Fisher™ FIELDVUE™ DLC3010 Digital Level Controller

Contents

This quick start guide applies to:

Device Type	DLC3010
Device Revision	1
Hardware Revision	1
Firmware Revision	8
DD Revision	3

W7977-2

Note

This guide describes how to install, setup, and calibrate the DLC3010 using a 475 Field Communicator. For all other information on this product, including reference materials, manual setup information, maintenance procedures, and replacement part details refer to the DLC3010 Instruction Manual (D102748X012). If a copy of this document is required, contact your Emerson sales office or Local Business Partner or visit our website at Fisher .com.

For information on using the Field Communicator, see the Product Manual for the Field Communicator, available from Emerson Performance Technologies.

Installation

WARNING

To avoid personal injury, always wear protective gloves, clothing, and eyewear when performing any installation operations.

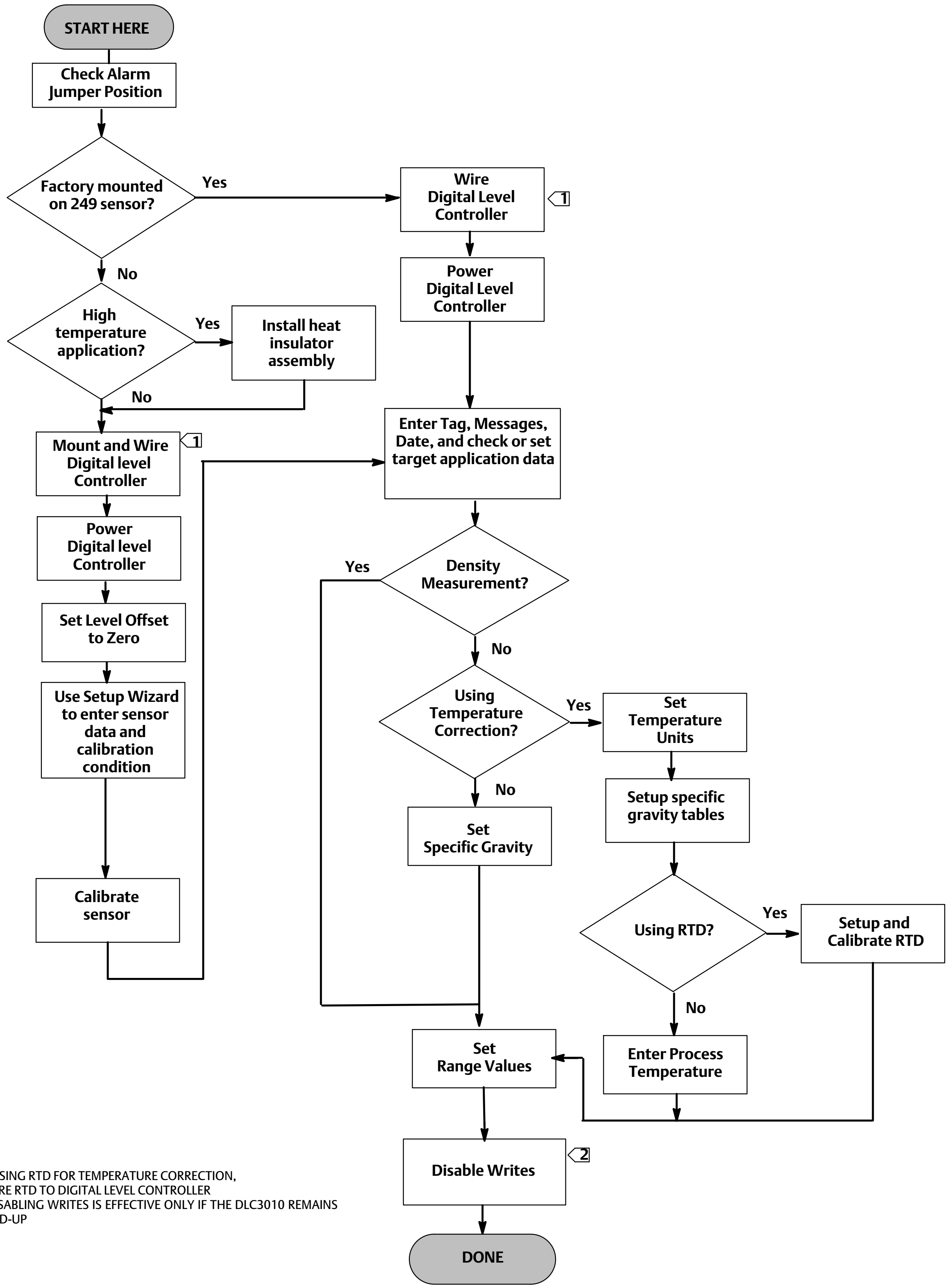
Personal injury or property damage due to sudden release of pressure, contact with hazardous fluid, fire, or explosion can be caused by puncturing, heating, or repairing a displacer that is retaining process pressure or fluid. This danger may not be readily apparent when disassembling the sensor or removing the displacer. Before disassembling the sensor or removing the displacer, observe the appropriate warnings provided in the sensor instruction manual.

Check with your process or safety engineer for any additional measures that must be taken to protect against process media.

This section contains digital level controller installation information, including an installation flowchart (figure 1), mounting and electrical installation information, and a discussion of failure mode jumpers.

Do not install, operate, or maintain a DLC3010 digital level controller without being fully trained and qualified in valve, actuator, and accessory installation, operation, and maintenance. **To avoid personal injury or property damage, it is important to carefully read, understand, and follow all of the contents of this manual, including all safety cautions and warnings.** If you have any questions regarding these instructions contact your Emerson sales office or Local Business Partner before proceeding.

Figure 1. Installation Flowchart



NOTE:
1 IF USING RTD FOR TEMPERATURE CORRECTION, ALSO WIRE RTD TO DIGITAL LEVEL CONTROLLER
2 DISABLING WRITES IS EFFECTIVE ONLY IF THE DLC3010 REMAINS POWERED-UP

Configuration: On the Bench or in the Loop

Configure the digital level controller before or after installation. It may be useful to configure the instrument on the bench before installation to ensure proper operation, and to familiarize yourself with its functionality.

Protecting the Coupling and Flexures

CAUTION

Damage to flexures and other parts can cause measurement errors. Observe the following steps before moving the sensor and controller.

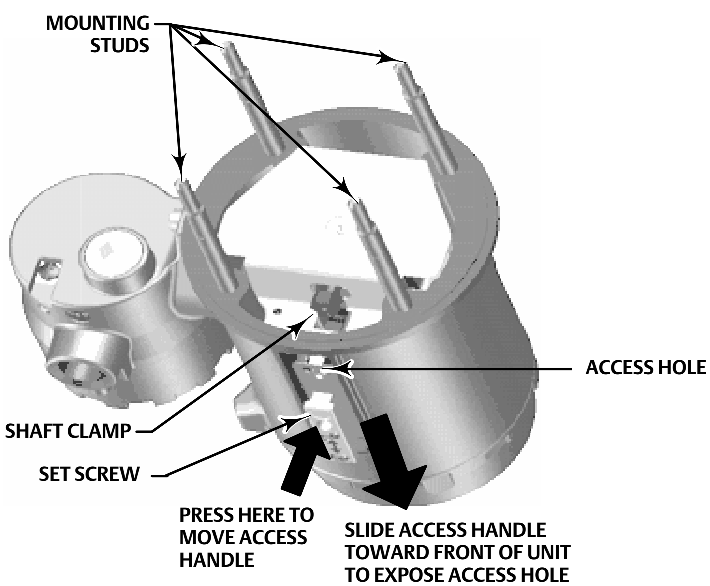
Lever Lock

The lever lock is built in to the coupling access handle. When the handle is open, it positions the lever in the neutral travel position for coupling. In some cases, this function is used to protect the lever assembly from violent motion during shipment.

A DLC3010 controller will have one of the following mechanical configurations when received:

1. A fully assembled and coupled caged-displacer system is shipped with the displacer or driver rod blocked within the operating range by mechanical means. In this case, the access handle (figure 2) will be in the unlocked position. Remove the displacer-blocking hardware before calibration. (See the appropriate sensor instruction manual). The coupling should be intact.

Figure 2. Sensor Connection Compartment (Adapter Ring Removed for Clarity)



CAUTION

When shipping an instrument mounted on a sensor, if the lever assembly is coupled to the linkage, and the linkage is constrained by the displacer blocks, use of the lever lock may result in damage to bellows joints or flexure.

2. If the displacer cannot be blocked because of cage configuration or other concerns, the transmitter is uncoupled from the torque tube by loosening the coupling nut, and the access handle will be in the locked position. Before placing such a configuration into service, perform the Coupling procedure.
3. For a cageless system where the displacer is not connected to the torque tube during shipping, the torque tube itself stabilizes the coupled lever position by resting against a physical stop in the sensor. The access handle will be in the unlocked position. Mount the sensor and hang the displacer. The coupling should be intact.
4. If the controller was shipped alone, the access handle will be in the locked position. All of the Mounting, Coupling and Calibration procedures must be performed.

The access handle includes a retaining set screw, as shown in figures 2 and 6. The screw is driven in to contact the spring plate in the handle assembly before shipping. It secures the handle in the desired position during shipping and operation. To set the access handle in the open or closed position, this set screw must be backed out so that its top is flush with the handle surface.

Hazardous Area Approvals and Special Instructions for "Safe Use" and Installations in Hazardous Locations

Certain nameplates may carry more than one approval, and each approval may have unique installation/wiring requirements and/or conditions of "safe use". These special instructions for "safe use" are in addition to, and may override, the standard installation procedures. Special instructions are listed by approval type.

Note

This information supplements the nameplate markings affixed to the product.

Always refer to the nameplate itself to identify the appropriate certification. Contact your Emerson sales office or Local Business Partner for approval/certification information not listed here.

⚠ WARNING

Failure to follow these conditions of safe use could result in personal injury or property damage from fire or explosion, or area re-classification.

CSA

Special Conditions of Safe Use

Intrinsically Safe, Explosion-proof, Division 2, Dust Ignition-proof

Ambient temperature rating: -40°C ≤ Ta ≤ +80°C; -40°C ≤ Ta ≤ +78°C; -40°C ≤ Ta ≤ +70°C

Refer to table 1 for approval information.

Table 1. Hazardous Area Classifications—CSA (Canada)

Certification Body	Certification Obtained	Entity Rating	Temperature Code
CSA	Ex ia Intrinsically Safe Class I, Division 1, 2 Groups A, B, C, D Class II, Division 1, 2 Groups E, F, G Class III T6 per drawing 28B5744 (see figure 13)	Vmax = 30 VDC Imax = 226 mA Ci = 5.5 nF Li = 0.4 mH	T6 (Tamb ≤ 80°C)
	Explosion-proof Class I, Division 1 GP B,C,D T5/T6	- - -	T5 (Tamb ≤ 80°C) T6 (Tamb ≤ 78°C)
	Class I Division 2 GP A,B,C,D T5/T6	- - -	T5 (Tamb ≤ 80°C) T6 (Tamb ≤ 70°C)
	Class II Division 1,2 GP E,F,G T5/T6 Class III T5/T6	- - -	T5 (Tamb ≤ 80°C) T6 (Tamb ≤ 78°C)

FM

Special Conditions of Safe Use

Intrinsically Safe, Explosion-proof, Non-incendive, Dust Ignition-proof

1. This apparatus enclosure contains aluminum and is considered to constitute a potential risk of ignition by impact or friction. Care must be taken into account during installation and use to prevent impact or friction.

