priority, with normal operating messages appearing last. The meter displays messages simultaneously on the *Process Variable* and *Process Variable Unit* lines as shown in “LCD Meter Faceplate” on page A-7. Messages on the *Process Variable* line refer to general device conditions, while messages on the *Process Variable Unit* line refer to specific causes for these conditions. A description of each diagnostic message follows.

[BLANK]

If the meter does not appear to function, make sure the transmitter is configured for the meter option you desire. The meter will not function if the LCD Meter option is set to Not Used.

FAIL -or- HDWR FAIL

This message indicates one of several conditions including:

- The transmitter has experienced an electronics module failure.
- The transmitter self-test has failed.

If diagnostics indicate a failure of the electronics module, replace the electronics module with a new one. Contact the nearest Emerson Process Management Field Service Center if necessary.

SNSR 1 FAIL -or- SNSR 2 FAIL

The transmitter has detected an open or shorted sensor condition. The sensor(s) might be disconnected, connected improperly, or malfunctioning. Check the sensor connections and sensor continuity.

SNSR 1 SAT -or- SNSR 2 SAT

The temperature sensed by the transmitter exceeds the sensor limits for this particular sensor type.

HOUSG SAT

The transmitter operating temperature limits (–40 to 185 °F (40 to 85 °C)) have been exceeded.

LOOP FIXED

During a loop test or a 4–20 mA output trim, the analog output defaults to a fixed value. The *Process Variable* line of the display alternates between the amount of current selected in milliamperes and “WARN.” The *Process Variable Unit* line toggles between “LOOP,” “FIXED,” and the amount of current selected in milliamperes.

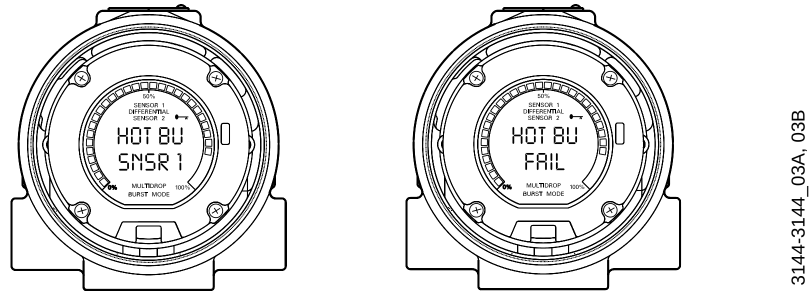
OFLOW

The location of the decimal point, as configured in the meter setup, is not compatible with the value to be displayed by the meter. For example, if the meter is measuring a process temperature greater than 9.9999 degrees, and the meter decimal point is set to 4 digit precision, the meter will display an “OFLOW” message because it is only capable of displaying a maximum value of 9.9999 when set to 4 digit precision.

HOT BU

Hot Backup is enabled and Sensor 1 has failed. This message is displayed on the *Process Variable* line and is always accompanied by a more descriptive message on the *Process Variable Unit* line. In the case of a Sensor 1 failure with Hot Backup enabled, for example, the *Process Variable* line displays “HOT BU,” and the *Process Variable Unit* line alternates between “SNSR 1” and “FAIL.”

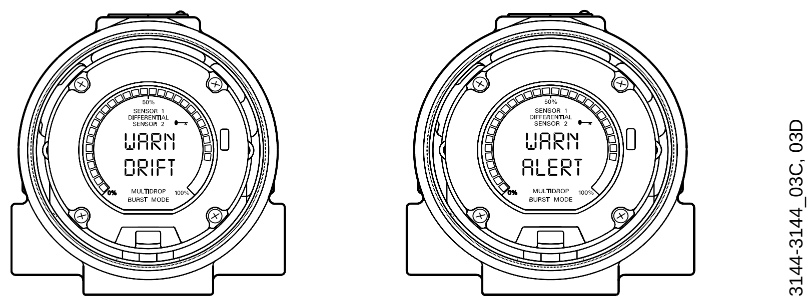
Figure 4-3. Hot Backup Display.



WARN DRIFT ALERT

Drift Alert warning is enabled and the difference between Sensor 1 and Sensor 2 has exceeded the user-specified limit. One of the sensors may be malfunctioning. The *Process Variable* line displays “WARN” and the *Process Variable Unit* line alternates between “DRIFT” and “ALERT.”

Figure 4-4. Sensor Drift Alert Display.



ALARM DRIFT ALERT

The analog output is in alarm. Drift Alert alarm is enabled and the difference between Sensor 1 and Sensor 2 has exceeded the user-specified limit. The transmitter is still operating, but one of the sensors may be malfunctioning. The *Process Variable* line displays “ALARM” and the *Process Variable Unit* line alternates between “DRIFT” and “ALERT.”

ALARM

The digital and analog outputs are in alarm. Possible causes of this condition include, but are not limited to, an electronics failure or an open sensor. This message is displayed on the *Process Variable* line and is always accompanied by a more descriptive message on the *Process Variable Unit* line. In the case of a Sensor 1 failure, for example, the *Process Variable* line displays “ALARM,” and the *Process Variable Unit* line alternates between “SNSR 1” and “FAIL.”

WARN

The transmitter is still operating, but something is not correct. Possible causes of this condition include, but are not limited to, an out-of-range sensor, a fixed loop, or an open sensor condition. In the case of a Sensor 2 failure with Hot Backup enabled, the *Process Variable* line displays “WARN,” and the *Process Variable Unit* line alternates between “SNSR 2” and “RANGE.”

AMS Screens Diagnostic Messages

AMS provides advanced diagnostic messages, as well as help screens for the messages. Using the help screens can provide quick reference to remedying the situation. The trouble shooting section for this manual can also be pasted in AMS to assist in quick and accurate troubleshooting reference.

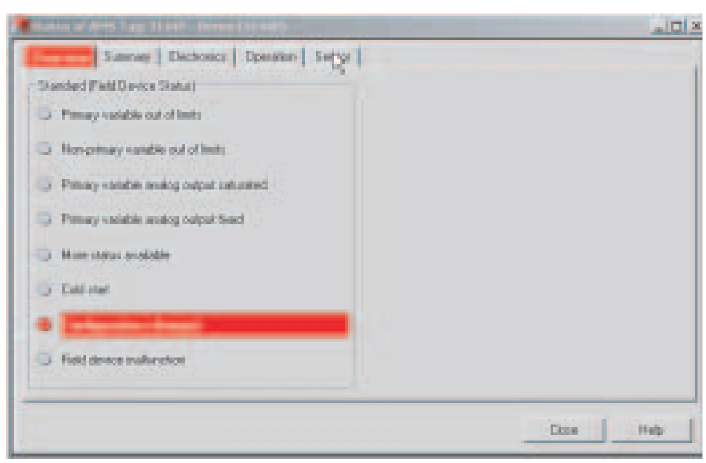
Alarms and Alerts

Right click on the device and select “Process Variables”. This screen shows the sensor reading and status of the sensor and transmitters. If no alarms or alerts are activated, the screen will look like this:

Sensor Failure

When the transmitter has detected an open or shorted sensor condition, the sensor(s) might be disconnected, connected improperly, or malfunctioning. Check the Sensor connections and continuity. Replace the sensor if necessary.

By right-clicking on the device and selecting “status,: the status screen appears. This screen shows an overview of the transmitter health. Red bars indicate system changes or that the transmitter is not working properly and should be investigated.



Hot BackUp®

Hot Backup is enabled and Sensor 1 or Sensor 2 has failed. The following is displayed on the Process Variable Screen. The suspect sensor should be investigated as soon as possible, and replaced as necessary.

Sensor Drift Alert

When the Drift Alert warning or alarm is enable, they indicate that the differences between Sensor 1 and Sensor 2 has exceeded the user-specified limit. One of the sensors may be malfunctioning. The sensors should both be investigated at the earliest opportunity.

MODEL 275 HART COMMUNICATOR

Diagnostic Messages

The following is a list of messages used by the Model 275 HART Communicator and their corresponding descriptions.

Variable parameters within the text of a message are indicated with <*variable parameter*>.

Reference to the name of another message is identified by [*another message*].

Message	Description
Add item for ALL device types or only for this ONE device type	Asks the user whether the hot key item being added should be added for all device types or only for the type of device that is connected.
Command not implemented	The connected device does not support this function.
Communication error	Either a device sends back a response indicating that the message it received was unintelligible, or the HART Communicator cannot understand the response from the device.
Configuration memory not compatible with connected device	The configuration stored in memory is incompatible with the device to which a transfer has been requested.
Device busy	The connected device is busy performing another task.
Device disconnected	Device fails to respond to a command.
Device write protected	Device is in write-protect mode. Data can not be written.
Device write protected. Do you still want to shut off?	Device is in write-protect mode. Press YES to turn the HART Communicator off and lose the unsent data.
Display value of variable on hot key menu?	Asks whether the value of the variable should be displayed adjacent to its label on the hot key menu if the item being added to the hot key menu is a variable.
Download data from configuration memory to device	Prompts user to press SEND softkey to initiate a memory to device transfer.
Exceed field width	Indicates that the field width for the current arithmetic variable exceeds the device-specified description edit format.
Exceed precision	Indicates that the precision for the current arithmetic variable exceeds the device-specified description edit format.
Ignore next 50 occurrences of status?	Asked after displaying device status. Softkey answer determines whether next 50 occurrences of device status will be ignored or displayed.
Illegal character	An invalid character for the variable type was entered.
Illegal date	The day portion of the date is invalid.
Illegal month	The month portion of the date is invalid.
Illegal year	The year portion of the date is invalid.
Incomplete exponent	The exponent of a scientific notation floating point variable is incomplete.
Incomplete field	The value entered is not complete for the variable type.
Looking for a device	Polling for multidropped devices at addresses 1–15.
Mark as read only variable on hotkey menu?	Asks whether the user should be allowed to edit the variable from the hotkey menu if the item being added to the hotkey menu is a variable.
No device configuration in configuration memory	There is no configuration saved in memory available to re-configure off-line or transfer to a device.
No device found	Poll of address zero fails to find a device, or poll of all addresses fails to find a device if auto-poll is enabled.
No hotkey menu available for this device.	There is no menu named “hotkey” defined in the device description for this device.
No offline devices available	There are no device descriptions available to be used to configure a device offline.
No simulation devices available	There are no device descriptions available to simulate a device.
No UPLOAD_VARIABLES in ddl for this device	There is no menu named “upload_variables” defined in the device description for this device. This menu is required for offline configuration.
No valid items	The selected menu or edit display contains no valid items.
OFF KEY DISABLED	Appears when the user attempts to turn the HART Communicator off before sending modified data or before completing a method.

Message	Description
Online device disconnected with unsent data. RETRY or OK to lose data	There is unsent data for a previously connected device. Press RETRY to send data, or press OK to disconnect and lose unsent data.
Out of memory for hotkey configuration. Delete unnecessary items.	There is no more memory available to store additional hotkey items. Unnecessary items should be deleted to make space available.
Overwrite existing configuration memory	Requests permission to overwrite existing configuration either by a device-to-memory transfer or by an offline configuration. User answers using the softkeys.
Press OK	Press the OK softkey. This message usually appears after an error message from the application or as a result of HART communications.
Restore device value?	The edited value that was sent to a device was not properly implemented. Restoring the device value returns the variable to its original value.
Save data from device to configuration memory	Prompts user to press SAVE softkey to initiate a device-to-memory transfer.
Saving data to configuration memory	Data is being transferred from a device to configuration memory.
Sending data to device	Data is being transferred from configuration memory to a device.
There are write only variables which have not been edited. Please edit them	There are write-only variables that have not been set by the user. These variables should be set or invalid values may be sent to the device.
There is unsent data. Send it before shutting off?	Press YES to send unsent data and turn the HART Communicator off. Press NO to turn the HART Communicator off and lose the unsent data.
Too few data bytes received	Command returns fewer data bytes than expected as determined by the device description.
Transmitter fault	Device returns a command response indicating a fault with the connected device.
Units for <variable label> has changed. Unit must be sent before editing, or invalid data will be sent.	The engineering units for this variable have been edited. Send engineering units to the device before editing this variable.
Unsent data to online device. SEND or LOSE data	There is unsent data for a previously connected device which must be sent or thrown away before connecting to another device.
Use up/down arrows to change contrast. Press DONE when done.	Gives direction to change the contrast of the HART Communicator display.
Value out of range	The user-entered value is either not within the range for the given type and size of variable or not within the min/max specified by the device.
<message> occurred reading/writing <variable label>	Either a read/write command indicates too few data bytes received, transmitter fault, invalid response code, invalid response command, invalid reply data field, or failed pre- or post-read method; or a response code of any class other than SUCCESS is returned reading a particular variable.
<variable label> has an unknown value. Unit must be sent before editing, or invalid data will be sent.	A variable related to this variable has been edited. Send related variable to the device before editing this variable.

