Errata Sheet
for

FIELDVUE® DLC3000 Series Digital Level Controllers
Form 5631, February 2007

The mounting kits in table 6-1 of the FIELDVUE® DLC3000 Series Digital Level Controllers instruction manual, Form 5631, are no longer available for order using the part numbers listed.

Contact your Emerson Process Management™ sales office for FS numbers for the following DLC3000 mounting options:

- Fisher® 249 Series − heat insulator for field mounting the DLC3010.
- Masoneilan® 12100, 12800 Series
- Masoneilan 12100, 12800 Series with heat insulator
- Masoneilan 12200, 12300 Series
- Masoneilan 12200, 12300 Series with heat insulator
- Yamatake Honeywell® Type NQP
- Yamatake Honeywell Type NQP with heat insulator
- Foxboro® Eckardt 134LD and 144LD
- Foxboro-Eckardt 134LD and 144LD with heat insulator
- Foxboro-Eckardt LP167
- Foxboro-Eckardt LP167 with heat insulator

Note

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FIELDVUE® DLC3000 Series Digital Level Controllers

This manual applies to:

Type DLC3010			*Model 375 Field Communicator*
Device Revision	*Firmware Revision*	*Hardware Revision*	*Device Description Revision*
1	*8*	*1*	*2*

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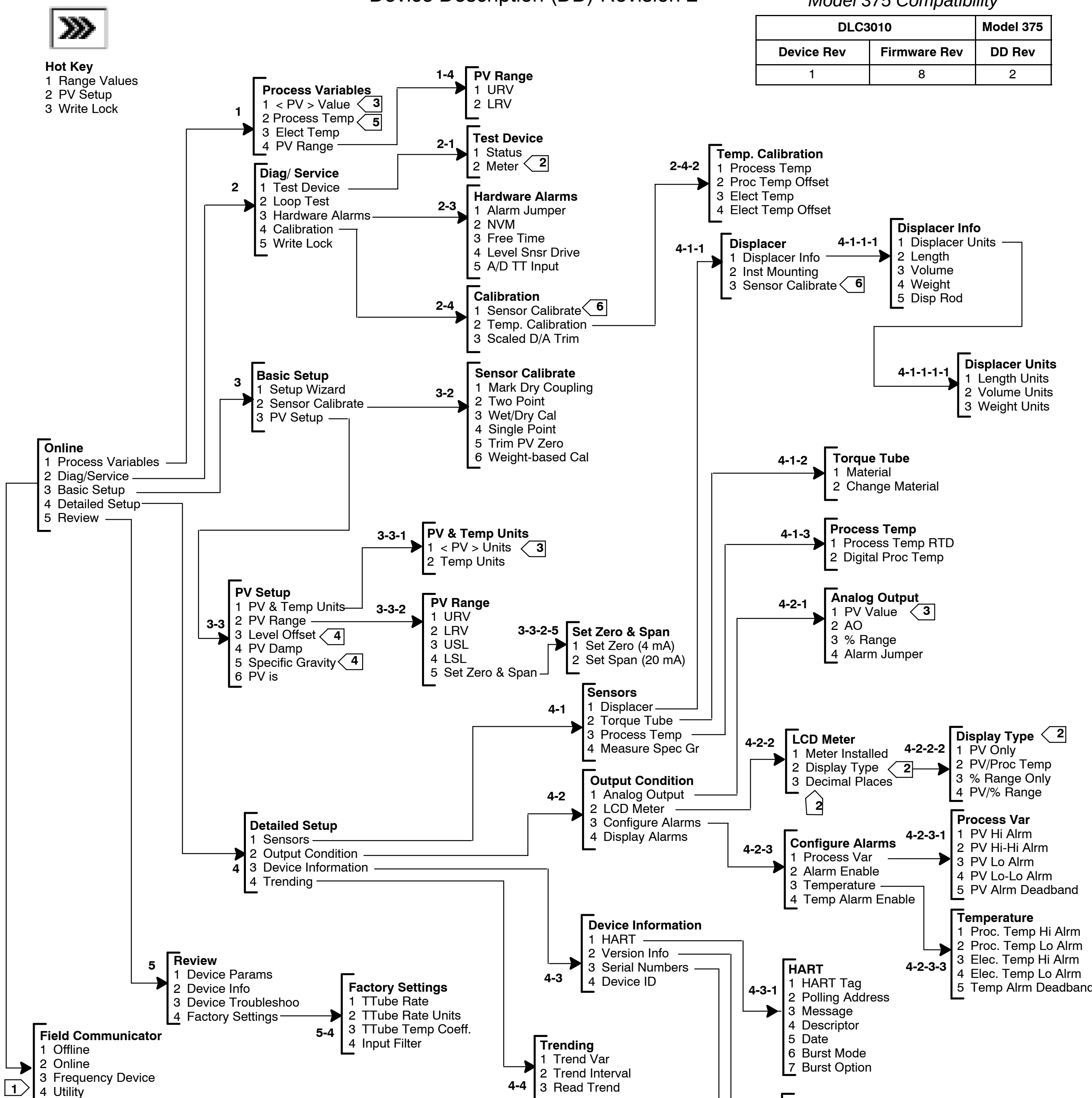
**Unfold This Sheet to See the
Model 375 Field Communicator
Menu Structure**

Model 375 Field Communicator Menu Tree for FIELDVUE® DLC3000

Device Description (DD) Revision 2

Model 375 Compatibility

DLC3010		Model 375
Device Rev	Firmware Rev	DD Rev
1	8	2



NOTES:

1 THIS MENU IS AVAILABLE BY PRESSING THE LEFT ARROW KEY FROM THE PREVIOUS MENU.

2 APPEARS ONLY IF LCD METER IS INSTALLED.

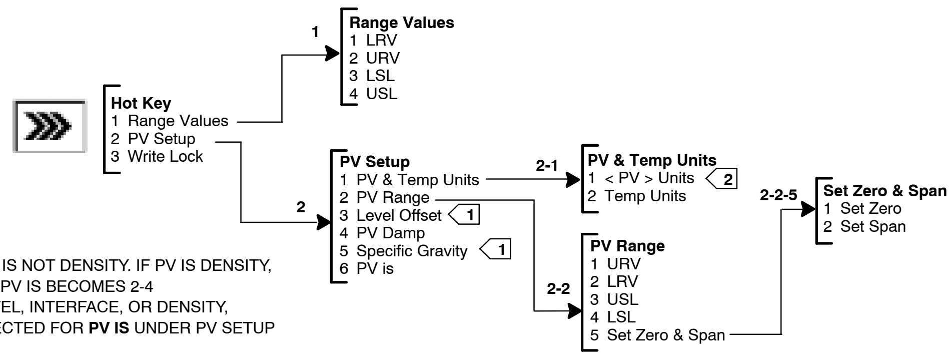
3 < PV > APPEARS AS "LEVEL", "INTERFACE", OR "DENSITY", DEPENDING ON WHAT IS SELECTED FOR **PV IS** UNDER PV SETUP

4 APPEARS ONLY IF **PV IS** NOT DENSITY. IF PV IS DENSITY, PV RANGE BECOMES 3-3, AND PV IS BECOMES 3-3-4.

5 APPEARS ONLY IF RTD IS INSTALLED. IF THE CONFIGURATION DOES NOT HAVE AN RTD INSTALLED, PV RANGE BECOMES 1-3 AND ELECT TEMP BECOMES 1-2.

6 SEE MENU 3-2.

Model 375 Field Communicator Menu Tree for Device Description Revision 2



NOTES:
1 APPEARS ONLY IF **PV IS** IS NOT DENSITY. IF PV IS DENSITY, PV RANGE BECOMES 2-3 AND PV IS BECOMES 2-4
2 < PV > APPEARS AS LEVEL, INTERFACE, OR DENSITY, DEPENDING ON WHAT IS SELECTED FOR **PV IS** UNDER PV SETUP

Model 375 Field Communicator Fast-Key Sequence. The Sequence Describes the Steps to go to a Menu Item(1)

Function	Condition	Fast–Key Sequence	Coordinates(1)
Analog Output		4-2-1	5-E
Alarms, Display		4-2-4	4-F
Alarm Jumper		4-2-1-4	5-E
Basic Setup		3	2-C
Burst Mode		4-3-1-6	5-H
Burst Option		4-3-1-7	5-H
Calibration		2-4	3-C
Damping, PV	PV is NOT Density	3-3-4	2-E
	PV is Density	3-3-3	
Date		4-3-1-5	5-H
Descriptor		4-3-1-4	5-H
Detailed Setup		4	2-F
Device Info		4-3	4-G
Diagnostic and Service		2	2-B
Displacer Info		4-1-1-1	6-B
Displacer Serial Number		4-3-3-2	5-I
Electronics Temperature	RTD Installed	1-3	2-B
	RTD Not Installed	1-2	
Filter, Input		5-4-4	3-H
Firmware Rev		4-3-2-2	5-H
Hardware Alarms		2-3	3-B
HART Tag		4-3-1-1	5-G
Instrument Mounting		4-1-1-2	5-C
Instrument Serial Number		4-3-3-1	5-I
LCD Meter		4-2-2	5-F
LCD Meter Test	LCD Meter Installed	2-1-2	3-B
	LCD Meter NOT Installed	N/A	
Level Offset	PV is NOT Density	3-3-3	2-E
	PV is Density	N/A	
Loop Test		2-2	2-B
LRV (Lower Range Value)		3-3-2-2	3-E
LSL (Lower Sensor Limit)		3-3-2-4	3-E
Message		4-3-1-3	5-H
Output Condition		4-2	4-F

Function	Condition	Fast–Key Sequence	Coordinates(1)
Percent Range		4-2-1-3	5-E
Polling Address		4-3-1-2	5-G
Process Temperature	RTD installed	1-2	2-B
	RTD NOT installed	N/A	
Process Variable Alarm Enable		4-2-3-2	5-G
Process Variable Alarm Limits		4-2-3-1	6-F
PV is	Level or Interface	3-3-6	2-E
	Density	3-3-4	
Process Variable Range	RDT Installed	1-4	3-A
	RTD NOT Installed	1-3	
Process Variable Units		3-3-1-1	3-D
PV Setup		Hot Key-2	See menu above
Range Values		Hot Key-1	
Review		5	2-G
RTD, Process Temperature		4-1-3-1	5-D
Scaled D/A Trim		2-4-3	3-C
Sensor Calibrate		3-2	3-D
Set Zero & Span		3-3-2-5	4-E
Setup Wizard		3-1	2-C
Specific Gravity	PV is NOT Density	3-3-5	2-E
	PV is Density	N/A	
Status		2-1-1	3-B
Temperature Alarm Enable		4-2-3-4	5-G
Temperature Alarm Limits		4-2-3-3	6-G
Temperature Units		3-3-1-2	3-D
Test Device		2-1	3-B
Torque Tube Rate		5-4-1	3-H
Torque Tube Material		4-1-2-1	5-D
Trending		4-4	4-H
URV (Upper Range Value)		3-3-2-1	3-E
USL (Upper Sensor Limit)		3-3-2-3	3-E
Weight Based Calibration		3-2-6	3-D
Write Lock		Hot Key-3	See menu above

1. Coordinates are to help locate the item on the menu tree on the facing page.
N/A = “Not available”

Section 1 Introduction

Scope of Manual

This instruction manual includes specifications, installation, operating, and maintenance information for FIELDVUE® DLC3000 Series digital level controllers.

The manual describes the functionality of instruments with Firmware Revision 8.

This instruction manual supports the Model 375 Field Communicator with device description revision 2, used with DLC3000 instruments with firmware revision 8. You can obtain information about the process, instrument, or sensor using the Model 375 Field Communicator or AMS™ Suite: Intelligent Device Manager. Contact your Emerson Process Management™ sales office to obtain the appropriate software

Do not install, operate, or maintain a Type DLC3000 digital level controller without first ● being fully trained and qualified in valve, actuator, and accessory installation, operation and maintenance, and ● carefully reading and understanding the contents of this manual. If you have any questions concerning these instructions, contact your Emerson Process Management sales office before proceeding.

Note

Neither Emerson, Emerson Process Management, nor any of their affiliated entities assumes responsibility for the selection, use, and maintenance of any product. Responsibility for the selection, use, and maintenance of any product remains with the purchaser and end-user.

Conventions Used in this Manual

Procedures that require the use of the Model 375 Field Communicator have the Field Communicator symbol in the heading.

Some of the procedures also contain the sequence of numeric keys required to display the desired Field Communicator menu. For example, to access the *Status* menu, from the Online menu, press 2 (selects *Diag/Service*) followed by 1 (selects *Test Device*) followed by a second 1 (selects *Status*). The key

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Figure 1-1. Type DLC3000 Digital Level Controller

sequence in the procedure heading is shown as (2-1-1). The path required to accomplish various tasks, the sequence of steps through the Field Communicator menus, is also presented in textual format. Menu selections are shown in italics, e.g., *Calibrate.* An overview of the Model 375 Field Communicator menu structure is shown on the inside front cover of this manual.

Description

Type DLC3010 Digital Level Controllers

Type DLC3010 digital level controllers (figure 1-1) are used with level sensors to measure liquid level, the level of interface between two liquids, or liquid specific gravity (density). Changes in level or specific gravity exert a buoyant force on a displacer, which rotates the torque tube shaft. This rotary motion is applied to the digital level controller, transformed to an electrical signal and digitized. The digital signal is compensated and processed per user configuration requirements, and converted back to a 4−20 mA analog electrical signal. The resulting current output signal is sent to an indicating or final control element.

DLC3010 digital level controllers are communicating, microprocessor-based level, interface, or density sensing instruments. In addition to the normal function of providing a 4 to 20 milliampere current signal, DLC3010 digital level controllers, using the HART® communications protocol, give easy access to information critical to process operation. You can gain information from the process, the instrument, or the sensor using a Model 375 Field Communicator with device descriptions (DDs) compatible with Type DLC3010 digital level controllers. The Field Communicator may be connected at the digital level controller or at a field junction box.

Using the Field Communicator, you can perform several operations with the DLC3010 digital level controller. You can interrogate, configure, calibrate, or test the digital level controller. Using the HART protocol, information from the field can be integrated into control systems or be received on a single loop basis.

DLC3010 digital level controllers are designed to directly replace standard pneumatic and electro-pneumatic level transmitters. DLC3010 digital level controllers mount on a wide variety of Fisher® 249 Series cageless and caged level sensors. They mount on other manufacturers' displacer type level sensors through the use of mounting adaptors.

249 Series Caged Sensors (see table 1-6)

- Type 249, 249B, 249BF, 249C, 249K, and 249L sensors side-mount on the vessel with the displacer mounted inside a cage outside the vessel. (The Type 249BF is available only in Europe, Middle East, and Africa.)

249 Series Cageless Sensors (see table 1-7)

- Type 249BP, 249CP, and 249P sensors top-mount on the vessel with the displacer hanging down into the vessel.

- Type 249V sensor side-mounts on the vessel with the displacer hanging out into the vessel.

- Type 249W wafer-style sensor mounts on top of a vessel or on a customer-supplied cage.

Specifications

Specifications for the Type DLC3000 digital level controllers are shown in table 1-1. Specifications for the 249 Series sensor are shown in table 1-3. Specifications for the Field Communicator can be found in the Product Manual for the Field Communicator.

Related Documents

Other documents containing information related to the Type DLC3000 digital level controllers and 249 Series sensors include:

- FIELDVUE® Type DLC3010 Digital Level Controllers (Bulletin 11.2:DLC3000)

- FIELDVUE® DLC3000 Series Digital Level Controller Quick Start Guide – From 5797

- Supplement to HART® Based FIELDVUE® Instrument Instruction Manuals—Using FIELDVUE® Instruments with the Smart HART® Loop Interface and Monitor (HIM) – Form 5809

- Supplement to HART® Based FIELDVUE® Instrument Instruction Manuals— Audio Monitor for HART® Communications – Form 5811

- Caged 249 Series Displacer Sensors Instruction Manual - Form 1802

- Cageless 249 Series Displacer Sensors Instruction Manual - Form 1803

- Type 249W Cageless Wafer Style Level Sensor Instruction Manual - Form 5729

- Supplement to 249 Series Sensors Instruction Manual—Simulation of Process Conditions for Calibration of Level-Trols - Form 5767

- Supplement to 249 Series Sensors Instruction Manual—Bolt Torque Information – Form 5801

- Technical Monograph 7: The Dynamics of Level and Pressure Control

- Technical Monograph 18: Level-Trol Density Transmitter

- Technical Monograph 26: Guidelines for Selection of Liquid Level Control Equipment

These documents are available from your Emerson Process Management sales office. Also visit our website at www.Fisher.com.

Educational Services

For information on available courses for the DLC3000 Series digital level controller, as well as a variety of other products, contact:

Emerson Process Management
Educational Services, Registration
P.O. Box 190; 301 S. 1st Ave.
Marshalltown, IA 50158–2823
Phone: 800–338–8158 or
Phone: 641–754–3771
FAX: 641–754–3431
e-mail: education@emersonprocess.com

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Table 1-1. Type DLC3000 Digital Level Controller Specifications

Available Configurations

Type DLC3010 Digital Level Controller: Mounts on Fisher 249 Series caged and cageless sensors. See tables 1-6 and 1-7 and sensor description.

Function: Transmitter

Communications Protocol: HART

Input Signal(1)

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(1)

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 1100 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	DLC3000 Digital Level Controller(1)	w/ NPS 3 249W, Using a 14-inch Displacer	w/ All Other 249 Series
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, and repeatability are derated by the factor (100%/PB)

Operating Influences

Power Supply Effect: Output changes <±0.2% of full scale when supply varies between min. and max 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 (see figure 1-2). 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 1-1. Type DLC3000 Digital Level Controller Specifications (continued)

Electromagnetic Interference (EMI): Tested per IEC 61326-1 (Edition 1.1). Complies with European EMC Directive. Meets emission limits for class A equipment (industrial locations) and class B equipment (domestic locations). Meets immunity requirements for industrial locations (Table A.1 in the IEC specification document). Immunity performance is shown in table 1-2.

Supply Requirements (See figure 3-11)

12 to 30 volts dc; 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

Hazardous Area:

CSA	Explosion proof, Intrinsic Safety Dust-Ignition proof
FM APPROVED	Explosion proof, Non-incendive, Dust-Ignition proof, Intrinsic Safety
ATEX	Intrinsic Safety, Type n, Flameproof
IECEx	Intrinsic Safety, Type n
SAA	Flameproof

Refer to Special Instructions for Safe Use and Installations in Hazardous Locations in the Installation section, tables 3-1, 3-2, 3-3, 3-4, and 3-5, and figures B-1, B-2, B-3, B-4, B-5, and B-6 for additional approvals information.

Electrical Housing: NEMA 4X, CSA Enclosure, and IP66

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 Series sensor specifications for standard displacer volumes and standard wall torque tubes. Standard volume for 249C and 249CP series 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.

–continued–

1

Table 1-1. Type DLC3000 Digital Level Controller Specifications (continued)

Mounting Positions

Digital level controllers can be mounted right- or left-of-displacer, as shown in figure 3-7.

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

DLC3000 Series Digital Level Controller:
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 female conduit connections; one on bottom and one on back of terminal box. M20 adapters available.

Options

■ Heat insulator. See description under Ordering Information. ■ 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 1-4 and figure 3-9.
Ambient Temperature and Humidity: See below

Conditions	Normal Limits(1,2, 3)	Transport and Storage Limits(1)	Nominal Reference(1)
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%

Weight

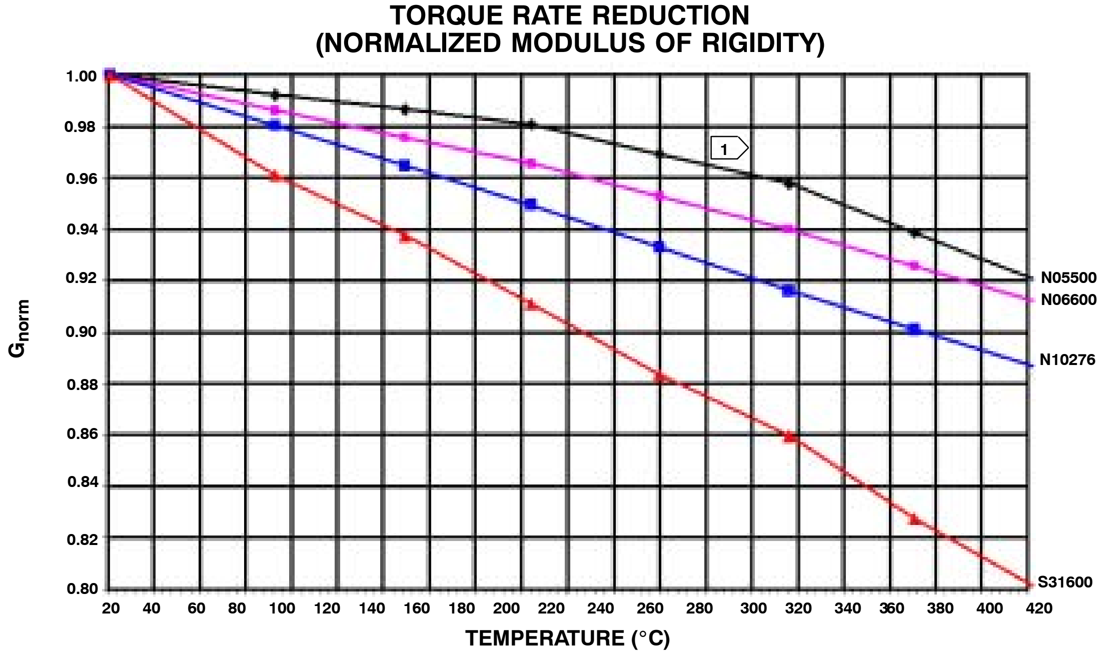
Less than 2.7 Kg (6 lbs)

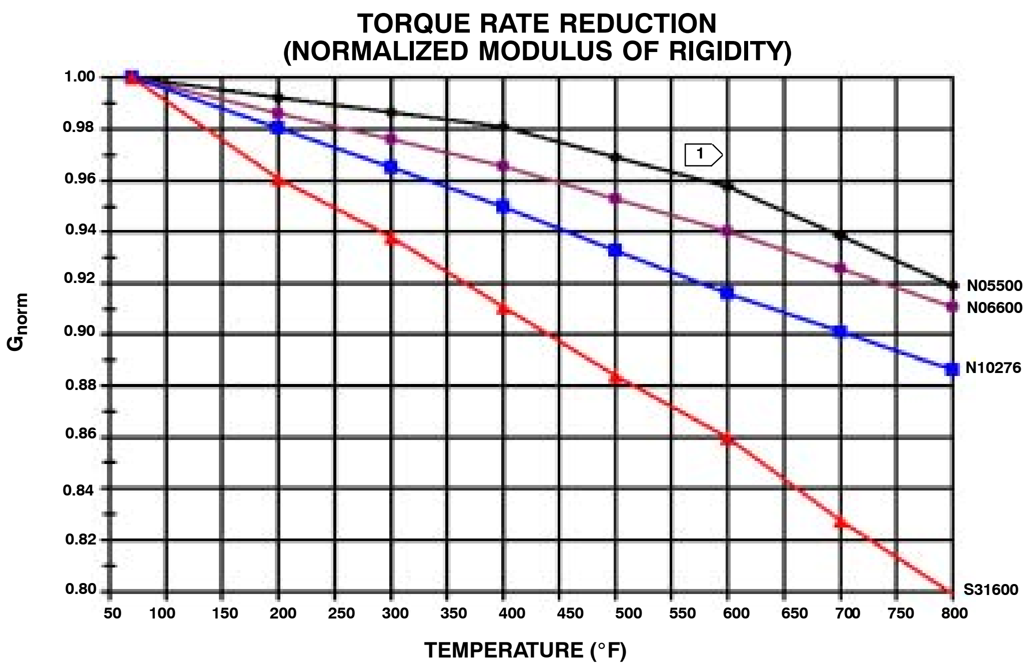
1. Defined in ISA Standard S51.1
2. LCD meter may not be readable below −20°C (−4°F)
3. Contact your Emerson Process Management sales office or application engineer if temperatures exceeding these limits are required.

Table 1-2. Immunity Performance

PORT	PHENOMENON	BASIC STANDARD	PERFORMANCE CRITERIA(1)
Enclosure	Electrostatic discharge (ESD)	IEC 61000-4-2	B
	EM field	IEC 61000-4-3	A
	Rated power frequency magnetic field	IEC 61000-4-8	A
I/O signal/control	Burst	IEC 61000-4-4	B
	Surge	IEC 61000-4-5	B
	Conducted RF	IEC 61000-4-6	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.





NOTE:
1 DUE TO THE PERMANENT DRIFT THAT OCCURS NEAR AND ABOVE 260°C (500°F), N05500 IS NOT RECOMMENDED FOR TEMPERATURES ABOVE 232°C (450°F).

Figure 1-2. Theoretical Reversible Temperature Effect on Common Torque Tube Materials

1

Table 1-3. 249 Series 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 Types 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 1-6 and 1-7 footnotes

Sensor Working Pressures

Consistent with applicable ANSI pressure/temperature ratings for the specific sensor constructions shown in tables 1-6 and 1-7

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 3-2.

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 3-7.

Construction Materials

See tables 1-5, 1-6, and 1-7

Operative Ambient Temperature

See table 1-4
For ambient temperature ranges, guidelines, and use of optional heat insulator, see figure 3-9.

Options

■ Heat insulator, see description under Ordering Information ■ 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 1-4. 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 1-5. 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 Process Management sales office or application engineer if temperatures exceeding this limit are required.

1

Table 1-6. Caged Displacer Sensors(1)

<table>
<tr><th rowspan="2">TORQUE TUBE ORIENTATION</th><th rowspan="2">TYPE NUMBER</th><th rowspan="2">STANDARD CAGE, HEAD, AND TORQUE TUBE ARM MATERIAL</th><th colspan="2">EQUALIZING CONNECTION</th><th rowspan="2">PRESSURE RATING(2)</th></tr>
<tr><th>Style</th><th>Size (NPS)</th></tr>
<tr><td rowspan="11">Torque tube arm rotatable with respect to equalizing connections</td><td rowspan="2">249(3)</td><td rowspan="2">Cast iron</td><td>Screwed</td><td>1-1/2 or 2</td><td rowspan="2">CL125 or CL250</td></tr>
<tr><td>Flanged</td><td>2</td></tr>
<tr><td rowspan="3">249B, 249BF(4)</td><td rowspan="3">Steel</td><td>Screwed or optional socket weld</td><td>1-1/2 or 2</td><td>CL600</td></tr>
<tr><td rowspan="2">Raised face or optional ring-type joint flanged</td><td>1-1/2</td><td>CL150, CL300, or CL600</td></tr>
<tr><td>2</td><td>CL150, CL300, or CL600</td></tr>
<tr><td rowspan="3">249C(3)</td><td rowspan="3">316 stainless steel</td><td>Screwed</td><td>1-1/2 or 2</td><td>CL600</td></tr>
<tr><td rowspan="2">Raised face flanged</td><td>1-1/2</td><td>CL150, CL300, or CL600</td></tr>
<tr><td>2</td><td>CL150, CL300, or CL600</td></tr>
<tr><td>249K</td><td>Steel</td><td>Raised face or optional ring-type joint flanged</td><td>1-1/2 or 2</td><td>CL900 or CL1500</td></tr>
<tr><td>249L</td><td>Steel</td><td>Ring-type joint flanged</td><td>2(5)</td><td>CL2500</td></tr>
</table>

1. Standard displacer lengths for all styles (except Type 249) are 14, 32, 48, 60, 72, 84, 96, 108 and 120 inches. Type 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. Type 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 1-7. Cageless Displacer Sensors(1)

<table>
<tr><th>MOUNTING</th><th>TYPE NUMBER</th><th>STANDARD HEAD(2), WAFER BODY(6) AND TORQUE TUBE ARM MATERIAL</th><th>FLANGE CONNECTION (SIZE)</th><th>PRESSURE RATING(3)</th></tr>
<tr><td rowspan="5">Mounts on top of vessel</td><td rowspan="2">249BP(4)</td><td rowspan="2">Steel</td><td>NPS 4 raised face or optional ring-type joint</td><td>CL150, CL300, or CL600</td></tr>
<tr><td>NPS 6 or 8 raised face</td><td>CL150 or CL300</td></tr>
<tr><td>249CP</td><td>316 Stainless Steel</td><td>NPS 3 raised face</td><td>CL150, CL300, or CL600</td></tr>
<tr><td rowspan="2">249P(5)</td><td rowspan="2">Steel or stainless steel</td><td>NPS 4 raised face or optional ring-type joint</td><td>CL900 or 1CL500
(EN PN 10 to DIN PN 250)</td></tr>
<tr><td>NPS 6 or 8 raised face</td><td>CL150, CL300, CL600, CL900, CL1500, or CL2500</td></tr>
<tr><td rowspan="7">Mounts on side of vessel</td><td rowspan="7">249V</td><td>Cast Iron</td><td>NPS 4</td><td>CL125 or CL250</td></tr>
<tr><td rowspan="4">Cast Steel</td><td>NPS 4 raised face or flat face</td><td>CL150</td></tr>
<tr><td>NPS 4 raised face or optional ring-type joint</td><td>CL300, CL600, CL900, or CL1500
(EN PN 10 to DIN PN 160)</td></tr>
<tr><td>NPS 4 ring-type joint</td><td>CL2500</td></tr>
<tr><td>NPS 4 raised face or flat face</td><td>CL150</td></tr>
<tr><td rowspan="2">316 Stainless Steel</td><td>NPS 4 raised face or optional ring-type joint</td><td>CL300, CL600, or CL900</td></tr>
<tr><td>NPS 4 raised face or flat face</td><td>CL150</td></tr>
<tr><td rowspan="2">Mounts on top of vessel or on customer supplied cage</td><td rowspan="2">249W</td><td>WCC (steel) or CF8M (316 stainless steel)</td><td>NPS 3 raised face</td><td>CL150, CL300, or CL600</td></tr>
<tr><td>LCC (steel) or CF8M (316 Stainless Steel)</td><td>NPS 4 raised face</td><td>CL150, CL300, or CL600</td></tr>
</table>

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. Type 249P available in EMA only.
6. Wafer Body only applicable to Type 249W.

Section 2 Principle of Operation

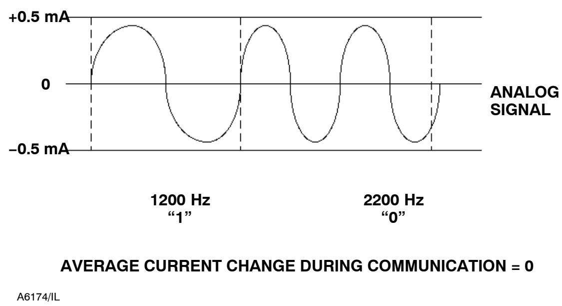


Figure 2-1. HART® Frequency Shift Keying Technique

HART® Communication

The HART (Highway Addressable Remote Transducer) protocol gives field devices the capability of communicating instrument and process data digitally. This digital communication occurs over the same two-wire loop that provides the 4–20 mA process control signal, without disrupting the process signal. In this way, the analog process signal, with its faster update rate, can be used for control. At the same time, the HART protocol allows access to digital diagnostic, maintenance, and additional process data. The protocol provides total system integration via a host device.

The HART protocol uses the frequency shift keying (FSK) technique based on the Bell 202 communication standard. By superimposing a frequency signal over the 4–20 mA current, digital communication is attained. Two individual frequencies of 1200 and 2200 Hz are superimposed as a sinewave over the 4–20 mA current loop. These frequencies represent the digits 1 and 0 (see figure 2-1). The average value of this sinewave is zero, therefore no dc value is added to the 4–20 mA signal. Thus, true simultaneous communication is achieved without interrupting the process signal.

The HART protocol allows the capability of multidropping, networking several devices to a single communications line. This process is well suited for monitoring remote applications such as pipelines, custody transfer sites, and tank farms.