Refer to table 2 for approval information.

Table 2. Hazardous Area Classifications—FM (United States)

Certification Body	Certification Obtained	Entity Rating	Temperature Code
FM	IS Intrinsically Safe Class I,II,III Division 1 GP A,B,C,D, E,F,G T5 per drawing 28B5745 (see figure 14)	Vmax = 30 VDC Imax = 226 mA Ci = 5.5 nF Li = 0.4 mH Pi = 1.4 W	T5 (Tamb ≤ 80°C)
	XP Explosion-proof Class I Division 1 GP B,C,D T5 NI Non-incendive Class I Division 2 GP A,B,C,D T5 DIP Dust Ignition-proof Class II Division 1 GP E,F,G T5 S Suitable for Use Class II, III Division 2 GP F,G	- - -	T5 (Tamb ≤ 80°C)

ATEX

Special Conditions for Safe Use

Intrinsically Safe

The apparatus DLC3010 is an intrinsically safe apparatus; it can be mounted in a hazardous area.

The apparatus can only be connected to an intrinsically safe certified equipment and this combination must be compatible as regards the intrinsically safe rules.

Operating ambient temperature: -40°C to + 80°C

Flameproof

Operating ambient temperature: -40°C to + 80°C

The apparatus must be fitted with a certified Ex d IIC cable entry.

Type n

This equipment shall be used with a cable entry ensuring an IP66 minimum and being in compliance with the relevant European standards.

Operating ambient temperature: -40°C to + 80°C

Refer to table 3 for additional approval information.

Table 3. Hazardous Area Classifications—ATEX

Certificate	Certification Obtained	Entity Rating	Temperature Code
ATEX	Intrinsically Safe ⟨Ex⟩II 1 G D Gas Ex ia IIC T5 Ga Dust Ex ia IIIC T83°C Da IP66	Ui = 30 VDC Ii = 226 mA Pi = 1.4 W Ci = 5.5 nF Li = 0.4 mH	T5 (Tamb ≤ 80°C)
	Flameproof ⟨Ex⟩II 2 G D Gas Ex d IIC T5 Gb Dust Ex tb IIIC T83°C Db IP66	- - -	T5 (Tamb ≤ 80°C)
	Type n ⟨Ex⟩II 3 G D Gas Ex nA IIC T5 Gc Dust Ex t IIIC T83°C Dc IP66	- - -	T5 (Tamb ≤ 80°C)

IECEx

Intrinsically Safe

The apparatus can only be connected to an intrinsically safe certified equipment and this combination must be compatible as regards the intrinsically safe rules.

Operating ambient temperature: -40°C to + 80°C

Flameproof, Type n

No special conditions for safe use.

Refer to table 4 for approval information.

Table 4. Hazardous Area Classifications—IECEx

Certificate	Certification Obtained	Entity Rating	Temperature Code
IECEx	Intrinsically Safe Gas Ex ia IIC T5 Ga Dust Ex ia IIIC T83°C Da IP66	Ui = 30 VDC Ii = 226 mA Pi = 1.4 W Ci = 5.5 nF Li = 0.4 mH	T5 (Tamb ≤ 80°C)
	Flameproof Gas Ex d IIC T5 Gb Dust Ex t IIIC T83°C Db IP66	- - -	T5 (Tamb ≤ 80°C)
	Type n Gas Ex nA IIC T5 Gc Dust Ex t IIIC T83°C Dc IP66	- - -	T5 (Tamb ≤ 80°C)

Mounting

Mounting the 249 Sensor

The 249 sensor is mounted using one of two methods, depending on the specific type of sensor. If the sensor has a caged displacer, it typically mounts on the side of the vessel as shown in figure 3. If the sensor has a cageless displacer, the sensor mounts on the side or top of the vessel as shown in figure 4.

Figure 3. Typical Caged Sensor Mounting

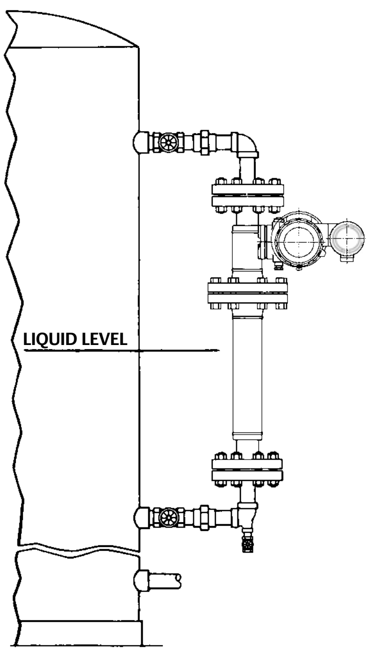
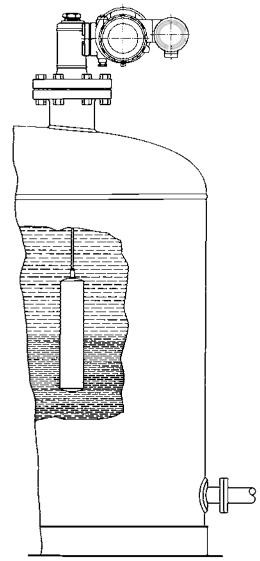


Figure 4. Typical Cageless Sensor Mounting



The DLC3010 digital level controller is typically shipped attached to the sensor. If ordered separately, it may be convenient to mount the digital level controller to the sensor and perform the initial setup and calibration before installing the sensor on the vessel.

Note

Caged sensors have a rod and block installed on each end of the displacer to protect the displacer in shipping. Remove these parts before installing the sensor to allow the displacer to function properly.

DLC3010 Orientation

Mount the digital level controller with the torque tube shaft clamp access hole (see figure 2) pointing downward to allow accumulated moisture drainage.

Note

If alternate drainage is provided by the user, and a small performance loss is acceptable, the instrument can be mounted in 90 degree rotational increments around the pilot shaft axis. The LCD meter may be rotated in 90 degree increments to accommodate this.

The digital level controller and torque tube arm are attached to the sensor either to the left or right of the displacer, as shown in figure 5. This can be changed in the field on a 249 sensor (refer to the appropriate sensor instruction manual). Changing the mounting also changes the effective action, because the torque tube rotation for increasing level, (looking at the protruding shaft), is clockwise when the unit is mounted to the right of the displacer and counter-clockwise when the unit is mounted to the left of the displacer.

All caged 249 sensors have a rotatable head. That is, the digital level controller can be positioned at any of eight alternate positions around the cage as indicated by the position numbers 1 through 8 in figure 5. To rotate the head, remove the head flange bolts and nuts and position the head as desired.

Mounting the Digital Level Controller on a 249 Sensor

Refer to figure 2 unless otherwise indicated.

1. If the set-screw in the access handle is driven against the spring plate, use a 2 mm hex key to back it out until the head is flush with the outer surface of the handle (see figure 6) . Slide the access handle to the locked position to expose the access hole. Press on the back of the handle as shown in figure 2 then slide the handle toward the front of the unit. Be sure the locking handle drops into the detent.
2. Using a 10 mm deep well socket inserted through the access hole, loosen the shaft clamp (figure 2). This clamp will be re-tightened in the Coupling portion of the Initial Setup section.
3. Remove the hex nuts from the mounting studs. Do not remove the adapter ring.

CAUTION

Measurement errors can occur if the torque tube assembly is bent or misaligned during installation.

Figure 5. Typical Mounting Positions for FIELDVUE DLC3010 Digital Level Controller on Fisher 249 Sensor

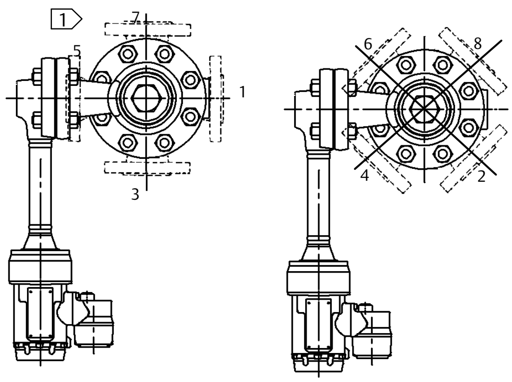
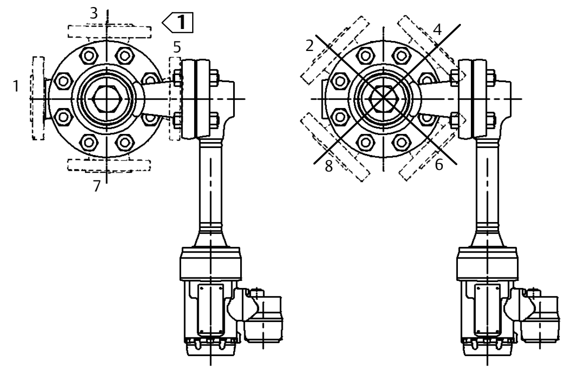
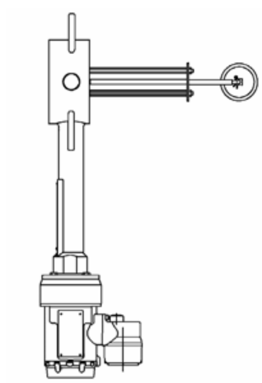
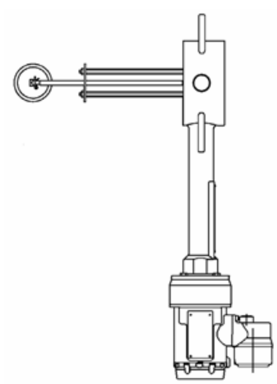
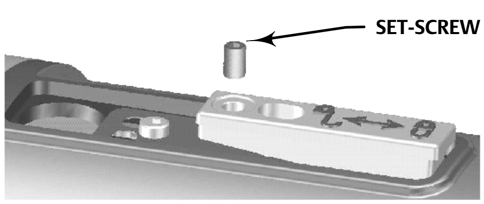
SENSOR	LEFT-OF-DISPLACER	RIGHT-OF-DISPLACER
CAGED		
CAGELESS		
1 Not available for NPS 2 CL300 and 600 249C.		

Figure 6. Close-up of Set-Screw



4. Position the digital level controller so the access hole is on the bottom of the instrument.
5. Carefully slide the mounting studs into the sensor mounting holes until the digital level controller is snug against the sensor.
6. Reinstall the hex nuts on the mounting studs and tighten the hex nuts to 10 N•m (88.5 lbf•in).

