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English
Rev. AA

Model 3095 Multivariable™ Level Controller

PlantWeb

Product Discontinued

ROSEMOUNT®

FISHER-ROSEMOUNT™ Managing The Process Better.™

Model 3095 Multivariable™ Level Controller

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: 1-800-999-9307 (*7:00 a.m. to 7:00 p.m. CST)*
Technical support, quoting, and order-related questions.

North American Response Center: 1-800-654-7768 (*24 hours a day – Includes Canada)*
Equipment service needs.

For equipment service or support needs outside the United States, contact your local Rosemount representative.

⚠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 Rosemount Sales Representative.

SNF-0004

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Table of Contents

IMPORTANT

Procedures and instructions in this manual 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 (⚠). **Refer to the safety messages listed at the beginning of each section before performing an operation preceded by this symbol.**

SECTION 3
Level Controller Operation

SECTION 4
Level Controller Configuration

Section 1

Introduction

USING THIS MANUAL

This manual provides installation, configuration, troubleshooting, and maintenance instructions for the Rosemount® Model 3095 Multivariable™ Level Controller and for its operation with the Model 275 HART® Communicator.

The rest of this manual consists of the following sections:

Section 2: Level Controller Overview and Installation introduces the Level Controller and explains how to install it. This includes an installation flowchart, installation considerations, and field installation.

Section 3: Level Controller Operation provides a summary of the Level Controller's features and functions.

Section 4: Level Controller Configuration provides information on the configuration and commissioning of the Level Controller.

Section 5: Troubleshooting and Maintenance provides troubleshooting instructions for dealing with potential mechanical or electrical difficulties.

Section 6: Level Controller Specifications and Reference Data includes specification data for the Level Controller.

Appendix A: HART Communicator contains a Model 275 overview, a HART Communicator menu tree for the Level Controller, and a table of HART Communicator fast key sequences. A table of diagnostic messages associated with this communicator is also included.

Appendix B: Level Controller Options and Accessories provides information about the options and accessories available with the Level Controller.

Appendix C: Approval Drawings illustrates Factory Mutual (FM) and Canada Standards (CSA) certified drawings.

SAFETY MESSAGES

Procedures and instructions in this manual 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 ().

Refer to the safety messages listed at the beginning of each section before performing an operation preceded by this symbol.

Section 2

Level Controller Overview and Installation

This section contains overview information about the Model 3095 Multivariable Level Controller system, an installation flowchart showing the sequence of Level Controller installation and wiring, installation considerations, and the field installation procedure.

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

Explosions could result in death or serious injury:

- Do not remove the instrument cover in explosive atmospheres when the circuit is alive.
- Before connecting a HART-based 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 controller covers must be fully engaged to meet explosion-proof requirements.
- The unused conduit opening on the controller housing must be plugged and sealed to meet explosion-proof requirements.

⚠WARNING

Failure to follow safe installation and servicing guidelines could result in death or serious injury:

- Make sure only qualified personnel perform these procedures.
- Use the equipment only as specified in this manual. Failure to do so may impair the protection provided by the equipment.
- Unauthorized parts can affect product performance and may impair the protection provided by the equipment.

⚠WARNING

Process leaks could result in death or serious injury:

- Install only the flange adapter O-ring designed to seal with the corresponding flange adapter.
- All four flange bolts must be installed and tight before applying pressure or process leaks will result.

⚠WARNING

High voltage that may be present on leads could cause electrical shock:

- Avoid contact with leads and terminals.

LEVEL CONTROLLER OVERVIEW

The Model 3095 Multivariable Level Controller is a multivariable, microprocessor-based, analog and digital output device for use in single loop, level process applications.

The Level Controller directly measures differential pressure (DP) and computes a separate process variable that represents level in a tank above a reference point.

The Level Controller uses the level variable in a control function to compute a control output value. The control function is a PID algorithm whose output is a 4–20 mA analog signal. A digital representation of the value of the 4–20 mA output may be obtained via HART digital communications.

Because the Level Controller is a multivariable device, optional process variables can be measured and obtained as a secondary HART process variable. The process variables available via HART are level, DP, control output (CO), and process temperature (PT).

FIGURE 2-1. Typical Level Controller Installation Site.

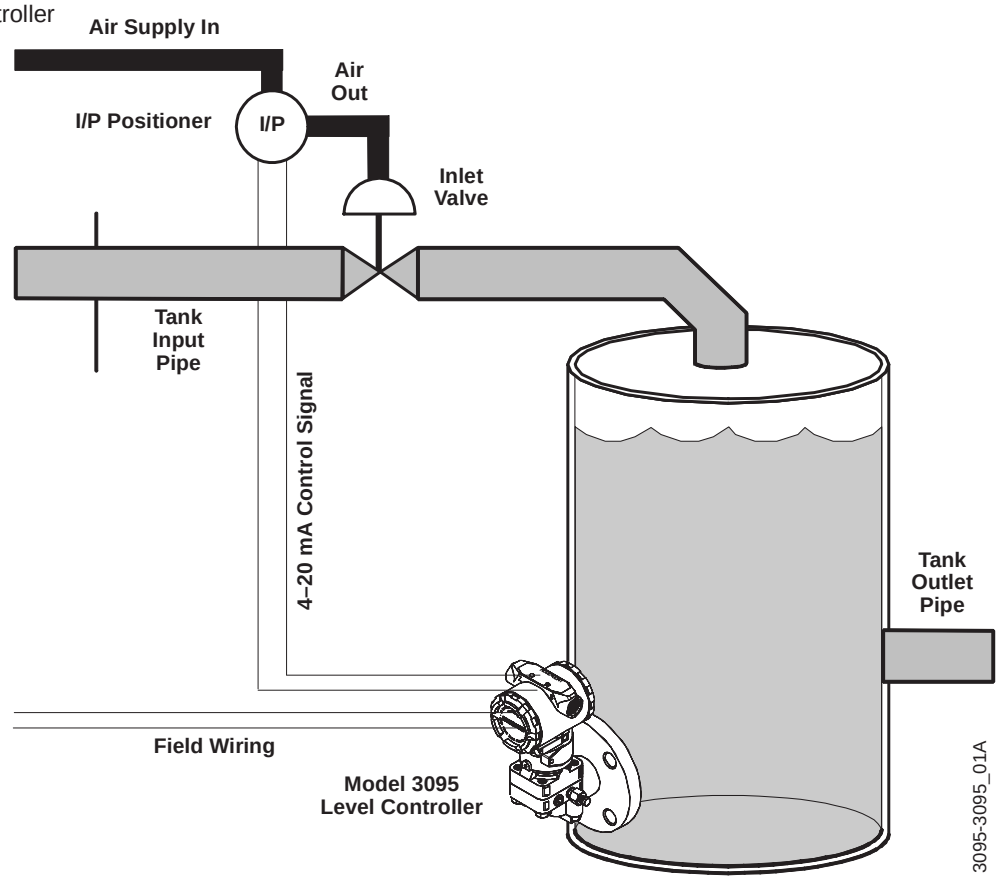


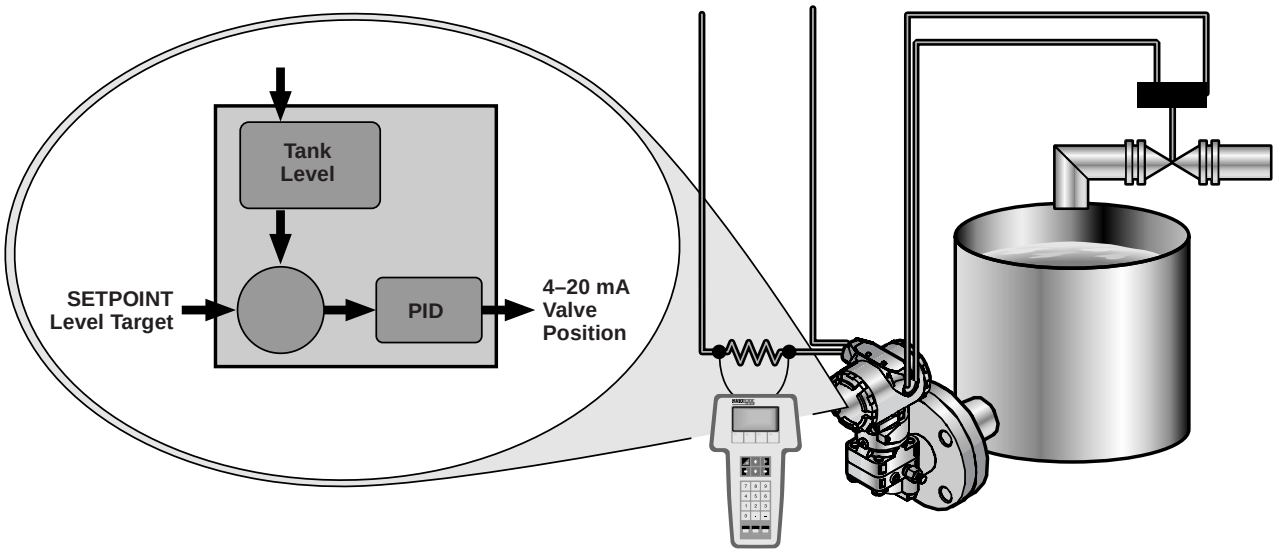
Figure 2-1 illustrates a single loop level control system. The single control loop consists of:

- A level process.
- A Level Controller with a 4–20 mA control output signal.
- An electrical-to-pneumatic converting device such as a 3311 I/P.
- An optional positioner device to correct for valve displacement before valve variations affect the process.
- An actuator device such as a valve.

Figure 2-2 is a more detailed diagram of the level process depicted in Figure 2-1. The *setpoint* is the desired process value at which the user wishes to maintain (control) the process. The error between the setpoint and the actual process variable (as measured by the sensor) is used by the controller to determine the value of its output.

The controller output is an electrical current (in mA) which is used by an electrical-to-pneumatic device, such as an I/P, to control the position of a valve. A positioner, which is mechanically connected to the moving part of the valve, automatically adjusts its output pressure in order to maintain a desired position that bears a predetermined relationship to the input signal.

FIGURE 2-2. Level Controller Process Diagram

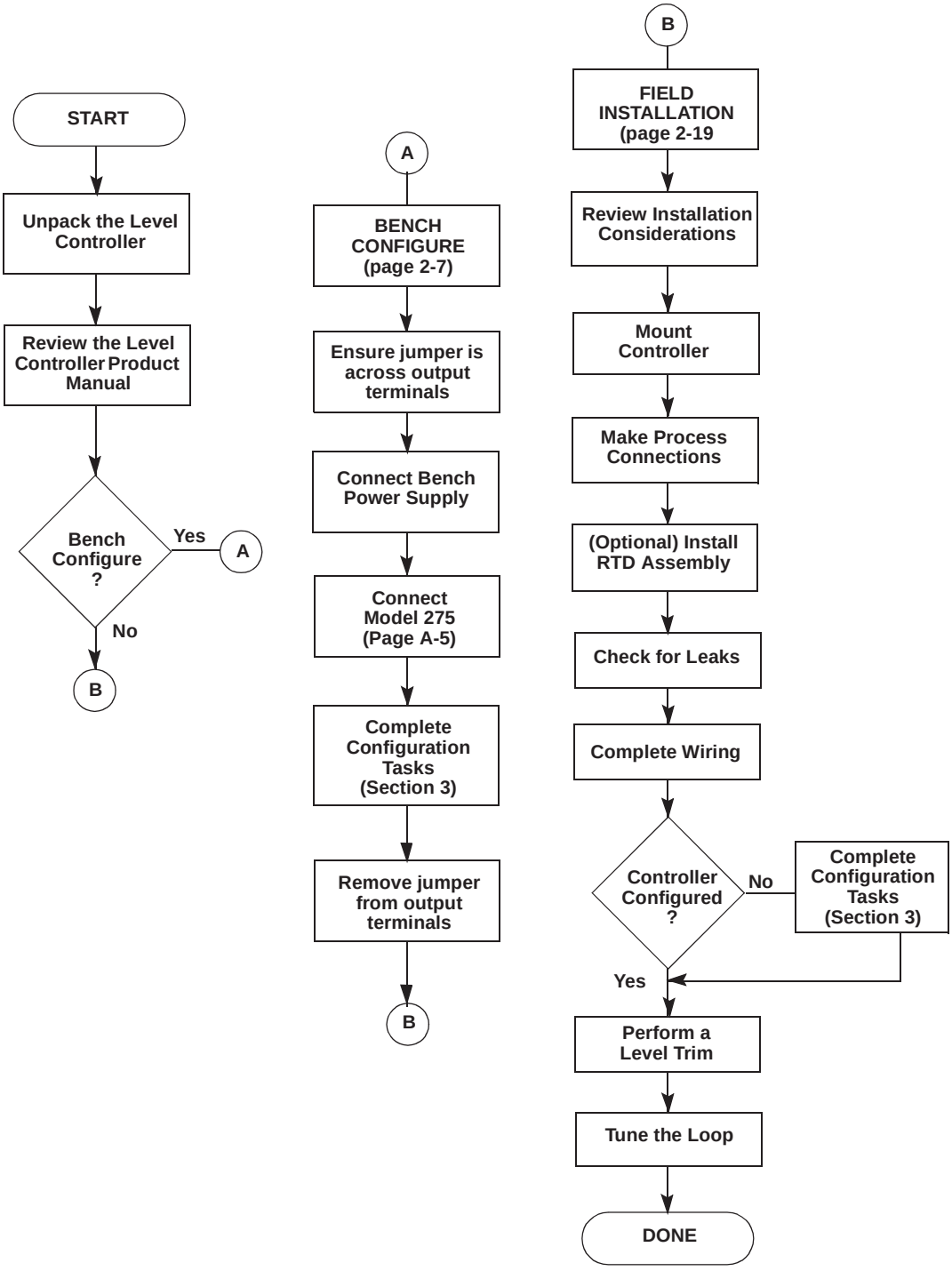


NOTE
The Level Controller differs from a standard transmitter in that the 4–20 mA output is a control output, not a differential pressure (DP) output.

BEFORE YOU BEGIN

Review the flowchart shown in Figure 2-3 before you begin installing the Level Controller. This flowchart summarizes the tasks you should complete to ensure a successful installation.

FIGURE 2-3. Level Controller Installation Flowchart.



UNPACKING THE LEVEL CONTROLLER

The Level Controller arrives in either one or two shipping containers, depending on the system ordered.

Level Controller
This box contains the Level Controller. If ordered, this package also contains an RTD cable and optional mounting hardware. One Model 3095 Multivariable Level Controller Product Manual is included with each order.

RTD Assembly (Optional)
This box contains the optional Series 68 or Series 78 RTD Assembly and the Sensor Wiring Instruction Sheet.

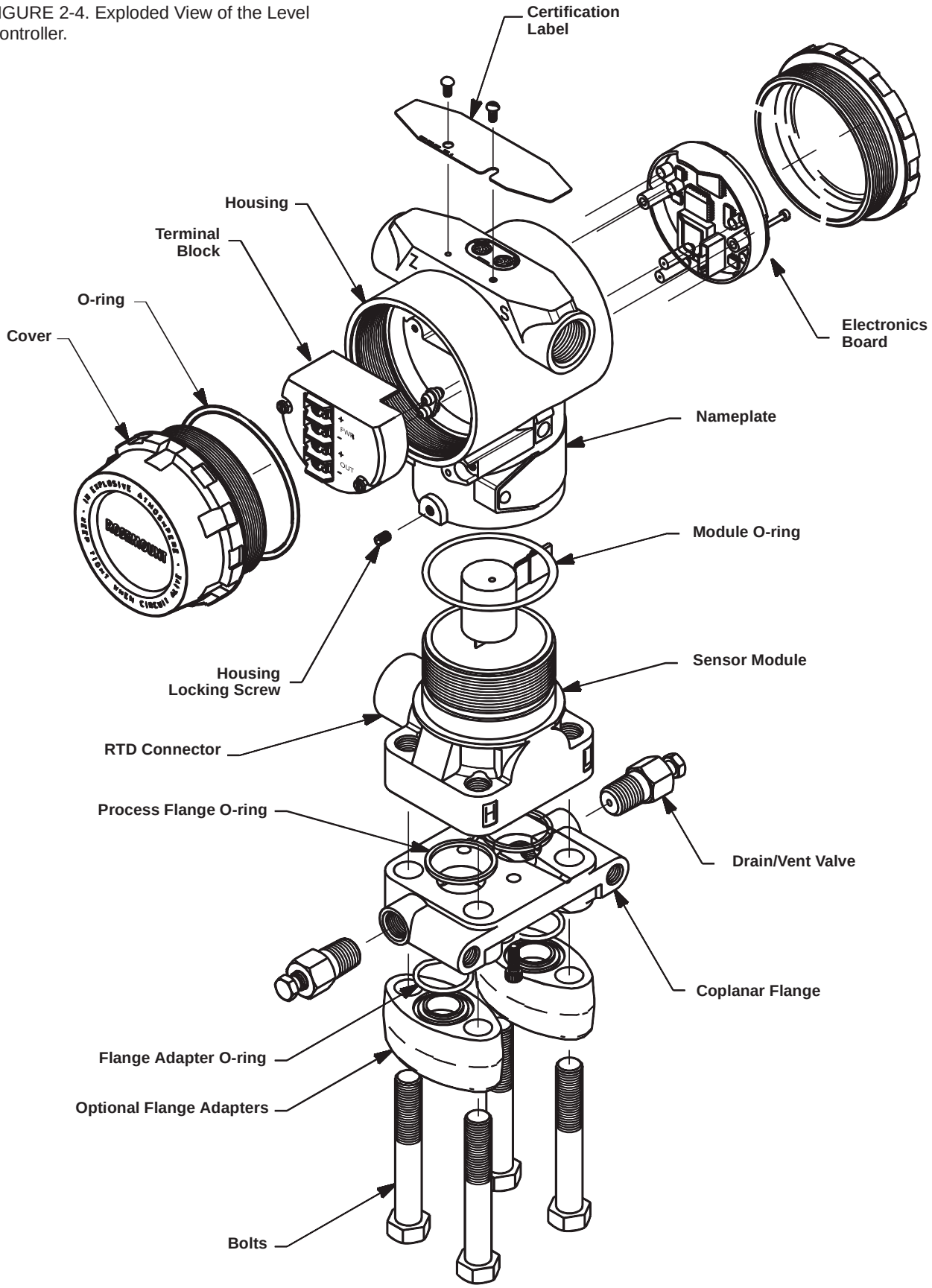
When you unpack the Level Controller:

1. Place the shipping containers on a secure bench and open them, taking care not to damage the contents.
2. Review the packing list to verify that all equipment was received.
3. Inspect the equipment and report any shipping damage to the carrier.

BECOMING FAMILIAR WITH THE LEVEL CONTROLLER

Figure 2-1 on page 2-2 illustrates a typical Level Controller installation site; Figure 2-4 shows the exploded view of the Model 3095 Level Controller. Major components of the Level Controller system and the Level Controller itself are identified in these figures.

FIGURE 2-4. Exploded View of the Level Controller.



BENCH CONFIGURATION

Before mounting the Level Controller in the field, the controller can be configured on the bench using a Model 275 HART Communicator.

NOTE
For bench configuration, a jumper must be installed across the output terminals.

Failure Mode Alarm vs. Saturation Output Values

Failure mode alarm output levels differ from the output values that occur when applied pressure is outside the range points. When pressure is outside the range points, the analog output continues to track the input pressure until reaching the saturation value listed below; the output does not exceed the listed saturation value regardless of the applied pressure. For example, for pressures outside the 4–20 range points, the output saturates at 3.9 mA or 20.8 mA.

When the controller diagnostics detect a failure, the analog output is set to a specific alarm value that differs from the saturation value to allow for proper troubleshooting.

Level	4–20 mA Saturation Value	4–20 mA Alarm Value
Low	3.9 mA	3.75 mA
High	20.8 mA	21.75 mA

Write Protect and Failure Mode Alarm Jumpers

These jumpers are both located on the electronics board just inside the electronics housing cover (see Figure 2-5). Set these jumpers during the commissioning stage on the bench to avoid exposing the controller electronics to the plant environment after installation.

Once the controller has been configured, the configuration data can be protected by moving the write protect (security) jumper. When this jumper is installed, the controller does not allow any changes to its configuration memory.

In the event of a critical hardware failure in the controller, the controller automatically drives the analog output either below 3.75 or above 21.75, depending on the position of the failure alarm jumper.

NOTE
This alarm jumper is different from a level measurement alarm condition. As part of its normal operation, the Level Controller continuously monitors its own operation. This automatic diagnostic routine is a timed series of checks repeated continuously.

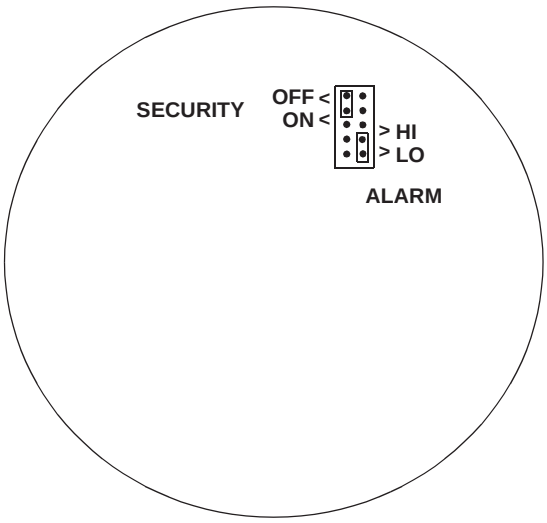
If the controller determines that a level measurement alarm exists, the controller performs one of the two Mode Shed routines (user selected):
– the controller signal freezes at the current level
– the signal switches to a pre-determined mode shed level
See Chapter 4 for additional mode shed information.

When shipped from the factory, the write protect jumper is set to “OFF,” and the alarm jumper is set to “LO.”

Use the following steps to change the jumper settings:

1. If the controller is installed, secure the loop and remove power.
2. Remove the housing cover opposite the field terminal side. Do not remove the instrument cover in explosive atmospheres when the circuit is alive.
3. Locate the jumper(s) on the output electronics board (see Figure 2-5), then move the jumper(s) to the desired setting.
4. Reattach the housing cover. Metal to metal contact is preferred. Both controller covers must be fully engaged to meet explosion-proof requirements.
5. If the controller is installed, reapply power.

FIGURE 2-5. Write Protect and Level Controller Alarm Jumpers.



NOTE
Security jumper not installed = Not Write Protected.
Alarm jumper not installed = High Alarm.

3095-3095G05A, 3095H05A

GENERAL INSTALLATION CONSIDERATIONS

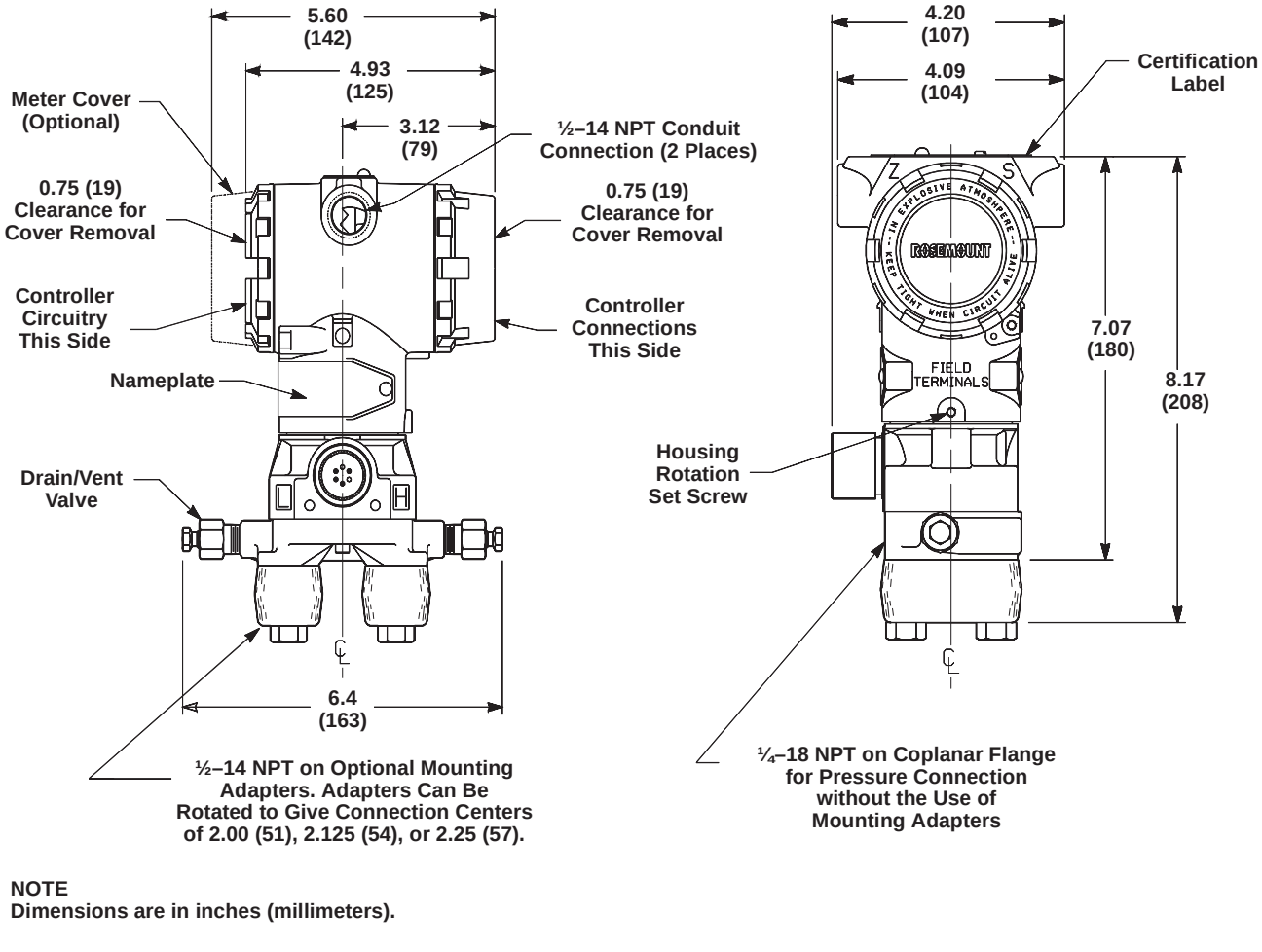
The accuracy of a level control measurement depends upon proper installation of the controller and impulse piping. The piping between the process and the controller must accurately transfer the pressure in order to obtain accurate measurements.

Mount the controller close to the process and use a minimum of impulse piping to achieve best accuracy. Keep in mind, however, the need for easy access, safety of personnel, and a suitable controller environment. (Refer to Figure 2-6 for Level Controller dimensions.) In general, install the controller so as to minimize vibration, shock, and temperature fluctuations.

The high pressure side of the level controller must always be plumbed to the bottom of the tank. For open vessels, the low pressure side of the Level Controller should be vented. For closed vessels, the low pressure side must always be plumbed to the top of the tank.

The following sections discuss the factors to consider for a successful Level Controller installation.

FIGURE 2-6. Dimensional Drawings of Level Controller.



NOTE
Dimensions are in inches (millimeters).

MECHANICAL CONSIDERATIONS

The Level Controller may be direct-mounted, mounted with one or two remote diaphragm seals, mounted with a level flange, or attached to a two-inch pipe with an optional mounting bracket. Figure 2-7 illustrates Level Controller mounting configurations; Figure 2-6 shows the Level Controller dimensions.

Mounting Considerations

The Level Controller total weight varies depending on the components ordered (see Table 2-1). This weight must be securely supported.

TABLE 2-1. Controller Weight.

Component	Weight lb (kg)
Level Controller	6.0 (2.7)
SST Mounting Bracket	1.0 (0.4)
12 ft (3.66 m) RTD Shielded Cable	0.5 (0.2)
12 ft (3.66 m) RTD Armored Cable	1.1 (0.5)
24 ft (7.32 m) RTD Shielded Cable	1.0 (0.4)
24 ft (7.32 m) RTD Armored Cable	2.2 (1.0)

Bolt Installation Guidelines

The following guidelines have been established to ensure a tight flange, adapter, or manifold seal. Use only bolts supplied with the controller or sold by Rosemount Inc. as a spare part to the Level Controller. Unauthorized parts can affect product performance and may impair the protection provided by the equipment.