AMS SOFTWARE

Diagnostic Messages

The following is a list of messages used by AMS software. These are communicated through pop-up menus.

Message	Description
Command not implemented	The connected device does not support this function.
Communication error	Either a device sends back a response indicating that the message it received was unintelligible, or the HART Communicator cannot understand the response from the device.
Device busy	The connected device is busy performing another task.
Device disappears from list	Device fails to respond to a command.
Device write protected	Device is in write-protect mode. Data can not be written.
Illegal character	An invalid character for the variable type was entered.
Illegal date	The day portion of the date is invalid.
Illegal month	The month portion of the date is invalid.
Illegal year	The year portion of the date is invalid.
Incomplete exponent	The exponent of a scientific notation floating point variable is incomplete.
Incomplete field	The value entered is not complete for the variable type.
Sending data to device	Data is being transferred from configuration memory to a device.
There are write only variables which have not been edited. Please edit them	There are write-only variables that have not been set by the user. These variables should be set or invalid values may be sent to the device.
There is unsent data. Send it before shutting off?	Press YES to send unsent data and turn the HART Communicator off. Press NO to turn the HART Communicator off and lose the unsent data.
Too few data bytes received	Command returns fewer data bytes than expected as determined by the device description.
Transmitter fault	Device returns a command response indicating a fault with the connected device.
Units for <variable label> has changed. Unit must be sent before editing, or invalid data will be sent.	The engineering units for this variable have been edited. Send engineering units to the device before editing this variable.
Unsent data to online device. SEND or LOSE data	There is unsent data for a previously connected device which must be sent or thrown away before connecting to another device.
Value out of range	The user-entered value is either not within the range for the given type and size of variable or not within the min/max specified by the device.
<message> occurred reading/writing <variable label>	Either a read/write command indicates too few data bytes received, transmitter fault, invalid response code, invalid response command, invalid reply data field, or failed pre- or post-read method; or a response code of any class other than SUCCESS is returned reading a particular variable.
<variable label> has an unknown value. Unit must be sent before editing, or invalid data will be sent.	A variable related to this variable has been edited. Send related variable to the device before editing this variable.

AMS VARIABLES

Appendix A Specifications and Reference Data

SPECIFICATIONS

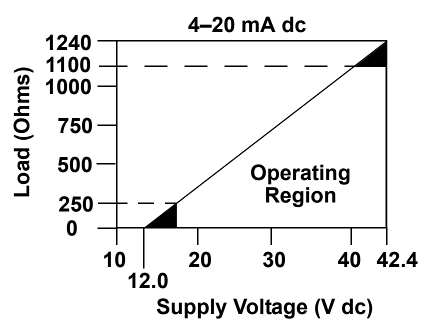
Functional

Inputs
User-selectable. See Accuracy Table for sensor options.

Output
2-wire 4–20 mA, linear with temperature or linear with input. Digital output signal superimposed on 4–20 mA signal, available for HART communicator or control system interface.

Load Limitations

Maximum Load = 40.8 X (Supply Voltage - 12.0)



NOTE
HART Communication requires a loop resistance between 250 and 1100 ohms. Do not communicate with the transmitter when power is below 12 V dc at the transmitter terminals.

Power Supply
External power supply required. Transmitters operate on 12.0 to 42.4 V dc transmitter terminal voltage (with 250 ohm load, 18.1 V dc power supply is required). Transmitter power terminals rated to 42.4 V dc.

Isolation
Input/output isolation tested up to 500 V rms (707 V dc)

Update Time
Approximately 0.5 seconds for a single sensor (1 second for dual sensors.)

Local Indication
Optional five-digit LCD meter includes 0–100% bar graph. Digits are 0.4 inches (8 mm) high. Display options include engineering units (°F, °C, °R, K, ohms, and millivolts), percent, and milliamperes. The display can also be set to alternate between engineering units/milliamperes, Sensor 1/Sensor 2, Sensor 1/Sensor 2/Differential Temperature, and Sensor 1/Sensor2/Average Temperature. All display options, including the decimal point, may be reconfigured in the field using a Model 275 HART Communicator or AMS.

Humidity Limits
0–100% relative humidity

Transient Protection (option code T1)
The transient protector helps to prevent damage to the transmitter from transients induced on the loop wiring by lightning, welding, heavy electrical equipment, or switch gears. The transient protection electronics are contained in an add-on assembly that attaches to the standard transmitter terminal block. Option code G1 external ground lug assembly is included with the Transient Protector option code T1.The transient protector has been tested per the following standard:

- ASME B 16.5 (ANSI)/IEEE C62.41-1991 (IEEE 587)/ Location Categories A2, B3.
  6kV/3kA peak (1.2 × 50 µS Wave 8 × 20 µS Combination Wave)
  6kV/0.5kA peak (100 kHz Ring Wave)
  4kV peak EFT (5 × 50 µS Electrical Fast Transient)
- Loop resistance added by protector: 22 ohms max.
- Nominal clamping voltages: 90 V (common mode), 77 V (normal mode)

Temperature Limits

Description	Operating Limit	Storage Limit
Without LCD Meter	–40 to 185 °F –40 to 85 °C	–60 to 250 °F –50 to 120 °C
With LCD Meter	–4 to 185 °F –20 to 85 °C	–50 to 185 °F –45 to 85 °C

Turn-on Time
Performance within specifications less than 5.0 seconds after power is applied to transmitter

Failure Mode
The Model 3144P features software and hardware failure mode detection. An independent circuit is designed to provide backup alarm output if the microprocessor hardware or software fails.

The alarm levels are user-selectable using the failure mode switch. If failure occurs, the position of the hardware switch determines the direction in which the output is driven (HI or LO). The switch feeds into the digital-to-analog (D/A) converter, which drives the proper alarm output even if the microprocessor fails. The values at which the transmitter drives its output in failure mode depends on whether it is configured to standard, or NAMUR-compliant (NAMUR recommendation NE 43, June 1997) operation. The values for standard and NAMUR-compliant operation are as follows:

Table A-1. Operation Parameters

	Standard (1)	NAMUR-Compliant(1)
Linear Output:	$3.9 \le I \le 20.5$	$3.8 \le I \le 20.5$
Fail High:	$21.75 \le I \le 23$ (default)	$21.5 \le I \le 23$ (default)
Fail Low:	$I \le 3.75$	$I \le 3.6$

(1) Measured in milliamperes

Custom Alarm and Saturation Levels

Custom factory configurations of alarm and saturation levels are available for valid values with option code C1. These values can also be configured in the field using a HART Communicator.

Physical

Conduit Connections

The standard field mount housing has ½–14 NPT conduit entries. Additional conduit entry type are available, including PG13.5 (PG11), M20 X 1.5 (CM20), or JIS G ½. When an of these additional entry types are ordered, adapters are placed in the standard field housing so these alternative conduit types fit correctly. See Dimensional drawings for increased dimensions.

HART Communicator Connections

HART communicator connections are permanently fixed to power/signal block.

Materials of Construction

Electronics Housing

- Low-copper aluminum or CF-8M (cast version of 316 Stainless Steel)

Paint

- Polyurethane

Cover O-rings

- Buna-N

Weight

Aluminum(1)	Stainless Steel(1)
3.1 lb (1.4 kg)	7.8 lb (3.5 kg)

(1) Add 0.5 lb (0.2 kg) for meter or 1.0 lb (0.5 kg) for bracket options.

Mounting

Transmitters may be attached directly to the sensor. Optional mounting brackets B4 and B5 permit remote mounting. See “Optional Transmitter Mounting Brackets” on page A-8.

Enclosure Ratings

NEMA 4X, CSA Enclosure Type 4X, IP66, and IP68

Performance

The Model 3144P transmitter maintains a specification conformance of at least 3 σ.

Stability

- ±0.1% of reading or 0.1 °C, whichever is greater, for 24 months for RTDs
- ±0.1% of reading or 0.1 °C, whichever is greater, for 12 months for thermocouples

5 Year Stability

- ±0.25% of reading or 0.25 °C, whichever is greater, for 5 years for RTDs
- ±0.5% of reading or 0.5 °C, whichever is greater, for 5 years for thermocouples.

Vibration Effect

Transmitters tested to the following specifications with no effect on performance:

Frequency	Acceleration
10–60 Hz	0.21 mm peak displacement
60–2000 Hz	3 g

Self Calibration

The analog-to-digital measurement circuitry automatically self-calibrates for each temperature update by comparing the dynamic measurement to extremely stable and accurate internal reference elements.

Power Supply Effect

Less than ±0.005% of span per volt

RFI Effect

Worst case RFI effect is equivalent to the transmitter's nominal accuracy specification, according to Table on page A-5, when tested in accordance with IEC 61326, 10 V/m, 80 to 1000 MHz, with unshielded cable.

CE Electromagnetic Compatibility Compliance Testing

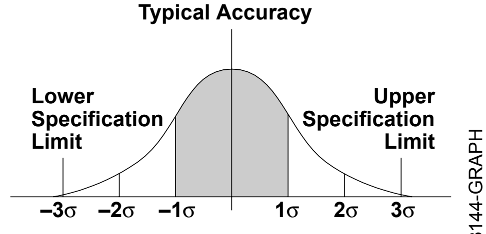
The Model 3144P meets all requirements listed under IEC 61326: Amendment 1, 1998.

Emerson Process Management Conformance to Specifications

A Rosemount product not only meets its published specifications, but most likely exceeds them. Advanced manufacturing techniques and the use of Statistical Process Control provide specification conformance to at least ± 3σ(1). Our commitment to continual improvement ensures that product design, reliability, and performance will improve annually.

For example, the Reference Accuracy distribution for the Model 3144P is shown to the right. Our Specification Limits are ± 0.10 °C, but, as the shaded area shows, approximately 68% of the units perform three times better than the limits. Therefore, it is very likely that you will receive a device that performs much better than our published specifications.

Conversely, a vendor who "grades" product without using Process Control, or who is not committed to ± 3σ performance, will ship a higher percentage of units that are barely within advertised specification limits.



Note: Accuracy distribution shown is for the Model 3144P, PT 100 RTD sensor, Range 0 to 100 °C.

(1) *Sigma (σ) is a statistical symbol to designate the standard deviation from the mean value of a normal distribution.*

Accuracy

Table A-2. Model 3144P Input Options and Accuracy

Sensor Options	Sensor Reference	Input Ranges		Recommended Min. Span(1)		Digital Accuracy(2)		D/A Accuracy(3)
2-, 3-, 4-wire RTDs		°C	°F	°C	°F	°C	°F	
Pt 100	IEC 751, 1995 (α = 0.00385)	–200 to 850	–328 to 1562	10	18	± 0.10	± 0.18	±0.02% of span
Pt 100	JIS 1604, 1981 (α = 0.003916)	–200 to 645	–328 to 1193	10	18	± 0.10	± 0.18	±0.02% of span
Pt 200	IEC 751, 1995 (α = 0.00385)	–200 to 850	–328 to 1562	10	18	± 0.22	± 0.40	±0.02% of span
PT 500	IEC 751, 1995 (α = 0.00385)	–200 to 850	–328 to 1562	10	18	± 0.14	± 0.25	±0.02% of span
Pt 1000	IEC 751, 1995 (α = 0.00385)	–200 to 300	–328 to 572	10	18	± 0.10	± 0.18	±0.02% of span
Ni 120	Edison Curve No. 7	–70 to 300	–94 to 572	10	18	± 0.08	± 0.14	±0.02% of span
Cu 10	Edison Copper Winding No. 15	–50 to 250	–58 to 482	10	18	±1.00	± 1.80	±0.02% of span
Thermocouples(4)								
Type B(5)	NIST Monograph 175, IEC 584	100 to 1820	212 to 3308	25	45	± 0.75	± 1.35	±0.02% of span
Type E	NIST Monograph 175, IEC 584	–50 to 1000	–58 to 1832	25	45	± 0.20	± 0.36	±0.02% of span
Type J	NIST Monograph 175, IEC 584	–180 to 760	–292 to 1400	25	45	± 0.25	± 0.45	±0.02% of span
Type K(6)	NIST Monograph 175, IEC 584	–180 to 1372	–292 to 2502	25	45	± 0.25	± 0.45	±0.02% of span
Type N	NIST Monograph 175, IEC 584	–200 to 1300	–328 to 2372	25	45	± 0.40	± 0.72	±0.02% of span
Type R	NIST Monograph 175, IEC 584	0 to 1768	32 to 3214	25	45	± 0.60	± 1.08	±0.02% of span
Type S	NIST Monograph 175, IEC 584	0 to 1768	32 to 3214	25	45	± 0.50	± 0.90	±0.02% of span
Type T	NIST Monograph 175, IEC 584	–200 to 400	–328 to 752	25	45	± 0.25	± 0.45	±0.02% of span
DIN Type L	DIN 43710	–200 to 900	–328 to 1652	25	45	± 0.35	± 0.63	±0.02% of span
DIN Type U	DIN 43710	–200 to 600	–328 to 1112	25	45	± 0.35	± 0.63	±0.02% of span
Type W5Re/ W26Re	ASTM E 988-96	0 to 2000	32 to 3632	25	45	± 0.70	± 1.26	±0.02% of span
Millivolt Input		–10 to 100 mV		3 mV		±0.015 mV		±0.02% of span
2-, 3-, 4-wire Ohm Input		0 to 2000 ohms		20 ohm		±0.35 ohm		±0.02% of span

(1) No minimum or maximum span restrictions within the input ranges. Recommended minimum span will hold noise within accuracy specification with damping at zero seconds.
(2) Digital accuracy: Digital output can be accessed by HART® Communicator.
(3) Total Analog accuracy is the sum of digital and D/A accuracies.
(4) Total digital accuracy for thermocouple measurement: sum of digital accuracy +0.25 °C (0.45 °F) (cold junction accuracy).
(5) Digital accuracy for NIST Type B is ±3.0 °C (±5.4 °F) from 100 to 300 °C (212 to 572 °F.)
(6) Digital accuracy for NIST Type K is ±0.50 °C (±0.9 °F) from –180 to –90 °C (–292 to –130 °F.)