Mounting the Digital Level Controller for Extreme Temperature Applications

Refer to figure 7 for parts identification except where otherwise indicated.

The digital level controller requires an insulator assembly when temperatures exceed the limits shown in figure 8.

A torque tube shaft extension is required for a 249 sensor when using an insulator assembly.

Figure 7. Digital Level Controller Mounting on Sensor in High Temperature Applications

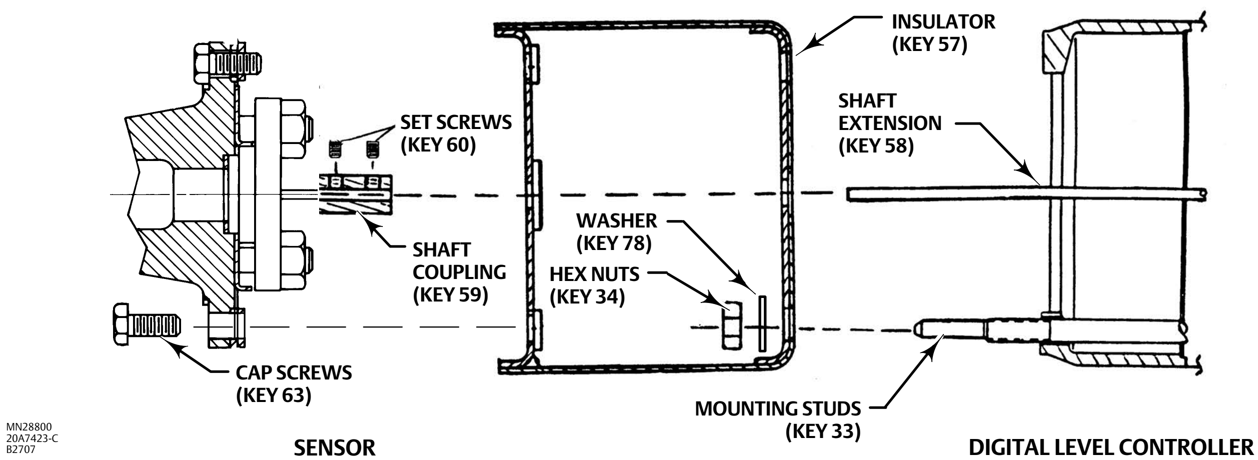
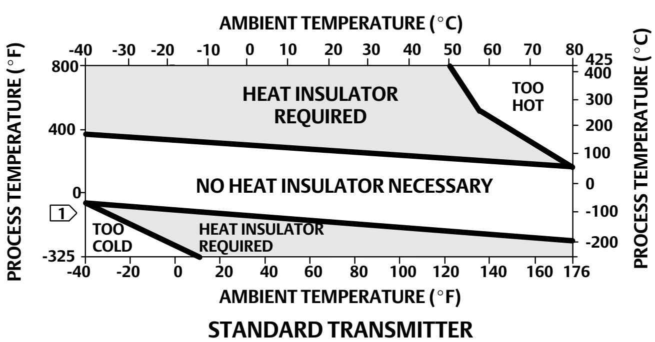


Figure 8. Guidelines for Use of Optional Heat Insulator Assembly



NOTES:
1 FOR PROCESS TEMPERATURES BELOW -29°C (-20°F) AND ABOVE 204°C (400°F) SENSOR MATERIALS MUST BE APPROPRIATE FOR THE PROCESS — SEE TABLE 9.
2. IF AMBIENT DEW POINT IS ABOVE PROCESS TEMPERATURE, ICE FORMATION MIGHT CAUSE INSTRUMENT MALFUNCTION AND REDUCE INSULATOR EFFECTIVENESS.
39A4070-B
A5494-1

CAUTION

Measurement errors can occur if the torque tube assembly is bent or misaligned during installation.

1. For mounting a digital level controller on a 249 sensor, secure the shaft extension to the sensor torque tube shaft via the shaft coupling and set screws, with the coupling centered as shown in figure 7.
2. Slide the access handle to the locked position to expose the access hole. Press on the back of the handle as shown in figure 2 then slide the handle toward the front of the unit. Be sure the locking handle drops into the detent.
3. Remove the hex nuts from the mounting studs.
4. Position the insulator on the digital level controller, sliding the insulator straight over the mounting studs.
5. Re-install the four hex nuts on the mounting studs and tighten the nuts.
6. Carefully slide the digital level controller with the attached insulator over the shaft coupling so that the access hole is on the bottom of the digital level controller.
7. Secure the digital level controller and insulator to the torque tube arm with four cap screws.
8. Tighten the cap screws to 10 N•m (88.5 lbf•in).

Coupling

If the digital level controller is not already coupled to the sensor, perform the following procedure to couple the digital level controller to the sensor.

1. Slide the access handle to the locked position to expose the access hole. Press on the back of the handle, as shown in figure 2, then slide the handle toward the front of the unit. Be sure the locking handle drops into the detent.
2. Set the displacer to the lowest possible process condition, (i.e. lowest water level or minimum specific gravity) or replace the displacer by the heaviest calibration weight.

Note

Interface or density applications with displacer/torque tube sized for a small total change in specific gravity are designed to be operated with the displacer always submerged. In these applications, the torque rod is sometimes resting on a stop while the displacer is dry. The torque tube does not begin to move until a considerable amount of liquid has covered the displacer. In this case, couple with the displacer submerged in the fluid with the lowest density and the highest process temperature condition, or with an equivalent condition simulated by the calculated weights.

If the sizing of the sensor results in a proportional band greater than 100% (total expected rotational span greater than 4.4 degrees), couple the transmitter to the pilot shaft while at the 50% process condition to make maximum use of available transmitter travel (±6°). The Capture Zero procedure is still performed at the zero buoyancy (or zero differential buoyancy) condition.

3. Insert a 10 mm deep well socket through the access hole and onto the torque tube shaft clamp nut. Tighten the clamp nut to a maximum torque of 2.1 N•m(18 lbf•in).
4. Slide the access handle to the unlocked position. (Press on the back of the handle as shown in figure 2 then slide the handle toward the rear of the unit.) Be sure the locking handle drops into the detent.

Electrical Connections

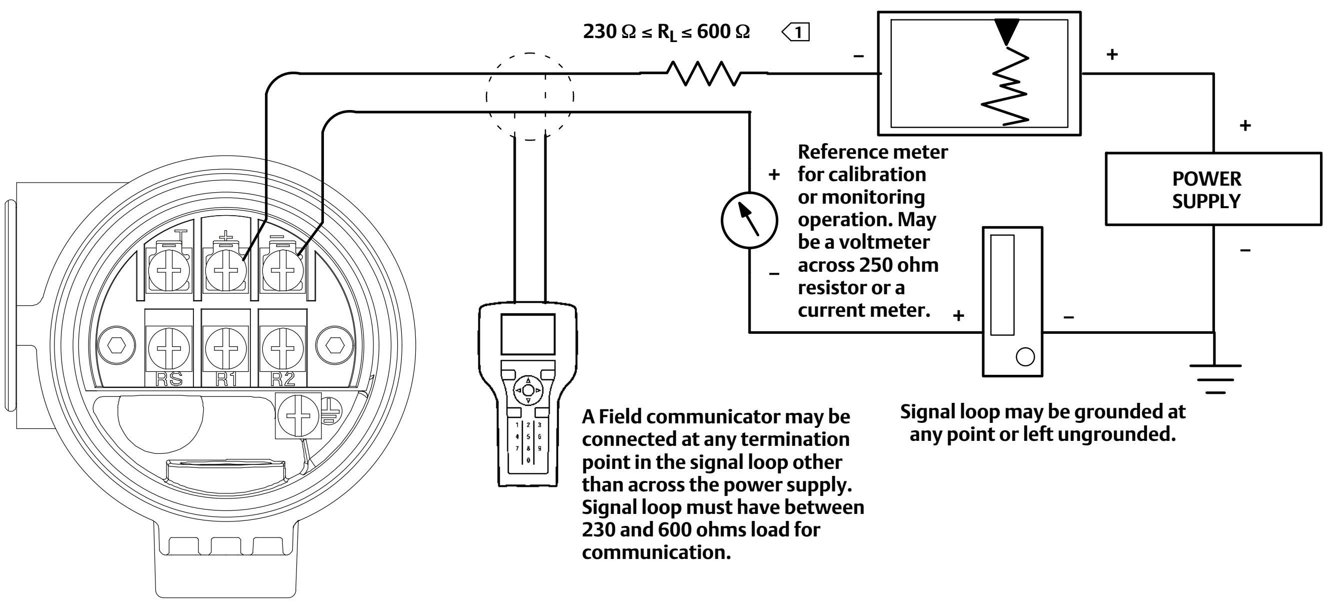
⚠ WARNING

Select wiring and/or cable glands that are rated for the environment of use (such as hazardous area, ingress protection and temperature). Failure to use properly rated wiring and/or cable glands can result in personal injury or property damage from fire or explosion.

Wiring connections must be in accordance with local, regional, and national codes for any given hazardous area approval. Failure to follow the local, regional, and national codes could result in personal injury or property damage from fire or explosion.

Proper electrical installation is necessary to prevent errors due to electrical noise. A resistance between 230 and 600 ohms must be present in the loop for communication with a Field Communicator. Refer to figure 9 for current loop connections.

Figure 9. Connecting a Field Communicator to the Digital Level Controller Loop



NOTE:
1 THIS REPRESENTS THE TOTAL SERIES LOOP RESISTANCE.
E0363

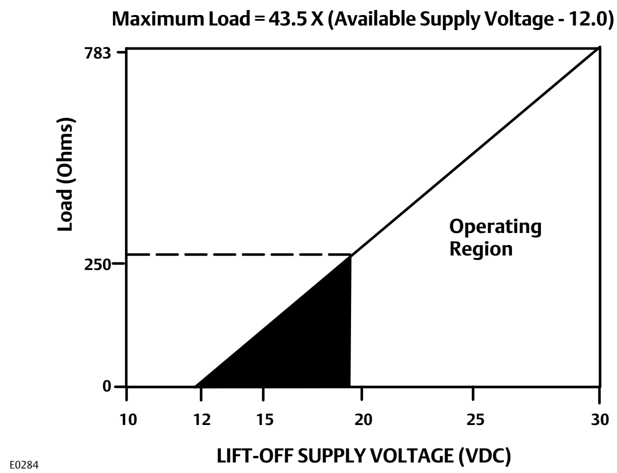
Power Supply

To communicate with the digital level controller, you need a 17.75 volt DC minimum power supply. The power supplied to the transmitter terminals is determined by the available supply voltage minus the product of the total loop resistance and the loop current. The available supply voltage should not drop below the lift-off voltage. (The lift-off voltage is the minimum “available supply voltage” required for a given total loop resistance). Refer to figure 10 to determine the required lift-off voltage. If you know your total loop resistance you can determine the lift-off voltage. If you know the available supply voltage, you can determine the maximum allowable loop resistance.

