

Kotron® Model 805 Smart RF Level Transmitter

Installation and Operating Manual



RF

Capacitance

Level

Measurement

7xxx

6xxx

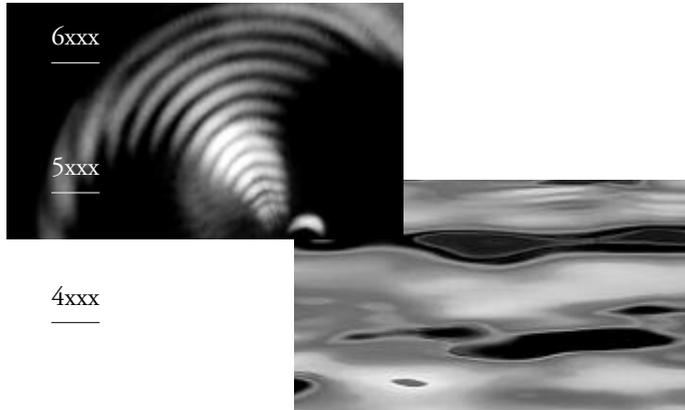
5xxx

4xxx

3xxx

2xxx

1xxx



Read this Manual Before Installing

This manual provides information on the Kotron® Model 805 Smart RF Transmitter. It is important that all instructions are read carefully and followed in sequence. The *QuickStart Installation* instructions are a brief guide to the sequence of steps for experienced technicians to follow when installing the equipment. Detailed instructions are included in the *Complete Installation* section of this manual.

Conventions Used in this Manual

Certain conventions are used in this manual to convey specific types of information. General technical material, support data, and safety information are presented in narrative form. The following styles are used for notes, cautions, and warnings.

Notes

Notes contain information that augments or clarifies an operating step. Notes do not normally contain actions. They follow the procedural steps to which they refer.

Cautions

Cautions alert the technician to special conditions that could injure personnel, damage equipment, or reduce a component's mechanical integrity. Cautions are also used to alert the technician to unsafe practices or the need for special protective equipment or specific materials. In this manual, a caution box indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

Warnings

Warnings identify potentially dangerous situations or serious hazards. In this manual, a warning indicates an imminently hazardous situation which, if not avoided, could result in serious injury or death.

Safety Messages

The KOTRON Model 805 system may be properly installed in Category II, Pollution Degree 2 installations. Follow all standard industry procedures for servicing electrical and computer equipment when working with or around high voltage. Always shut off the power supply before touching any components. Although high voltage is not present in this system, it may be present in other systems.

Electrical components are sensitive to electrostatic discharge. To prevent equipment damage, observe safety procedures when working with electrostatic sensitive components.

Low Voltage Directive

For use in Category II installations. If equipment is used in a manner not specified by manufacturer, protection provided by equipment may be impaired.

WARNING! Explosion hazard. Do not connect or disconnect equipment unless power has been switched off or the area is known to be non-hazardous.

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Magnetrol® reserves the right to make changes to the product described in this manual at any time without notice. MAGNETROL makes no warranty with respect to the accuracy of the information in this manual.

Warranty

All MAGNETROL electronic level and flow controls are warranted free of defects in materials or workmanship for one full year from the date of original factory shipment.

If returned within the warranty period; and, upon factory inspection of the control, the cause of the claim is determined to be covered under the warranty; then, MAGNETROL will repair or replace the control at no cost to the purchaser (or owner) other than transportation.

MAGNETROL shall not be liable for misapplication, labor claims, direct or consequential damage or expense arising from the installation or use of equipment. There are no other warranties expressed or implied, except special written warranties covering some MAGNETROL products.

Quality Assurance

The quality assurance system in place at MAGNETROL guarantees the highest level of quality throughout the company. MAGNETROL is committed to providing full customer satisfaction both in quality products and quality service.

The MAGNETROL quality assurance system is registered to ISO 9001 affirming its commitment to known international quality standards providing the strongest assurance of product/service quality available.





Kotron[®] Model 805 Smart RF Level Transmitter

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1.0 QuickStart Installation

The QuickStart Installation procedures provide the key steps for mounting, wiring, and configuring the KOTRON Model 805 Level Transmitter. These procedures are intended for experienced installers of electronic level measurement instruments. See Complete Installation, Section 2.0, for detailed installation instructions.

1.1 Getting Started

Before beginning the QuickStart Installation procedures, have the correct equipment, tools, and information available.

1.1.1 Equipment and Tools

- 1½" open-end wrench or adjustable wrench to fit the probe process connection size and type.
- 1¼" open-end wrench or adjustable wrench to fit adaptor on transmitter housing.
- Flat-blade screwdriver
- Digital multimeter or digital volt/ammeter
- 24 VDC power supply, 23 mA

1.1.2 Configuration Information

Some key information is needed to configure the Model 805 transmitter. Complete the following operating parameters table before beginning configuration.

Display	Question	Answer
Units	What units of measurement will be used? (inches or centimeters)	_____
Set 4.0 mA	What is the 0% reference point for the 4.0 mA value?	_____
Set 20.0 mA	What is the 100% reference point for the 20.0 mA value?	_____

1.2 QuickStart Mounting

NOTE: Confirm the configuration style and process connection size and type of the KOTRON Model 805 transmitter. Ensure it matches the requirements of the installation before continuing with the QuickStart installation.

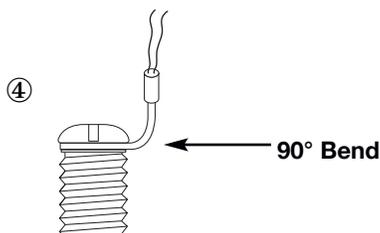
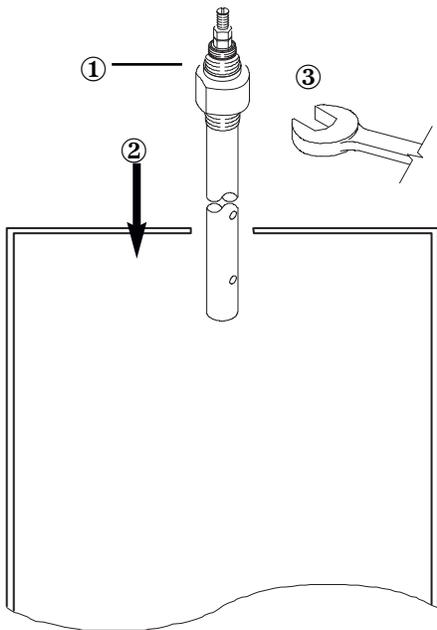
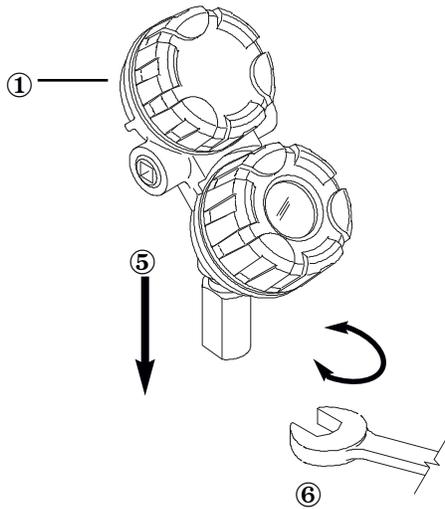
- ① Confirm the model and serial numbers.

1.2.1 Probe

- ② Carefully place the probe into the vessel. Align the probe process connection with the threaded or flanged mounting on the vessel.
- ③ Tighten the probe using the flats of the probe process connection or flange bolts.

1.2.2 Transmitter

- ④ Loosen screw on top of the probe and attach white wire to probe, making sure that spade lug is at a 90° upward angle. Tighten probe screw securely. (See figure below)
- ⑤ Place the transmitter on the probe.
- ⑥ Tighten the connection by using the flats on the adaptor.

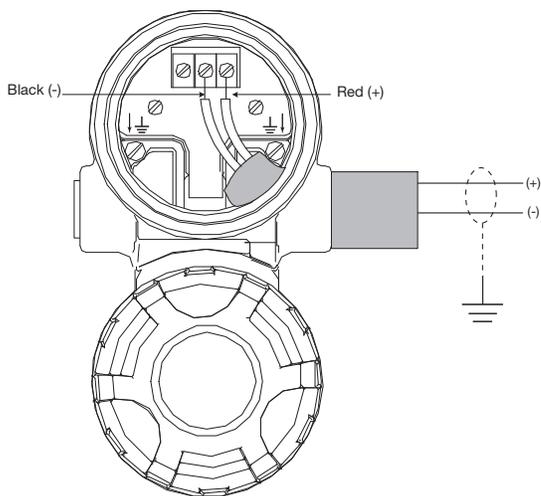


1.3 QuickStart Wiring

WARNING! Explosion hazard. Do not connect or disconnect equipment unless power has been switched off or the area is known to be safe.

NOTE: Make sure the electrical wiring to the KOTRON Model 805 transmitter is complete and in compliance with all regulations and codes.

1. Remove the cover of the wiring compartment of the transmitter.
2. Attach a conduit fitting and mount the conduit plug in the spare opening. Pull the power supply wire (twisted, shielded pair of at least 22 AWG) through the conduit fitting.
3. Connect shield to an earth ground at power supply and leave floating at the transmitter.
4. Connect an earth ground to the nearest green ground screw. (Not shown in illustration.)
5. Connect the positive supply wire to the (+) terminal and the negative supply wire to the (-) terminal.
6. Replace the cover and tighten.

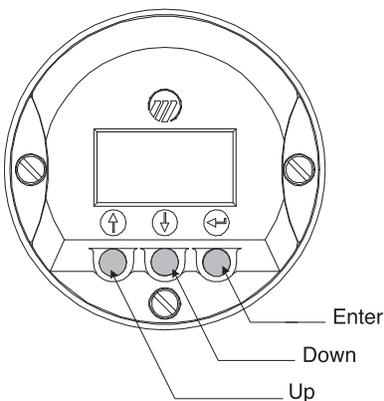


1.4 QuickStart Configuration and Calibration (LCD version)

NOTE: The KOTRON Model 805 transmitter is equipped with a 2-line by 8-character LCD.

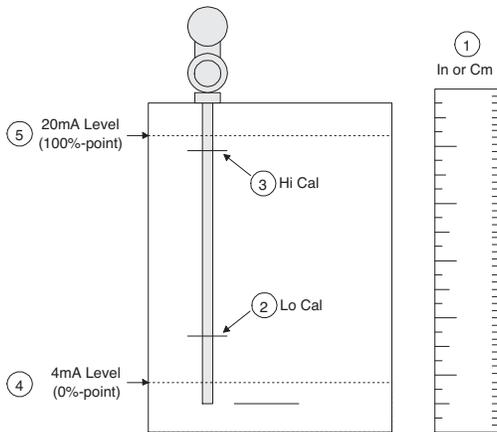
1. Power-up the transmitter.
The display changes every 5 seconds to show one of the three measured values: Level, %Output, and Loop current.
2. Remove the cover of the electronic compartment.
3. Use the Up (↑) or Down (↓) Arrow keys to move from one step of the configuration program to the next step.
4. Press the Enter Arrow (↵) key. The last character in the first line of the display changes to an exclamation point (!).
For example:

Units!
xxx
5. Use the Up (↑) or Down (↓) keys to increase or decrease the value in the display or to scroll through the choices.