Reference Accuracy Example

When using a Pt 100 (α = 0.00385) sensor input with a 0 to 100 °C span: Digital Accuracy would be ±0.10 °C, D/A accuracy would be ±0.02% of 100 °C or ±0.02 °C, Total = ±0.12 °C.

Differential Capability Exists Between Any Two Sensor Types (dual-sensor option)

For all differential configurations, the minimum and maximum input range is X to +Y where:

- X = Sensor 1 minimum – Sensor 2 maximum
- Y = Sensor 1 maximum – Sensor 2 minimum.

Digital Accuracy for Differential Configurations (dual-sensor option)

- Sensor types are similar (e.g., both RTDs or both T/Cs): Digital Accuracy = 1.5 times worst case accuracy of either sensor type.
- Sensor types are dissimilar (e.g., one RTD, one T/C): Digital Accuracy = Sensor 1 Accuracy + Sensor 2 Accuracy.

Ambient Temperature Effect

Transmitters may be installed in locations where the ambient temperature is between –40 and 85 °C (–40 and 185 °F).

Each transmitter is individually characterized over this ambient temperature range at the factory in order to maintain excellent accuracy performance.

The factory characterization technique is accomplished through extreme hot and cold temperature profiling with individual adjustment factors programmed into each transmitter. Transmitters automatically adjust for component drift caused by changing environmental conditions.

Table A-3. Ambient Temperature Effect

Sensor Options	Digital Accuracy per 1.0 °C (1.8 °F) Change in Ambient(1)	Range	D/A Effect (% of span)
2-, 3-, or 4- Wire RTDs			
Pt 100(2)	0.0015 °C	Entire Sensor Input Range	0.001%
Pt 100(3)	0.0015 °C	Entire Sensor Input Range	0.001%
Pt 200	0.0023 °C	Entire Sensor Input Range	0.001%
Pt 500	0.0015 °C	Entire Sensor Input Range	0.001%
Pt 1000	0.0015 °C	Entire Sensor Input Range	0.001%
Ni 120	0.0010 °C	Entire Sensor Input Range	0.001%
Cu 10	0.015 °C	Entire Sensor Input Range	0.001%
Thermocouples			
Type B	0.014 °C 0.029 °C – 0.0021% of (R – 300) 0.046 °C – 0.0086% of (R – 100)	R ≥ 1000 °C 300 °C ≤R < 1000 °C 100 °C ≤R < 300 °C	0.001%
Type E	0.004 °C + 0.00043% of R		0.001%
Type J	0.004 °C + 0.00029% of R 0.004 °C + 0.0020% of abs. val. R	R ≥ 0 °C R < 0 °C	0.001%
Type K	0.005 °C + 0.00054% of R 0.005 °C + 0.0020% of abs. val. R	R ≥ 0 °C R < 0 °C	0.001%
Type N	0.005 °C + 0.00036% of R	All	0.001%
Types R and S	0.015 °C 0.021 °C – 0.0032% of R	R ≥ 200 °C R < 200 °C	0.001%
Type T	0.005 °C 0.005 °C + 0.00036% of abs. val. R	R ≥ 0 °C R < 0 °C	0.001%
DIN Type L	0.0054 °C + 0.00029% of R 0.0054 °C + 0.0025% of abs. val. R	R ≥ 0 °C R < 0 °C	0.001%
DIN Type U	0.0064 °C 0.0064 °C + 0.0043% of abs. val. R	R ≥ 0 °C R < 0 °C	0.001%
Type W5Re/W26Re	0.016 °C 0.023 °C + 0.0036% of R	R ≥ 200 °C R < 200 °C	0.001%
Millivolt Input	0.00025 mV	Entire Sensor Input Range	0.001%
2, 3, or 4-Wire Ohm Input	0.007 Ω	Entire Sensor Input Range	0.001%

(1) Change in ambient is in reference to the calibration temperature of the transmitter (20° C [68° F])
(2) α = 0.00385
(3) α = 0.003916

Temperature Effects Example

When using a Pt 100 (α = 0.00385) sensor input with a 0 to 100 °C span at 30 °C ambient temperature, the following statements would be true:

Digital Temp Effects: 0.0015 °C × [(30 – 20)] = 0.015 °C

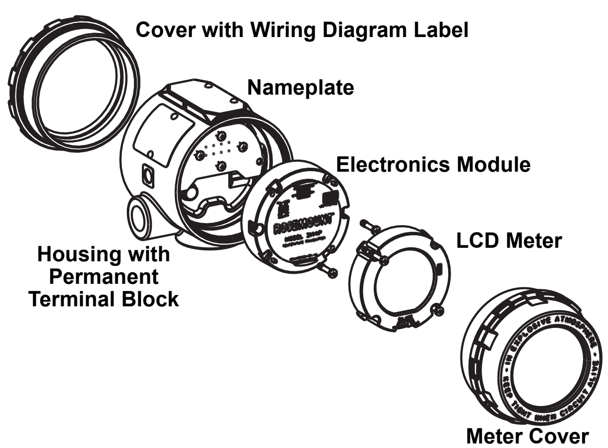
D/A Effects: [0.001% of 100] × [(30 – 20)] = 0.01 °C

Worst Case Error: Digital + D/A + Digital Temp Effects + D/A Effects = 0.10 °C + 0.02 °C + 0.015 °C + 0.01 °C = 0.145 °C

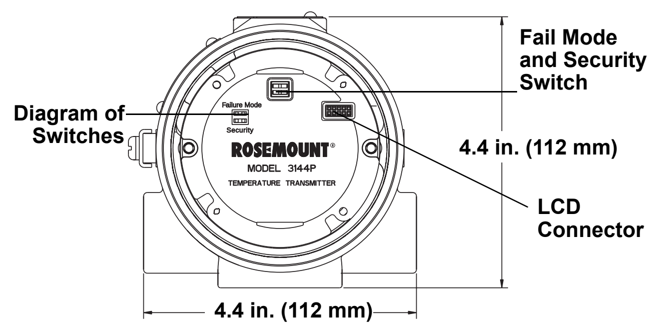
Total Probable Error: $\sqrt{0.10^2 + 0.02^2 + 0.015^2 + 0.01^2} = 0.10° C$

DIMENSIONAL DRAWINGS

Transmitter Exploded View

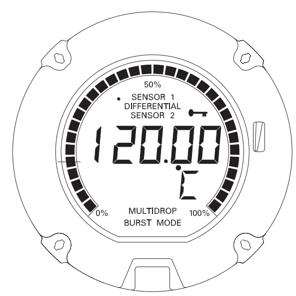


Switch Location



2352A01D, 0000A03B

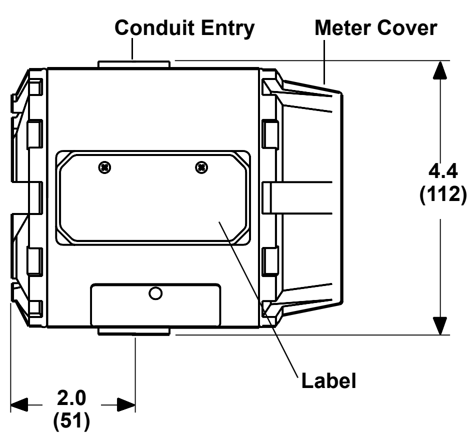
LCD Meter Faceplate



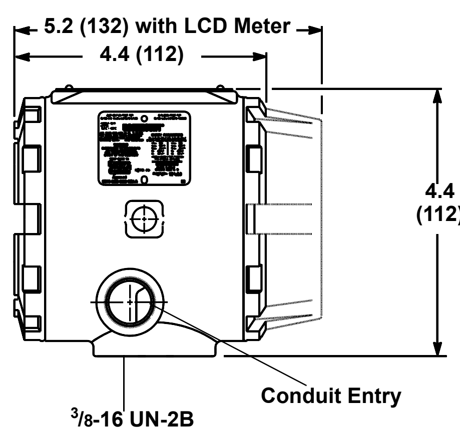
3144-0001B01B,

Transmitter Dimensional Drawing

Top View



Side View

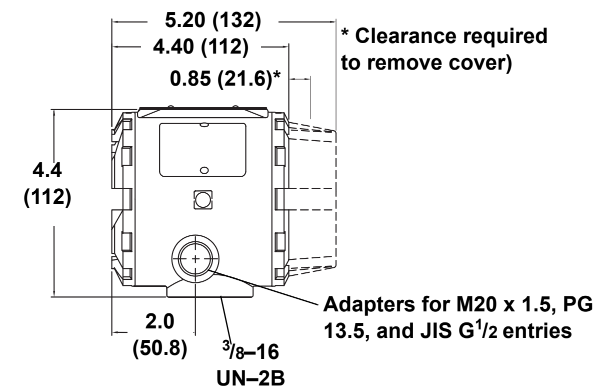


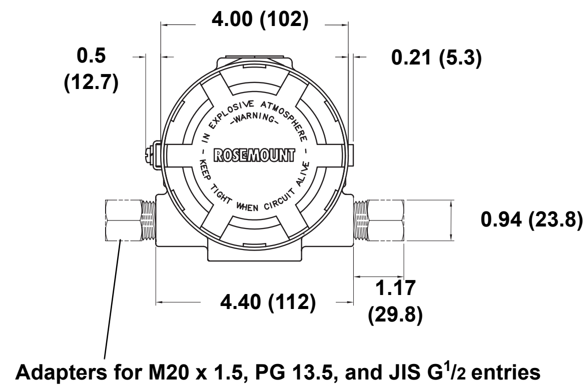
3144-0204B02A, 0000A07A

Dimensions are in inches (millimeters)

Transmitter Dimensional Drawing for Conduits with M20 x 1.5, PG 13.5, and JIS G1/2 Entries