If the power supply voltage drops below the lift-off voltage while the transmitter is being configured, the transmitter may output incorrect information.

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

Figure 10. Power Supply Requirements and Load Resistance



Field Wiring

WARNING

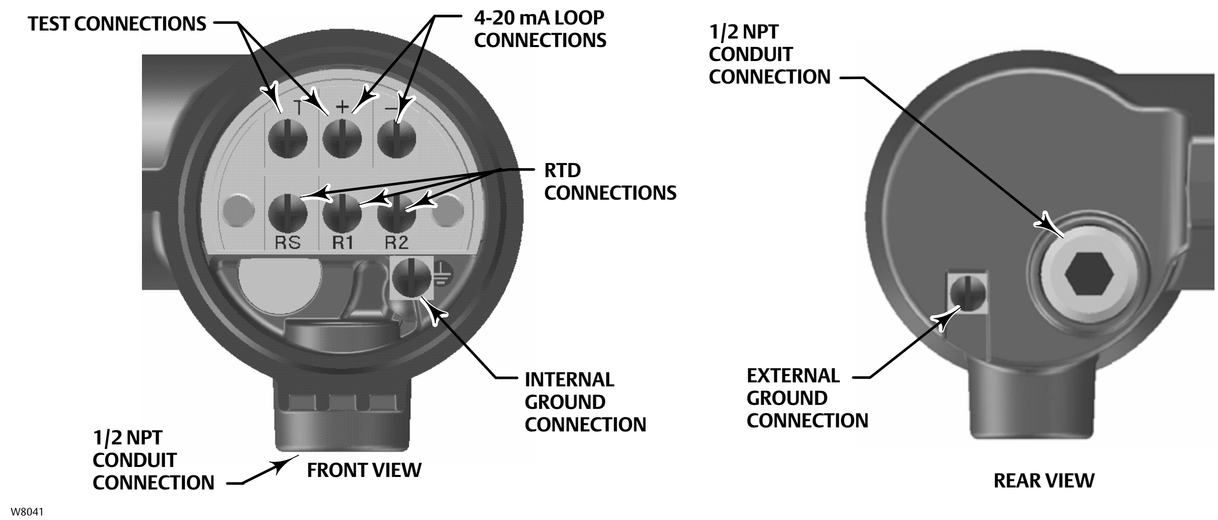
To avoid personal injury or property damage caused by fire or explosion, remove power to the instrument before removing the digital level controller cover in an area which contains a potentially explosive atmosphere or has been classified as hazardous.

Note

For intrinsically safe applications, refer to the instructions supplied by the barrier manufacturer.

All power to the digital level controller is supplied over the signal wiring. Signal wiring need not be shielded, but use twisted pairs for best results. Do not run unshielded signal wiring in conduit or open trays with power wiring, or near heavy electrical equipment. If the digital controller is in an explosive atmosphere, do not remove the digital level controller covers when the circuit is alive, unless in an intrinsically safe installation. Avoid contact with leads and terminals. To power the digital level controller, connect the positive power lead to the + terminal and the negative power lead to the - terminal as shown in figure 11.

Figure 11. Digital Level Controller Terminal Box



CAUTION

Do not apply loop power across the T and + terminals. This can destroy the 1 Ohm sense resistor in the terminal box. Do not apply loop power across the Rs and - terminals. This can destroy the 50 Ohm sense resistor in the electronics module.

When wiring to screw terminals, the use of crimped lugs is recommended. Tighten the terminal screws to ensure that good contact is made. No additional power wiring is required. All digital level controller covers must be fully engaged to meet explosion proof requirements. For ATEX approved units, the terminal box cover set screw must engage one of the recesses in the terminal box beneath the terminal box cover.

Grounding

⚠ WARNING

Personal injury or property damage can result from fire or explosion caused by the discharge of static electricity when flammable or hazardous gases are present. Connect a 14 AWG (2.1 mm^2) ground strap between the digital level controller and earth ground when flammable or hazardous gases are present. Refer to national and local codes and standards for grounding requirements.

The digital level controller will operate with the current signal loop either floating or grounded. However, the extra noise in floating systems affects many types of readout devices. If the signal appears noisy or erratic, grounding the current signal loop at a single point may solve the problem. The best place to ground the loop is at the negative terminal of the power supply. As an alternative, ground either side of the readout device. Do not ground the current signal loop at more than one point.

Shielded Wire

Recommended grounding techniques for shielded wire usually call for a single grounding point for the shield. You can either connect the shield at the power supply or to the grounding terminals, either internal or external, at the instrument terminal box shown in figure 11.

Power/Current Loop Connections

Use ordinary copper wire of sufficient size to ensure that the voltage across the digital level controller terminals does not go below 12.0 volts DC. Connect the current signal leads as shown in figure 9. After making connections, recheck the polarity and correctness of connections, then turn the power on.

RTD Connections

An RTD that senses process temperatures may be connected to the digital level controller. This permits the instrument to automatically make specific gravity corrections for temperature changes. For best results, locate the RTD as close to the displacer as practical. For optimum EMC performance, use shielded wire no longer than 3 meters (9.8 feet) to connect the RTD. Connect only one end of the shield. Connect the shield to either the internal ground connection in the instrument terminal box or to the RTD thermowell. Wire the RTD to the digital level controller as follows (refer to figure 11):

Two-Wire RTD Connections

1. Connect a jumper wire between the RS and R1 terminals in the terminal box.
2. Connect the RTD to the R1 and R2 terminals.

Note

During Manual Setup, you must specify the connecting wire resistance for a 2-wire RTD. 250 feet of 16 AWG wire has a resistance of 1 ohm.

Three-Wire RTD Connections

1. Connect the 2 wires which are connected to the same end of the RTD to the RS and R1 terminals in the terminal box. Usually these wires are the same color.
2. Connect the third wire to terminal R2. (The resistance measured between this wire and either wire connected to terminal RS or R1 should read an equivalent resistance for the existing ambient temperature. Refer to the RTD manufacturer's temperature to resistance conversion table.) Usually this wire is a different color from the wires connected to the RS and R1 terminals.

Communication Connections

⚠ WARNING

Personal injury or property damage caused by fire or explosion may occur if this connection is attempted in an area which contains a potentially explosive atmosphere or has been classified as hazardous. Confirm that area classification and atmosphere conditions permit the safe removal of the terminal box cap before proceeding.

The Field Communicator interfaces with the DLC3010 digital level controller from any wiring termination point in the 4–20 mA loop (except across the power supply). If you choose to connect the HART® communicating device directly to the instrument, attach the device to the loop + and - terminals inside the terminal box to provide local communications with the instrument.

Alarm Jumper

Each digital level controller continuously monitors its own performance during normal operation. This automatic diagnostic routine is a timed series of checks repeated continuously. If diagnostics detect a failure in the electronics, the instrument drives its output to either below 3.70 mA or above 22.5 mA, depending on the position (HI/LO) of the alarm jumper.

An alarm condition occurs when the digital level controller self-diagnostics detect an error that would render the process variable measurement inaccurate, incorrect, or undefined, or a user defined threshold is violated. At this point the analog output of the unit is driven to a defined level either above or below the nominal 4-20 mA range, based on the position of the alarm jumper.

On encapsulated electronics 14B5483X042 and earlier, if the jumper is missing, the alarm is indeterminate, but usually behaves as a FAIL LOW selection. On encapsulated electronics 14B5484X052 and later, the behavior will default to FAIL HIGH when the jumper is missing.

Alarm Jumper Locations

<u>Without a meter installed:</u>

The alarm jumper is located on the front side of the electronics module on the electronics side of the digital level controller housing, and is labeled FAIL MODE.

<u>With a meter installed:</u>

The alarm jumper is located on the LCD faceplate on the electronics module side of the digital level controller housing, and is labeled FAIL MODE.

Changing Jumper Position

⚠ WARNING

Personal injury or property damage caused by fire or explosion may occur if the following procedure is attempted in an area which contains a potentially explosive atmosphere or has been classified as hazardous. Confirm that area classification and atmosphere conditions permit the safe removal of the instrument cover before proceeding.

Use the following procedure to change the position of the alarm jumper:

1. If the digital level controller is installed, set the loop to manual.
2. Remove the housing cover on the electronics side. Do not remove the cover in explosive atmospheres when the circuit is alive.
3. Set the jumper to the desired position.
4. Replace the cover. All covers must be fully engaged to meet explosion proof requirements. For ATEX approved units, the set screw on the transducer housing must engage one of the recesses in the cover.

Accessing Configuration and Calibration Procedures

Procedures that require the use of the Field Communicator have the text path and the sequence of numeric keys required to display the desired Field Communicator menu.

For example, to access the *Full Calibration* menu:

Field Communicator	Configure > Calibration > Primary > Full Calibration (2-5-1-1)

Configuration and Calibration

Initial Setup

If a DLC3010 digital level controller ships from the factory mounted on a 249 sensor, initial setup and calibration is not necessary. The factory enters the sensor data, couples the instrument to the sensor, and calibrates the instrument and sensor combination.

Note

If you received the digital level controller mounted on the sensor with the displacer blocked, or if the displacer is not connected, the instrument will be coupled to the sensor and the lever assembly unlocked. To place the unit in service, if the displacer is blocked, remove the rod and block at each end of the displacer and check the instrument calibration. (If the “factory cal” option was ordered, the instrument will be precompensated to the process conditions provided on the requisition, and may not appear to be calibrated if checked against room temperature 0 and 100% water level inputs).

If the displacer is not connected, hang the displacer on the torque tube.

If you received the digital level controller mounted on the sensor and the displacer is not blocked (such as in skid mounted systems), the instrument will not be coupled to the sensor, and the lever assembly will be locked. Before placing the unit in service, couple the instrument to the sensor, then unlock the lever assembly.

When the sensor is properly connected and coupled to the digital level controller, establish the zero process condition and run the appropriate zero calibration procedure under Partial Calibration. The Torque Rate should not need to be re-calibrated.

To review the configuration data entered by the factory, connect the instrument to a 24 VDC power supply as shown in figure 9. Connect the Field Communicator to the instrument and turn it on. Go to *Configure* and review the data under Manual Setup, Alert Setup, and Communications. If your application data has changed since the instrument was factory-configured, refer to the Manual Setup section for instructions on modifying configuration data.

For instruments not mounted on a level sensor or when replacing an instrument, initial setup consists of entering sensor information. The next step is coupling the sensor to the digital level controller. When the digital level controller and sensor are coupled, the combination may be calibrated.

Sensor information includes displacer and torque tube information, such as:

- Length units (meters, inches, or centimeters)
- Volume units (cubic inches, cubic millimeters, or milliliters)

- Weight units (kilograms, pounds, or ounce)
- Displacer Length
- Displacer Volume
- Displacer Weight
- Displacer Driver Rod Length (moment arm) (see table 5)
- Torque Tube Material

Note
A sensor with an N05500 torque tube may have NiCu on the nameplate as the torque tube material.