6. Press the Enter Arrow (\leftarrow key) to accept a value and move to the next step of the configuration program.
7. The default password is 0. (No password is required.)

The following parameter entries are the minimum required for initial setup and calibration. The default password is 0.



①

Units lu

Scroll down to the **Units** display. Press the Enter Arrow (\leftarrow) key. Select the **Units** of measurement for the level readout (cm or inches). Press the Enter Arrow (\leftarrow) key.

②

Lo Cal xxx.x lu

Scroll down to the **Lo Cal** display. Press the Enter Arrow (\leftarrow) key. Enter the current level (in or cm) of media on the probe by using the Up and Down Arrow (\uparrow / \downarrow) keys. Holding either key down causes the values to change first by 1s and then by 10s. Single depression of either key causes the values to change by 0.1s. Once the desired value is displayed, press the Enter Arrow (\leftarrow) key.

③

Hi Cal xxx.x lu

Move the media in the tank to a higher level. The greater the amount of level change, the more accurate the level measurement. Scroll down to the **Hi Cal** display. Press the Enter Arrow (\leftarrow) key. Enter the new current media level in the same manner as above. Press the Enter Arrow (\leftarrow) key.

NOTE: If calibrating the 805 for interface measurement, enter the level of the interface rather than the upper level.

④

Set 4mA xxx.x

Scroll down to the **Set 4 mA** display. Press the Enter Arrow (\leftarrow) key. Enter the minimum level value for the desired **4 mA** point. Press the Enter Arrow (\leftarrow) key.

⑤

Set 20mA xxx.x

Scroll down to the **Set 20 mA** display. Press the Enter Arrow (\leftarrow) key. Enter the maximum level value for the desired **20 mA** point. Press the Enter Arrow (\leftarrow) key.

The transmitter is now calibrated for **this probe in this medium in this tank** (or vessel) and it provides a 4–20 mA output over the desired range. **Damping** factor and **Fault** output will automatically default to factory set values of 1 second and 22 mA. Changing these values and those for other parameters are covered in detail in the next section, *Complete Installation*.

2.0 Complete Installation

This section provides detailed procedures for properly installing, configuring, and, as needed, troubleshooting the KOTRON Model 805 Level Transmitter.

2.1 Unpacking

Unpack the instrument carefully. Make sure all components have been removed from the packing material. Check all the contents against the packing slip and report any discrepancies to the factory. Before proceeding with the installation, do the following:

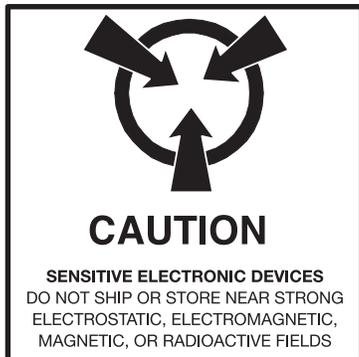
- Inspect all components for damage. Report any damage to the carrier within 24 hours.
- Make sure the nameplate model number agrees with the packing slip and purchase order.
- Record the model and serial numbers for future reference when ordering parts.

2.2 Electrostatic Discharge (ESD) Handling Procedure

MAGNETROL electronic instruments are manufactured to the highest quality standards. These instruments use electronic components that may be damaged by static electricity present in most work environments.

The following steps are recommended to reduce the risk of component failure due to electrostatic discharge.

- Ship and store circuit boards in anti-static bags. If an anti-static bag is not available, wrap the board in aluminum foil. Do not place boards on foam packing materials.
- Use a grounding wrist strap when installing and removing circuit boards. A grounded workstation is recommended.
- Handle circuit boards only by the edges. Do not touch components or connector pins.
- Make sure that all electrical connections are completely made and none are partial or floating. Ground all equipment to a good, earth ground.



2.3 Before You Begin

2.3.1 Site Preparation

Each KOTRON Model 805 transmitter is built to match the specific physical specifications of the required installation. Make sure the probe connection is correct for the threaded or flanged mounting on the vessel or tank where the transmitter will be placed. See *Mounting, Section 2.4*.

Make sure that the wiring between the power supply and Model 805 transmitter is complete and correct for the type of installation. See *Specifications, Section 3.6*.

When installing the Model 805 transmitter in a general purpose or hazardous area, all local, state, and federal regulations and guidelines must be observed. See *Wiring, Section 2.5*.

2.3.2 Equipment and Tools

No special equipment or tools are required to install the Model 805 transmitter. The following items are recommended:

- 1½" Open-end wrench or adjustable wrench to fit the probe process connection size and type
- Flat-blade screwdriver
- Digital multimeter or digital volt/ammeter
- 24 VDC power supply, 23 mA

2.3.3 Operational Considerations

The Model 805 transmitter should be located for easy access for service, configuration, and monitoring. There should be sufficient headroom to allow the probe to be inserted into the tank. Special precautions should be made to prevent exposure to corrosive atmosphere, excessive vibration, shock, or physical damage.

The transmitter electronics should not be exposed to ambient temperatures above +175° F (+80° C) or below -40° F (-40° C). The proper operating temperature range for the display is -10° to +160° F (-20° to +70° C). The temperature limits for the probe depend on the style and part number of the specific probe used. See *Brochure 50-125, Kotron® RF Sensing Probes*.

2.4 Mounting

The Model 805 transmitter can be mounted to a tank using a variety of process connections. Generally, either a threaded or flanged connection is used. For information about the sizes and types of connections available, see *Brochure 50-125, Kotron® RF Sensing Probes*.

Make sure all mounting connections are properly in place on the tank before installing the probe. Make sure the KOTRON probe is correct for the intended installation.

It is common practice to use the metal tank wall as the reference electrode. In such cases, it is required that the probe housing makes a good electrical connection to the tank wall. If there is any doubt about this connection or to the use of PTFE thread tape gaskets, paint, rust, or any other reason, a separate strap should be installed between the probe housing and the tank.

Caution: This unit contains CMOS electronics which may be damaged by static electricity. Do not touch any semi-conductor devices unless you are properly grounded.

Metal Walled Tanks

On water-based liquids, there should be no problem with sensitivity or linearity. With non-conductive, low dielectric media, sensitivity can be enhanced by locating the probe close to and parallel with the tank wall. If this is not practical, a concentric ground tube surrounding the probe (sometimes called a stilling well), may be the solution.

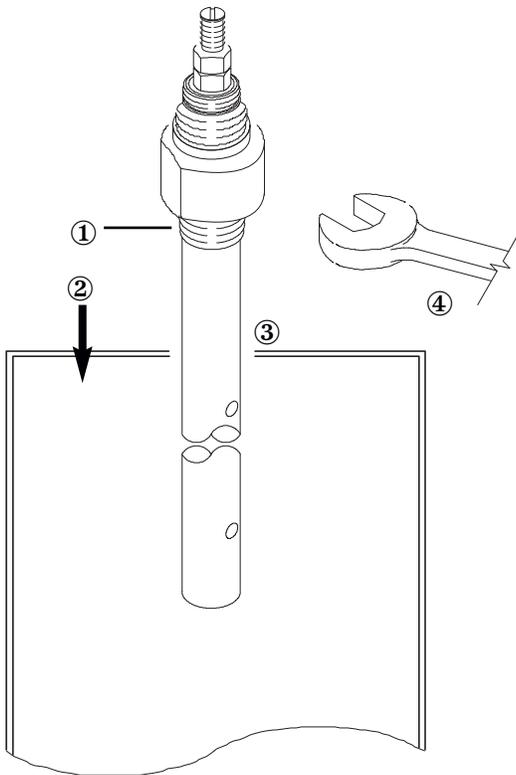
NOTE: These comments are also true for glass-lined metal walled tanks.

Tanks/Silos with Non-Conductive Materials of Construction

With plastic, concrete, wood, or any other non-conductive walled vessels, the reference electrode mentioned above needs clarification. Most commonly, this electrode will be in the form of a concentric ground tube (i.e. stilling well). In questionable circumstances, consult the factory. In all cases, a good electrical connection must be made between the ground surface and the probe housing.

Transmitter/Probe Assembly

Transmitters with probes up to and including 12 inches (305 mm) in length are shipped pre-assembled. All other transmitters are shipped unassembled to avoid damage during transit. These transmitters must be assembled prior to mounting. Choose your particular configuration from the following sections and follow the instructions carefully.



2.4.1 Installing a Rigid Probe

Before installing, ensure the:

- Probe has adequate headroom for installation and has unobstructed entry to the bottom of the vessel.
- Process temperature, pressure, dielectric, and viscosity are within the probe specifications for the installation. See *Specifications, Section 3.6*.

To install a probe:

- ① Make sure the process connection is at least $\frac{3}{4}$ " NPT or a flanged mounting.
- ② Carefully place the probe into the vessel. Align the gasket on flanged installations.
- ③ Align the probe process connection with the threaded or flanged mounting on the vessel.
- ④ Tighten the threaded probe process connection using only the flats on the probe.

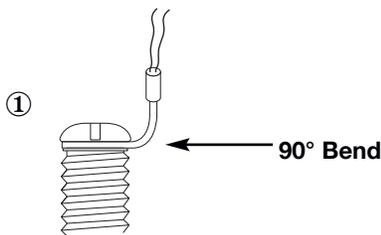
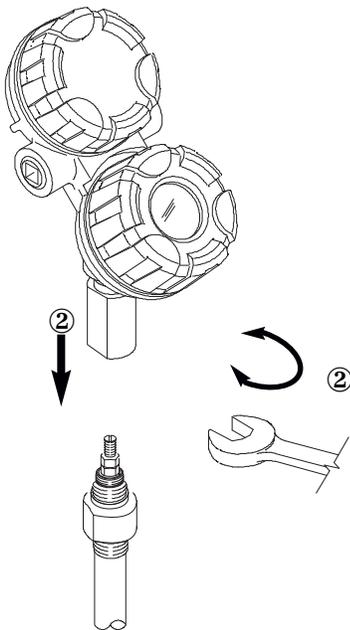
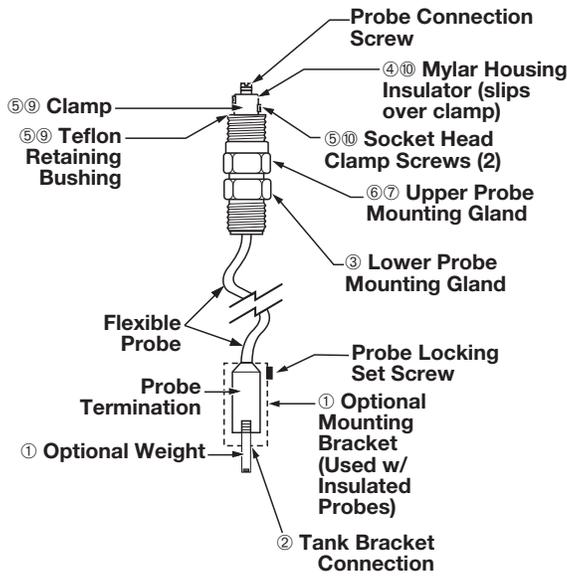
Caution: Packing glands used on all MAGNETROL rigid probe assemblies have been sealed at the factory under controlled conditions. Care must be exercised when installing probe assemblies to avoid breaking the pressure tight gland seal, which destroys the seal.