The Level Controller is shipped with the Coplanar™ flange installed with four 1.75-inch flange bolts. The following bolts also are supplied to facilitate other mounting configurations:

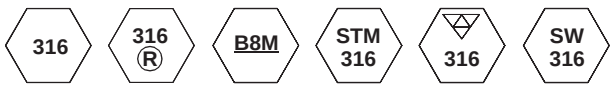
- Four 2.25-inch manifold/flange bolts for mounting the Coplanar flange on a three-valve manifold. In this configuration, the 1.75-inch bolts may be used to mount the flange adapters to the process connection side of the manifold.
- (Optional) If flange adapters are ordered, four 2.88-inch flange/adapter bolts for mounting the flange adapters to the Coplanar flange.

Figure 2-7 shows the optional mounting bracket and mounting configurations. Figure 2-8 shows mounting bolts and bolting configuration for the Level Controller with the Coplanar flange.

Stainless steel bolts supplied by Rosemount Inc. are coated with a lubricant to ease installation. Carbon steel bolts do not require lubrication. Do not apply additional lubricant when installing either type of bolt. Use the equipment only as specified in this manual. Failure to do so may impair the protection provided by the equipment. Bolts supplied by Rosemount Inc. are identified by the following head markings:

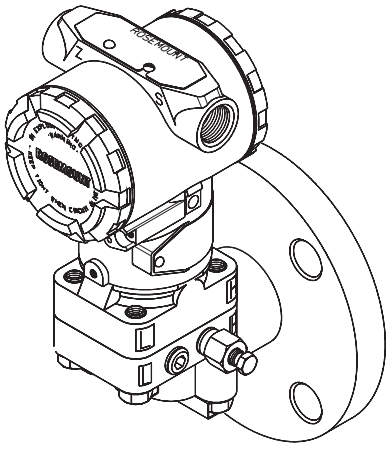
Carbon Steel Head Markings (CS)

Stainless Steel Head Markings (SST)

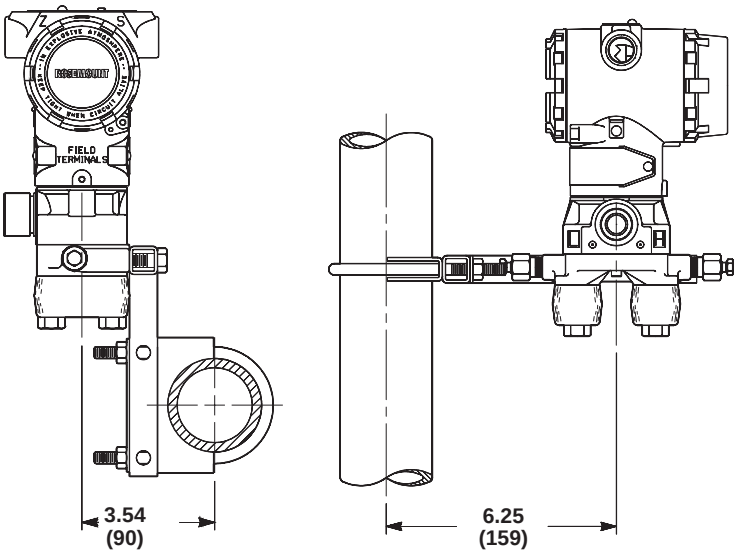


3051-3031106A

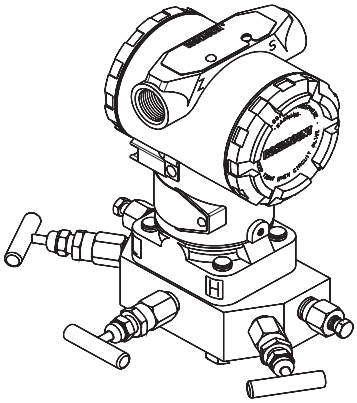
FIGURE 2-7. Mounting Configurations and Optional Mounting Accessories.



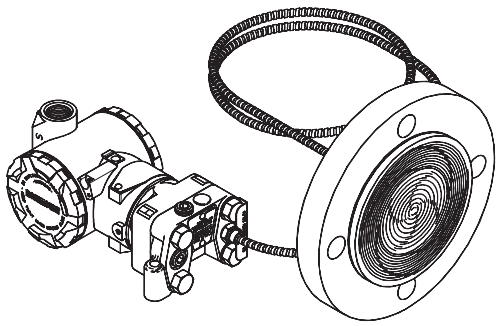
LEVEL FLANGE



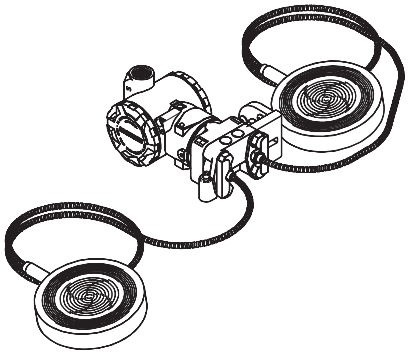
PIPE MOUNTED WITH OPTIONAL BRACKET



INTEGRAL MOUNT MANIFOLD



ONE DIAPHRAGM SEAL



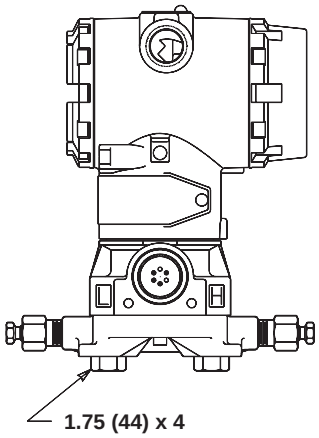
TWO DIAPHRAGM SEALS

NOTE
Dimensions are in inches (millimeters).

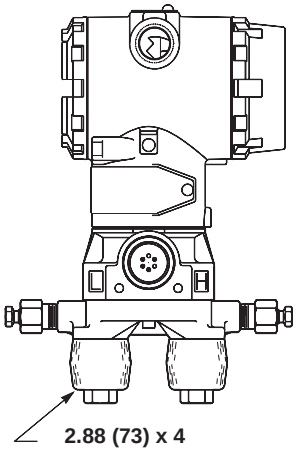
3001-3051AO1A, 3095-3095K04A, 3095L04A 3051\305-3031A29B, 3051-3051A29B, A28A

FIGURE 2-8. Coplanar Mounting Bolts and Bolting Configurations for Coplanar Flange.

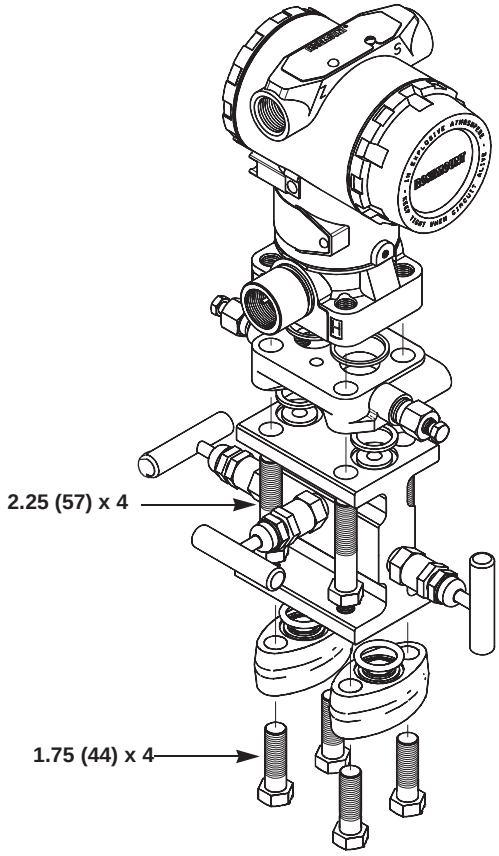
Description	Qty.	Size in. (mm)
Flange bolts	4	1.75 (44)
Flange/adapter bolts	4	2.88 (73)
Manifold/flange bolts	4	2.25 (57)



CONTROLLER WITH FLANGE BOLTS



CONTROLLER WITH OPTIONAL FLANGE ADAPTERS AND FLANGE/ADAPTER BOLTS



CONTROLLER WITH 3-VALVE MANIFOLD MANIFOLD/FLANGE BOLTS FLANGE ADAPTERS AND FLANGE/ADAPTER BOLTS

3095-3095D05M, 3095C05A, 3095C29A

NOTE
Dimensions are in inches (millimeters).

EXAMPLE INSTALLATIONS

Figure 2-9 illustrates example installations for the Model 3095 Level Controller. “H” and “L” in the examples correspond to the H and L stamped on the Level Controller sensor module and indicate which way the controller is to be installed.

Open Tanks

In open vessels a pressure controller mounted near the bottom of the tank will measure the pressure corresponding to the height of the fluid above it.

The connection is made to the high pressure side of the controller. The low pressure side is vented to atmosphere.

Process Connections Options: Impulse piping; one diaphragm seal, (capillary or direct mount) level flange.

Open Tanks with Bubbler

A “bubbler” system using a top-mounted controller can be used in open vessels. This system consists of an air supply, a constant flow regulator, a controller, and tube extending down into the vessel.

Air is bubbled through the tube at a constant flow rate. The pressure required to maintain flow is determined by the vertical height of the liquid above the tube opening, process density, and local gravity.

Process Connections Option: Impulse piping,

Closed Tanks with Dry Leg

In closed vessels, the pressure above the liquid will affect the pressure measured at the bottom. The pressure at the bottom of the vessel is determined by the height of the liquid, the density of the liquid, plus the vessel pressure.

To measure true level, the vessel pressure must be subtracted from the measurement. This is accomplished by making a pressure tap at the top of the vessel and connecting this to the low side of a differential pressure controller. Vessel pressure is now equally applied to both the high and low sides of the controller. The resulting differential pressure is determined by liquid height, process density, and specific gravity.

If the gas above the liquid does not condense, the piping for the low side of the controller will remain empty. Calculations for determining the controller height will be the same as those shown for open vessel bottom mounted controllers.

Process Connections Options: Impulse piping; one diaphragm seal (capillary or direct mount); two diaphragm seals, level flange.

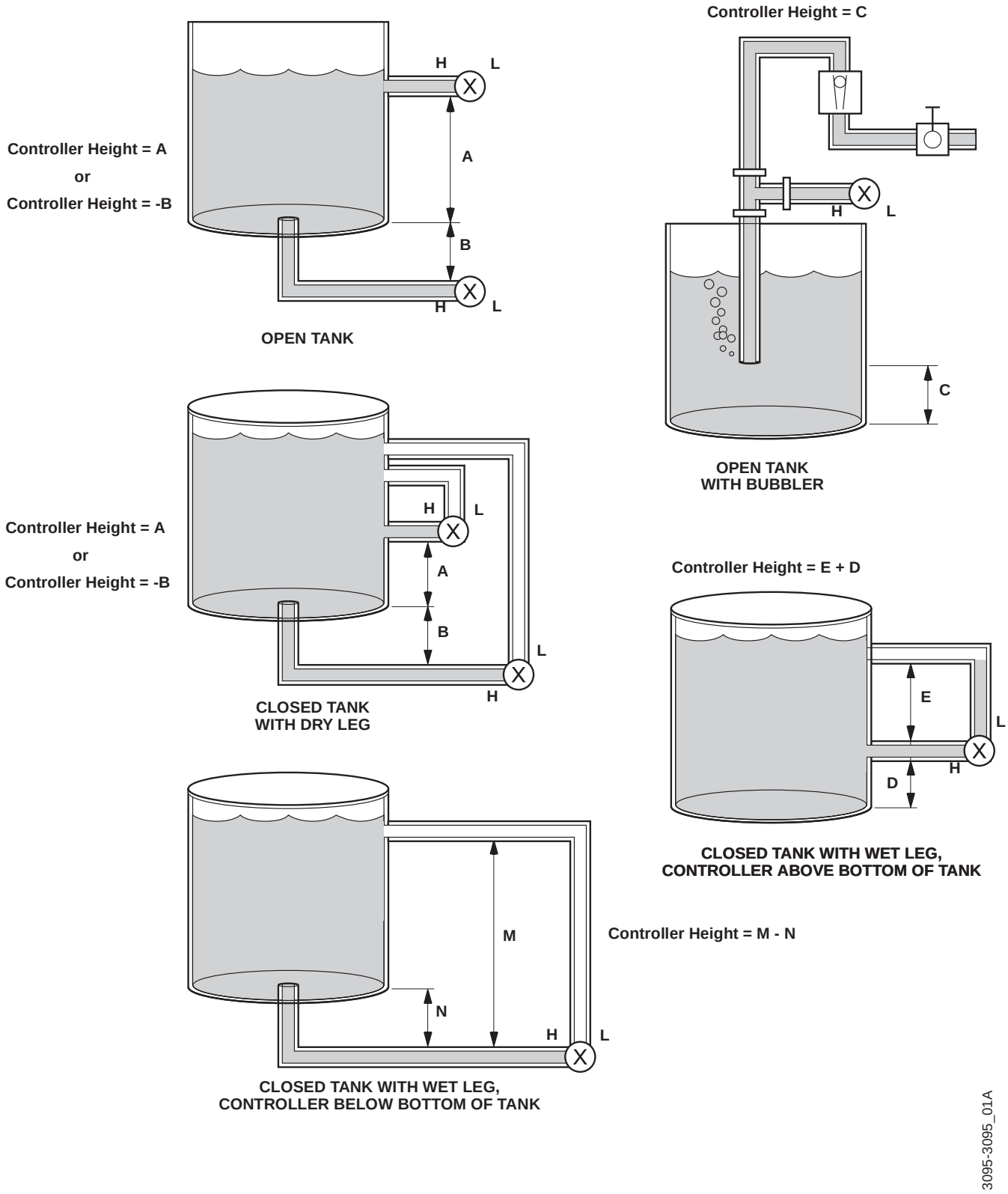
Closed Tanks with Wet Leg

If the gas above the liquid condenses, the piping for the low side of the controller will slowly fill up with liquid. To eliminate this potential error, the pipe is purposely filled with a convenient reference fluid.

The reference fluid exerts a head pressure on the low side of the controller.

Process Connections Options: Impulse piping; one diaphragm seal (capillary or direct mount); two diaphragm seals, level flange.

FIGURE 2-9. Example Installations.



TAP CONSIDERATIONS

When the Level Controller is oriented on its side, the Coplanar™ flange may be mounted to ensure proper venting or draining. Mount the flange so that the drain/vent connections are on the top half of the flange for liquid service.

CAUTION
In elevated temperature services, it is important that temperatures at the Coplanar process flanges not exceed 250 °F (121 °C).

Impulse Piping

The piping between the process and the controller must accurately transfer the pressure in order to obtain accurate control. In this pressure transfer, there are five possible sources of error: leaks, friction loss (particularly if purging is used), trapped gas in a liquid line, and temperature-induced or other density variation between the legs.

The best location for the Level Controller in relation to the process pipe depends on the process itself. Consider the following guidelines in determining controller location and placement of impulse piping:

- Keep impulse piping as short as possible.
- Slope the impulse piping at least one inch per foot (8 centimeters per meter) upward from the controller toward the process connection for liquid.
- Avoid high points in liquid lines.
- Make sure both impulse legs are the same temperature.
- Use impulse piping large enough to avoid friction effects and prevent blockage.
- Vent all gas from liquid piping legs.
- Avoid purging through the controller.
- Keep corrosive or hot (above 250 °F (121 °C)) process material out of direct contact with the sensor module and flanges.
- Prevent sediment deposits in the impulse piping.
- Avoid conditions that might allow process fluid to freeze within the process flange.

Diaphragm Seals

Because instrument response time is directly proportional to capillary length, and the fill fluid volume in the capillary changes with temperature to affect the output, care must be taken to optimize performance:

- Keep the capillary length as short as possible.
- Mount a controller with one seal at the same level, or below the seal and process connection. Use direct mount when possible.
- In vacuum applications, mount the controller below the lower tap to ensure proper operation. This requirement applies to both one- and two-seal systems.
- Avoid mounting seals and capillaries in direct sunlight.
- Keep the capillary lengths equal when two seals are involved.
- Rezero the controller on a seasonal basis.
- Never attempt to disconnect the seals or capillaries. Doing so will void the warranty.

ENVIRONMENTAL CONSIDERATIONS

Mount the Level Controller to minimize ambient temperature changes. **Section 6: Level Controller Specifications and Reference Data** lists the Model 3095 temperature operating limits. Mount the Level Controller to avoid vibration and mechanical shock, and to avoid external contact with corrosive materials.

Access Requirements

When choosing an installation location and position, take into account the need for access to the controller.

Process Flange Orientation

The process flanges must be oriented so that process connections can be made. In addition, consider the possible need for testing the controller.

CAUTION
Drain/vent valves must be oriented so that process fluid is directed away from technicians when the valves are used.

Housing Rotation

The electronics housing may be rotated to improve field access to the two compartments. To rotate the housing less than 90 degrees, release the housing rotation set screw and turn the housing not more than 90 degrees from the orientation shown in Figure 2-7 on page 2-11. To rotate the housing more than 90 degrees, follow steps 1–6 of the disassembly procedure on page 5-11.

CAUTION
Rotating the housing more than 90 degrees without performing the disassembly procedure may damage the Level Controller sensor module.

Terminal Side of Electronics Housing

Wiring connections are made through the conduit openings on the top side of the Level Controller housing. The field terminal side is marked on the housing.

Mount the Level Controller so that the terminal side is accessible. A 0.75-inch clearance is required for cover removal.

Install a conduit plug on the unused side of the conduit opening.

Circuit Side of Electronics Housing

The circuit compartment should not routinely need to be opened when the unit is in service; however, provide 0.75 inches minimum clearance if possible to allow access.

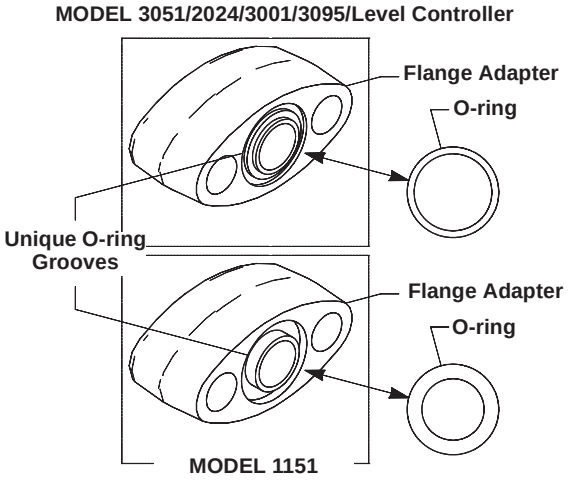
Process Considerations

Level Controller process connections on the controller flange are ¼–18 NPT. Flange adapter unions with ½–14 NPT connections are available as options. These are Class 2 threads; use your plant-approved lubricant or sealant when making the process connections. The process connections on the controller flange are on 2 1/8-inch (54-mm) centers to allow direct mounting to a three- or five-valve manifold. By rotating one or both of the flange adapters, connection centers of 2, 2 1/8, or 2¼ inches (51, 54, or 57 mm) may be obtained.

There are two styles of Rosemount flange adapters, each requiring a unique O-ring, as shown below. Each flange adapter is distinguished by its unique groove. Use only the O-ring designed to seal with the corresponding flange adapter.

Use only the O-ring designed to seal with the corresponding flange adapter. Failure to install proper flange adapter O-rings can cause process leaks.

FIGURE 2-10. Flange Adapter O-rings.



When compressed, Teflon® O-rings tend to cold flow, which aids in their sealing capabilities. Whenever flanges or adapters are removed, visually inspect the Teflon O-rings. Replace them if there are any signs of damage, such as nicks or cuts. If they are undamaged, they can be reused. If the O-rings are replaced, the flange bolts may need to be retorqued after installation to compensate for cold flow. Refer to the process sensor body reassembly procedure on page 5-16.

ELECTRICAL CONSIDERATIONS

The signal terminals are located in a compartment of the electronics housing separate from the controller electronics. Figure 2-11 illustrates power supply load limitations for the controller.

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 resistor, actuator, indicator, and related pieces. Note that the resistance of intrinsic safety barriers, if used, must be included.

NOTE

A loop resistance between 250–1100 ohms inclusive is required to communicate with a HART Communicator. With 250 ohms of loop resistance, a power supply voltage of at least 16.5 V dc is required. Quick troubleshooting check: there must be at least 11.0 V dc across the controller terminals.

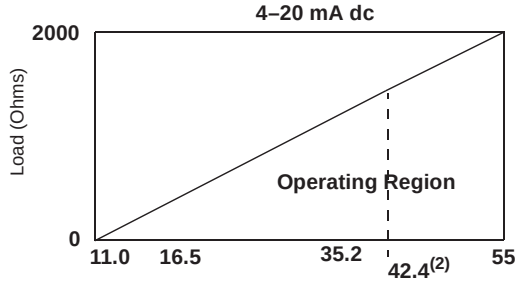
If a single power supply is used to power more than one Level Controller, the power supply used, and circuitry common to the controllers, should not have more than 20 ohms of impedance at 1200 Hz.

For CSA approval, power supply must not exceed 42.4 V dc.

FIGURE 2-11. Power Supply Load Limitations.

Loop resistance is determined by the voltage level of the external power supply, as described by:

$$\text{Max. Loop Resistance} = \frac{\text{Power Supply Voltage} - 11.0 - \text{Actuator Voltage}^{(1)}}{0.022}$$



HART protocol communication requires a loop resistance value between 250–1100 ohms, inclusive.

(1) Actuator Voltage is the maximum voltage drop across the actuator device.

(1) For CSA approval, power supply must not exceed 42.4 V dc.

3051-0103A

FIELD INSTALLATION PROCEDURE

The field installation procedure involves mounting the Level Controller, connecting it to the process, and completing the field wiring.

Field Installation Equipment

The following equipment and tools are *not* provided with the Level Controller. Be sure to review this list before field installing the controller.

- Installation tools
- Field wire between the power supply and the Level Controller and between the Level Controller and the actuator device
- Actuator device
- Barriers or seals required for hazardous locations
- Conduit
- 2-in. mounting pipe or saddles
- Power supply
- 3- or 5-valve manifold
- Impulse piping
- Tie wraps
- Load resistor

Review Installation Considerations

Review the installation considerations described on pages 2-9 through 2-18 in this section to determine the location for the Level Controller.

Mount Controller and Install Bolts

Mount the Level Controller in the desired location, and install flange or flange/adapter bolts. Only use bolts supplied with the Level Controller or sold by Rosemount Inc. as a spare part to the Level Controller. Unauthorized parts can affect product performance and may impair the protection provided by the equipment.

1. Finger-tighten the bolts.
2. Torque the bolts to the initial torque value (see Table 2-2) using a cross-pattern.
3. Torque the bolts to the final torque value (see Table 2-2) using the same cross-pattern.

TABLE 2-2. Bolt Installation Torque Values.

Bolt Material	Initial Torque Value	Final Torque Value
Carbon Steel (CS)	300 in-lb (407 n-m)	650 in-lb (881 n-m)
Stainless Steel (SST)	150 in-lb (203 n-m)	300 in-lb (407 n-m)

When installing the controller to one of the mounting brackets, torque the mounting bracket bolts to 125 in-lb (169 n-m).

Make Process Connections

Connect the Level Controller to the process. All four flange bolts must be installed and tight before applying pressure, or process leakage will result. When properly installed, the flange bolts protrude through the top of the module housing. Attempting to remove the flange bolts while the controller is in service will result in process leaks.

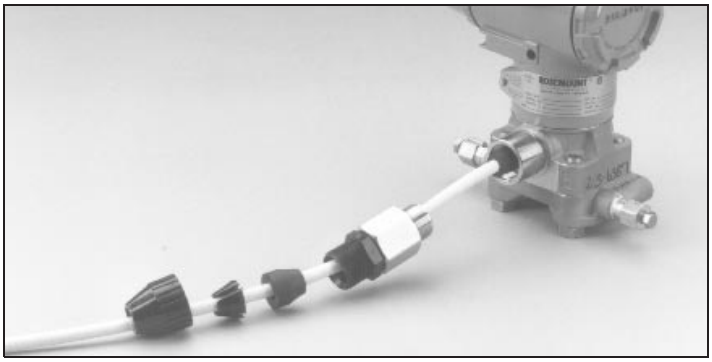
Install RTD Assembly

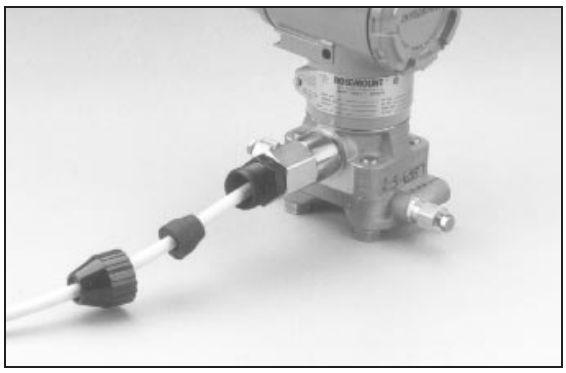
The external RTD assembly is optional and not required for Level Controller operation. The RTD Assembly allows you to read temperatures as a HART variable only.

To install the Series 68 or Series 78 RTD Assembly:

1. Mount the RTD Assembly in the desired location. Refer to the appropriate differential producer standard concerning recommended RTD installation location.
2. Connect the RTD cable to the Level Controller RTD connector. **First, fully engage the black cable connector**, then screw in and tighten the cable adapter until metal to metal contact occurs (see photos).

FIRST, FULLY ENGAGE THE BLACK CABLE CONNECTOR



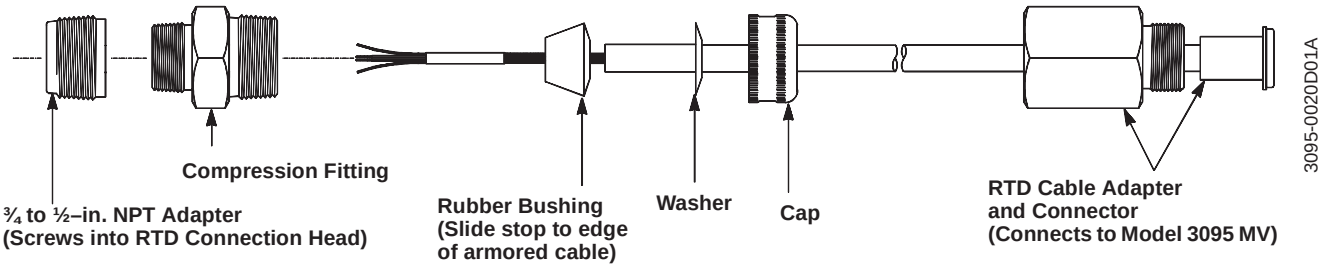


SECOND, SCREW IN AND TIGHTEN THE CABLE ADAPTER UNTIL METAL TO METAL CONTACT OCCURS

THIRD, SCREW IN AND TIGHTEN THE STRAIN RELIEF CLAMP

3095-069AB, 068AB, 067AB

3. (Optional) If using an armored, shielded cable, install the armored cable compression seal as illustrated below, and use a pliers to tighten the cap onto the compression fitting
4. Make all necessary wiring connections inside the RTD Flat Connection Head as explained in the Sensor Wiring Instructions included with the RTD.



Check for Leaks

⚠ Check all process penetrations for leaks. Process leaks can cause death or serious injury.

Field Wiring (Power and Signal)

Make field wiring connections (see Figure 2-12). These connections provide both power and signal wiring.

⚠ For *all* installations, wiring connections must be made in accordance with local or national installation codes such as the NEC NFPA 70. Make sure only qualified personnel perform these procedures.

NOTES

- Do not run field wiring in conduit or open trays with other power wiring, or near heavy electrical equipment.
- Field wiring need not be shielded, but use twisted pairs for best results.
- To ensure communication, wiring should be 24 AWG or larger and not exceed 5,000 feet (1,500 meters).
- For connections in ambient temperatures above 140 °F (60 °C), use wiring rated for at least 194 °F (90 °C).