- Instrument mounting (right or left of displacer)
- Measurement Application (level, interface, or density)

Configuration Advice

Guided Setup directs you through initialization of configuration data needed for proper operation. When the instrument comes out of the box, the default dimensions are set for the most common Fisher 249 construction, so if any data is unknown, it is generally safe to accept the defaults. The mounting sense 'instrument left or right of displacer' - is important for correct interpretation of positive motion. The torque tube rotation is clockwise with rising level when the instrument is mounted to the right of the displacer, and counterclockwise when mounted to the left of the displacer. Use Manual Setup to locate and modify individual parameters when they need to be changed.

Preliminary Considerations

Write Lock

Field Communicator	Overview > Device Information > Alarm Type and Security > Security > Write Lock (1-7-3-2-1)

To setup and calibrate the instrument, write lock must be set to *Writes Enabled*. Write Lock is reset by a power cycle. If you have just powered up the instrument Writes will be enabled by default.

Guided Setup

Field Communicator	Configure > Guided Setup > Instrument Setup (2-1-1)

Note

Place the loop into manual operation before making any changes in setup or calibration.

Instrument Setup is available to aid initial setup. Follow the prompts on the Field Communicator display to enter information for the displacer, torque tube, and digital measurement units. Most of the information is available from the sensor nameplate. The moment arm is the effective length of the displacer (driver) rod length, and depends upon the sensor type. For a 249 sensor, refer to table 5 to determine displacer rod length. For a special sensor, refer to figure 12.

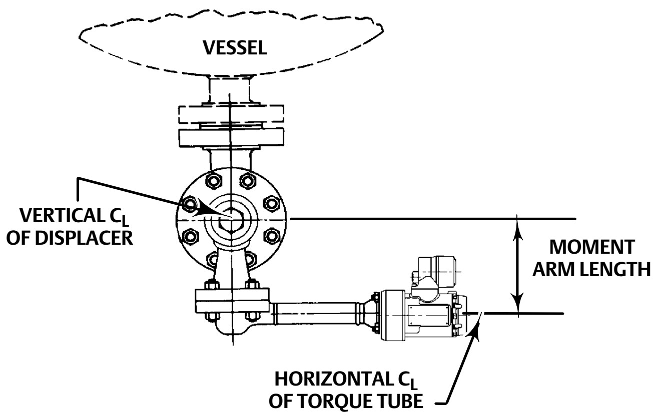
Table 5. Moment Arm (Driver Rod) Length(1)

SENSOR TYPE(2)	MOMENT ARM	
	mm	Inch
249	203	8.01
249B	203	8.01
249BF	203	8.01
249BP	203	8.01
249C	169	6.64
249CP	169	6.64
249K	267	10.5
249L	229	9.01
249N	267	10.5
249P (CL125-CL600)	203	8.01
249P (CL900-CL2500)	229	9.01
249VS (Special)(1)	See serial card	See serial card
249VS (Std)	343	13.5
249W	203	8.01

1. Moment arm (driver rod) length is the perpendicular distance between the vertical centerline of the displacer and the horizontal centerline of the torque tube. See figure 12. If you cannot determine the driver rod length, contact your Emerson sales office and provide the serial number of the sensor.
2. This table applies to sensors with vertical displacers only. For sensor types not listed, or sensors with horizontal displacers, contact your Emerson sales office for the driver rod length. For other manufacturers' sensors, see the installation instructions for that mounting.

1. Enter displacer length, weight, and volume units and values, and driver rod (moment arm) length (in the same units chosen for displacer length) when prompted.
2. Choose Instrument Mounting (left or right of displacer, refer to figure 5).
3. Choose Torque Tube Material.

Figure 12. Method of Determining Moment Arm from External Measurements



4. Select the measurement application (level, interface, or density).

Note

For interface applications, if the 249 is not installed on a vessel, or if the cage can be isolated, calibrate the instrument with weights, water, or other standard test fluid, in level mode. After calibrating in level mode, the instrument can be switched to interface mode. Then, enter the actual process fluid specific gravity(s) and range values.

If the 249 sensor is installed and must be calibrated in the actual process fluid(s) at operating conditions, enter the final measurement mode and actual process fluid data now.

a. If you choose “Level” or “Interface,” the default process variable units are set to the same units chosen for displacer length. You are prompted to key in the level offset. Range values will be initialized based on Level Offset and displacer size. The default upper range value is set to equal the displacer length and the default lower range value is set to zero when the level offset is 0.

b. If you choose “Density,” the default process variable units are set to “SGU” (Specific Gravity Units). The default upper range value is set to “1.0” and the default lower range value is set to “0.1”.

5. Select the desired output action: Direct or Reverse.

Choosing “reverse acting” will swap the default values of the upper and lower range values (the process variable values at 20 mA and 4 mA). In a reverse acting instrument, the loop current will decrease as the fluid level increases.

6. You are given the opportunity to modify the default value for the process variable engineering units.
7. You are then given the opportunity to edit the default values that were entered for the upper range value (PV Value at 20 mA) and lower range value (PV Value at 4 mA).

8. The default values of the alarm variables will be set as follows:

Direct-Acting Instrument (Span = Upper Range Value - Lower Range Value	
Alarm Variable	Default Alarm Value
Hi-Hi Alarm	Upper Range Value
Hi Alarm	95% span + Lower Range Value
Lo Alarm	5% span + Lower Range Value
Lo-Lo Alarm	Lower Range Value

Reverse-Acting Instrument (Span = Lower Range Value - Upper Range Value	
Alarm Variable	Default Alarm Value
Hi-Hi Alarm	Lower Range Value
Hi Alarm	95% span + Upper Range Value
Lo Alarm	5% span + Upper Range Value
Lo-Lo Alarm	Upper Range Value

PV alert thresholds are initialized at 100%, 95%, 5% and 0% span.

PV alert deadband is initialized to 0.5% span.

PV alerts are all disabled. Temperature alerts are enabled.

- If Density mode was chosen, setup is complete.
- If Interface or Density mode was chosen, you are prompted to enter the specific gravity of the process fluid (if interface mode, the specific gravities of the upper and lower process fluids).

Note

If you are using water or weights for calibration, enter a specific gravity of 1.0 SGU. For other test fluids, enter the specific gravity of the fluid used.

For temperature compensation, go to *Manual Setup*. Under *Process Fluid* select *View Fluid Tables*. Temperature compensation is enabled by entering values into the fluid tables.

Two data specific gravity tables are available that may be entered in the instrument to provide specific gravity correction for temperature (refer to the Manual Setup section of the instruction manual). For interface level applications, both tables are used. For level measurement applications, only the lower specific gravity table is used. Neither table is used for density applications. Both tables may be edited during manual setup.

Note

The existing tables may need to be edited to reflect the characteristics of the actual process fluid.

You can accept the current table(s), modify an individual entry, or enter a new table manually. For an interface application, you can switch between the upper and lower fluid tables.

Calibration

Guided Calibration

Field Communicator	Configure > Calibration > Primary > Guided Calibration (2-5-1-1)

Guided Calibration recommends an appropriate calibration procedures for use in the field or on the bench based on your input. Answer questions about your process scenario to reach the calibration recommendation. When feasible, the appropriate calibration method will be initiated from within the procedure.

Detailed Calibration Examples

PV Sensor Calibration

If the advanced capabilities of the transmitter are to be used, it is necessary to calibrate the PV sensor.

Calibration—with Standard Displacer and Torque Tube

Run the initial calibration near ambient temperature at design span to take full advantage of the available resolution. This is accomplished by using a test fluid with a specific gravity (SG) close to 1. The value of SG in the instrument memory during the calibration process should match the SG of the test fluid being used in the calibration. After the initial calibration, the instrument may be set up for a target fluid with a given specific gravity, or an interface application, by simple configuration data changes.

1. Run through Guided Setup and verify that all sensor data is correct.
   Procedure:
   Change the PV mode to Level
   If your input observations are going to be made with respect to location of the bottom of the displacer at the lowest process condition, set the Level Offset value to 0.00
   Set the Specific Gravity value to the SG of the test fluid being used.

Establish the test fluid level at the desired process zero point. Make sure that the DLC3010 lever assembly has been properly coupled to the torque tube (see coupling procedure on page 12). To unlock the lever assembly and allow it to freely follow the input, close the coupling access door on the instrument. It is often possible to watch the instrument display and/or the analog output to detect when the fluid hits the displacer, because the output will not start moving upward until that point is reached.

Select the Min/Max calibration from the Full Calibration menu, and confirm that you are at the 'Min' condition at the prompt. After the 'Min' point has been accepted, you will be prompted to establish the 'Max' condition. (The 'displacer completely covered' condition should be slightly higher than the 100% level mark to work correctly. For example, 15 inches above the zero mark would generally be enough for a 14 inch displacer on a 249B, because the amount of displacer rise expected for that configuration is about 0.6 inch.)

Accept this as the 'Max' condition. Adjust the test fluid level and check the instrument display and current output against external level at several points distributed across the span to verify the level calibration.

a. To correct bias errors, 'Trim Zero' at a precisely known process condition.

b. To correct gain errors, 'Trim Gain' at a precisely-known high level condition.

Note

If you are able to precisely observe individual input states, the Two-Point calibration may be used instead of Min/Max.

If you are unable to complete the Min/Max or Two Point Calibration, set the lowest process condition and Capture Zero. Run Trim Gain at a process level of minimum 5% above the Lower Range Value.

If the measured output doesn't come off the low saturation value until the level is considerably above the bottom of the displacer, it is possible that the displacer is overweight. An overweight displacer will rest on the lower travel stop until sufficient buoyancy has developed to allow the linkage to move. In that case, use the calibration procedure for overweight displacers below.

After the initial calibration:

For a level application— Go to the Sensor Compensation menu and use 'Enter constant SG' to configure the instrument for the target process fluid density.

For an interface application— Change the PV mode to Interface, verify or adjust the range values presented by the Change PV mode procedure, and then use 'Enter constant SG' to configure the instrument for the SGs of each of the target process fluids.

For a density application— Change the PV mode to Density, and establish the desired range values in the 'Change PV mode' procedure.

If the target application temperature is considerably elevated or depressed from ambient, refer to the DLC3010 Instruction Manual (D102748X012) for information on temperature compensation.

Note

Information on computing precise simulation of this effect is available in the Simulation of Process Conditions for Calibration of Fisher Level Controllers and Transmitters instruction manual supplement (D103066X012), available from your Emerson sales office or Local Business Partner, or at www.fisher.com.

Calibration with an Overweight Displacer

When the sensor hardware is sized for greater mechanical gain (as it is in some interface or density measurement applications), the dry displacer weight is often greater than the maximum permissible load on the torque tube. In this situation it is impossible to 'capture' the zero buoyancy rotation of the torque tube, because the linkage is lying on a travel stop at that condition.