2.4.2 Installing a Flexible Probe

Caution: Flexible probes are shipped with the cable clamp and the packing gland nut hand tightened. The end of a flexible probe **MUST** be kept taut by attaching the anchor end at the bottom of the vessel or by using a MAGNETROL supplied probe weight.

Caution: Do not discard the Mylar housing insulator.

Caution: The probe cable must not be in contact with any metallic surface in its final installation position.



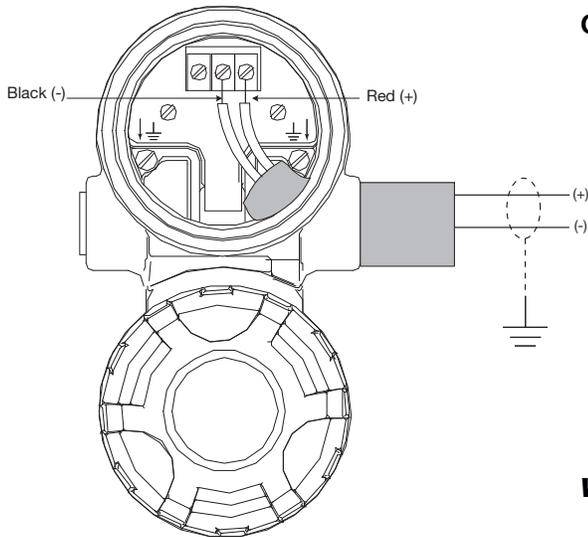
To install a probe:

- ① Attach the weight or anchor assembly to the end of the probe. Insert the probe through the vessel's mounting connection, and feed the cable into the vessel. Do not allow the probe to scrape against the connection threads.
- ② Secure the anchor assembly (if used), to the bottom of the vessel.
- ③ Apply thread sealant to the mounting nut. Screw the mounting nut into the mounting connection until tight.
- ④ Remove the Mylar housing insulator located over the clamp. **DO NOT DISCARD.**
- ⑤ Loosen both socket head screws from the clamp. Pull the clamp and Teflon retaining bushing off of the probe.
- ⑥ While holding on to the probe cable, loosen the upper packing gland nut. **DO NOT ALLOW THE PROBE CABLE TO FALL INTO THE VESSEL.**
- ⑦ Pull the excess cable up through the packing gland nut until the cable is taut. Tighten the packing gland nut.
- ⑧ Cut the cable 1.35" (34 mm) above the packing gland nut and strip off 1.25" (32 mm) of insulation.
- ⑨ Slide the Teflon retaining bushing onto the cable and seat it into the packing gland nut. Slide the clamp onto the cable and seat it against the Teflon retaining bushing.
- ⑩ Tighten both socket head screws, on the clamp, to approximately 35 in/lbs of torque. Slip the Mylar insulator over the clamp.

2.4.3 Installing the Transmitter

- ① Loosen screw on top of the probe and attach white wire to probe, making sure that spade lug is at a 90° upward angle. Tighten probe screw securely.
- ② Slide white wire through the adaptor while placing the transmitter on the probe. Tighten the connection by using the flats on the adaptor.

2.5 Wiring



Caution: The KOTRON Model 805 transmitter operates at voltages of 11–36 VDC (GP) and 11–28.6 VDC (IS). Higher voltages will damage the transmitter.

All wiring between the power supply and the Model 805 transmitter should be made using 18–22 AWG shielded twisted pair instrument cable. Within the transmitter enclosure, connections are made to the terminal strip and the ground connections. The directions for wiring the Model 805 transmitter depend on the application:

- General Purpose or Non-incendive (Cl I, Div. 2)
- Intrinsically Safe

WARNING! Explosion hazard. Do not disconnect equipment unless power has been switched off or the area is known to be safe.

2.5.1 General Purpose or Non-incendive (Cl I, Div. 2)

A general purpose installation does not have flammable media present. Areas rated non-incendive (Cl I, Div. 2) have flammable media present only under abnormal conditions. No special electrical connections are required. If flammable media is contained in the vessel, the transmitter must be installed per Cl I, Div. 1 standards of area classification.

To install General Purpose or Non-incendive wiring:

1. Remove the cover to the wiring compartment of the transmitter. Install the conduit plug in the unused opening.
2. Install a conduit fitting and pull the supply wires.
3. Connect shield to an earth ground at power supply and leave floating at the transmitter.
4. Connect an earth ground wire to the nearest green ground screw. (Not shown in illustration.)
5. Connect the positive supply wire to the (+) terminal and the negative supply wire to the (-) terminal.
6. Replace the cover to the wiring compartment of the transmitter.

2.5.2 Intrinsically Safe

An intrinsically safe (IS) installation potentially has flammable media present. An approved IS barrier must be installed in the nonhazardous (safe) area. See *Agency Drawing – Intrinsically Safe Installation, Section 3.4.1*.

To install Intrinsically Safe wiring:

1. Make sure the IS barrier is properly installed in the safe area (refer to local plant or facility procedures). Complete the wiring from the barrier to the Model 805 transmitter. See *Agency Specifications – Intrinsically Safe Installations, Section 3.4.1.*
2. Remove the cover to the wiring compartment of the transmitter. Install the conduit plug in the unused opening.
3. Install a conduit fitting and pull the supply wires.
4. Connect shield to an earth ground at power supply and leave floating at the transmitter.
5. Connect an earth ground wire to the nearest green ground screw. (Not shown in illustration.)
6. Connect the positive supply wire to the (+) terminal and the negative supply wire to the (-) terminal.
7. Replace the cover to the wiring compartment of the transmitter.

2.6 Configuring and Calibrating the Transmitter (LCD version)

Before configuring the Model 805 transmitter, collect the operating parameters information. Then, power-up the transmitter. Information on configuring the transmitter using a HART® communicator is given in *Configuration Using HART, Section 2.7.*

2.6.1 Operating Parameters

Some key information is needed to calibrate the Model 805 transmitter. Complete the configuration information table. See *Configuration Information, Section 1.1.2.*

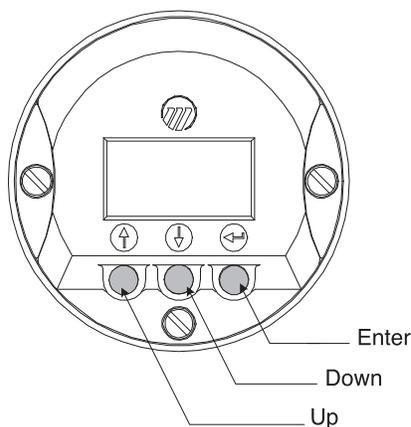
2.6.2 LCD Transmitter Display and Keypad

The Model 805 LCD transmitter has a liquid-crystal display (LCD) capable of showing two lines of 8 characters each. Transmitter measurements and configuration menu screens are shown on the LCD.

The transmitter default display is the measurement screen. It cycles every 5 seconds to display LEVEL, %OUTPUT, and LOOP information. The transmitter defaults to this display after 5 minutes if no keystrokes are sensed.

The keypad has three arrows used to scroll through the displays and to calibrate the transmitter – the Up (↑) or Down (↓) Arrow keys and the Enter (↵) key.

Either the Lo Cal or Hi Cal point levels can be entered first. It is not necessary to do the Lo Cal first. In addition, the 4 mA and 20 mA setpoints can be entered for either DIRECT action or REVERSE action as desired.



Arrows	Function in Display Mode	Function in Configuration Mode
Up and Down ↑ ↓	Moves forward and backward in the configuration program from one display to another.	Increases or decreases the value displayed or moves to another choice. <i>NOTE: Hold arrow key for rapid scrolling.</i>
Enter ↵	Enters the configuration mode (noted by an exclamation point as the last character in the top display line).	Accepts a value and moves to the next step of the configuration program.

2.6.3 Password Protection (Default = 0)

The Model 805 transmitter includes optional password protection to restrict access to certain portions of the menu structure that affect the operation of the system. The password can be changed to any numerical value up to 255. The password is required whenever configuration values are changed.

The default password installed in the transmitter at the factory is 0. The last step in the configuration menu provides the option to enter a new password. With 0 as the password, the transmitter is no longer password protected and any value in the menu can be altered without entering a confirming password.

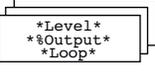
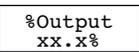
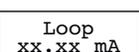
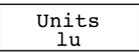
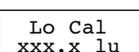
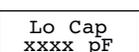
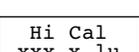
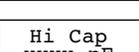
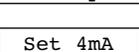
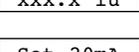
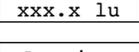
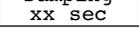
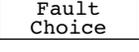
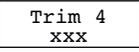
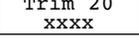
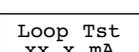
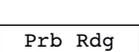
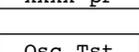
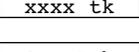
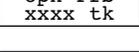
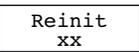
NOTE: If the password is not known, the menu item New Password displays an encrypted value representing the present password. Call the factory with this encrypted value to determine the present password.

2.6.4 LCD Menu: Step-By-Step Procedure

The following table provides a complete explanation of the software menus displayed by the Model 805 transmitter. Use this table as a step-by-step guide to configure the transmitter.

The first column presents the menus shown on the transmitter display. The displays are in the order they would appear if the arrow keys were used to scroll through the menu. The numbers are not shown on the display. They are provided as a reference.

The second column provides the actions to take when configuring the transmitter. Additional information or an explanation of an action is given in the third column.