Digital Level Controller Operation

DLC3000 Series digital level controllers are loop-powered instruments that measure changes in liquid level, level of an interface between two liquids, or density of a liquid. Changes in the buoyancy of a displacer suspended in a vessel vary the load on a torque tube. The displacer and torque tube assembly constitute the primary mechanical sensor. The angular deflection of the torque tube is measured by the instrument transducer, which consists of a magnet system moving over a Hall effect device. A liquid crystal display (LCD) meter can display the analog output; process variable (level, interface level, or density); the process temperature, if an RTD (resistance temperature detector) is installed; the degrees of torque tube rotation; and percent range.

The instrument uses a microcontroller and associated electronic circuitry to measure the process variable, provide a current output, drive the LCD meter, and provide HART communications capability. Figure 2-2 shows the digital level controller assembly. Figure 2-3 is a block diagram of the main components in the instrument electronics; the LCD meter, the processor module, the transducer board, and the terminal board. The processor module contains the microprocessor, the analog-to-digital (A/D) converters, loop interface, signal conditioning, the digital-to-analog (D/A) output, power supply and interfaces to other boards.

The transducer board contains the Hall sensor, a temperature sensor to monitor the Hall sensor temperature, and an EEPROM to store the coefficients associated with the Hall sensor. The terminal board contains the EMI filters, the loop connection terminals, and the connections for the optional RTD used to measure process temperature.

A level, density, or interface level change in the measured fluid causes a change in the displacer position (figure 2-5). This change is transferred to the torque tube assembly. As the measured fluid changes, the torque tube assembly rotates up to 4.4 degrees for a 249 Series sensor, varying the digital level controller output between 4 and 20 mA.

The rotary motion of the torque tube is transferred to the digital level controller lever assembly. The rotary motion moves a magnet attached to the lever assembly, changing the magnetic field that is sensed by the Hall effect sensor. The sensor converts the magnetic field signal to an electronic signal.

The microcontroller accepts the electronic signal, which is ambient-temperature-compensated and linearized. The microcontroller can also actively compensate for changes in liquid specific gravity due to changes in process temperature based on an input via HART protocol or via an optional RTD, if it is connected. The D/A output circuit accepts the microcontroller output and provides a 4 to 20 mA current output signal.

During normal operation, when the input is between the lower and upper range values, the digital level controller output signal ranges between 4 and 20 mA and is proportional to the input. See figure 2-4. If the input should exceed the lower and upper range values, the output will continue to be proportional to the input

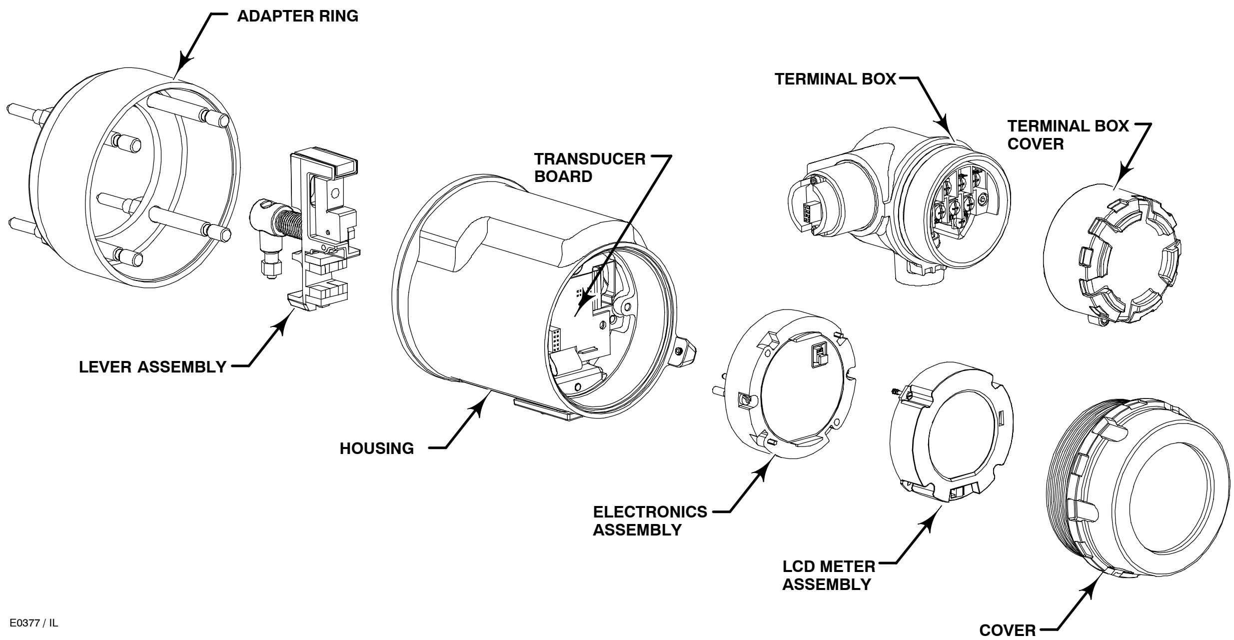


Figure 2-2. DLC3000 Series Digital Level Controller Assembly

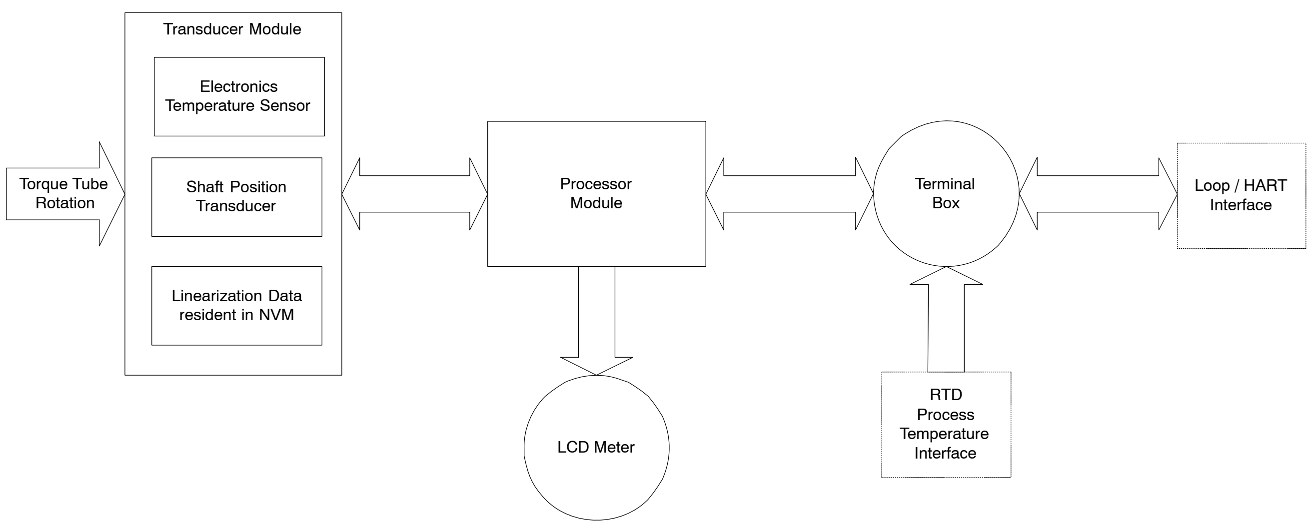


Figure 2-3. DLC3000 Series Digital Level Controller Principle of Operation

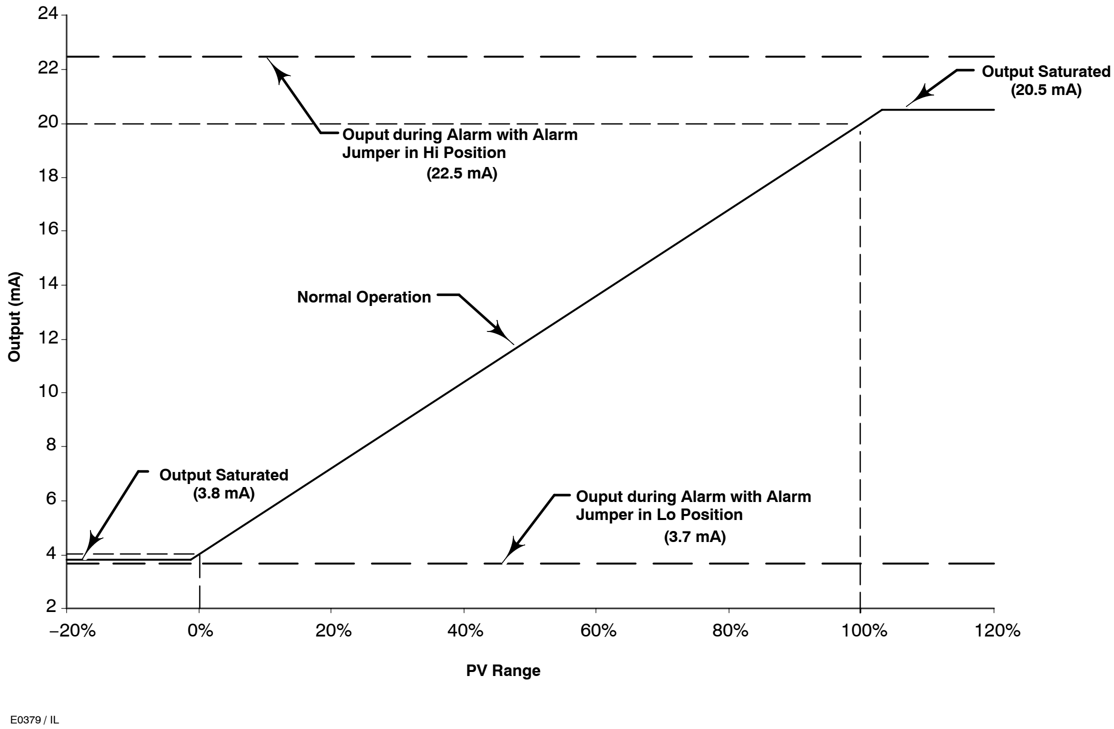


Figure 2-4. Digital Level Controller Analog Output Signal

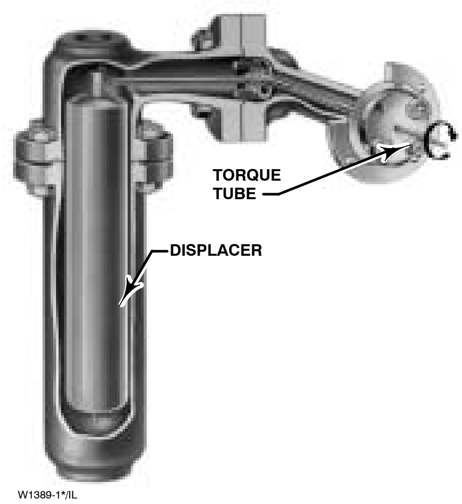
until the output reaches either 3.8 or 20.5 mA. At this time the output is considered saturated and will remain at this value until the input returns to the normal operating range. However, should an alarm occur, the output is driven to either 3.7 or 22.5 mA, depending upon the position of the alarm jumper.

Note

The upper alarm value is compliant with NAMUR NE-43, but the lower alarm value is not.

If using in a system with NAMUR NE-43 compatibility, the high alarm value may be an appropriate choice.

Other circuits in the digital level controller provide reverse polarity protection, transient power surge protection, and electromagnetic interference (EMI) protection.



249 SERIES (SIDE VIEW)

Figure 2-5. Typical Sensor Operation

3

Section 3 Installation

This section contains digital level controller installation information including an installation flowchart (figure 3-1), mounting and electrical installation information, and a discussion of failure mode jumpers.

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 door. When the door 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 shipped with the displacer or driver rod blocked within the operating range by mechanical means. In this case, the access handle (figure 3-5) will be in the unlocked position. Remove the displacer-blocking hardware before calibration. (See the appropriate sensor instruction manual). The coupling should be intact.

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 found on page 4-7.

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 3-5 and 3-6. 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 open or close the access door, this set screw must be backed out so that its top is flush with the handle surface.

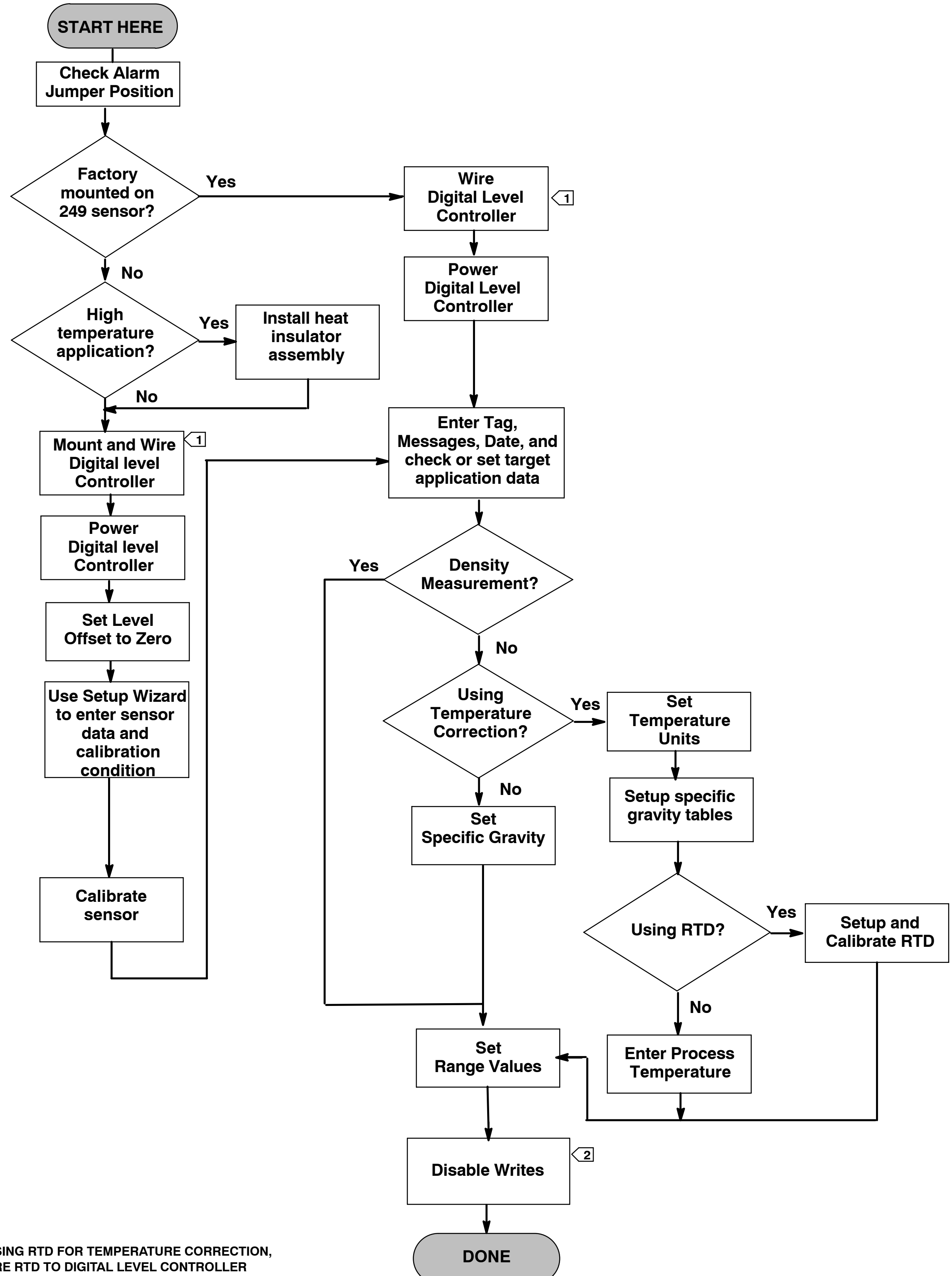
Mounting

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.



NOTE:
1 IF USING RTD FOR TEMPERATURE CORRECTION, ALSO WIRE RTD TO DIGITAL LEVEL CONTROLLER
2 DISABLING WRITES IS EFFECTIVE ONLY IF THE DLC3000 REMAINS POWERED-UP

Figure 3-1. Installation Flowchart

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 requirements and/or conditions of safe use. Special instructions are listed by agency/approval.

After reading and understanding these special conditions of use, proceed with standard installation procedures.

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

No special conditions for safe use.

Refer to table 3-1 for approval information, figure B-1 for the CSA loop schematic, and figure B-3 for the nameplate.

FM

Special Conditions of Safe Use

No special conditions for safe use.

Refer to table 3-2 for approval information, figure B-2 for the FM loop schematic and figure B-3 for the nameplate.

ATEX Intrinsic Safety, Dust

Special Conditions for Safe Use

The apparatus Type 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

Refer to table 3-3 for additional approval information, and figure B-4 for the ATEX approvals nameplate.

ATEX Flameproof, Dust

Special Conditions for Safe Use

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

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

Refer to table 3-3 for additional approval information, and figure B-4 for the ATEX approvals nameplate.

ATEX Type n, Dust

Special Conditions for Safe Use

This equipment shaft can 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 3-3 for additional approval information, and figure B-4 for the ATEX approvals nameplate.

IECEx

Special Conditions for Safe Use

No special conditions for safe use.

Refer to table 3-4 for approval information, and figure B-5 for the IECEx nameplate.

SAA

Conditions of Certification

1. It is a condition of safe use that on installations utilizing gland entries, the gland used must be Standards Australia certified and must be capable of maintaining the nominated IP rating.

2. It is a condition of safe use that the unused conduit entry is fitted with the original conduit plug provided with the equipment certified as part of this certification or other appropriately certified conduit plug.

Refer to table 3-5 for additional approval information, and figure B-6 for the SAA approval nameplate.

Table 3-1. Hazardous Area Classifications—Canada (CSA)

CERTIFICATION BODY	CERTIFICATION OBTAINED	ENTITY RATING	TEMPERATURE CODE	ENCLOSURE RATING
CSA	(Intrinsic Safety) Class/Division Class I,II,III Division 1 GP A,B,C,D,E,F,G per drawing 28B5744	V_{max} = 30 Vdc I_{max} = 226 mA C_i = 5.5 nF L_i = 0.4 mH	T6 (T_{amb} < 80°C)	4X
	(Explosion Proof) Class/Division Class I, Division 1 GP B,C,D	– – –	T6 (T_{amb} < 80°C)	4X
	Class I Division 2 GP A,B,C,D Class II Division 1, 2 GP E,F,G Class III	– – –	T6 (T_{amb} < 80°C)	4X

3

Table 3-2. Hazardous Area Classifications—United States (FM)

CERTIFICATION BODY	CERTIFICATION OBTAINED	ENTITY RATING	TEMPERATURE CODE	ENCLOSURE RATING
FM	(Intrinsic Safety) Class/Division Class I,II,III Division 1 GP A,B,C,D,E,F,G per drawing 28B5745	V_{max} = 30 Vdc I_{max} = 226 mA P_i = 1.4 W C_i = 5.5 nF L_i = 0.4 mH	T5 (T_{amb} < 80°C)	4X
	(Explosion Proof) Class/Division Class I, Division 1 GP A,B,C,D	– – –	T5 (T_{amb} < 80°C)	4X
	Class I Division 2 GP A,B,C,D Class II Division 1 GP E,F,G Class II Division 2 GP F,G	– – –	T5 (T_{amb} < 80°C)	4X

Table 3-3. Hazardous Area Classifications—ATEX

CERTIFICATE	CERTIFICATION OBTAINED	ENTITY RATING	TEMPERATURE CODE	ENCLOSURE RATING
ATEX	⟨Ex⟩ II 1 G D Gas EEx ia IIC T6—Intrinsic Safety Dust T85C (Tamb < 80°C)	U_i = 30 Vdc I_i = 226 mA P_i = 1.4 W C_i = 5.5 nF L_i = 0.4 mH	T6 (T_{amb} < 80°C)	IP66
	⟨Ex⟩ II 2 G D Gas EEx d IIC T6—Flameproof Dust T85C (Tamb < 80°C)	– – –	T6 (T_{amb} < 80°C)	IP66
	⟨Ex⟩ II 3 G D Gas EEx nCL IIC T4—Type n Dust T85C (Tamb < 80°C)	– – –	T4 (T_{amb} < 80°C)	IP66

Table 3-4. Hazardous Area Classifications—IECEx

CERTIFICATE	CERTIFICATION OBTAINED	ENTITY RATING	TEMPERATURE CODE	ENCLOSURE RATING
IECEx	Ex ia IIC T5—Intrinsic Safety	U_i = 30 Vdc I_i = 226 mA P_i = 1.4 W C_i = 5.5 nF L_i = 0.4 mH	T5 (T_{amb} < 80°C)	IP66
	Ex nA IIC T5—Type n	– – –	T5 (T_{amb} < 80°C)	IP66

Table 3-5. Hazardous Area Classifications—SAA

CERTIFICATE	CERTIFICATION OBTAINED	ENTITY RATING	TEMPERATURE CODE	ENCLOSURE RATING
SAA	Gas Ex d IIC T6—Flameproof	– – –	T6 (T_{amb} < 80°C)	IP66

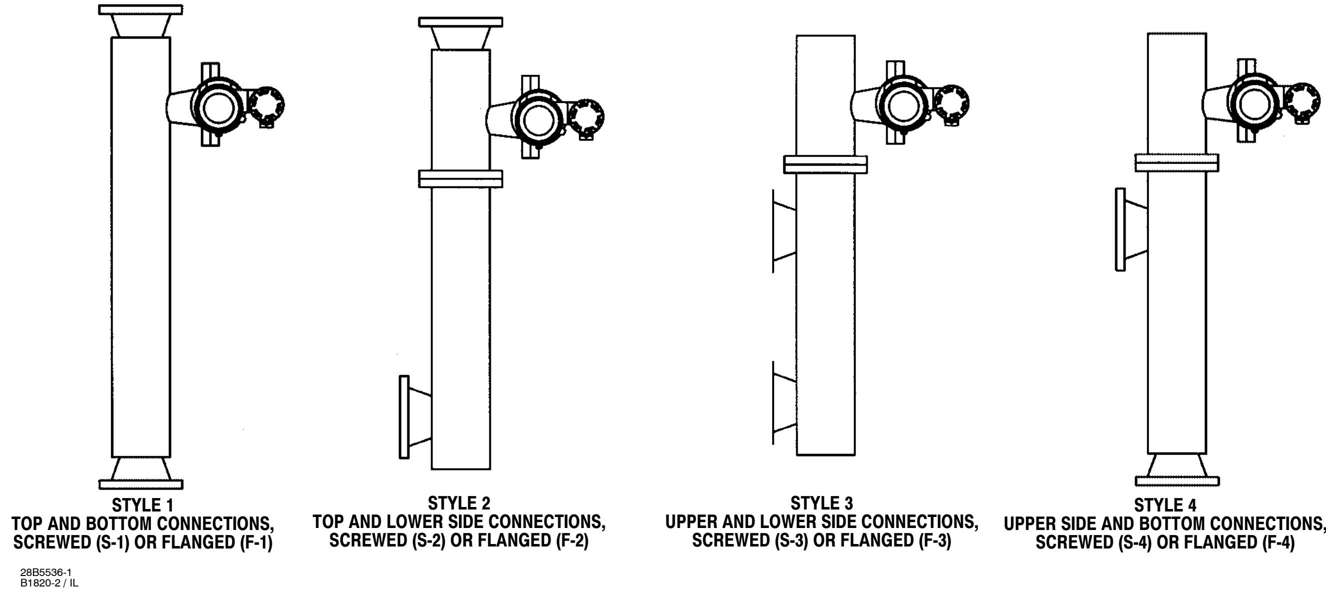


Figure 3-2. Style Number of Equalizing Connections

Mounting the 249 Series Sensor

The 249 Series 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 3-3. If the sensor has a cageless displacer, the sensor mounts on the side or top of the vessel as shown in figure 3-4.

The Type DLC3000 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.

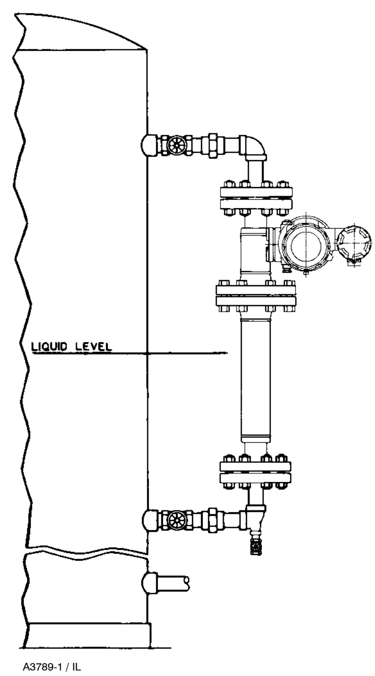


Figure 3-3. Typical Caged Sensor Mounting

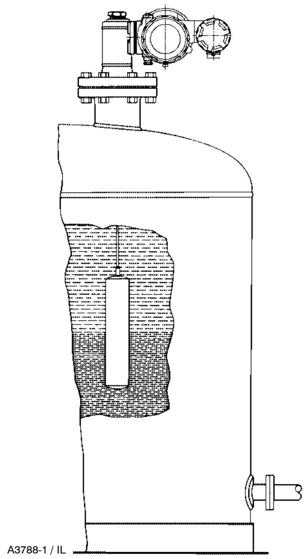


Figure 3-4. Typical Cageless Sensor Mounting

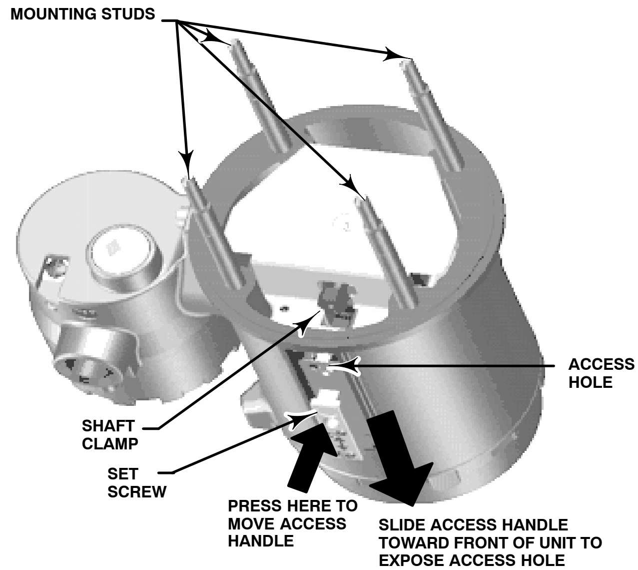


Figure 3-5. Sensor Connection Compartment (Adapter Ring Removed for Clarity)

Digital Level Controller Orientation

Mount the digital level controller with the torque tube shaft clamp access hole (see figure 3-5) 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 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.

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 3-7. This can be changed in the field on the 249 Series sensors (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.

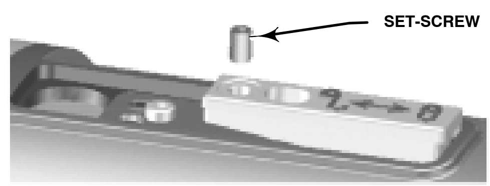


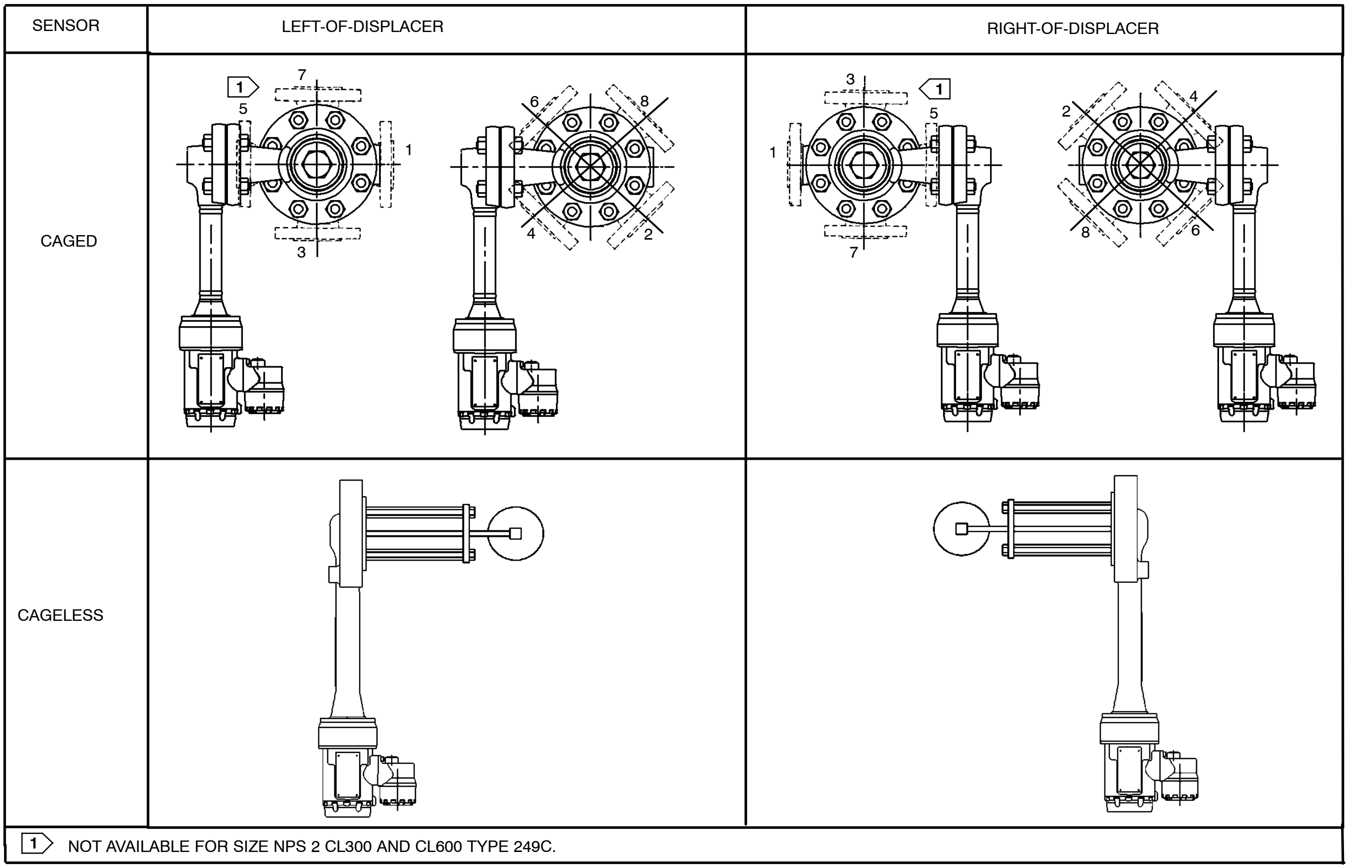
Figure 3-6. Close-up of Set-Screw

All caged 249 Series 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 3-7. 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 Series Sensor

Refer to figure 3-5 unless otherwise indicated.

1. If the set-screw in the access handle, (see figure 3-6) is driven against the spring plate, back it out until the head is flush with the outer surface of the handle, using a 2 mm hex key. Slide the access handle to the locked position to expose the access hole. Press on the back of the handle as shown in figure 3-5 then slide the handle toward the front of the unit. Be sure the locking handle drops into the detent.



19B2787 Rev. D
19B6600 Rev. C
B1407-2/IL

Figure 3-7. Typical Mounting Positions for Type DLC3010 Digital Level Controller on 249 Series Sensor

2. Using a 10 mm deep well socket inserted through the access hole, loosen the shaft clamp (figure 3-5). 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.

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 High Temperature Applications

Refer to figure 3-8 for parts identification except where otherwise indicated.

The digital level controller requires an insulator assembly when temperatures exceed the limits shown in figure 3-9.