The 'Capture Zero' routine in the Partial Calibration menu group will therefore not function correctly in the target PV modes of interface or density when the displacer is overweight.

The Full Calibration routines: Min/Max, Two-Point, and Weight, will all work correctly at the actual process conditions when in interface or density mode, because they back-compute the theoretical zero-buoyancy angle instead of capturing it.

If it is necessary to use the Partial Calibration methods when the displacer is overweight, the following transformation may be used:

An interface or density application can be mathematically represented as a level application with a single fluid whose density is equal to the difference between the actual SGs of the fluid covering the displacer at the two process extremes.

The calibration process flows as follows:

- Change the PV mode to Level.
- Set the Level Offset to zero.
- Set the Range Values to:
  LRV = 0.0,
  URV = displacer length.
- Capture Zero at the lowest process condition (that is, with the displacer completely submerged in the fluid of the lowest density - NOT dry).
- Set Specific Gravity to the difference between the SGs of the two fluids (for example, if SG_upper = 0.87 and SG_lower = 1.0, enter a specific gravity value of 0.13).
- Set up a second process condition more than 5% of span above the minimum process condition, and use the Trim Gain procedure at that condition. The gain will now be initialized correctly. (The instrument would work fine in this configuration for an interface application. However, if you have a density application, it won't be possible to report the PV correctly in engineering units if the instrument calibration is concluded at this point.)

Since you now have a valid gain:

- Change the PV mode to Interface or Density,
- reconfigure the fluid SGs or range values to the actual fluid values or extremes, and
- use the Trim Zero procedure in the Partial Calibration menu to back-compute the theoretical zero-buoyancy angle.

The last step above will align the value of the PV in engineering units to the independent observation.

Note

Information on simulating process conditions is available in the Simulation of Process Conditions for Calibration of Fisher Level Controllers and Transmitters instruction manual supplement (D103066X012), available from your Emerson sales office or Local Business Partner, or at www.fisher.com

Following are some guidelines on the use of the various sensor calibration methods when the application uses an overweight displacer:

Weight-based: Use two accurately known weights between minimum and maximum buoyancy conditions. The full displacer weight is invalid because it will put the linkage on a stop.

Min/Max: Min now means submerged in the lightest fluid and Max means submerged in the heaviest fluid.

Two point: Use any two interface levels that actually fall on the displacer. Accuracy is better if the levels are farther apart. The result should be close if you can move the level even 10%.

Theoretical: If the level cannot be changed at all, you can enter a theoretical value for torque tube rate manually then Trim Zero to adjust the output to the current independent observation of the process condition. Gain and bias errors will exist with this approach, but it can provide nominal control capability. Keep records of subsequent observations of actual process versus instrument output and different conditions and use the ratios between the process and instrument changes to scale the torque rate value. Repeat Zero Trim after each gain change.

Density Applications - with Standard Displacer and Torque Tube

Note

When you change 'PV is' from level or interface to density, the range values will be initialized to 0.1 and 1.0 SGU. You may edit the range values and density units after that initialization. The initialization is performed to clear out irrelevant numerical values from length dimensions that cannot be reasonably converted to density dimensions.

Any of the full sensor calibration methods (Min/Max, Two Point, and Weight) can be used in density mode.

Min/Max: The Min/Max Calibration first asks for the SG of the minimum density test fluid (which could be zero if the displacer is not overweight). Then, it has you set up a completely submerged displacer condition with that fluid. Next it asks for the SG of your maximum density test fluid and directs you to completely submerge the displacer in that fluid. If successful, the computed torque rate and zero reference angle are displayed for reference.

Two Point: The Two Point Calibration requires you to set up two different process conditions with as much difference as possible. You could use two standard fluids with well-known density and alternately submerge the displacer in one or the other. If you are going to try to simulate a fluid by using a certain amount of water, remember that the amount of displacer covered by the water is what counts, not the amount in the cage. The amount in the cage will always need to be slightly more because of the displacer motion. If successful, the computed torque rate and zero reference angle are displayed for reference.

Weight Based: The Weight Calibration asks you for the lowest and highest density you want to use for the calibration points, and computes weight values for you. If you can't come up with the exact values asked for, you are allowed to edit the values to tell it what weights you actually used. If successful, the computed torque rate and zero reference angle are displayed for reference.

Sensor Calibration at Process Conditions (Hot Cut-Over) when input cannot be varied

If the input to the sensor cannot be varied for calibration, you can configure the instrument gain using theoretical information and use Trim Zero to trim the output to the current process condition. This allows you to make the controller operational and to control a level around a setpoint. You can then use comparisons of input changes to output changes over time to refine the gain estimate. A new trim zero will be required after each gain adjustment. This approach is not recommended for a safety-related application, where exact knowledge of the level is important to prevent an overflow or dry sump condition. However, it should be more than adequate for the average level-control application that can tolerate large excursions from a midspan set point.

Two Point Calibration allows you to calibrate the torque tube using two input conditions that put the measured interface anywhere on the displacer. The accuracy of the method increases as the two points are moved farther apart, but if the level can be adjusted up or down a minimum 5% span, it is enough to make a calculation. Most level processes can accept a small, manual adjustment of this nature. If your process cannot, then the theoretical approach is the only method available.

1. Determine all the information you can about the 249 hardware: 249 type, mounting sense (controller to the right or left of displacer), torque tube material and wall thickness, displacer volume, weight, length, and driver rod length. (the driver rod length is not the suspension rod length, but the horizontal distance between the centerline of the displacer and the centerline of the torque tube). Also obtain process information: fluid densities, process temperature, and pressure. (The pressure is used as a reminder to consider the density of an upper vapor phase, which can become significant at higher pressures.)
2. Run Instrument Setup and enter the various data that is requested as accurately as possible. Set the *Range Values* (LRV, URV) to the PV values where you will want to see 4 mA and 20 mA output, respectively. These might be 0 and 14 inches on a 14 inch displacer.
3. Mount and couple at the current process condition. Do not run the Capture Zero procedure, because it will not be accurate.
4. With the torque tube type and material information, find a theoretical value for the composite or effective torque-tube rate, (refer to the Simulation of Process Conditions for Calibration of Fisher Level Controllers and Transmitters supplement for information on theoretic torque tube rates), and enter it in the instrument memory. The value can be accessed by selecting:
   Configure > Manual Setup > Sensor > Torque Tube > Change Torque Rate (2-2-1-3-2).
   If you select the 'Need Assistance' option instead of the 'Edit value directly' approach, the procedure can look up values for commonly available torque tubes.
5. If the process temperature departs significantly from room temperature, use a correction factor interpolated from tables of theoretical normalized modulus of rigidity. Multiply the theoretical rate by the correction factor before entering the data. You should now have the gain correct to within perhaps 10%, at least for the standard wall, short length torque tubes. (For the longer torque tubes [249K, L, N] with thin-wall and a heat insulator extension, the theoretical values are much less accurate, as the mechanical path departs considerably from the linear theory.)

Note

Tables containing information on temperature effects on torque tubes can be found in the Simulation of Process Conditions for Calibration of Fisher Level Controllers and Transmitters instruction manual supplement (D103066X012), available from your Emerson sales office or Local Business Partner, or at www.fisher.com. This document is also available in the device help files linked to some host applications with graphical user interfaces.

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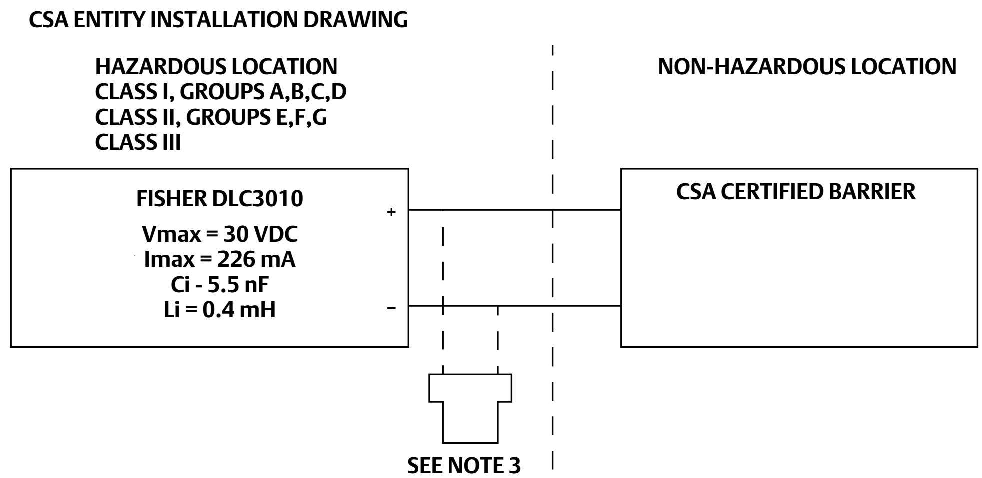
6. Using a sight glass or sampling ports, obtain an estimate of the current process condition. Run the Trim Zero calibration and report the value of the actual process in the PV engineering units.
7. You should now be able to go to automatic control. If observations over time show the instrument output exhibits, for example,1.2 times as much excursion as the sight glass input, you could divide the stored torque tube rate by 1.2 and send the new value to the instrument. Then run another Trim Zero calibration and observe results for another extended period to see if further iteration is required.

Schematics

This section includes loop schematics required for wiring of intrinsically safe installations. If you have any questions, contact your Emerson sales office or Local Business Partner.