	Display	Action	Comment
RUN MODE	① 	Transmitter Display	Transmitter default display. <i>Level</i> , <i>% Output</i> , and <i>Loop</i> values cycle every 5 seconds (two seconds each value).
	② 	Transmitter Display	Level measurement in cm or in.
	③ 	Transmitter Display	Level as percentage of loop current (20 mA) span.
	④ 	Transmitter Display	Loop current output.
CALIBRATION/CONFIGURATION	⑤ 	Select units for level measurement display.	lu = cm or in .
	⑥ 	Enter level value for the lower calibration point.	Use Up and Down keys to set reading to present level of medium in vessel. See <i>Section 1.4</i> .
	⑦ 	Transmitter Display	Measured capacitance at low calibration point.
	⑧ 	Enter level value for the higher calibration point.	Move the level in the tank. Use Up and Down keys to set reading to present level of medium in vessel. See <i>Section 1.4</i> .
	⑨ 	Transmitter Display	Measured capacitance at high calibration point.
	⑩ 	Enter the level value for the 4 mA point.	Use Up and Down keys to set reading to level corresponding to 4 mA loop current.
	⑪ 	Enter the level value for the 20 mA point.	Use Up and Down keys to set reading to level corresponding to 20 mA loop current.
	⑫ 	Enter damping factor.	Choose the damping factor (1–45 sec) for smoothing the level/output/loop displays.
	⑬ 	Enter the desired loop current in presence of a fault.	Select 22 mA , 3.6 mA or Hold . (3.6 mA is not valid if unit includes <i>both</i> digital display and HART)
	⑭ 	Enter HART poll address.	Select a HART poll address (0–15). Enter 0 for a single transmitter installation.
	⑮ 	Trim loop current to 4.00 mA.	With a meter in the loop, use Up and Down keys to adjust current to 4.00 mA.
	⑯ 	Trim loop current to 20.00 mA.	With a meter in the loop, use Up and Down keys to adjust current to 20.00 mA.
DIAGNOSTICS	⑰ 	Enter test value of loop current	Use Up and Down keys to set loop current to a desired value (3.5–22.0 mA) for testing.
	⑱ 	Transmitter Display	Measured capacitance at present level of medium in vessel.
	⑲ 	Transmitter Display	Internal timing count with known capacitance in circuit (factory diagnostic).
	⑳ 	Transmitter Display	Internal timing count with probe disconnected (factory diagnostic).
	㉑ 	Transmitter Display	Internal timing count at present level of medium in vessel (factory diagnostic).
	㉒ 	Select Yes to reinitialize all values	Resets all configuration parameters to factory default values.
	㉓ 	Transmitter Display	Shows version number of firmware.
	㉔ 	Enter new password	Use Up and Down keys to select desired value (0–255).

2.7 Configuring and Calibrating the Transmitter Using HART

A HART (Highway Addressable Remote Transducer) remote unit can be used to provide a communication link to the Model 805 transmitter. When connected to the control loop, the same system measurement readings shown on the transmitter are shown on the communicator. In addition, the communicator can be used to configure the transmitter.

The HART communicator may need to be updated to include the Model 805 software (Device Descriptors). Contact your local HART Service Center for additional information.

2.7.1 Connections

A HART communicator can be operated from a remote location by connecting to a remote junction or by connecting directly to the terminal block in the electronics housing of the Model 805 transmitter.

HART uses the Bell 202 frequency shift key technique of high-frequency digital signals. It operates on the 4–20 mA loop and requires 250 Ω of minimum load resistance. A typical connection between a communicator and the Model 805 transmitter is illustrated.

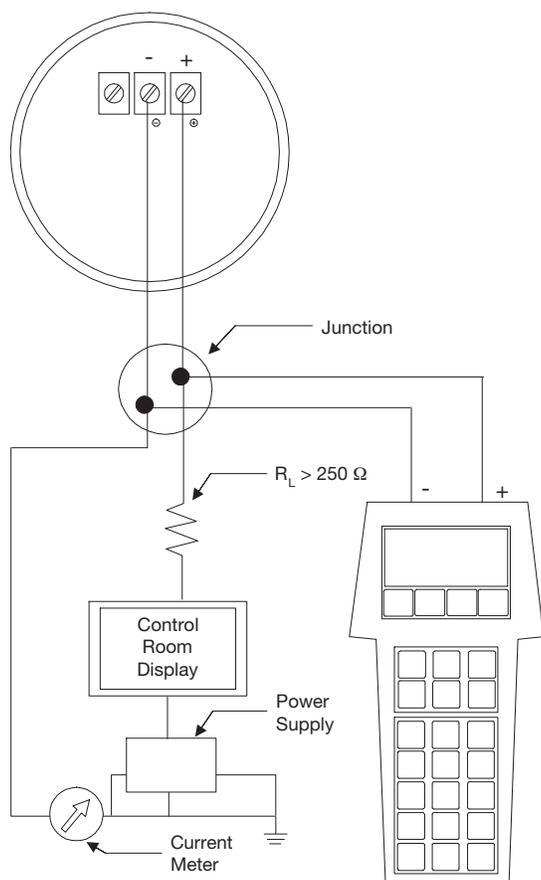
2.7.2 HART Display Menu

When connected, the top line of each online menu displays the model (Model 805) and its tag number or address. For detailed operating information, refer to the instruction manual provided with the HART communicator.

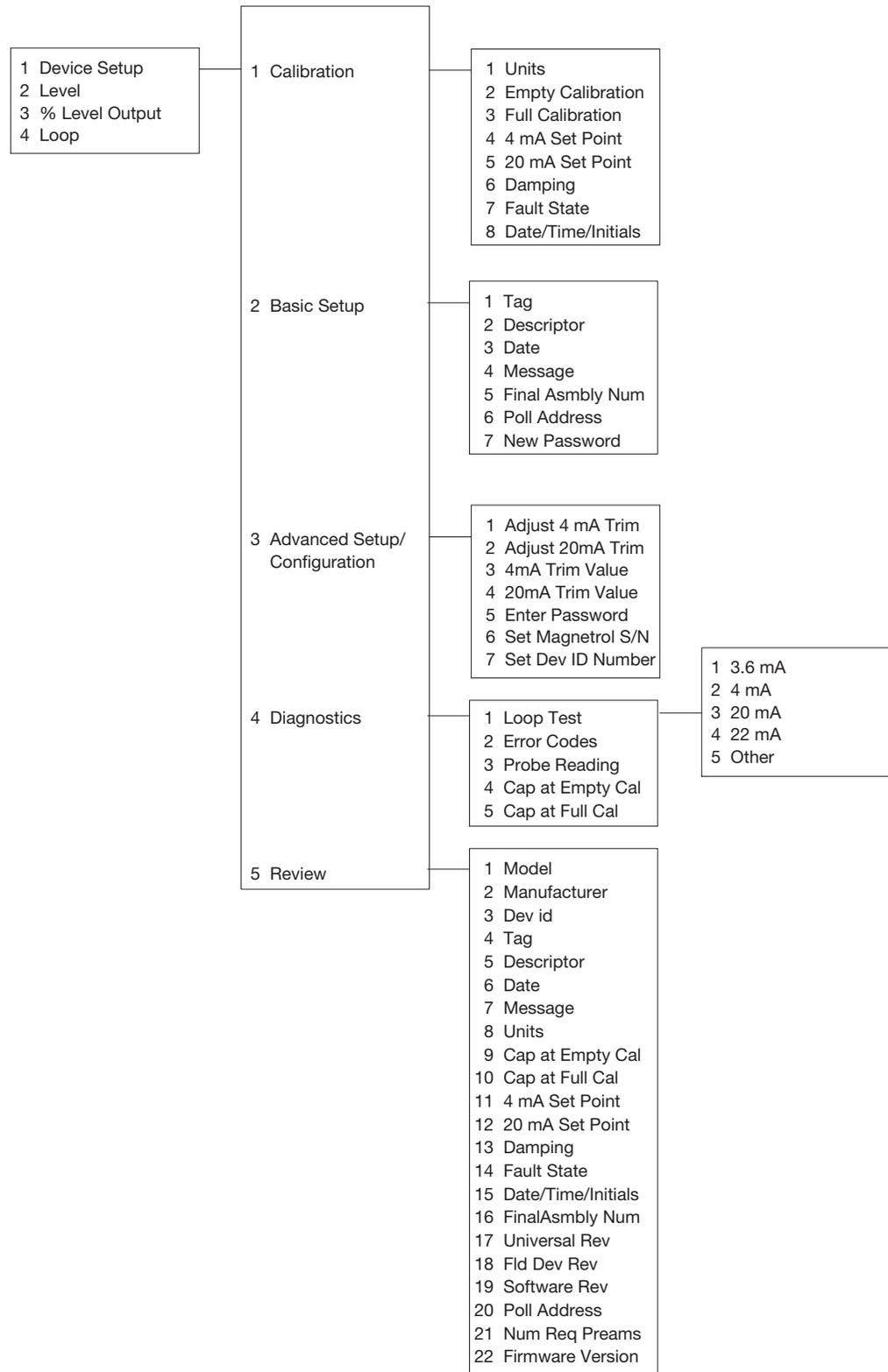
The Model 805 transmitter online menu tree is shown in the following illustration. Open the menu by pressing the alphanumeric key 1, Device Setup, to display the second-level menu.

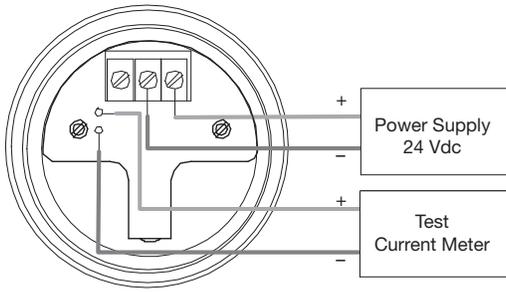
2.7.3 HART Device Description (DD)

Device Version 1 (Dev v1), Device Description 2 (DD v2) was registered with HART Communication Foundation in May, 1999 and is available on the CD-ROM 1999–2 issued in July, 1999.



2.7.4 HART Menu





3.0 Reference Information

This section presents an overview of the operation of the KOTRON Model 805 transmitter, information on troubleshooting common problems, listings of agency approvals, lists of replacement and recommended spare parts, and detailed physical, functional, and performance specifications.

3.1 Description

Model 805 is a two wire, 24 VDC, level transmitter based on the concept of RF Capacitance.

The Model 805 electronics are housed in an ergonomic housing comprised of two tandem compartments angled at 45 degrees for ease of wiring and calibration. These two compartments connect via an explosion-proof and water-tight feed-through.

3.2 Theory of Operation

RF capacitance electronic level measurement utilizes the same fundamentals as any electronic capacitor (Figure A). A capacitor is formed when an AC signal is applied across two conductive plates separated by an insulating medium, or dielectric. The value of a capacitor is determined by the:

1. Area of the conductive plates (A);
2. Distance between the plates (D), and;
3. Dielectric of the insulating medium between the plates (E). Refer to Figure A.

$$\text{Capacitance} = EA/D$$

(The AC frequency is fixed as part of the design.)

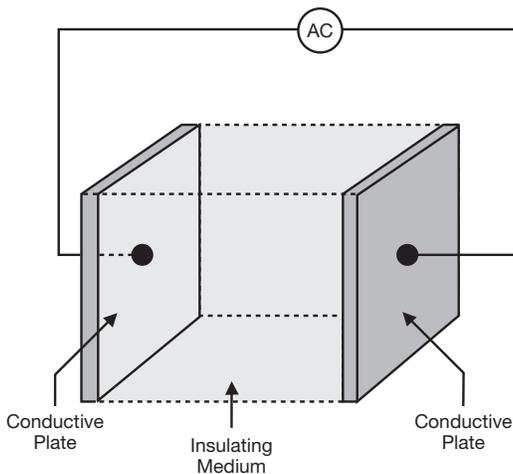


Figure A

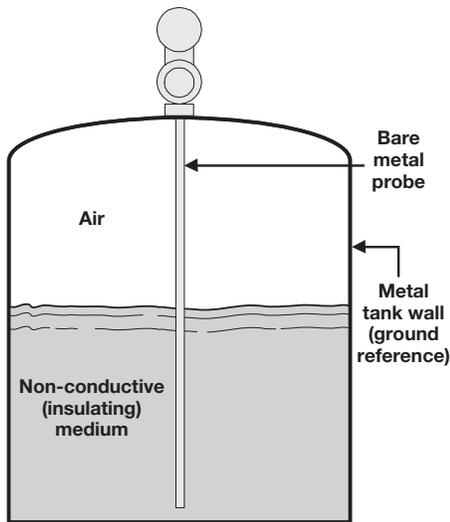


Figure B

Capacitance is measured in Farads. The value we utilize in industrial measurement is an extremely small unit called a pico Farad (pF). A pico Farad is one trillionth of a Farad (10^{-12}).