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

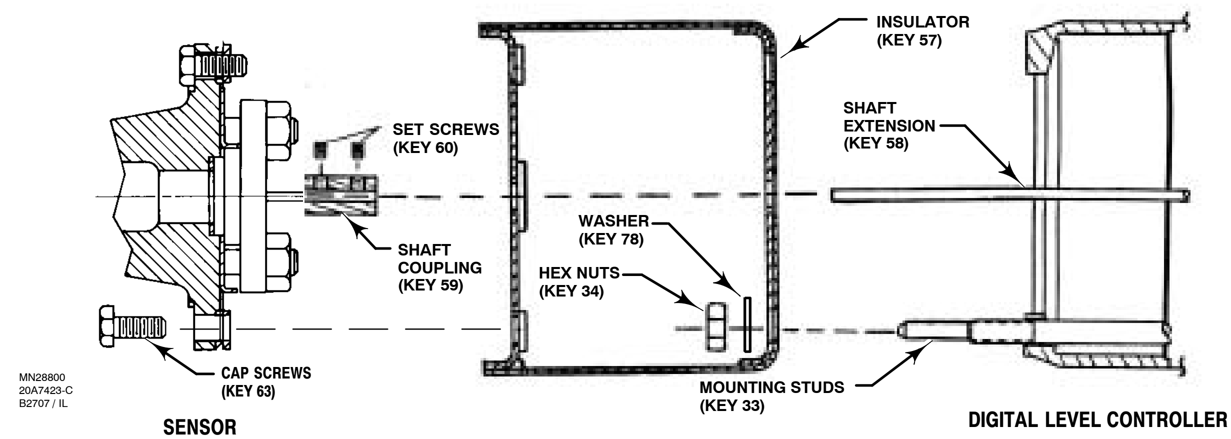


Figure 3-8. Digital Level Controller Mounting on Sensor in High Temperature Applications

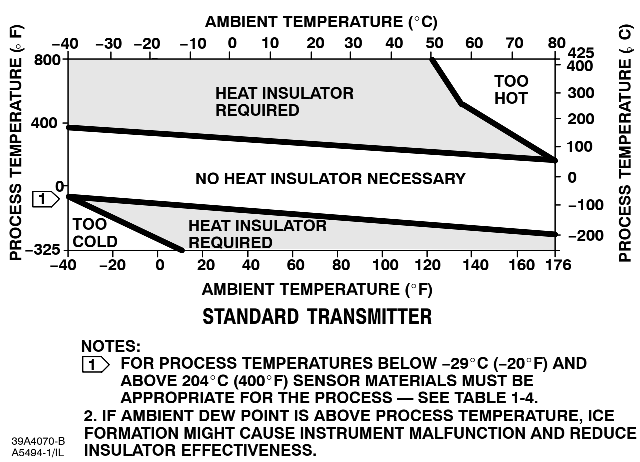


Figure 3-9. Guidelines for Use of Optional Heat Insulator Assembly

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 Series 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 3-8.

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 3-5 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. Install 4 washers (key 78) over the studs. Install the four hex nuts and tighten.

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).

3

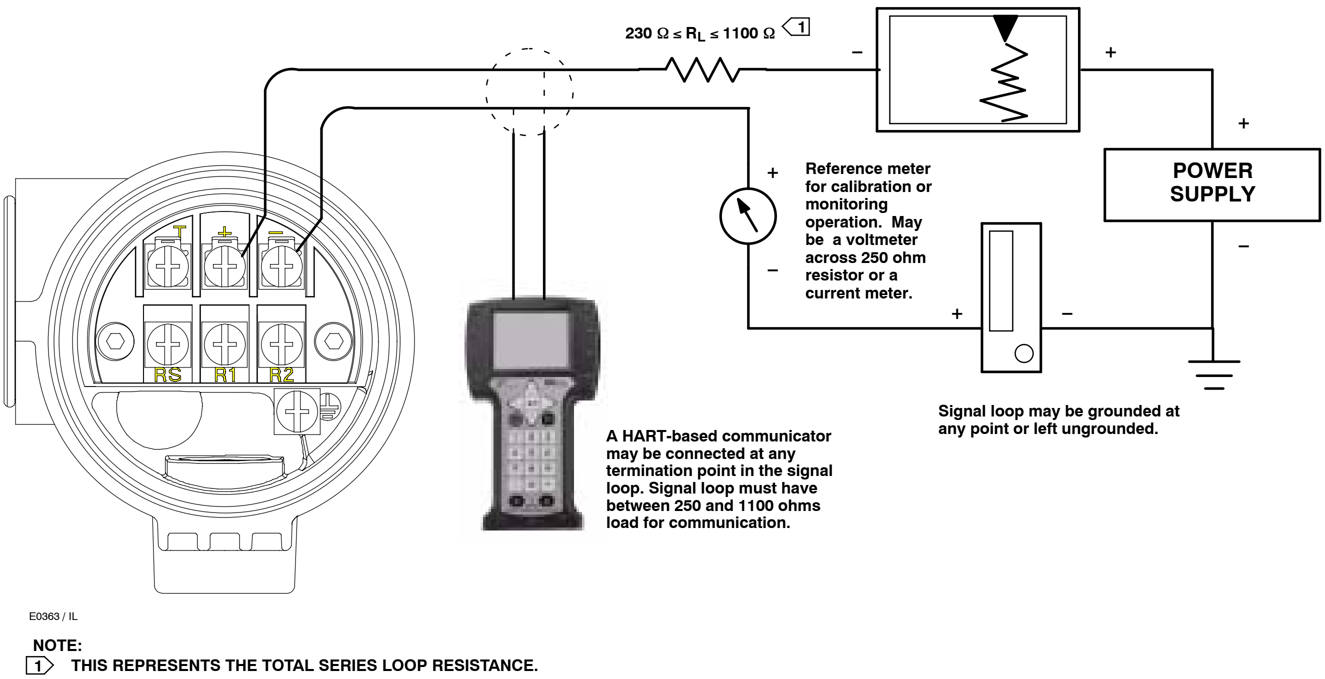


Figure 3-10. Connecting a Communicator to the Digital Level Controller Loop

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.

Proper electrical installation is necessary to prevent errors due to electrical noise. **A resistance between 230 and 1100 ohms must be present in the loop for communication with a HART-based communicator.** Refer to figure 3-10 for current loop connections.

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 3-11 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.

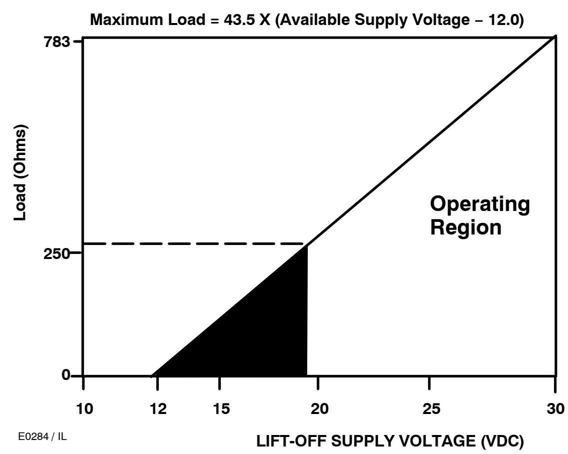


Figure 3-11. Power Supply Requirements and Load Resistance

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.

Field Wiring

Note

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

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.

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 3-12.

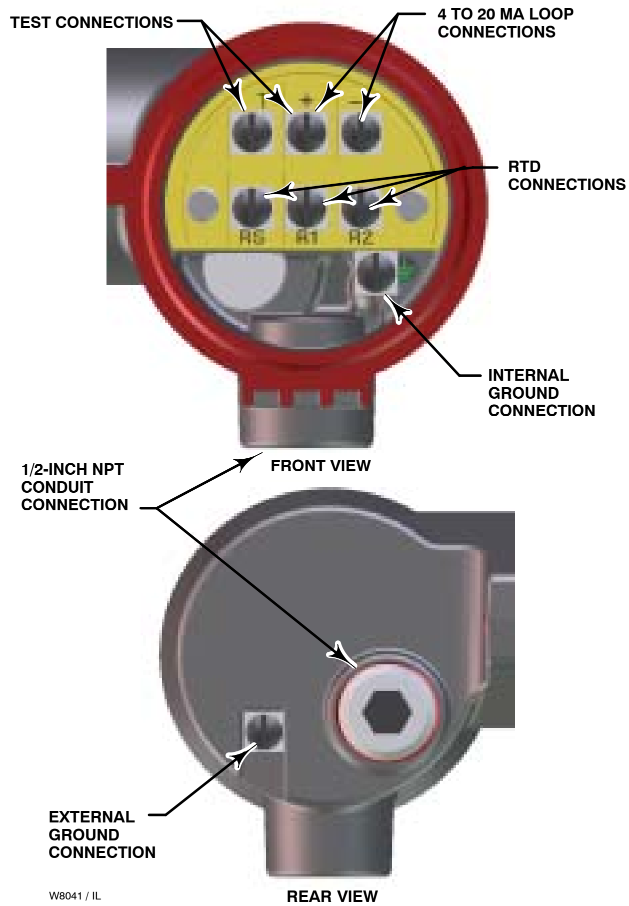


Figure 3-12. Digital Level Controller Terminal Box

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 3-12.

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 3-10. 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 3-12):

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.

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 375 Field Communicator interfaces with the Type DLC3000 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,

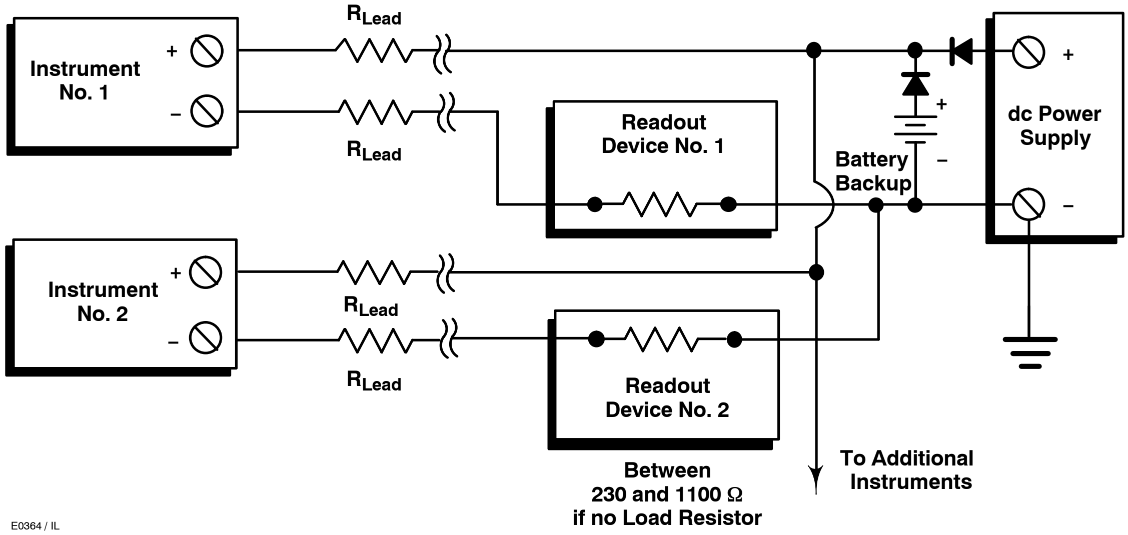


Figure 3-13. Multichannel Installations

attach the device to the loop + and − terminals inside the terminal box to provide local communications with the instrument.

Test Connections

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 terminal box cap before proceeding.

Test connections inside the terminal box can be used to measure loop current across an internal 1 ohm resistor.

1. Remove the terminal box cap.
2. Adjust the test meter to measure a range of 0.001 to 0.1 volts.
3. Connect the positive lead of the test meter to the + connection and the negative lead to the T connection inside the terminal box.
4. Measure Loop current as:

Voltage (on test meter) $\times$ 1000 = milliamps

example:

Test meter Voltage X 1000 = Loop Milliamps

0.004 X1000 = 4.0 milliamperes

0.020 X 1000 = 20.0 milliamperes

5. Remove test leads and replace the terminal box cover.

Multichannel Installations

You can connect several instruments to a single master power supply as shown in figure 3-13. In this case, the system may be grounded only at the negative power supply terminal. In multichannel installations where several instruments depend on one power supply, and the loss of all instruments would cause operational problems, consider an uninterruptible power supply or a back-up battery. The diodes shown in figure 3-13 prevent unwanted charging or discharging of the back-up battery. If several loops are connected in parallel, make sure the net loop impedance does not reach levels that would prevent communication.

Note that to provide a 4−20 mA analog output signal, the DLC3010 must use HART polling address 0. Therefore, if a multichannel installation is used with all transmitters in 4−20 mA output mode, some means must be provided to isolate an individual transmitter for configuration or diagnostic purposes. A multichannel installation is most useful if the instruments are also in multi-drop mode and all signaling is done by digital polling.

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 14B5483X052 and later, the behavior will default to FAIL HIGH when the jumper is missing.

Alarm Jumper Locations

Without a meter installed

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.

With a meter installed

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.

Loop Test  (2−2)

Loop test can be used to verify the controller output, the integrity of the loop, and the operations of any recorders or similar devices installed in the loop. To initiate a loop test, perform the following procedure:

1. Connect a reference meter to the controller. To do so, either connect the meter to the test connections inside the terminal box (see the Test Connections procedure) or connect the meter in the loop as shown in figure 3-10.

2. From the Online menu, select *Diag/Services*, and *Loop Test,* to prepare to perform a loop test.

3. Select *OK* after you set the control loop to manual.

The Field Communicator displays the loop test menu.

4. Select a discreet milliamp level for the controller to output. At the “Choose analog output” prompt, select *4 mA*, *20 mA,* or *Other* to manually input a value between 4 and 20 milliamps.

5. Check the reference meter to verify that it reads the value you commanded the controller to output. If the readings do not match, either the controller requires an output trim, or the meter is malfunctioning.

After completing the test procedure, the display returns to the loop test screen and allows you to choose another output value or end the test.

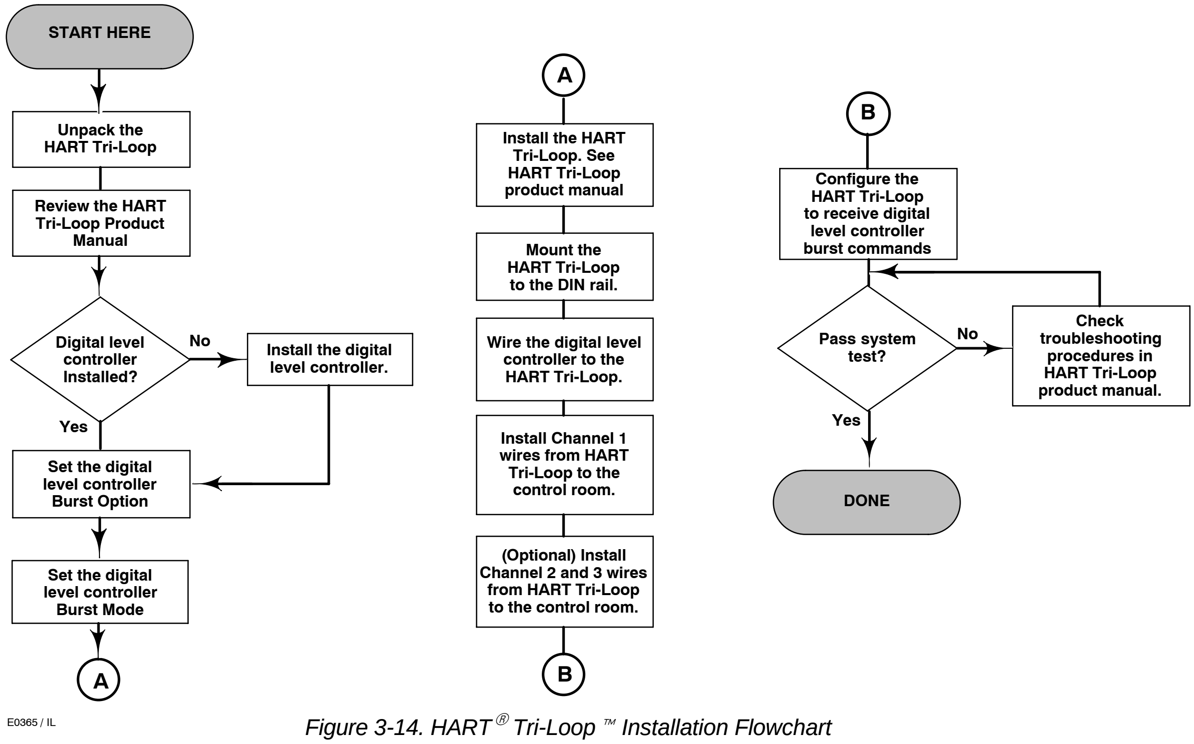


Figure 3-14. HART® Tri-Loop ™ Installation Flowchart

Installation in Conjunction with a Rosemount Model 333 HART® Tri-Loop™ HART®-to-Analog Signal Converter

Use the Type DLC3000 digital level controller in operation with a Rosemount Model 333 HART Tri-Loop™ HART-to-Analog Signal Converter to acquire an independent 4–20 mA analog output signal for the process variable, % range, electronics temperature, and process temperature. The HART Tri-Loop divides the digital signal and outputs any or all of these variables into as many as three separate 4–20 mA analog channels.

Refer to figure 3-14 for basic installation information. Refer to the Model 333 HART Tri-Loop HART-to-Analog Signal Converter Product Manual for complete installation information.

Commissioning the Digital Level Controller for use with the HART® Tri-Loop™

To prepare the digital level controller for use with a Model 333 HART Tri-Loop, you must configure the digital level controller to burst mode, and select the dynamic variables to burst. In burst mode, the digital level controller provides digital information to the HART Tri-Loop HART-to-Analog Signal Converter. The HART Tri-Loop converts the digital information to a 4 to 20 mA analog signal. The HART Tri-Loop divides the signal into separate 4 to 20 mA loops for the primary (PV), secondary (SV), tertiary (TV), and quaternary (QV) variables. Depending upon the burst option selected, the digital level controller will burst the variables as shown in table 3-6.

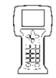
The DLC3010 status words are available in the HART Burst messages. However, the Tri-Loop cannot be configured to monitor them directly.

To commission a Type DLC3010 digital level controller for use with a HART Tri-Loop, perform the following procedure.

Table 3-6. Burst Variables Sent by Type DLC3010

BURST OPTION	VARIABLE	VARIABLE BURST[1]	BURST COMMAND
Read PV	Primary	Process variable (EU)	1
Read PV mA and % Range	Primary	Process variable (mA)	2
	Secondary	Percent range (%)	
Read Dynamic Vars	Primary	Process variable (EU)	3
	Secondary	Electronics temperature (EU)	
	Tertiary	Process temperature (EU)	
	Quaternary	Not used	

1. EU—engineering units; mA—current in milliamperes; %—percent

Set the Burst Operation  *(4-3-1-7)*

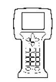
1. From the Online menu, select *Detailed Setup*, *Device Information*, *HART,* and *Burst Option*.

2. Select the desired burst option and press *ENTER*

3. From the *Hart* menu, select *Burst Mode*.

4. Select *On* to enable burst mode and press *ENTER*.

5. Select *SEND* to download the new configuration information to the digital level controller.

Section 4 Setup and Calibration 

Initial Setup

Calibration

4

Detailed Setup

Initial Setup

If a Type DLC3010 digital level controller ships from the factory mounted on a 249 Series 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 will 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, and re-zero the instrument by performing the Mark Dry Coupling procedure.

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. To place the unit in service, unlock the lever assembly and couple the instrument to the sensor. Then perform the Mark Dry Coupling procedure.

To review the configuration data entered by the factory, connect the instrument to a 24 volt dc power supply as shown in figure 3-10. Connect the 375 Field Communicator to the instrument and turn it on. From the Online menu select *Review* then select *Device Params* (Device Parameters). You can then page through the configuration data using the NEXT and PREV keys. If your application data has changed since the instrument was factory-configured, refer to the Detailed 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 4-1)
- Torque Tube Material
- Instrument mounting (right or left of displacer)
- Measurement Application (level, interface, or density)

Note

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

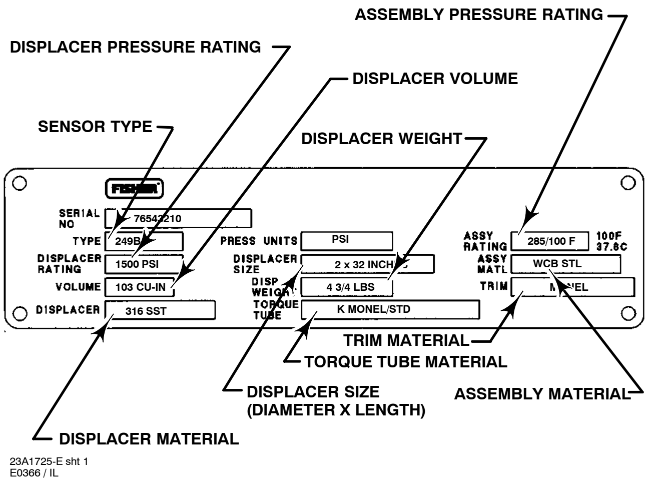


Figure 4-1. Example Sensor Nameplate

Table 4-1. 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
249V (Special)(1)	See serial card	See serial card
249V (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 4-2. If you cannot determine the driver rod length, contact your Emerson Process Management 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 Process Management sales office for the driver rod length. For other manufacturers' sensors, see the installation instructions for that mounting.

Preliminary Considerations

Write Lock

To setup and calibrate the instrument, write lock must be set to *Writes Enabled* with the Field Communicator. (Write Lock is reset by a power cycle. If you have just powered up the instrument Writes will be enabled by default.) To change the write lock, press the Hot Key on the Field Communicator. Select *Write Lock* then select *Writes Enabled*.

Level Offset *(3-3-3)*

The Level Offset parameter should be cleared to zero before running Setup Wizard. To clear Level Offset, select *Basic Setup*, *PV Setup* then select *Level Offset.* Enter the value 0.0 and press *Enter* and *Send.*

Setup Wizard *(3-1)*

Note

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

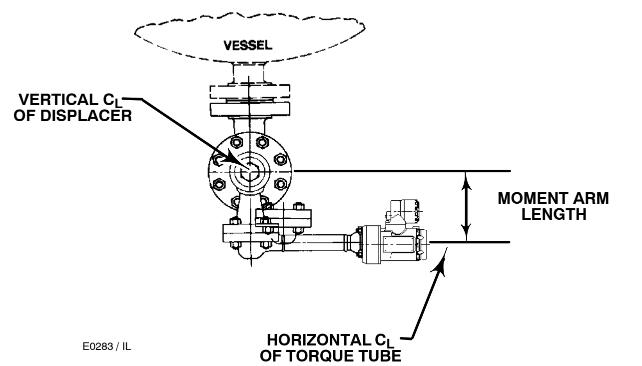


Figure 4-2. Method of Determining Moment Arm from External Measurements

A Setup Wizard is available to aid initial setup. To use the Setup Wizard, from the Online Menu select *Basic Setup* then *Setup Wizard*. 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, shown in figure 4-1. The moment arm is the effective length of the driver rod and depends upon the sensor type. For a 249 Series sensor, refer to table 4-1 to determine driver rod length. For a special sensor, refer to figure 4-2.

1. You are prompted for displacer length, weight, volume units and values, and moment arm length (in the same units chosen for displacer length).

2. You are asked to choose Instrument Mounting (left or right of displacer, refer to figure 3-7).

3. You are asked to select 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. The default upper range value is set to equal the displacer length and the default lower range value is set to zero.

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”.

4. You are asked, “Do you wish to make the instrument direct or reverse acting?”

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.

5. You are given the opportunity to modify the default value for the process variable engineering units.

6. You are now 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).

Note

If Setup Wizard aborts on step 6, clear the Level Offset parameter before restarting Setup Wizard.

7. 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

The PV alarm deadband is set to zero.

The process variable alarms are all disabled.

8. You are asked if temperature compensation is to be used.

a. If you select “No Temperature Compensation”

- If Density mode was chosen, the Setup Wizard is complete.
- If specific gravity temperature compensation tables exist in the instrument, you will be asked if it’s ok to overwrite them with single values.
- 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.

b. If you select “Temperature Compensation”, two data tables are available that may be entered in the instrument to provide specific gravity correction for temperature (see tables 4-3 and 4-4). 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 detailed setup. The Setup Wizard asks if the tables should be used. If not, you must supply a “single point” specific gravity value (or two “single point” values for interface applications).

Note

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

- If Density mode was NOT chosen, you will be presented with the current specific gravity temperature compensation table (or lower fluid specific gravity temperature compensation table if interface application) for editing. You can accept the current table(s), modify an individual entry, or enter a new table manually. For an interface application, the user can switch between the upper and lower fluid tables.

- You are prompted to choose a torque tube material. The instrument loads the default torque tube temperature compensation table for the material chosen. If you choose “Unknown” for the material, the N05500 temperature compensation table is loaded. If you choose “Special” the current table in the instrument will be left unchanged, but the label for the material is changed to “Special”. This feature allows a special user table to be retained without overwriting, but does not allow it to be copied to a stored configuration.

- You are presented with the torque-tube temperature compensation table for editing. You can accept the table, edit an individual table entry, load a temperature compensation table for a different torque tube material, or enter a new table manually. If a temperature compensation table for a different material is chosen, the torque tube material will be updated to reflect the new material chosen. If a new table is entered manually, or an individual entry is modified, then the torque tube material will be changed to “Special.”

Note

In firmware version 07 and 08, the data tables for torque-tube correction are simply stored without implementation. The user may use the information to pre-compensate the measured torque-tube rate manually.

Coupling

After entering the sensor information, the Setup Wizard prompts you to couple the digital level controller to the sensor. If not already coupled, 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 3-5 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 with 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 Mark Dry Coupling 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 3-5 then slide the handle toward the rear of the unit.) Be sure the locking handle drops into the detent.

Calibration

Introduction: Calibration of Smart Instruments

Analog instruments generally have only one interface that can be calibrated by the user. A zero and span output calibration is normally performed at the corresponding two input conditions. Zero/Span calibration is very simple to use, but provides little versatility. If the 0% and 100% input conditions are not available to the user, a calibration can sometimes be accomplished, but the gain and offset adjustments will likely interact, requiring considerable iteration to achieve accuracy. In contrast, intelligent instruments have many interfaces that can be calibrated or scaled by the user, with consequent increased versatility.

Table 4-2. Relationships in the DLC3000 that can be User Calibrated or Configured

Torque Tube Rate	The scale factor between the internal digital representation of the measured pilot shaft rotation and the physical torque input to the sensor.
Reference (dry) Coupling Point	The angle of pilot shaft rotation associated with the zero buoyancy condition. (The zero reference for the input of the PV calculation).
Driver Rod Length	The scale factor (moment arm) between a force input to the sensor driver rod and the torque developed as input to the torque tube.
Displacer Volume	The scale factor relating the density of the process fluid to the maximum force that can be produced as an input to the driver rod of the sensor.
SG	The density of the process fluid normalized to the density of water at reference conditions. The scale factor that transforms displacer volume and measured buoyancy into a level signal normalized to displacer length.
Displacer Length	The scale factor to convert normalized level to level on the displacer in engineering units.
Level Offset	The zero reference for the output of the PV calculation, referred to the location of the bottom of the displacer at zero buoyancy condition.
URV (Upper Range Value)	The value of computed process variable at which a 20 mA output (100% Range) is desired.
LRV (Lower Range Value)	The value of computed process variable at which a 4 mA output (0% Range) is desired.
DAC Trim	The gain and offset of the D/A converter which executes the digital commands to generate output
Elec Temp Offset	Bias to improve the accuracy of the ambient temperature measurement used to provide temperature compensation for the mechanical-to-electronic transducer.
Proc Temp Offset	Bias to improve the accuracy of the (RTD) temperature measurement used to provide compensation for process-temperature-related density changes.

Refer to table 4-2 for a list of relationships in the DLC3000 that can be calibrated or configured by the user. Note that not all relationships are listed here.

These parameters are factory-set to the most common values for the 249 Series products. Therefore, for the bulk of units sold in simple level applications, it is possible to accept the defaults and proceed to a simple zero-and-span operation. If any of the advanced features of the instrument are to be used, accurate sensor and test fluid information should generally be entered before beginning the calibration.

Quick Calibration

The following procedure may be used to calibrate the instrument as an analog transmitter replacement. The output 4 and 20 mA conditions will be related to a given pair of mechanical input conditions only, the PV in engineering units will not be calibrated. This approach will give satisfactory results for many of the simple level measurement applications encountered.

Note

This procedure assumes that you are using the instrument in Level Measurement Mode, even if the process is interface or density.

The SG value used for Level is the actual fluid SG, the SG value used for Interface is the difference between the SGs upper and lower fluid, and, the SG value entered for Density is the difference between the minimum and maximum density range of the application.

1. Connect a 24 V dc supply and make there is between 230 and 1100 Ohms series resistance in the loop. Hook up a 375 Field Communicator (or other HART master) across the instrument terminals or across the series resistor and establish communication with the transmitter.
2. Enter the mounting sense (**4-1-1-1-2**), then *SEND*.
3. Set *Level Offset* to zero (**3-3-3**); then *SEND*.
4. Set *PV is* (**3-3-6**) to LEVEL, then *SEND*.
5. Set *Specific Gravity* (**3-3-5**) to the difference between SGs of the upper and lower fluids.
6. Set up the lowest process condition (or hang weight equal to the displacer weight − minimum buoyancy).
7. Couple to the 249 Series sensor and close the access door (this unlocks the lever assembly).
8. *Mark Dry-Coupling* point (this marks zero differential buoyancy). (**3-2-1**).
9. *Set Zero* (**3-3-2-5-1**).
10. Set up the highest process condition (or hang a weight equal to the displacer weight minus the maximum buoyancy).
11. *Set Span* (**3-3-2-5-2**).
12. Set *Meter Type* to *% Range Only* (**4-2-2-2-3**).

PV Sensor Calibration

If the advance capabilities of the transmitter are to be used, it is necessary to calibrate the PV sensor instead of using the “zero and span” approach. The following is a description of the functionality of the various HART command procedures for calibrating the sensor. Subsequently, we will relate which procedures to use in a given scenario, and in which order to apply them.

Procedures that Affect the Zero of the PV Calculation

Mark Dry Coupling (3-2-1)

This procedure captures the current pilot shaft rotation value and associates it with the zero buoyancy or “dry displacer” condition. (If the pilot shaft is not already physically coupled to the transmitter, perform the mechanical procedure under Coupling first). The Mark Dry Coupling procedure prompts you to hang the displacer, unlock the lever arm, and verify that the displacer is completely dry.

From the Online menu select *Basic Setup, Sensor Calibrate*, and *Mark Dry Coupling*. Follow the prompts on the Field Communicator to mark the dry coupling point.

Note

If the handle on the coupling access door is in the position towards the front of the transmitter, the coupling access hole is open and the lever is “locked” (pinned in the neutral travel position). In this condition, the true “at-rest” position of the linkage may not be captured correctly. Moving the handle to the rear of the transmitter closes the coupling-access hole and unlocks the lever.

The captured number can be read back as the “Reference Coupling Point”. It functions as the pre-calculation zero for the process measurement algorithm. This procedure can be run either before or after most of the gain calibrations, (with the exception of the “single-point” calibration, for which coupling point must have been marked first). However, the procedure returns a valid result at only one input condition − zero buoyancy, although in Level mode, it is equivalent to zero differential buoyancy.

Trim PV Zero (3-2-5)

This procedure computes and adds an offset to the computed process variable, so that the computed value matches the user's external observation of the process measurement. For example (see figure 4-4), if the bottom of the displacer is 4 feet above the bottom of the vessel, and the user's observation is measured from the bottom of the vessel, a Level Offset value of 4 feet would be computed. The liquid level indicated by the PV would then be referenced to the bottom of the vessel. If the Level Offset is 0.0, the reference for the PV measurement is understood to be the location of the bottom of the displacer at the dry condition. Other useful references include the center of the displacer, the system set-point, or even sea level. (It may not be possible to use sea level as a reference in many cases, as there is currently a 100 ft. magnitude limit on the Level Offset parameter).

The Level Offset parameter can also be edited manually under *Basic Setup, PV Setup, Level Offset* (**3-3-3**).

If the computed process variable is biased due to the inability to mark the reference coupling point correctly, (which can happen when the sensor hardware is oversized to provide additional gain for some interface-level applications), the Level Offset (computed by Trim PV Zero or entered manually) can be used to trim out that bias. However, the reasonableness limits (USL, LSL) on the range values are also shifted by the Level Offset. If the magnitude of the Level Offset value exceeds 20% of the displacer length, at least one of the desired range values will no longer be inside the legal range. Checking range values against the USL and LSL is only done when writing the range values, so in systems that use the DLC3000 DD, it is possible to temporarily remove the offset, adjust the range values, and replace the offset afterwards.