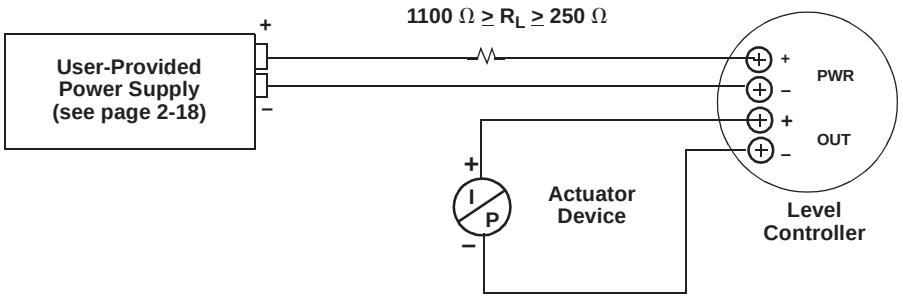
⚠ 1. Remove the cover on the side marked FIELD TERMINALS on the electronics housing. Do not remove the instrument cover in explosive atmospheres when the circuit is alive.

⚠ 2. Connect the lead that originates at the positive side of the power supply to the terminal marked "+ PWR." Be sure to include loop resistance. Avoid contact with leads and terminals.

3. Connect the lead that originates at the negative side of the power supply to the terminal marked "– PWR."

4. Connect the I/P or other actuator device to "+ OUT" and "– OUT."

FIGURE 2-12. Field Wiring Connections.



NOTE

If you are not connecting the OUT terminals to an actuator device, you must install a jumper wire between "+ OUT" and "– OUT" for proper operation.

5. Plug and seal unused conduit connections on the Level Controller housing to avoid moisture accumulation in the terminal side of the housing. The unused conduit opening on the controller housing must be plugged and sealed to meet explosion-proof requirements.

NOTE
If the conduit connections are not sealed, mount the Level Controller with the electrical housing positioned downward for drainage. Conduit should be installed with a drip loop, and the bottom of the drip loop should be lower than the conduit connections or the controller housing.

Install Field Wiring Grounds

Field wiring may be grounded at any one point on the signal loop, or it may be left ungrounded. The negative terminal of the power supply is a recommended grounding point.

The controller case should always be grounded in accordance with national and local electrical codes. The most effective controller case grounding method is direct connection to earth ground with minimal impedance. Methods for grounding the controller case include:

- **External Ground Assembly**: This assembly is included with the transient protection terminal block. The External Ground Assembly can also be ordered as a spare part (03031-0398-0001).
- **Internal Ground Connection**: Inside the FIELD TERMINALS side of the electronics housing is the Internal Ground Connection screw. This screw is identified by a ground symbol:  .

NOTE
The transient protection terminal block does not provide transient protection unless the controller case is properly grounded. Use the above guidelines to ground the controller case.

Do not run the transient protection ground wire with field wiring as the ground wire may carry excessive current if a lighting strike occurs.

Grounding the controller case using threaded conduit connection may not provide sufficient ground.

Replace Cover

Replace the Level Controller cover. Both controller covers must be fully engaged to meet explosion-proof requirements.

CALIBRATION

The Level Controller does not require any bench or field calibration. The differential pressure sensor has been factory calibrated from – URL to + URL.

After installation, a standard level trim (offset and slope) must be completed (see page 4-10).

Section 3

Level Controller Operation

INTRODUCTION

The Model 3095 Multivariable Level Controller is a multi-variable differential pressure transmitter and level controller combined into one instrument. Because external controllers are not needed to operate the Model 3095 Multivariable Level Controller, installation costs are significantly reduced, while accuracy, performance, and reliability of the control loop increases.

Rosemount has designed the Model 3095 Multivariable Level Controller to provide users with the same benefits of stand-alone transmitters and external controllers. This section explains the operation, design, functionality and options of the Level Controller.

LEVEL VARIABLES AND VALUES

The 3095 Level Controller measures differential pressure (DP) and uses that measurement to calculate process level. The level calculation is completed by the sensor microprocessor using the following equation:

$$\text{Level} = (\text{DP} \div \text{Density} \times \text{Gravity}) + \text{Transmitter Height}$$

The calculation uses values for density, gravity, and transmitter location compared to the bottom of the vessel, as specified by the operator.

The operator uses the Model 275 HART communicator or AMS to input the following variables:

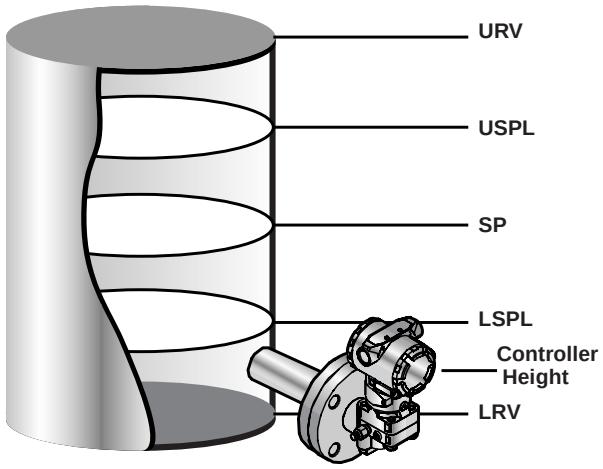
- Units of measure
- Density
- Gravity (if different from default)
- Upper Range Value (tank height)
- Lower Range Value (recommend bottom of tank, or 0)
- Setpoint
- Setpoint limits (recommend below the top of the tank)

The Level Controller assumes a constant density and does not correct for density changes caused by ambient temperature changes.

Level is the primary variable used by the output board to compare to the user-specified setpoint. The calculated level is converted into a unit-less variable based on percentage, which is determined by the Range Values (or, tank height) as specified by the operator.

- *Range values* should be from the bottom of the tank (0) to the tank height.
- *Setpoint Upper Limit* should be below the top of the tank to prevent overflow.

FIGURE 3-1. Recommended Range Values and Setpoint Limits.



KEY:
Upper Range Value (URV) = Top of Vessel
Upper Setpoint Limit (USPL) = Select Below Vessel Top
Setpoint (SP)
Level Controller Height = Measured from Vessel Bottom
Lower Setpoint Limit (LSPL) = Select Above Vessel Bottom
Lower Range Value (LRV) = Bottom of Vessel

LEVEL CONTROLLER SENSOR

The Model 3095 Level Controller uses the proven multi-variable sensor designed for the Rosemount 3095 series multi-variable transmitters.

This multi-variable sensor is designed with Rosemount's capacitance sensor technology and microprocessor-based sensor correction coefficients delivery for ±0.075% accuracy for the DP sensor.

There is no need to calibrate the DP sensor. All Model 3095 Level Controllers are factory-calibrated from –LRL to +URL.

The Level Controller uses the DP input to calculate the Primary Variable, which is *Level*. Instead of calibration, the user simply completes a Level Trim after installation of the Level Controller.

PID CONTROLLER DESCRIPTION AND DETAILS

The Model 3095 Multivariable Level Controller features a series-type controller for Proportional (P), Proportional and Derivative (PD), Proportional and Integral (PI), and Proportional-Integral-Derivative (PID) control modes.

The controller algorithm:

- Sets the control type (PID)
- Performs Start-up, Control Output, and Mode Shedding
- Activates modes (out-of-service, manual, auto)
- Provides a “bumpless transfer” between mode transitions
- Initiates Setpoint, Rate Limits, and Setpoint Tracking
- Initiates power-up variables
- Initiates Adaptive Bias and Manual Bias

The controller algorithm is updated three times per second. Although the Level Controller can perform several tasks in Auto Mode, some specific tasks must be completed in Manual or Out-of-Service mode. Table 3-1 provides a list of Level Controller tasks and the modes in which those tasks must be performed.

FIGURE 3-2. PID Block Diagram.

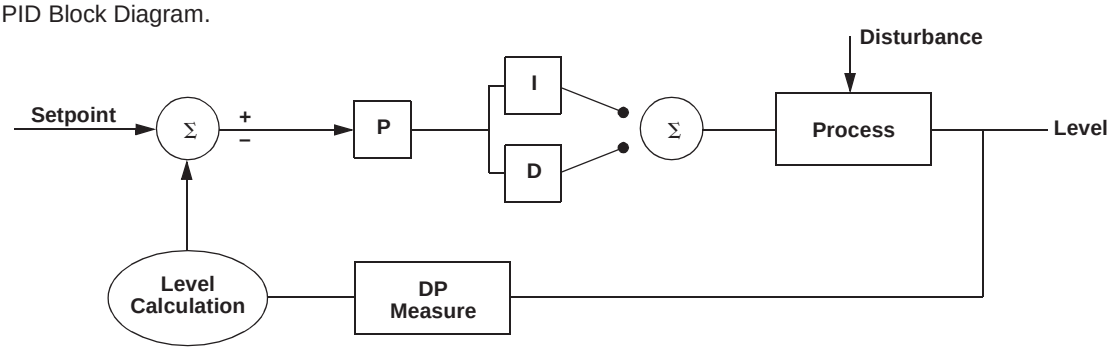


TABLE 3-1. Level Controller Tasks and Operation Modes.

Level Controller Parameter or Task	Required Mode
Level Parameters	MAN, OOS
Control Type and Action	MAN, OOS
Setpoint Adjustment	ALL
Setpoint Limits	ALL
Setpoint Tracking	ALL
Control Setup	ALL
Control Gain	ALL
Controller Output	MAN, OOS
Autotuner Setup	AUTO, MAN, OOS
Autotuner “Alpha”	AUTO, MAN, OOS
Invoke Auto-tuning	AUTO, MAN
Manual Output	MAN
Mode Shed Configuration	ALL
Local Operator Interface Units	ALL
Local Operator Interface Slots	ALL
Local Operator Interface Enable	ALL
RTD Install	ALL
Range Values	ALL
Units Code	ALL
Damping Values	ALL
Sensor Trim	MAN, OOS
DAC Trim	OOS
Trim Recall	MAN, OOS
Tag, Description, Date	ALL
Final Assembly Part Numbers	ALL
Materials of Construction	MAN, OOS
Trim Recall	MAN, OOS

OOS = Out-of-Service
MAN = Manual Mode
AUTO = Automatic Mode
ALL = All Modes

AUTOTUNING

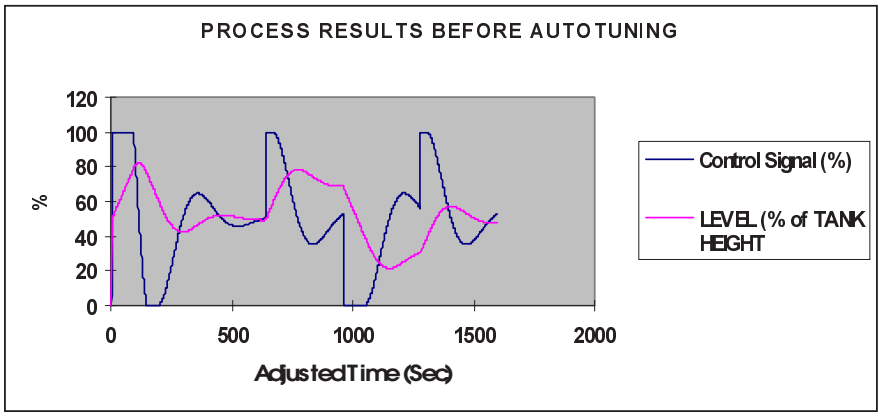
The Model 3095 Level Controller is available with Rosemount’s Autotuning algorithm, which accurately determines the optimal tuning parameters for a level control loop without operator interaction. The Autotuner algorithm is specified by the “CC” option code in the level controller ordering table.

Improved loop tuning results in superior process control, reduced process variability, an increase in loop performance, and extended control element life. The Autotuner determines the optimal tuning parameters after the user enters the required autotuning setup information.

Why Autotune?

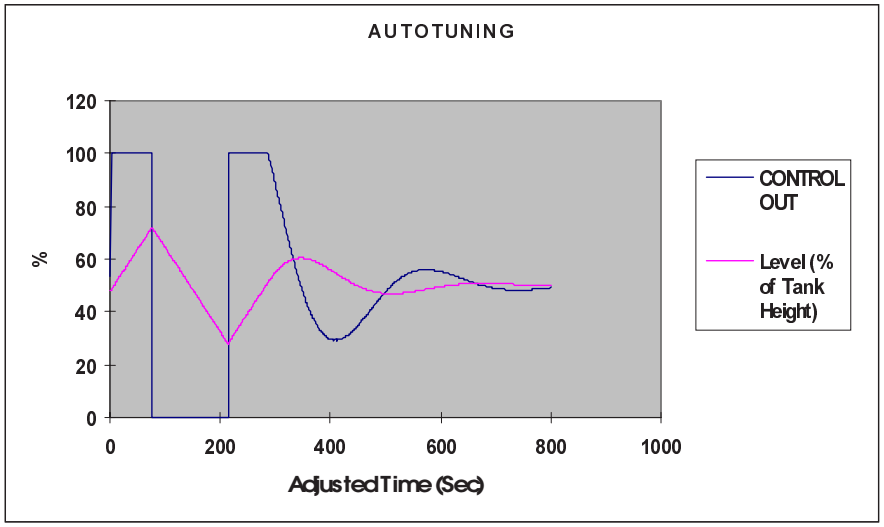
A poorly tuned loop results in poor process level control and excess stress on the control element. Figure 3-3 illustrates the relationship between the Control Signal percentage and the Level (or, percent of tank height) of a poorly tuned loop.

FIGURE 3-3. Example of a Poorly Tuned Loop.



A properly tuned loop results in significant reductions in process variability, as shown in Figure 3-4.

FIGURE 3-4. Example of the Same Loop After Autotuning.



Autotuner Operation

The Level Controller Autotuner works without any pre-tuning of the control loop. The Autotuner functions under any condition, and does not require a steady-state process.

Use the Model 275 HART Communicator or Asset Management Solutions (AMS) to simply input the required tuning setup parameters, which are:

- Level limits around a setpoint to tune
- Level limits allowable overshoot
- Control output minimum and maximum percentage
- Number of cycles

The Autotuner automatically activates the control element to change the vessel's level to the minimum and maximum level limits. This activation repeats for the number of cycles and time as specified by the user. As the process level changes, the Level Controller learns the loop's dynamics: the rate of change level, dead time, and the dynamics of the control element. The Level Controller uses Ziegler-Nichols IMC tuning rules to calculate the optimal tuning processes (process gain, delay, and bias).

The Level Controller informs the user when tuning is completed successfully, and asks the user to accept or reject the calculated tuning parameters. If accepted, the new parameters must then be sent to the Level Controller to be used.

If the Level Controller is not able to successfully calculate new tuning parameters, the Level Controller aborts the Autotune procedure and informs the user of a tuning failure. Common reasons for an unsuccessful Auto-tune include a lack of sufficient time to complete the cycles, or an insufficient allowable overshoot.

To help ensure a successful Autotune,

- Set the High and Low level limits close to the setpoint.
- Ensure that you have allowed a sufficient overshoot.
- Allow for additional cycles for extremely noisy processes; one cycle is usually sufficient for standard applications.
- Allow enough time to complete the number of Auto-tuning cycles selected.

Alpha Adjustment for Tuning

The Level Controller Auto-tuning algorithm features the ability to recalculate the tuning parameters after adjustments were made to the controller. The "Alpha Adjustment Knob" allows users to adjust the controller variables without having to complete a new Autotuning routine.

ADAPTIVE BIAS CONTROL

Rosemount's Adaptive Bias Control algorithm is a standard offering with the Model 3095 Level Controller. The Adaptive Bias Control (ABC) algorithm is used when operating in Proportional (P) or Proportional-Derivative (PD) modes. Adaptive Bias Control eliminates limit cycling caused by the control element's attempts to adjust the level around a setpoint.

When to Use Adaptive Bias Control

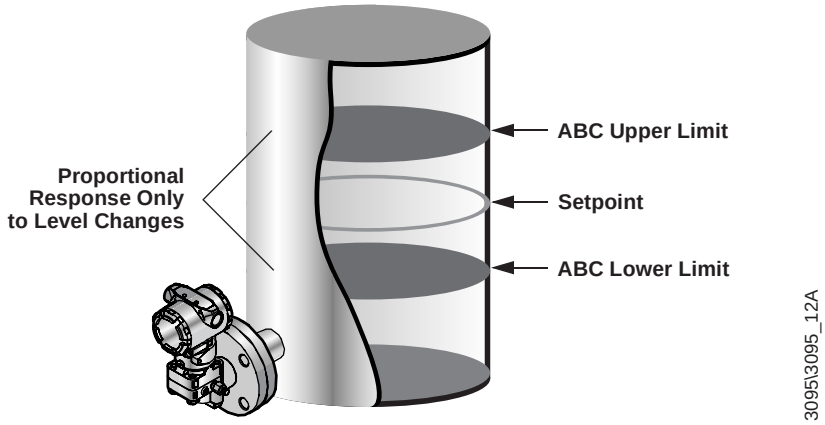
ABC is used when the application does not require accurate control around the setpoint. In these applications, standard PID or PI control can result in a large amount of limit cycling as the control element attempts to maintain the level around the setpoint. Excessive limit cycling results in unnecessary control element wear.

How ABC Works

The operator uses a 275 HART communicator or AMS to select a maximum and minimum range around the setpoint for ABC. The ABC algorithm restricts the Level Controller's output to only the *proportional response* to level changes within the selected ABC region, ignoring any offset. If the level moves beyond the selected ABC region, the ABC algorithm initiates the required control element response that will return the level to the selected ABC region.

By providing a larger allowable level range, ABC reduces the number of required level changes to be made by the control element. Limit cycle elimination reduces control element operation, which may significantly extend the operating life of the control element. In summary, ABC brings the users the benefits of PID control while eliminating limit cycling.

FIGURE 3-5. ABC Operation.



ABC:

- is standard with all Model 3095 Multivariable Level Controllers.
- can be initiated in Proportional or Proportional/Derivative (PD) control modes by using the Model 275 HART communicator or AMS.
- initiates only the P response to level changes within the upper and lower limits as selected by the user, thus eliminating limit cycling of the control element.
- allows the Level Controller to complete the P response and I response when the level is outside the selected upper and lower limits until the level is again within the specified range.

LOCAL OPERATOR INTERFACE

The Model 3095 Level Controller is available with an optional Local Operator Interface (LOI), which acts as a local indicator and operator interface. The LOI can be configured with the Model 275 HART communicator, AMS, or locally through a set series of adjustments to the Z and S buttons located at the top of the Level Controller housing.

The LOI will always display Level as the Primary Variable (PV). The user may select additional PVs, including:

- Differential Pressure (DP)
- Control Output (CO)
- Process Temperature (PT) (if an external RTD is installed)

If alternative PVs are selected, each PV will display for two seconds before displaying the next PV.

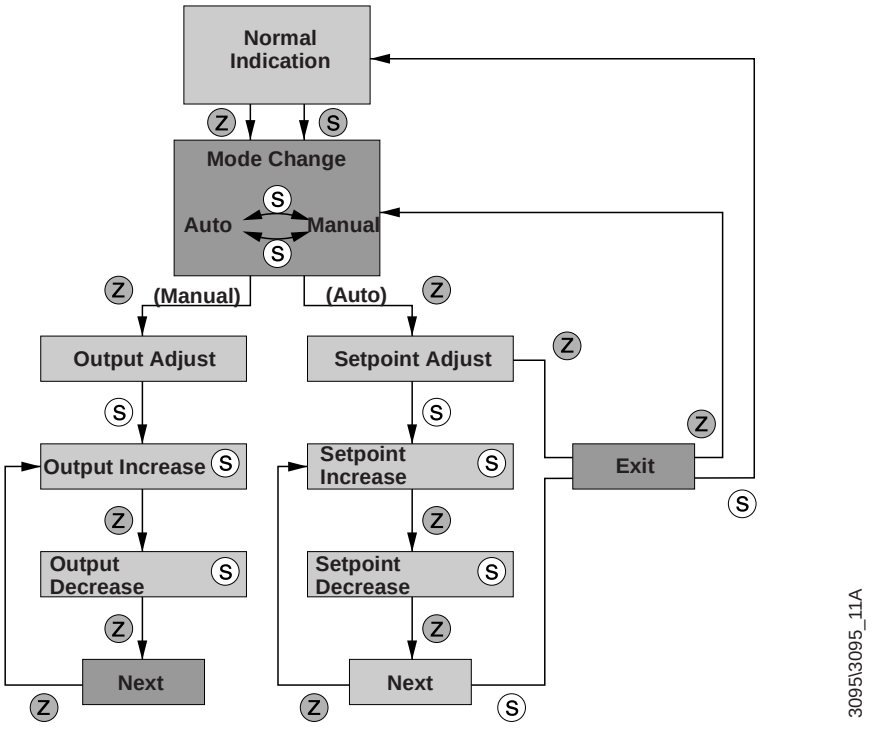
The LOI will always show the current Mode (Auto, Manual, or Out-of-Service (OOS)).

If the device experiences a failure, the LOI will flash “FAIL” every two seconds.

The Z and S buttons allow the user to change the Mode and the setpoint, and to select PVs.

- When the display is in operational mode (i.e., automatically scrolling through display data), press any button to begin *configuration mode*.
- When in configuration mode, press the “Z” button to see the next display in the series. Press the “S” button to perform the action associated with the current display.
- The output adjust display appears only when the controller is in MAN mode.
- If the controller detects no activity for 60 seconds while in configuration mode, the controller reverts back to operational mode.

FIGURE 3-6. LOI Map.



MODE SHED OPTION

The Mode Shed option allows the Level Controller to maintain control of the process loop in the event of measuring sensor failure.

The Model 3095 Level Controller continuously completes diagnostics of the multi-variable sensor and the controller. If the diagnostics determines that the level measurement is in a failed condition, the controller allows the user to select a “mode shed,” directing the controller to set the control element in a safe position. The Level Controller will remain at the “mode shed” position until the failed signal clears, or, until re-positioned by the user.

If the Level Controller determines that its ability to control the loop is compromised, the unit immediately drives the hardware analog alarm high or low, as selected by the user.

Section 4

Level Controller Configuration

This section describes the tasks involved in configuring the Model 3095 Level Controller.

CONFIGURATION OVERVIEW

Configuring the Level Controller consists of four major tasks:

1. **Set Up the Level Calculation:** These tasks set up the Level Controller for the specific process, and include setting process density, level units, controller height, and damping.
2. **Configure the Controller:** These tasks configure how you want to control the liquid level process, and include setting range values, control type, control action, ABC, output limits, setpoint, and mode shed options.
3. **Perform a Level Trim:** This task automatically adjusts the controller height and process density so that the actual level measurement matches the observed tank level.
4. **Tuning the Loop:** These tasks set the gain, reset, rate and bias parameters for the PID equation. The tasks differ depending on whether or not you have purchased the Autotuning feature.

If you completed a Configuration Data Sheet and your Level Controller is factory-configured, tasks 1 and 2 are done; you need only perform a level trim and tune the loop.

NOTE
For bench configuration, a jumper must be installed across the output terminals on the Level Controller terminal block. When bench configuration is complete, remove the jumper before installing the controller in the field.

You can use the Model 275 or any HART host device to configure the Level Controller and perform the other configuration tasks.

The **HART Comm.** box to the left of each section identifies the corresponding HART fast key sequence. See **Appendix A: HART Communicator** for additional information.

SET UP THE LEVEL CALCULATION

These tasks set up the Level Controller for the specific process.

Place Controller into Out-of-Service (OOS) Mode

Target Mode

HART Comm.	3, (OOS)

The user can select the mode of the control function to be MAN (manual), AUTO (automatic), or OOS (out-of-service).

- In automatic mode, the controller output is determined by the control function, where a control algorithm sets the control output value.
- In manual mode, the controller output is adjusted by the operator via digital communications or the local operator interface.
- In out-of-service mode, the operator can configure the controller without changing the control signal. The control signal remains fixed at the value when OOS mode was entered until the OOS mode is exited.

The Model 3095 Level Controller is shipped in OOS mode.

Before configuring the controller, ensure that the controller is in the OOS mode (Out-of-Service).

Factory Default: OOS (Out-of-Service)

Valid Options: OOS, AUTO, MAN

NOTE
To complete a change of mode, press the "SEND" key on the HART Communicator.

Set Density

Density

HART Comm.	6, 1, 1, 1, 2

This selection sets the nominal density of the process material. The Level Controller does not compensate for compressibility or thermal expansion of process materials. Level calculation will assume a constant density.

Factory Default: 1 g/cm^3

Valid Range: 0.1 to 10 g/cm^3

Set Level Units

Level Units

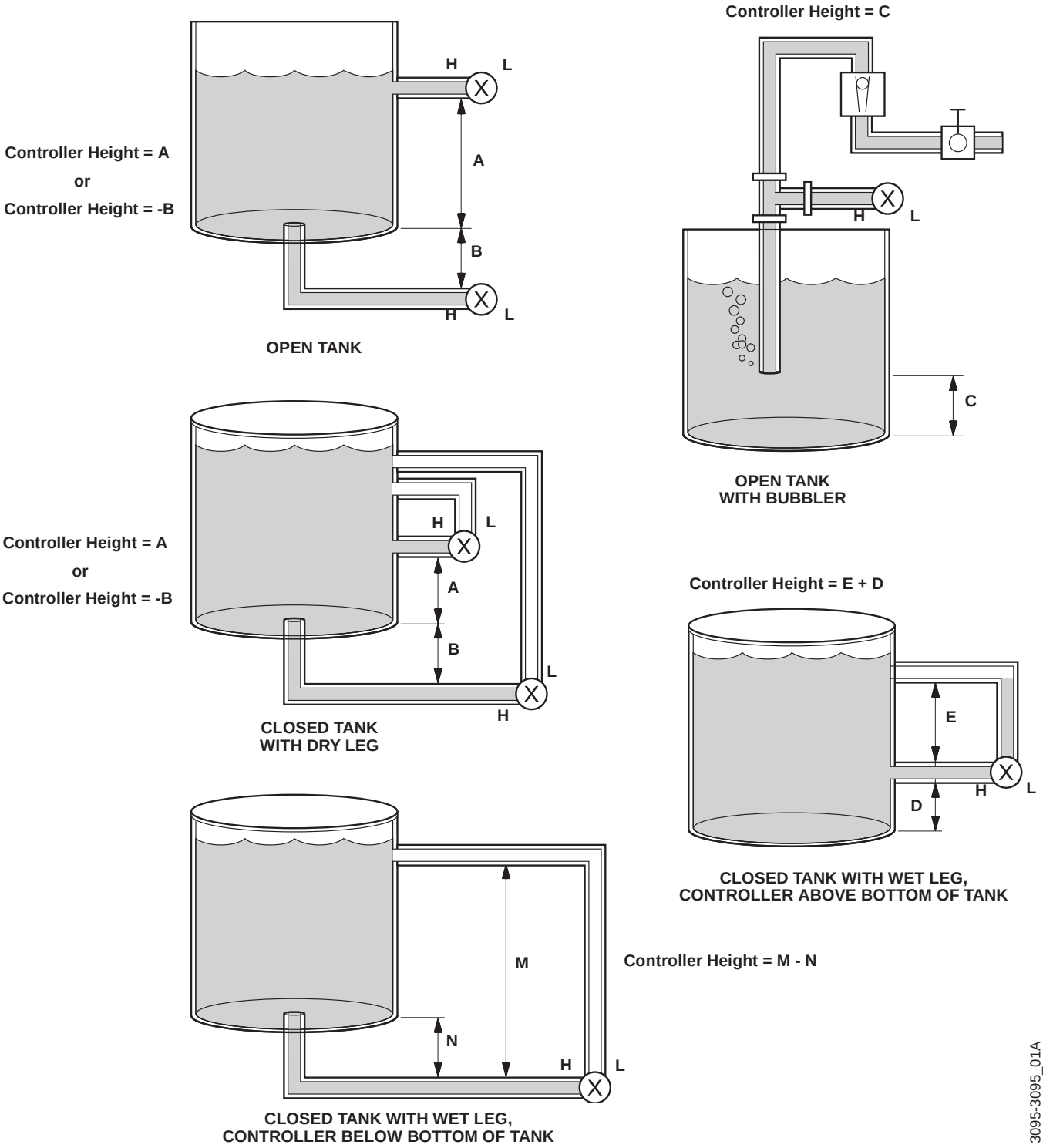
HART Comm.	6, 1, 1, 3

This selection sets the units of measure for the following parameters: level value, controller height, level range, setpoint, setpoint limit, and static error.