Top View | **Front View**

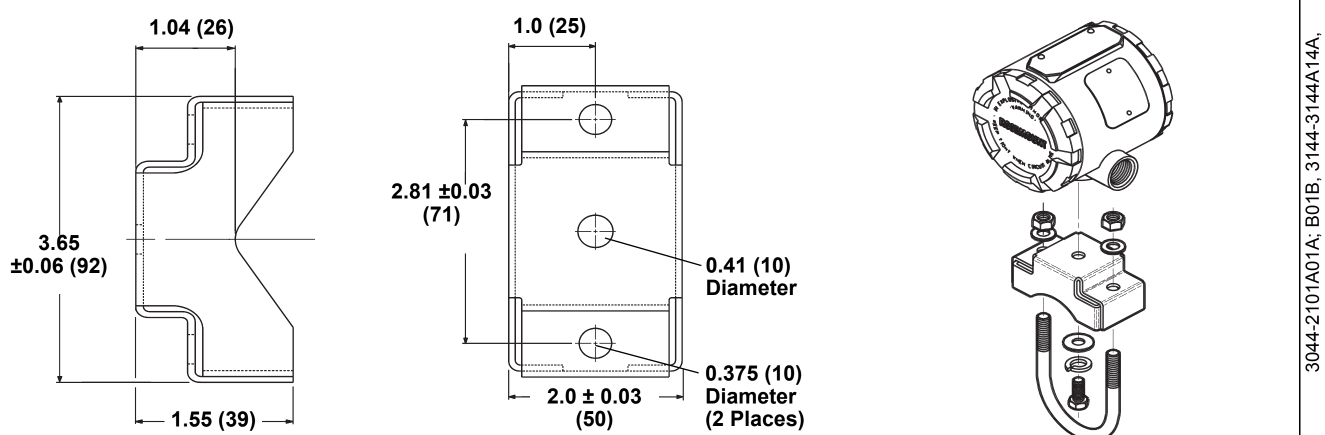




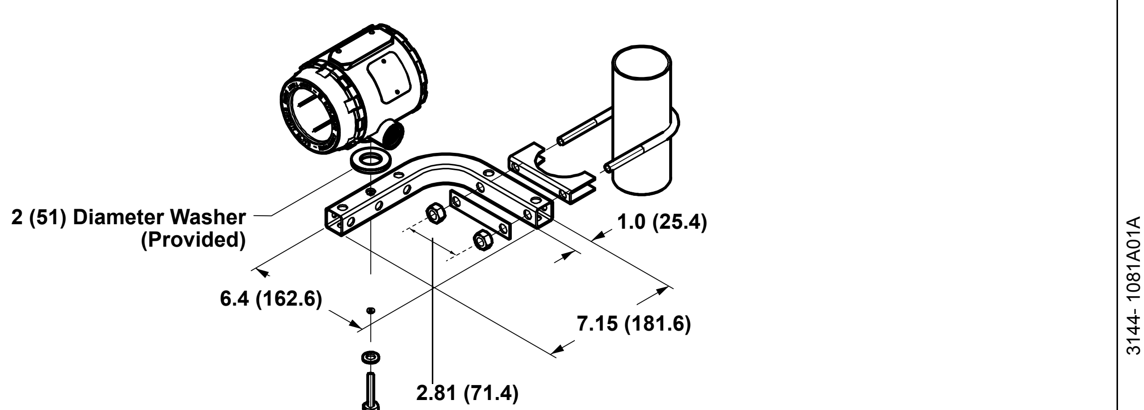
Dimensions are in inches (millimeters)

Optional Transmitter Mounting Brackets

Option Code B4 Bracket



Option Code B5 Bracket



Dimensions are in inches (millimeters)

ORDERING INFORMATION
Transmitter

Model	Product Description
3144P	Smart Temperature Transmitter
Code	**Transmitter Housing Type/Conduit Entry**
D1	Field Mount Housing (Dual-Compartment), Aluminum, 1/2–14 NPT
D2	Field Mount Housing (Dual-Compartment), Aluminum, M20 x 1.5 (CM20)
D3	Field Mount Housing (Dual-Compartment), Aluminum, PG 13.5 (PG11)
D4	Field Mount Housing (Dual-Compartment), Aluminum, JIS G 1/2
D5	Field Mount Housing (Dual-Compartment), Stainless Steel, 1/2–14 NPT
D6	Field Mount Housing (Dual-Compartment), Stainless Steel, M20 x 1.5 (CM20)
D7	Field Mount Housing (Dual-Compartment), Stainless Steel, PG 13.5 (PG11)
D8	Field Mount Housing (Dual-Compartment), Stainless Steel, JIS G 1/2
Code	**Output**
A	4-20 mA with Digital Signal based on HART protocol
Code	**Measurement Type Configuration**
1	Single-Sensor Input
2	Dual-Sensor Input
Code	**Hazardous Locations Certifications**
NA	No Approval
E5	FM explosion-proof and non-incendive approval
K5	FM intrinsic safety, non-incendive and explosion-proof approval combination
KB	FM and CSA intrinsic safety, explosion-proof, and non-incendive approval combination
K6	CSA intrinsic safety, explosion-proof and non-incendive approval combination
E1	CENELEC/Kema flameproof approval
N1	CENELEC/BASEEFA type n approval
I1	CENELEC/BASEEFA intrinsic safety approval
K1	CENELEC intrinsic safety, flameproof and type n combination
ND	CENELEC dust ignition proof approval
KA	CENELEC/CSA intrinsic safety, explosion-proof combination
E7	SAA flameproof approval
N7	SAA type N approval
I7	SAA intrinsic safety approval
K7	SAA intrinsic safety, flameproof and Type n approval combination
I2	CEPEL intrinsic safety approval
E4	JIS flameproof approval; requires either housing code D4 or D8.
Code	**Options**
	Accessory
B4	Universal mounting bracket for 2-inch pipe and panel mounting—SST bracket and bolts
B5	Universal “L” mounting bracket for 2-inch pipe mounting—SST bracket and bolts
M5	LCD meter
G1	External ground lug assembly (See “External Ground Screw Assembly” on page A-11.)
T1	Integral transient protector
	Custom Configuration
C1	Factory configuration of date, descriptor, and message fields (CDS required with order)
F5	50 Hz line voltage filter
A1	Analog output levels compliant with NAMUR recommendation NE-43, 27-June-1996, Alarm Configuration-high
CN	Analog output levels compliant with NAMUR recommendation NE-43, 27-June-1996, Alarm Configuration-low
C8	Low alarm (standard Rosemount alarm and saturation values)
	Calibration
C2	Transmitter-Sensor Matching–Trim to specific Rosemount RTD calibration schedule
C4	5-point calibration (use option code Q4 to generate a calibration certificate)
Q4	Calibration certificate (3-point standard; use C4 with Q4 option for a 5-point calibration certificate)
C7	Trim to special non-standard sensor (special sensor–customer must provide sensor information)
	Dual-Input Custom Configuration (only with measurement type option code 2)
U1	*Hot Backup*
U2	Average temperature with *Hot Backup* and sensor drift alert
U4	Two independent sensors
U5	Differential temperature
U6	Average temperature
	Assembly
X1(1)	Assemble transmitter to a sensor assembly (hand tight, *Teflon* (PTFE) tape where appropriate, fully wired)
X2	Assemble transmitter to a sensor assembly (hand tight, no *Teflon* (PTFE) tape, unwired)
X3(1)	Assemble transmitter to a sensor assembly (wrench tight, *Teflon* (PTFE) tape where appropriate, fully wired)
	Special Certifications
QS	Quality Certification for Safety Instrumented Systems
Typical Model Number: 3144P D1 A 1 E5 B4 M5	

(1) If ordering X1, X2, or X3 options, specify the same code in the sensor model number. Option codes X1 and X3 are not available with CSA approval.

Spare Parts List

Description	Part Number
Electronics Modules	
Model 3144P Electronics Module (configured as a single sensor)	03144-3111-0001
Model 3144P Electronics Module (configured as a dual-sensor)	03144-3111-0002
M5 Meter Kit (includes meter display, captive mounting hardware, 10-pin interconnection header and cover)	
M5 Meter Kit–Aluminum	03144-3120-0001
M5 Meter Kit–Stainless Steel	03144-3120-0011
Meter (includes meter, captive mounting hardware, 10-pin interconnection header)	03144-3120-0002
Meter Parts	
Aluminum Meter Cover Kit (includes cover and O-ring)	03144-1043-0001
Stainless Steel Meter Cover Kit (includes cover and O-ring)	03144-1043-0011
LCD Adapter Kit (required for using a Model 3144/3244MV meter with a Model 3144P transmitter)	03144-2114-0001
Mounting Bracket Kit	
B4 Mounting Bracket Kit	03044-2131-0001
B5 Mounting Bracket Kit	03144-1081-0001
Housing Cover (includes O-ring)	
Model 3144P Aluminum Housing Cover	03144-1142-0001
Model 3144P Stainless Steel Housing Cover	03144-1142-0002
O-ring for cover (package of 12)	01151-0033-0003
Housing Kit (does not include covers)	
Model 3144P Aluminum Housing Kit	03144-1141-0001
Model 3144P Aluminum Housing Kit with External Ground Lug Assembly	03144-1141-0002
Model 3144P Stainless Steel Housing Kit	03144-1141-0003
Model 3144P Stainless Steel Housing Kit with External Ground Lug Assembly	03144-1141-0004
Additional	
Screw/Washer combination for Sensor / Power Terminals (package of 12)	03144-1044-0001
Jumper (10-pin)–Meter interconnection header (package of 12)	03144-1146-0001
External Ground Lug Assembly (includes hardware to be used with existing ground lug installed in the transmitter–ground lug not included in kit)	03144-1047-0001
Integral Transient Protector Kit (Includes terminal screws and transient protector)	03144-3040-0001

TAGGING

Hardware

- No charge
- 2 lines of 28 characters (56 characters total)
- Tags are stainless steel
- Permanently attached to transmitter
- Character height is 1/16-in. (1.6mm)
- A wire-on tag is available upon request. 5 lines of 12 characters (60 characters total)

Software Tag

- The transmitter can store up to 8 characters.
- Can be ordered with different software and hardware tags.
- If no software tag characters are specified, the first 8 characters of the hardware tag are the default.

EXTERNAL GROUND SCREW ASSEMBLY

The external ground screw assembly can be ordered by specifying option code G1 when an enclosure is specified. However, some approvals include the ground screw assembly in the transmitter shipment, hence it is not necessary to order option code G1. See below to determine which approval options include the external ground screw assembly. Option code G1 is also included with Integral Protector option code T1 and does not need to be ordered separately.

Approval Type	Ground Screw Assembly Included?
NA, E5, K5, K6, KB	No–Order option code G1
N1, E1, I1, ND, K1, E7, N7, I7, K7, KA, I2 and E4	Yes

CONFIGURATION

Standard

Both standard and custom configuration settings may be changed using a HART communicator. Unless specified, the transmitter will be shipped as follows:

Standard Configuration	
4 mA value	0 °C
20 mA value	100 °C
Damping	5 seconds
Output	Linear with temperature
Failure Mode	High
Line Voltage Filter	60 Hz
Software Tag	See “Tagging”
Optional Integral Meter	Units and mA
Single Sensor option	
Sensor Type	4-wire Pt 100 α = 0.00385 RTD
Primary Variable (4–20 mA)	Sensor 1
Secondary Variable	Terminal Temperature
Tertiary Variable	Not Available
Quaternary Variable	Not Available
Dual-Sensor option	
Sensor Type	Two 3-wire Pt 100 α = 0.00385 RTD
Primary Variable (4–20 mA)	Sensor 1
Secondary Variable	Sensor 2
Tertiary Variable	Terminal Temperature
Quaternary Variable	Not Used

Custom

The Model 3144P transmitter can be ordered with custom configuration. The table below lists the requirements necessary to specify a custom configuration.

Option Code	Requirements/Specification
C1: Factory Data[(1)]	Date: day/month/year Descriptor: 16 alphanumeric character Message: 32 alphanumeric character Custom Alarm Levels can be specified for configuration at the factory.
C2: Transmitter Sensor Matching	The transmitters are designed to accept Callendar-van Dusen constants from a calibrated RTD schedule and generate a custom curve to match any specific sensor curve. Specify a Series 68, 65, or 78 RTD sensor on the order with a special characterization curve (V or X8Q4 option). These constants will be programmed into the transmitter with this option.
C4: Five Point Calibration	Will include five-point calibration at 0, 25, 50, 75, and 100% analog and digital output points. Use with option code Q4 to obtain a Calibration Certificate.

Option Code	Requirements/Specification
C7: Special Sensor	Used for non-standard sensor, adding a special sensor or expanding input. Customer must supply the non-standard sensor information.Additional special curve will be added to sensor curve input choices.
A1: NAMUR-Compliant, high alarm	Analog output levels compliant with NAMUR. Alarm is set to fail high.
CN: NAMUR-Compliant, low alarm	Analog output levels compliant with NAMUR. Alarm is set to fail low.
C8: Low Alarm	Rosemount standard analog output levels with alarm set to fail low
F5: 50 Hz Line Filter	Calibrated to 50 Hz line voltage filter.

(1) CDS required

To custom configure the Model 3144P with the dual-sensor option transmitter for one of the applications described below, indicate the appropriate option code in the model number. If a sensor type is not specified, the transmitter will be configured for two 3-wire Pt 100 (α = 0.00385) RTDs if any of the following option codes are selected.