Note

On systems that cannot access the Level Offset, and that write the range values automatically during initialization, (such as a DeltaV™ system), it is not advisable to use Trim PV Zero to compensate for an invalid Reference Coupling Point. If a communication drop-out occurs, DeltaV will attempt to write unit and range data to the DLC3000. DeltaV will continuously repeat initialization attempts when a range value is rejected. The other parameters that are successfully written during each iteration will rapidly use up the write-cycle life of the NVM in the DLC3000's microprocessor.

The Level Offset is effectively a post-calculation zero. Therefore, the Trim PV Zero procedure should be performed after the gain calibration, but it may be run at any valid process condition. The range values should be set after running Trim PV Zero if it is being used to shift the zero reference away from the bottom of the displacer. The range values must be set before running Trim PV Zero if it is being used to compensate for an invalid Reference Coupling Point.

Note

The Trim PV Zero command and Level Offset parameter are not available in density measurement mode at firmware revision 8. If displacer sizing for a density application results in an overweight displacer, it will be necessary to set the system up in Level or Interface measurement mode to calibrate effectively. The output of the instrument will only make sense in "% Range" units in such a case, since density units are not available in Level or Interface Mode.

From the Online menu select *Basic Setup, Sensor Calibrate,* and *Trim PV Zero.*

Follow the prompts on the Field Communicator.

1. Adjust the process condition or simulation to any valid and observable value.

2. Enter the external observation of the measurement in the current PV units. The Level Offset is computed and stored.

3. Recheck the upper and lower range values against the USL and LSL. If the offset is being added to shift the physical zero reference, shift the range values by the same amount. If you are trimming out a Reference Coupling Point calibration error, note whether one of the range values has become illegal. If so, it will be necessary to temporarily remove the Level Offset before running the Setup Wizard or changing the range values. If the range values will be written automatically by any system, do *not* use the Trim PV Zero command for trimming out a Reference Coupling Point error. Instead, use Level measurement mode, enter the delta SG between fluids as the system SG, and Mark Dry Coupling point at the lowest process condition. The Reference Coupling Point will then represent the zero *differential* buoyancy condition, and the algorithm will compute the interface level correctly.

Procedures that Affect the Gain of the PV Calculation

Two-Point Sensor Calibration (3-2-2)

This procedure is usually the most accurate method for calibrating the sensor. It uses independent observations of two valid process conditions, together with the hardware dimensional data and SG information, to compute the effective torque rate of the sensor. The two data points can be separated by any span between a few percent to 100%, as long as they remain on the displacer. Within this range, the calibration accuracy will generally increase as the data-point separation gets larger. Accuracy is also improved by running the procedure at process temperature, as the temperature effect on torque rate will be captured. (It is possible to use theoretical data to pre-compensate the measured torque rate for a target process condition when the calibration must be run at ambient conditions.)

An external method of measuring the process condition is required. This procedure may be run before or after marking the coupling point. It adjusts the calculation gain only, so the *change* in PV output will track the change in input correctly after this procedure. However, there may be a constant bias in the PV until the Mark Dry Coupling procedure has been run.

From the Online menu, select *Basic Setup, Sensor Calibrate*, and *Two Point*.

Follow the prompts on the Field Communicator to calibrate the sensor.

1. Put the control loop in manual control.

2. Adjust the process condition to a value near the top or bottom of the valid range.

3. Enter this externally measured process condition in the current PV units.

4. Adjust the process condition to a value near the bottom or top of the valid range, but at a position that is toward the opposite end of the range relative to the condition used in step

5. Enter this second externally measured process condition in the current PV units.

The sensor torque rate is now calibrated. Be sure to verify that there is no bias in the PV calculation and that the upper and lower range values are correct before returning the loop to automatic control.

Single-Point Sensor Calibration (3-2-4)

This procedure uses the previously stored Reference Coupling Point, together with a single independent observation of the current process condition, to compute the sensor torque rate. The Single-Point sensor calibration procedure is useful when the dry condition can only be established during a plant shut down, and/or the process condition is difficult to change during operation. (e.g., a top or side-mounted cageless sensor on a large vessel.)

An accurate means of externally measuring the process condition is required. A valid Reference Coupling Point, (representing either zero buoyancy or zero differential buoyancy), must have been previously stored. Actions that improve the accuracy of this calibration method include:

a. entering the correct displacer information,

b. entering the actual SG of the process fluid, and

c. running the Mark Dry Coupling procedure with the torque tube at the same temperature it will reach under process conditions, (or an accurate simulation of that rotation).

From the Online menu, select *Basic Setup, Sensor Calibrate*, and *Single Point*.

Follow the prompts on the Field Communicator to calibrate the instrument and sensor.

1. Allow the process condition to settle to a stable, non-zero value.

2. Enter the externally measured process condition in the current PV units.

The sensor torque rate is calibrated. Be sure to verify that the upper and lower range values are correct before returning the loop to automatic control. There should be no bias in the PV calculation if the previously stored Reference Coupling Point was accurate.

If the PV does not match the observed process after using this procedure, there is likely to be both a gain error and a bias error present. This is due to a change in the actual zero buoyancy rotation compared to the stored value. If it is possible, repeat the Mark Dry Coupling and Single-Point calibration sequence at process temperature to improve the accuracy.

Wet/Dry Calibration (3-2-3)

The following procedure can be used to calibrate the sensor if the process condition can be changed to the equivalent of a completely dry and completely submerged displacer, but the actual precise intermediate values cannot be observed. (E.g., no sight glass is available, but the cage can be isolated and drained or flooded.)

Correct displacer information and the SG of the test fluid must be entered before performing this procedure. It is only valid in Level measurement mode. It will work for an interface application that has been set up as a Level application using "SG (lower fluid) − SG (upper fluid)" as the calibration SG.

From the Online menu select *Basic Setup*, *Sensor Calibrate*, and *Wet/Dry Cal.* Follow the prompts on the Field Communicator to calibrate the instrument and sensor.

1. Set the control loop for manual control.

2. Enter the specific gravity for the liquid in the system. (Use difference between fluid SGs for an interface application being calibrated in Level measurement mode.)

3. Adjust the liquid level until the displacer is dry (or completely submerged in upper liquid). Allow the output to settle, then acknowledge establishment of the "dry" condition to the system.

4. Adjust the liquid level until the displacer is completely submerged in the lower liquid. Allow the output to settle, then acknowledge establishment of the "wet" condition of the system.

The sensor torque rate is calibrated. If the Mark Dry Coupling procedure was run at the "dry" (or completely submerged in upper liquid) condition, the zero of the PV calculation will be correct also. Verify that the upper and lower range values are correct and return the loop to automatic control.

Weight-Based Calibration (3-2-6)

This procedure may be used on the bench or with a calibration jig that is capable of applying a mechanical force to the driver rod to simulate displacer buoyancy changes. It allows the instrument and sensor to be calibrated using equivalent weights or force inputs instead of using the actual displacer buoyancy changes. If the displacer information has been entered prior to beginning the procedure, the instrument will be able to compute reasonable weight value suggestions for the calibration. However, the only preliminary data essential for the correct calibration of the torque rate is the length of the driver rod being used for the calibration.

Weight equivalent to the net displacer weight at two valid process conditions must be available. The sensor must have been sized properly for the expected service, so that the chosen process conditions are in the free-motion linear range of the sensor. The coupling point should be marked at what is going to be the zero buoyancy weight or the zero differential-buoyancy weight, depending on the calibration approach. The instrument should normally be physically coupled to the pilot shaft at that condition. (However, if the expected operational travel of the pilot is greater than 5 degrees, it is advisable to couple the transmitter to the pilot shaft at the condition representing mid-travel instead. This will prevent hitting a stop in the transmitter before limiting in the sensor.) The Mark Dry Coupling procedure may be run either before or after the Weight-based Cal. However, the PV output is expected to have a bias error until the Reference Coupling Point is correctly marked.

To begin the weight-based calibration select *Basic Setup, Sensor Calibrate,* and *Weight Based Cal* from the Online menu*.*

Follow the prompts on the Field Communicator to calibrate the sensor.

1. For interface level or density measurements, enter the specific gravity of the upper fluid and lower fluid as requested.

2. Place a weight on the displacer rod that is approximately equal to that indicated on the prompt. The suggested weight is equivalent to the effective displacer weight when the liquid is at its lowest level or the displacer is suspended in the liquid with the lower specific gravity.

3. After allowing the system to stabilize, enter the actual value of the weight suspended on the displacer rod.

4. Place a weight on the displacer rod that is approximately equal to that indicated on the prompt. The suggested weight is equivalent to the effective displacer weight when the liquid is at its highest level or the displacer is suspended in the liquid with the higher specific gravity.

5. After allowing the system to stabilize, enter the actual value of the weight suspended on the displacer rod.

The sensor torque rate is calibrated. If the Mark Dry Coupling procedure was performed at the zero buoyancy (or zero differential buoyancy) condition, the zero of the PV calculation will be correct also. Check the range values before putting the loop in service.

Theoretical Calibration

In cases where it is not possible to manipulate the input at all, the user may set up a nominal calibration using information available about the hardware and the process. The theoretical torque rate for the installed torque tube may be looked up and compensated for process temperatures. This value is then manually entered in the instrument configuration. The displacer information and fluid SGs are entered. The desired range values are entered manually. Finally, the Level Offset is adjusted, by using the Trim PV Zero command, to bias the computed PV to the current value of the process. It should be possible to control the loop with this rough calibration.

Note

The theoretical torque rate for the installed torque tube is available in the Supplement to 249 Series Sensors Instruction Manual—Simulation of Process Conditions for Calibration of Level-Trols – Form 5767 (part number D103066X012). Contact your Emerson Process Management sales office for information on obtaining this manual supplement.

Observations of the sight glass or other independent measurements may be logged against DLC outputs over time. The ratio of the independent-observable process changes to the DLC output changes may then be used as a scale factor to modify the theoretical torque rate stored in the instrument. After each gain adjustment, a new zero trim will be required. When a plant-maintenance shutdown occurs, the instrument may be isolated and calibrated in the normal manner.

Note

This method can cause problems with the Setup Wizard and with DeltaV, because the Level Offset will move the USL and LSL (reasonableness checks on the range values). If the required Level Offset is greater than 20% of the displacer length, one of the desired range values will appear illegal to the DLC. This reasonableness check is only performed while writing a range value, so the Setup Wizard can be accommodated by temporarily removing the Level Offset and replacing it after the procedure is complete. DeltaV does not have access to the Level Offset, so this method is not advisable in a DeltaV application, or with any similar HART-based control system that does not have access to the specific DLC3000 device description.

Ranging Operations

The Set Zero and Set Span procedures capture the existing (engineering unit) PV values when they are run, and use them to compute scale and offset for the conversion of PV to %-range and mA-output commands. These procedures are provided for treating the instrument like a conventional analog transmitter. They are not normally used when running a full sensor calibration. When the full capability of the transmitter is used, it is usually better to edit the range values directly.

To modify the output span with respect to the digital PV, press the Hot Key and select *Range Values*, or, from the Online menu, select *Basic Setup*, *PV Setup*, and *PV Range*. Follow the prompts on the Field Communicator to edit the URV and/or LRV.

Temperature Calibration (2-4-2)

This procedure allows you to display the temperature as measured by the instrument. You can then trim the temperature reading so that it matches the actual temperature more closely in the region of interest. (This is an offset adjustment only. There is no ability to change the gain.)

This calibration is initially performed at the factory. Performing it in the field requires an accurate independent measurement of the instrument housing temperature or process temperature, (as appropriate). The instrument should be at a steady-state condition with respect to that temperature when performing the procedure.

Note

The effectiveness of the instrument electronic temperature compensation depends upon the accuracy of the electronics temperature offset stored in the NVM (non-volatile memory). If the electronics temperature is incorrect, the temperature curve applied to the magnets and Hall sensor will be misaligned, resulting in over- or under-compensation.

From the Online menu select *Diag/Service, Calibration,* and *Temp. Calibration*. Follow the prompts on the Field Communicator to trim the temperature readings.

1. Display the temperature reading:

- To display the process temperature reading, select *Process Temp*.
- To display the electronics temperature reading, select *Elect Temp*.

2. When you have noted the temperature reading, press *EXIT*.

3. If necessary, trim the temperature reading:

- To trim the process temperature reading, select *Proc Temp Offset*.
- To trim the electronics temperature reading, select *Elect Temp Offset.*

4. Enter the difference between the actual temperature and the reading noted in step 2.

Manual Entry of Process Temperature (4-1-3-2)

If a process temperature sensor (RTD) is not installed, it is possible to manually set the Digital Process Temperature variable to the target process temperature. This value will be used by any SG-compensation tables that the user has entered. If no compensation tables are active, the Digital Process Temperature value may be used to document the process temperature at which the instrument was calibrated, or the process temperature for which the stored torque rate is pre-compensated.

From the Online menu select *Detailed Setup*, *Sensors*, *Process Temp*, *Digital Proc Temp*. Follow the prompts on the Field Communicator to edit the Digital Proc Temp.

Output DAC Calibration: Scaled D/A Trim (2-4-3)

This procedure allows trimming the gain and offset of the Digital-to-Analog (D/A) converter to adjust the accuracy at which the output follows 4 to 20 mA current commands from the firmware. This relationship is initially set in the factory, and should not require frequent user adjustment. Reasons for using this procedure include:

- Correction for component aging after the instrument has been in service for an extended period.
- Adjusting D/A calibration to be optimum at the normal operating temperature, when that temperature is considerably removed from room temperature conditions.

The procedure is iterative, and will eventually reach a resolution limit where attempts to improve the result will cycle at a few decimal places to either side of the target.

From the Online menu select *Diag/Service*, *Calibration*, *Scaled D/A Trim*. Follow the prompts on the Field Communicator to trim the D/A output.

1. Scale the output from 4 to 20 mA? If your reference meter is graduated in “mA”, select *Proceed* and go to step 5. If the reference reading is presented in some other unit system, such as “%” or “mm”, select *Change* and continue with step 2.

2. Enter the scale low output value.

3. Enter the scale high output value.

4. If the high and low output values are correct, select *Proceed* and continue to step 5. If they are not correct, select *Change* and return to step 2.

5. Connect a reference meter across the test connections in the terminal box. See the Test Connections procedure in the Installation section. You can also connect a reference meter in the loop as shown in figure 3-10.

6. The Field Communicator commands the instrument to set its output to 4 mA or the low output value.

7. Enter the reading from the reference meter.

8. If the reference meter reading equals 4 mA or the low output value, select *Yes* and continue to step 9. If not, select *No* and return to step 7.

9. The Field Communicator commands the instrument to set its output to 20 mA or the high output value.

10. Enter the reading from the reference meter.

11. If the reference meter reading equals 20 mA or the high output value, select *Yes* and continue to step 12. If not, select *No* and return to step 10.

12. The Field Communicator commands the instrument to set its output back to the original value.

Calibration Examples

Level Application—with standard displacer and torque tube, using water as test fluid

Standard practice is to initially calibrate the system at full design span to determine the sensitivity of the sensor/transmitter combination. (This practice has traditionally been called “matching”). The data is recorded in transmitter non-volatile memory. The instrument may then be set up for a target fluid with a given specific gravity by changing the value of SG in memory. 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.

1. From the Online menu select: *Basic Setup, PV Setup, Level Offset* (**3-3-3**). Set Level Offset to 0.00, press *ENTER* and *SEND.*

2. Run through Setup Wizard (**3-3-1**) and verify that all sensor data is correct.
Select Application = *Level, Direct Action.*
Use No temperature compensation.
Enter SG = 1.0 (for water) or actual SG of of test fluid if different than 1.0

3. After completing the Setup Wizard, raise the test fluid level to the process zero point, (e.g., if connection style is 1 or 3, up to the centerline of the lower side connection. It is often possible to watch the display and/or current output to recognize when the fluid hits the displacer, because the output will not start moving upward until that point.)

From the Online menu select: *Basic Setup*, *Sensor Calibrate*, *Mark Dry Coupling* point (**3-2-1**).

Follow all prompts, making sure that the coupling access door is closed to unlock the lever assembly and allow it to freely follow the input.

4. Select the *Wet/Dry* calibration (item **3**) from the *Sensor Calibration* menu, and confirm that you are in the “Dry” condition at the prompt.

After the “Dry” point has been accepted, you will be prompted to completely cover the displacer with test liquid. (The *completely covered* condition should be higher than the 100% level mark to work correctly. e.g., 15 inches above the zero mark would generally be enough for a 14 inch displacer, because the amount of displacer rise expected is ∼0.6 inch.)

Accept this as the “Wet” condition.

5. Adjust the test fluid level and check the instrument display and current output against external level at several points to verify the level calibration.

a. For bias errors, try re-marking the “coupling point” at the exact zero level condition.

b. For gain errors, try repeating the wet/dry sensor calibration. If the output doesn’t come off 4 mA until the level is considerably above the bottom of the displacer, it is possible that the displacer is overweight and is lying on a travel stop until enough buoyancy is developed to allow the linkage to move.

After the calibration, edit the SG parameter (**3-3-5**) to configure the instrument for the target process fluid. The sensor is calibrated.

Interface Application—with standard displacer and torque tube

This procedure assumes that process temperature is near ambient temperature and that the displacer is not overweight for the torque tube. If these assumptions are not correct for your installation, refer to the temperature correction or overweight displacer procedures in this section.

1. From the Online menu select *Basic Setup, PV Setup, Level Offset*. Set Offset to 0.00 in., press *ENTER* and *SEND*.

2. Run through the Setup Wizard and verify all displacer data is correct.
Select Application = *Level, Direct Action*
Use No temperature compensation.
Enter SG =1.0 or actual SG of test fluid if different than 1.0

3. After completing the Setup Wizard, put a little of test fluid in the dry cage (up to CL [centerline] of lower side connection if connection style is 1 or 3, or just barely to bottom of displacer if the style is not 1 or 3). From the Online menu select *Basic Setup, Sensor Calibrate, Mark Dry Coupling Point* (**3-2-1**). Follow all prompts.

4. Fill the cage with test liquid to near top of displacer. From the Online menu select: *Basic Setup, Sensor*

Calibration, Single Point (**3-2-4**). Follow the prompts and enter the actual test liquid level in the currently selected engineering units.

5. Adjust test fluid level and check instrument display and current output against external level at several points to verify the level calibration. If the display is slightly inaccurate:

a. For bias errors, try re-marking the coupling point at the zero level condition.

b. For gain errors, try using the two-point sensor calibration to trim the torque tube rate. Use two separate fluid levels, on the displacer, separated by at least 10 inches.

6. When the water calibration is as accurate as you can get it, bring the actual lower process fluid to the zero interface level position and fill the rest of the cage with the actual lighter process liquid (the upper fluid).

The output in % should now be approximately:

100 * SGupperfluid / SGlowerfluid

From the Online menu select *Basic Setup, PV Setup, PV is* (**3-3-6**). (Note: if *PV is* has been set to density, the menu selection for *PV is* is **3-3-4**.) Select Interface, press *ENTER* and *SEND*.

7. From the PV Setup menu (where you should be after finishing PV is selection), select the *Specific Gravity* menu. Use single point entry method, and enter the SG of the lower fluid and the SG of the upper fluid respectively at the prompts.

8. If you are using the actual upper fluid, make sure the displacer is completely covered.

If you are simulating the upper fluid with water, you will need to fill the cage to SGupperfluid times displacer length plus a little extra to account for the amount that the displacer rises because of the increase in buoyancy.

Note

Information on computing precise simulation of this effect is available in the Supplement to 249 Series Sensors Instruction Manual—Simulation of Process Conditions for Calibration of Level-Trols – Form 5767 (part number D103066X012). Contact your Emerson Process Management sales office for information on obtaining this manual supplement.

From the Online menu select *Basic Setup, Sensor Calibrate, Trim PV Zero* (**3-2-5**).

Enter 0.0 inches. This will trim out the displacer rise correction at the minimum buoyancy condition. (Check the Level Offset variable, to see how much correction was made. If the Level Offset exceeds 20% of displacer length there may be problems when using DeltaV [see the notes on pages 4-18 and 4-19 regarding DeltaV interaction]. However, the fraction of an inch that is trimmed out here will not hurt. This step is taken to make sure that a 4 mA output will be produced at the lowest measurable process condition. Since the output will not change any more for interface levels dropping below the bottom of the displacer, we arbitrarily re-label that point as zero. An alternative approach is to adjust the range values slightly to get 4 mA out at the lowest possible computed PV.

9. The sensor is calibrated. Check output against input to validate reconfiguration to Interface mode.

Interface Application—with an overweight displacer

An interface application can be mathematically represented as a level application with a single fluid whose density is equal to the difference between the actual fluid densities.

1. From the Online menu select *Basic Setup, PV Setup* (**3-3**).

2. Set *Level Offset* (**3-3-3**) to zero.

3. Set the *range values* (**3-3-2**) to: LRV = 0.0, URV = displacer length.

4. Mark the coupling point at lowest process condition (displacer completely submerged in the upper fluid−NOT dry).

5. Set *PV is* (**3-3-6**) to Level.

6. Set *Specific Gravity* (**3-3-5**) to the difference between the 2 fluid SGs. (For example, if SG upper = 0.87 and SG lower = 1.0, the specific gravity to enter is 0.13).

7. Use any of the sensor calibration methods to calibrate torque tube rate, but use actual process fluids, (or use a single test fluid to set up buoyancy conditions simulating the process conditions you are reporting to the instrument.) From the Online menu select *Basic Setup, Sensor Calibrate* (**3-2**).

Note

Information on simulating process conditions is available in the Supplement to 249 Series Sensors Instruction Manual—Simulation of Process Conditions for Calibration of Level-Trols – Form 5767 (part number D103066X012). Contact your Emerson Process Management sales office for information on obtaining this manual supplement.

8. Trim the PV Zero with actual process:

   a. Adjust the process so you have an interface in the sight glass.

   b. From the Online menu select *Basic Setup, Sensor Calibration, Trim PV zero*.

   c. Enter the measured value at the prompt.

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 unit on a stop.

Wet/dry: “Dry” now means submerged in the lightest fluid and “wet” means submerged in the heaviest fluid.

Single-point: Set up any valid process condition that you can independently measure, (other than the condition that matches the coupling point). The higher the data point is, the better the resolution will be.

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. In this case you would not be able to mark the coupling point at the 0% interface condition. Because this means you will need a large offset to trim the PV to the process condition, there is no advantage to using the differential SG approach. The large offset requirement also means that this approach is not appropriate for use with DeltaV.

Trim PV Zero: If you are trimming PV zero with an initial offset in place, be sure to report the independent level measurement with the same zero reference established by that initial offset. For example, if you manually put in an offset to make the instrument report level from the bottom of the tank, then when you are doing a zero trim you must measure from the bottom of the tank to the sight glass level. If you measure from the bottom of the displacer, the instrument will take out your initial offset.

Density Applications – with Standard Displacer and Torque Tube

Note

You will need to select PV Units when changing from level or interface to density. After sending the information, it is necessary to back out of the handheld menu that shows SG and Level Offset, and then re-enter that menu and select Range Values. The range values will need to be edited to provide reasonable magnitude in the new unit system.

If the displacer is overweight, there is no way to get the output numerically correct in density mode, because the Level Offset is not available. Therefore, density calibration normally has to begin with the assumption that the displacer is free moving at zero buoyancy (dry) conditions. “Mark” the coupling point accurately at dry displacer conditions, and any of the four sensor calibration methods (weight-based, wet/dry, single-point, and two-point) can be used in density mode. The terminology can be confusing, because it usually refers to a “level” as the process condition to set up. When using one of these method, remember that you are in the density mode and enter observed PV in current units of SGU, g/L, lb/in^3, kg/m^3, etc.

Weight Based: The weight-based method 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.

Wet/dry: The wet/dry method essentially reverts to level mode during the calibration process. It asks for the SG of your test fluid first. Then, it has you set up first a dry and then a completely submerged displacer condition.

Single-point: When using the single-point calibration, you must report the density condition in current PV units when it asks you for the "level" in current PV units. In order for for single-point calibration to work, the coupling point must have been previously "marked" at the zero buoyancy state.

Two-point: The two-point calibration method 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. Because of this inconvenience, and the extra work of draining and flooding with two fluids, the two-point calibration method is probably the least attractive in density mode.

Note: These calibration methods advise you to trim PV zero for better accuracy. That command is not available in density mode.

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 trim the output offset 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 offset trim 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.

There are a number of calibration methods available in the DLC3000 Device Description. 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 even a few inches, 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.

Note

This approach is not recommended for use with DeltaV. It results in a large value being entered in the Level Offset parameter, which can trigger a recursive attempt to write range values to the digital level controller after a communications glitch. The non-volatile memory write-cycle life in the instrument will be exhausted rapidly.

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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. (Driver rod length is called "*Disp Rod*" in the DD menus. It 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 the Setup Wizard 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. It is not necessary to run the Mark Dry Coupling procedure, because it stores the current torque tube angle as the zero buoyancy condition, and will therefore 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 Entering Theoretical Torque Tube (TT) Rates procedure in this section), and enter it in the instrument memory. The value can be accessed in the *Review Menu* under *Factory Settings*.

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 Supplement to 249 Series Sensors Instruction Manual—Simulation of Process Conditions for Calibration of Level-Trols – Form 5767 (part number D103066X012). Contact your Emerson Process Management sales office for information on obtaining this manual supplement.

6. Now using a sight glass or sampling ports, obtain an estimate of the current process condition. Run the Trim PV Zero procedure and report the value of the actual process in the PV engineering units. (for example, sight glass reads 11 inches.) The instrument will compute an offset to trim out the difference between your value and it's calculation, and store it in the *Level Offset* parameter.

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 PV Zero procedure to correct the offset, and observe results for another extended period to see if further iteration is required.

Entering Theoretical Torque Tube (TT) Rates

The Supplement to 249 Series Sensors Instruction Manual—Simulation of Process Conditions for Calibration of Level-Trols, Form 5767, provides the theoretical composite torque tube (TT) rate for 249 Series sensors with Type DLC3010 controllers. These numbers are nominal values. They should be within 10% of the values that the instrument would compute when you perform a sensor calibration. They will be less accurate for the long torque tubes (Type 249K, L, N, V, and P), especially with thin-wall constructions.

If you are unable to perform a sensor calibration during installation, you may enter the values into the instrument at the following menu item in the handheld:

Review, Factory Settings, TT rate (**5-4-1**)

Then, manually set the LRV and URV to the PV values at which you desire 4 and 20 mA output, respectively.

Basic Setup, PV Setup, PV Range, URV LRV (**3-3-2-2**)

Next, perform a *Trim PV Zero* operation to align the instrument output with the sight glass reading.

Basic Setup, Sensor Calibrate, Trim PV Zero (**3-2-5**)

These steps will provide an approximate PV calibration to get a system operational. Further refinements can then be made when it is possible to manipulate and observe the level and instrument output.

Note

This approach is not advised when using the HART interface in a DeltaV installation, because the computed Level Offset can exceed 20% of displacer length, making one of the range values appear invalid during the DeltaV initialization process. This can lead to repetitive re-initialization attempts, using up the write-cycle life of the instrument NVM.

Accuracy Considerations

Effect of Proportional Band

If you are operating at low Proportional Band [PB = 100% times (full span torque tube rotation) / (4.4 degrees)], you can expect a degradation factor of about (100%)/(PB%) on the Transmitter accuracy specifications.

Note

This formula is most correct for linearity errors that are relatively steep-sided. If the linearity error curve shape is simple with relatively gradual slope, the net effect of reducing span may be less. Instruments such as the DLC3000, that use a compensation technique to reduce the residual mechanical or electrical non-linearity, will generally have a complex shape for the net-error curve.

If this is too much degradation, an improvement of 2.0 can be obtained by using a thin-wall torque tube. Additional gain can be achieved by increasing the displacer diameter. Available clearance inside the cage, and the need to keep the net displacer weight at the highest and lowest process conditions within the usable range of the torque tube / driver rod combination, place practical limits on how much the sizing can be adjusted.

With an overweight displacer, the calibration process becomes more difficult, (because the zero buoyancy condition will occur with the linkage driven hard into a travel stop). In interface measurement mode it becomes impossible to mark the “dry” coupling point correctly or use the single-point calibration. One simple and effective solution is to use Level measurement mode. Mark the coupling point at the lowest process condition instead of zero buoyancy, and enter the differential SG = (SGlowerfluid − SGupperfluid). The algorithm then computes level correctly.

Density Variations in Interface Applications

A high sensitivity to errors in the knowledge of fluid density can develop in some interface applications. For example: Suppose the whole input span is represented by an effective change in SG of 0.18. Then a change in the actual SG of the upper fluid from 0.8 to 0.81 could cause a measurement error of 5.6% of span at the lowest interface level. The sensitivity to the knowledge of a fluid density is maximum at the process condition where that fluid covers all of the displacer, and zero at the opposite extreme process condition.

If the fluid density changes are batch-related or very gradual, it may be practical to keep track of the SG of the fluid and periodically reconfigure the transmitter memory to match the actual process condition. Frequent automatic updates to this variable are not advised, as the NVM location where it is stored has an expected lifetime of about 10,000 write operations. If changes are only a function of temperature, the characteristic of the fluid can be loaded once in the NVM table, and an RTD connected to measure the process temperature and drive the correction table. If temperature is not the driving influence, the best that can be done is to calibrate for the widest potential differential SG. (This will keep the variations as small a percentage of calibrated span as possible.) Then calculate an alarm threshold that will prevent vessel over- or under-flow at the worst case error.

Extreme Process Temperatures

For applications that will run at extreme temperatures, the effect of process temperature on the torque tube must be taken into account. Best results are obtained by running the torque tube calibration at actual process temperature. However, the decrease in spring rate with temperature can be simulated at room temperature by increasing the load on the torque tube during room-temperature calibration. This will produce the same deflection that would occur at actual process conditions. This compensation is theoretical and not perfect, but is still an improvement over ambient calibration with no attempt at compensation.

Note

For additional information, refer to the Supplement to 249 Series Sensors Instruction Manual—Simulation of Process Conditions for Calibration of Level-Trols − Form 5767 (part number D103066X012). Contact your Emerson Process Management sales office for information on obtaining this manual supplement.

Temperature Compensation

If the process temperature departs significantly from calibration temperature, you will need to apply a correction factor. Refer to Temperature Compensation at the end of this section for detailed setup information.

Detailed Setup

The DLC3000 Series digital level controller has the capability to communicate via the HART protocol. This section describes the advanced features that can be accessed with the Model 375 Field communicator. The *Basic Setup* and *Detailed Setup* selections from the Online Menu allow you to configure the digital level controller to your application.

Setting Protection

Changing setup parameters may require enabling writing to the instrument with the Field Communicator. To change the write protection, press the Hot Key and select *Write Lock*, or, from the Online menu, select *Diag/Service, Write Lock.* Select *Writes Enabled* to enable writing setup and calibration data, or select *Writes Disabled* to disable writing data. Not that cycling power will clear the Write Lock condition to “Writes Enabled”.

Setting Up the Sensor

Entering Displacer Data (4-1-1-1)

To enter displacer data, from the Online menu select *Detailed Setup*, *Sensors*, *Displacer*, and *Displacer Info*. Follow the prompts on the Field Communicator display to enter *Displ Units* (Displacer Units), *Length* (Displacer Length), *Volume* (Displacer Volume), *Weight* (Displacer Weight), and *Disp Rod* (Displacer Rod Length).

- *Displ Units*—Permits setting the units of measure for the displacer length (feet, meters, inches, or centimeters), volume (liters, cubic inches, cubic millimeters, or milliliters) and weight (grams, kilograms, pounds, or ounces).

- *Length*—Enter the displacer length from the sensor nameplate. See figure 4-1.

- *Volume*—Enter the displacer volume from the sensor nameplate. See figure 4-1.

- *Weight*—Enter the displacer weight from the sensor nameplate. See figure 4-1.

- *Disp Rod*—Enter the displacer rod length. The displacer rod length depends upon the sensor type. For a 249 Series sensor, obtain the displacer rod length from table 4-1 or from the Field Communicator Help. Refer to figure 4-2 to physically measure this value.