Capacitance value increases as the dielectric increases, the plate size increases, or the distance between the plates decreases.

In industrial applications (Figure B), the probe is one plate of the capacitor, the tank wall is the other plate (ground reference). The insulating material that separates them is the dielectric. A tank that is empty is actually filled with air that has a dielectric of 1, the baseline of the dielectric scale. All materials have a dielectric higher than air, e.g. oil = 2.5, alcohol = 18, tap water = 80, etc. As a tank is filled with media, the air (dielectric = 1) is being displaced by the media having a higher dielectric; consequently, the amount of capacitance being generated between the probe and the tank wall increases.

3.3 Troubleshooting

The Model 805 transmitter is designed and built for trouble-free operation over a wide range of operating conditions. Common transmitter problems are discussed in terms of their symptoms and recommended corrective actions. In addition, information on how to handle material build-up on the probe is provided in this section.

WARNING! Explosion hazard. Do not connect or disconnect equipment unless power has been switched off or the area is known to be safe.

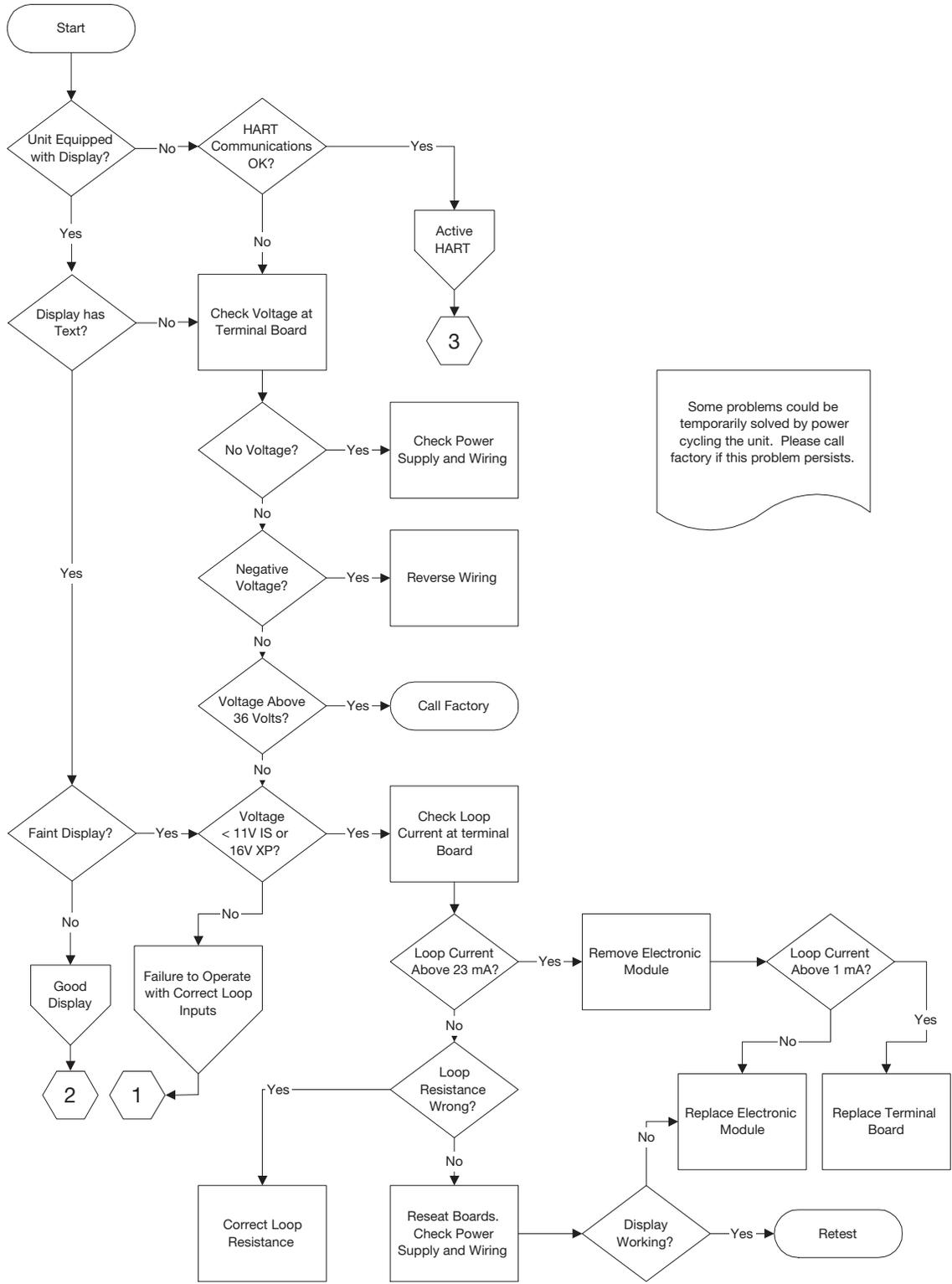
3.3.1 Troubleshooting System Problems

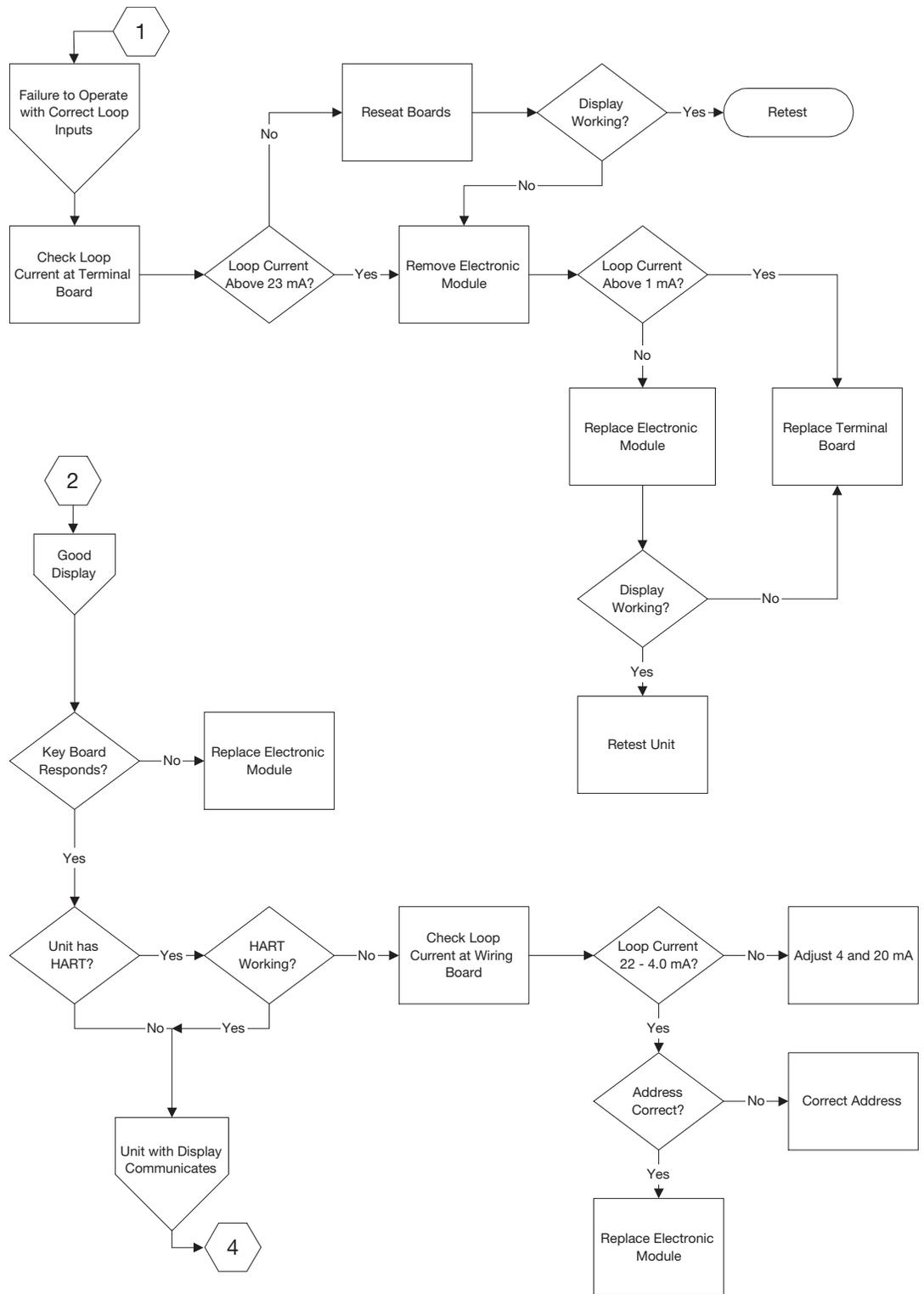
Symptom	Problem	Solution
OUTPUT signal always at 4 mA.	HART Poll address is not 0.	Change HART Poll Address to 0. See Section 2.6.4, Step 14.
LEVEL, % OUTPUT and LOOP values are all inaccurate.	Basic configuration data is questionable.	Check values and recalibrate if necessary (either or both points).
LEVEL readings are repeatable but consistently high or low from actual by a fixed amount.	Configuration data does not accurately match tank height.	Recalibrate if necessary.
LEVEL, % OUTPUT and LOOP values fluctuate.	Turbulence.	Increase the Damping factor until the readings stabilize.
LOOP value jittery, usually in tenths or hundredths digit.	Factory settings corrupted.	Check # of Ticks. If the number is also jittery, consult the Factory.
HART device only: handheld will only read Universal Commands.	Most current Device Descriptors (DDs) are not installed in handheld	Contact local HART service center for the latest DDs.
HART device only; reads Product information (e.g., Mfgs. ID, Device #, Serial #, etc.) but will not read any process variables.	Early HART software does not account for Mfgs. ID #'s greater than 63. The Magnetrol ID is 86.	Contact manufacturer of your HART master software for upgrade. This is a shortcoming of early HART master software.