Option Code U1: Hot Backup Configuration	
Primary Usage	Primary usage sets the transmitter to automatically use sensor 2 as the primary input if sensor 1 fails. Switching from sensor 1 to sensor 2 is accomplished without any effect on the analog signal.
Primary Variable (4–20 mA)	Sensor 1
Secondary Variable	Sensor 2
Tertiary Variable	Terminal Temperature
Quaternary Variable	Not Used

Option Code U2: Average Temperature with Hot Backup and Sensor Drift Alert(1)	
Primary Usage	Critical applications, such as safety interlocks and control loops. Outputs the average of two measurements and alerts if temperature difference exceeds the set maximum differential (sensor drift alert). If a sensor fails, an alert will be sent and the primary variable will hold working sensor measurement.
Primary Variable (4–20 mA)	Sensor Average
Secondary Variable	Sensor 1
Tertiary Variable	Sensor 2
Quaternary Variable	Terminal Temperature

(1) Default Drift Alert Configuration Temperature difference limit is 3 °C (5.4 °F). Damping is 5 seconds.

Option Code U4: Two Independent Sensors	
Primary Usage	Used in non-critical applications where the digital output is used to measure two separate process temperatures.
Primary Variable (4-20 mA)	Sensor 1
Secondary Variable	Sensor 2
Tertiary Variable	Terminal Temperature
Quaternary Variable	Not Used

Option Code U5: Differential Temperature	
Primary Usage	The differential temperature of two process temperatures are configured as the primary variable.
Primary Variable (4–20 mA)	Differential Temperature
Secondary Variable	Sensor 1
Tertiary Variable	Sensor 2
Quaternary Variable	Terminal Temperature

Option Code U6: Average Temperature	
Primary Usage	When average measurement of two different process temperatures is required. If a sensor fails, an alert will be sent and the primary variable will hold the measurement of the working sensor.
Primary Variable (4-20 mA)	Sensor Average
Secondary Variable	Sensor 1
Tertiary Variable	Sensor 2
Quaternary Variable	Terminal Temperature

Appendix B Product Certifications

HAZARDOUS LOCATIONS INSTALLATIONS

⚠ The transmitter is designed with explosion-proof housings and circuitry suitable for intrinsically safe and non-incendive operation. Each transmitter is clearly marked with a tag indicating the approvals. To maintain certified ratings for installed transmitters, install in accordance with all applicable installation codes and approval drawings. Verify that the operating atmosphere of the transmitter is consistent with the appropriate hazardous locations certifications. Both transmitter covers must be fully engaged to meet explosion proof requirements.

North American Approvals

Factory Mutual (FM) Approvals

E5 Explosion Proof for Class I, Division 1, Groups A, B, C, and D.
Dust Ignition-Proof for use in Class II/III, Division 1, Groups E, F, and G.
Explosion-Proof and Dust Ignition-Proof when installed in accordance with Rosemount drawing 03144-0320. Indoor and outdoor use. NEMA Type 4X.

Temperature code: T5 (T_{amb} = – 50 to 85 °C)

NOTE
For Group A, seal all conduits, seal all conduits within 18 inches of enclosure; otherwise, conduit seal not required for compliance with NEC 501-5a(1).

Non-incendive for use in Class I, Division 2, Groups A, B, C, and D.
Non-incendive when installed in accordance with Rosemount drawing 03144-0321.

Temperature codes: T5 (T_{amb} = – 50 to 85 °C),
T6 (T_{amb} = – 50 to 60°C)

K5 Combination of E5 and the following:
Intrinsically Safe for Class I/II/III, Division 1, Groups A, B, C, D, F, and G.

Temperature codes: T4A (T_{amb} = – 50 to 60 °C),
T5 (T_{amb} = – 50 to 50°C)

Non-Incendive for use in Class I, Division 2, Groups A, B, C, and D.
Suitable for use in Class II/III, Division 2, Groups F and G.

Temperature codes: T5 (T_{amb} = – 50 to 85 °C),
T6 (T_{amb} = – 50 to 60°C)

Intrinsically safe and non-incendive when installed in accordance with Rosemount drawing 03144-0321.

Canadian Standards Association (CSA) Approvals

K6 Combination of the following:
Explosion Proof for Class I, Division 1, Groups A, B, C, and D; Class II, Division 1, Groups E, F, and G; Class III, Division 1 hazardous locations. Factory sealed. Class I, Division 2, Groups A, B, C, and D.

Intrinsically Safe for Class I, Division 1, Groups A, B, C, and D; Class II, Division 1, Groups E, F, and G; Class III, Division 1 hazardous locations intrinsically safe when installed in accordance with Rosemount drawing 03144-0322.

European Approvals

E1 Flameproof Approval (Zone 1)
Certificate Number: KEMA01ATEX2181
ATEX Category Marking ⟨Ex⟩ II 2 G
EEx d IIC T6 (T_{amb} = –40 to 70 °C)
EEx d IIC T5 (T_{amb} = –40 to 80 °C)
Max supply voltage: 55 Vdc

ND CENELEC Dust Ignition Proof Approval
Certificate Number: KEMA01ATEX2181
ATEX Category Marking ⟨Ex⟩ II 1 D
T95 °C (T_{amb} = –40 to 85 °C)

N1 CENELEC Type n Approval (Zone 2)
Certificate Number: BAS01ATEX3432X
ATEX Category Marking ⟨Ex⟩ II 3 G
EEx nL IIC T6 (T_{amb} = –40 to 50 °C)
EEx nL IIC T5 (T_{amb} = –40 to 75 °C)
U_i = 55V

Special Conditions for Safe Use (x):
The transmitter is not capable of withstanding the 500 insulating test required by Clause 9.1 of EN50021:1999. This condition must be taken into account during installation.

I1 CENELEC Intrinsic Safety Approval (Zone 0)
Certificate Number: BAS01ATEX1431X
ATEX Category Marking ⟨Ex⟩ II 1 G
EEx ia IIC T6 (T_{amb} = –60 to 50 °C)
EEx ia IIC T5 (T_{amb} = –60 to 75 °C)

Table B-1. Input Entity Parameters

Power/Loop	Sensor
U_i = 30 V dc	U_o = 13.6 V
I_i = 300 mA	I_o = 56 mA
P_i = 1.0 W	P_o =190 mW
C_i = 5 nF	C_i = 78 nF
L_i = 0	L_i = 0

Special Conditions for Safe Use (x):
The transmitter is not capable of withstanding the 500V insulation test as defined in Clause 6.4.12 of EN50 020. This condition must be taken into account during installation.

K1 Combination of E1, N1, and I1

Australian Approvals

Standard Australia Quality Assurance Services (SAA)

E7 Flameproof Approval
Certificate Number: AUS Ex 02.3813X
Ex d IIC T6 (T_{amb} = –20 to 60 °C)

Special Conditions for Safe Use (x):

1. Apparatus must be installed in accordance to Rosemount drawing 03144-0325.
2. If the sensor is intended to be remote mounted, it should be installed in a suitable Standards Australia certified Flame-Proof enclosure and installed in accordance with Rosemount drawing 03144-0325.
3. Standards Australia certified cable glands or conduit adapters must be used when connecting to external circuits. Where only one conduit entry is used for connection to external circuits, the unused entry is to be closed by means of a blanking plug supplied by Rosemount or by a suitable Standards Australia certified blanking plug.

N7 Type N Approval
Certificate Number: AUS Ex 02.3794X
Ex n IIC T6 (T_{amb} = –60 to 50 °C)
Ex n IIC T5 (T_{amb} = –60 to 75 °C)
IP66
U_n = 55 V
P_n = 1.3 W

I7 Intrinsic Safety Approval
Certificate Number: AUS Ex 02.3794X
Ex ia IIC T6 (T_{amb} = –60 to 50 °C)
Ex ia IIC T5 (T_{amb} = –60 to 75 °C)

Table B-2. Input Entity Parameters

Power/Loop	Sensor
U_i = 30 V dc	U_o = 13.6 V
I_i = 300 mA	I_o = 100 mA
P_i = 1.0 W	P_o = 80 mW
C_i = 0.005 μF	C_o = 0.66 μF
L_i = 20 μH	L_o = 1.9 mH

Special Conditions for Safe Use (x):

1. For options using the transient protection board, the apparatus should be connected to earth with a copper conductor of 4 mm (^2) or greater.
2. For the label with more than one type of marking on it, upon completion of commissioning the apparatus the irrelevant marking code(s) shall be permanently scrubbed off.

K7 Combination of E7, N7, and I7.

Japanese Approval

Japanese Industrial Standard (JIS) Flameproof Certification

E4 Without sensor: Ex d IIB T6 (T_{amb} = –20 to 55 °C)
With sensor: Ex d IIB T4 (T_{amb} = –20 to 55 °C)

Brazilian Approval

Centro de Pesquisas de Energia Eletrica (CEPEL) Approval

I2 Intrinsic Safety
BR-Ex ia IIC T6

Combination Approval

Factory Mutual and Canadian Standards Association Approvals

KB Combination of K5 and K6

CENELEC and CSA Approvals

KA Combination of K1 and K6

Additional Approvals

American Bureau of Shipping (ABS) Type Approval

ABS Type Approval for temperature measurements in hazardous locations on ABS Classed Vessels, Marine and Offshore Installations. Type Approval is based on Factory Mutual (FM) Approvals; therefore, specify order code K5. Please contact your Emerson Process Management representative if a copy of the certification is required.

Det Norske Veritas (DNV) Type Approval for Shipboard and Offshore Installations

DNV rules for classifications of ships and mobile offshore units for temperature measurements in the following locations:

Table B-3. Applications / Limitations

Location	Class
Temperature	D
Humidity	B
Vibration	B/C
Enclosure	D

NOTE
The transient protector (option code T1) is required when requesting DNV Type Approval. Additionally, hazardous locations approvals may be required (based on shipboard location) and will need to be specified by the Hazardous Locations option code.

Please contact your Emerson Process Management representative if a copy of the certification is required.

GOSTANDART

Tested and approved by Russian Metrological Institute GOSTANDART.

INSTALLATION DRAWINGS

Rosemount Drawing 03144-0320, 1 Sheet:
Factory Mutual Explosion-proof Installation Drawing.

Rosemount Drawing 03144-0321, 3 Sheets:
Factory Mutual Intrinsic Safety and Nonincendive Field Circuit Configuration Installation Drawing.

Rosemount Drawing 03144-0322, 1 Sheet:
CSA Intrinsic Safety Approval Configuration Installation Drawing.

Rosemount Drawing 03144-0324, 1 Sheet:
KEMA/CENELEC Flame-proof Temperature Measurement Assembly Installation Drawing.

Rosemount Drawing 03144-0325, 1 Sheet:
SAA Flameproof Temperature Measurement Assembly Installation Drawing.

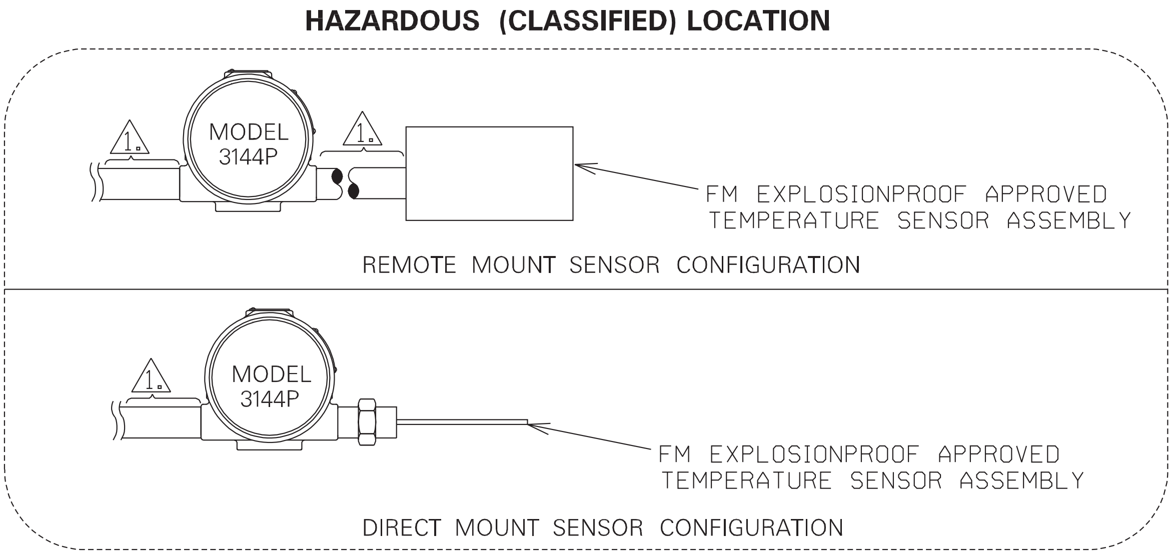
IMPORTANT
Once a device labeled with multiple approval types is installed, it should not be reinstalled using any of the other labeled approval types. To ensure this, the approval label should be permanently marked to distinguish the used from the unused approval type(s).