Entering Torque Tube Data (4-1-2)

To enter torque tube data, from the Online menu select *Detailed Setup*, *Sensors*, and *Torque Tube*. Select *Material* (Torque Tube Material) to display the torque tube material or *Change Materia*l to Change the torque tube material.

- *Material*—Displays the torque tube material currently stored in the instrument.

Note

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

- *Change Material*—Enter the sensor torque tube material. You can also load a table with the material temperature coefficients. You can select to load the table with the defaults, or, if you select No, you can enter the torque tube temperature coefficient values. To enter the torque tube material temperature coefficients, from the Online menu select *Review*, *Factory Settings,* and *TTube Temp. Coeff* (Torque Tube Temperature Coefficient).

Specifying Instrument Mounting (4-1-1-2)

To indicate on which side of the displacer the instrument is mounted, from the Online menu select *Detailed Setup, Sensors, Displacer,* and *Inst Mounting*. Specify if the instrument is to the right or left of the displacer. See figure 3-7.

Process Temperature Indications

The digital level controller can receive the process temperature from a resistance temperature detector (RTD) connected to the unit or, if no RTD is connected to the unit, you can enter the process temperature directly. The digital level controller uses the process temperature to make specific gravity corrections.

Entering RTD Data (4-1-3-1)

If an RTD is connected to the digital level controller, select *Detailed Setup*, *Sensors*, *Process Temp,* and *Process Temp RTD*. Follow the prompts on the Field

Communicator display to indicate an RTD is installed. Enter the type of RTD; either 2-wire or 3-wire.

For a 2-wire RTD, you must specify the connecting wire resistance. If you know the resistance, select *Resistance* and enter the resistance of the wire. 250 feet of 16 AWG wire has a resistance of 1 ohm. If you do not know the resistance, select *Wire Gauge/Lngth* and the Field Communicator will prompt you for the length and gauge of the wire and calculate the resistance.

Setting Temperature Units (3-3-1-2)

To enter the temperature units, select *Basic Setup*, *PV Setup, PV & Temp Units,* and *Temp Units.* Select either *degC* (degrees centigrade) or *degF* (degrees Fahrenheit). Note that when using degF, the Temperature Alarm Deadband parameter is incorrectly displayed with a 32° bias.

Setting Up the Instrument for the Application

Selecting the Process Variable (3-3-6)

The DLC3000 Series digital level controller can be used for level, interface level, or density measurements. To select the process variable to fit the application, from the Online menu select *Basic Setup*, *PV Setup,* and *PV is*. (Note: if *PV is* has been set to density, the menu selection for *PV is* will be **3-3-4**.) Follow the prompts on the Field Communicator display to select *Level, Interface*, or *Density*.

Setting PV Engineering Units

To set process variable units, press the Hot Key and select *PV Setup*, or, from the Online menu, select *Basic Setup*, and *PV Setup.* Select *PV & Temp Units*. The menu selection appears as one of the following:

- *Level Units*—if the PV is level,
- *Interface Units*—if the PV is Interface, or
- *Density Units*—if the PV is Density.

You can select from the following units:

Process Variable Units

For density measurement:
g/cm^3—grams per cubic centimeter
kg/m^3—kilograms per cubic meter
lb/gal—pounds per gallon
lb/ft^3—pounds per cubic foot
g/mL—grams per milliliter
kg/L—kilograms per liter
g/L—grams per liter
lb/in^3—pounds per cubic inch
SGU—specific gravity units

For level and interface measurement:
ft—feet
m—meters
in—inches
cm—centimeters
mm—millimeters

Displacer Units

Weight:	Volume:
g—grams	liter—liters
kg—kilograms	in^3—cubic inches
lb—pounds	mm^3—cubic millimeters
oz—ounces	mL—milliliters

Length:
(Same as level and interface process variable units.)

Torque Tube Rate Units

lbf-in per deg—pounds-force inches per degree rotation
newton-m per deg—newton-meters per degree rotation
dyne-cm per deg—dyne−centimeters per degree rotation

Setting PV Range (3-3-2)

Instrument Action

Two methods are available for setting the range. You can enter the upper and lower range values, in engineering units, as described below or, if you are able to raise and lower the level, perform the Setting Zero and Span procedure.

Reverse Action

To obtain reverse action, set the lower range value higher than the upper range value. This is easiest to do in the Setup Wizard.

Entering the Upper and Lower Range Values

Press the Hot Key and select *Range Values*, or, from the Online menu, select *Basic Setup*, *PV Setup,* and *PV Range*. Follow the prompts on the Field Communicator display to enter *URV* (Upper Range Value), *LRV* (Lower Range Value), and to display the *LSL* (Lower Sensor Limit), and *USL* (Upper Sensor Limit).

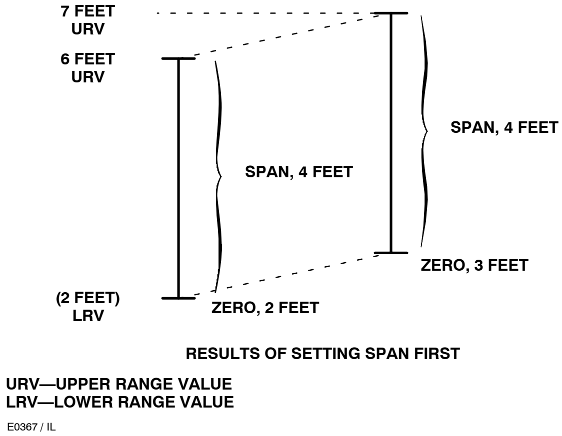


Figure 4-3. Relationship of Zero and Span to Upper and Lower Range Value

- *URV*—Defines the operational end point from which the Analog Value, and the 100% point of the percent range are derived.

- *LRV*—Defines the operational end point from which the Analog Value, and the 0% point of the percent range are derived.

- *LSL*—Indicates the minimum usable value for the Lower Range Value.

- *USL*—Indicates the maximum usable value for the Upper Range Value.

When you have finished editing the range values, press the *SEND* key. The ranging operation is complete. Do not continued to the *Set Zero / Set Span* commands after changing the range values manually.

Setting Zero and Span (3-3-2-5)

If you are able to raise and lower the liquid level or change the density between 0 and 100%, you can use Set Zero and Span to set the operational range.

Always set the zero first, then the span. If you set the span first, the upper range value will shift when you set the zero. For example, refer to figure 4-3, suppose the zero is set to 2 feet from a previous ranging. If you set the span at 4 feet then the lower range value is 2 feet and the upper range value is 6 feet. The span is 4 feet (6 − 2 = 4). If you now set the zero at, say 3 feet, the span is still 4 feet so the upper range value will shift to 7 feet (3 + 4 = 7). However, if you set the zero first then the span, the lower range value (zero) will stay fixed while you set the upper range value (span).

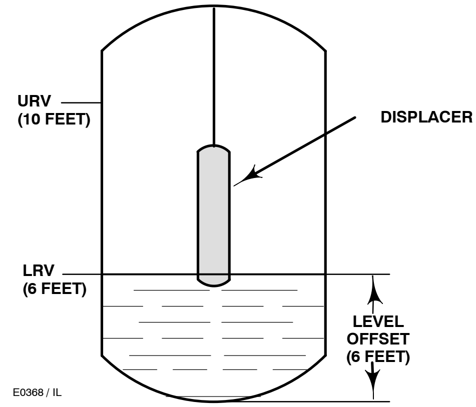


Figure 4-4. Example of the Use of Level Offset

To set zero and span select *Basic Setup*, *PV Setup*, *PV Range,* and *Set Zero and Span* from the Online menu. Follow the procedure to set zero and span.

Setting Zero

1. Select *Set Zero* from the *Set Zero and Span* menu.
2. Set the control loop for manual control.
3. Set the process variable (level, interface, or density) to the lower range value.
4. Press OK on the Field Communicator.
5. Perform the Setting Span procedure.

Setting Span

1. Select *Set Span* from the *Set Zero and Span* menu.
2. Set the control loop for manual control.
3. Set the process variable (level, interface, or density) to the upper range value.
4. Press OK on the Field Communicator.
5. Return the control loop to automatic control.

Setting Level Offset

Adding a level offset permits the process variable engineering units to correspond to the externally measured level or interface (see figure 4-4). To add a Level offset, press the Hot Key and select *PV Setup*, or, from the Online menu, select *Basic Setup*, *Level Setup*. Select *Level Offset* and follow the prompts on the Field Communicator to enter the offset value. If you set the level offset after you have set the range values, be sure to verify that the range values are still correct.

4

Note

If you can manipulate the level, you can also add a level offset by performing the Trim PV Zero procedure in the Calibration section.

Note

On systems that cannot access the Level Offset, and that write the range values automatically during initialization, (such as DeltaV), it is not advisable to use Trim PV Zero to compensate for an invalid Reference Coupling Point. The *Level Offset* will move the USL and LSL (reasonableness checks on the range values). If the required Level Offset is greater than 20% of the displacer lengths, one of the desired range values will appear illegal to the DLC. If a communication drop-out occurs, DeltaV will attempt to write unit and range data to the DLC. DeltaV will continuously repeat initialization attempts when a range value is rejected. The other parameters that are successfully written during each iteration will rapidly use up the write-cycle life of the NVM in the DLC3000's microprocessor.

Setting PV Damping (3-3-4)

PV Damping changes the response time of the controller to smooth variations in output readings caused by rapid changes in input. Determine the appropriate damping setting based on the necessary response time, signal stability, and other requirements of the loop dynamics of your system. The default damping value is 0.2 seconds. and can be reset to any value between 0 and 16 seconds in 0.1 second increments. When set to 0, the damping function is off.

To set PV damping select *Basic Setup, PV Setup,* and *PV Damp* from the Online menu.

Net instrument response is a combination of analog input filtering and output filtering.

Table 4-3. Example Specific Gravity vs Temperature Table for Saturated Water

Data Point	Temperature °C	Temperature °F	Specific Gravity
1	26.7	80.0	0.9985
2	93.3	200.0	0.9655
3	176.7	350.0	0.8935
4	248.9	480.0	0.8040
5	304.4	580.0	0.7057
6	337.8	640.0	0.6197
7	354.4	670.0	0.5570
8	365.6	690.0	0.4940
9	371.1	700.0	0.4390
10	374.7	706.5	0.3157

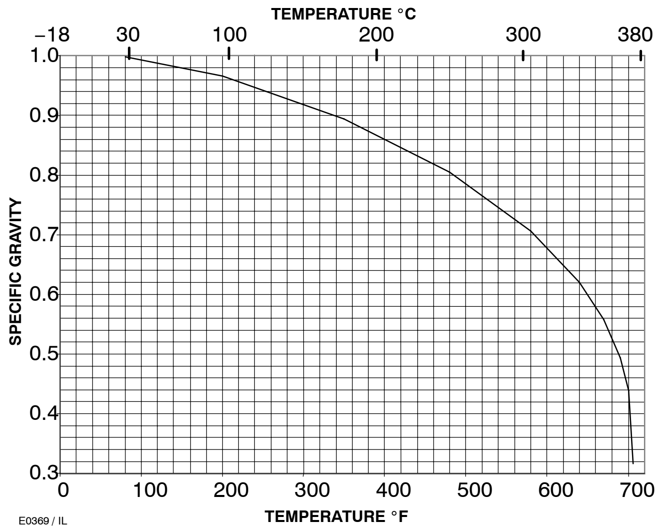


Figure 4-5. Example Saturated Water Curve Plotted with Values from Table 4-3

Setting Response (5-4-4)

From the Online menu select *Review, Factory Settings*, and *Input Filter.* Follow the prompts on the Field Communicator display to configure the input filter.

- *Input Filter*—Time constant for the input filter, in seconds, for the A/D measurement. The filter is applied before PV processing, after the A/D conversion. Range is 0 to 16 seconds in 0.1 second increments. The default value is 0.0 seconds. To disable the filter, set the time constant to 0 seconds. This filter is provided for extreme input noise situations. Use of this filter normally should not be necessary.

Net instrument response is a combination of analog input filtering and output filtering.

Table 4-4. Example Specific Gravity vs Temperature Table for Saturated Steam

DATA POINT	TEMPERATURE °C	TEMPERATURE °F	SPECIFIC GRAVITY
1	126.7	260	0.00095
2	210.0	410	0.00850
3	271.1	520	0.02760
4	304.4	580	0.04900
5	326.7	620	0.07200
6	343.3	650	0.09800
7	357.8	676	0.13500
8	365.6	690	0.16800
9	371.1	700	0.21000
10	374.4	706	0.31570

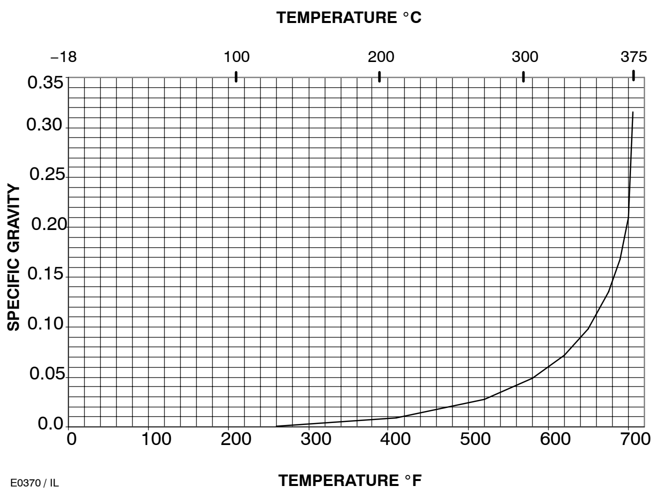


Figure 4-6. Example Saturated Steam Curve Plotted from Values in Table 4-4

Setting the Specific Gravity (3-3-5)

Two specific gravity tables are available in the instrument to provide specific gravity correction for temperature. For level measurement applications, only the lower specific gravity table is used. For interface applications, both the upper and lower table can be displayed and edited. For density applications, no specific gravity correction table is presented. (Note: if *PV is* has been set to density, the menu selection 3-3-5 does not appear.) Example entries for saturated water are given in table 4-3. Figure 4-5 shows the curve that results when these values are plotted. Table 4-4 lists example entries for saturated steam.

Figure 4-6 is the curve that results when these values are plotted.

You can enter up to 10 temperature and specific gravity pairs in the table. The table entry function is terminated by entering zero for the specific gravity. Keep this in mind when setting up a table for a upper fluid, such as steam, whose specific gravity approaches 0 at lower temperatures.

The resolution of the table entry for specific gravity is 5 decimal places. This means the smallest specific gravity value you can enter is 0.00001, which should be sufficient to allow a starting temperature around 15.6 °C (60 °F) for the steam specific gravity table.

The example set of tables given are generated by visually laying linear segments over a reference curve, and are not guaranteed to provide any particular accuracy. They are provided to illustrate the guidelines for developing your own table:

4

1. Establish a table for the fluid(s) you are using over the expected operating range of process temperature. This allows you to make best use of the maximum of ten points to obtain the accuracy you require. If your fluid specific gravity is very linear over the operating temperature range, two data points may be sufficient. (The correction algorithm provides linear interpolation between data points, and bounds the result at the table end points.)

2. Pick points closer together in regions of higher slope.

3. Pick linear segments that distribute the error equally on each side of the true curve.

To enter or display the specific gravity, or to enter values in the specific gravity tables, from the Online menu select *Basic Setup, PVSetup,* and *Specific Gravity*. The Field Communicator prompts for either a single value for specific gravity or a table of specific gravity versus temperature. To enter a single specific gravity value, select *Single Point* and enter the specific gravity value. To display or enter values in the tables, select *Table of SG vs T*.

The Field Communicator begins by prompting for the temperature of the first pair in the lower table. After entering the temperature for the first pair, press ENTER. Enter the specific gravity for the first pair and press ENTER. The Field Communicator then prompts for the temperature for the second pair. Enter this temperature and press ENTER. The Field Communicator then prompts for the specific gravity for the second pair. Continue entering each temperature and specific gravity pair. When finished, enter zero at the Field Communicator prompt for the next specific gravity value to exit the table. For level applications, the Field Communicator exits to the *Basic Setup* menu. For interface applications, the Field Communicator then prompts for the first temperature and specific gravity pair for the upper table.

Setting Up the LCD Meter (4-2-2)

To set up the LCD meter, from the Online menu select *Detailed Setup*, *Output Condition*, and *LCD meter*. Follow the prompts on the Field Communicator to indicate if the meter is installed, set up the information the meter will display, and assign the number of decimal places.

- **Meter Installed**—Select this parameter to indicate if the meter is installed. If the meter is physically installed, select *Installed*. The meter must be installed before you can set the display type or the decimal places.

- **Display Type**—Select the type of information the meter should display and how it should be displayed. You can select for display:

PV Only—Displays the process variable (level, interface, or density) in engineering units.

PV/Proc Temp—Alternately displays the process variable in engineering units, the process temperature in the units selected under *Temp Units* (PV Setup), and the degrees of torque tube rotation.

% Range Only—Displays the process variable as a percent of span (determined by the LRV and URV).

PV/% Range—Alternately displays the process variable in engineering units and the process variable in percent of span.

- **Decimal Places**—Selects the number of decimal places to display, up to four. Setting the value to zero puts the display in auto-scale mode. It will then display as may decimals places as will fit.

If *PV/Proc Temp* or *PV/% Range* is selected, the display alternates every two seconds between the selected readings. The meter also simultaneously displays the analog output signal using a percent of scale bar graph around the perimeter of the display face as shown in figure 4-7, no matter what display type is selected.

After you have selected the desired meter settings, press SEND on the Field Communicator to download the meter settings to the instrument.

Testing the Meter

The meter activates all segments immediately after power-up, during a digital level controller self-test, or during a master reset sent by a host supporting HART communications. You can also test the meter by selecting *Diag/Service* from the Online menu. Select *Test Device* and *Meter*. Select *Turn Cells On* to turn on all display segments, including the analog output bar graph, or select *Turn Cells Off* to turn off all display segments. When finished with the test, press OK to return the meter to normal display mode.

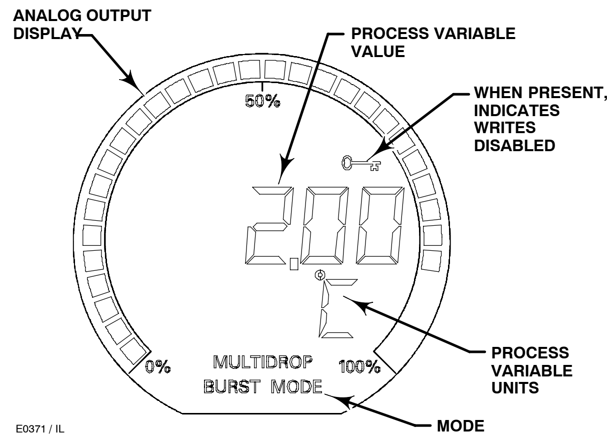


Figure 4-7. LCD Meter Display

Setting Alarms

The following menus are available for configuring Alarms.

Setting Process Variable (4-2-3-1) Alarm Limits

Select *Detailed Setup, Output Condition, Configure Alarms*, and *Process Var*. Follow the prompts on the Field Communicator display to set: *PV Hi Alrm* (Process Variable High Alarm), *PV Hi-Hi Alrm* (Process Variable High-High Alarm), *PV Lo Alrm* (Process Variable Low Alarm), *PV Lo-Lo Alrm* (Process Variable Low-Low Alarm), and *PV Alrm DeadBand* (Process Variable Alarm Dead Band).

- *PV Hi Alrm*—Process Variable High Alarm is the value of the process variable, in engineering units, which, when exceeded, sets the process variable High Alarm.

- *PV Hi-Hi Alrm*—Process Variable High-High Alarm is the value of the process variable, in engineering units, which, when exceeded, sets the process variable High-High Alarm.

- *PV Lo Alrm*—Process Variable Low Alarm is the value of the process variable, in engineering units, which, when exceeded, sets the Process Variable Low Alarm.

- *PV Lo-Lo Alrm*—Process Variable Low-Low Alarm is the value of the process variable, in

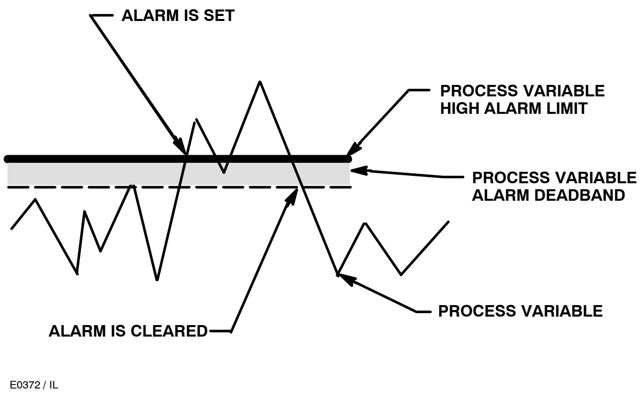


Figure 4-8. Process Variable Alarm Deadband (Process Variable High Alarm Example)

engineering units, which, when exceeded, sets the Process Variable Low Low Alarm.

- *PV Alrm Deadband*—The Process Variable Alarm Deadband is the amount the process variable, in engineering units, must change to clear a process variable alarm, once it has been set. The deadband applies to all the process variable alarms. See figure 4-8.

Setting Temperature Alarm (4-2-3-3) Limits

Select *Detailed Setup, Output Condition, Configure Alarms,* and *Temperature*. Follow the prompts on the Field Communicator display to configure the following: *Proc. Temp Hi Alrm* (Process Temperature High Alarm), *Proc. Temp Lo Alrm* (Process Temperature Low Alarm), *Elec. Temp Hi Alrm* (Electronics Temperature High Alarm), *Elec. Temp Lo Alrm* (Electronics Temperature Low Alarm) and *Temp Alrm Deadband* (Temperature Alarm Deadband).

- *Proc. Temp Hi Alrm*—Process Temperature High Alarm is the process variable temperature, in temperature units, which, when exceeded, will set the Process Temperature High Alarm.

- *Proc. Temp Lo Alrm*—Process Temperature Low Alarm is the process variable temperature, in temperature units, which, when exceeded, will set the Temperature Low Alarm.

- *Elec. Temp Hi Alrm*—Electronics Temperature High Alarm is the instrument electronics temperature, in temperature units, which, when exceeded, will set the Electronics High Alarm.

- *Elec. Temp Lo Alrm*—Electronics Temperature Low Alarm is the instrument electronics temperature, in temperature units, which, when exceeded, will set the Electronics Low Alarm.

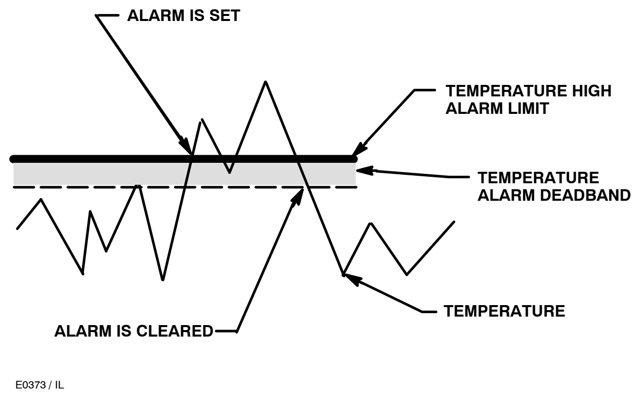


Figure 4-9. Temperature Alarm Deadband (Temperature High Alarm Example)

- *Temp Alrm Deadband*—The Temperature Alarm Deadband is the amount the temperature, in temperature units, must change to clear a temperature alarm, once it has been set. The deadband applies to all the temperature alarms. See figure 4-9. In firmware revision 8, the Temp Alarm Deadband is displayed incorrectly when the units are DegF. (The number displayed is 32° more than the actual deadband.)

Enabling Process Variable (4-2-3-2) Alarms

Select *Detailed Setup, Output Condition, Configure Alarms* and *Alarm Enable*. Follow the prompts on the Field Communicator display to configure the following: *Hi Alrm Enabl* (High Alarm Enable), *Hi Hi Alrm Enabl* (High High Alarm Enable), *Lo Alrm Enabl* (Low Alarm Enable), *Lo Lo Alrm Enabl* (Low Low Alarm Enable).

- *Hi Alrm Enabl*—On or Off. High Alarm Enable activates checking the process variable against the PV High Alarm limit. High Alarm is set if the process variable rises above the PV High Alarm limit. Once the alarm is set, the process variable must fall below the PV High Alarm limit by the PV Alarm Deadband before the alarm is cleared. See figure 4-8.

Note

If the Hi Hi Alarm or Lo Lo Alarm are enabled and either is set, the digital level controller output will go to below 3.75 mA or above 21.0 mA, depending on the position of the alarm jumper.

- *Hi Hi Alrm Enabl*—On or Off. High High Alarm Enable activates checking the process variable against the PV High-High Alarm limit. The High High Alarm is set if the process variable rises above the PV High High Alarm limit. Once the alarm is set, the process variable must fall below the PV High High Alarm limit by the PV Alarm Deadband before the alarm is cleared. See figure 4-8.

- *Lo Alrm Enabl*—On or Off. Low Alarm Enable activates checking the process variable against the PV Low Alarm limit. Low Alarm is set if the process variable falls below the PV Low Alarm limit. Once the alarm is set, the process variable must rise above the PV Low Alarm limit by the PV Alarm Deadband before the alarm is cleared. See figure 4-8.

- *Lo Lo Alrm Enabl*—On or Off. Low Low Alarm Enable activates checking the process variable against the PV Low-Low Alarm limit. The Low Low Alarm is set if the process variable falls below the PV Low Low Alarm limit. Once the alarm is set, the process variable must rise above the PV Low Low Alarm limit by the PV Alarm Deadband before the alarm is cleared. See figure 4-8.

Enabling Temperature Alarms (4-2-3-4)

Select *Detailed Setup, Output Condition, Configure Alarms* and *Temp Alarm Enable*. Follow the prompts on the Field Communicator display to configure the following: *Proc Temp Hi Alr* (Process Temperature High Alarm), *Proc Temp Lo Alrm* (Process Temperature Low Alarm), *Elect Temp Hi Alrm* (Electronics Temperature High Alarm), *Elect Temp Lo Alrm* (Electronics Temperature Low Alarm Enable).

- *Proc Temp Hi Alrm*—On or Off. Process Temperature High Alarm Enable activates checking of the process variable temperature against the Process Temperature High Alarm limit. The Process Temperature High Alarm is set if the process variable temperature rises above the Process Temperature High Alarm limit. Once the alarm is set, the process variable temperature must fall below the Process Temperature High Alarm limit by the Temperature Alarm Deadband before the alarm is cleared. See figure 4-9.

- *Proc Temp Lo Alrm*—On or Off. Process Temperature Low Alarm Enable activates checking of the process variable temperature against the Process Temperature Low Alarm limit. Process Temperature Low Alarm is set if the process variable temperature falls below the Process Temperature Low Alarm limit. Once the alarm is set, the process variable temperature must rise above the Process Temperature Low Alarm limit by the Temperature Alarm Deadband before the alarm is cleared. See figure 4-9.

- *Elect Temp Hi Alrm*—On or Off. Electronics Temperature High Alarm Enable activates checking of the instrument electronics temperature against the Electronics Temperature High Alarm limit. Electronics Temperature High Alarm is set if the instrument electronics temperature rises above the Electronics Temperature High Alarm limit. Once the alarm is set, the instrument electronics temperature must fall below the Electronics Temperature High Alarm limit by the Temperature Alarm Deadband before the alarm is cleared. See figure 4-9.

- *Elect Temp Lo Alrm*—On or Off. Electronics Temperature Low Alarm Enable activates checking of the instrument electronics temperature against the Electronics Temperature Low Alarm limit. Electronics Temperature Low Alarm is set if the instrument electronics temperature falls below the Electronics Temperature Low Alarm limit. Once the alarm is set, the instrument electronics temperature must rise above the Electronics Temperature Low Alarm limit by the Temperature Alarm Deadband before the alarm is cleared. See figure 4-9.

Entering HART® Information (4-3-1)

From the Online menu select *Detailed Setup, Device Information,* and *HART*. Follow the prompts on the Field Communicator display to enter or view information in the following fields: *HART Tag*, *Polling Address, Message*, *Descriptor*, and *Date*.

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

- *Polling Address*—If the digital level controller is used in a point-to-point configuration, the Polling Address is 0. When several devices are connected in the same loop, each device must be assigned a unique polling address. The Polling Address may be set to a value between 0 and 15.

For the Field Communicator to be able to communicate with a device whose polling address is not 0, it must be configured to automatically search for

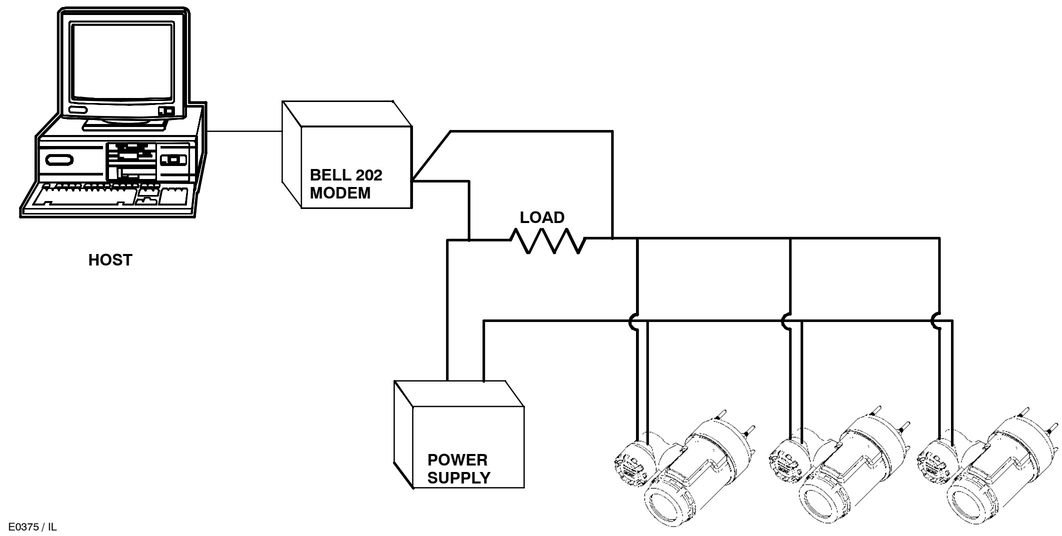


Figure 4-10. Typical Multidropped Network

all or specific connected devices. For information on configuring the Field Communicator for automatic polling, see the Model 375 Field Communicator Basics section, Appendix A.

- *Message*—Message provides the most specific user-defined means for identifying individual controllers in multi-controller environments. it allows for 32 characters of information and is stored with the other configuration data. Message has no impact on the operation of the controller or the HART-based communicator.

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

- *Date*—Date is a user-defined variable that provides a place to save the date of the last revision of configuration or calibration information. It has no impact on the operation of the controller or Field Communicator. Enter a date with the format MM/DD/YY.

Multidrop Communication

“Multidropping” refers to the connection of several digital level controllers or transmitters to a single communications transmission line. Communication between the host and the field instruments takes place digitally with the analog output of the instruments deactivated. With the HART communications protocol, up to 15 field instruments can be connected on a single twisted pair of wires or over leased phone lines. Multidrop installations are not recommended where intrinsic safety is a requirement.

The application of a multidrop installation requires consideration of the update rate necessary from each instrument, the combination of instrument models, and the length of the transmission line. Communication with the field instruments can be accomplished with commercially available Bell 202 modems and a host implementing the HART protocol. Each instrument is identified by a unique address (1−15) and responds to the commands defined in the HART protocol.

Figure 4-10 shows a typical multidrop network. Do not use this figure as an installation diagram. Contact your Emerson Process Management sales office with specific requirements for multidrop applications.

The Field Communicator can test, configure, and format a multidropped DLC3000 Series digital level controller in the same way as in a standard point-to-point installation.

Note

DLC3000 Series digital level controllers are set to address 0 at the factory, allowing them to operate in the standard point-to-point manner with a 4−20 mA output signal. To activate multidrop communication, the address must be changed to a number between 1 and 15. This change deactivates the 4−20 mA analog output, sending it to 4 mA. The failure mode current also is disabled.