Factory Default: Inches

Valid Units: In, ft, cm, m

FIGURE 4-1. Guidelines for Determining Controller Height.



Set Controller Height

Determining the controller height varies according to the installation type and controller location (see Figure 3-3). Note that the controller height units are determined by the units selected for the level units.

Controller Height

HART Comm.	6, 1, 1, 1, 4

Open Tank, controller above tank bottom	**A**
Open Tank, controller below tank bottom	**–B**
Open Tank with Bubbler	**C**
Closed Tank w/dry leg, controller above tank bottom	**A**
Closed Tank w/dry leg, controller below tank bottom	**–B**
Closed tank w/wet leg, controller above tank bottom	**E + D**
Closed tank w/wet leg, controller below tank bottom	**M – N**

Factory Default: 0

Valid Range: –300 to 300 meters

Additional Options

The following options are *not* required for Level Controller operation.

Set Damping

The Level Controller has electronic damping that can change the response time of the level measurement to smooth the level reading when there are rapid input variations.

Level Damping

HART Comm.	6, 1, 1, 5

High damping values filter out process noise, but response time is increased. Low damping values decrease response time, but process noise can also be detected.

DP Damping

HART Comm.	6, 1, 2, 3

Two damping settings are available: level and DP. Level damping affects loop tuning. Changes to level damping require re-tuning the controller. DP damping is independent of level output, and does not affect controller output or loop tuning.

Factory Default: 0 sec

Valid Range for Level Damping: 0 to 32 sec
Valid Range for DP Damping: 0.1 to 27.6 sec

CONFIGURE THE CONTROLLER

These tasks configure how you want to control the liquid level process.

Set Range Values

The Level Controller range is determined by user-entered range points: Lower Range Value (LRV) and Upper Range Value (URV). The level measurement span (URV – LRV) must be within the level variable limits.

Level LRV

HART Comm.	6, 1, 1, 4, 2

Set LRV to the normal low operating point of the process, or the bottom of the tank.

Level URV

HART Comm.	6, 1, 1, 4, 1

Set URV to the normal high operating point of the process, or the top of the vessel.

Level Variable	Factory Default	Valid Range	Recommendation
LRV	0 inches	level_lsl to level_usl	Bottom of Tank (0)
URV	level_url	level_lsl to level_usl	Top of Tank

Set Control Type

The user can select from four different Control Types. The selected control method is used to adjust the control signal to maintain the level at the target setpoint.

Control Type

HART Comm.	6, 2, 1, 1, 1

P (Proportional control only). This algorithm only uses the P (gain) factor for the control algorithm. Manual Bias is also used in conjunction with a time-decay balance term to provide for bumpless mode transfers.

PI (Proportional plus Integral control). This algorithm use the P (gain) and I (Reset) factors for the control algorithm. Manual Bias and Adaptive Bias are not used for this control type.

Quick Lookup Table

Abbrev.	Algorithm Term	a.k.a.
P	Proportional	Gain
I	Integral	Reset
D	Derivative	Rate

PID (Proportional plus Integral plus Derivative control). This algorithm use the P (gain), I (reset), and D (derivative) factors for the control algorithm. Manual Bias and Adaptive Bias are not used for this control type.

PD (Proportional plus Derivative control). This algorithm use the P (gain) and D (derivative) factors for the control algorithm. Manual Bias is also used in conjunction with a time-decay balance term to provide for bumpless mode transfers.

Factory Default: PID

Valid Options: P, PI, PID, PD

Set Control Action (Direct, Reverse)

Control Action

HART Comm.	6, 2, 1, 1, 2

The user can set the action of the control output to either direct or reverse acting output to accommodate processes with negative or positive gains. In direct action, the controller output increases when the PV exceeds the setpoint. In reverse action, the controller output decreases when the PV exceeds the setpoint.

Factory Default: Reverse

Valid Options: Direct, Reverse

Adaptive Bias Control (ABC) Settings

Adaptive Bias Control (ABC) provides a method to create a steady state deadband for the level controller. Once the desired level is obtained, the controller could repeatedly open and close the valve for very small differences between the setpoint and the actual tank level. ABC allows the controller to determine that the level is stable, and to not change the valve position except when a larger difference occurs between the setpoint and the actual tank level. This saves on unnecessary valve wear.

ABC is only available if the control mode is set to P or PD.

Bias is modified when ABC is enabled in Auto mode. See page 3-7 for details about ABC.

Adaptive Bias Control

HART Comm.	6, 2, 1, 8

This selection enables or disables the ABC algorithm.

Factory Default: Off

Valid Range: On, Off

ABC Static Error

HART Comm.	6, 2, 1, 9

This selection sets the minimum amount that the level must differ from the setpoint before the ABC algorithm changes the bias level.

This parameter is set in level units.

Factory Default: 1.0 inch

Valid Range: 0.0 to 20 in.

ABC Stability Threshold

HART Comm.	6, 2, 1

The stability threshold is the user-defined limit on the rate of change of level. When inside this limit, the algorithm considers the process to be stable.

This parameter is set in level units per second.

Factory Default: 1.0 inch per second

Valid Range: 0 – 10 in./sec.

Set Power-Up Output

Power-Up Output

HART Comm.	6, 2, 3, 6

The user can set the control output value when the Level Controller powers up or the Level Controller is reset.

This value is entered as a percentage of controller output. For example, a power-up output value of 50% corresponds to 12 mA.

$$(50\% \times (20 - 4\ \text{mA}) + 4\ \text{mA} = 12\ \text{mA})$$

Factory Default: 0%

Valid Range: –0.625 to 105% (3.9 to 20.8 mA)
(Saturation Low to Saturation High)

Set Mode Shed Options (Failure Condition)

See page 3-9 for details about Mode Shed.

Shed Action

HART Comm.	6, 2, 3, 3

Shed Action selects whether the controller remains at its present value (hold output) or goes to the shed output value if the Level Controller determines that the level measurement has failed.

Factory Default: Go to shed output

Valid Options: Hold output, go to shed output

.

Shed Output

HART Comm.	6, 2, 3, 4

This selection sets the control output value during a mode shed action.

If the Level Controller determines that the level measurement is bad, **AND** the Mode Shed Action is set to "go to shed output," the Level Controller will then automatically set the control output to this value.

This value is entered as a percentage of controller output. For example, a mode shed output value of 25% corresponds to 8 mA.

$$(25\% \times (20 - 4\ \text{mA}) + 4\ \text{mA} = 8\ \text{mA})$$

Factory Default: 0%

Valid Range: –2.5 to 112.5% (3.6 to 22 mA)

Shed Return

HART Comm.	6, 2, 3, 5

This selection determines whether the controller returns from the mode shed routine if the failed level measurement condition ends.

Factory Default: Return

Valid Options: Return, no return

Set Manual Output

Manual Rate Limit

HART Comm.	6, 2, 5, 2

Output rate limits define the maximum rate of change of the control output when the controller is in manual mode. Setting this variable to 0.0 disables manual output rate limits.

Factory Default: 0.0 (No rate limit)

Valid Range: $\geq$ 0.0% per second

Manual Output

HART Comm	4

Setting manual output is a two step process. First, set the target mode to manual (MAN). Second, set the manual output value.

When in manual output mode, the operator enters a value as a percentage of controller output. For example, a manual output value of 25% corresponds to 8 mA.

$$(25\% \times (20 - 4\ \text{mA}) + 4\ \text{mA} = 8\ \text{mA})$$

Valid Range: –0.625 to 105% (3.9 to 20.8 mA)

Set Auto Output Limits

Output limits determine the allowable minimum and maximum control output values when the controller is in automatic mode.

For example, the minimum allowable control output may be 7.2 mA (20% of valve stroke) and the maximum allowable control output may be 16.8 mA (80% of valve stroke).

Output Hi Limit

HART Comm.	6, 2, 1, 1, 3

Output Lo Limit

HART Comm.	6, 2, 1, 1, 4

Variable	Factory Default	Valid Range
Auto Out Hi Limit	100%	9.4% to 105% and ≥ (out_lo_limit +10.0)
Auto Out Lo Limit	0.0%	–0.6% to 95% and ≤ (out_hi_limit –10.0)

Choose Setpoint Values

Setpoint limits define the minimum and maximum process setpoint values that can be used by an operator. For example, in a 100 inch tall tank, the minimum allowable setpoint may be set to 60 inches, while the maximum allowable setpoint may be set to 90 inches.

Setpoint Hi Limit

HART Comm.	6, 2, 2, 4

CAUTION
Selecting a setpoint near the top of the tank is not recommended. Overshoot potential at PID control could cause overflow.

Setpoint Lo Limit

HART Comm.	6, 2, 2, 5

Variable	Factory Default	Valid Range
Setpoint Hi Limit	level_url	level_lrl to level_url and ≥ sp_lo_limit
Setpoint Lo Limit	level_lrl	level_lrl to level_url and ≤ sp_hi_limit

Setpoint

HART Comm.	2

Setpoint is the defined setpoint for the controller when in AUTO (Automatic) mode. When in AUTO mode, the controller uses the selected Control Type and control parameters to maintain the level at the target setpoint.

Factory Default: Level units (see page 4-2)

Valid Range: Setpoint Lo Limit to Setpoint Hi Limit

Additional Options

The following options are *not* required for Level Controller operation.

Setpoint Tracking

HART Comm.	6, 2, 2, 6

When enabled and in manual mode, setpoint tracking automatically changes the setpoint to the measured level value. This option is valid in manual (MAN) mode only.

For example, assume that the target setpoint is set to 90 inches when the controller is switched from automatic to manual mode. At the conclusion of manual mode activities, the actual liquid level is now 82 inches. If setpoint tracking is ON, the new target setpoint will automatically change to 82 inches when the operator switches back to automatic mode.

Factory Default: Tracking Disabled

Valid Options: Tracking Disabled, Tracking Enabled

Setpoint Rate Limit

HART Comm.	6, 2, 2, 3

Setpoint rate limit defines the maximum ramp rate at which changes in the setpoint are acted on. For example, assume that the setpoint rate limit is set to 5 inches per second. When an operator changes the setpoint from 65 to 85 inches, it will take the controller 4 seconds to ramp to the new setpoint (20 inches ÷ 5 inches per second = 4 seconds).

Setting this variable to 0.0 disables setpoint rate limiting.

Factory Default: 0.0 level units per second

Valid Range: ≥ 0.0 level units per second

PERFORM A LEVEL TRIM

Performing a level trim is recommended for all field installations. Level trim can be done in OOS and MAN mode; it cannot be done in AUTO mode (see page 4-2).

The level trim process allows the user to calibrate the level calculation against the actual tank level as measured with a sight glass or other visual reference. A level offset trim is normally done at or near the lower level value; a level slope trim is normally done at or near the upper level limit.

The level trim process corrects for offset and/or slope errors by adjusting the controller height and process density terms.

For best results, perform a level offset trim before performing a level slope trim.

Best overall accuracy is also achieved by performing the offset and slope trim at two widely separated level values.

NOTE
Changing certain level values (controller height or process density) after performing a level trim overwrites the results of the level trim.

Trim Level

HART Comm.	6, 1, 1, 6, 2

To perform a level offset trim, first adjust the level to the value you wish to trim at. Once the process stabilizes, perform an offset trim. You will be asked to select the level engineering units and then enter the level value observed with a sight glass or other visual reference.

Once the level offset trim is complete, you may notice that the controller height in the level setup parameters has changed. This is how the level offset trim is accomplished.

To perform a level slope trim, first adjust the level to the value you wish to trim at. Once the process stabilizes, perform a slope trim. You will be asked to select the level engineering units and then enter the level value observed with a sight glass or other visual reference.

Once the level slope trim is complete, you may notice that the controller height and process density in the level setup parameters have changed. This is how the level slope trim is accomplished.

Level Trim Recall

HART Comm.	6, 1, 1, 6, 3

The level offset and slope trims modify the user-entered values for controller height and process density. If the trims are not performed satisfactorily, the user may revert to the controller height and process density parameters entered during initial device setup by performing a level trim recall.

TUNE THE LOOP

At this point, you should tune the loop according to industry accepted practices. See “Autotuner” on page 4-12 if you have purchased the Autotune feature (Option Code CC). If you do not have Autotune capabilities, follow the instructions in “Set Control Tuning.”

NOTE
You cannot tune the loop if the controller is out-of-service (OOS). You must change the controller mode to MAN or AUT before tuning the loop.

Set Target Mode

HART Comm.	3, (MAN) (AUT) (OOS)

The user can select the mode of the control function to be MAN (manual), AUT (automatic), or OOS (out-of-service).

In automatic mode the controller output is determined by the control function, where a control algorithm sets the control output value.

In manual mode the controller output is adjusted by the operator via digital communications.

In OOS mode, the output remains frozen.

Set Control Tuning

Gain

HART Comm.	6, 2, 1, 2

This selection sets the controller gain value. This value is used for all four control types (P, PI, PID, PD).

Gain is a proportional calculation value (higher numbers result in larger gain action).

Factory Default: 1.0

Valid Range: 0.0 to 100.0

Reset

HART Comm.	6, 2, 1, 3

This selection sets the controller reset value. This value is only used if the Control Type is set to PI or PID.

This setting is used as the integral time for the PID or PI algorithm equation.

Rate is an inverse calculation value (smaller numbers result in larger reset action). However, setting the reset value to 0 turns off the reset factor.

Factory Default: 0.0 seconds (OFF)

Valid Range: Any value $\geq$ 0.0

Rate

HART Comm.	6, 2, 1, 4

This selection sets the controller rate value. This value is only used if the Control Type is set to PD or PID.

this setting is used as the derivative time for the PID or PD algorithm equation.

Rate is a proportional calculation value (higher numbers result in larger rate action). Setting the rate value to 0 turns off the rate factor.

Factory Default: 0.0 seconds (OFF)

Valid Range: Any value $\geq$ 0.0

Manual Bias

HART Comm.	6, 2, 1, 6

This selection sets the controller bias value. (This parameter is sometimes called *manual bias* or *manual reset*.)

This value is only used if the Control Type is set to P or PD. This setting is used as the controller bias term for the P or PD algorithm equations.

Factory Default: 0.0%

Valid Range: 0.0 to 100%

Derivative Filter

HART Comm.	6, 2, 1, 5

This selection sets the derivative filter factor. The tuning algorithm multiplies the derivative filter value by the derivative time (the D portion of the PID tuning algorithm).

The derivative filter value is factory set, and adjustment is not recommended. If the setting is adjusted, you must retune the loop.

Factory Default: 0.125

Valid Range: 0.1 to 1.0

Autotuner (Optional)

Autotuning (Option Code CC) is the process of determining the process parameters, and then applying standard tuning rules to determine the optimal tuning parameters (gain, reset, rate, and bias) for the PID equation. See page 3-4 for further details.

Autotuning may be done at any range, and is not limited to values just around the setpoint. However, autotuning must be done in a region of the tank that is representative of the control region.

Autotuning is a two step process. First, the tuner estimates the process gain, delay and demand by working the process (opening and closing the valve under live process conditions). Second, the proposed tuning parameters (calculated values for gain, reset, rate, and bias) are calculated using the process conditions, loop performance factor, and the control type.

The Autotune procedure uses seven parameters to tune the loop: Alpha, Cycles, Output Limits, Level Lo Limit, Level Hi Limit, Time Limit, and Tune Overshoot. Set these parameters before starting the Autotune procedure.

CAUTION

Autotuning will disturb the process and will not maintain a bumpless, balanceless transfer. The valve will move abruptly without consideration of balance time or manual rate limit. The loop must be out of commission before performing the Autotune procedure.

Autotuning is not allowed in OOS mode. If you are in OOS mode, you must change the Controller Mode before beginning the Autotune setup (see page 4-11). When the Autotune procedure is finished, the controller returns to the previous control mode (AUTO or MAN) and reverts to previous tuning values. You must “accept” the autotune (page 4-14) for the new tuning parameters to take effect.

Alpha

HART Comm.	6, 2, 4, 3, 3

Alpha is the loop performance factor used to adjust the loop response. A lower value results in more aggressive control while a higher value results in more conservative control. Once the system has been autotuned, the Alpha parameter may be revised and new tuning parameters will be calculated.

Factory Default: 3.0

Valid Range: 0.5 to 10.0

Cycles

HART Comm.	6, 2, 4, 3, 8

This selection sets the number of open/close cycles to perform during tuning after the initial close cycle. Multiple cycles can average out noise due to process demand changes during the autotune procedure.

Factory Default: 1

Valid Range: 1, 2, 3

Tuning Output Min (Valve)

HART Comm.	6, 2, 4, 3, 7

This selection sets the lower output value used when the autotuner opens and closes the valve.

Factory Default: 0%

Valid Range: –0.625% to 105%

Tuning Output Max (Valve)

HART Comm.	6, 2, 4, 3, 6

This selection sets the upper output value used when the autotuner opens and closes the valve.

Factory Default: 0%

Valid Range: –0.625% to 105%

Tuning Lo Limit (Level)

HART Comm.	6, 2, 4, 3, 2

The level low limit is how far the level will travel on the low side during tuning as measured from the bottom of the tank.

This value is entered in selected level units (see page 4-2).

Factory Default: 0 in.

Valid Range: Level LRL to Tuning Hi Limit

Tuning Hi Limit (Level)

HART Comm.	6, 2, 4, 3, 1

The level high limit is how far the level will travel on the high side during tuning as measured from the bottom of the tank.

This value is entered in selected level units (see page 4-2).

Factory Default: 0 in.

Valid Range: Tuning Lo Limit to level URL

Time Limit

HART Comm.	6, 2, 4, 3, 5

This selection sets the maximum time allowed for the autotuning procedure to complete. If tuning does not complete within this time frame, tuning will cease and a message is displayed indicating that tuning failed. The unit returns to the previous mode of operation.

Factory Default: 0 minutes

Valid Range: 0 to 1,000 minutes

Overshoot

HART Comm.	6, 2, 4, 3, 4

This selection sets a tolerance above and below the Tuning Lo Limit and Tuning Hi Limit. When the level strays out of the tolerance, tuning ceases and indicates which boundary was exceeded.

This value is entered in level units.

Factory Default: 0

Valid Range: 0 to 25 inches

Perform Auto Tune

HART Comm.	6, 2, 4, 4

This procedure must be followed for the actual autotuning calculations to occur.

1. Enter the Perform Auto-Tune menu.
2. Select “Yes” from Start Auto-Tune Yes/No
3. The HART Communicator displays the level value and tuning state.

   When the tuning process completes the HART Communicator displays “Complete”.

   Should the level process go beyond the tune level limits plus overshoot or go beyond the time-out period, the tuner will abort and display a "Tuning Aborted" message.

Accept Auto Tune

HART Comm.	6, 2, 4, 5

The calculated autotuning parameters will not be in effect until you “accept” them.

Once the autotuner completes successfully, the calculated tuning parameters may be viewed. [6, 2, 4]

If the calculated values are acceptable, you may accept the tuning parameters (gain, reset and rate), or the bias, or both on the Accept Auto-Tune menu.

Once the system has been autotuned the Alpha parameter may be revised (refer to page 4-13) and new tuning parameters will be calculated. The new tuning parameters may then be reviewed and accepted.

Section 5

Troubleshooting and Maintenance

This section describes troubleshooting and maintenance tasks associated with the Model 3095 Level Controller. These include Level Controller device maintenance procedures and field replaceable part procedures.

Use only the procedures and new parts specifically referenced in this manual.

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

Explosions could result in death or serious injury:

- Do not remove the instrument cover in explosive atmospheres when the circuit is alive.
- Before connecting a HART-based 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 controller covers must be fully engaged to meet explosion-proof requirements.
- The unused conduit opening on the controller housing must be plugged and sealed to meet explosion-proof requirements.

⚠WARNING

Failure to follow safe installation and servicing guidelines could result in death or serious injury:

- Make sure only qualified personnel perform these procedures.
- Use the equipment only as specified in this manual. Failure to do so may impair the protection provided by the equipment.
- Unauthorized procedures or parts can affect product performance and the output signal used to control a process, and may render the instrument dangerous.

⚠WARNING

Process leaks could result in death or serious injury:

- Install only the flange adapter O-ring designed to seal with the corresponding flange adapter.

⚠WARNING

High voltage that may be present on leads could cause electrical shock:

- Avoid contact with leads and terminals.

LEVEL CONTROLLER TROUBLESHOOTING

If a malfunction is suspected, follow the procedures described here to verify that device hardware and process connections are in good working order. Under each major symptom, specific suggestions are offered for solving the problem. Always deal with the most likely and easiest-to-check conditions first.

Communication Problems

Table 5-1 identifies the most likely causes for communication problems between the Model 275 HART Communicator and the Level Controller.

TABLE 5-1. Device Does not Communicate with the HART Communicator.

Symptom	Corrective Action
No Communication between the HART Communicator and the Level Controller	**LOOP WIRING** • HART protocol communication requires a loop resistance value between 250–1100 ohms, inclusive. • Check for adequate voltage to the device. (If the HART Communicator is connected and 250 ohms resistance is properly in the loop, a power supply voltage of at least 16.5 V dc plus actuator voltage drop is required.) There must be at least 11V dc at the device terminals. • Check for intermittent shorts, open circuits, and multiple grounds. • Check for capacitance across the load resistor. Capacitance should be less than 0.1 microfarad. • If no device is connected across the “OUT” terminals, the terminals must be shorted (jumpered) together.

Interpreting Level Controller Alarms and Error Conditions

If an alarm or error condition exists in the Level Controller, it will be displayed when the next Model 275 next communicates with the device.

Table 5-2 explains critical alarms, Table 5-3 lists overrange conditions, and Table 5-4 identifies sensor limits.

Critical Alarms

Critical alarms are the highest priority Level Controller alarms, and typically indicate an error that prevents accurate sensor or flow measurements. Regardless of which of these alarms occur, the analog output and the digital output respond as indicated in Table 5-2.

TABLE 5-2. Critical Alarms.

Alarm text as displayed in Diagnostics, Error Info	Corrective Action
Output Board EEPROM Not Initialized Output Board EEPROM Burn Failure	The output electronics has not been properly initialized at the factory. Replace the output electronics board as described on page 5-11. Contact your Field Service Center.
Sensor Hardware is Incompatible	The sensor electronics has undergone a component or software failure. Replace the sensor module as described on page 5-11. Contact your Field Service Center.
Sensor Brd EEPROM Not Initialized	The sensor electronics has undergone a component or software failure. Replace the sensor module as described on page 5-11. Contact your Field Service Center.
Sensor Module is Not Updating	The 10-pin ribbon cable may be disconnected, or the device electronics may have undergone a component or software failure. Contact your Field Service Center.
Sensor Module is Not Responding	The 10-pin ribbon cable may be disconnected, or the device electronics may have undergone a component or software failure. Contact your Field Service Center.
Static Pressure Sensor is Shorted	The sensor module has undergone a component or software failure. Replace the sensor module as described on page 5-11. Contact your Field Service Center.
RAM Failure	Issue a master reset to the device.
Device Self Test Failed	The output electronics has undergone a component or software failure. Replace the output electronics board as described on page 5-11.
Static Pressure Sensor is Open	This display means that the device absolute pressure reading exceeds its sensor limits. There are two possible causes. Either the device is overpressured, or it has a sensor malfunction. Check the pressure input to the device. If an overpressure condition exists, correct it. If not, replace the sensor module as described on page 5-11.
Process Temp Sensor is Disconnected	Check the device RTD connector and RTD screw terminals to ensure the RTD cable is properly connected. For controller installations not using the RTD option, make certain the RTD option is set to “Not Installed.”

Overrange Conditions

Overrange conditions are typically caused by an error in which the sensor or level measurements have reached an overrange condition where substitute values are being used.

TABLE 5-3. Corrective Action: Overrange Conditions.

Alarm text as displayed in Diagnostics, Error Info	Corrective Action
DP above URL+	These displays indicate that the device differential pressure reading exceeds its sensor limits by more than 10%. There are two possible causes; either the device is overpressured (underpressured), or it has a sensor malfunction. Check the pressure input to the device. If an overpressure (underpressure) condition exists, correct it. If not, replace the sensor module as described on page 5-11.
DP below LRL–	
Working Pressure above URL+	These displays indicate that the device absolute pressure reading exceeds its sensor limits by more than 10%. There are two possible causes; either the device is overpressured (underpressured), or it has a sensor malfunction. Check the pressure input to the device. If an overpressure (underpressure) condition exists, correct it. If not, replace the sensor module as described on page 5-11.
Working Pressure below LRL–	
PT above URL+	Check the device RTD connector and RTD screw terminals to ensure that the RTD cable is properly connected. Verify that the process temperature is between –40 °F and 1200 °F.
PT below LRL–	
ST above URL+	These displays indicate that the ambient temperature limit of the device is being exceeded. Verify that the device ambient temperature is between –40 °F and 185 °F. If device temperature exceeds these limits, correct the temperature. If device temperature is within these limits, replace the sensor module as described on page 5-11.
ST below LRL–	

Sensor Limits and Alarm Abbreviation

Table 5-4 identifies sensor limits. Standard alarm abbreviations used in alarm Tables 5-3 and 5-4 are:

LRL Lower Range Limits
URL Upper Range Limits
LRV Lower Range Value
URV Upper Range Value
URL+ URL + (10%URL)
(For example, URL+ = 250 + (0.10 × 250) = 275
LRL– LRL – (10%LRL)
(For example, LRL– = –250 –[0.10 × (250)] = –275

TABLE 5-4. Level Controller Sensor Limits.

Sensor	LRL– (1)	LRL	URL	URL+(2)
DP Range 2	–275 inH_20 at 68 °F	–250 inH_20 at 68 °F	250 inH_20 at 68 °F	275 inH_20 at 68 °F
DP Range 3	–913 inH_20 at 68 °F	–830 inH_20 at 68 °F	830 inH_20 at 68 °F	913 inH_20 at 68 °F
PT (3)	–44 °F (–42 °C)	–40 °F (–40 °C)	1200 °F (649 °C) (4)	1220 °F (660 °C)
Sensor Temperature	–44 °C	–40 °C	85 °C	93.5 °C

(1) LRL– is equal to LRV and lower sensor trim limits.
(2) URL+ is equal to URV and upper sensor trim limits.
(3) In the fixed temperature mode, PT range is –459 to 3500 °F (–273 to 1927 °C).
(4) For Alpha Two field trial units, PT URL is 800 °F (427 °C).

Unexpected Process Variable (PV) Readings

⚠ Use a Model 275 HART Communicator to display the current process variables. Before connecting a HART-based 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.

The following performance limitations may inhibit efficient or safe operation. Critical applications should have appropriate diagnostic and backup systems in place.

Pressure devices contain an internal fill fluid. It is used to transmit the process pressure through the isolating diaphragms to the pressure sensing element. In rare cases, oil loss paths in oil-filled pressure devices can be created. Possible causes include:

- Physical damage to the isolator diaphragms.
- Process fluid freezing.
- Isolator corrosion due to an incompatible process fluid.

A device with oil fill fluid loss may continue to perform normally for a period of time. Sustained oil loss will eventually cause one or more of the operating parameters to exceed published specifications while a small drift in operating point output continues. Symptoms of advanced oil loss and other unrelated problems include:

- Sustained drift rate in true zero and span or operating point output or both.
- Sluggish response to increasing or decreasing pressure or both.
- Limited output rate or very nonlinear output or both.
- Change in output process noise.
- Noticeable drift in operating point output.
- Abrupt increase in drift rate of true zero or span or both.
- Unstable output.
- Output saturated high or low.

TABLE 5-5. Unexpected Process Variable (PV) Readings.