Figure B-1. Factory Mutual Explosion-Proof Installation Drawing 03144-0320, Rev. AB

CONFIDENTIAL AND PROPRIETARY INFORMATION IS CONTAINED HEREIN AND MUST BE HANDLED ACCORDINGLY

REVISIONS

REV	DESCRIPTION	CHG. NO.	APP'D	DATE
AB	ADD T5 TO NOTE 5	RTC1012632	D.B.	2/21/02



5. MODEL 3144P FM APPROVAL CLASSIFICATION:
EXPLOSION PROOF FOR CLASS I, DIVISION 1, GROUPS A, B, C, & D (T5)
DUST-IGNITION PROOF FOR CLASS II/III, DIVISION 1, GROUPS E, F, & G;
NONINCENDIVE FOR CLASS I, DIVISION 2, GROUPS A, B, C, & D (T4A).
NEMA ENCLOSURE TYPE 4X
AMBIENT TEMP. LIMITS: -50°C TO +85°C.

4. FOR FIELD WIRING CONNECTIONS IN AMBIENT TEMPERATURES ABOVE 60°, USE WIRING RATED FOR AT LEAST 90°C.

3. TEMPERATURE SENSOR ASSEMBLY MUST BE FM APPROVED FOR APPROPRIATE AREA CLASSIFICATION.

2. ALL CONDUIT THREADS MUST BE ASSEMBLED WITH A MINIMUM OF FIVE FULL THREADS ENGAGEMENT.

⚠1. INSTALL PER NATIONAL ELECTRICAL CODE (NEC). FOR GROUP A, SEAL ALL CONDUITS WITHIN 18 INCHES OF ENCLOSURE; OTHERWISE, CONDUIT SEAL NOT REQUIRED FOR COMPLIANCE WITH NEC 501-5a(1).

NOTES:

CAD MAINTAINED (MicroStation)

UNLESS OTHERWISE SPECIFIED DIMENSIONS IN INCHES [mm]. REMOVE ALL BURRS AND SHARP EDGES. MACHINE SURFACE FINISH 125

-TOLERANCE-
.X ± .1 [2,5]
.XX ± .02 [0,5]
.XXX ± .010 [0,25]
FRACTIONS ± 1/32
ANGLES ± 2°

DO NOT SCALE PRINT

CONTRACT NO.

DR.	NGA DOAN	6/29/01
CHK'D		
APP'D.	D. BAUSCHKE	7/17/01
APP'D. GOVT.		

EMERSON. Process Management
ROSEMOUNT®
8200 Market Boulevard • Chanhassen, MN 55317 USA

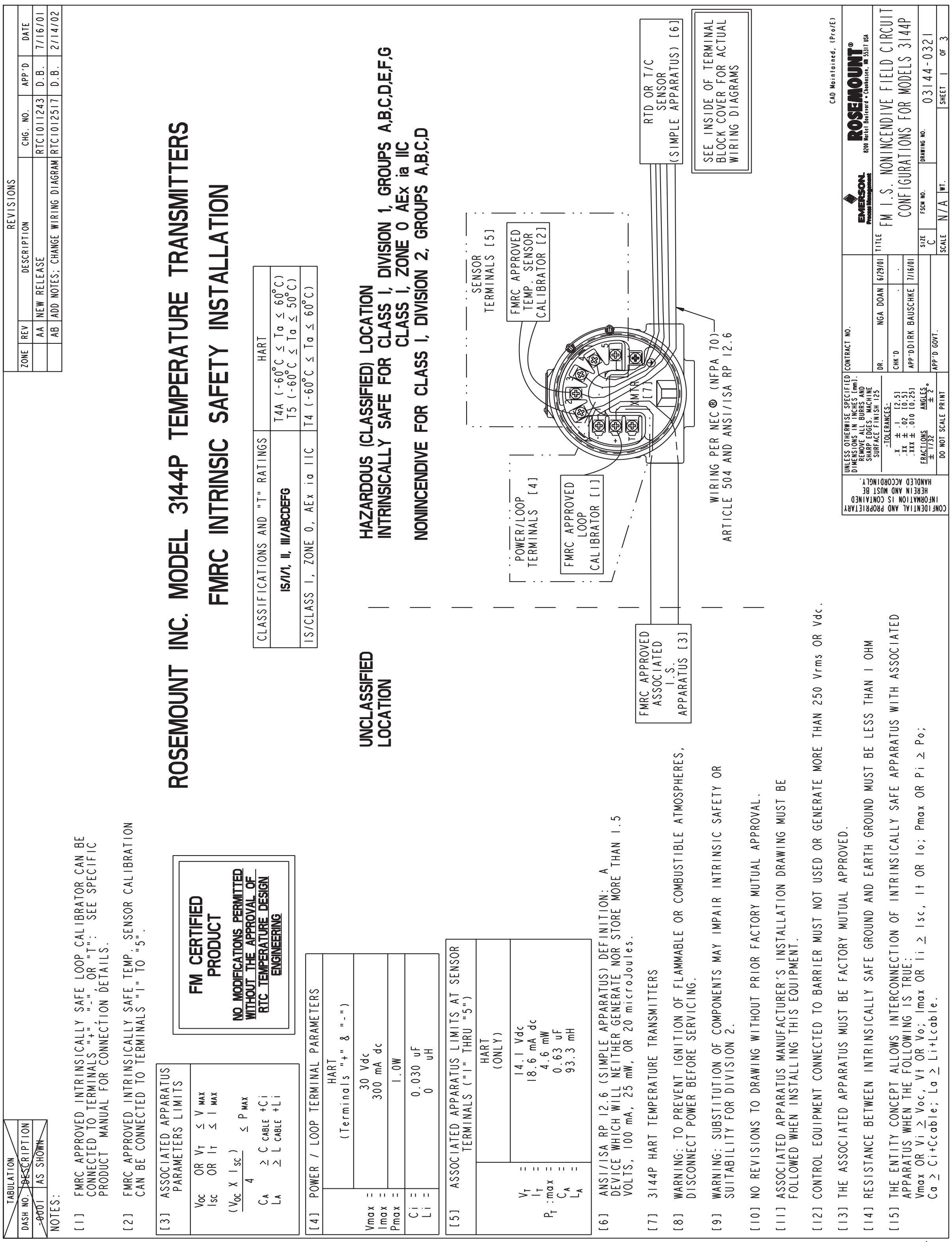
TITLE INSTALLATION DRAWING: MODEL 3144P FACTORY MUTUAL (FM) EXPLOSIONPROOF

SIZE	FSCM NO	DWG NO.
A		03144-0320

SCALE N/A | WT. ———— | SHEET 1 OF 1

3144_3144-0320A01A

Figure B-2. Factory Mutual Intrinsic Safety and Noincendive Field Circuit Configuration Installation Drawing 03144-0321, Rev.AB



3144_3144-0321A01A

REVISIONS					
ZONE	REV	DESCRIPTION	CHG. NO.	APP'D	DATE
	AB		RTC1012517		

ROSEMOUNT INC. MODEL 3144P TEMPERATURE TRANSMITTER
FMRC DIV. 2 INSTALLATION OPTIONS

CLASSIFICATIONS AND "T" RATINGS	HART
NI/I/2/ ABCD	T6 ($-60°C \le Ta \le 60°C$) T4A ($-60°C \le Ta \le 85°C$)

NOTES:

[1] FMRC INTRINSICALLY SAFE OR NONINCENDIVE FIELD CIRCUIT APPROVED LOOP CALIBRATOR CAN BE CONNECTED TO TERMINALS "+", "-", OR "T": SEE SPECIFIC PRODUCT MANUAL FOR CONNECTION DETAILS.

[2] FMRC INTRINSICALLY SAFE OR NONINCEDIVE FIELD CIRCUIT APPROVED TEMP. SENSOR CALIBRATION CAN BE CONNECTED TO TERMINALS "1" TO "5".

[3] ASSOCIATED NONINCENDIVE APPARATUS PARAMETERS LIMITS
V_{OC} OR $V_T \le V_{MAX}$ $C_A \ge C_{CABLE} + Ci$ $L_A \ge L_{CABLE} + Li$

[4] TRANSMITTER POWER/LOOP TERMINAL PARAMATER LIMITS
HART ("+" TO "-") Vmax
55 Vdc
Ci = 0.030 uF Li = 20 uH

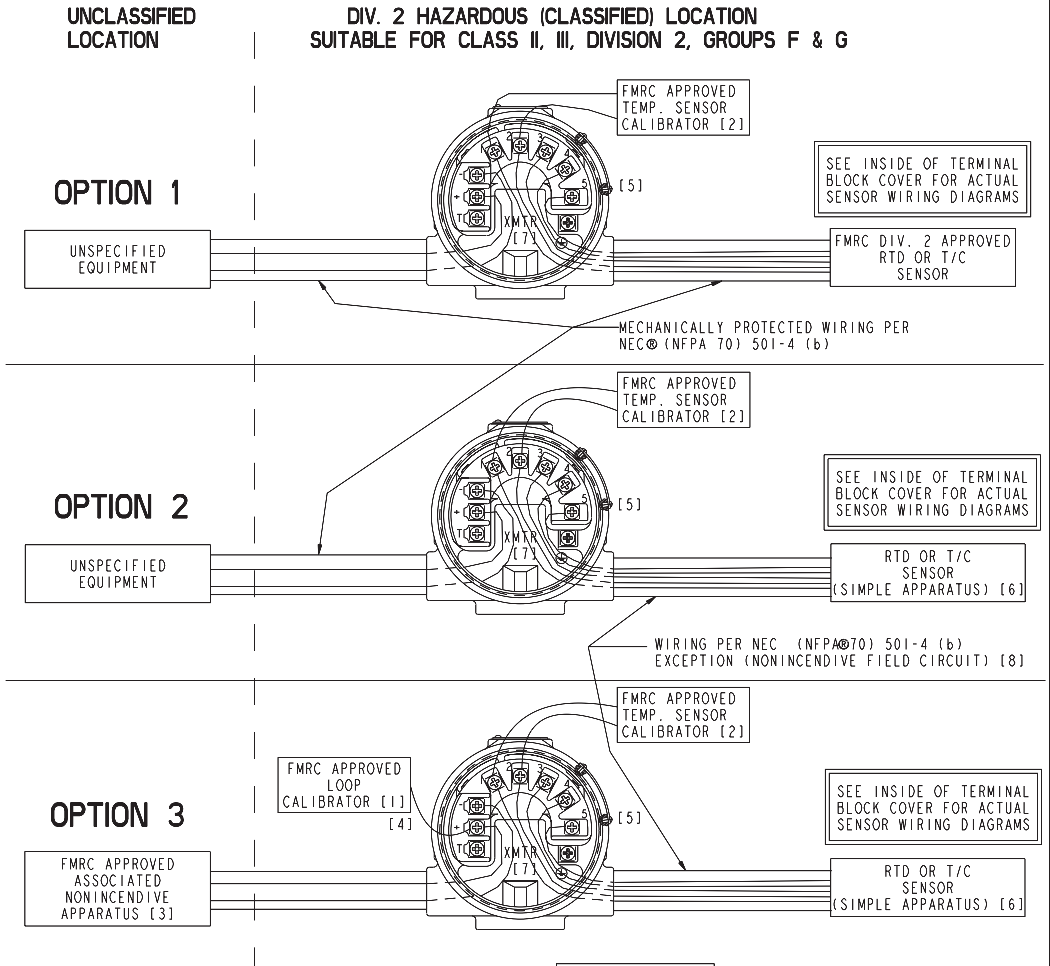
[5] ASSOCIATED NONINCENDIVE (ANI) FIELD CIRCUIT PARAMETER LIMITS AT SENSOR TERMINALS ("1" THRU "5")	HART (ONLY)
V_T =	14.1 Vdc
I_T =	18.6 mA dc
P_T:max =	4.6 mW
C_A =	0.63 uF
L_A =	93.3 mH

[6] ANSI/ISA RP 12.6 (SIMPLE APPARATUS) DEFINITION: A DEVICE WHICH WILL NEITHER GENERATE NOR STORE MORE THAN 1.5 VOLTS, 100 mA, 25 mW.

[7] 3144P HART TEMPERATURE TRANSMITTERS.

[8] NFPA 70 National Electrical Code® ARTICLE 501-4(b) EXCEPTION: "WIRING IN NONINCENDIVE CIRCUITS SHALL BE PERMITTED USING ANY OF THE METHODS SUITABLE FOR WIRING IN ORDINARY LOCATIONS."