4

Temperature Compensation

If the process temperature departs significantly from calibration temperature, you will need to apply a correction factor. Interpolate the correction factor from the material-specific tables of theoretical normalized modulus of rigidity versus temperature, as described in the *Supplement to 249 Series Sensors Instruction Manual*—Simulation of Process Conditions for Calibration of Level-Trols − Form 5767. (Contact your Emerson Process Management sales office for information on obtaining a copy of this manual). Multiply the measured torque tube rate (editable in the review menu under factory settings) by the correction factor and enter the new value. When you cannot calibrate at process temperature this approach allows a better approximation of the actual torque tube behavior at process conditions.

Section 5 Troubleshooting & Maintenance

5

DLC3000 Series digital level controllers feature modular design for easy maintenance. If you suspect a malfunction, check for an external cause before performing the diagnostics described in this section.

Sensor parts are subject to normal wear and must be inspected and replaced as necessary. For sensor maintenance information, refer to the appropriate sensor instruction manual.

WARNING

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

CAUTION

When replacing components, use only components specified by the factory. Always use proper component replacement techniques, as presented in this manual. Improper techniques or component selection may invalidate the approvals and the product specifications, as indicated in table 1-1. It may also impair operations and the intended function of the device.

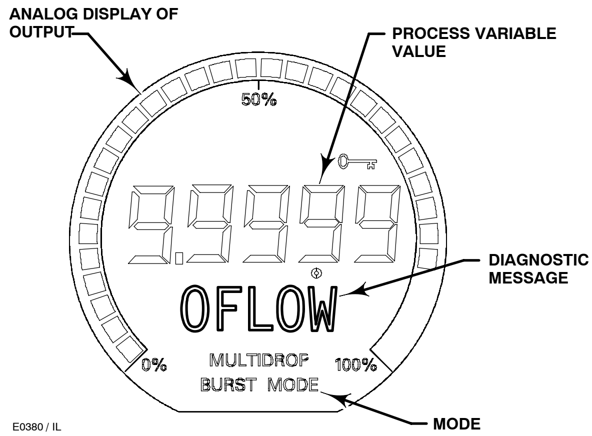


Figure 5-1. LCD Meter Diagnostic Display

5

Diagnostic Messages

In addition to the output, the LCD meter displays abbreviated diagnostic messages for troubleshooting the digital level controller. To accommodate two-word messages, the display alternates between the first and second word. The meter displays messages simultaneously on the Process Variable and Process Variable Unit lines as shown in figure 5-1. Messages on the Process Variable line refer to general device conditions, while messages on the Process Variable Unit line refer to specific causes for these conditions. A description of each diagnostic message follows.

- **[BLANK]**—If the meter does not appear to function, and the instrument is otherwise functioning correctly, make sure the digital level controller is configured for the LCD meter. The meter will not function if the *Meter Installed* selection is “Not Installed.” To check this function, connect the Field Communicator to the digital level controller and turn it on. From the Online menu, select *Detailed Setup*, *Output Condition*, *LCD Meter*, and *Meter Installed*. For information on setting up the LCD meter see Section 4. A diagnostic test for meter function is also detailed later in this section.

- **FAIL HDWR**—This message indicates the existence of one or more of the following conditions:

  —The primary sensor input conversion is out of range.

  —The primary sensor drive current is out of range.

  —The internal reference voltage for controlling the loop current is out of range.

Perform the diagnostic procedures detailed later in this section to isolate the specific failure. If diagnostics indicate a failure of a particular module, replace the indicated module with a new one. Otherwise, correct the mechanical input condition to clear the message.

- **OFLOW**—The location of the decimal point, as configured in the meter setup, is not compatible with the value to be displayed by the meter. For example, if the meter is measuring a level greater that 99.999 mm, and the meter decimal point is set to 3 digit precision, the meter will display an “OFLOW” message because it is only capable of displaying a maximum value of 99.999 when set to 3 digit precision. The position of the decimal point may be adjusted by using the Field Communicator. From the Online menu, select *Detailed Setup, Output Condition, LCD Meter,* and *Decimal Places.* Selecting “0” will put the display in auto-scale mode. (The number of decimal places displayed will be the maximum remaining in the display field for the current value of PV.)

Hardware Diagnostics

If you suspect a malfunction despite the absence of diagnostic messages on the Field Communicator display, follow the procedures described in table 5-1 to verify that the digital level controller hardware and process connections are in good working order. Under each of the major symptoms, specific suggestions are offered for solving problems. Always deal with the most likely and easiest-to-check conditions first.

Test Terminals

Test connections inside the terminal box can be used to measure loop current. These terminals are across an internal 1 ohm resistor that is in series with the loop.

1. Remove the terminal box cap.

2. Adjust the test meter to measure a range of 0.001 to 0.1 volts.

3. Connect the positive lead of the test meter to the + connection and the negative lead to the T connection inside the terminal box.

4. Measure Loop current as:

Voltage (on test meter) $\times$ 1000 = milliamps

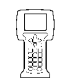
example:

Test meter Voltage X 1000 = Loop Milliamps

0.004 X1000 = 4.0 milliamperes

0.020 X 1000 = 20.0 milliamperes

5. Remove test leads and replace the terminal box cover.

Viewing Device Information 

The following menus are available to define and/or view information about the instrument.

Viewing Process Variable Information (1)

To view the process variable and the corresponding ranges, from the Online Menu select *Process Variables.* Follow the prompts on the Field Communicator display to view the process variable (level, interface, or density), electronics temperature, or PV range.

- *PV*—Indicates the type of measurement either level, interface (the interface of two liquids of different specific gravities), or density (measures the liquid specific gravity). The process variable displayed and measured depends on the entry for “PV is” under PV Setup.

- *Process Temp*—Indicates the process temperature if a two-wire or three-wire RTD is present and has been set up in the instrument.

- *Elect Temp*—Indicates the electronics temperature in the units specified under PV Setup, Temp Units.

- *PV Range*—Displays the Upper Range Value and Lower Range Value for the process variable.

Table 5-1. Troubleshooting

Symptom	Potential Source	Corrective Action
Analog Output is within valid range but Instrument does not communicate with Field Communicator	Loop Wiring	1. Check resistance between the power supply and the Field Communicator connection. The net resistance in the loop must be between 230 and 1100 Ohms for HART communication. 2. Check for adequate voltage to the digital level controller. Refer to figure 3-11 for requirements. Some models of battery-operated field calibrators do not have sufficient compliance voltage to operate a DLC3010 over the entire output current range. 3. Check for excessive capacitance in the field wiring. (Isolate the instrument from field wiring and try to communicate locally.)
	Terminal Box	4. If the terminal box does not have a 4-digit date-code sticker inside the lower lip, it may have developed a high internal resistance. Try a new terminal box.
	Electronics Module	5. Swap the electronics module with a known good part.
	Transducer Module	6. If the electronics module and terminal box work on a known good transducer module, replace the old transducer module.
Output ≅ 0 mA	Loop Wiring	7. Check for open circuits. 8. Check for proper polarity at the signal terminals. — See item 2. above.
	Terminal Box	9. Check resistance between “Loop+” and “T” terminals of terminal box. If greater than 1.1 Ohm, the internal sense resistor may be damaged. An external jumper may be added for a temporary repair. Replace terminal box and avoid applying loop voltage across “T” and “Loop+” for long term solution. — See item 4. above
	Electronics Module	— See item 5. above.
	Transducer Module	— See item 6. above.
Fixed Output ≅ 3.7 mA	Alarm Condition (Fail-low setting)	Connect the Field Communicator and: 10. Select *Test Device* (2-1-1) to isolate a module failure. 11. Check PV against Hi-Hi and Lo-Lo alarm thresholds and PV alarm deadband setting, if these alarms are enabled.
Fixed Output = 3.8 mA	Low Saturation	Connect the Field Communicator and: 12. Check the PV against the upper and lower range values. Check actual process condition and calibration adjustments.
Fixed Output = 20.5 mA	High Saturation	Connect the Field Communicator and: — see item 12. above.
Fixed Output ≅ 22.5 mA	Alarm Condition (Fail-high setting)	Connect the Field Communicator and: — see items 10. and 11. above.
Fixed Output > 22.5 mA	Loop Wiring	13. Check for short circuits.
	Terminal Box	14. Remove terminal box from the instrument, and apply 24 Volts between Loop+ and Loop− terminals, (with a series resistance of approximately 1200 Ohms to protect power supply). If any current flows, replace terminal box.
	Electronics Module	— See item 5. above.
Output is within 4−20 mA range, but does not track displayed PV value (e.g., a) gain error, b) low saturation occurs at a value higher than 3.8 mA, c) high saturation occurs at a value lower than 20.5 mA)	Electronics Module	Connect the Field Communicator and: 15. Run Loop diagnostic test (2-2). If the forced output does not track commands, attempt *Scaled DAC Trim* procedure (2-4-3). If DAC calibration cannot be restored, replace Electronics Module.
Output Drifting while at fixed process input.	Sensor	16. Check torque tube spring rate change versus process temperature per figure 1-2 and Form 5767. Use appropriate material for process temperature. Pre-compensate the calibration for target process condition.
	Transducer Module	Connect the Field Communicator and: 17. Check *Electronics Temperature* (2-4-2-3) against an independent measurement of DLC3010 temperature. a) If inaccurate, trim the electronics temperature measurement (2-4-2-4) to improve ambient temperature compensation performance. b) If *Electronics Temperature* value is extreme, replace transducer module.
	Electronics Module	Connect the Field Communicator and: 18. Run Loop diagnostic test (2-2). Leave instrument in fixed current mode at 12 mA command and observe analog output variation with ambient temperature. If drift exceeds specifications replace electronics module.
	Configuration Data	Connect the Field Communicator and: 19. Check stored *Specific Gravity* values (3-3-5) against independent measurement of process density. If process SG has changed from calibration values, correct configuration data to match process
Erratic Output	Loop Wiring	If output current enters a limit cycle between zero and a value within the 4−20 mA range when level reaches some arbitrary upper threshold, 20. Check for excessive loop resistance or low compliance voltage. (See items 2. and 4. above.)
Scrambled or erratic Display on LCD	Loop Wiring	—see item 20. above. (Insufficient voltage to operate display)
	LCD Assy	21. Swap LCD Assy with known good part.
	Electronics Module	22. Connector solder joint failure in electronics module. Replace module.

5

Viewing Output Information (4-2-1)

To view the analog output variables, from the Online Menu select *Detailed Setup, Output Condition,* and *Analog Output.* Follow the prompts on the Field Communicator display to view the process variable (level, interface, or density), analog output, percent range, or Alarm jumper.

- *PV*—Indicates the type of measurement either level, interface (the interface of two liquids of different specific gravities), or density (measures the liquid specific gravity). The process variable displayed and measured depends on the entry for “PV is” under PV Setup.

- *AO*—Indicates the current analog output value of the instrument, in milliamperes.

- *% Range*—Indicates the current process variable in percent of the span determined by the lower range value and the upper range value.

Refer to figure 5-2. If the digital level controller is setup for direct action (i.e., the lower range value is less than the upper range value), 0% range corresponds to the lower range value (LRV) and 100% range corresponds to the upper range value (URV). If the digital level controller is setup for reverse action (i.e., the lower range value is greater than the upper range value), 0% range corresponds to the upper range value (URV) and 100% range corresponds to the lower range value (LRV). Use the following equation to calculate the % range values:

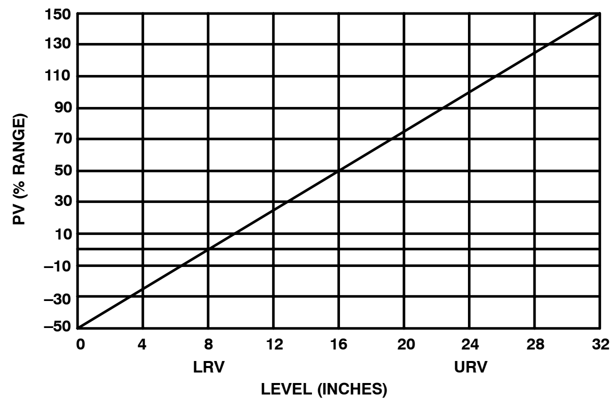
$$\mathrm{PV}(\%\mathrm{range}) = \frac{(\mathrm{PV}_{EU} - \mathrm{LRV})}{(\mathrm{URV} - \mathrm{LRV})} \times 100$$

where:

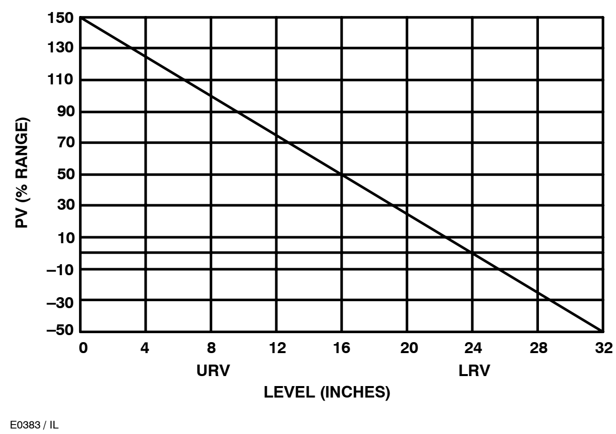
PV_{EU} = process variable in engineering units

The LRV always represents the 0% range value and the URV always represents the 100% range value.

- *Alarm Jumper*—Displays the position of the hardware alarm jumper, either high current or low current.



DIRECT ACTION



REVERSE ACTION

Figure 5-2. PV % Range Indication for Direct and Reverse Action with a 32-Inch Displacer Ranged for 8 to 24 Inches

Measuring Specific Gravity (4-1-4)

If the instrument and sensor are calibrated, you can have the digital level controller measure the liquid specific gravity, if it is not known. You must be able to manipulate the level and externally measure it to have the instrument measure the specific gravity. To work properly, this procedure must be in done in Level Measurement mode, and a valid dry coupling reference must have been obtained at the zero buoyance condition. Use as high a test level as possible to improve accuracy.

To measure specific gravity, from the Online menu select *Detailed Setup*, *Sensors*, and *Measure Spec Gr*. Follow the prompts on the Field Communicator and the following procedure:

1. Set the control loop for manual control.

2. Adjust the liquid level so that the displacer is partially submerged.

3. Enter the externally measured level, in engineering units.

After you press OK on the Field Communicator, the instrument begins calculating the specific gravity. You can then elect to use this value as the specific gravity for all level measurements. If you select *No*, the instrument uses the specific gravity entered under PV Setup, or the values from the specific gravity tables.

4. When finished measuring specific gravity, return the control loop to automatic control.

Trending (4-4)

The DLC3000 Series digital level controller can store up to five samples of a selected variable. This trend information can be communicated via the HART protocol to a HART-based control system. To set up the instrument for trending, from the Online menu, select *Detailed Setup* and *Trending*. Follow the prompts on the Field Communicator to specify the variable to be trended, the sampling rate, and to have the Communicator display the trend values.

- *Trend Var*—Permits selecting the variable for trending: PV, Process Temperature, or Electronics Temperature. Off turns the trending function off.

- *Trend Interval*—Permits selecting how often the instrument should sample and store the selected trend variable. Enter a sample interval between 0.2 and 10.0 seconds.

- *Read Trend*—Permits viewing the five most recent samples on the Field Communicator display. The five sample values are displayed along with a sample number. The smaller sample number contains the oldest sample value. When finished viewing the displayed sample values, press OK on the Field Communicator to view the next five samples. Press ABORT to exit the display.

Viewing the Device ID (4-3-4)

Each instrument has a unique Device Identifier. The device ID provides additional security to prevent this instrument from accepting commands meant for other instruments. To view the device ID, from the Online Menu select *Detailed Setup*, *Device Information*, and *Device ID*.

Viewing Version Information (4-3-2)

The Version Information menu is available to view information about the instrument. From the Online menu, select *Detailed Setup, Device Information,* and *Version Info.* Follow the prompts on the Field Communicator display to view information in the following fields: *Device Rev* (Device Revision), *Firmware Rev* (Firmware Revision), *Hardware Rev* (Hardware Revision), *HART Univ Rev* (HART Universal Revision).

- *Device Rev*—Device Revision is the revision of the protocol for interfacing to the functionality of the instrument.

- *Firmware Rev*—Firmware Revision is the revision number of the Fisher software in the instrument.

- *Hardware Rev*—Hardware Revision is the revision number of the Fisher instrument hardware.

- *HART Univ Rev*—HART Universal Revision is the revision number of the HART Universal Commands which are used as the communications protocol for the instrument.

- *375 DD Rev*—DD Rev is the revision level of the Device Description used by the 375 Field Communicator while communicating with the instrument.

Viewing Serial Number (4-3-3) Information

To view or enter serial number information, from the Online menu select *Detailed Setup, Device Information,* and *Serial Numbers*. Follow the prompts on the Field Communicator display to enter or view the following serial numbers: *Instrument S/N* (Instrument Serial Number), *Displacer S/N* (Displacer Serial Number), and *Final Assembly Num* (Final Assembly Number).

- *Instrument S/N*—Enter the serial number on the instrument nameplate, up to 12 characters.

- *Displacer S/N*—Use this field to enter or view the displacer serial number. The displacer serial number is the same as the sensor serial number found on the sensor nameplate.

- *Final Assembly Num*—The Final Assembly Number is a number that can be used to identify the instrument and sensor combination.

Viewing Process and (4-2-4) Temperature Alarms

To view active process or temperature alarms, from the Online menu, select *Detailed Setup, Output Condition,* and *Display Alarms*.

If a process or temperature alarm is active, it will appear when the Display Alarms menu is selected. If more than one alarm is active, they will appear on the display one at a time in the order listed below.

1. PV Exceeds Hi Alarm Limit

2. PV Exceeds Hi Hi Alarm Limit
3. PV Exceeds Lo Alarm Limit
4. PV Exceeds Lo Lo Alarm Limit
5. Process Temperature Exceeds Hi Alarm Limit
6. Process Temperature Exceeds Lo Alarm Limit
7. Electronics Temperature Exceeds Hi Alarm Limit
8. Electronics Temperature Exceeds Lo Alarm Limit

Viewing Hardware Alarms (2-3)

To view hardware alarm information, from the Online menu select *Diag/Service* and *Hardware Alarms*. Follow the prompts on the Field Communicator display to view information in the following fields: *Alarm Jumper, NVM* (Non-Volatile Memory), *Free Time, Level Snsr Drive* (Level Sensor Drive), and *A/D TT Input* (Analog to Digital Torque Tube Input).

- *Alarm Jumper*—Displays the position of the hardware alarm jumper, either high current or low current.

- *NVM*—Displays the current value of the remaining number of NVM writes. Setup data is stored in NVM. If the remaining number of NVM writes seems to be decreasing rapidly, check to make sure the control system is not unnecessarily writing to the NVM. Reaching 0 will cause the NVM Write Limit Exceeded status to be activated.

- *Free Time*—Displays the current microprocessor free time. If the free time limit check fails, the Free Time Limit Exceeded status is activated.

- *Level Snsr Drive*—Displays the current limit and value of the Level Sensor Drive Signal. If the drive value exceeds the hardcoded limits, either above or below, the instrument forces the output current to the alarm value determined by the alarm jumper and activates the Field Device Malfunction status message. (The Level Snsr Drive Limit field is for factory use only.)

- *A/D TT Input*—Displays the current limit and value of the A/D Torque Tube Input. If the input exceeds the hardcoded limits, either above or below, the Torque Tube A/D Input Failed status is activated. (The A/D TT Input Limit field is for factory use only.)

Viewing Instrument Status (2-1-1)

To view the instrument status, from the Online menu select *Diag/Service, Test Device, Status*. The following describes the various displays for the instrument Status menu.

- **Torque Tube A/D Input Failed**—When active, indicates the torque tube position reading has exceeded the hardcoded limits, either above or below. When active the instrument forces the output current to the alarm value determined by the alarm jumper. If this status message appears, the lever assembly may been driven to a hard stop by a bad mechanical coupling condition. Try recoupling the instrument to clear it. If it does not clear, from the Online menu, select *Diag/Serv, Hardware Alarms, A/D TT input* (**2-3-5**). If the value is 1230 mV and does not respond to lever assembly motion, try installing a new Electronics Module. If a new Electronics Module does not clear the failure, the Transducer Module is at fault.

Note

When using the handheld communicator, it is necessary to exit the menu item, move the lever, and re-enter the menu item with the lever in the new position. The variable is not read dynamically, only once per entry. In AMS Device Manager, this variable is updated dynamically, although at a slow rate.

- **Hall Current Readback Limit Failed**—When active, indicates the Hall current readback has exceeded the hardcoded limits, either above or below. When active the instrument forces the output current to the alarm value determined by the alarm jumper. This status typically indicates an electronics failure. If this status message appears, try cycling power to the instrument and see if it clears. If it does not clear, try replacing the Electronics Module. If the message still doesn’t clear, the problem is on the transducer board. Contact your Emerson Process Management sales office for repair information.

- **Reference Voltage Limit Failed**—When active, indicates the reference voltage reading of the A/D converter has exceeded the hardcoded limits, either above or below. When active the instrument forces the output current to the alarm value determined by the alarm jumper. If this status message appears, try cycling power to the instrument and see if it clears. If it does not clear, replace the Electronics Module.

- **NVM Write Limit Exceeded**—When active, indicates the total number of writes to one of the three areas of NVM has exceeded the hardcoded limit. If this status message appears, run the hardware alarm diagnostics to determine which area of NVM is at zero count. From the Online menu, select *Diag/Serv, Hardware Alarms, NVM* (**2-3-2**).

If the *HC12* (Microprocessor) count is zero, correct the condition that is causing excessive writes to the transmitter. Try cycling power to the instrument and see if it clears. If it does not clear, replace the Electronics Module. If the *Hall* (Transducer) count is zero, replace the Transducer Module.

- **Free Time Limit Exceeded**—When active, indicates the instrument has failed the free time check and the execution period cannot be maintained. If this status message appears, try cycling power to the instrument and see if it clears. If it does not clear, replace the Electronics Module.

- **Process Temperature Sensor Failed**—When active, indicates the process temperature sensor (RTD) reading has exceeded the hardcoded limits (<10 ohms or >320 ohms). If this status message appears, reinstall the process temperature sensor (RTD).

The following status messages appear whenever they are active. You do not need to access any specific Online menu item to see them.

- **Field Device Malfunction**—When active, indicates that an attempt to write to NVM failed, usually in the *message* or *date* fields. Try to write the field again at a later time.

- **Primary Variable Analog Output Fixed**—When active, indicates the analog and digital outputs for the Primary Variable are held at the requested value. They will not respond to the applied process.

- **Primary Variable Analog Output Saturated**—When active, indicates the analog and digital outputs for the Primary Variable are beyond their limits and no longer represent the true applied process.

- **Non-Primary Variable Out of Limits**—When active, indicates the process applied to a sensor, other than that of the Primary Variable, is beyond the operating limits of the device. This indicates a temperature alarm is active.

- **Primary Variable Out of Limits**—When active, indicates the process applied to the sensor for the Primary Variable is beyond the operating limits of the device.

Removing the Digital Level Controller from the Sensor

Because of its modular design, most of the service and maintenance to the digital level controller can be done without removing it from the sensor. However, if necessary to replace sensor to instrument mating parts or parts in the transducer housing, or to perform bench maintenance, perform the following procedures to remove the digital level controller from the sensor.

WARNING

On an explosion-proof instrument, remove the electrical power before removing the instrument covers in a hazardous area. Personal injury or property damage may result from fire and explosion if power is applied to the instrument with the covers removed.

Tools Required

Table 5-2 lists the tools required for maintaining the DLC3000 Series digital level controller.

Table 5-2. Tools Required

TOOL	SIZE	USAGE	KEYS
Hex Key	2 mm	Handle Cover-lock set screws	31 20
Hex Key	2.5 mm	Small cap screws	13
Hex Key	4 mm	Lever assembly mtg cap screw	14
Hex Key	5 mm	Terminal box mtg cap screw	7
Hex Socket	10 mm	Coupling nut	76
Open-end	13 mm	Transmitter mounting nuts	34
Phillips Screwdriver		Terminal screws Electronics module mtg screws	25 36
Small flat blade screwdriver		LCD assy mtg screws	40
Strap wrench		Helpful for removing a display cover that has been over-tightened	3
Large flat blade screwdriver[1]		Flex circuit mtg screws	19
Needle nose pliers[1]		Align/clamp ring extraction	17

1. Needed to remove a flex circuit if date code numbers are requested for warranty information.

Removing the Type DLC3010 Digital Level Controller from a 249 Series Sensor

249 Series Sensor in Standard Temperature Applications

1. Loosen the set screw (key 31) in the terminal box cover assembly (key 6) so that the cover can be unscrewed from the terminal box.

2. After removing the cover (key 6), note the location of field wiring connections and disconnect the field wiring from the wiring terminals.

3. As shown in figure 3-5, locate the access handle on the bottom of the transducer housing. Using a 2 mm hex key, back out the set screw in the depression on the access handle until it is flush with the handle surface. Press on the back of the handle, as shown in the figure, and slide the handle toward the front of the unit, (the locked position), to expose the access hole. Be sure the locking handle drops into the detent.

Note

If the access handle will not slide, the sensor linkage is most likely in an extreme position. When the lever assembly is at a hard stop inside the housing, the locking pin on the access door may not be able to engage the mating slot in the lever assembly. This condition can occur if the displacer has been removed, if the sensor is lying on its side, or if the instrument had been coupled to the sensor while the displacer was not connected. To correct this condition, manipulate the sensor linkage to bring the lever assembly to within approximately 4 degrees of the neutral position before attempting to slide the handle. A probe inserted through the top vent of the 249 head may be required to deflect the driver rod to a position where the lever assembly is free.

4. Using a 10 mm deep well socket inserted through the access hole, loosen the shaft clamp (figure 3-5).

5. Loosen and remove the hex nuts (key 34) from the mounting studs (key 33).

6. Carefully pull the digital level controller straight off the sensor torque tube.

CAUTION

Tilting the instrument when pulling it off of the sensor torque tube can cause the torque tube shaft to bend. To prevent damage to the torque tube shaft, ensure that the digital level controller is level when pulling it off of the sensor torque tube.

7. When re-installing the digital level controller, follow the appropriate procedure outlined in the Installation section. Also setup the digital level controller as described in the Initial Setup section.

249 Series Sensor in High Temperature Application

1. Loosen the set screw (key 31) in the terminal box cover assembly (key 6) so that the cover can be unscrewed from the terminal box.

2. After removing the cover (key 6), note the location of field wiring connections and disconnect the field wiring from the wiring terminals.

3. As shown in figure 3-5, locate the access handle on the bottom of the transducer housing. Using a 2 mm hex key, back out the set screw in the depression on the access handle until it is flush with the handle surface. Press on the back of the handle, as shown in the figure, and slide the handle toward the front of the unit, (the locked position), to expose the access hole. Be sure the locking handle drops into the detent.

Note

If the access handle will not slide, the sensor linkage is most likely in an extreme position. When the lever assembly is at a hard stop inside the housing, the locking pin on the access door may not be able to engage the mating slot in the lever assembly. This condition can occur if the displacer has been removed, if the sensor is lying on its side, or if the instrument had been coupled to the sensor while the displacer was not connected. To correct this condition, manipulate the sensor linkage to bring the lever assembly to within approximately 4 degrees of the neutral position before attempting to slide the handle. A probe inserted through the top vent of the 249 head may be required to deflect the driver rod to a position where the lever assembly is free.

4. Using a 10 mm deep well socket inserted through the access hole, loosen the shaft clamp (figure 3-5).

5. While supporting the instrument, loosen and remove the cap screws (key 63).

6. Carefully pull the digital level controller straight off the torque tube shaft extension (key 58).

CAUTION

Tilting the instrument when pulling it off of the sensor torque tube can cause the torque tube shaft to bend. To prevent damage to the torque tube shaft, ensure that the digital level controller is level when pulling it off of the sensor torque tube.

7. Loosen and remove the hex nuts (key 34) from the mounting studs (key 33).

8. Pull the heat insulator (key 57) off the mounting studs.

9. When re-installing the digital level controller, follow the appropriate procedure outlined in the Installation section. Also setup the digital level controller as described in the Setup and Calibration section.

LCD Meter Assembly

WARNING

In an explosion-proof or flame-proof installation remove the electrical power before removing the instrument covers in a hazardous area. Personal injury or property damage may result from fire and explosion if power is applied to the instrument with the covers removed.

The digital level controller is designed with a dual-compartment housing; one compartment contains the LCD meter and Electronics Module; the other contains all wiring terminals and the communication receptacles. The LCD meter is located in the compartment opposite the wiring terminals, as shown in figure 5-3.

Removing the LCD Meter

Perform the following procedure to remove the LCD meter.

1. Disconnect power to the digital level controller.

2. Remove the cover from the transducer housing. In explosive atmospheres, do not remove the instrument cover when the circuit is alive, unless in an intrinsically safe installation.

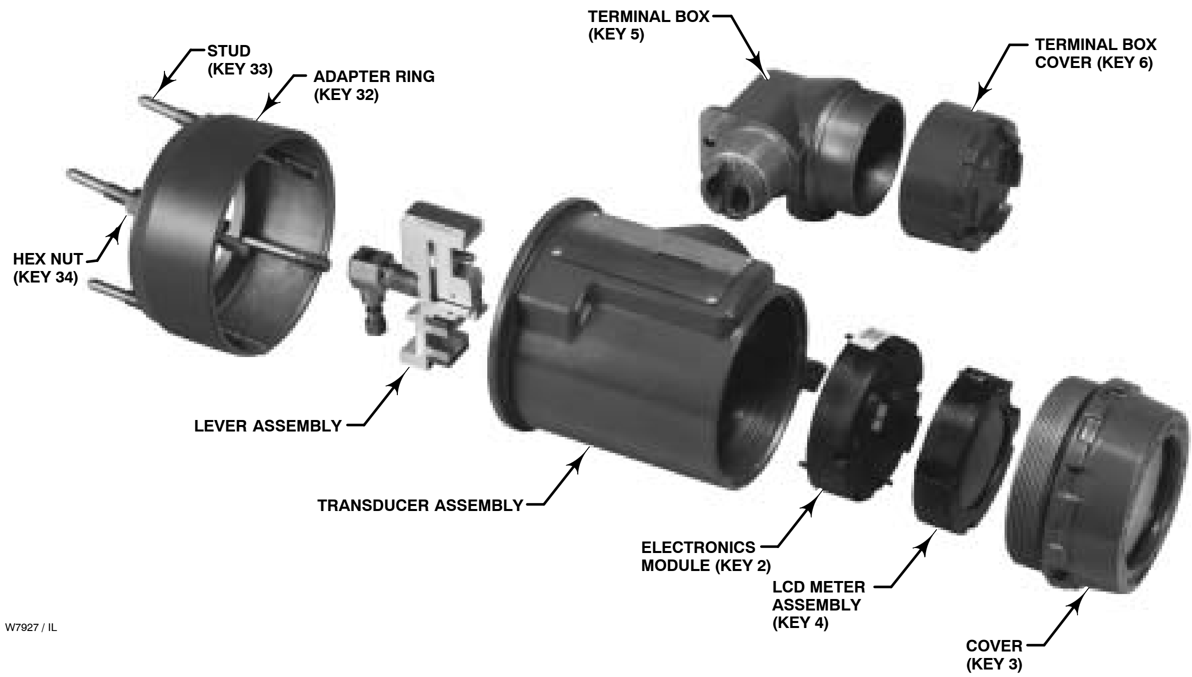


Figure 5-3. DLC3000 Series Digital Level Controller Assembly

3. Loosen the two screws that anchor the LCD meter to the Electronics Module. These screws are captive and should not be removed.

4. Firmly grasp the LCD meter and pull it straight away from the Electronics Module. Retain the six-pin dual header for later reinstallation.

Replacing the LCD Meter

Perform the following procedure to replace the LCD meter.

1. Verify that the interconnection header is in the six-pin socket on the face of the Electronics Module. The longer set of pins should be inserted in the Electronics Module socket.

2. Decide which direction to orient the meter. The meter can be rotated in 90-degree increments for easy viewing. Position one of the four six-pin sockets on the back of the meter to accept the interconnection header, and insert the long meter screws into the two holes on the meter to coincide with the appropriate holes on the Electronics Module.