Symptom	Corrective Action
High PV Reading	**IMPULSE PIPING** • Check to ensure that the process connection is correct. • Check for leaks or blockage. • Check to ensure that blocking valves are fully open. • Check for entrapped gas in liquid lines and for liquid in gas lines. • Check to ensure that the density of fluid in impulse lines is unchanged. • Check for sediment in the device process flange. • Make sure that process fluid has not frozen within the process flange. **POWER SUPPLY** **CAUTION** Do not use higher than the specified voltage to check the loop or damage to the device may result. • Check the output voltage of the power supply at the device. It should be 11 to 55 V dc at the device terminals. **DEVICE ELECTRONICS** • Connect a Model 275 to check the sensor limits to ensure calibration adjustments are within the sensor range and that calibration is correct. • Make sure the post connectors are clean. • Confirm that the electronics housing is properly sealed against moisture. • If the electronics are still suspect, substitute new electronics. **SENSING ELEMENT** • The sensing element is not field repairable and must be replaced if found to be defective. Check for obvious defects, such as a punctured isolating diaphragm or fill fluid loss, and contact your nearest Rosemount Service Center.

TABLE 5-5. (continued).

Symptom	Corrective Action
Erratic PV Reading	**LOOP WIRING** **CAUTION** Do not use higher than the specified voltage to check the loop or damage to the device may result. • Check for adequate voltage to the device. It should be 11 to 55 V dc at the device terminals. • Check for intermittent shorts, open circuits, and multiple grounds. **PROCESS PULSATION** • Adjust the electronic damping (see page 4-4). **DEVICE ELECTRONICS** • Connect a Model 275 to check the sensor limits to ensure calibration adjustments are within the sensor range and that calibration is correct. • Make sure the post connectors are clean. • Confirm that the electronics housing is properly sealed against moisture. • If the electronics are still suspect, substitute new electronics. **IMPULSE PIPING** • Check for entrapped gas in liquid lines and for liquid in gas lines. • Make sure that process fluid has not frozen within the process flange. **SENSING ELEMENT** • The sensing element is not field repairable and must be replaced if found to be defective. Check for obvious defects, such as a punctured isolating diaphragm or fill fluid loss, and contact your nearest Rosemount Service Center.

TABLE 5-5. (continued).

Symptom	Corrective Action
Low PV Reading or No PV Reading	**LOOP WIRING** **CAUTION** Do not use higher than the specified voltage to check the loop or damage to the device may result. • Check for adequate voltage to the device. It should be 11 to 55 V dc at the device terminals. • Check the milliampere rating of the power supply against the total current being drawn for all devices being powered. • Check for shorts and multiple grounds. • Check for proper polarity at the signal terminal. • Check loop impedance. • Check the wire insulation to detect possible shorts to ground. **IMPULSE PIPING** • Check to ensure that the pressure connection is correct. • Check for leaks or blockage. • Check to ensure that blocking valves are fully open and that bypass valves are tightly closed. • Check for entrapped gas in liquid lines and for liquid in gas lines. • Check for sediment in the device process flange. • Make sure that process fluid has not frozen within the process flange. **DEVICE ELECTRONICS** • Connect a Model 275 to check the sensor limits to ensure calibration adjustments are within the sensor range and that calibration is correct. • Make sure the post connectors are clean. • Confirm that the electronics housing is properly sealed against moisture. • If the electronics are still suspect, substitute new electronics. **SENSING ELEMENT** • The sensing element is not field repairable and must be replaced if found to be defective. Check for obvious defects, such as a punctured isolating diaphragm or fill fluid loss, and contact your nearest Rosemount Service Center.

TABLE 5-5. (continued).

Symptom	Corrective Action
Sluggish Output Response/Drift	**IMPULSE PIPING** • Check for leaks or blockage. • Ensure that blocking valves are fully open • Check for sediment in the device process flange. • Check for entrapped gas in liquid lines and for liquid in gas lines. • Ensure that the density of fluid in impulse lines is unchanged. • Make sure that process fluid has not frozen within the process flange. **DEVICE ELECTRONICS** • Connect a Model 275 to check the sensor limits to ensure calibration adjustments are within the sensor range and that calibration is correct. • Confirm that damping is correctly set. • Confirm that the electronics housing is properly sealed against moisture. **SENSING ELEMENT** • The sensing element is not field repairable and must be replaced if found to be defective. Check for obvious defects, such as a punctured isolating diaphragm or fill fluid loss, and contact your nearest Rosemount Service Center. • Confirm that the electronics housing is properly sealed against moisture.

DISASSEMBLY PROCEDURES

Read the following information carefully before disassembling a device. General information concerning the process sensor body and electrical housing follow. Figure 2-4 on page 2-6 shows an exploded view of the Level Controller.

Do not remove the instrument cover in explosive atmospheres when the circuit is alive.

Process Sensor Body

NOTE
Do not leave devices in service once they have been determined to be inoperable.

Be aware of the following:

- The process should be isolated from the device and vented before the device is removed from service for disassembly.
- The process flange can be detached by removing the four flange bolts and the two alignment screws that secure it.

CAUTION
To prevent damage which may lead to inaccurate measurements, do not scratch, puncture, or depress the isolating diaphragms.

- Isolating diaphragms can be cleaned with a soft rag, mild cleaning solution, and clear water rinse.

CAUTION
To prevent damage which may lead to inaccurate measurements, do not use any chlorine or acid solutions to clean the diaphragms.

- The flange adapters and process flange can be rotated or reversed for mounting convenience.
- When removing the process flange or flange adapters, visually inspect the Teflon O-rings. Replace the O-rings if they show any signs of damage, such as nicks or cuts. If they are undamaged, they can be reused.
- If the Teflon sensor module O-rings have been replaced, re-torque the flange bolts after installation to compensate for cold flow.

Electrical Housing

Electrical connections are located in a compartment identified as FIELD TERMINALS on the electronics housing. Unscrew the cover on the Field Terminal side to access the signal terminal block.

Remove the signal terminal block by loosening the two small screws located at the 9 o'clock and 4 o'clock positions, then pulling the terminal block straight out to disconnect the block from the post connectors.

Remove the Electronics Board

The device electronics are located behind the cover opposite the terminal side.

CAUTION
To prevent damage to the circuit board, remove power from the device before removing the electronics cover.

To remove the electronics board:


3095LC02

1. Remove the housing cover opposite the field terminal side. Do not remove the instrument cover in explosive atmospheres when the circuit is alive.

2. Loosen the two captive screws that anchor the board.

CAUTION
The circuit board is electrostatically sensitive. To prevent damage to the circuit board, be sure to observe handling precautions for static-sensitive components.


3095LC03

3. Slowly pull the electronics board out of the housing.

3095LC04

4. Disconnect the sensor module ribbon cable to release the electronics board from the device.

3095LC05

5. Carefully tuck the cable connector completely inside the internal shroud. The shroud protects the cable from damage that might occur when the housing is rotated.

CAUTION

Do not remove the housing until the cable connector has been completely tucked inside the internal shroud. Damage to the sensor module ribbon cable may occur if the connector does not rotate with the sensor module.

Remove the Sensor Module from the Electronics Housing

3095LC06

6. Loosen the housing rotation set screw with a 5/64-inch hex wrench and back off one full turn.

CAUTION
Before removing the sensor module from the electronics housing, disconnect the electronics board power cable from the sensor module. This will prevent damage to the sensor module ribbon cable.

3095LC07

7. Unscrew the housing from the module, making sure the shroud and sensor cable do not catch on the housing. Damage can occur to the cable if the internal shroud and sensor cable rotate with the housing. Carefully pull the shroud and sensor ribbon cable assembly through the housing opening.

CAUTION
If the Coplanar flange has been removed, take care not to damage the isolating diaphragm after disassembly. Damage to the isolating diaphragm may lead to inaccurate measurements.

3095LC08

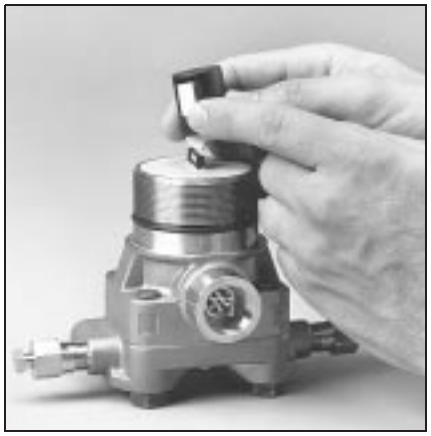
The sensor module is a complete assembly and cannot be further disassembled.

REASSEMBLY PROCEDURES

Follow these procedures carefully to ensure proper reassembly:

Attach the Sensor Module to the Electronics Housing

1. Inspect all cover and housing (non-process-wetted) O-rings and replace if necessary. Lightly lubricate with silicone to ensure a good seal.


3095-031AB

2. Carefully tuck the cable connector completely inside the internal shroud. To do this, turn the shroud and cable counterclockwise one rotation to tighten the cable.


3095LC07

3. Lower the electronics housing onto the module, and guide the internal shroud and cable through the housing and into the external shroud.
4. Fasten the housing to the module by turning clockwise.

CAUTION
To prevent damage to the cable connector, watch the cable and shroud as you attach the housing to the module. Make sure the cable connector does not slip out of the internal shroud and begin to rotate with the housing. Reinsert the cable connector into the shroud if it escapes before the housing is fully fastened.

5. Inspect the threaded connections.


3095LC06

6. Tighten the housing rotation set screw. The bottom of the electronics housing must be within 1/16 in. of the sensor module to maintain explosion-proof requirements.

Attach the Electronics Board

3095LC04

1. Remove the cable connector from its position inside the internal shroud, and attach the cable to the electronics board.

2. Align the post-receptacle connectors with the posts inside the electronics housing.

3. Insert the electronics board into the housing and tighten the captive mounting screws.

3095LC02

⚠ 4. Replace the electronics housing cover. Metal to metal contact is preferred. Both device covers must be fully engaged to meet explosion-proof requirements.

Reassemble the Process Sensor Body

1. Visually inspect the Teflon sensor module O-rings. If the O-rings are undamaged, they can be re-used. If the O-rings show signs of damage, such as nicks or cuts, or if there is any doubt about their sealing ability, replace them with new O-rings.
   - Remove the damaged O-rings by carefully prying them from the O-ring grooves. Take care not to damage the surface of the isolating diaphragm during this process.
   - Replace the damaged O-rings by fitting new O-rings into the O-ring grooves.

2. Install the process flange on the sensor module. To hold the process flange in place, install the two hex head alignment screws. These screws are not pressure retaining and need only be finger tight. Do not overtighten; this will affect the module/flange alignment.
   - Install the appropriate flange bolts using Figure 2-8 on page 2-12 as a reference:
   - For installations requiring a ¼–18 NPT mounting, install the four 1.75-inch process flange bolts. First, finger-tighten the bolts. Then tighten the bolts incrementally in a cross pattern until they are securely tightened to 650 in-lb (300 in-lb for stainless steel bolts). After tightening, the bolts should protrude through the top of the module housing.
   - For installations requiring a ½–14 NPT mounting, hold the optional flange adapters and flange adapter O-rings in place while finger-tightening the four 2.88-inch process flange/ adapter bolts. Tighten the bolts in a cross pattern following the procedure outlined above. (Use two 2.88- inch bolts and two 1.75-inch bolts for gage pressure configurations.) After tightening, the bolts should protrude through the top of the module housing. If the bolts do not extend all the way through the module housing, you have used a bolt of incorrect length. Replace the bolt with one of the correct length, and repeat the procedure.
   - For installations with a three-valve manifold, align the process flange with the three-valve manifold. Install the four 2.25-inch manifold flange bolts following the procedure outlined above. After tightening, the bolts should protrude through the top of the module housing. If the bolts do not extend all the way through the module housing, you have used a bolt of incorrect length. Replace the bolt with one of the correct length, and repeat the procedure. Optional flange adapters can be installed on the process end of the three-valve manifold using the 1.75-inch flange bolts supplied with the device.
3. If the Teflon sensor module O-rings have been replaced, the flange bolts should be re-torqued after installation to compensate for cold flow.
4. Follow these steps to install the drain/vent valve:
   - Apply sealing tape to the threads on the seat. Starting at the base of the valve with the threaded end pointing toward the installer, apply two clockwise turns of the sealing tape.
   - Take care to orient the opening on the valve so that process fluid will drain toward the ground and away from personnel when the valve is opened.
   - Tighten the drain/vent valve to 250 in-lb.

RETURN OF MATERIALS

To expedite the return process outside the United States, contact the nearest Rosemount representative.

Within the United States, call the Rosemount National Response Center using the 1-800-654-RSMT (7768) toll-free number. This center, available 24 hours a day, will assist you with any needed information or materials.

The center will ask for product model and serial numbers, and will provide a Return Material Authorization (RMA) number. The center will also ask for the name of the process material the product was last exposed to.

CAUTION

People who handle products exposed to a hazardous substance can avoid injury if they are informed and understand the hazard. If the product being returned was exposed to a hazardous substance as defined by OSHA, a copy of the required Material Safety Data Sheet (MSDS) for each hazardous substance identified must be included with the returned goods.

The Rosemount National Response Center will detail the additional information and procedures necessary to return goods exposed to hazardous substances.

Section 6

Level Controller Specifications and Reference Data

FUNCTIONAL SPECIFICATIONS

Service

Liquid level measurement and control.

Differential Sensor

Ranges

Code 2: 0–2.5 to 0–250 inH_2O (0–0.62 to 0–62.2 kPa).
Code 3: 0–10 to 0–830 inH_2O (0–2.48 to 0–206 kPa).

Limits

Code 2: –250 to 250 inH_2O (–62.2 to 62.2 kPa).
Code 3: –830 to 830 inH_2O (–206 to 206 kPa).

Output

Two-wire 4–20 mA liquid level control signal with digital signal based on HART protocol.

Power Supply

External power supply required. Controller operates on terminal voltage of 11–55 V dc.

Humidity Limits

0–100% relative humidity.

Overpressure Limit

0 psia to a maximum of 1,600 psia (11032 kPa).

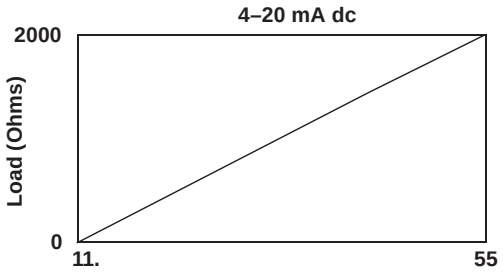
Static Pressure Limit

Operates within specifications between static line pressures of 0.0 psia through 800 psia (5516 kPa) maximum.

Load Limitations

Loop resistance is determined by the voltage level of the external power supply, as described by:

$$\text{Max. Loop Resistance} = \frac{\text{Power Supply Voltage} - 11.0 - \text{Actuator Voltage}^{(1)}}{0.022}$$



HART protocol communication requires a loop resistance value between 250–1100 ohms, inclusive.

(1) Control Element Voltage is the maximum voltage drop across the Control Element.

Hazardous Locations Certifications

Factory Mutual (FM) Approvals

A Explosion Proof for Class I, Division 1, Groups B, C, and D. Dust-Ignition Proof for Class II, Division 1, Groups E, F, and G. Suitable for Class III, Division 1, indoor and outdoor (NEMA 4X) hazardous locations. Factory Sealed. Provides nonincendive RTD connections for Class I, Division 2, Groups A, B, C, and D. Install per Rosemount drawing 03095-1025.

B Combination of Approval Code A and the following: Intrinsically Safe for use in Class I, Division 1, Groups A, B, C and D; Class II, Division 1, Groups E, F, G; nonincendive for Class I, Division 2, Groups A, B, C, and D. Temperature Code T4. NEMA 4X. Factory Sealed. Install per Rosemount drawing 03095-1020.

Canadian Standards Association (CSA) Approvals

C Explosion Proof for Class I, Division 1, Groups B, C, and D. Dust-Ignition Proof for Class II, Division 1, Groups E, F, and G. Suitable for Class III, Division 1, indoor and outdoor hazardous locations, CSA enclosure Type 4X. Factory Sealed. Provides nonincendive RTD connection for Class I, Division 2, Groups A, B, C, and D. Approved for Class I, Division 2, Groups A, B, C, and D. Install in accordance with Rosemount Drawing 03095-1024.

D Combination of Approval Code C and the following: Intrinsically Safe for Class I, Division 1, Groups A, B, C, and D when installed in accordance with Rosemount drawing 03095-1021. Temperature Code T3C.

BASEEFA/CENELEC Intrinsic Safety Certification

F EEx ia IIC T5 (T_{amb} = –45 °C to 40 °C).
EEx ia IIC T4 (T_{amb} = –45 °C to 70 °C).

Connection Parameters (Power/Signal Terminals)

$U_{max:in}$ = 30 V dc.
$I_{max:in}$ = 200 mA dc.
$W_{max:in}$ = 1.0 W.
C_{eq} = 0.012 μF.
L_{eq} = 0.

Temperature Sensor Connection Parameters

$U_{max:out}$ = 30 V.
$I_{max:out}$ = 12 mA.
$W_{max:out}$ = 100 mW.
C_{eq} = 0.002 μF.
L_{eq} = 0.

Connection Parameters for Temperature Sensor Terminals	Gas Group
C_a = 0.018 μF	IIC
C_a = 0.328 μF	IIB
C_a = 0.878 μF	IIA
L_a = 220 mH	IIC
L_a = 660 mH	IIB
L_a = 1760 mH	IIA
L/R = 163 μH/ohm	IIC
L/R = 489 μH/ohm	IIB
L/R= 1304 μH/ohm	IIA

BASEEFA Type N Certification

G Ex N IIC T5 (T_{amb} = –45 °C to 40 °C).
Ex N IIC T4 (T_{amb} = –45 °C to 70 °C).
4-Pin Connector Connection Parameters.
Output $Voltage_{max}$ = 35 V.
Output $Current_{max}$ = 13 mA.
$Capacitance_{max}$ (cable and device) = 0.25 μF.
$Inductance_{max}$ (cable and device) = 480 mH.

ISSeP/CENELEC Flameproof Certification

H EEx d IIC T6 (T_{amb} = 40 °C).
EEx d IIC T5 (T_{amb} = 70 °C).
IP65.

Failure Mode Alarm

If self-diagnostics detect a non-recoverable level controller device failure, the analog signal will either follow a mode shedding strategy or switch to a pre-set control signal. All failure mode settings are user selectable.

Gross failures will drive the analog output high or low according to the user-selecteable alarm jumper.

Turn-on Time

Digital measured variables will be within specifications 12–14 seconds after power is applied to controller.

Digital and analog control output will be functional within 12–14 seconds after a measured value is obtained.

Temperature Limits

Process (at controller isolator flange):
–40 to 250 °F (–40 to 121 °C).

Ambient:
–40 to 185 °F (–40 to 85 °C).
With LOI: –4 to 125 °F (–20 to 80 °C).

Storage:
–50 to 212 °F (–46 to 100 °C).
With LOI: –40 to 185 °F (–40 to 85 °C).

Damping

Response to step input change can be user-selectable from 0 to 32 seconds for one time constant. This is in addition to sensor response time of 0.2 seconds.

PERFORMANCE SPECIFICATIONS

(Zero-based spans, reference conditions, silicone oil fill, 316 SST isolating diaphragms.)

Level Accuracy

± 0.1% of span (assume the process density is constant and rangedown is 1:1 to 10:1) Differential Pressure.

Range 2: 0–2.5 to 0–250 inH_2O (0–0.62 to 0–62.2 kPa) (100:1 rangeability is allowed).

Range 3: 0–10 to 0–830 inH_2O (0–2.48 to 0–206 kPa) (83:1 rangeability is allowed).

Reference Accuracy (including Linearity, Hysteresis, Repeatability)

±0.075% of span for spans from 1:1 to 10:1 of URL.

For rangedowns greater than 10:1 of URL,

$$\text{Accuracy} = \left[0.025 + 0.005\left(\frac{\text{URL}}{\text{Span}}\right)\right]\% \text{ of Span}$$

Ambient Temperature Effect per 50 °F (28 °C)

±(0.025% of URL + 0.175% of span) spans from 1:1 to 30:1.
±(0.035% of URL – 0.125% of span) spans from 30:1 to 100:1.

Static Pressure Effects

Zero error = ±0.10% of URL per 1,000 psi (6894 kPa).
Span error = ±0.20% of reading per 1,000 psi (6894 kPa).

Stability

±0.1% of URL for 12 months.

Process Temperature (RTD)

Sensor errors caused by the RTD are not included. The level controller is compatible with any PT100 RTD conforming to IEC 751 Class B, which has a nominal resistance of 100 ohms at 0 °C and $\propto$ = 0.00385. Examples of compatible RTDs include the Rosemount Series 68 and 78 RTD Temperature Sensors.

Range

–40 to 1200 °F (–40 to 649 °C).

Accuracy (including Linearity, Hysteresis, Repeatability)

±1.0 °F (0.56 °C).

Ambient Temperature Effects per 50 °F (28 °C)

±0.72 °F (0.40 °C) for process temperatures from –40 to 185 °F (–40 to 85°C).
±(1.28 °F (0.72 °C) + 0.16% of reading) for process temperatures from 185 to 1200 °F (85 to 649 °C).

Stability

±1.0 °F (0.56 °C) for 12 months.

PHYSICAL SPECIFICATIONS

Electrical Connections

½–14 NPT, M20 × 1.5 (CM20), PG 13.5.

Process Connections

Controller: ¼–18 NPT on 2⅛-in. centers.
½–14 NPT on 2-, 2⅛-, or 2¼-in. centers with optional flange adapters.

Process Wetted Parts

Isolating Diaphragms

316L SST or Hastelloy C-276®.

Drain/Vent Valves

316 SST or Hastelloy C®.

Flanges

Plated carbon steel, 316 SST, or Hastelloy C.

Wetted O-rings

Glass-Filled TFE.

Level Flange and Seal Options

2-inch Stainless Steel ANSI Class 150 Flange

Flange Style Code 0 and Option Code FA.

2-inch Stainless Steel ANSI Class 300 Flange

Flange Style Code 0 and Option Code FB.

3-inch Stainless Steel ANSI Class 150 Flange

Flange Style Code 0 and Option Code FC.

3-inch Stainless Steel ANSI Class 300 Flange

Flange Style Code 0 and Option Code FD.

DIN DN 50 PN 40 Stainless Steel Flange

Flange Style Code 0 and Option Code FP.

DIN DN 80 PN 40 Stainless Steel Flange

Flange Style Code 0 and Option Code FQ.

Remote Seal

Flange Style Code 0 and Option Code S1 or S2. Refer to Model 1199 Remote Seals Product Data Sheet PDS 4016.

RTD

Process connection varies depending on RTD physical specifications.

Non-Wetted Parts

Electronics Housing

Low copper aluminum or optional 316 SST.

Bolts

Plated carbon steel per ASTM A449, Grade 5;
or austenitic 316 SST.

Fill Fluid

Silicone oil.

Paint

Polyurethane.

O-rings

Buna-N.

Weight

Component	Weight in lb (kg)
Model 3095 Level Controller	6.0 (2.7)
SST Mounting Bracket	1.0 (0.4)
12 ft (3.66 m) RTD Shielded Cable	0.5 (0.2)
12 ft (3.66 m) RTD Armored Cable	1.1 (0.5)
24 ft (7.32 m) RTD Shielded Cable	1.0 (0.4)
24 ft (7.32 m) RTD Armored Cable	2.2 (1.0)

ORDERING INFORMATION

Model	Product Description	
3095C	Level Controller	
Code	**Output**	
A	4–20 mA with Digital Signal Based on *HART* Protocol	
Code	**Differential Pressure Range**	
2	0–2.5 to 0–250 inH_2O (0–0.62 to 0–62.2 kPa)	
3	0–10 to 0–830 inH_2O (0–2.48 to 0–206 kPa)	
Code	**Reserved for Future Option**	
0	None	
Code	**Isolator Material**	**Fill Fluid**
A	316L SST	Silicone
B(1)	*Hastelloy C-276*	Silicone
Code	**Flange Style, Material**	
A	*Coplanar*, CS	
B(1)	*Coplanar*, SST (Required for Option Code S1 or S2)	
C(1)	*Coplanar, Hastelloy C*	
0	Alternate Flange (See Option Codes FA, FB, FC, FD, FP, FQ, S5)	
Code	**Drain/Vent Material**	
A	SST	
C(1)	*Hastelloy C*	
0	None (Required for Option Code S5)	
Code	**O-ring**	
1	Glass-filled TFE	
Code	**Process Temperature Input (RTD ordered separately)**	
0	Fixed Process Temperature (no cable - RTD plug installed)	
1	RTD Input with 12 ft (3.66 m) of Shielded Cable (Intended for use with conduit)	
2	RTD Input with 24 ft (7.32 m) of Shielded Cable (Intended for use with conduit)	
3	RTD Input with 12 ft (3.66 m) of Armored, Shielded Cable	
4	RTD Input with 24 ft (7.32 m) of Armored, Shielded Cable	
Code	**Controller Housing Material**	**Conduit Entry Size**
A	Polyurethane-covered Aluminum	½–14 NPT
B	Polyurethane-covered Aluminum	M20 × 1.5 (CM20)
C	Polyurethane-covered Aluminum	PG 13.5
J	316 SST	½–14 NPT
K	316 SST	M20 × 1.5 (CM20)
L	316 SST	PG 13.5
Code	**Terminal Block**	
A	Standard	
B	With Integral Transient Protection	
Code	**Meter**	
0	None	
1	Local Operator Interface (LOI)	
Code	**Bracket**	
0	None (Required for Option Codes FA, FB, FC, FD, FP, FQ, and S5)	
1	*Coplanar* SST Flange Bracket for 2-in. Pipe or Panel Mount, SST bolts	
Code	**Bolts**	
0	CS bolts	
1	Austenitic 316 SST bolts	
N	None (Required for Option Codes FA, FB, FC, FD, FP, FQ, and S5)	
Code	**Approvals**	
0	None	
A	FM Explosion-Proof Approval	
B	FM Explosion-Proof Approval and Non-Incendive/Intrinsic Safety Approval Combination	
C	CSA Explosion-Proof Approval	
D	CSA Explosion-Proof Approval and Non-Incendive/Intrinsic Safety Approval Combination	
F	BASEEFA/CENELEC Intrinsic Safety Certification	
G	BASEEFA Type N Certification	
H	ISSeP/CENELEC Flameproof Certification	

(1) Meets NACE material recommendations per MR 01–75.

Code	Software Functionality
L	Level Control
Code	**Options**
CC	Autotuner
FA	Level Flange, SST, 2 in., ANSI Class 150, Vertical Mount
FB	Level Flange, SST, 2 in., ANSI Class 300, Vertical Mount
FC	Level Flange, SST, 3 in., ANSI Class 150, Vertical Mount
FD	Level Flange, SST, 3 in., ANSI Class 300, Vertical Mount
FP	DIN Level Flange, SST, DN 50, PN 40, Vertical Mount
FQ	DIN Level Flange, SST, DN 80, PN 40, Vertical Mount
P1	Hydrostatic Testing
P2	Cleaning for Special Services
Q4	Inspection Certificate for Calibration Data
Q8	Material Inspection Certificate
C2	Custom Configuration
S1	Assembly with One Diaphragm Seal (requires diaphragm seal model number – see 00813-0100-4016)
S2	Assembly with Two Diaphragm Seals (requires diaphragm seal model number – see 00813-0100-4016)
S5	Assembly with Model 305 Integral Manifold (requires integral manifold model number – see 00813-0100-4733)
DF	Flange Adapters — Adapter Type Determined by Selected Flange Material: { Plated CS / SST / *Hastelloy C*
Typical Model Number	**3095C A 2 4 A A A 1 1 A A 0 1 1 0 L**

Options

Standard Configuration

Unless otherwise specified, the controller is shipped as follows:

Engineering units:

Differential	inH_2O (Range 2)
Process Temp.	°F
Output	Level Control
Flange type:	Specified model code option
Flange material:	Specified model code option
O-ring material:	Specified model code option
Drain/vent:	Specified model code option
Software tag:	(Blank)

Software tag (8 characters maximum) is left blank unless specified.

Unless otherwise specified, the Level Controller is shipped as follows:

- Measures level of water in feet with controller height set to 0 feet.
- Control Algorithm set to reverse-acting PID control, with P=1, and I and D terms set to 0; power-up control signal set to 0%: target setpoint set to 50% of full scale; and mode shed action set to go to shed output.