[9] DUST-TIGHT CONDUIT SEAL MUST BE USED WHEN INSTALLED IN CLASS II AND CLASS III ENVIRONMENTS.

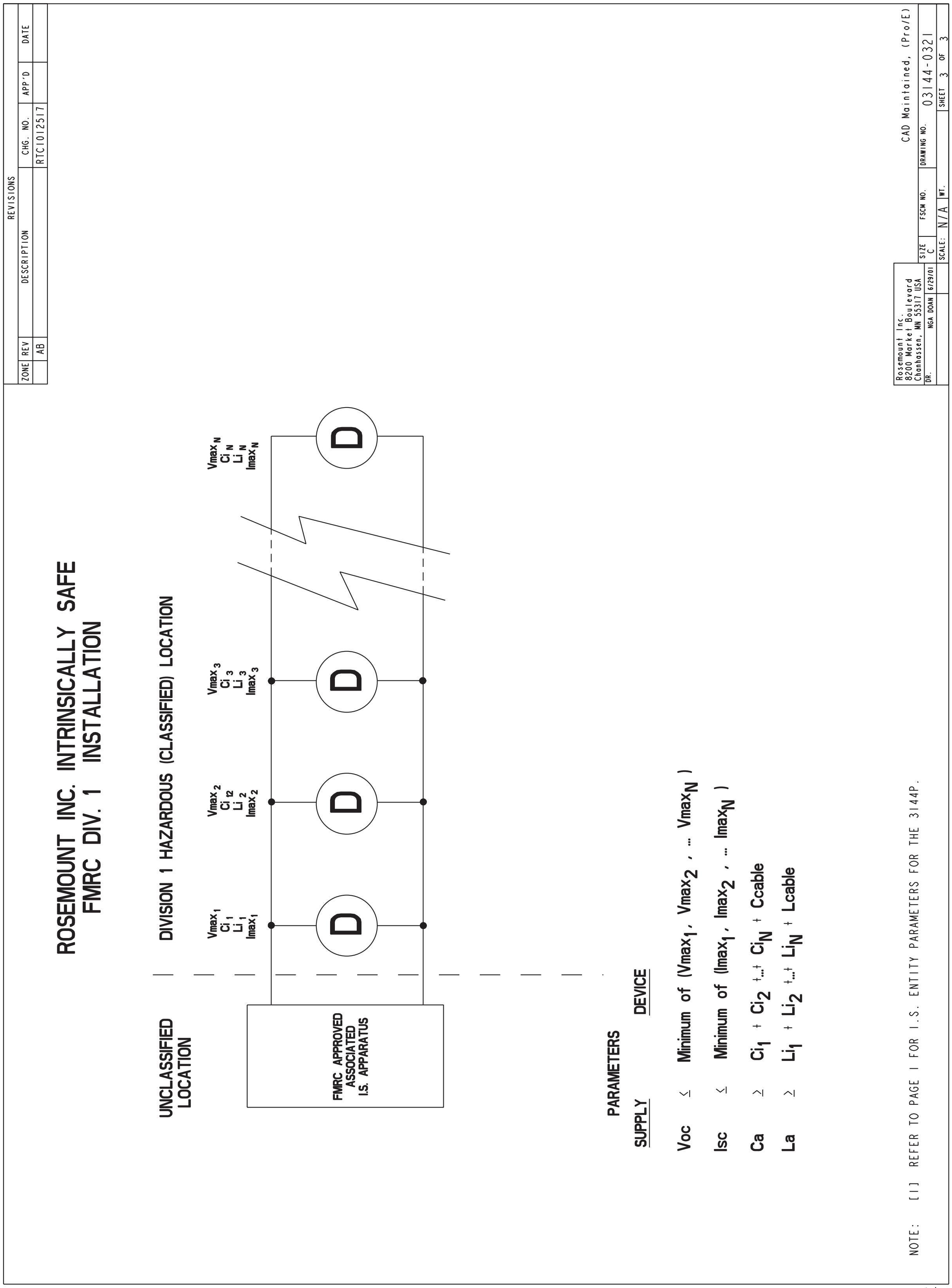


Rosemount Inc.
8200 Market Boulevard
Chanhassen, MN 55317 USA

DR.	NGA DOAN	6/29/01	SIZE C	FSCM NO.	DRAWING NO. 03144-0321
SCALE: N/A	WT.				SHEET 2 OF 3

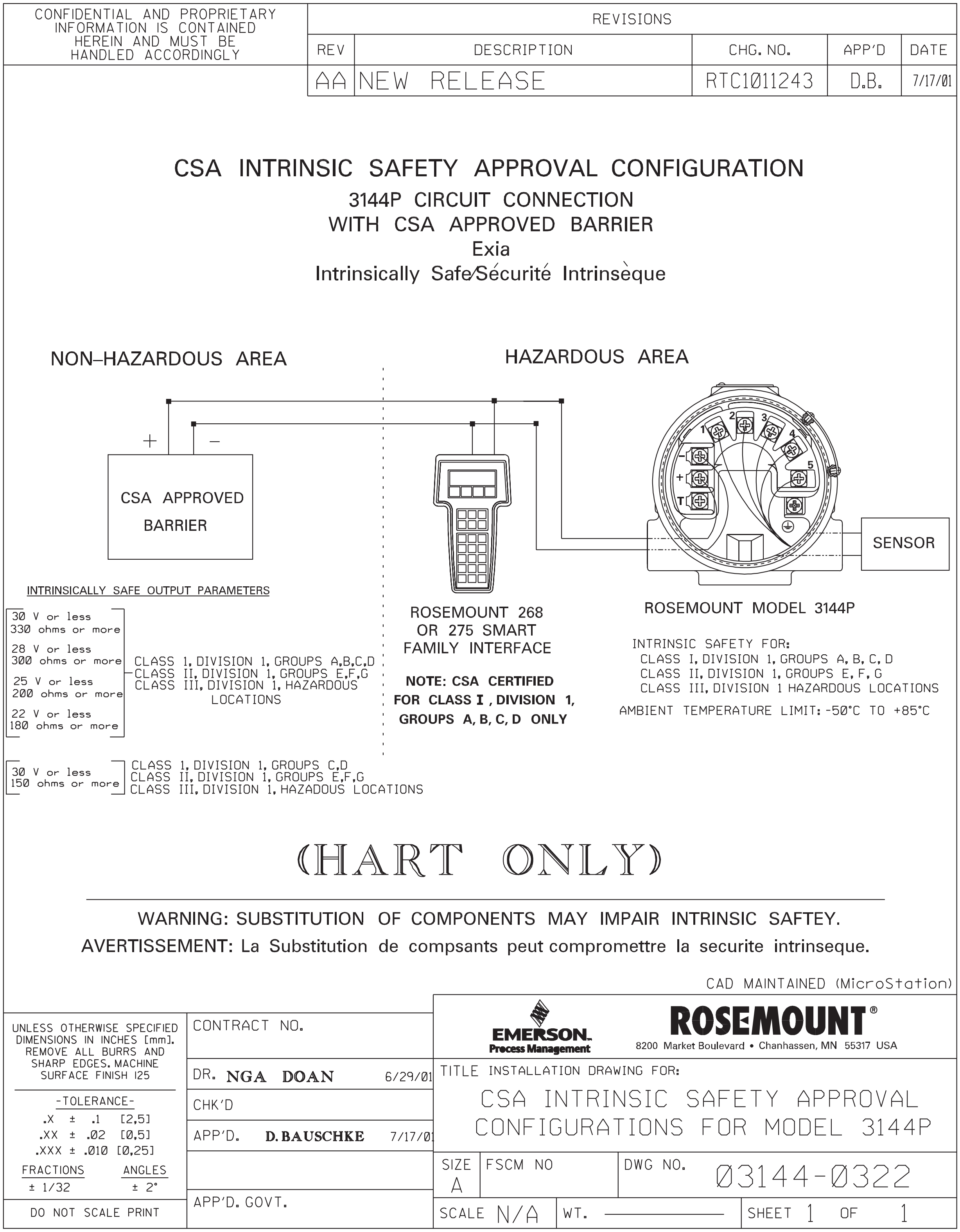
CAD Maintained, (Pro/E)

3144_3144-0321A02A



3144_3144-0321A04A

Figure B-3. CSA Intrinsic Safety Approval Configuration Installation Drawing 03144-0322, Rev. AA

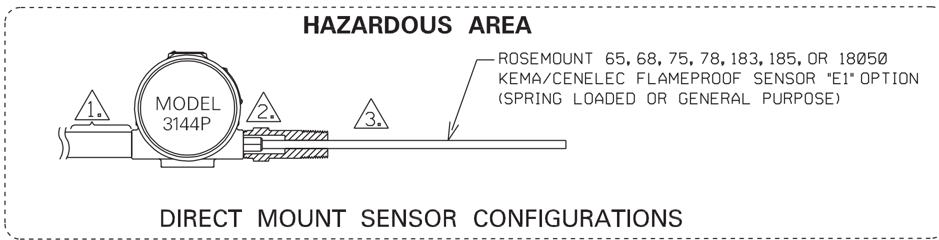


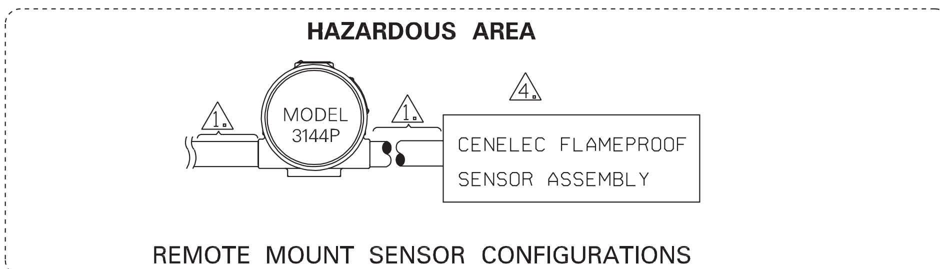
3144_3144-0322A01A

Figure B-4. ISSEP\CENELEC Flame-Proof Temperature Measurement Assembly Installation Drawing 03144-0324, Rev. AA

CONFIDENTIAL AND PROPRIETARY INFORMATION IS CONTAINED HEREIN AND MUST BE HANDLED ACCORDINGLY

REVISIONS				
REV	DESCRIPTION	CHG. NO.	APP'D	DATE
AA	NEW RELEASE	RTC1011243	D.B.	7/17/01
AB	CHANGE ISSEP REFERENCES TO KEMA	RTC1011874	D.B.	11/26/01





7. WAIT 1Ø SECONDS AFTER DISCONNECTING POWER BEFORE REMOVING COVER.

6. A CONDUIT PLUG MUST BE INSTALLED INTO ANY UNUSED CONDUIT ENTRIES.

5. ROSEMOUNT MODELS 3144P KEMA/CENELEC FLAMEPROOF APPROVAL Ex II 2 G
DESCRIPTION: EEx d IIC T6 (Tamb= -4Ø°C TO +7Ø°C) T5 (-4Ø°C TO +8Ø°C).
IP66

4. TEMPERATURE SENSOR ASSEMBLY MUST BE CENELEC APPROVED FOR APPROPRIATE AREA CLASSIFICATION.

3. SPRING LOADED SENSORS MUST USE A THERMOWELL ASSEMBLY.

2. THREADS MUST BE ASSEMBLED WITH LOCTITE THREAD SEALANT AND HAVE A MINIMUM OF FIVE FULL THREADS ENGAGEMENT AND 8 mm AXIAL LENGTH ENGAGEMENT.

1. INSTALL PER LOCAL INSTALLATION CODES.
CENELEC APPROVED CABLE ENTRY OR STOPPING BOX REQUIRED.

CAD MAINTAINED (MicroStation)

UNLESS OTHERWISE SPECIFIED DIMENSIONS IN INCHES [mm]. REMOVE ALL BURRS AND SHARP EDGES. MACHINE SURFACE FINISH 125

-TOLERANCE-
.X ± .1 [2,5]
.XX ± .Ø2 [Ø,5]
.XXX ± .Ø1Ø [Ø,25]

FRACTIONS ± 1/32 — ANGLES ± 2°

DO NOT SCALE PRINT

CONTRACT NO.

DR.	NGA DOAN	6/29/01
CHK'D		
APP'D.	DIRK BAUSCHKE	7/17/01
APP'D. GOVT.		