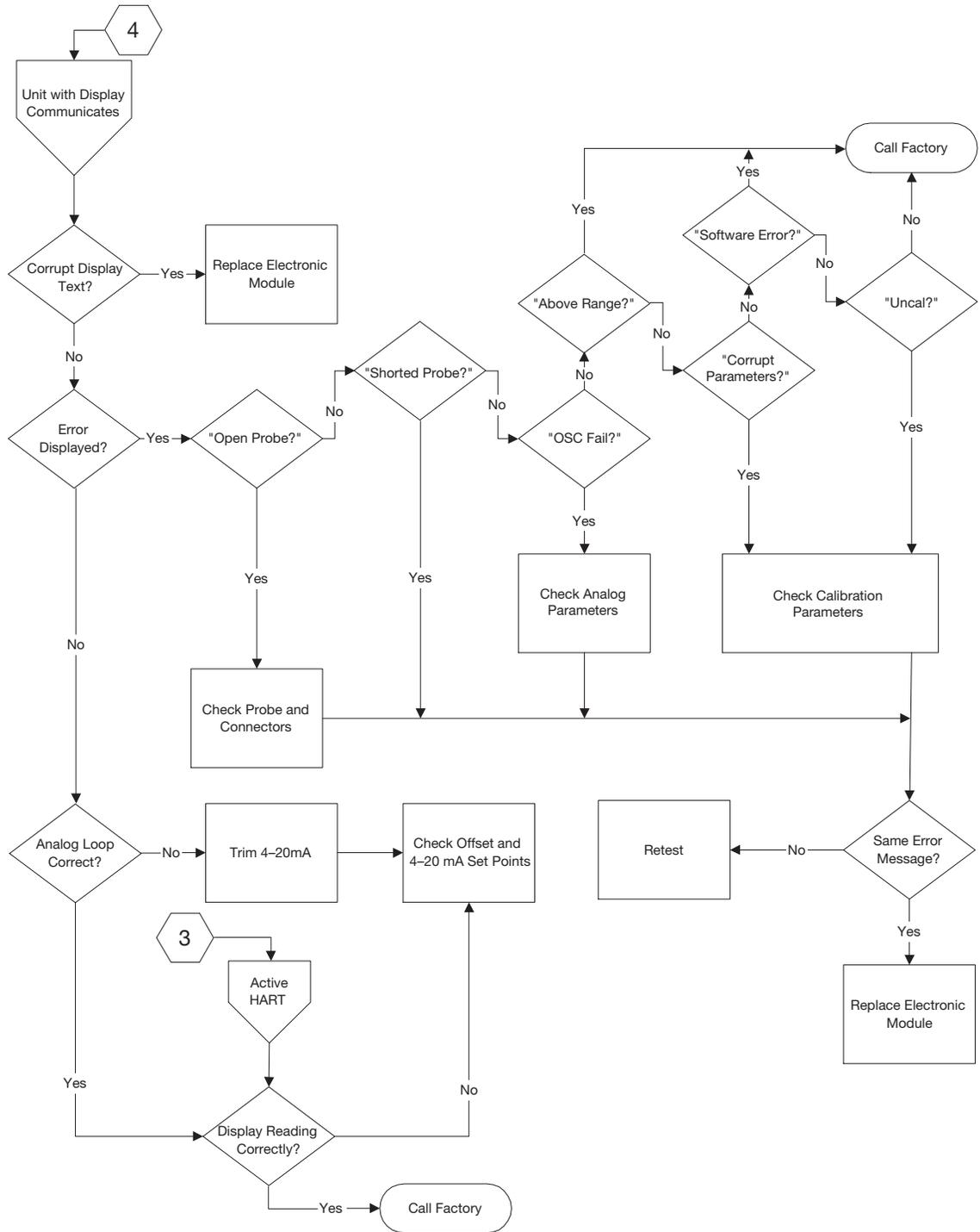
3.3.2 Error Messages

Symptom	Problem	Solution
805 FAULT (Open)	Open probe.	Check probe wiring and electronics module connector.
805 FAULT (Shorted)	Shorted probe.	Check probe wiring and integrity of insulated probe in conductive liquid.
OSC FAIL (HART error code = 0x40)	Malfunctioning analog board and/or 32 pin connector.	Check connection between boards and replace electronic module if necessary.
ABV RNG	Above range.	Measured capacitance > 12,000 pF. Contact factory.
CORRUPT PARAMTRS (HART error code = 0x10)	Configuration parameters may have been lost.	Check all Configuration parameters and recalibrate if necessary.
SFWR ERROR	Software error.	Bad internal state, unexpected condition. Contact factory.
LEVEL (Uncal)	Unit is not calibrated.	Make sure that both Lo Cal and Hi Cal points have been entered.

3.3.3 Troubleshooting Flowchart (LCD version)







3.4 Agency Approvals

AGENCY	MODEL APPROVED	APPROVAL CATEGORY	APPROVAL CLASSES
FM 	805-5XXX-11X	Intrinsically Safe	Class I, Div. 1; Groups A, B, C, & D Class II, Div. 1; Groups E, F, & G Class III T4 Ta = +71° C Entity NEMA 4X IP66
	805-5XXX-11X	Non-Incendive	Class I, Div. 2; Groups A, B, C, & D Class II, Div. 2; Groups F & G Class III T4 Ta = +71° C NEMA 4X IP66
CSA 	805-5XXX-110	Intrinsically Safe	Class I, Div. 1; Groups A, B, C, & D Class II, Div. 1; Group E, F, & G (insulated probes) (Group G only with bare probe) Class III T4 Ta = +71° C Entity Type 4X
	805-5XXX-110	Suitable for:	Class I, Div. 2; Groups A, B, C, & D Class II, Div. 2; Groups E, F, & G (insulated probes) (Group G only with bare probe) Class III T4 Ta = +71° C Type 4X
ATEX 	805-5XXX-AXX	Intrinsically Safe	 II 1G EEx ia IIC T6* (-40° to +40° C ambient temp.)  II 1G EEx ia IIC T4* (-40° to +80° C ambient temp.)

*Special conditions for safe use:

Because the enclosure of the transmitter is made of aluminum alloy, the transmitter must be installed so, that even in the event of rare incidents, an ignition source due to impact or friction between the enclosure and iron/steel is excluded.

Probes with an insulating layer, used in potentially explosive atmosphere with gas, vapor or mist of gas group IIC, may only be used for the measurement of the level of a conductive fluid.



These units have been tested to EN 50081-2 and EN 50082-2 and are in compliance with the EMC Directive 89/336/EEC.

3.4.1 Agency Specifications – Intrinsically Safe Installation

REVISIONS		BY & DATE	CHANGE NO.
SYM	RELEASED		
A	DF 8-99		3185-894
B	REMOVED NOTE 1 & RENUMBERED NOTES.	DF 9-06	3121-649

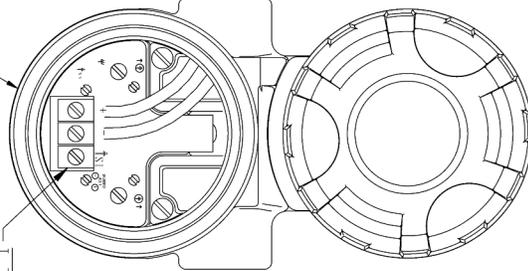
HAZARDOUS LOCATION

INTRINSICALLY SAFE FOR CLS I, DIV 1, GROUPS A, B, C & D
CLS II, DIV 1, GROUPS E, F & G (G ONLY FOR CSA)

ENTITY

V_{max} = 28.6 V
I_{max} = 140 mA
P_{max} = 1 W
C1 = 2.2 nF
L1 = 37.5 aH

SEE NOTE 1
TRANSMITTER
INSTRUMENT

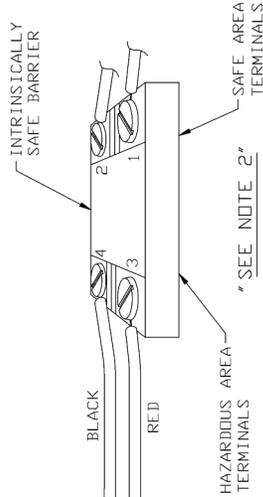


NON-HAZARDOUS LOCATION

LIMITING VALUES

V_{oc} < 28.6 V C_a > 2.2 nF
I_{sc} < 140 mA L_a > 37.5 aH

THE VOLTAGE (V_{max}) AND CURRENT (I_{max}) WHICH THE TRANSMITTER CAN RECEIVE MUST BE EQUAL TO OR GREATER THAN THE MAXIMUM OPEN CIRCUIT VOLTAGE (V_{oc} OR V_o) AND THE MAXIMUM SHORT CIRCUIT CURRENT (I_{sc} OR I_s) WHICH CAN BE DELIVERED BY THE SOURCE DEVICE. IN ADDITION, THE MAXIMUM CAPACITANCE (C_a) AND INDUCTANCE (L_a) OF THE LOAD AND THE CAPACITANCE AND INDUCTANCE OF THE INTERCONNECTING WIRING MUST BE EQUAL TO OR LESS THAN THE CAPACITANCE (C₁) OR THE INDUCTANCE (L₁) WHICH CAN BE DRIVEN BY THE SOURCE DEVICE.



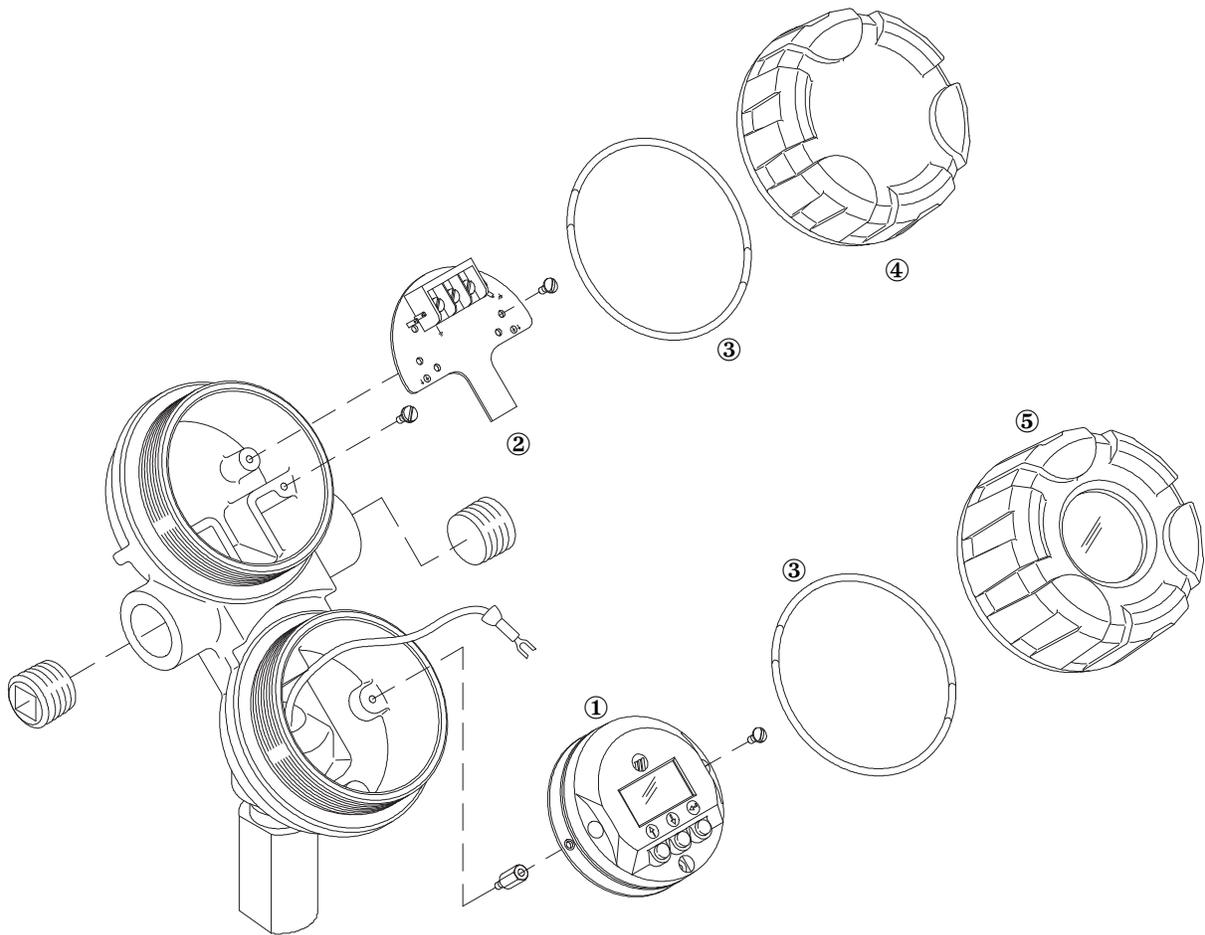
NOTES:

- FOR EXPLOSION-PROOF OR DUST-IGNITION-PROOF INSTALLATIONS, THE I-S-GROUND TERMINAL SHALL BE CONNECTED TO APPROPRIATE INTRINSICALLY SAFE GROUND IN ACCORDANCE WITH THE CANADIAN ELECTRICAL CODE (CEC) FOR CSA OR THE NATIONAL ELECTRICAL CODE (NEC) AND TERMINALS FOR OTHER INTRINSICALLY SAFE INSTALLATIONS SHALL BE INSTALLED IN ACCORDANCE WITH THE INTRINSICALLY SAFE BARRIER'S INSTALLATION INSTRUCTIONS SUPPLIED WITH THE PROTECTIVE BARRIER AND THE CEC (FOR CSA) OR THE NEC AND ANSI/ISA RP 12.6 (FOR FMRC) MUST BE FOLLOWED WHEN INSTALLING THIS EQUIPMENT.
- CONTROL EQUIPMENT CONNECTED TO PROTECTIVE BARRIERS MUST NOT USE OR GENERATE MORE THAN 250 VDC OR V RMS.
- NRTL LISTED DUST-TIGHT SEALS MUST BE USED WHEN TRANSMITTER IS INSTALLED IN CLASS II & III ENVIRONMENTS.
- NO REVISIONS TO THIS DRAWING WITHOUT CSA AND FMRC APPROVAL.
- FOR CSA: EXIA INTRINSICALLY SAFE/SECURE INTRINSEQUE.
- IMPAIR SUITABILITY FOR HAZARDOUS LOCATIONS.
- FOR CSA: WARNING - EXPLOSION HAZARD - DO NOT DISCONNECT EQUIPMENT UNLESS POWER HAS BEEN SWITCHED OFF OR THE AREA IS KNOWN TO BE NON-HAZARDOUS.
- FOR SUPPLY CONNECTIONS, USE WIRE SUITABLE FOR THE OPERATING TEMPERATURE. FOR 71° C AMBIENT, USE WIRE WITH A MINIMUM TEMPERATURE RATING OF 75° C.
- THE TRANSMITTER CAN ALSO BE INSTALLED IN CLASS 2, GROUPS A, B, C & D, CLASS II, DIVISION 2, GROUPS E, F & G (F & G ONLY FOR FMRC), CLASS I, DIVISION 2 HAZARDOUS LOCATIONS AND DOES NOT REQUIRE CONNECTION TO A PROTECTIVE BARRIER WHEN INSTALLED PER THE CEC (FOR CSA) OR THE NEC (FOR FMRC) AND WHEN CONNECTED TO A POWER SOURCE NOT EXCEEDING 30 VDC.

P/N 099-5056-001

TITLE:		Magnetrol®	
SYSTEM DRAWING		5300 BELMONT ROAD, DOWNERS GROVE ILLINOIS 60515, AREA CODE 630/969-4000	
MODEL 805 TRANSMITTER		SCALE: NONE	SHEET 1 OF 1
DRAWN: D. FRANCOEUR (DATE: 8-6-99)	CHECKED: J. M. JARAS (DATE: 8-12-99)	PROJECT NO. 3185-894 (REVISION)	
APPROVED: R. BOTWINSKI (DATE: 8-12-99)	SIZE: C 099-5056		
UNLESS OTHERWISE SPECIFIED:		DRAWN: D. FRANCOEUR (DATE: 8-6-99)	
DIMENSIONS ARE IN INCHES (1) OR MM DIMENSIONS ARE IN MILLIMETERS		CHECKED: J. M. JARAS (DATE: 8-12-99)	
MAX. ALLOWED: .002 (0.051) INSIDE FINISH; .003 (0.076) ALL FINISHES; .125 (3.175) OR BETTER		APPROVED: R. BOTWINSKI (DATE: 8-12-99)	
REMOVE ALL BURRS AND SHARP EDGES		PROJECT NO. 3185-894 (REVISION)	
TOLERANCES - .0005 IN (0.0127) 2 PL. DECIMAL - .0001 IN (0.00254) ANGULAR .2°		DRAWING LAST MODIFIED: Saturday, June 28, 2014 3:53:56 PM	
MATERIAL	RAW MATERIAL PART NO.	HEAT FINISH	FINISH
THIS DRAWING IS THE EXCLUSIVE PROPERTY OF MAGNETROL INTERNATIONAL. NO USE, REPRODUCTION, OR REPRODUCTION OF THIS DRAWING OR ANY PART THEREOF IS PERMITTED WITHOUT THE WRITTEN CONSENT OF MAGNETROL INTERNATIONAL.			

3.5 Parts



3.5.1 Replacement Parts

Item	Description	Part Number
1	Electronic module includes:	
	Display (English) and HART	Z31-2809-001
	Display only	Z31-2809-003
2	Terminal board includes:	Z30-9106-003
3	O-ring (Viton®)	Z12-2201-237
4	Housing cover without glass	004-9193-003
5	Housing cover with glass	036-4410-001

Viton and Kalrez are registered trademarks of DuPont Performance Elastomers.

3.6 Specifications

3.6.1 Functional

System Design

Measurement Principle RF Capacitance

Input

Measured Variable Level, determined by change in capacitance values

Zero and Range 0" to 1800" (0 cm to 4572 cm)

Span 5 pF min., 10,000 pF max.

Output

Type Analog 4 to 20 mA with optional HART digital signal

Range Analog 3.8 to 20.5 mA useable

Digital 0 to 1800" (0 to 4472 cm)

Resolution Analog 0.01 mA

Digital 0.1"

Loop Resistance (maximum) GP/IS-620 Ω @ 24 VDC

Alarm Adjustable 3.6 mA, (no Display or no HART) 22 mA, HOLD

Damping Adjustable 1–45 seconds

LCD User Interface

Keypad 3-button menu-driven data entry and system security

Indication 2-line x 8-character display

Digital Communication

HART Version 5.x compatible

Power (Measured at instrument terminals)

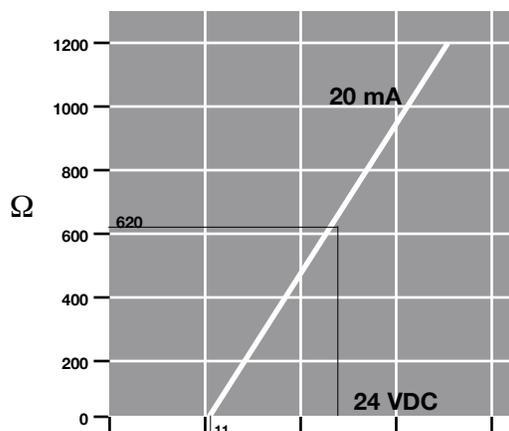
General Purpose 11 to 36 VDC

Intrinsically Safe 11 to 28.6 VDC

Housing

Material Aluminum A356T6 (< 0.2% copper)

Cable Entry $\frac{3}{4}$ " NPT, M20, PG13.5, PG16



3.6 Specifications

3.6.1 Functional (continued)

Process Conditions

Maximum process temperature ①	+1000° F @ 500 psig (+538° C @ 35 bar)
Maximum process pressure ①	5000 psig from -500° to +100° F (345 bar from -296° to +38° C)
Minimum process pressure ①	-85° F (-65° C)

Environment

Operating temperature	-40 to +175° F (-40 to +80° C)
Display function operating temperature	-5 to +160° F (-20 to +70° C)
Storage temperature	-40 to +175° F (-40 to +80° C)
Humidity	0–99%, non-condensing
Electromagnetic compatibility	Meets CE Requirements (EN 50081-2, EN 50082-2)

Installation

Orientation	Vertical, top-mounted
-------------	-----------------------

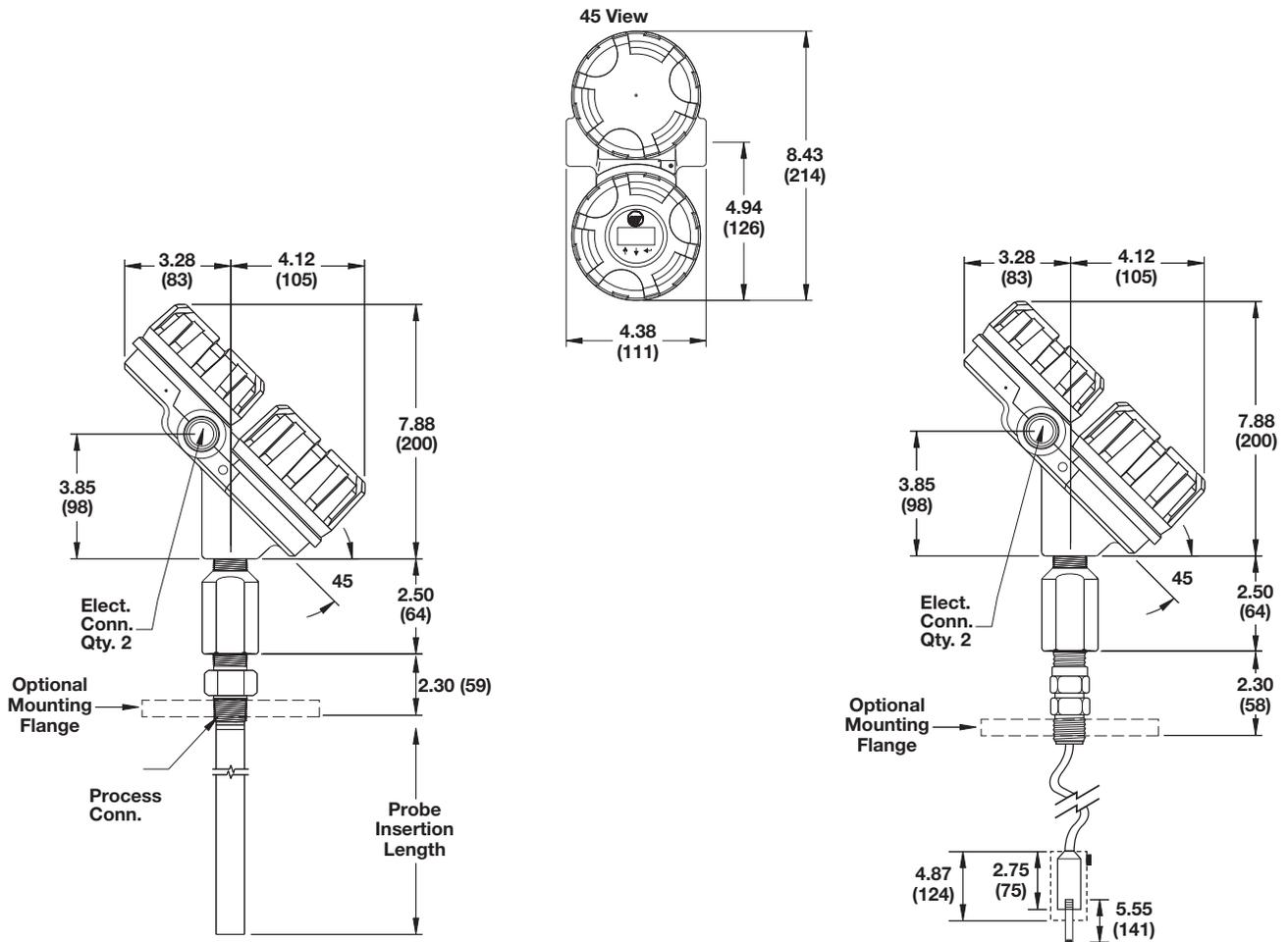
- ① Depends on probe selection.
See bulletin 50-125 for specifications of available probes.