Figure 13. CSA Loop Schematic



NOTES:

1. **BARRIERS MUST BE CSA CERTIFIED WITH ENTITY PARAMETERS AND ARE TO BE INSTALLED IN ACCORDANCE WITH THE MANUFACTURERS I.S. INSTALLATION INSTRUCTIONS.**
2. **EQUIPMENT SHALL BE INSTALLED IN ACCORDANCE WITH THE CANADIAN ELECTRICAL CODE, PART 1.**
3. **IF HAND-HELD COMMUNICATOR OR MULTIPLEXER IS USED, IT MUST BE CSA CERTIFIED AND INSTALLED PER THE MANUFACTURE'S CONTROL DRAWING.**
4. **FOR ENTITY INSTALLATION: Vmax > Voc, Imax > Isc**
   Ci + Ccable < Ca, Li + Lcable < La

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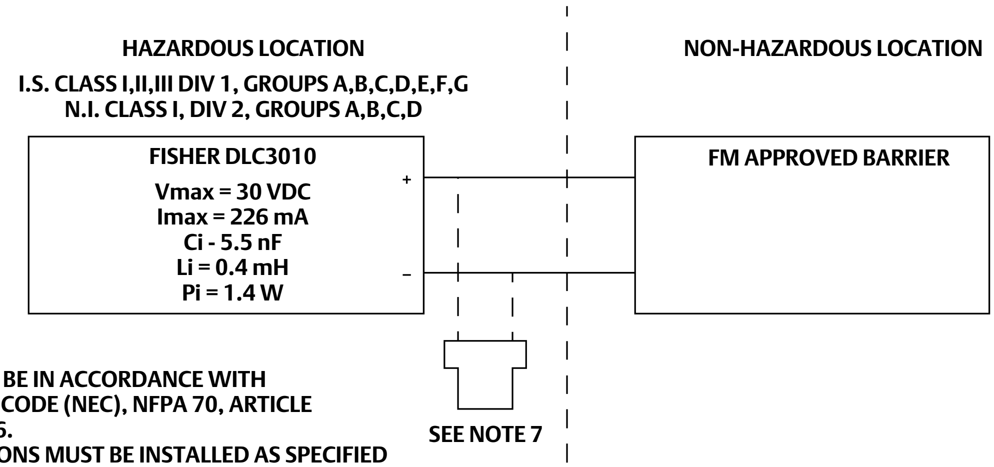
Figure 14. FM Loop Schematic



1. THE INSTALLATION MUST BE IN ACCORDANCE WITH THE NATIONAL ELECTRIC CODE (NEC), NFPA 70, ARTICLE 504 AND ANSI/ISA RP12.6.
2. CLASS 1, DIV 2 APPLICATIONS MUST BE INSTALLED AS SPECIFIED IN NEC ARTICLE 501-4(B). EQUIPMENT AND FIELD WIRING IS NON-INCENDIVE WHEN CONNECTED TO APPROVED BARRIERS WITH ENTITY PARAMETERS.
3. LOOPS MUST BE CONNECTED ACCORDING TO THE BARRIER MANUFACTURERS INSTRUCTIONS.
4. MAXIMUM SAFE AREA VOLTAGE SHOULD NOT EXCEED 250 Vrms.
5. RESISTANCE BETWEEN BARRIER GROUND AND EARTH GROUND MUST BE LESS THAN ONE OHM.
6. NORMAL OPERATING CONDITIONS 30 VDC 20 mADC.
7. IF HAND-HELD COMMUNICATOR OR MULTIPLEXER IS USED, IT MUST BE FM APPROVED AND INSTALLED PER THE MANUFACTURE'S CONTROL DRAWING.
8. FOR ENTITY INSTALLATION (I.S. AND N.I.);
   Vmax > Voc, or Vt   Ci + Ccable < Ca
   Imax > Isc, or It   Li + Lcable < La
   Pi > Po, or Pt
9. THE APPARATUS ENCLOSURE CONTAINS ALUMINUM AND IS CONSIDERED TO CONSTITUTE A POTENTIAL RISK OF IGNITION BY IMPACT OR FRICTION. AVOID IMPACT AND FRICTION DURING INSTALLATION AND USE TO PREVENT RISK OF IGNITION.

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Specifications

Specifications for DLC3010 digital level controllers are shown in table 6. Specifications for 249 sensors are shown in table 8.

Table 6. DLC3010 Digital Level Controller Specifications

Available Configurations

Mounts on caged and cageless 249 sensors. See tables 11 and 12 and sensor description.

Function: Transmitter

Communications Protocol: HART

Input Signal

Level, Interface, or Density: Rotary motion of torque tube shaft proportional to changes in liquid level, interface level, or density that change the buoyancy of a displacer.

Process Temperature: Interface for 2- or 3-wire 100 ohm platinum RTD for sensing process temperature, or optional user-entered target temperature to permit compensating for changes in specific gravity

Output Signal

Analog: 4 to 20 milliamperes DC (■ direct action—increasing level, interface, or density increases output; or ■ reverse action—increasing level, interface, or density decreases output)

High saturation: 20.5 mA
Low saturation: 3.8 mA
High alarm: 22.5 mA
Low Alarm: 3.7 mA

Only one of the above high/low alarm definitions is available in a given configuration. NAMUR NE 43 compliant when high alarm level is selected.

Digital: HART 1200 Baud FSK (frequency shift keyed)

HART impedance requirements must be met to enable communication. Total shunt impedance across the master device connections (excluding the master and transmitter impedance) must be between 230 and 600 ohms. The transmitter HART receive impedance is defined as:
Rx: 42K ohms and
Cx: 14 nF

Note that in point-to-point configuration, analog and digital signalling are available. The instrument may be queried digitally for information, or placed in Burst mode to regularly transmit unsolicited process information digitally. In multi-drop mode, the output current is fixed at 4 mA, and only digital communication is available.

Performance

Performance Criteria	DLC3010 Digital Level Controller(1)	w/ NPS 3 249W, Using a 14-inch Displacer	w/ All Other 249 Sensors
Independent Linearity	±0.25% of output span	±0.8% of output span	±0.5% of output span
Hysteresis	<0.2% of output span	- - -	- - -
Repeatability	±0.1% of full scale output	±0.5% of output span	±0.3% of output span
Dead Band	<0.05% of input span	- - -	- - -
Hysteresis plus Deadband	- - -	<1.0% of output span	<1.0% of output span

NOTE: At full design span, reference conditions.
1. To lever assembly rotation inputs.

At effective proportional band (PB)<100%, linearity, dead band, repeatability, power supply effect, and ambient temperature influence are potentially derated by the factor (100%/PB)

Operating Influences

Power Supply Effect: Output changes <±0.2% of full scale when supply varies between minimum and maximum voltage specifications.

Transient Voltage Protection: The loop terminals are protected by a transient voltage suppressor. The specifications are as follows:

Pulse Waveform		Max V_{CL} (Clamping Voltage) (V)	Max I_{PP} (Pulse Peak @ Current) (A)
Rise Time (μs)	Decay to 50% (μs)		
10	1000	93.6	16
8	20	121	83

Note: μs = microsecond

Ambient Temperature: The combined temperature effect on zero and span without the 249 sensor is less than 0.03% of full scale per degree Kelvin over the operating range -40 to 80°C (-40 to 176°F)

Process Temperature: The torque rate is affected by the process temperature. The process density may also be affected by the process temperature.

Process Density: The sensitivity to error in knowledge of process density is proportional to the differential density of the calibration. If the differential specific gravity is 0.2, an error of 0.02 specific gravity units in knowledge of a process fluid density represents 10% of span.

-continued-

Table 6. DLC3010 Digital Level Controller Specifications (continued)

Electromagnetic Compatibility

Meets EN 61326-1:2013 and EN 61326-2-3:2006
Immunity—Industrial locations per Table 2 of EN 61326-1 and Table AA.2 of EN 61326-2-3. Performance is shown in table 7 below.
Emissions—Class A
ISM equipment rating: Group 1, Class A

Supply Requirements (See figure 10)

12 to 30 volts DC ⎓ ; 22.5 mA
Instrument has reverse polarity protection.

A minimum compliance voltage of 17.75 is required to guarantee HART communication.

Compensation

Transducer compensation: for ambient temperature
Density parameter compensation: for process temperature (requires user-supplied tables)
Manual compensation: for torque tube rate at target process temperature is possible

Digital Monitors

Linked to jumper-selected Hi (factory default) or Lo analog alarm signal:
Torque tube position transducer: Drive monitor and signal reasonableness monitor
User-configurable alarms: Hi-Hi and Lo-Lo Limit process alarms

HART-readable only:
RTD signal reasonableness monitor: When RTD installed
Processor free-time monitor.
Writes-remaining in Non Volatile Memory monitor.
User-configurable alarms: Hi and Lo limit process alarms, Hi and Lo limit process temperature alarms, and Hi and Lo limit electronics temperature alarms

Diagnostics

Output loop current diagnostic.
LCD meter diagnostic.
Spot specific gravity measurement in level mode: used to update specific gravity parameter to improve process measurement
Digital signal-tracing capability: by review of “troubleshooting variables”, and
Basic trending capability for PV, TV and SV.

LCD Meter Indications

LCD meter indicates analog output on a percent scale bar graph. The meter also can be configured to display:

Process variable in engineering units only.
Percent range only.
Percent range alternating with process variable or
Process variable, alternating with process temperature (and degrees of pilot shaft rotation).

Electrical Classification

Pollution Degree IV, Overvoltage Category II per IEC 61010 clause 5.4.2 d

Hazardous Area:

CSA— Intrinsically Safe, Explosion-proof, Division 2, Dust Ignition-proof

FM— Intrinsically Safe, Explosion-proof, Non-incendive, Dust Ignition-proof

ATEX— Intrinsically Safe, Type n, Flameproof

IECEx— Intrinsically Safe, Type n, Flameproof

Refer to Hazardous Area Approvals and Special Instructions for “Safe Use” and Installations in Hazardous Locations in the Installation section, starting on page 5, for additional approvals information.

Electrical Housing:

CSA— Type 4X

FM— NEMA 4X

ATEX— IP66

IECEx— IP66

Other Classifications/Certifications

CUTR— Customs Union Technical Regulations (Russia, Kazakhstan, Belarus, and Armenia)

INMETRO— National Institute of Metrology, Standardization, and Industrial Quality (Brazil)

KGS— Korea Gas Safety Corporation (South Korea)

NEPSI— National Supervision and Inspection Centre for Explosion Protection and Safety of Instrumentation (China)

PESO CCOE— Petroleum and Explosives Safety Organisation - Chief Controller of Explosives (India)

TIIS— Technology Institution of Industrial Safety (Japan)

Contact your Emerson sales office or Local Business Partner for classification/certification specific information

-continued-

Table 6. DLC3010 Digital Level Controller Specifications (continued)

Minimum Differential Specific Gravity

With a nominal 4.4 degrees torque tube shaft rotation for a 0 to 100 percent change in liquid level (specific gravity=1), the digital level controller can be adjusted to provide full output for an input range of 5% of nominal input span. This equates to a minimum differential specific gravity of 0.05 with standard volume displacers.

See 249 sensor specifications for standard displacer volumes and standard wall torque tubes. Standard volume for 249C and 249CP is ~980 cm^3 (60 in^3), most others have standard volume of ~1640 cm^3 (100 in^3).

Operating at 5% proportional band will degrade accuracy by a factor of 20. Using a thin wall torque tube, or doubling the displacer volume will each roughly double the effective proportional band. When proportional band of the system drops below 50%, changing displacer or torque tube should be considered if high accuracy is a requirement.

Mounting Positions

Digital level controllers can be mounted right- or left-of-displacer, as shown in figure 5.

Instrument orientation is normally with the coupling access door at the bottom, to provide proper drainage of lever chamber and terminal compartment, and to limit gravitational effect on the lever assembly. If alternate drainage is provided by user, and a small performance loss is acceptable, the instrument could be mounted in 90 degree rotational increments around the pilot shaft axis. The LCD meter may be rotated in 90 degree increments to accommodate this.

Construction Materials

Case and Cover: Low-copper aluminum alloy
Internal: Plated steel, aluminum, and stainless steel; encapsulated printed wiring boards; Neodymium Iron Boron Magnets

Electrical Connections

Two 1/2-14 NPT internal conduit connections; one on bottom and one on back of terminal box. M20 adapters available.