Fixed Process Temperature

If process temperature input code is set to 0, the desired fixed process temperature can be specified during order entry.

Custom Configuration (Option Code C2)

If Option Code C2 is ordered, the customer specifies level parameters and controller configuration parameters in addition to the standard configuration parameters. Requires a completed Configuration Data Sheet (00806-0100-4741).

Tagging

Three customer tagging options are available:

1. Standard SST tag is wired to the controller. Tag character height is 0.125 in. (3.18 mm), 85 characters maximum.
2. Tag may be permanently stamped on controller nameplate upon request. Tag character height is 0.0625 in. (1.59 mm), 65 characters maximum.
3. Tag may be stored in controller memory. Software tag (8 characters maximum) is left blank unless specified.

Accessories

Optional Model 1199 Remote Diaphragm Seals

Model 3095 Level Controller and Model 1199 Remote Diaphragm Seals are fully assembled, filled, calibrated, and pressure tested by the factory. Refer to PDS 00813-0100-4016 for additional information.

Optional Three-Valve Manifolds

Anderson, Greenwood & Co. (Packaged Separately).

Description (Part Number)
Carbon Steel, M4AVIC **(01151-0150-0001).**
316 SST, M4AVIS **(01151-0150-0002).**

Temperature Sensors and Assemblies

Fisher-Rosemount offers many types of temperature sensors and assemblies. Contact your Fisher-Rosemount Sales Engineer for a product data sheet.

Model 333 HART Tri-Loop™ HART-to-Analog Signal Converter

The Model 333 HART Tri-Loop can be installed with the Level Controller without disrupting existing device wiring. The Tri-Loop provides up to three additional analog outputs for monitoring or other controlling purposes.

The HART Tri-Loop accepts the Level Controller digital signal and converts it to three independent 4–20 mA analog signals. Any of the Model 3095 Level Controller process variables (DP, PT, level, or control output) can be provided via the Tri-Loop.

For additional information on the HART Tri-Loop, see Product Data Sheet 00813-0100-4754.

Appendix A HART Communicator

INTRODUCTION

This appendix provides an introduction to using the Model 275 HART Communicator with a Model 3095 Multivariable Level Controller. It describes the HART Communicator keypad, connections, menu structure, and Fast Key sequence features. It also includes a menu tree and a table of Fast Key sequences that apply specifically to the Level Controller.

This brief summary will familiarize you with the HART Communicator, but is not meant to replace the HART Communicator product manual.

For information on all the capabilities of the HART Communicator, refer to the HART Communicator Product Manual 00809-0100-4275.

SAFETY MESSAGES

Procedures and instructions 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.

⚠WARNING

Explosions could result in death or serious injury:

- Verify that the operating environment is consistent with the appropriate hazardous locations certifications.
- Before connecting a HART-based 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.
- Do not make connections to the serial port or NiCad recharger jack in an explosive atmosphere.

⚠WARNING

Failure to follow safe installation and servicing guidelines could result in death or serious injury:

- Make sure only qualified personnel perform these procedures.
- Use the equipment only as specified in this manual. Failure to do so may impair the protection provided by the equipment.
- Do not perform any service other than those contained in this manual unless you are qualified.

FIGURE A-1. HART Communicator Menu Tree for the Level Controller.

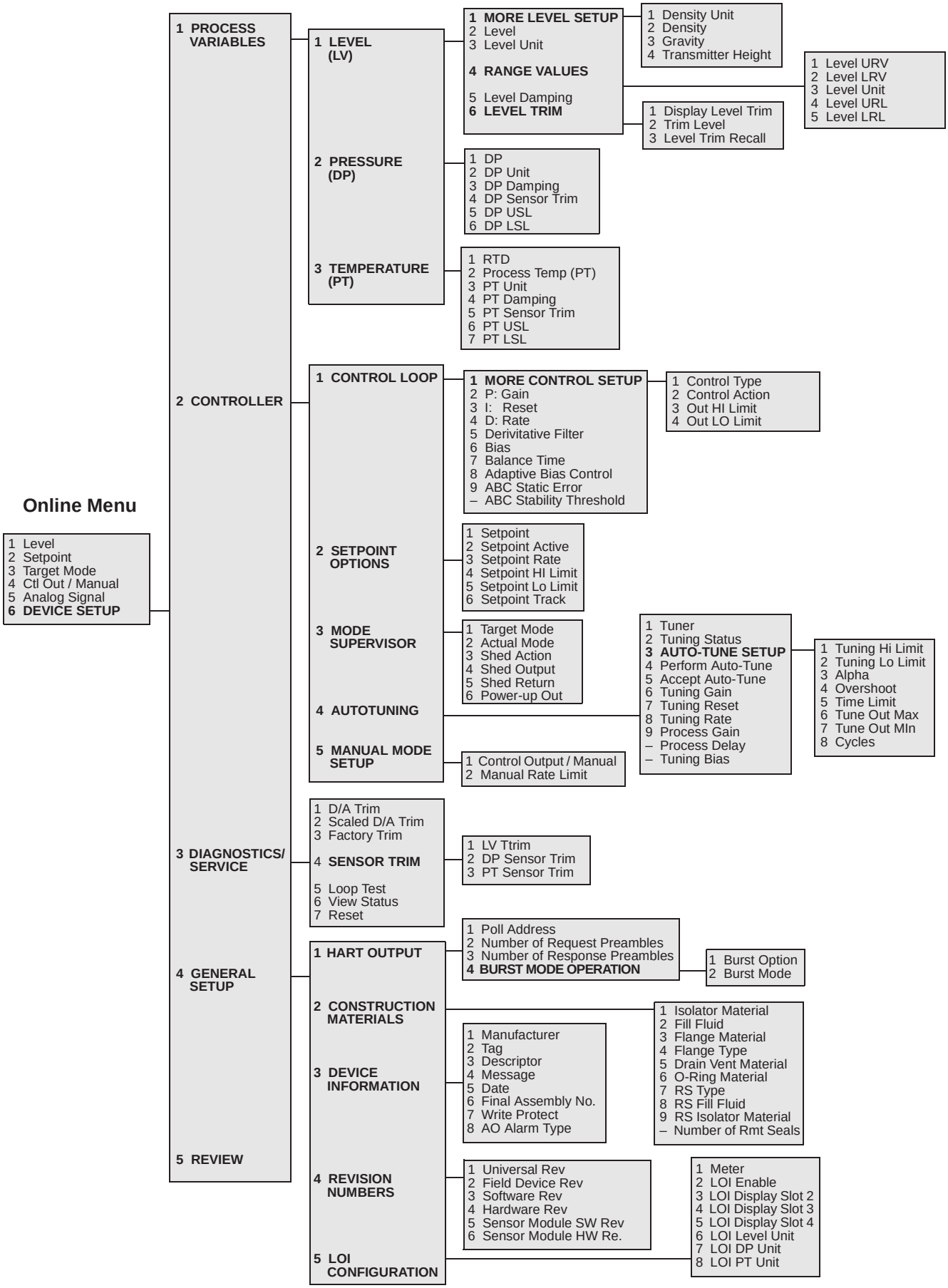


TABLE A-1. HART Fast Key Sequences for the Level Controller.

Function	HART Communicator Fast Key Sequences
ABC Static Error	6, 2, 1, 9
AO Alrm typ	6, 4, 3, 8
Accept Auto-Tune	6, 2, 4, 5
Actual Mode	6, 2, 3, 2
Adapt Bias Ctl	6, 2, 1, 8
Alpha	6, 2, 4, 3, 3
Analog Signal	5
Balance Time	6, 2, 1, 7
Bias	6, 2, 1, 6
Burst Mode	6, 4, 1, 4, 2
Burst option	6, 4, 1, 4, 1
Cntl Action	6, 2, 1, 1, 2
Cntl Out	6, 2, 5, 1
Cntl Type	4 or 6, 2, 1, 1, 1
Cycles	6, 2, 4, 3, 8
D/A trim	6, 3, 1
D: Rate	6, 2, 1, 4
DP Damping	6, 1, 2, 3
DP LSL	6, 1, 2, 6
DP Sensor Trim	6, 1, 2, 4
DP Sensor Trim	6, 3, 4, 2
DP USL	6, 1, 2, 5
DP Unit	6, 1, 2, 2
DP	6, 1, 2, 1
Date	6, 4, 3, 5
Density	6, 1, 1, 1, 2
Deriv Fltr	6, 2, 1, 5
Descriptor	6, 4, 3, 3
Density Unit	6, 1, 1, 1, 1
Drain vent matl	6, 4, 2, 5
Factory Trim	6, 3, 3
Fill fluid	6, 4, 2, 2
Final asmbly num	6, 4, 3, 6
Flange type	6, 4, 2, 4
Fld dev rev	6, 4, 4, 2
Flnge matl	6, 4, 2, 3
Gravity	6, 1, 1, 1, 3
Hardware rev	6, 4, 4, 4
I: Reset	6, 2, 1, 3
Isoltr matl	6, 4, 2, 1
LOI Enable	6, 4, 5, 2
LOI Display Slot 2	6, 4, 5, 3
LOI Display Slot 3	6, 4, 5, 4
LOI Display Slot 4	6, 4, 5, 5
LOI DP Unit	6, 4, 5, 7
LOI Level Unit	6, 4, 5, 6
LOI PT Unit	6, 4, 5, 8

(Table continues on following page)

Function	HART Communicator Fast Key Sequences
LV Damping	6, 1, 1, 5
LV LRL	6, 1, 1, 4, 5
LV LRV	6, 1, 1, 4, 2
LV Trim	6, 1, 1, 6
LV URL	6, 1, 1, 4, 4
LV URV	6, 1, 1, 4, 1
LV Unit	6, 1, 1, 3
Level	1 or 6, 1, 1, 2
Loop test	6, 3, 5
Manual Rate Limit	6, 2, 5, 2
Manual	4 or 6, 2, 5, 1
Manufacturer	6, 4, 3, 1
Message	6, 4, 3, 4
Meter	6, 4, 5, 1
Num req preams	6, 4, 1, 2
Num resp preams	6, 4, 1, 3
O ring matl	6, 4, 2, 6
Out HI Lim	6, 2, 1, 1, 3
Out LO Lim	6, 2, 1, 1, 4
Overshoot	6, 2, 4, 3, 4
P: Gain	6, 2, 1, 2
PT Damping	6, 1, 3, 4
PT LSL	6, 1, 3, 7
PT Sensor Trim	6, 1, 3, 5
PT USL	6, 1, 3, 6
PT Unit	6, 1, 3, 3
PT	6, 1, 3, 2
Perform Auto-Tune	6, 2, 4, 4
Power-up Out	6, 2, 3, 6
Process Gain	6, 2, 4, 9
RS fill fluid	6, 4, 2, 8
RS isoltr matl	6, 4, 2, 9
RS type	6, 4, 2, 7
Reset	6, 3, 7
RTD	6, 1, 3, 1
SP Hi Lim	6, 2, 2, 4
SP Lo Lim	6, 2, 2, 5
SP Rate Limits	6, 2, 2, 3
SP Track	6, 2, 2, 6
Scaled D/A trim	6, 3, 2
Setpoint	2 or 6, 2, 2, 1
Setpoint Active	6, 2, 2, 2
Shed Action	6, 2, 3, 3
Shed Return	6, 2, 3, 5
Shed Out	6, 2, 3, 4
Snsr Module hw rev	6, 4, 4, 6
Snsr Module sw rev	6, 4, 4, 5

Function	HART Communicator Fast Key Sequences
Software rev	6, 4, 4, 3
Tag	6, 4, 3, 2
Target Mode	3
Time Limit	6, 2, 4, 3, 5
Tuner	6, 2, 4, 1
Tune Out Max	6, 2, 4, 3, 6
Tune Out Min	6, 2, 4, 3, 7
Tuning Bias	6, 2, 4, –
Tuning Gain	6, 2, 4, 6

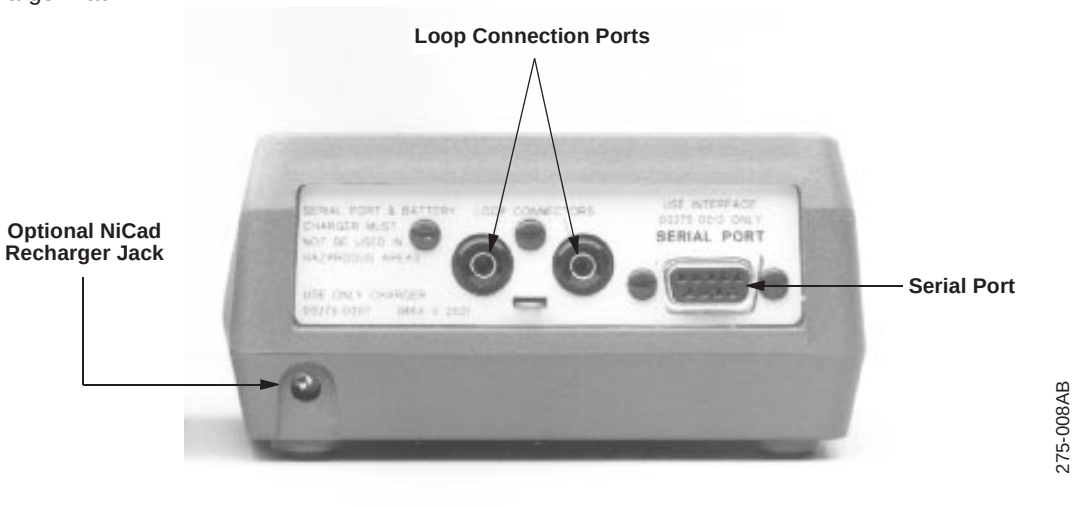
Function	HART Communicator Fast Key Sequences
Tuning Hi Limit	6, 2, 4, 3, 1
Tuning Lo Limit	6, 2, 4, 3, 2
Tuning Rate	6, 2, 4, 8
Tuning Reset	6, 2, 4, 7
Tuning Status	6, 2, 4, 2
Universal rev	6, 4, 4, 1
View Status	6, 3, 6
Write protect	6, 4, 3, 7
Xmtr Height	6, 1, 1, 1, 4

CONNECTIONS AND HARDWARE

The HART Communicator Model 275 can interface with a transmitter from the control room, the instrument site, or any wiring termination point in the loop through the rear connection panel as shown in Figure A-2. To communicate, connect the HART Communicator in parallel with the instrument or load resistor. The connections are non-polarized.

⚠ Do not make connections to the serial port or NiCad recharger jack in an explosive atmosphere.

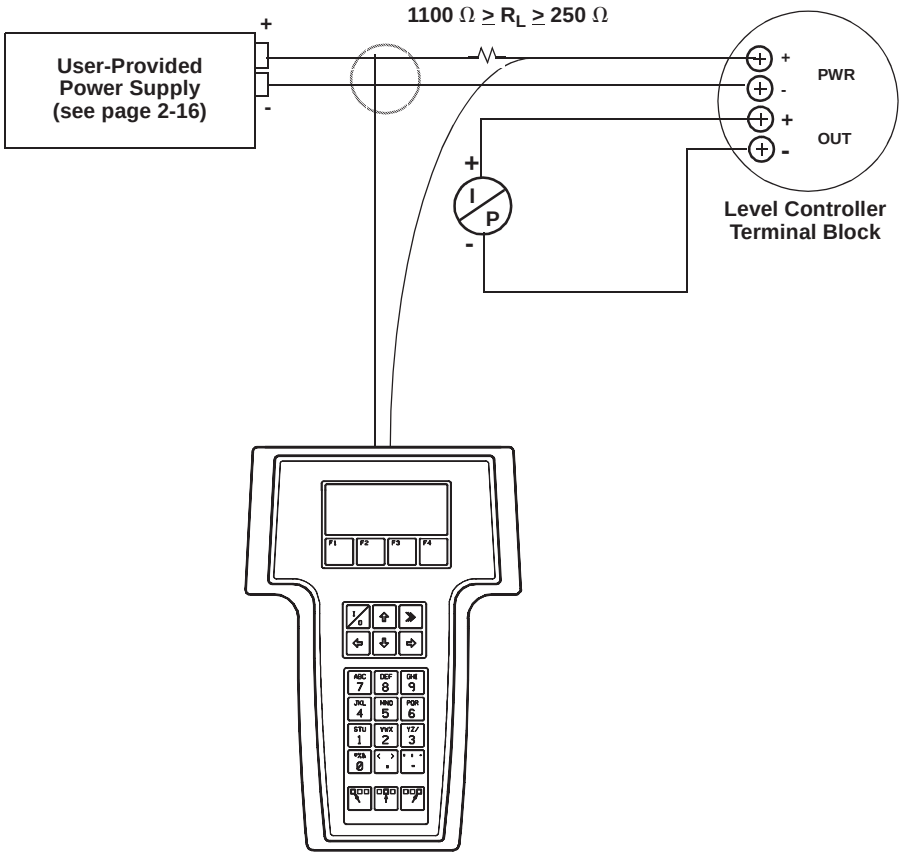
FIGURE A-2. Rear Connection Panel with Optional NiCad Recharger Pack.



⚠ 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.

NOTE
The HART Communicator needs a minimum of 250 ohms resistance in the loop to function properly. The HART Communicator does not measure loop current directly.

FIGURE A-3. Wiring Connections.



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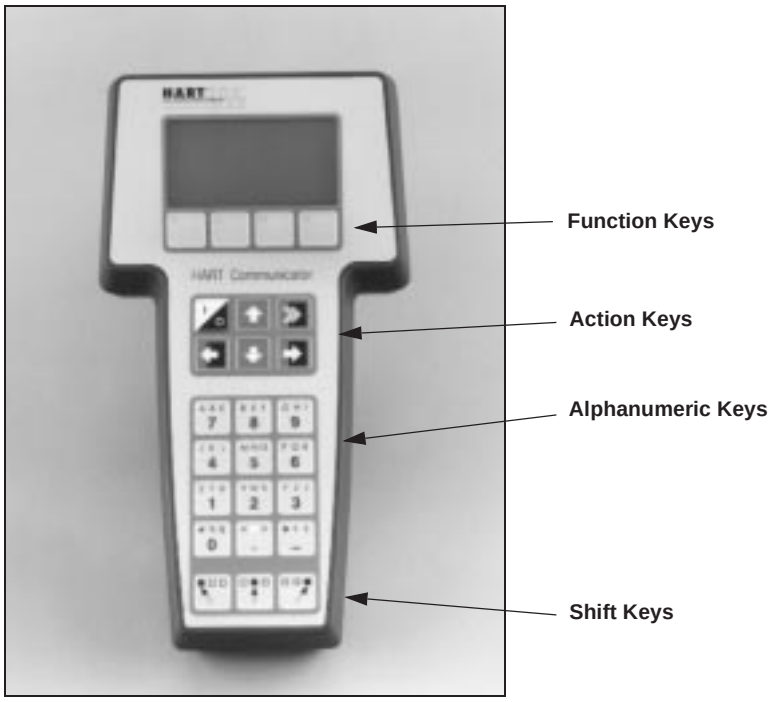
COMMUNICATOR KEYS

The keys of the HART Commuincator include action, function, alphanumeric, and shift keys

FIGURE A-4. The HART Communicator.



Action Keys

As shown in Figure A-4, the action keys are the six blue, white, and black keys located above the alphanumeric keys. The function of each key is described as follows:

ON/OFF Key

Use this key to power the HART Communicator. When the communicator is turned on, it searches for a transmitter on the 4–20 mA loop. If a device is not found, the communicator displays the message, “No Device Found. Press OK.”

If a HART-compatible device is found, the communicator displays the Online Menu with device ID and tag.

Directional Keys

Use these keys to move the cursor up, down, left, or right. The right arrow key also selects menu options, and the left arrow key returns to the previous menu.

HOT Key

Use this key to quickly access important, user-selectable options when connected to a HART-compatible device. Pressing the Hot Key turns the HART Communicator on and displays the Hot Key Menu.
See Customizing the Hot Key Menu in the HART Communicator manual for more information.

Function Keys

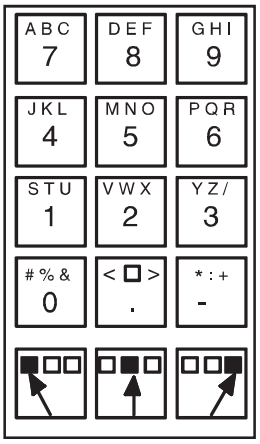
Use the four software-defined function keys, located below the LCD, to perform software functions. On any given menu, the label appearing above a function key indicates the function of that key for the current menu.

As you move among menus, different function key labels appear over the four keys. For example, in menus providing access to on-line help, the HELP label may appear above the F1 key. In menus providing access to the Home Menu, the HOME label may appear above the F3 key. Simply press the key to activate the function. See your HART Communicator manual for details on specific function key definitions.

Alphanumeric and Shift Keys

The Alphanumeric keys (Figure A-5) perform two functions: fast selection of menu options (refer to "HART Fast Key Feature" in this section) and data entry.

FIGURE A-5. HART Communicator Alphanumeric and Shift Keys.



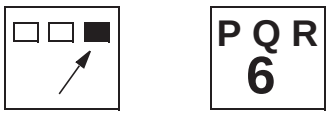
Some menus require data entry. Use the Alphanumeric and Shift keys to enter all alphanumeric information into the HART Communicator. If you press an Alphanumeric key alone from within an edit menu, the bold character in the center of the key appears. These large characters include the numbers zero through nine, the decimal point (.), and the dash symbol (–).

To enter an alphabetic character:

1. Press the Shift key that corresponds to the position on the Alphanumeric key of the letter you want.
2. Press the Alphanumeric key.

For example, to enter the letter R, first press the right Shift key, then the "6" key (see Figure A-6). Do not press these keys simultaneously, but one after the other.

FIGURE A-6. Data Entry Key Sequence.



MENUS AND FUNCTIONS

The HART Communicator is a menu driven system. Each screen provides a menu of options that can be selected or provides direction for input of data, warnings, messages, or other instructions.

Main Menu

When the HART Communicator is turned on, one of two menus appears: the Online Menu or the Main Menu.

If the HART Communicator is connected to an operating loop, the communicator finds the device and displays the Online Menu.

If it is not connected to a loop, the communicator indicates that no device was found. When you press OK (F4), it displays the Main Menu.

The Main Menu provides the following options:

- *Offline* – The Offline option provides access to offline configuration data and simulation functions.
- *Online* – The Online option checks for a device and if it finds one, brings up the Online Menu. Online communication with the APEX Radar Gauge automatically loads the current gauge data to the HART Communicator.
- *Transfer* – The Transfer option provides access to options for transferring data either from the HART Communicator (memory) to the APEX Radar Gauge (device) or vice versa. Transfer is used to move offline data from the HART Communicator to the gauge, or to retrieve data from a gauge for offline revision.
- *Frequency Device* – The Frequency Device option displays the frequency output and corresponding pressure output of current-to-pressure transmitters.
- *Utility* – The Utility option provides access to the contrast control for the HART Communicator LCD screen and to the autopoll setting used in multidrop applications.

To select an option from the menu, you can use the up and down arrow keys and the select (right arrow) key or you can simply press the corresponding number on the alphanumeric keypad to “fast select” the option.

After selecting a Main Menu option, the HART Communicator provides the information you need to complete the operation. If further details are required, consult the HART Communicator manual.

Online Menu

The Online Menu can be selected from the Main Menu or it appears automatically if the HART Communicator is connected to an active loop and can detect an operating Level Controller.

Online mode is used for direct evaluation of a particular meter, re-configuration, changing parameters, maintenance, and other functions.

When configuration variables are reset in online mode, the new settings are not activated until the data is sent to the gauge. Press SEND (F2) when it is activated to update the process variables of the Level Controller.

NOTE
The Main Menu can be accessed from the Online Menu. Press the left arrow action key to deactivate the online communication with the Level Controller and to activate the Main Menu options.

HART Fast Key Feature

The HART Fast Key feature provides quick online access to Level Controller variables and functions. Instead of stepping your way through the menu structure using the Action Keys, you can press a HART Fast Key sequence to move from the Online Menu to the desired variable or function. On-screen instructions guide you through the rest of the screens.

The HART Fast Key sequences are made up of the series of numbers corresponding to the individual options in each step of the menu structure. For example, from the Online Menu you can change the **Date**. Following the menu structure, you would:

1. Press 6 to reach **Device Setup**.
2. Press 4 for **General Setup**.
3. Press 3 for **Device Information**.
4. Press 5 for **Date**.

So, the corresponding HART Fast Key sequence is **6**, **4**, **3**, **5**.

HART Fast Keys are operational only from the Online Menu. If you use them consistently, you return to the Online Menu by pressing HOME (F3) when it is available. If you do not start at the Online Menu, the HART Fast Keys will not function properly.

Use Table A-1, an alphabetical listing of online functions, to find the corresponding HART Fast Keys. These codes are applicable only to the Level Controller and the HART Communicator.

Diagnostic Messages

The following pages contain a list of messages used by the Model 275 HART Communicator (HC) 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 <*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 HC 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 HC off and lose the unsent data.
Display value of variable on hotkey menu?	Asks whether the value of the variable should be displayed adjacent to its label on the hotkey menu if the item being added to the hotkey 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.

Message	Description
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 HC off before sending modified data or before completing a method.
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 which have not been set by the user. These variables should be set or invalid values may be sent to the device.

Message	Description
There is unsent data. Send it before shutting off?	Press YES to send unsent data and turn the HC off. Press NO to turn the HC 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 parameter> 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 HC 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 parameter>	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 parameter> 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.

Appendix B

Level Controller Accessories and Options

Options and accessories available with the Model 3095 Level Controller can facilitate installation and enhance operation and ease of use.

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

Explosions could result in death or serious injury:

- Do not remove the instrument cover in explosive atmospheres when the circuit is alive.
- Both controller covers must be fully engaged to meet explosion-proof requirements.
- The unused conduit opening on the controller housing must be plugged and sealed to meet explosion-proof requirements.

⚠WARNING

Failure to follow safe installation and servicing guidelines could result in death or serious injury:

- Make sure only qualified personnel perform these procedures.
- Use the equipment only as specified in this manual. Failure to do so may impair the protection provided by the equipment.

⚠WARNING

High voltage that may be present on leads could cause electrical shock:

- Avoid contact with leads and terminals.

ACCESSORIES

Model 1199 Remote Diaphragm Seals

The Level Controller can be supplied with Rosemount's complete family of Model 1199 Diaphragm Seals for capillary or direct mount to the tank. Refer to the Model 1199 Filled Systems PDS, 00813-0100-4016, for additional information.

Model 305 Integral Manifold

The Level Controller can be fully assembled to the Model 305 Integral Manifold. The system is fully assembled, filled, calibrated, and pressure tested by the factory. Refer to PDS 00813-0100-4733 for additional information.

SST Mounting Brackets

Optional mounting brackets available with the Level Controller facilitate mounting to panel, wall, or 2-inch pipe. The bracket option for use with the Coplanar™ flange is 316 SST with 316 SST bolts.

Transient Protection Terminal Block

The transient protection terminal block option increases the Model 3095 Level Controller's ability to withstand electrical transients induced by lightning, welding, or heavy electrical equipment. The Level Controller, with integral transient protection installed, meets the standard performance specifications as outlined in this product manual.

Transient protection terminal blocks can be ordered factory-installed, or they can be ordered as a spare part to retrofit existing Model 3095 Level Controllers already in the field. The Rosemount spare part number for the transient protection terminal block is 03095-0964-0002.