3. Attach the meter to the interconnection pins. Thread the long meter screws into the holes on the Electronics Module and tighten to secure the meter.

4. Note the position of the alarm jumper on the LCD meter removed from the digital level controller. Remove the alarm jumper and install it on the replacement meter in the same position.

5. Install the six-pin dual header on the LCD meter. Carefully insert the LCD meter to mate with the interconnecting pins with the receptacles on the Electronics Module .

CAUTION

To prevent damage to the interconnecting pins when installing the LCD Meter, use the guide pins to insert the LCD meter straight onto the Electronics Module, without twisting or turning.

6. Replace the cover. Tighten 1/3 of a revolution after the cover begins to compress the O-ring. Both instrument covers must be fully engaged to meet explosion-proof or flame-proof requirements.

Electronics Module

Removing the Electronics Module

Perform the following procedure to remove the Electronics Module.

Note

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

WARNING

On an explosion-proof instrument, remove the electrical power before removing the instrument covers in a hazardous area. Personal injury or property damage may result from fire and explosion if power is applied to the instrument with the covers removed.

1. Disconnect power to the digital level controller.

2. Remove the cover from the transducer housing. In explosive atmospheres, do not remove the instrument cover when the circuit is alive, unless in an intrinsically safe installation. Remove the LCD meter assembly.

3. Loosen the two screws that anchor the Electronics Module to the transducer housing. These screws are captive and should not be removed.

4. Firmly grasp the Electronics Module and pull it straight out of the housing.

Replacing the Electronics Module

Perform the following procedure to replace the Electronics Module.

1. Carefully insert the Electronics Module to mate the interconnecting pins with the receptacles on the Transducer housing.

CAUTION

To prevent damage to the interconnecting pins when installing the Electronics Module, use the guide pins to insert the Electronics Module straight onto the Transducer housing receptacles without twisting or turning.

2. Tighten the two mounting screws. Replace the LCD meter assembly.

3. Replace the cover. Tighten 1/3 of a revolution after the cover begins to compress the O-ring. Both instrument covers must be fully engaged to meet explosion-proof requirements.

Terminal Box

The terminal box is located on the transducer housing and contains the terminal strip assembly for field wiring connections. Unless indicated otherwise, refer to figure 6-3.

WARNING

On an explosion-proof instrument, remove the electrical power before removing the instrument covers in a hazardous area. Personal injury or property damage may result from fire and explosion if power is applied to the instrument with the covers removed.

Removing the Terminal Box

1. Loosen the set screw (key 31) in the terminal box cover assembly (key 6) so that the cover can be unscrewed from the terminal box.

2. After removing the cover (key 6), note the location of field wiring connections and disconnect the field wiring from the wiring terminals.

3. Remove the screw (key 7), and pull out the terminal box assembly.

CAUTION

To avoid damaging the terminal box assembly connector, pull the terminal box assembly straight out of the housing, without twisting or turning.

Replacing the Terminal Box

Note

Inspect all O-rings for wear and replace as necessary.

1. Apply sealant to the O-ring (key 27) and install the O-ring over the stem of the terminal box as shown in figure 6-3.

2. Orient the terminal box so that the connectors engage properly, and carefully insert the terminal box into the transducer housing until the O-ring is seated.

CAUTION

To avoid damaging the mating pins in the Transducer housing, ensure that the guiding mechanism is engaged properly before applying force.

3. Fasten the terminal box to the transducer housing with the screw (key 7). Tighten the screw to 6 N•m (53 lbf•in).

4. Apply sealant to the O-ring (key 26) and install the O-ring over the cover threads on the terminal box. Use a tool to prevent cutting the O-ring while installing it over the threads.

5. Reconnect the field wiring as noted in step 2 in the Removing the Terminal Box procedure.

6. Apply lubricant to the threads on the terminal box to prevent seizing or galling while installing the terminal box cover.

7. Screw the terminal box cover assembly (key 6) completely onto the terminal box to seat the O-ring (key 26). Loosen the cover (not more than 1 turn) until the set screw (key 31) aligns with one of the recesses in the terminal box beneath the cover. Tighten the set screw to engage the recesses but no more than 0.88 N•m (7.8 lbf•in).

8. Apply lubricant to the conduit entrance plug (key 28) and install it in the unused conduit entrance.

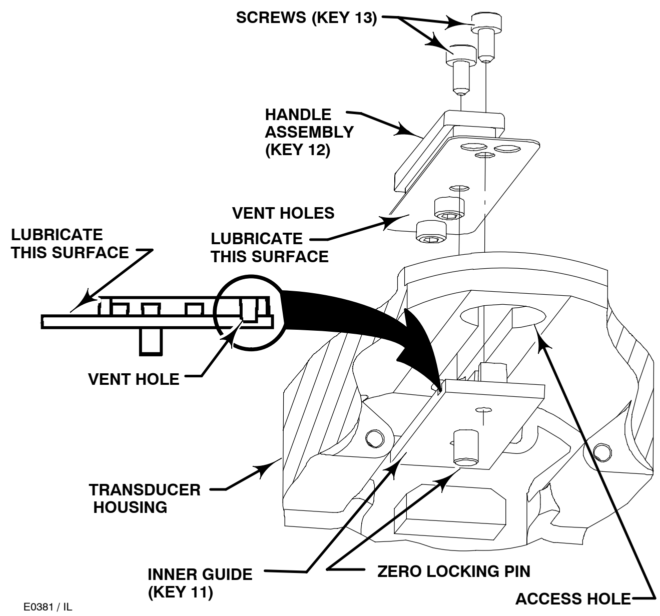


Figure 5-4. Installing Inner Guide and Access Handle Assembly

Removing and Replacing the Inner Guide and Access Handle Assembly

The access handle and inner guide are located on the transducer housing. Unless indicated otherwise, refer to figure 6-2.

1. Remove the digital level controller from the sensor as described in Removing the Digital Level Controller from the Sensor.

2. Loosen and remove the hex nuts (key 34) from the studs (key 33) and remove the adapter ring (key 32).

Note

In the next step the screws (key 13) will be attracted by the magnets on the lever assembly. Use care to keep the screws from falling beneath the coupling shield.

3. Remove the coupling shield (key 16) by removing the two screws (key 13). Take care not to drop the screws into the lever assembly compartment where they will be attracted by the magnets.

4. Loosen and remove the two screws (key 13) in the handle assembly (key 12). Remove the handle assembly and the inner guide (key 11).

5. Apply thread lock to the internal threads of the replacement inner guide. Also apply a thin coat of a light grade of grease to the zero locking pin on the inner guide and on the surface that is opposite the zero locking pin, as shown in figure 5-4 (this surface contacts the transducer housing when installed).

6. Place the inner guide in the slot inside the transducer housing so that the vent holes in the inner guide (the milled slots in the inner guide, see figure 5-4) face the exterior of the housing and are over the access hole.

7. Apply a thin coat of a light grade of grease to the surface of the replacement handle assembly (see figure 5-4) where it will contact the transducer housing.

8. Install the handle assembly (key 12) in the slot of the transducer housing over the inner guide (key 11) so that the vent holes in the handle assembly are over the access hole.

9. Install two screws (key 13) to secure the handle assembly (key 12) to the inner guide (key 11). Tighten the screws to 0.48 N•m (4.2 lbf•in).

10. Press down on the handle as shown in figure 3-5 and slide it forward to make sure it works smoothly and that the zero locking pin engages the lever assembly. Also check for free travel of the lever assembly when the handle is in the unlocked position.

11. Install the coupling shield (key 16) and secure with the two screws (key 13). Tighten the screws to 0.48 N•m (4.2 lbf•in).

12. Refer to figure 6-1. Install the adapter ring (key 32) on the studs (key 33) and secure with hex nuts (key 34).

13. When re-installing the digital level controller, follow the appropriate procedure outlined in the Installation section. Also setup the digital level controller as described in the Setup and Calibration section.

Lever Assembly

Removing the Lever Assembly

The lever assembly is located in the transducer housing. Unless indicated otherwise, refer to figure 6-2.

1. Remove the digital level controller from the sensor as described in Removing the Digital Level Controller from the Sensor.
2. Loosen and remove the hex nuts (key 34) from the studs (key 33) and remove the adapter ring (key 32).
3. Remove the coupling shield (key 16) by removing the two screws (key 13). Take care not to drop the screws into the lever assembly compartment where they will be attracted by the magnets.
4. Inspect the lever assembly alignment with the housing. If it is off center or not co-axial with the main housing, continue with the removal procedure.
5. Loosen and remove the mounting screw (key 14) from the lever assembly.
6. Loosen the flexure block from its machined pocket in the housing, by inserting a smooth tool into the hole for the mounting screw, and gently rocking it back and forth in what would be the vertical axis if the transmitter were installed.
7. Lift the lever assembly out of the housing.

Inspect the flexure for damage. If the flexure is bent or torn, replace the lever assembly.

Replacing the Lever Assembly

Replacing the lever assembly in the field may result in a slight degradation in linearity performance, since the factory characterizes the entire transducer module as a unit. For most applications, this degradation should not be noticeable. (If guaranteed restoration to factory specification is desired, the entire transducer module should be replaced.)

1. Move the zero-pin slide to the locking position.
2. Apply a thin coat of a light grade of grease to the internal thread of the hole for the lever mounting bolt.
3. Hold lever assembly by coupling block and guide the flexure block into its aligning slot in the housing without applying any downward force to the sprung parts of the lever assembly.

CAUTION

To prevent damage to the flexure when inserting the flexure block into its aligning slot in the housing, apply pressure to the flexure block only.

A long pin inserted into the bolt-hole in the flexure block may be used to pull it against the inside corner of the aligning slot.

4. Secure the block by reinstalling the M5x20 socket-head cap screw (key 14). Torque to 2.8 N•m (25 lbf•in) ±10%.

5. Mark bolt head and block with a movement-detecting sealant.

6. Install the coupling shield (key 16) and secure with the two screws (key 13). Tighten the screws to 0.48 N•m (4.2 lbf•in).

7. Refer to figure 6-1. Install the adapter ring (key 32) on the studs (key 33) and secure with hex nuts (key 34). When re-installing the digital level controller, follow the appropriate procedure outlined in the Installation section. Set up the digital level controller as described in the Setup and Calibration section.

Packing for Shipment

If it becomes necessary to return the unit for repair or diagnosis, contact your Emerson Process Management sales office for returned goods information.

CAUTION

Lock the lever assembly when shipping the stand-alone instrument, to prevent damage to the flexure.

Use the original shipping carton if possible.

Section 6 Replaceable Parts

Table 6-1. Mounting Kits

	FISHER 249 SERIES	MASONEILAN		YAMATAKE NQP	FOXBORO-ECKARDT	
		12100 or 12800	12200 or 12300		144LD	LP167
Without Heat Insulator	- - -	28B5742X012	28B8444X012	GB0101X0012	29B5900X012	29B8480X012
With Heat Insulator	28B5741X012	28B5743X012	28B8445X012	GB0105X0012	29B8491X012	- - -

Parts Ordering

Whenever corresponding with your Emerson Process Management sales office about this equipment, always mention the controller serial number. When ordering replacement parts, refer to the 11-character part number of each required part as found in the following parts list. Parts that do not show part numbers are not orderable.

6

WARNING

Use only genuine Fisher replacement parts. Components that are not supplied by Emerson Process Management, should not, under any circumstances, be used in any Fisher instrument. The use of components not manufactured by Emerson Process Management will void your warranty, might adversely affect the performance of the instrument, and could give rise to personal injury and property damage.

Note

Neither Emerson, Emerson Process Management nor any of their affiliate entities assumes responsibility for the selection, use, and maintenance of any product. Responsibility for the selection, use, and maintenance of any product remains with the purchaser and end-user.

Mounting Kits

Heat Insulator Kit, for mounting Type DLC3010 on 249 Series sensor. Includes heat insulator (key 57), cap screws (key 61), shaft extension (key 58), shaft coupling (key 59), and set screws (key 60). 28B5741X012

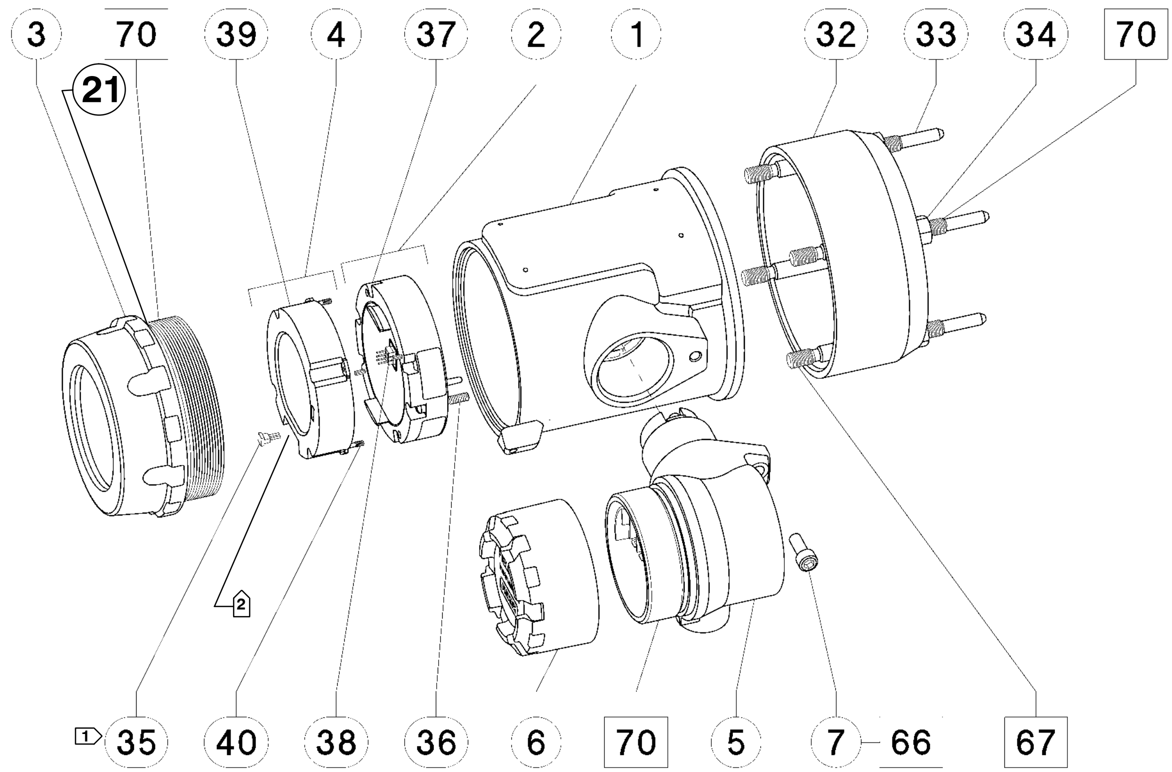
Note

Contact your Emerson Process Management sales office for information on the availability of additional mounting kits.

Parts Kits

Key	Description	Part Number
1*	Small Hardware Spare Parts Kit	19B1643X032
	Includes	Qty/kit
	Screw (key 7)	1
	Set Screw (key 20)	2
	Set Screw (key 31)	2
	Test Terminal (key 24	4
	Wire Retainer (key 25)	8
	Lock Washer (key 31)	1
	Alarm Jumper (key 35)	2
	Header Assembly (key 38)	2
	Washer, Lock, Spring (key 47),	1
	Clamp Nut (key 76)	1
2*	Spare O-Rings Kit Includes three each of keys 21, 26, and 27	19B1643X022

* Recommended spare part



NOTES:
1 INSTALL ALARM JUMPER (KEY 35) ON ELECTRONICS ASSEMBLY (KEY2) WHEN LCD METER (KEY 4) IS NOT INSTALLED.
2 LOCATION OF ALARM JUMPER (KEY 35) WHEN LCD METER (KEY 4) IS INSTALLED.

☐ APPLY LUB/THREADLOCK

58B5510-C /IL

Figure 6-1. DLC3000 Series Digital Level Controller Assembly

Parts List

Type DLC3010 Digital Level Controllers (figure 6-1)

Key	Description	Part Number
1	Transducer Module(1)	GE18497X012
2	Electronics Ass'y, includes alarm jumper (key 35) and captive screws (key 36), and header ass'y (key 38) and captive screws (key 40)	
	For use with transducer module 48B5763X012 (has obsolete Hall sensor on Flex circuit)	18B5529X022
	For use with transducer module GE18497X012 (has new Hall sensor on rigid boards)	18B5529X032
3	Cover Assy, includes O-ring (key 21)	38B5734X012
4	LCD Meter Ass'y,includes alarm jumper (key 35) and captive screws (key 36), and header ass'y (key 38) and captive screws (key 40)	28B5738X012
5	Terminal Box Ass'y	28B5740X022
6	Terminal Box Cover Ass'y, includes labels (key 30 and 64) and set screw (key 31)	28B5531X012
7*	Screw, hex socket(2)	11B9076X042
8	Nameplate	
9	Drive Screw, 18-8 SST	1A368228982
21*	O-ring, nitrile(3)	1K1810X0012
32	Adaptor Ring, A03600	1N10160G012
33	Stud, SST (4 req'd)	1N10162G012
34	Hex Nut, 304 SST (4 req'd)	1N10252G012
35*	Alarm Jumper(2)	18B5733X012
36	Screw, captive, 18-8 SST	
	For electronics ass'y (2 req'd)	18B5732X022
38*	Header Assembly, dual row (not shown)(2)	18B5736X012
40	Screw, captive, 18-8 SST	
	For LCD meter (2 req'd)	18B5732X012
66	Anti-Seize Sealant (not furnished with instrument)	
67	Thread locking adhesive (medium strength) (not furnished with instrument)	
70	Lithium grease (not furnished with instrument)	

* Recommended spare part
1. These parts are not replaced in the field due to serialization and characterization issues, but can be replaced at a qualified service center. Contact your Emerson Process Management sales office for additional information.
2. Included in small hardware spare parts kit.
3. Included in spare O-rings kit.

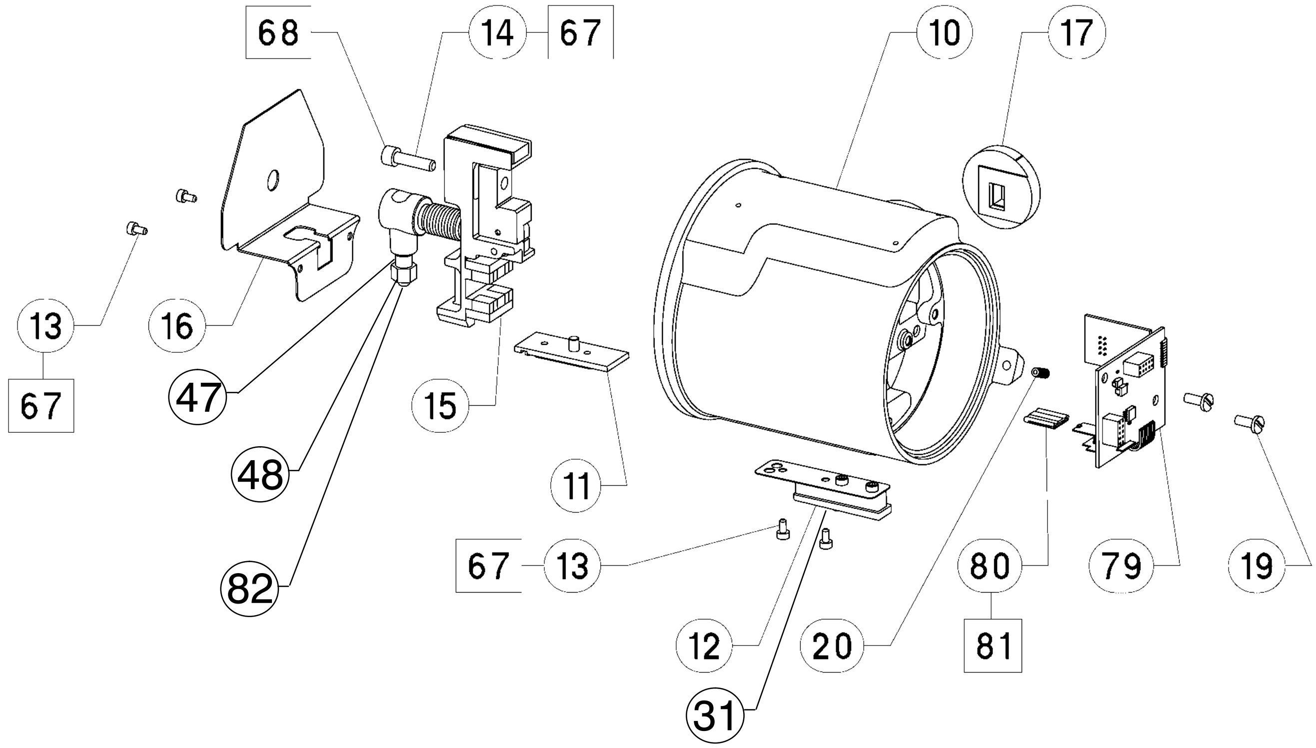


Figure 6-2. DLC3000 Series Digital Level Controller Transducer Assembly

Transducer Assembly (figure 6-2)

Key	Description	Part Number
11	Inner Guide, aluminum	28B5482X012
12	Handle Ass'y aluminum/SST	18B5522X012
13	Screw, hex socket, 18-8 SST (4 req'd)	18B5513X012
14	Screw, cap, 18-8 SST	18B5515X012
15	Lever Assembly, aluminum/SST/NdFeB/CS	38B5509X022
16	Coupling Shield, 18-8 SST	38B5485X012
17	Ring, align/clamp	28B5479X022
19	Machine Screw, pan head	18B5518X012
20*	Set Screw, 18-8 SST(2)	18B5516X012
31*	Set Screw, hex socket, 18-8 SST(2)	18B5517X012
47	Spring Lock Washer, 18-8 SST(2)	19B0819X012
48	Clamp Nut, 18-8 SST(2)	19B5497X012
67	Thread Locking adhesive (medium strength) (not furnished with instrument)	
68	Sealant	
79	Transducer Board Assembly(1)	GE14863X012
80	Hall Guard	GE15488X012
81	Compound, silicone	
82	Bolt, lock, coupling block, SST	28B5494X012

* Recommended spare part
1. These parts are not replaced in the field due to serialization and characterization issues, but can be replaced at a qualified service center. Contact your Emerson Process Management sales office for additional information.
2. Included in small hardware spare parts kit.

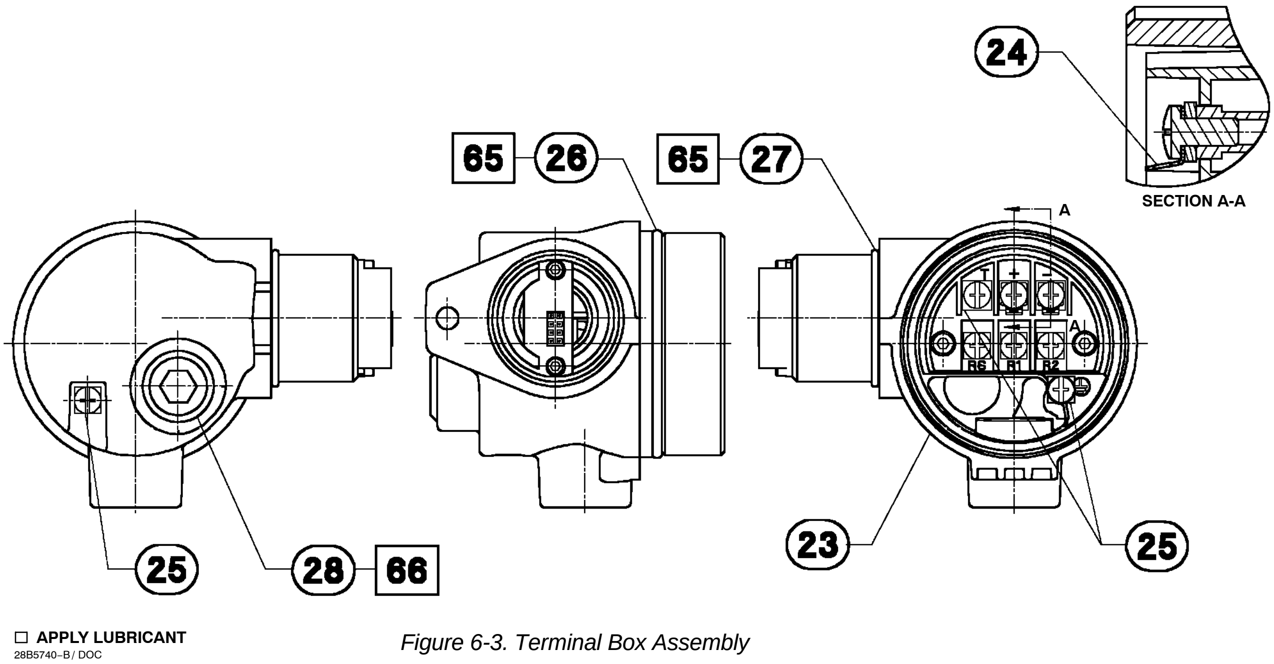


Figure 6-3. Terminal Box Assembly

Key Description Part Number

Terminal Box Assembly (figure 6-3)

Key	Description	Part Number
24*	Test Terminal, 18-8 SST (2 req'd)(2)	28B5716X012
25*	Wire Retainer, 18-8 SST (8 req'd)(2)	18B5532X012
26*	O-Ring, nitrile(3)	1H8762X0012
27*	O-Ring, nitrile(3)	10A8218X032
28	Pipe Plug, 18-8 SST	1H5137X0012
65	Lubricant, Silicone (not furnished with instrument)	
66	Anti-Seize Sealant (not furnished with instrument)	

Terminal Box Cover Assembly (figure 6-4)

Key	Description	Part Number
30	Label, internal, plastic	28B5721X012
31*	Set Screw, hex socket, 18-8 SST(2)	18B5517X012
64	Label, external	18B5537X012

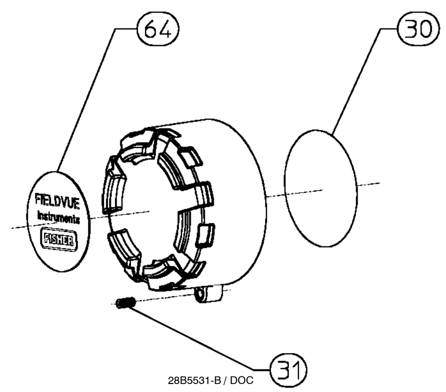
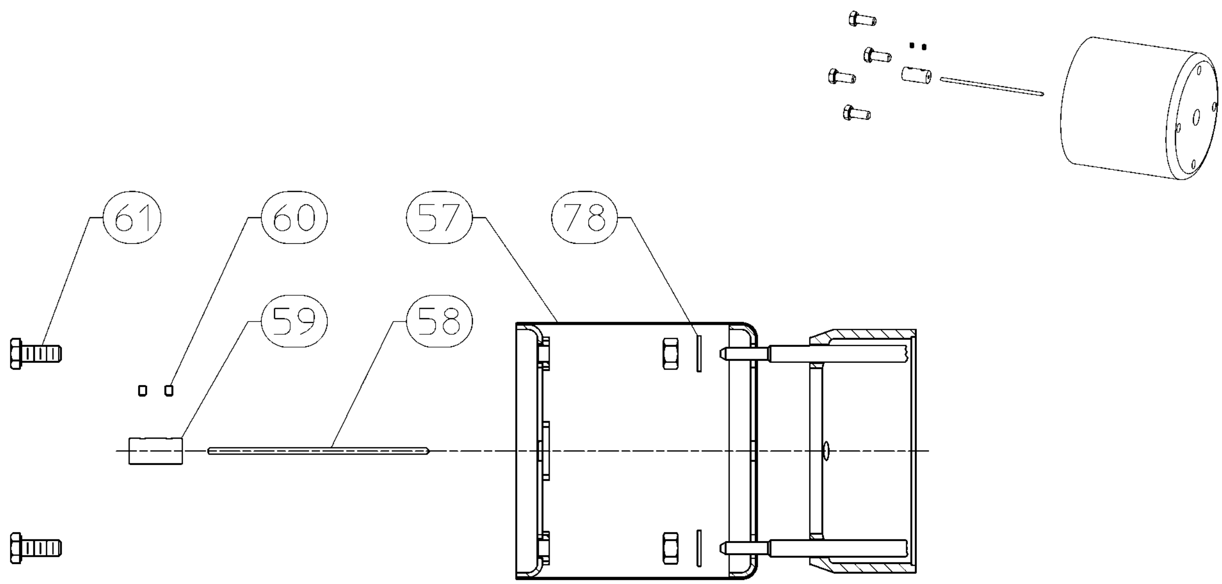


Figure 6-4. Terminal Box Cover Assembly

* Recommended spare part
1. Included in small hardware spare parts kit.
2. Included in spare O-rings kit.



28B5741-A

Figure 6-5. Mounting Kit for 249 Series Sensor with Heat Insulator

Key Description Part Number

Mounting Parts

These parts are also available as a kit. Refer to the Mounting Kits section.