3.6.2 Performance

Reference conditions	+20° C (+68° F)
Accuracy	±0.5% of span or 0.1" (whichever is greater)
Resolution	0.1 pF
Repeatability	±0.1% of span
Linearity	±0.25% of span
Hysteresis	±0.1% of span
Response time	< 1 s (adjustable via damping)
Warm up time	< 5 s
Temperature effect	Approximately +0.03%/° C

3.6 Specifications

3.6.3 Physical



3.7 Model Numbers

3.7.1 Transmitter

BASIC MODEL NUMBER

805	Kottron® Smart RF Level Transmitter
-----	-------------------------------------

POWER

5	24 VDC, Two Wire, Loop Powered
---	--------------------------------

SIGNAL OUTPUT

0	4-20 mA only, without HART
1	4-20 mA with HART

MENU LANGUAGE

1	English
2	Spanish
3	French
4	German

ACCESSORIES

A	Digital display and keypad
---	----------------------------

MOUNTING/CLASSIFICATION

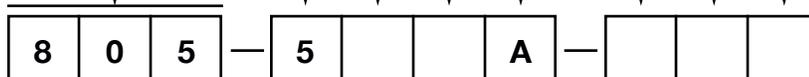
1	Integral, General Purpose, Non-incendive & Intrinsically Safe (FM & CSA)
A	Integral, Intrinsically Safe (ATEX)

HOUSING

1	Aluminum, Dual Compartment, 45°
2	316 Stainless Steel, Dual Compartment, 45°

CONDUIT CONNECTION:

0	¾" NPT
1	M20



Complete details on the available probes can be found in Bulletin 50-125, Kottron® RF Sensing Probes

Glossary

Accuracy The maximum positive and negative % deviation over the total span.

ANSI *American National Standards Institute.*

CE *Conformité Européene* Standards and performance criteria for the new European Union.

CSA *Canadian Standards Association* Canadian, third party agency that qualifies the safety of electrical equipment.

Damping The mathematical averaging of a meter and/or output signal to stabilize the effects of a noisy process due to surface turbulence.

Default Values The main position of the menu structure that displays the primary measurement values of LEVEL, % OUTPUT, and LOOP. The transmitter returns to this position after 5 minutes of inactivity.

Dielectric Constant (ϵ) The electrical permittivity of a material. The units are farad/meter.

DVM/DMM Digital Volt Meter/Digital Multimeter.

EMI *Electromagnetic Interference* Electrical noise caused by electromagnetic fields that may affect electrical circuits, particularly low-power electronic devices.

EN *European Normal* Committee guidelines in EC countries that take precedence over local, country guidelines.

Ergonomic A mechanism that considers human capability in its design or function.

Fault A defect or failure in a circuit. The current (mA) value unit defaults to 3.6, 22, or Hold when a diagnostic condition occurs.

Feedthrough A small, connecting cavity between the main housing compartments, carrying the cable that supplies the operating energy to the measurement circuitry and returns the output value proportional to level. This cavity is potted to maintain the environmental isolation between the two compartments.

FM *Factory Mutual* American, third party agency that qualifies the safety of electrical equipment.

Four Wire An electronic instrument design that uses one set of wires to supply power (120/240 VAC, 24 VDC) and another set to carry the process measurement signal (4–20 mA). Also called *Line Powered*.

FSK Frequency Shift Keying.

Ground An electrical connection to the Earth's potential that is used as a reference for the system and electrical safety.

Grounded A state where no electrical potential exists between the ground (green) connection on the transmitter and the Earth or system ground.

HART *Highway Addressable Remote Transducer.* Protocol that uses the Bell 202 frequency shift keying (FSK) method to superimpose low level frequencies (1200/2000 Hz) on top of the standard 4–20 mA loop to provide digital communication.

HART ID *See Poll Address.*

Hazardous Area An area where flammable gases or vapors are or may be present in the air in quantities sufficient to produce explosive or ignitable mixtures.

IEC *International Electrotechnical Commission* Organization that sets international standards for electrical devices.

Increased Safety Designs and procedures that minimize sparks, arcs, and excessive temperatures in hazardous areas. Defined by the IEC as Zone 1 environments (Ex e).

Interface: Electrical A boundary between two related, electronic circuits.

Interface: Process A boundary between two or more immiscible liquids.

Intrinsic Safety A design or installation approach that limits the amount of energy that enters a hazardous area to eliminate the potential of creating an ignition source.

Level The present reading of the height of material in a vessel.

Linearity The worst case error calculated as a deviation from a perfect straight line drawn between two calibration points.

Line Powered *See Four Wire.*

Loop The present reading of the 4–20 mA current output.

Loop Powered *See Two Wire.*

Low Voltage Directive A European Community requirement for electrical safety and related issues of devices using 50–1000 VDC or 75–1500 VAC.

Measured Value The typical level measurement values used to track the level of a process: Level, % Output, and Loop.

Glossary (continued)

Media The liquid material being measured by the level transmitter.

Multidrop The ability to install, wire, or communicate with multiple devices over one cable. Each device is given a unique address and ID.

Nonhazardous Area An area where no volatile mixtures of vapors/gas and oxygen will be found at any time. *Also called General Purpose Area.*

Non-incendive Equipment and wiring which in its normal operating condition is incapable of igniting a specific hazardous atmosphere or hazardous dust layer.

Offset The distance from the bottom of the tank to the bottom of the probe.

Password A numerical value between 0 and 65,000 that protects stored configuration data from unauthorized manipulation.

Percent (%) Output The present reading as a fraction of the 16 mA scale (4–20mA).

Poll Address (HART ID) A number between 1 and 15 which sets an address or location of a device in a multi-drop loop.

Probe A waveguide that propagates an electromagnetic pulse from the top of the tank into the process fluid.

Probe Length Exact measurement from the bottom of the process thread connection to the very bottom of the probe.

Probe Type Particular RF configuration or design. Each probe type is designed to accomplish specific objectives in an application.

QuickStart The essential information needed for the Model 805 transmitter and probe to be installed, wired, and calibrated.

Range A value related to probe length (factory setting).

Relative Dielectric (ϵ_r) A unitless number that indicates the permittivity of a material.

Repeatability The maximum error between two or more output readings of the same point.

RFI *Radio Frequency Interference* Electrical noise that can have an adverse affect on electrical circuits, particularly low-power devices.

Span The difference between the upper and lower limits of the range.

Specific Gravity (SG) The ratio of the density of a material to the density of water at the same conditions.

Tst Loop *Test Loop* Built-in system capability to test/calibrate a loop (or separate loop device) by driving the transmitter output to a particular value.

Trim 4/Trim 20 Built-in system capability to fine tune the 4 mA and 20 mA points so the transmitter output corresponds exactly to user's meter, DCS input, etc.

Two Wire An electrical instrument design that uses one set of wires to provide both the supply power and process measurement signal. The process measurement is achieved by varying the current of the loop. Also called *Loop Powered*.

Units The engineering units used to measure level in the system. The choices are in (inches) and cm (centimeters).

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Kotron® Model 805 Smart RF Transmitter Configuration and Calibration Data Sheet

Copy blank page and store calibration data for future reference.

Item	Value	Value	Value
Vessel Name			
Vessel #			
Media			
Tag #			
Probe P/N			
Electronics P/N			
Electronics S/N			
Units			
Lo Cal			
Lo Cap			
Hi Cal			
Hi Cap			
4mA point			
20mA point			
Damping			
Fault Choice			
HART Poll Address			
Trim 4			
Trim 20			
Loop Test			
Probe Reading			
OSC Test			
Open Probe			
# Ticks			
Reinit			
Version Firmware			
New Password			
Name			
Date			
Time			

Service Policy

Owners of Magnetrol may request the return of a control or any part of a control for complete rebuilding or replacement. They will be rebuilt or replaced promptly. Controls returned under our service policy must be returned by Prepaid transportation. Magnetrol will repair or replace the control at no cost to the purchaser (or owner) other than transportation if:

1. Returned within the warranty period; and
2. The factory inspection finds the cause of the claim to be covered under the warranty.

If the trouble is the result of conditions beyond our control; or, is NOT covered by the warranty, there will be charges for labor and the parts required to rebuild or replace the equipment.

In some cases it may be expedient to ship replacement parts; or, in extreme cases a complete new control, to replace the original equipment before it is returned. If this is desired, notify the factory of both the model and serial numbers of the control to be replaced. In such cases, credit for the materials returned will be determined on the basis of the applicability of our warranty.

No claims for misapplication, labor, direct or consequential damage will be allowed.

Return Material Procedure

So that we may efficiently process any materials that are returned, it is essential that a "Return Material Authorization" (RMA) number be obtained from the factory, prior to the material's return. This is available through a Magnetrol local representative or by contacting the factory. Please supply the following information:

1. Company Name
2. Description of Material
3. Serial Number
4. Reason for Return
5. Application

Any unit that was used in a process must be properly cleaned in accordance with OSHA standards, before it is returned to the factory.

A Material Safety Data Sheet (MSDS) must accompany material that was used in any media.

All shipments returned to the factory must be by prepaid transportation.

All replacements will be shipped F.O.B. factory.

NOTE: See Electrostatic Discharge Handling Procedure on page 8.



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