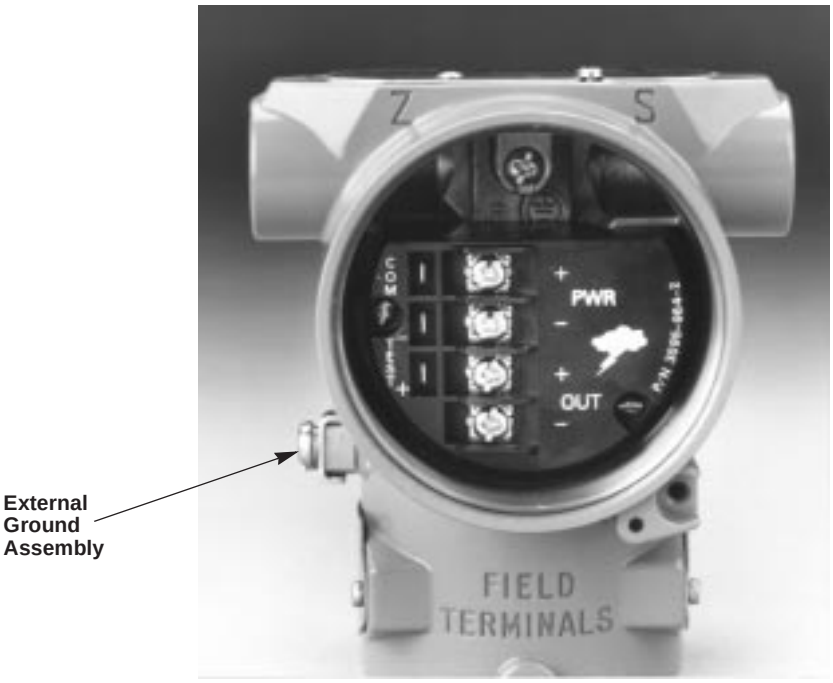
Installation Procedure

The transient protection terminal block is shipped installed when ordered at the same time as the Level Controller. Use the following procedure to install this terminal block when this option is ordered as a spare part or retrofit.

1. Remove the cover above the side marked FIELD TERMINALS on the Level Controller electronics housing. Do not remove the instrument cover in explosive atmospheres when the circuit is alive.
2. Loosen the two terminal block mounting screws and pull the standard terminal block out.
3. If present, transfer the signal wires from the old terminal block to the transient protection terminal block. Be sure that the + signal wire is reconnected to the SIG + terminal, and the – signal wire is reconnected to the SIG – terminal.
4. Install the terminal block by positioning the terminal block above the post connector pins and pressing into place.
5. Use the captive mounting screws on the terminal block to secure it to the electronics housing.
6. Ground the terminal block using one of the options described on page 2-22.
7. Replace the Level Controller cover. Both transmitter covers must be fully engaged to meet explosion-proof requirements.
8. (Optional) If desired, re-trim the Level Controller (see page 4-10).

NOTE
Installation of the Transient Protection Terminal Block does not provide transient protection unless the Level Controller is properly grounded. See page 2-22 for grounding information.

FIGURE B-1. Transient Protection Terminal Block with External Ground Assembly.



OPTIONS

Auto-Tuning (Option Code CC)

The Model 3095 Level Controller can be supplied with auto-tuning for level control. Auto-tuning determines the process parameters and applies tuning rules to determine the optimal tuning parameters (gain, reset, rate, and bias) for the PID equation. Refer to “Autotuner” on page 4-12 for information.

Local Operator Interface

The Level Controller is supplied blank as standard. An optional Local Operator Interface (LOI) is available. The LOI allows the user to locally change the setpoint and basic controller setup and provides local display of process variables.

Custom Configuration (Option Code C2)

Custom factory configuration allows a customer to receive a Model 3095 Level Controller configured for their specific application. A Configuration Data Sheet (CDS 00806-0100-4741) must be completed and returned to Rosemount. The CDS is shown in Section 6 of this manual.

Appendix C

Approval Drawings

PROPRIETARY INFORMATION IS CONTAINED HEREIN AND MUST BE HANDLED ACCORDINGLY
BY _____ DATE _____

REVISIONS				
REV	DESCRIPTION	CHG. NO.	APP'D	DATE
C	ADD NOTE 10	656722	B.L.L.	10/12/93
D	CHG TO A SIZE, ADD NOTE 11	656967	B.L.L.	10/28/93
E	CHG NOTES 9,11	657643	M.J.Z.	1/26/94
F	DEL NOTES 7,10,11 ADD NOTE 12	661305	K.J.A.	8/26/94
G	ADD DIV 1,2	662265	M.J.Z.	9/6/94

NOTES:

12. INSTALLATION TO BE IN ACCORDANCE WITH NATIONAL ELECTRICAL CODE.

9. NON-INCENDIVE FIELD WIRING METHODS MAY BE USED FOR CONNECTING THE TEMPERATURE SENSING ASSEMBLY. WHEN USING NON-INCENDIVE FIELD WIRING, THE CONNECTION HEAD AND TEMPERATURE SENSOR ASSEMBLY NEED NOT BE EXPLOSION PROOF, BUT ALL COMPONENTS CONNECTED TO THE TEMP SENSOR CONNECTOR MUST BE CLASSIFIED "SIMPLE APPARATUS". SIMPLE APPARATUS ARE DEVICES WHICH ARE INCAPABLE OF GENERATING OR STORING MORE THAN 1.2V, 0.1A, 25mW, OR 20 μJ (RTD's QUALIFY AS SIMPLE APPARATUS).

8. DIVISION 2 WIRING METHOD.

6. CLASS II INSTALLATIONS MUST USE A CSA APPROVED DUST-IGNITIONPROOF SENSOR.

5. IN AMBIENTS GREATER THAN 40°C, SPRING LOADED TEMPERATURE SENSORS USED WITHOUT AN EXPLOSIONPROOF THERMOWELL MUST BE RATED FOR AT LEAST 85°C.

4. COMPONENTS REQUIRED TO BE APPROVED MUST BE APPROVED FOR GAS GROUP APPROPRIATE TO AREA CLASSIFICATION.

3. ALL CONDUIT THREADS TO BE ASSEMBLED WITH FIVE FULL THREADS MINIMUM.

2. TRANSMITTER MUST NOT BE CONNECTED TO EQUIPMENT GENERATING MORE THAN 250VAC.

1. WIRING METHOD SUITABLE FOR CLASS I, DIV 1, ANY LENGTH.

THIS DRAWING WAS CREATED ON CAD. DRAWING IS ARCHIVED ON MAGNETIC TAPE FOR ECO CHANGES.

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

- TOLERANCES -

DECIMALS
.X±.1
.XX±.02
.XXX±.010

FRACTIONS
±1/32

ANGLES
±2°

DO NOT SCALE PRINT

CONTRACT NO.

DR. Myles Lee Miller 7/21/93

CHK'D BLL

APP'D. BEN LOUWAGIE 8/17/93

APP'D. GOVT.

ROSEMOUNT® Measurement Control Analytical Valves

Rosemount Inc.
12001 Technology Drive
Eden Prairie, MN 55344 USA

TITLE MODEL 3095 EXPLOSIONPROOF INSTALLATION DRAWING, FACTORY MUTUAL

SIZE	FSCM NO	DWG NO.
A		03095-1025

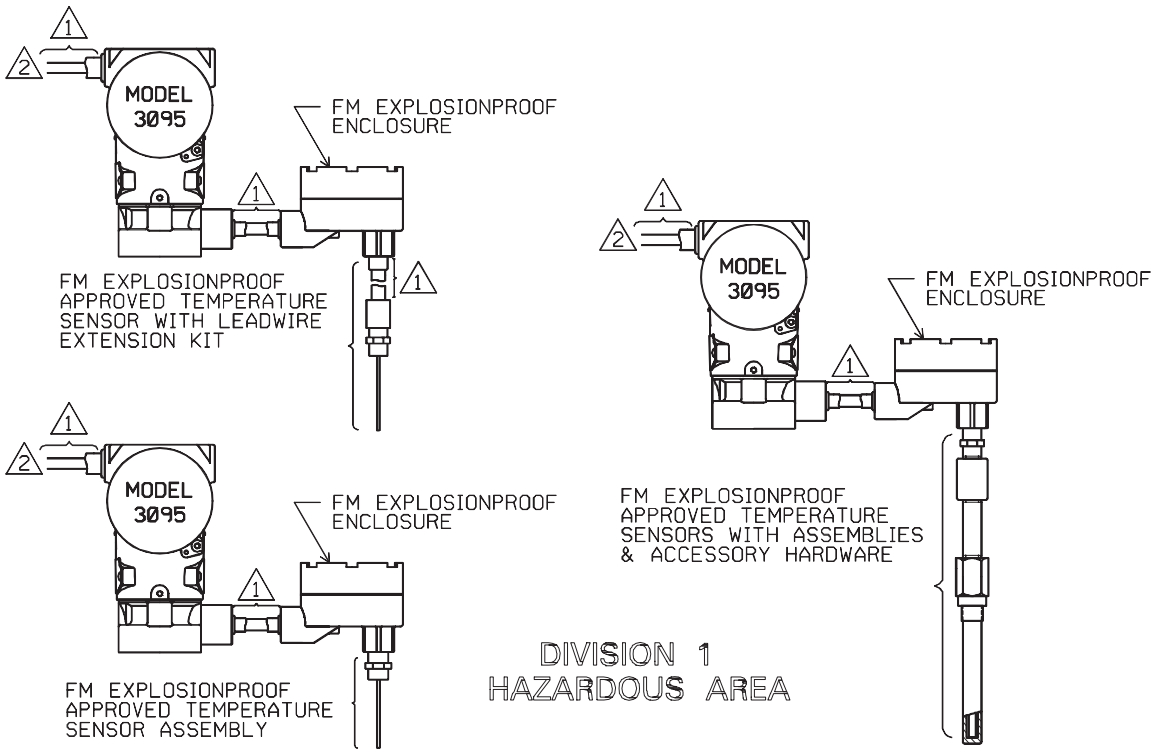
SCALE | WT. _____ | SHEET 1 OF 3

3095-1025A01A

FORM NO. 60651A-1 REV. C

FIGURE 3-1. Explosion-Proof Drawing, Factory Mutual.

REVISIONS				
REV	DESCRIPTION	CHG. NO.	APP'D	DATE
G		662265		



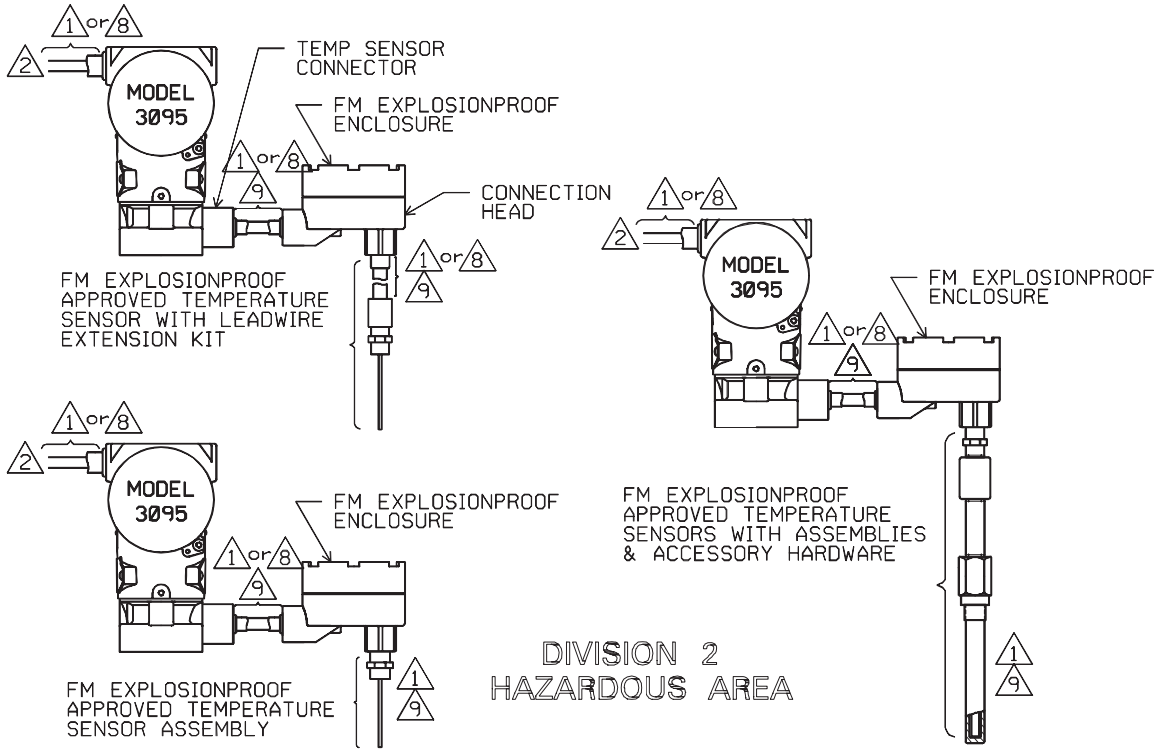
Rosemount Inc. 12001 Technology Drive Eden Prairie, MN 55344 USA	THIS DRAWING WAS CREATED ON CAD. DRAWING IS ARCHIVED ON MAGNETIC TAPE FOR ECO CHANGES.			
DR. Myles Lee Miller	SIZE A	FSCM NO	DWG NO. 03095-1025	
ISSUED	SCALE N/A	WT. ———	SHEET 2 OF 3	

3095-1025A02A

FORM NO. 60651A-1 REV. C

FIGURE 3-1. (continued).

REVISIONS				
REV	DESCRIPTION	CHG. NO.	APP'D	DATE
G		662265		



Rosemount Inc. 12001 Technology Drive Eden Prairie, MN 55344 USA	THIS DRAWING WAS CREATED ON CAD. DRAWING IS ARCHIVED ON MAGNETIC TAPE FOR ECO CHANGES.			
DR. Myles Lee Miller	SIZE A	FSCM NO	DWG NO. 03095-1025	
ISSUED	SCALE N/A	WT. ———	SHEET 3 OF 3	

3095-1025A03A

FORM NO. 60651A-1 REV. C

FIGURE 3-1. (continued).

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

REVISIONS

REV	DESCRIPTION	CHG. NO.	APP'D	DATE
B	ADD OPTIONAL COMPUTER CONNECTION	655550	D.E.W.	8/17/94
C	CORRECT ENTITY PARAMETERS	660398	K.D.V.	5/16/94
D	INCREASE VMAX	660728	K.D.V.	6/1/94
AA	ADD 3095C	RTC1003705	G.H.	4/17/98

ENTITY APPROVALS FOR 3095

THE ROSEMOUNT TRANSMITTERS LISTED ABOVE ARE F.M. APPROVED AS INTRINSICALLY SAFE WHEN USED IN CIRCUIT WITH F.M. APPROVED BARRIERS WHICH MEET THE ENTITY PARAMETERS LISTED IN THE CLASS I, II, AND III, DIVISION 1 GROUPS INDICATED, TEMP CODE T4. ADDITIONALLY, THE ROSEMOUNT 751 FIELD SIGNAL INDICATOR IS F.M. APPROVED AS INTRINSICALLY SAFE WHEN CONNECTED IN CIRCUIT WITH ROSEMOUNT TRANSMITTERS (FROM ABOVE) AND F.M. APPROVED BARRIERS WHICH MEET THE ENTITY PARAMETERS LISTED FOR CLASS I, II, AND III, DIVISION 1, GROUPS INDICATED, TEMP CODE T4.

TO ASSURE AN INTRINSICALLY SAFE SYSTEM, THE TRANSMITTER AND BARRIER MUST BE WIRED IN ACCORDANCE WITH THE BARRIER MANUFACTURER'S FIELD WIRING INSTRUCTIONS AND THE APPLICABLE CIRCUIT DIAGRAM INDICATED ON SHEET 3.

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. Myles Lee Miller 3/19/93

CHK'D

APP'D. Kevin Voegele 4/8/93

APP'D. GOVT.

ROSEMOUNT® MEASUREMENT
FISHER-ROSEMOUNT

ROSEMOUNT INC.
12001 TECHNOLOGY DRIVE
EDEN PRAIRIE, MN 55344 USA

TITLE INDEX OF I.S. F.M. FOR 3095

SIZE A | FSCM NO | DWG NO. 03095-1020

SCALE N/A | WT. ——— | SHEET 1 OF 6

3095-1020A01A

FIGURE 3-2. Index of I.S. F.M. for 3095.

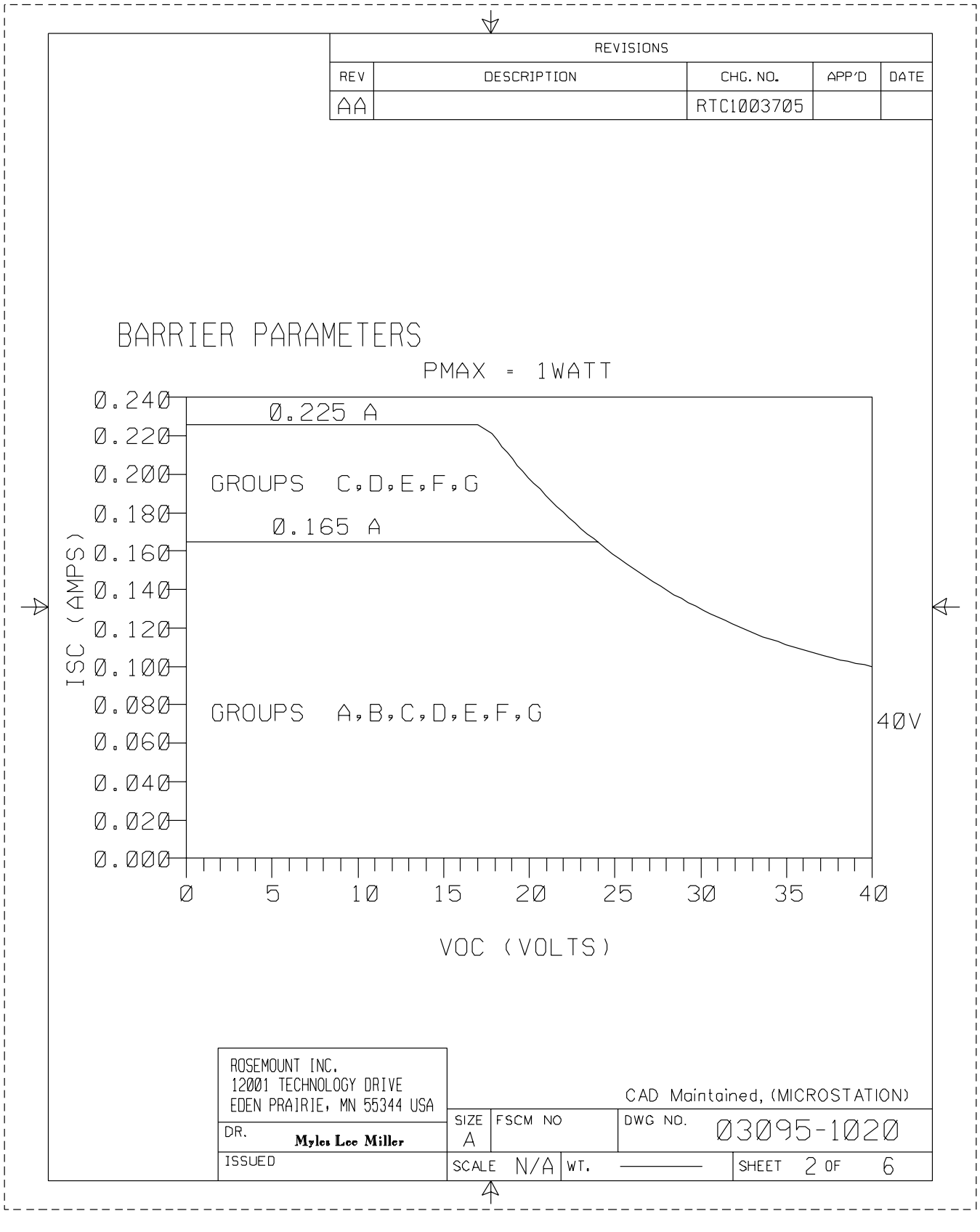
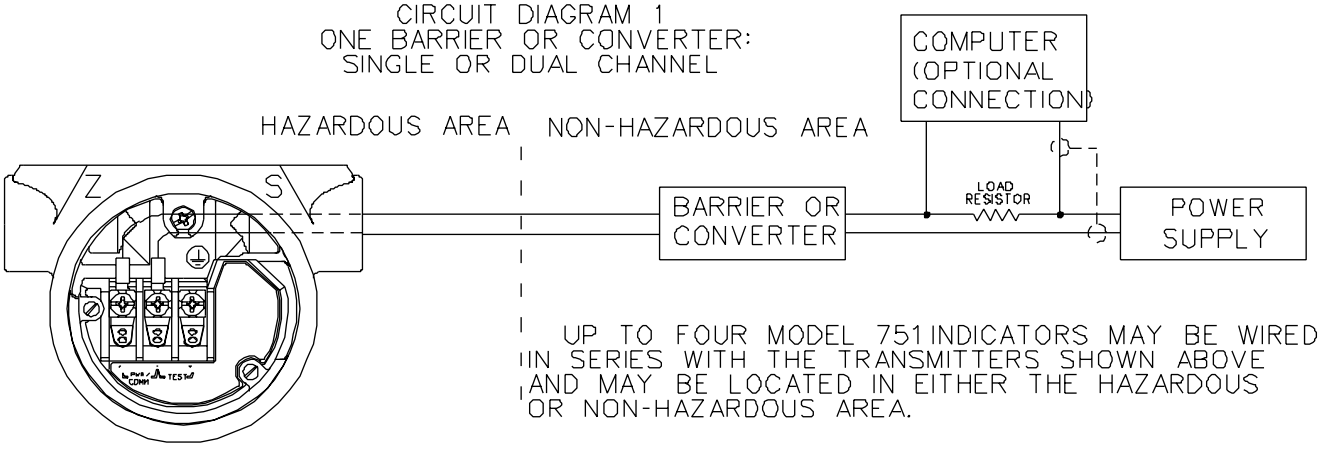


FIGURE 3-2. (continued).

REVISIONS

REV	DESCRIPTION	CHG. NO.	APP'D	DATE
AA		RTC1003705		

CIRCUIT DIAGRAM 1
ONE BARRIER OR CONVERTER:
SINGLE OR DUAL CHANNEL

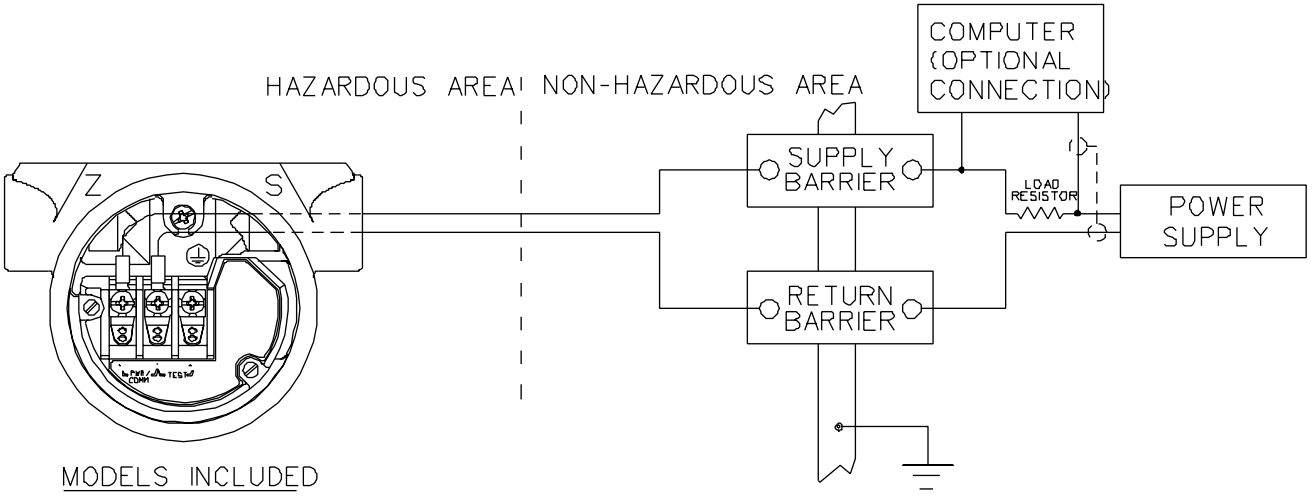


UP TO FOUR MODEL 751 INDICATORS MAY BE WIRED IN SERIES WITH THE TRANSMITTERS SHOWN ABOVE AND MAY BE LOCATED IN EITHER THE HAZARDOUS OR NON-HAZARDOUS AREA.

MODELS INCLUDED

3095 (EXCEPT C)

CIRCUIT DIAGRAM 2
SUPPLY AND RETURN BARRIERS
(ONLY FOR USE WITH BARRIERS APPROVED IN THIS CONFIGURATION)



MODELS INCLUDED

3095 (EXCEPT C)

UP TO FOUR MODEL 751 INDICATORS MAY BE WIRED IN SERIES WITH THE TRANSMITTERS SHOWN ABOVE AND MAY BE LOCATED IN EITHER THE HAZARDOUS OR NON-HAZARDOUS AREA.

ROSEMOUNT INC.
12001 TECHNOLOGY DRIVE
EDEN PRAIRIE, MN 55344 USA

CAD Maintained, (MICROSTATION)

DR. Myles Lee Miller	SIZE A	FSCM NO	DWG NO. 03095-1020
ISSUED	SCALE N/A	WT. ———	SHEET 3 OF 6

3095-1020A03A

FIGURE 3-2. (continued).

REVISIONS				
REV	DESCRIPTION	CHG. NO.	APP'D	DATE
AA		RTC1003705		

ENTITY CONCEPT APPROVALS

THE ENTITY CONCEPT ALLOWS INTERCONNECTION OF INTRINSICALLY SAFE APPARATUS TO ASSOCIATED APPARATUS NOT SPECIFICALLY EXAMINED IN COMBINATION AS A SYSTEM. THE APPROVED VALUES OF MAX. OPEN CIRCUIT VOLTAGE (VOC OR VT) AND MAX. SHORT CIRCUIT CURRENT (ISC OR IT) AND MAX.POWER (VOC X ISC/4) OR (VT X IT/4), FOR THE ASSOCIATED APPARATUS MUST BE LESS THAN OR EQUAL TO THE MAXIMUM SAFE INPUT VOLTAGE (VMAX), MAXIMUM SAFE INPUT CURRENT (IMAX), AND MAXIMUM SAFE INPUT POWER (PMAX) OF THE INTRINSICALLY SAFE APPARATUS. IN ADDITION, THE APPROVED MAX. ALLOWABLE CONNECTED CAPACITANCE (CA) OF THE ASSOCIATED APPARATUS MUST BE GREATER THAN THE SUM OF THE INTERCONNECTING CABLE CAPACITANCE AND THE UNPROTECTED INTERNAL CAPACITANCE (CI) OF THE INTRINSICALLY SAFE APPARATUS, AND THE APPROVED MAX. ALLOWABLE CONNECTED INDUCTANCE (LA) OF THE ASSOCIATED APPARATUS MUST BE GREATER THAN THE SUM OF THE INTERCONNECTING CABLE INDUCTANCE AND THE UNPROTECTED INTERNAL INDUCTANCE (LI) OF THE INTRINSICALLY SAFE APPARATUS.

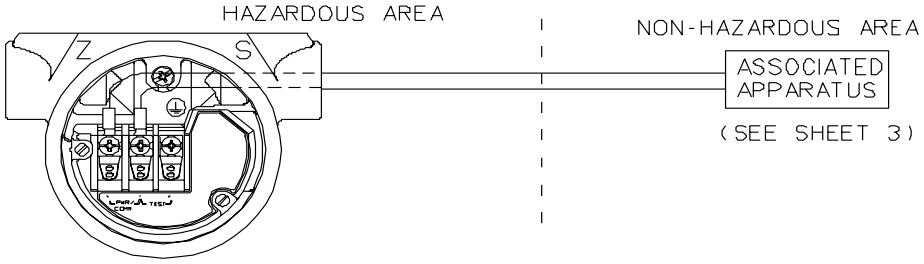
NOTE: ENTITY PARAMETERS LISTED APPLY ONLY TO ASSOCIATED APPARATUS WITH LINEAR OUTPUT.