EMERSON. Process Management — ROSEMOUNT®
8200 Market Boulevard • Chanhassen, MN 55317 USA

TITLE: INSTALLATION DRAWING: KEMA/CENELEC FLAMEPROOF TEMPERATURE MEASUREMENT ASSEMBLY (EI)

SIZE	FSCM NO	DWG NO.
A		Ø3144-Ø324

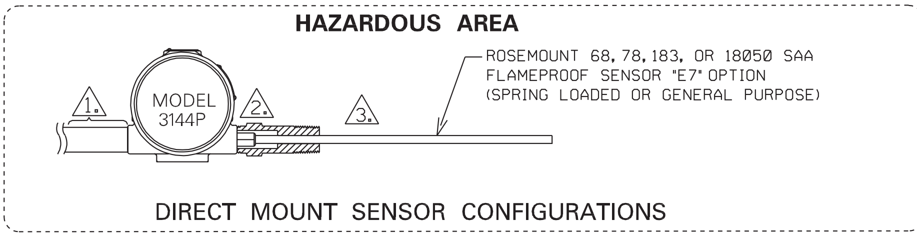
SCALE NONE — WT. ———— — SHEET 1 OF 1

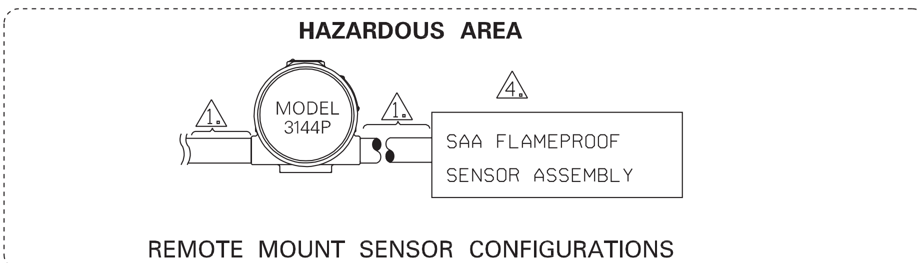
3144_3144-0324A02A

Figure B-5. Standard Australia Quality Assurance Services Flameproof Temperature Measurement Assembly Installation Drawing 03144-0325, Rev. AA

CONFIDENTIAL AND PROPRIETARY INFORMATION IS CONTAINED HEREIN AND MUST BE HANDLED ACCORDINGLY

REVISIONS				
REV	DESCRIPTION	CHG. NO.	APP'D	DATE
AA	INITIAL RELEASE	RTC1011500	D.B.	8/17/01





7. WAIT 10 SECONDS AFTER DISCONNECTING POWER BEFORE REMOVING COVER.

6. A CONDUIT PLUG MUST BE INSTALLED INTO ANY UNUSED CONDUIT ENTRIES.

5. ROSEMOUNT MODELS 3144P SAA FLAMEPROOF APPROVAL DESCRIPTION: Ex d IIC T6 (Tamb= -40°C TO +50°C). IP66

4. TEMPERATURE SENSOR ASSEMBLY MUST BE SAA APPROVED FOR APPROPRIATE AREA CLASSIFICATION.

3. SPRING LOADED SENSORS MUST USE A THERMOWELL ASSEMBLY.

2. THREADS MUST BE ASSEMBLED WITH LOCTITE THREAD SEALANT AND HAVE A MINIMUM OF FIVE FULL THREADS ENGAGEMENT AND 8 mm AXIAL LENGTH ENGAGEMENT.

1. INSTALL PER LOCAL INSTALLATION CODES. SAA APPROVED CABLE ENTRY OR STOPPING BOX REQUIRED.

CAD MAINTAINED (MicroStation)

UNLESS OTHERWISE SPECIFIED DIMENSIONS IN INCHES [mm]. REMOVE ALL BURRS AND SHARP EDGES. MACHINE SURFACE FINISH 125	CONTRACT NO.	EMERSON. Process Management — ROSEMOUNT® 8200 Market Boulevard • Chanhassen, MN 55317 USA
-TOLERANCE- .X ± .1 [2,5] .XX ± .02 [0,5] .XXX ± .010 [0,25]	DR. NGA DOAN 8/7/01	TITLE INSTALLATION DRAWING: SAA FLAMEPROOF TEMPERATURE MEASUREMENT ASSEMBLY (E7)
FRACTIONS ± 1/32 ANGLES ± 2°	CHK'D	
	APP'D. DIRK BAUSCHKE 8/17/01	SIZE A; FSCM NO; DWG NO. 03144-0325
DO NOT SCALE PRINT	APP'D. GOVT.	SCALE N/A; WT. ——; SHEET 1 OF 1

3144_3144-0325A01A

Appendix C Safety Instrumented System (SIS)

OVERVIEW

This section details the requirements for using the Model 3144P in Safety Instrumented Systems (SIS). Although the Model 3144P is not certified for functional safety per IEC61508, a complete Failure Modes, Effects, and Diagnosis Analysis (FMEDA) was completed to determine the safe failure fraction (SFF) when using this device in a SIS application.

FMEDA are the device characteristics that are taken into account when attempting to achieve functional safety certification per IEC61508 of a device. From the FMEDA, failure rates are determined for all temperature sensing device options. Furthermore, the Safe Failure Fraction is calculated for each of the four different input device configurations.

The Model 3144P is an isolated 2-wire 4-20 mA SMART device classified as Type B according to IEC61508. It contains self-diagnostics and is programmed to send its output to either a high or low failure state upon internal detection of a failure.

The analysis shows that the device has a safe failure fraction between 60 and 90% (assuming that the logic solver is programmed to detect over-scale and under-scale currents). The device has a safe failure fraction of over 90% when used with a temperature sensing device, such as thermocouple or RTD. The device can detect open and short circuit failures of these temperature sensing devices.

Table C-1. Definitions

Abbreviation	Description	Definition
λ^{H}	Fail High(1)	Failure that will result in an output current that is higher than 20 mA
λ^{L}	Fail Low(1)	Failure that will result in an output current that is lower than 4 mA
λ^{DU}	Fail Dangerous Undetected	Failure that is dangerous and that is not being diagnosed by internal diagnostics
SFF	Safe Failure Fraction	Fraction of the overall failure rate of a device that results in either a safe fault or a diagnosed unsafe fault.

(1) Detected by the logic solver.

FAILURE RATE DATA

Model 3144P with and without a RTD

The failure rates for the Model 3144P transmitter operating in 4-wire RTD mode, excluding the failure rates for the sensing device, are as follows:

- λ^{H} = 32.85 * 10^{-9} failures per hour
- λ^{L} = 351.96 * 10^{-9} failures per hour(1)
- λ^{DU} = 74.29 * 10^{-9} failures per hour
- SFF = 83.82%(2)

If these are combined with failure rates for a closely coupled, shock protected, 4-wire RTD then the total failure rates for the temperature sensing subsystem are as follows:

- λ^{H} = 32.85 * 10^{-9} failures per hour
- λ^{L} = 2331.96 * 10^{-9} failures per hour (1)
- λ^{DU} = 94.29 * 10^{-9} failures per hour
- SFF = 96.17%(2)

Model 3144P with and without a Thermocouple

The failure rates for the Model 3144P transmitter operating in thermocouple mode, excluding the failure rates for the sensing device, are as follows:

- λ^{H} = 32.85 * 10^{-9} failures per hour
- λ^{L} = 344.16 * 10^{-9} failures per hour(1)
- λ^{DU} = 74.29 * 10^{-9} failures per hour
- SFF = 82.62%

If these are combined with failure rates for a closely coupled thermocouple then the total failure rates for temperature sensing subsystem are as follows:

- λ^{H} = 32.85 * 10^{-9} failures per hour
- λ^{L} = 5094.16 * 10^{-9} failures per hour(1)
- λ^{DU} = 329.29 * 10^{-9} failures per hour
- SFF = 93.96%(2)

(1) Assuming the specified failure state is low.
(2) Assuming the high and low out of range signals are detected by the logic solver.

INSTALLATION

No special installation practices are necessary with the Model 3144P in a Safety Instrumented System. However, a full review of the Failure Mode and Security switches is required. Follow the standard installation requirements (see Section 2: Installation).

Switches

Failure Mode Switch

The transmitter monitors itself during normal operation using an automatic diagnostic routine. If the diagnostic routine detects a sensor failure or a failure in the transmitter electronics, the transmitter goes into high or low alarm, depending on the position of the failure mode switch.

The analog alarm and saturation values that the transmitter uses depend on whether it is configured to standard (set by the factory) or NAMUR-compliant operation. These values are also custom-configurable in both the factory and the field using the Model 275 HART Communicator. The limits are:

- 21.0 ≤ I ≤ 23 for high alarm
- 3.5 ≤ I ≤ 3.75 for low alarm

The values for standard and NAMUR operation are as follows:

Characteristics	Standard Operation	NAMUR-Compliant Operation
Fail High	21.75 mA ≤ I ≤ 23.0 mA	21.0 mA ≤ I ≤ 23.0 mA
High Saturation	I ≥ 20.5 mA	I ≥ 20.5 mA
Low Saturation	I ≤ 3.90 mA	I ≤ 3.8 mA
Fail Low	I ≤ 3.75 mA	I ≤ 3.6 mA

Transmitter Security Switch

The transmitter is equipped with a write-protect switch that can be positioned to prevent both accidental and deliberate change of configuration data.

Changing Switch Position

The Failure Mode and Security switches are located on the top center of the electronics module (see Figure C-1). The electronics module is on the electronics side of the transmitter housing. For transmitters with LCD meters, the electronics module is located behind the LCD meter faceplate.

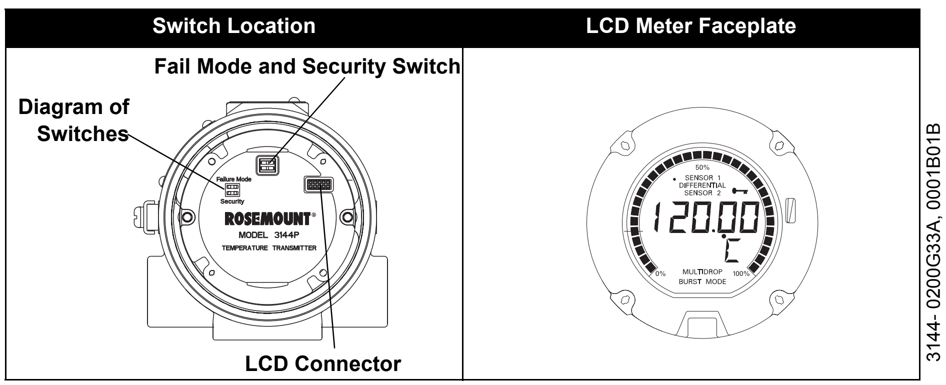
Without a LCD meter

1. If the transmitter is installed, set the loop to manual.
2. Remove the housing cover on the electronics side of the transmitter. Do not remove the transmitter cover in explosive atmospheres when the circuit is live.
3. Set the switches to the desired position (see Figure C-1).
4. Replace the transmitter cover. Both transmitter covers must be fully engaged to meet explosion-proof requirements.
5. Set the loop to automatic control.

With a LCD meter

1. If the transmitter is installed, set the loop to manual.
2. ⚠ Remove the housing cover on the electronics side of the transmitter. Do not remove the transmitter cover in explosive atmospheres when the circuit is live.
3. Remove the housing cover, unscrew the LCD meter screws and gently slide the meter straight off.
4. Set the switches to the desired position (see Figure C-1).
5. Gently slide the LCD meter back into place, taking extra precautions of the 10 pin connection.
6. Secure the LCD meter by replacing the LCD meter screws.
7. ⚠ Replace the transmitter cover. Both transmitter covers must be fully engaged to meet explosion-proof requirements.
8. Set the loop to automatic control.

Figure C-1. Transmitter Jumper Locations.



Index

T

W

Rosemount, the Rosemount logotype, and Hot Backup are registered trademarks of Rosemount Inc.
HART is a registered trademark of the HART Communication Foundation.
Teflon is a registered trademark of E.I. du Pont de Nemours & Co.
All other marks are the property of their respective owners.

Emerson Process Management

Rosemount Inc.
8200 Market Boulevard
Chanhassen, MN 55317 USA
T (U.S.) 1-800-999-9307
T (International) (952) 906-8888
F (952) 949-7001

www.rosemount.com

Rosemount Temperature GmbH
Frankenstrasse 21
63791 Karlstein
Germany
T 49 (6188) 992 0
F 49 (6188) 992 112

Emerson Process Management Asia Pacific Private Limited
1 Pandan Crescent
Singapore 128461
T (665) 777 8211
F (665) 777 0947
AP.RMT-Specialist@emersonprocess.com