Options

■ Heat insulator ■ Mountings for Masoneilan™, Yamatake and Foxboro™/Eckhardt displacers available ■ Level Signature Series Test (Performance Validation Report) available (EMA only) for instruments factory-mounted on 249 sensor
■ Factory Calibration: available for instruments factory-mounted on 249 sensor, when application, process temperature and density(s) are supplied
■ Device is compatible with user-specified remote indicator

Operating Limits

Process Temperature: See table 9 and figure 8
Ambient Temperature and Humidity: See below

Conditions	Normal Limits[1,2]	Transport and Storage Limits	Nominal Reference
Ambient Temperature	-40 to 80°C (-40 to 176°F)	-40 to 85°C (-40 to 185°F)	25°C (77°F)
Ambient Relative Humidity	0 to 95%, (non-condensing)	0 to 95%, (non-condensing)	40%

Altitude Rating
Up to 2000 meters (6562 feet)

Weight

Less than 2.7 Kg (6 lb)

NOTE: Specialized instrument terms are defined in ANSI/ISA Standard 51.1 - Process Instrument Terminology.
1. LCD meter may not be readable below -20°C (-4°F)
2. Contact your Emerson sales office or application engineer if temperatures exceeding these limits are required.

Table 7. EMC Summary Results—Immunity

Port	Phenomenon	Basic Standard	Test Level	Performance Criteria(1)(2)
Enclosure	Electrostatic discharge (ESD)	IEC 61000-4-2	4 kV contact 8 kV air	A
	Radiated EM field	IEC 61000-4-3	80 to 1000 MHz @ 10V/m with 1 kHz AM at 80% 1400 to 2000 MHz @ 3V/m with 1 kHz AM at 80% 2000 to 2700 MHz @ 1V/m with 1 kHz AM at 80%	A
	Rated power frequency magnetic field	IEC 61000-4-8	60 A/m at 50 Hz	A
I/O signal/control	Burst	IEC 61000-4-4	1 kV	A
	Surge	IEC 61000-4-5	1 kV (line to ground only, each)	B
	Conducted RF	IEC 61000-4-6	150 kHz to 80 MHz at 3 Vrms	A

Note: RTD wiring must be shorter than 3 meters (9.8 feet)
1. A = No degradation during testing. B = Temporary degradation during testing, but is self-recovering. Specification limit = +/- 1% of span.
2. HART communication was considered as "not relevant to the process" and is used primarily for configuration, calibration, and diagnostic purposes.

Table 8. 249 Sensor Specifications

Input Signal

Liquid Level or Liquid-to-Liquid Interface Level: From 0 to 100 percent of displacer length
Liquid Density: From 0 to 100 percent of displacement force change obtained with given displacer volume—standard volumes are ■ 980 cm^3 (60 $inches^3$) for 249C and 249CP sensors or ■ 1640 cm^3 (100 $inches^3$) for most other sensors; other volumes available depending upon sensor construction

Sensor Displacer Lengths

See tables 11 and 12 footnotes

Sensor Working Pressures

Consistent with applicable ANSI pressure/temperature ratings for the specific sensor constructions shown in tables 11 and 12

Caged Sensor Connection Styles

Cages can be furnished in a variety of end connection styles to facilitate mounting on vessels; the equalizing connection styles are numbered and are shown in figure 15.

Mounting Positions

Most level sensors with cage displacers have a rotatable head. The head may be rotated through 360 degrees to any of eight different positions, as shown in figure 5.

Construction Materials

See tables 10, 11, and 12

Operative Ambient Temperature

See table 9
For ambient temperature ranges, guidelines, and use of optional heat insulator, see figure 8.

Options

■ Heat insulator ■ Gauge glass for pressures to 29 bar at 232°C (420 psig at 450°F), and ■ Reflex gauges for high temperature and pressure applications

Table 9. Allowable Process Temperatures for Common 249 Sensor Pressure Boundary Materials

MATERIAL	PROCESS TEMPERATURE	
	Min.	Max.
Cast Iron	-29°C (-20°F)	232°C (450°F)
Steel	-29°C (-20°F)	427°C (800°F)
Stainless Steel	-198°C (-325°F)	427°C (800°F)
N04400	-198°C (-325°F)	427°C (800°F)
Graphite Laminate/SST Gaskets	-198°C (-325°F)	427°C (800°F)
N04400/PTFE Gaskets	-73°C (-100°F)	204°C (400°F)

Table 10. Displacer and Torque Tube Materials

Part	Standard Material	Other Materials
Displacer	304 Stainless Steel	316 Stainless Steel, N10276, N04400, Plastic, and Special Alloys
Displacer Stem, Driver Bearing, Displacer Rod and Driver	316 Stainless Steel	N10276, N04400, other Austenitic Stainless Steels, and Special Alloys
Torque Tube	N05500(1)	316 Stainless Steel, N06600, N10276

1. N05500 is not recommended for spring applications above 232°C (450°F). Contact your Emerson sales office or application engineer if temperatures exceeding this limit are required.

Table 11. Caged Displacer Sensors[1]

TORQUE TUBE ORIENTATION	SENSOR	STANDARD CAGE, HEAD, AND TORQUE TUBE ARM MATERIAL	EQUALIZING CONNECTION		PRESSURE RATING[2]
			Style	Size (NPS)	
Torque tube arm rotatable with respect to equalizing connections	249[3]	Cast iron	Screwed	1-1/2 or 2	CL125 or CL250
			Flanged	2	
	249B, 249BF[4]	Steel	Screwed or optional socket weld	1-1/2 or 2	CL600
			Raised face or optional ring-type joint flanged	1-1/2	CL150, CL300, or CL600
				2	CL150, CL300, or CL600
	249C[3]	316 stainless steel	Screwed	1-1/2 or 2	CL600
			Raised face flanged	1-1/2	CL150, CL300, or CL600
				2	CL150, CL300, or CL600
	249K	Steel	Raised face or optional ring-type joint flanged	1-1/2 or 2	CL900 or CL1500
	249L	Steel	Ring-type joint flanged	2[5]	CL2500

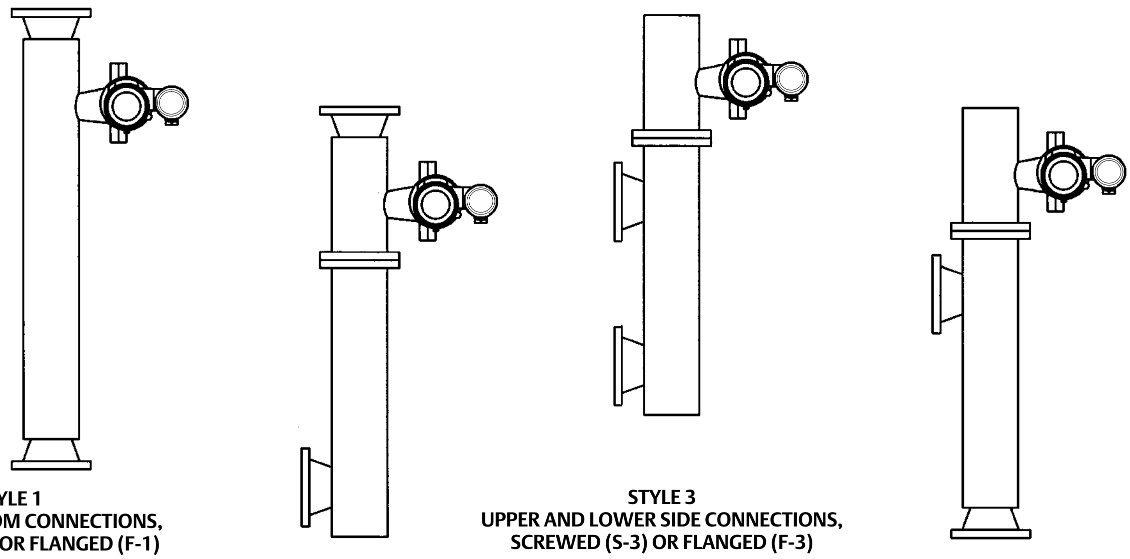
1. Standard displacer lengths for all styles (except 249) are 14, 32, 48, 60, 72, 84, 96, 108 and 120 inches. The 249 uses a displacer with a length of either 14 or 32 inches.
2. EN flange connections available in EMA (Europe, Middle East and Africa).
3. Not available in EMA.
4. The 249BF available in EMA only. Also available in EN size DN 40 with PN 10 to PN 100 flanges and size DN 50 with PN 10 to PN 63 flanges.
5. Top connection is NPS 1 ring-type joint flanged for connection styles F1 and F2.

Table 12. Cageless Displacer Sensors[1]

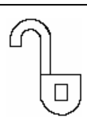
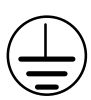
Mounting	Sensor	Standard Head[2], Wafer Body[6] and Torque Tube Arm Material	Flange Connection (Size)	Pressure Rating[3]
Mounts on top of vessel	249BP[4]	Steel	NPS 4 raised face or optional ring-type joint	CL150, CL300, or CL600
			NPS 6 or 8 raised face	CL150 or CL300
	249CP	316 Stainless Steel	NPS 3 raised face	CL150, CL300, or CL600
	249P[5]	Steel or stainless steel	NPS 4 raised face or optional ring-type joint	CL900 or CL1500 (EN PN 10 to DIN PN 250)
			NPS 6 or 8 raised face	CL150, CL300, CL600, CL900, CL1500, or CL2500
Mounts on side of vessel	249VS	WCC (steel) LCC (steel), or CF8M (316 stainless steel)	For NPS 4 raised face or flat face	CL125, CL150, CL250, CL300, CL600, CL900, or CL1500 (EN PN 10 to DIN PN 160)
		WCC, LCC, or CF8M	For NPS 4 buttweld end, XXS	CL2500
Mounts on top of vessel or on customer supplied cage	249W	WCC or CF8M	For NPS 3 raised face	CL150, CL300, or CL600
		LCC or CF8M	For NPS 4 raised face	CL150, CL300, or CL600

1. Standard displacer lengths are 14, 32, 48, 60, 72, 84, 96, 108, and 120 inches.
2. Not used with side-mounted sensors.
3. EN flange connections available in EMA (Europe, Middle East and Africa).
4. Not available in EMA.
5. 249P available in EMA only.
6. Wafer Body only applicable to the 249W.

Figure 15. Style Number of Equalizing Connections



Instrument Symbols

Symbol	Description	Location on Instrument
	Lever Lock	Handle
	Lever Unlock	Handle
	Earth	Terminal Box Housing
	National Pipe Thread	Terminal Box Housing
T	Test	Inside Terminal Box
+	Positive	Inside Terminal Box
–	Negative	Inside Terminal Box
RS	RTD Connection	Inside Terminal Box
R1	RTD Connection 1	Inside Terminal Box
R2	RTD Connection 2	Inside Terminal Box

Emerson Automation Solutions
Marshalltown, Iowa 50158 USA
Sorocaba, 18087 Brazil
Cernay, 68700 France
Dubai, United Arab Emirates
Singapore 128461 Singapore

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