CLASS I, DIV. 1, GROUPS A AND B

V_{MAX} = 40V	V_T OR V_{OC} IS LESS THAN OR EQUAL TO 40V
I_{MAX} = 165MA	I_T OR I_{SC} IS LESS THAN OR EQUAL TO 165MA
P_{MAX} = 1 WATT	$(\frac{V_T \times I_T}{4})$ $(\frac{VOC \times ISC}{4})$ OR IS LESS THAN OR EQUAL TO 1 WATT
C_I = .012 µF	C_A IS GREATER THAN .012 µF
L_I = 20 µH	L_A IS GREATER THAN 20 µH

CLASS I, DIV. 1, GROUPS C AND D

V_{MAX} = 40V	V_T OR V_{OC} IS LESS THAN OR EQUAL TO 40V
I_{MAX} = 225MA	I_T OR I_{SC} IS LESS THAN OR EQUAL TO 225MA
P_{MAX} = 1 WATT	$(\frac{V_T \times I_T}{4})$ $(\frac{VOC \times ISC}{4})$ OR IS LESS THAN OR EQUAL TO 1 WATT
C_I = .012 µF	C_A IS GREATER THAN .012 µF
L_I = 20 µH	L_A IS GREATER THAN 20 µH



MODELS INCLUDED

3095 (EXCEPT C)

ROSEMOUNT INC.
12001 TECHNOLOGY DRIVE
EDEN PRAIRIE, MN 55344 USA

CAD Maintained, (MICROSTATION)

DR. Myles Lee Miller	SIZE A	FSCM NO	DWG NO. 03095-1020
ISSUED	SCALE N/A	WT. ———	SHEET 4 OF 6

3095-1020A04A

FIGURE 3-2. (continued).

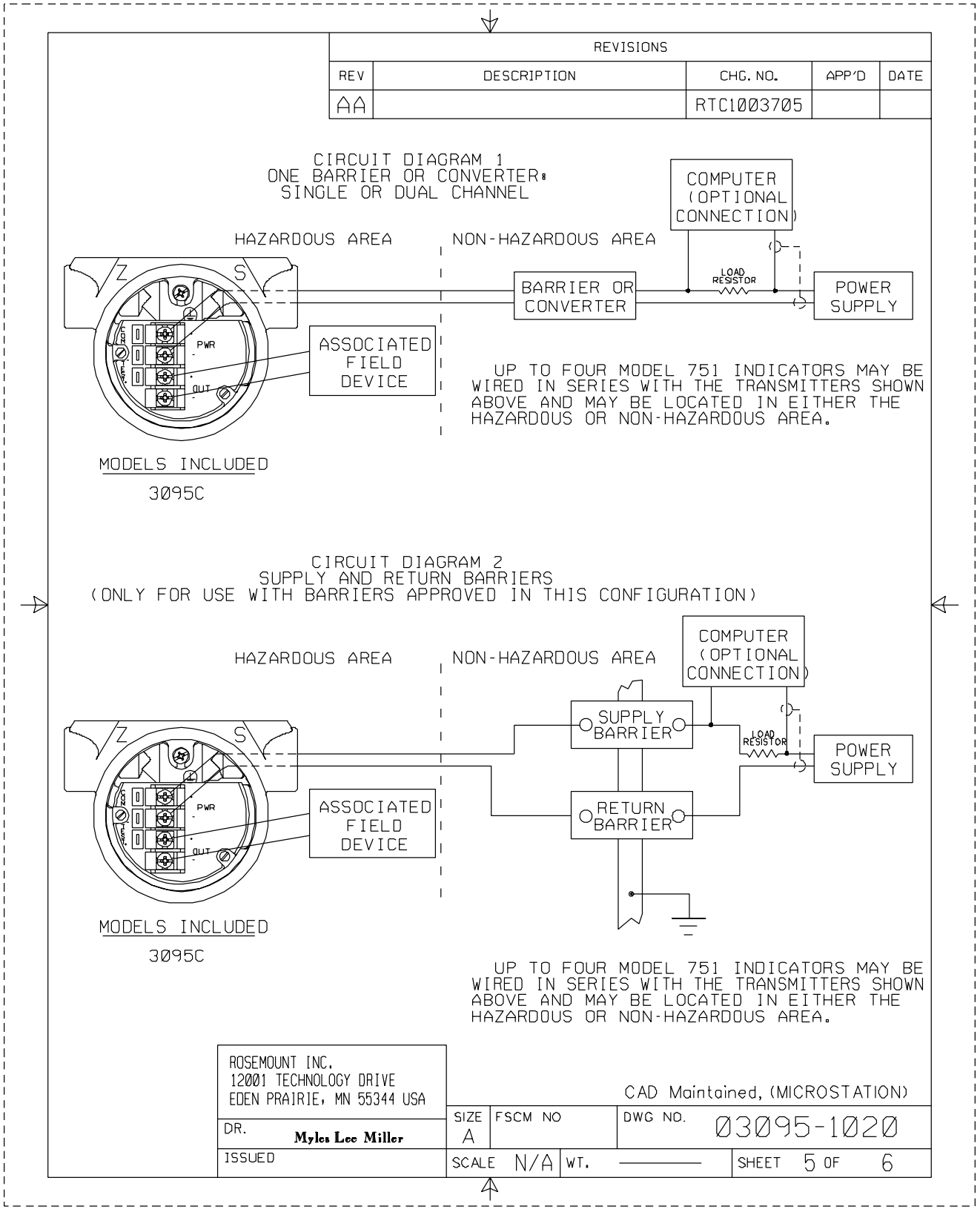


FIGURE 3-2. (continued).

REVISIONS				
REV	DESCRIPTION	CHG. NO.	APP'D	DATE
AA		RTC1003705		

ENTITY CONCEPT APPROVALS

THE ENTITY CONCEPT ALLOWS INTERCONNECTION OF INTRINSICALLY SAFE APPARATUS TO ASSOCIATED APPARATUS NOT SPECIFICALLY EXAMINED IN COMBINATION AS A SYSTEM. THE APPROVED VALUES OF MAX. OPEN CIRCUIT VOLTAGE (VOC OR VT) AND MAX. SHORT CIRCUIT CURRENT (ISC OR IT) AND MAX.POWER (VOC X ISC/4) OR (VT X IT/4), FOR THE ASSOCIATED APPARATUS MUST BE LESS THAN OR EQUAL TO THE MAXIMUM SAFE INPUT VOLTAGE (VMAX), MAXIMUM SAFE INPUT CURRENT (IMAX), AND MAXIMUM SAFE INPUT POWER (PMAX) OF THE INTRINSICALLY SAFE APPARATUS. IN ADDITION, THE APPROVED MAX. ALLOWABLE CONNECTED CAPACITANCE (CA) OF THE ASSOCIATED APPARATUS MUST BE GREATER THAN THE SUM OF THE INTERCONNECTING CABLE CAPACITANCE AND THE UNPROTECTED INTERNAL CAPACITANCE (CI) OF THE INTRINSICALLY SAFE APPARATUS, AND THE APPROVED MAX. ALLOWABLE CONNECTED INDUCTANCE (LA) OF THE ASSOCIATED APPARATUS MUST BE GREATER THAN THE SUM OF THE INTERCONNECTING CABLE INDUCTANCE AND THE UNPROTECTED INTERNAL INDUCTANCE (LI) OF THE INTRINSICALLY SAFE APPARATUS.

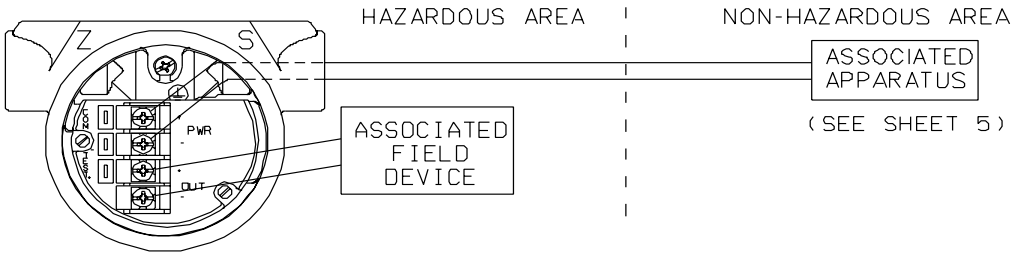
NOTE: ENTITY PARAMETERS ARE FOR 3095C ONLY. USER MUST TAKE ENTITY PARAMETERS OF THE ASSOCIATED FIELD DEVICE INTO CONSIDERATION FOR INSTALLATION.

CLASS I, DIV. 1, GROUPS A AND B

V_{MAX} = 40V	V_T OR V_{OC} IS LESS THAN OR EQUAL TO 40V
I_{MAX} = 165MA	I_T OR I_{SC} IS LESS THAN OR EQUAL TO 165MA
P_{MAX} = 1 WATT	$(\frac{V_T \times I_T}{4})$ $(\frac{VOC \times ISC}{4})$ OR IS LESS THAN OR EQUAL TO 1 WATT
C_I = .012 μF	C_A IS GREATER THAN .012 μF
L_I = 20 μH	L_A IS GREATER THAN 20 μH

CLASS I, DIV. 1, GROUPS C AND D

V_{MAX} = 40V	V_T OR V_{OC} IS LESS THAN OR EQUAL TO 40V
I_{MAX} = 225MA	I_T OR I_{SC} IS LESS THAN OR EQUAL TO 225MA
P_{MAX} - 1 WATT	$(\frac{V_T \times I_T}{4})$ $(\frac{VOC \times ISC}{4})$ OR IS LESS THAN OR EQUAL TO 1 WATT
C_I - .012 μF	C_A IS GREATER THAN .012 μF
L_I = 20 μH	L_A IS GREATER THAN 20 μH



MODELS INCLUDED

3095C

ROSEMOUNT INC.
12001 TECHNOLOGY DRIVE
EDEN PRAIRIE, MN 55344 USA

CAD Maintained, (MICROSTATION)

DR. Myles Lee Miller	SIZE A	FSCM NO	DWG NO. 03095-1020
ISSUED	SCALE N/A	WT. ———	SHEET 6 OF 6

3095-1020A06A

FIGURE 3-2. (continued).

PROPRIETARY INFORMATION IS CONTAINED HEREIN AND MUST BE HANDLED ACCORDINGLY
BY _____ DATE _____

REVISIONS

REV	DESCRIPTION	CHG. NO.	APP'D	DATE
A	INITIAL RELEASE	656967	B.L.L.	10/28/93
B	CHG NOTES 9,11	657643	M.J.Z.	1/26/94
C	DEL NOTES 7,10,11 ADD NOTE 12	661305	K.J.A.	8/26/94
D	ADD DIV 1,2	662265	M.J.Z.	9/6/94

12. INSTALLATION TO BE IN ACCORDANCE WITH CANADIAN ELECTRICAL CODE.

△9. NON-INCENDIVE FIELD WIRING METHODS MAY BE USED FOR CONNECTING THE TEMPERATURE SENSING ASSEMBLY. WHEN USING NON-INCENDIVE FIELD WIRING, THE CONNECTION HEAD AND TEMPERATURE SENSOR ASSEMBLY NEED NOT BE EXPLOSION PROOF, BUT ALL COMPONENTS CONNECTED TO THE TEMP SENSOR CONNECTOR MUST BE CLASSIFIED "SIMPLE APPARATUS". SIMPLE APPARATUS ARE DEVICES WHICH ARE INCAPABLE OF GENERATING OR STORING MORE THAN 1.2V, 0.1A, 25mW, OR 20 μJ (RTD's QUALIFY AS SIMPLE APPARATUS).

△8. DIVISION 2 WIRING METHOD.

6. CLASS II INSTALLATIONS MUST USE A CSA APPROVED DUST-IGNITIONPROOF SENSOR.

5. IN AMBIENTS GREATER THAN 40°C, SPRING LOADED TEMPERATURE SENSORS USED WITHOUT AN EXPLOSIONPROOF THERMOWELL MUST BE RATED FOR AT LEAST 85°C.

4. COMPONENTS REQUIRED TO BE APPROVED MUST BE APPROVED FOR GAS GROUP APPROPRIATE TO AREA CLASSIFICATION.

3. ALL CONDUIT THREADS TO BE ASSEMBLED WITH FIVE FULL THREADS MINIMUM.

△2. TRANSMITTER MUST NOT BE CONNECTED TO EQUIPMENT GENERATING MORE THAN 250VAC.

△1. WIRING METHOD SUITABLE FOR CLASS I, DIV 1, ANY LENGTH.

NOTES:

THIS DRAWING WAS CREATED ON CAD. DRAWING IS ARCHIVED ON MAGNETIC TAPE FOR ECO CHANGES.

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

- TOLERANCES -

DECIMALS .X±.1 .XX±.02 .XXX±.010
FRACTIONS ±1/32
ANGLES ±2°

DO NOT SCALE PRINT

CONTRACT NO.

DR. Myles Lee Miller 10/27/93

CHK'D

APP'D. BEN LOUWAGIE 10/28/93

APP'D. GOVT.

ROSEMOUNT® Measurement Control Analytical Valves

Rosemount Inc.
12001 Technology Drive
Eden Prairie, MN 55344 USA

TITLE MODEL 3095
EXPLOSIONPROOF INSTALLATION DRAWING, CSA

SIZE	FSCM NO	DWG NO.	
A		03095-1024	

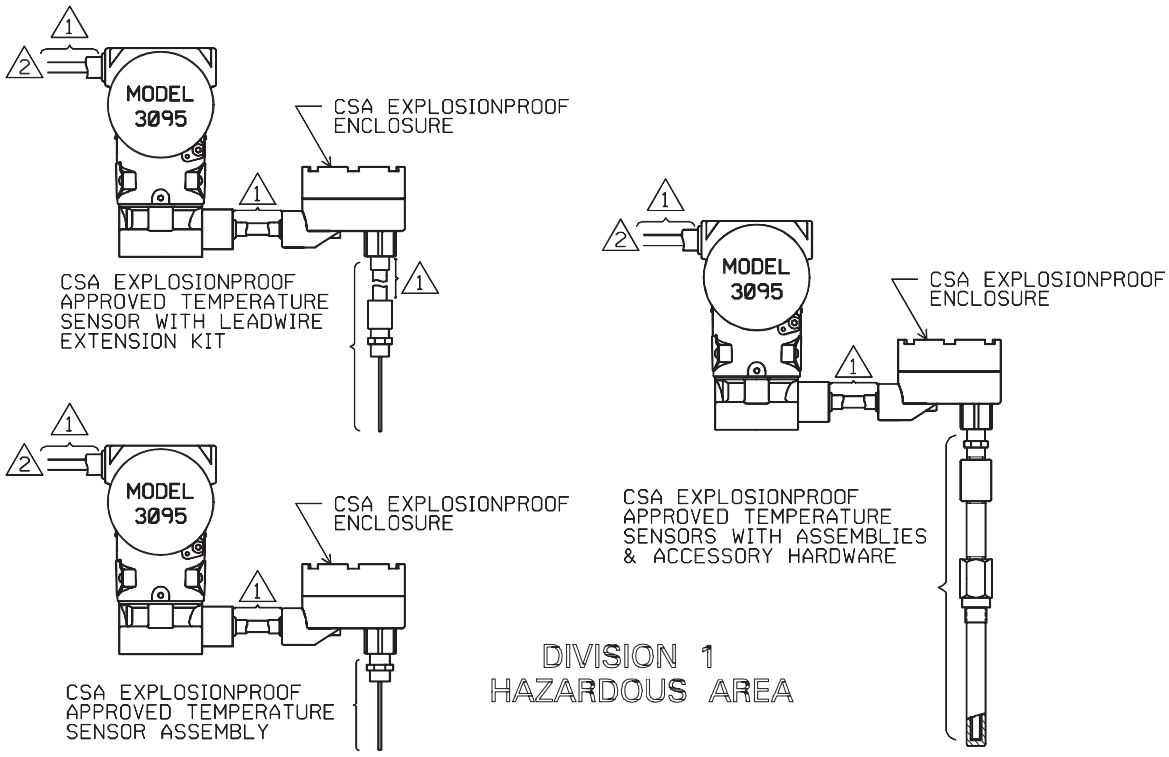
SCALE | WT. _____ | SHEET 1 OF 3

3095-1024A01A

FORM NO. 60651A-1 REV. C

FIGURE 3-3. Model 3095 Multivariable Level Controller Explosion-Proof Installation Drawing.

REVISIONS				
REV	DESCRIPTION	CHG. NO.	APP'D	DATE
D		662265		



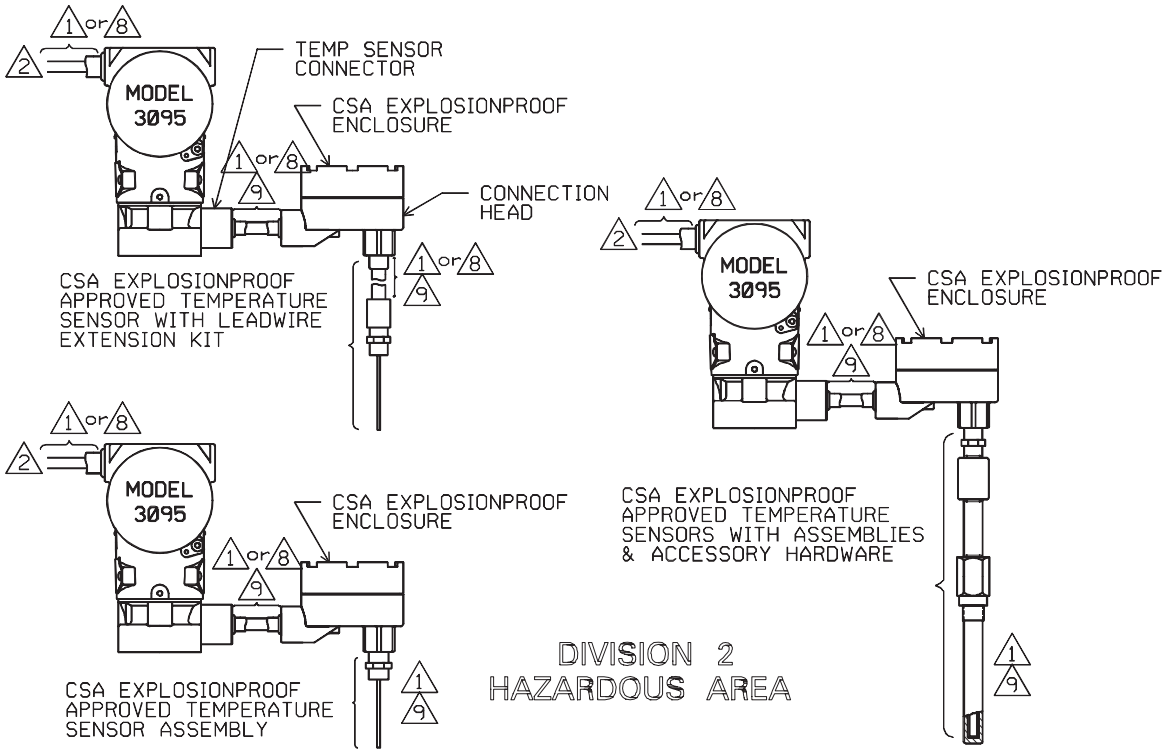
Rosemount Inc. 12001 Technology Drive Eden Prairie, MN 55344 USA	THIS DRAWING WAS CREATED ON CAD. DRAWING IS ARCHIVED ON MAGNETIC TAPE FOR ECO CHANGES.			
DR. Myles Lee Miller	SIZE A	FSCM NO	DWG NO. 03095-1024	
ISSUED	SCALE N/A	WT. ———	SHEET 2 OF 3	

3095-1024A02A

FORM NO. 60651A-1 REV. C

FIGURE 3-3. (continued).

REVISIONS				
REV	DESCRIPTION	CHG. NO.	APP'D	DATE
D		662265		



Rosemount Inc. 12001 Technology Drive Eden Prairie, MN 55344 USA	THIS DRAWING WAS CREATED ON CAD. DRAWING IS ARCHIVED ON MAGNETIC TAPE FOR ECO CHANGES.			
DR. Myles Lee Miller	SIZE A	FSCM NO	DWG NO. 03095-1024	
ISSUED	SCALE N/A	WT. ———	SHEET 3 OF 3	

3095-1024A03A

FORM NO. 60651A-1 REV. C

FIGURE 3-3. (continued).

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

REVISIONS

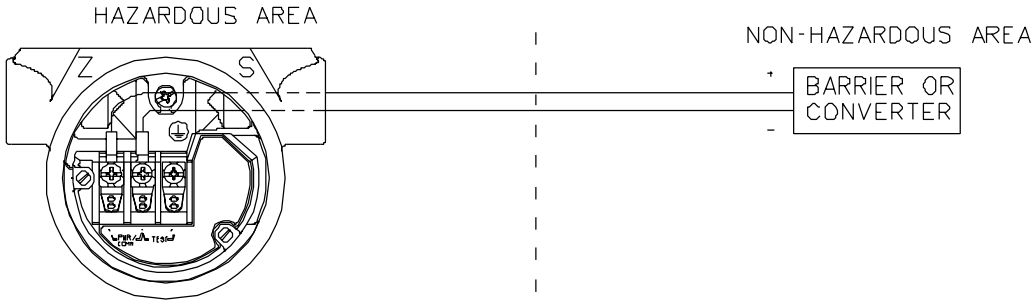
REV	DESCRIPTION	CHG. NO.	APP'D	DATE
C	ADD 3095-5000 TO DEVICES	656973	M.L.S.	11/03/93
AA	ADD 3095C	RTC1003705	G.H.	4/17/98

CSA INTRINSIC SAFETY APPROVALS

CIRCUIT CONNECTION WITH BARRIER OR CONVERTER

Ex ia

INTRINSICALLY SAFE/SECURITE INTRINSEQUE



ROSEMOUNT
MODELS INCLUDED
[WITH OR WITHOUT T1
(TRANSIENT PROTECTION) OPTION]

3095

WARNING - EXPLOSION HAZARD - SUBSTITUTION OF COMPONENTS MAY IMPAIR SUITABILITY FOR CLASS I, DIVISION 2.

AVERTISSEMENT - RISQUE D'EXPLOSION - LA SUBSTITUTION DE COMPOSANTS PEUT RENDRE CE MATERIEL INACCEPTABLE POUR LES EMPLACEMENTS DE CLASSE I, DIVISION 2.

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. Myles Lee Miller 3/19/93

CHK'D

APP'D. Kevin Voegele 4/8/93

APP'D. GOVT.

ROSEMOUNT MEASUREMENT
FISHER-ROSEMOUNT

ROSEMOUNT INC.
12001 TECHNOLOGY DRIVE
EDEN PRAIRIE, MN 55344 USA

TITLE
INDEX OF I.S. CSA FOR 3095

SIZE A | FSCM NO | DWG NO. 03095-1021

SCALE N/A | WT. ——— | SHEET 1 OF 3

3095-1021A01A

FIGURE 3-4. Index of I.S. CSA for 3095.

REVISIONS				
REV	DESCRIPTION	CHG. NO.	APP'D	DATE
AA		RTC1003705		

DEVICE	PARAMETERS	APPROVED FOR CLASS I, DIV.1
CSA APPROVED SAFETY BARRIER	30 V OR LESS 330 OHMS OR MORE 28 V OR LESS 300 OHMS OR MORE 25 V OR LESS 200 OHMS OR MORE 22 V OR LESS 180 OHMS OR MORE	GROUPS A, B, C, D
FOXBORO CONVERTER 2A1-12V-CGB, 2AI-13V-CGB, 2AS-131-CGB, 3A2-12D-CGB, 3A2-13D-CGB, 3AD-131-CGB, 3A4-12D-CGB, 2AS-121-CGB, 3F4-12DA		GROUPS B, C, D
CSA APPROVED SAFETY BARRIER	30 V OR LESS 150 OHMS OR MORE	GROUPS C, D
ROSEMOUNT 03095-5000-1012 03095-5000-2002	19 V OR LESS 200 OHMS OR MORE	GROUPS A, B, C, D

ROSEMOUNT INC.
12001 TECHNOLOGY DRIVE
EDEN PRAIRIE, MN 55344 USA

CAD Maintained, (MICROSTATION)

DR. Myles Lee Miller	SIZE A	FSCM NO	DWG NO. 03095-1021
ISSUED	SCALE N/A	WT. ———	SHEET 2 OF 3

3095-1021A02A

FIGURE 3-4. (continued).

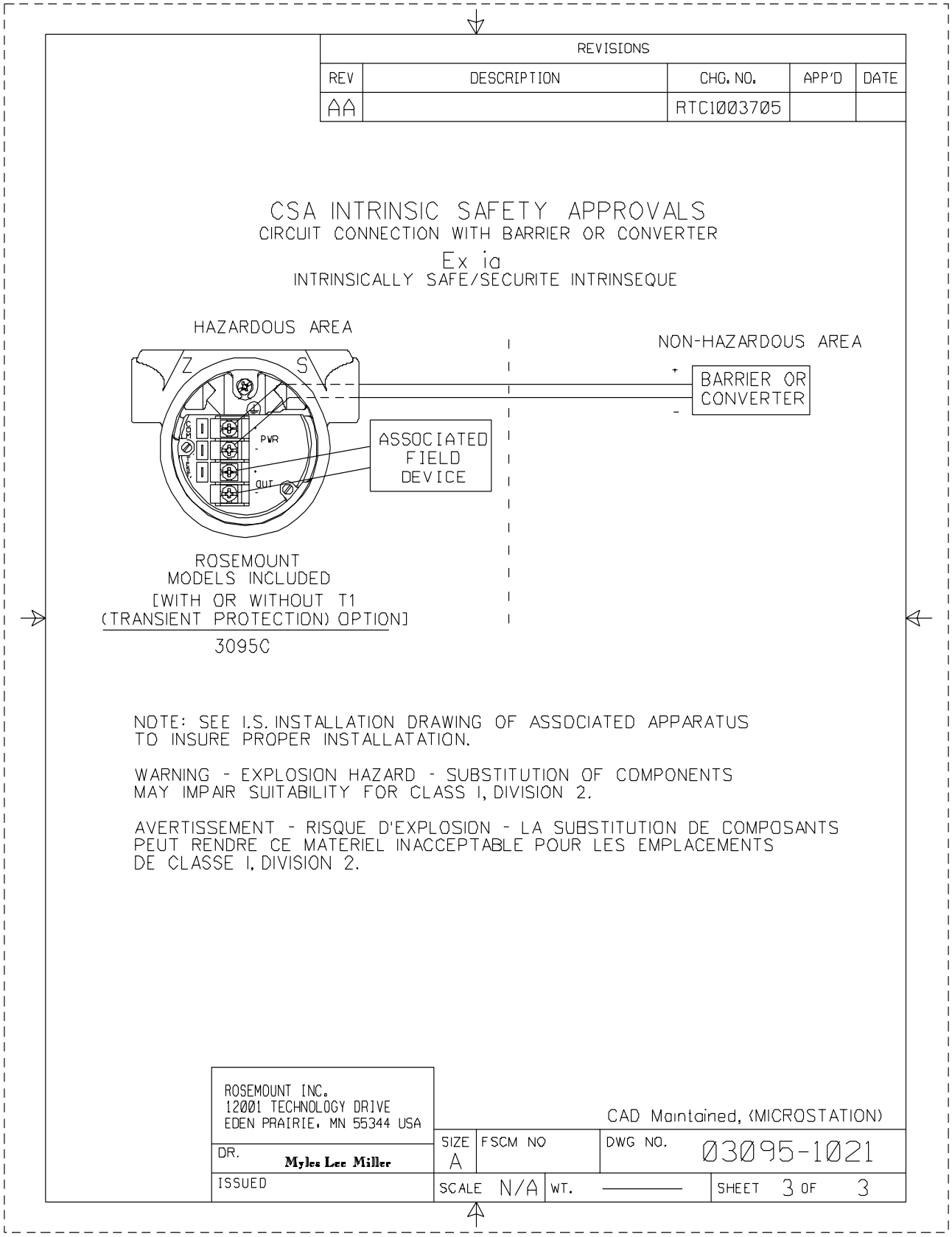


FIGURE 3-4. (continued).

Rosemount Inc.
8200 Market Boulevard
Chanhassen, MN 55317 USA
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Telex 4310012
Fax (612) 949-7001

http://www.rosemount.com

00809-0100-4741 Rev. AA

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Heath Place
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Fax 44 (1243) 867 5541

Fisher-Rosemount
Singapore Pte Ltd.
1 Pandan Crescent
Singapore 128461
Tel (65) 777-8211
Fax (65) 777-0947
Tlx RS 61117 FRSPL

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