249 Series Sensor with Heat Insulator (figure 6-5)

Key	Description	Part Number
57	Heat Insulator, S30400	22A0033X012
58	Shaft Extension, N05500	1B681540022
59	Shaft Coupling, S30300	1A577935032
60	Set Screw, hex socket, SST (2 req'd)	1E6234X0022
61	Screw, hex hd, SST (4 req'd)	1A3816K0012
78	Washer, plain (4 req'd)	1B865928982

Key Description Part Number

Masoneilan® Sensors (figures 6-6 and 6-7)

12100 or 12800 without Heat Insulator

Key	Description	Part Number
58	Shaft Extension, S31600	10B2396X012
59	Shaft Coupling, S30300	1A577935032
60	Set Screw, hex socket, SST (2 req'd)	1E6234X0022
61	Screw, hex hd, 18-8 SST (4 req'd)	1A3816K0012
62	Mounting Adapter, A03560	31B1453X012
63	Screw, hex socket, (4 req'd)	10B7283X012

12100 or 12800 with Heat Insulator

Key	Description	Part Number
57	Heat Insulator, S30400	22A0033X012
58	Shaft Extension, N05500	11B1454X012
59	Shaft Coupling, S30300	1A577935032
60	Set Screw, hex socket, SST (2 req'd)	1E6234X0022
61	Screw, hex hd, SST (4 req'd)	1A3816K0012
62	Mounting Adapter, A03560	31B1453X012
63	Screw, hex socket, steel (4 req'd)	10B7283X012
78	Washer, plain (4 req'd)	1B865928982

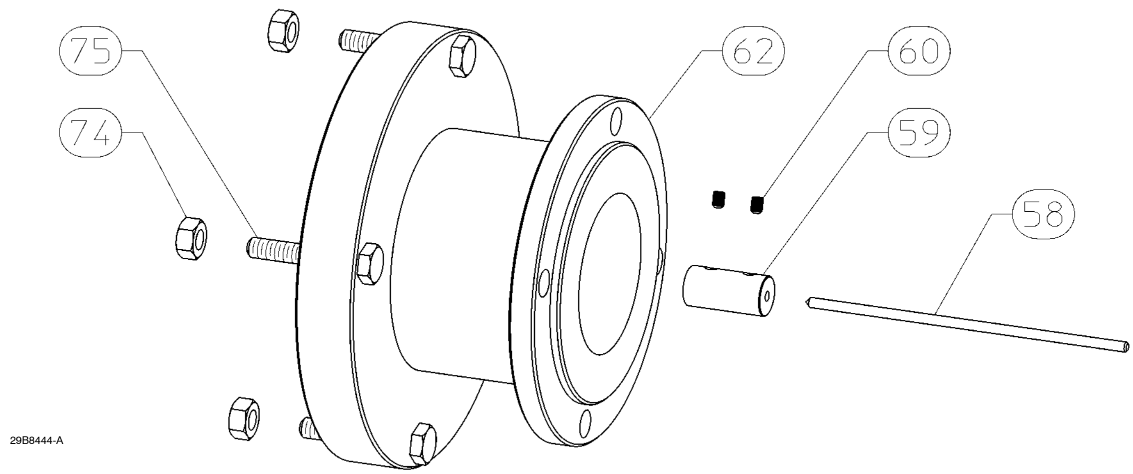


Figure 6-6. Mounting Kit for Masoneilan® 12200 and 12300 Sensor without Heat Insulator

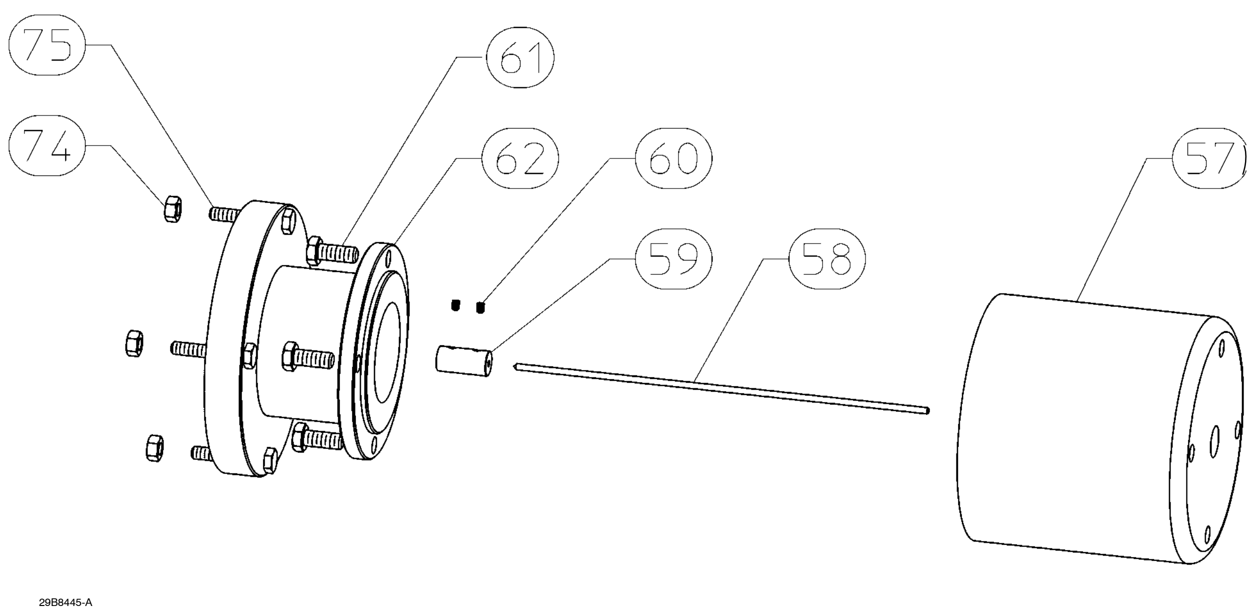


Figure 6-7. Mounting Kit for Masoneilan® 12200 and 12300 Sensor with Heat Insulator

Key	Description	Part Number
	12200 or 12300 without Heat Insulator	
58	Shaft Extension N05500	1B681540022
59	Shaft Coupling, S30300	1A577935032
60	Hex Socket Screw (2 req'd)	1E6234X0022
62	Mounting Adaptor, A92024	39B8487X012
74	Hex Nut, SST (4 req'd)	1A3457K0012
75	Hex Cap Screw, SST (4 req'd)	1A3904X0032

Key	Description	Part Number
	12200 or 12300 with Heat Insulator	
57	Heat Insulator, S30400	22A0033X012
58	Shaft Extension N05500	19B8446X012
59	Shaft Coupling, S30300	1A577935032
61	Hex Cap Screw, SST (4 req'd)	1A3816K0012
60	Hex Socket Screw (2 req'd)	1E6234X0022
62	Mounting Adaptor, A92024	39B8487X012
74	Hex Nut, SST (4 req'd)	1A3457K0012
75	Hex Cap Screw, SST (4 req'd)	1A9304X0032
78	Washer, plain (4 req'd) not shown	1B865928982

Yamatake NQP Sensor

Without Heat Insulator

Key	Description	Part Number
58	Shaft Extension, S31600	GB0099X0012
59	Shaft Retainer, S30400	GB0104X0012
60	Hex Socket Screw, SST	18B5517X012
62	Mounting Adaptor, A96061	GB0100X0012
63	Hex Socket Screw, SST (3 req'd)	1J6857X0012
71	Hex Socket Screw, SST (3 req'd)	18B5512X012
72	Shaft Adapter, S30400	GB0107X0012
73	Hex Socket Screw, SST (2 req'd)	1U8830X0012

With Heat Insulator

Key	Description	Part Number
57	Heat Insulator, S30400	22A0033X012
58	Shaft Extension, N05500	GB0103X0012
59	Shaft Retainer, S30400	GB0104X0012
60	Hex Socket Screw, SST	18B5517X012
61	Hex Cap Screw, SST (4 req'd)	1A3816K0012
62	Mounting Adaptor, A96061	GB0100X0012
63	Hex Socket Screw, SST (3 req'd)	1J6857X0012
71	Hex Socket Screw, SST (3 req'd)	18B5512X012
72	Shaft Adapter, S30400	GB0107X0012
73	Hex Socket Screw, SST (2 req'd)	1U8830X0012
78	Washer, plain (4 req'd)	1B865928982

6

Foxboro®-Eckardt Sensors

144LD without Heat Insulator

Key	Description	Part Number
58	Shaft Extension, S31600	10B2396X012
59	Shaft Coupling, S30300	19B5898X012
60	Set Screw, hex socket, SST (2 req'd)	1E6234X0022
62	Mounting Adapter, A92024	39B5899X012
74	Hex Nut, steel (4 req'd)	19A4788X012
75	Hex Cap Screw, steel (4 req'd)	17B6153X012

144LD with Heat Insulator

Key	Description	Part Number
57	Heat Insulator, S30400	22A0033X012
58	Shaft Extension, 316 SST	11B1454X012
59	Shaft Coupling, S30300	19B5898X012
60	Set Screw, hex socket, SST (2 req'd)	1E6234X0022
61	Screw, hex hd, SST (4 req'd)	1A3816K0012
62	Mounting Adapter, A92024	39B5899X012
74	Hex Nut, steel (4 req'd)	19A4788X012
75	Hex Cap Screw, steel (4 req'd)	17B6153X012
78	Washer, plain (4 req'd)	1B865928982

LP167 without Heat Insulator

Key	Description	Part Number
58	Shaft Extension, S31600	19B8478X012
59	Shaft Coupling, S30300	19B5898X012
60	Set Screw, hex socket, SST (2 req'd)	1E6234X0022
62	Mounting Adapter, A92024	39B8479X012
63	Screw, hex socket, (4 req'd)	19B8477X012

Appendix A Model 375 Field Communicator Basics

A

Figure A-1. Model 375 Field Communicator

Note

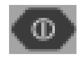
The Model 375 Field Communicator device description revision (DD) determines how the Field Communicator interfaces with the instrument. For information on displaying the device description revision, see page A-5.

This section discusses the display, keypad, and menu structure for the Field Communicator, shown in figure A-1. It includes information for displaying the Field Communicator device description revision number. For information on connecting the Field Communicator to the instrument, see the Installation section. For more information on the Field Communicator, such as specifications and servicing, see the User's Manual for the Field Communicator 00375-0047-0001, included with the Field Communicator. This manual also is available from Rosemount Inc., Measurement Division.

Display

The Field Communicator communicates information through a 1/4 VGA (240 by 320 pixels) monochrome touch screen. It has a viewing area of approximately 9 cm by 12 cm.

Using the Keypad

On/Off Key 

The on/off key is used to turn the Field Communicator on and off.

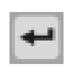
From the Main Menu, select HART Application to run the HART application. On startup, the HART Application automatically polls for devices.

If a HART-compatible device is found, the Field Communicator displays the Online menu. For more information on Online and Offline operation, see Menu Structure in this section.

The on/off key is disabled while any applications are open, making it necessary for you to exit the 375 Main Menu before using the on/off key. This feature helps to avoid situations where the Field Communicator could be unintentionally turned off while a device's output is fixed or when configuration data has not been sent to a device.

Navigation Keys

Four arrow navigation keys allow you to move through the menu structure of the application. Press the right arrow () navigation key to navigate further into the menu.

Enter Key 

The enter key allows you perform the highlighted item, or to complete an editing action. For example, if you highlight the Cancel button, and then push the enter key, you will cancel out of that particular window. The enter key does not navigate you through the menu structure.

Tab Key 

The tab key allows you to move between selectable controls.

Alphanumeric Keys

Figure A-2 shows the alphanumeric keypad. Data entry, and other options, using letters, number and

Figure A-2. Model 375 Field Communicator Alphanumeric and Shift Keys

other characters can be performed using this keypad. The 375 Field Communicator will automatically determine the mode depending upon the input necessary for the particular field.

To enter text when in alphanumeric mode, press the desired keypad button in quick repetition to scroll through the options to attain the appropriate letter or number.

For example, to enter the letter “Z”, press the 9 key quickly four times.

The alphameric keys are also used for the Fast Key sequence. The Fast Key sequence is a sequence of numerical button presses, corresponding to the menu options that lead you to a given task. See the Model 375 Field Communicator Menu Structures at the beginning of this manual.

Backlight Adjustment Key 

The backlight adjustment key has four settings allowing you to adjust the intensity of the display. Higher intensities will shorten the battery life.

Function Key 

The function key allows you to enable the alternate functionality of select keys. The grey characters on the keys indicate the alternate functionality. When enabled, the orange multifunction LED light will appear and an indication button can be found on the soft input panel (SIP). Press the key again to disable the function key.

Multifunction LED

The multifunction LED indicates when the 375 Field Communicator is in various states. Green signifies that the Field Communicator is on, while flashing green indicates that it is in power saving mode. Green and orange indicate that the function key is enabled, and a green and orange flash indicates that the on/off button has been pressed long enough for the Field Communicator to power up.

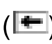
Using the Touch Screen

The touch screen display allows you to select and enter text by touching the window.

Tap the window once to select a menu item or to activate a control. Double-tap to access the various options associated with the menu item.

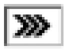
CAUTION

The touch screen should be contacted by blunt items only. The preferred item is the stylus that is included with the 375 Field Communicator. The use of a sharp instrument can cause damage to the touch screen interface.

Use the back arrow button() to return to the previous menu. Use the terminate key () in the upper right corner of the touch screen to end the application.

Using the Soft Input Panel (SIP) Keyboard

As you move between menus, different dynamic buttons appear on the display. For example, in menus providing access to on-line help, the HELP button may appear on the display. In menus providing access to the Home menu, the HOME button may appear on the display. In many cases the SEND label appears indicating that you must select the button on the display to send the information you have entered on the keypad to the FIELDVUE instrument’s memory. Online menu options include:

- **Hot Key** 

Tap the Hot Key from any Online window to display the Hot Key menu. This menu allows you to quickly:

- Set instrument range values
- Perform PV setup
- Change the instrument protection

For details on ranging, PV setup, and protection, and other configuration parameters, see the Detailed Setup section of this manual.

The Hot Key can also be accessed by enabling the function key, and pressing the 3 key on the alphanumeric key pad.

- **SCRATCHPAD**  is a text editor that allows you to create, open, edit and save simple text (.txt) documents.

- **HELP**—gives you information regarding the display selection.

- **SEND**—sends the information you have entered to the instrument.

- **HOME**—takes you back to the Online menu.

- **EXIT**—takes you back to the menu from which you had requested the value of a variable that can only be read.

- **ABORT**—cancels your entry and takes you back to the menu from which you had selected the current variable or routine. Values are not changed.

- **OK**—takes you to the next menu or instruction screen.

- **ENTER**—sends the information you have selected to the instrument or flags the value that is to be sent to the instrument. If it is flagged to be sent, the SEND dynamic label appears as a function key selection.

- **ESC**—cancels your entry and takes you back to the menu from which you had selected the current variable or routine. Values are not changed.

- **SAVE**—saves information to the internal flash or the configuration expansion module.

Menu Structure

The Field Communicator is generally used in two environments: offline (when not connected to an instrument) and online (connected to an instrument).

Offline Operation

Selecting HART Application when not connected to a FIELDVUE instrument causes the Field Communicator to display the message “No device found at address 0. Poll?” Selecting “Yes” or “No” will bring you to the HART Application menu. Three choices are available from this screen: *Offline, Online* and *Utility.* The Offline menu allows you to create offline configurations, as well as view and change device configurations stored on the 375 Field Communicator. The Utility menu allows you to set the polling option, change the number of ignored status messages, view the available Device Descriptions, perform a simulation, and view HART diagnostics.

Do not change units in the offline mode. Changed units will be written back to the instrument when the online mode is entered.

You can set up a “reset to factory defaults” function for saving a configuration of a new DLC3000. The function will be labeled DLCDEFAULTS. This function will allow you to return to factory defaults using the handheld communicator. Marking the Process Temp Offset and Electronics Temp Offset “NOT TO SEND” will prevent you from overwriting the factory characterizations of these variables in an instrument different than the one you saved the configuration from. If you are trying to restore these values for the same instrument, after having corrupted them in a DLC3010, you could mark them SEND. The choice of marking the HART data (tag, date, descriptor, etc.) at the end NOT TO SEND is correct if you entered all the data at one point with a handheld and don’t want to have to recreate it.

Note that the SAVE feature allows you to create a set of standard configurations that you can load to instruments quickly, and then go in and update just the variable info by hand. This feature is very useful if you have a few dozen similar installations.

Refer to the the 375 Field Communicator instruction manual for discussion of the methods of saving configurations, editing configurations, and loading saved configurations to instruments.

Following is a list of variables that are stored in a “Saved Configuration” in the handheld memory when you push the SAVE button.

WriteProtect
DisplacerWeightUnits
DisplacerWeight
DisplacerVolumeUnits

DisplacerVolume
DisplacerLengthUnits
DisplacerLength
MomentArmLength
SensorAction
TorqueTubeRateUnits

TorqueTubeRate
TorqueTubeMaterial
primary_variable_code
PV Units
UPPER_RANGE_VALUE
LOWER_RANGE_VALUE
DAMPING_VALUE
InputFilter
LevelOffset
TempUnits

ProcTempOffset (Mark this "NOT TO SEND)
ElecTempOffset (Mark this "NOT TO SEND)
PV.HI_ALARM
PV.HI_HI_ALARM
PV.LO_ALARM
PV.LO_LO_ALARM
PV.DEADBAND
PVAlarmEnable (packed binary)
ElecTempHI_ALARM
ElecTempLO_ALARM

ProcTempHI_ALARM
ProcTempLO_ALARM
TempDEADBAND
TempAlarmEnable (packed binary)
MeterInstalled
MeterType
MeterDecimalPoint
TrendVariable
TrendInterval
RTDType

WireResistancetag (Mark this "NOT TO SEND" if desired)
date (Mark this "NOT TO SEND" if desired
descriptor (Mark this "NOT TO SEND" if desired)
message (Mark this "NOT TO SEND" if desired)
InstrumentSerialNumber (Mark this "NOT TO SEND" if desired)
final_assembly_number (Mark this "NOT TO SEND" if desired)
DisplacerSerialNumber (Mark this "NOT TO SEND" if desired)
polling_address
burst_mode_select

Polling

When several devices are connected in the same loop, such as for split ranging, each device must be assigned a unique polling address. Use the Polling options to configure the Field Communicator to automatically search for all or specific connected devices.

To enter a polling option, select *Utility* from the HART Application menu. Select *Configure HART Application*, and then select *Polling.* Tap ENTER to select the highlighted option.

The Polling options are:

1. **Never Poll**—connects to a device at address 0, and if not found will not poll for devices at addresses 1 through 15.
2. **Ask Before Polling**—connects to a device at address 0, and if not found asks if you want to poll for devices at addresses 1 through 15.
3. **Always Poll**—connects to a device at address 0, and if not found will automatically poll for devices at addresses 1 through 15.
4. **Digital Poll**—automatically polls for devices at address 0 through 15 and lists devices found by tag.
5. **Poll Using Tag**—asks for a device HART tag and then polls for that device.
6. **Poll Using Long Tag**—allows you to enter the long tag of the device. (Only supported in HART Universal revision 6 devices.)

To find individual device addresses, use the Digital Poll option to find each connected device in the loop and list them by tag.

For more information on setting the polling address, see the Detailed Setup section.

System Information

To access the Field Communicator system information, select *Settings* from the 375 Main Menu.

About 375 includes software information about your 375 Field Communicator.

Licensing can be viewed when you turn on the 375 Field Communicator and in the License settings menu. The license setting allows you to view the license on the System Card.

Memory settings consists of System Card, Internal Flash size, and Ram size, as well as the Expansion Module if installed. It allows you to view the total memory storage and available free space.

Reviewing Instrument Device Descriptions

The Field Communicator memory module contains device descriptions for specific HART-compatible devices. These descriptions make up the application software that the communicator needs to recognize particular devices.

To review the device descriptions programmed into your Field Communicator, select *Utility* from the HART

Application menu, then select *Available Device Descriptions*. The manufacturers with device descriptions installed on the Field Communicator are listed.

Select the desired manufacturer to see the list of the currently installed device models, or types, provided by the selected manufacturer.

Select the desired instrument model or type to see the available device revisions that support that instrument.

Simulation

The Field Communicator provides a simulation mode that allows you to simulate an online connection to a HART-compatible device. The simulation mode is a training tool that enables you to become familiar with the various menus associated with a device without having the Field Communicator connected to the device.

To simulate an online connection, select *Utility* from the main menu. Select *Simulation* then select *Fisher Controls.* Select *DLC3000* to see the menu structure for the DLC3000 Series digital level controller. Refer to the appropriate sections of this manual for information on the various menus.

Online Operation

The Online menu is the first to be displayed when connecting to a HART compatible device. It contains important information about the connected device.

The figure on the front cover foldout shows an overview of the DLC3000 Series digital level controller menu structure.

Displaying the Field Communicator Device Description Revision

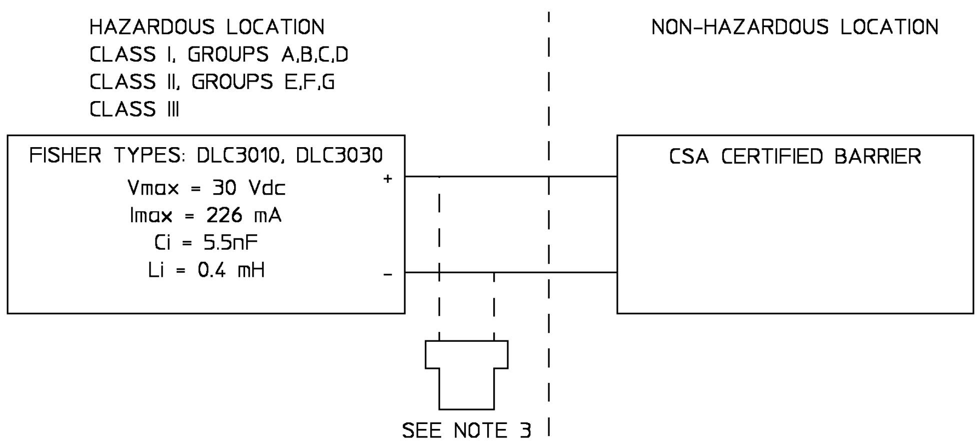
Device Description (DD) Revision is the revision number of the Fisher Device Description that resides in the Field Communicator. It defines how the Field Communicator is to interact with the user and instrument.

Field Communicators with device description revision 2 are used with DVC3000 Series instruments. You can display the device description revision when the Field Communicator is Offline or Online: to see the Field Communicator device description revision number from the Offline menu, select *Utility, Simulation, Fisher Controls,* and *DLC3000*. From the Online menu, select *Detailed Setup, Device Information, Version Info,* and *Device Description* (4-3-2-5).

Appendix B Loop Schematics/Nameplates

This section includes loop schematics required for wiring of intrinsically safe installations and the approvals nameplates. If you have any questions, contact your Emerson Process Management sales office.

CSA ENTITY INSTALLATION DRAWING



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 I.
3. IF HAND-HELD COMMUNICATOR OR MULTIPLEXER IS USED, IT MUST BE CSA CERTIFIED AND INSTALLED PER THE MANUFACTURER'S CONTROL DRAWING.
4. FOR ENTITY INSTALLATION: Vmax > Voc, Imax > Isc, Ci + Ccable < Ca, Li + Lcable < La.

28B5744-B / DOC

Figure B-1. CSA Schematic

B

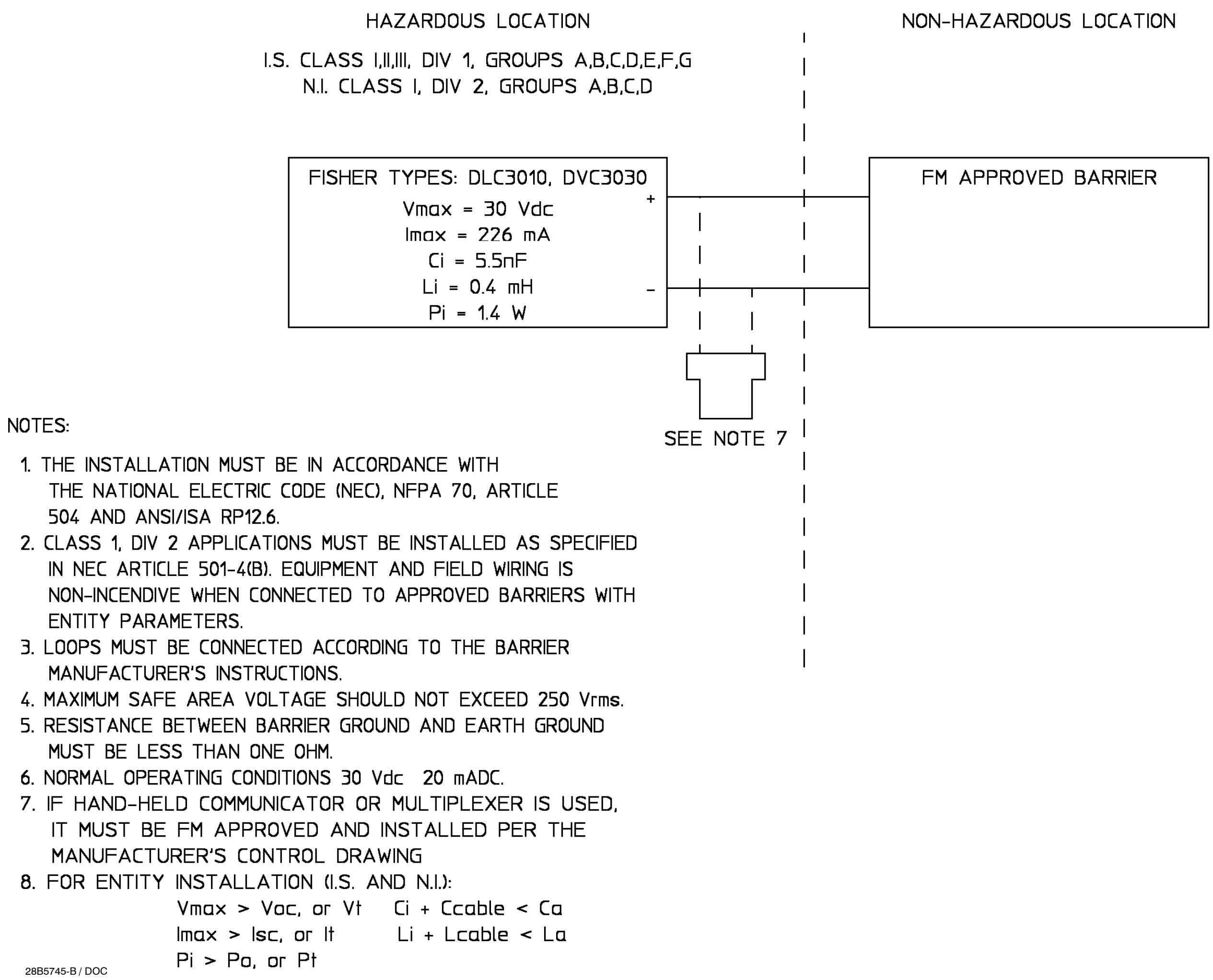


Figure B-2. FM Schematic

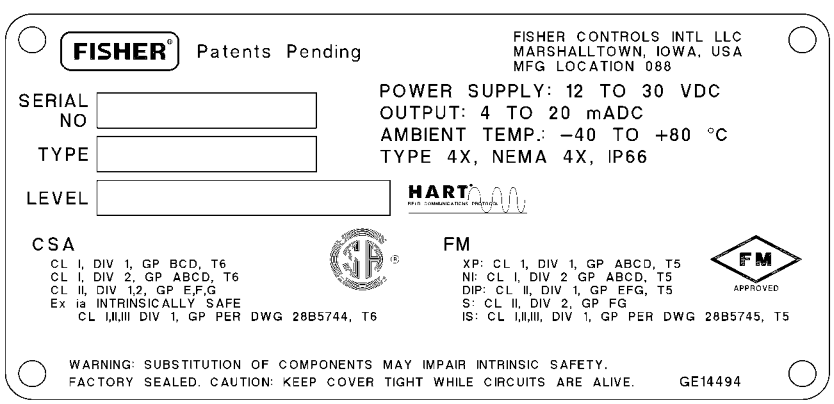


Figure B-3. CSA and FM Approvals Nameplate

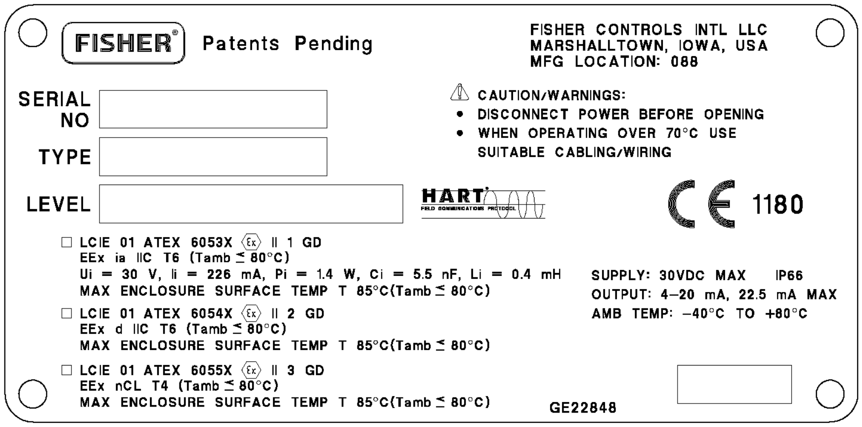


Figure B-4. ATEX Approvals Nameplate

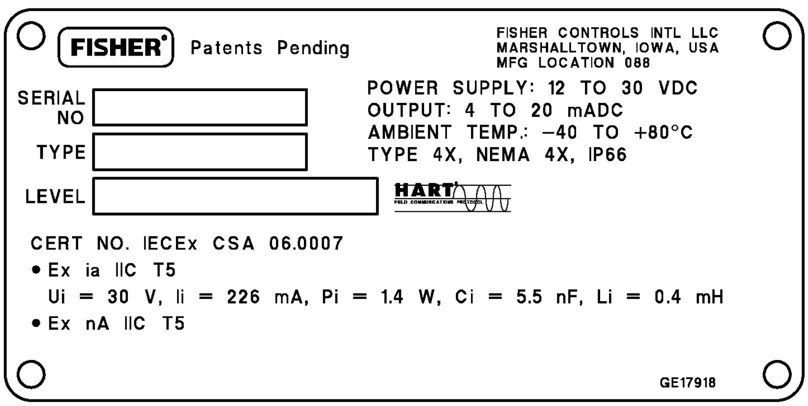


Figure B-5. IECEx Approval Nameplate

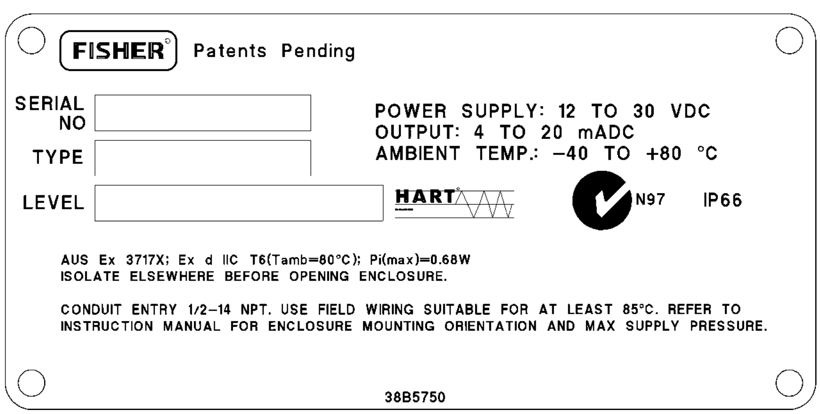


Figure B-6. SAA Approval Nameplate

B

Glossary

Alarm Deadband
The amount by which the process variable must return within normal limits for the alarm to clear.

Alarm Limit
An adjustable value that, when exceeded, activates an alert.

Algorithm
A set of logical steps to solve a problem or accomplish a task. A computer program contains one or more algorithms.

Alphanumeric
Consisting of letters and numbers.

ANSI (acronym)
The acronym ANSI stands for the American National Standards Institute

Burst
Burst mode is an extension to HART protocol that provides the continuous transmission of standard HART command response by a field device.

Byte
A unit of binary digits (bits). A byte consists of eight bits.

Commissioning
Functions performed with a Field Communicator and the digital level controller to test the instrument and loop and verify digital level controller configuration data.

Configuration
Stored instructions and operating parameters for a FIELDVUE Instrument.

Control Loop
An arrangement of physical and electronic components for process control. The electronic components of the loop continuously measure one or more aspects of the process, then alter those aspects as necessary to achieve a desired process condition. A simple control loop measures only one variable. More sophisticated control loops measure many variables and maintain specified relationships among those variables.

Damping
Output function that increases the time constant of the digital level controller output to smooth the output when there are rapid input variations.

Descriptor
Sixteen-character field for additional identification of the digital level controller, its use, or location. The descriptor is stored in the instrument and can be changed using a Field Communicator and the device information function.

Device ID
Unique identifier embedded in the instrument at the factory.

Device Revision
Revision number of the interface software that permits communication between the Field Communicator and the instrument.

Firmware Revision
The revision number of the instrument firmware. Firmware is a program that is entered into the instrument at time of manufacture and cannot be changed by the user.

Free Time
Percent of time that the microprocessor is idle. A typical value is 25%. The actual value depends on the number of functions in the instrument that are enabled and on the amount of communication currently in progress.

Gain
The ratio of output change to input change.

Hardware Revision
Revision number of the Fisher instrument hardware. The physical components of the instrument are defined as the hardware.

HART (acronym)
The acronym HART stands for Highway Addressable Remote Transducer. The communications standard that provides simultaneous analog and digital signal transmission between control rooms and field devices.

HART Tag
An eight-character field for identifying the digital level controller. The HART tag is stored in the instrument and can be changed using a Field Communicator and the device information function.

HART Universal Revision
Revision number of the HART Universal Commands which are the communications protocol for the instrument.

Instrument Serial Number
The serial number assigned to the instrument.

Lower Range Value (LRV)
Lowest value of the process variable that the digital level controller is currently configured to measure in the 4 to 20 mA loop.

Lower Sensor Limit (LSL)
Lowest value of the process variable that the digital level controller can be configured to measure.

Memory
A type of semiconductor used for storing programs or data. FIELDVUE instruments use three types of memory: Random Access Memory (RAM), Read Only Memory (ROM), and Non-Volatile Memory (NVM). See also these listings in this glossary.

Menu
A list of programs, commands, or other activities that you select by using the arrow keys to highlight the item then pressing ENTER, or by entering the numeric value of the menu item.

Message
Thirty-two character field for any additional information the user may want to include.

Multidropping
The connection of several field devices to a single communications transmission line.

Non-Volatile Memory (NVM)
A type of semiconductor memory that retains its contents even though power is disconnected. NVM contents can be changed during configuration unlike ROM which can be changed only at time of instrument manufacture. NVM stores configuration data.

On-Line Configuration
Configuration of the digital level controller operational parameters using a Field Communicator connected to the instrument.

Parallel
Simultaneous: said of data transmission on two or more channels at the same time.

Polling Address
Address of the instrument. If the digital level controller is used in a point-to-point configuration, set the polling address to 0. If it is used in a multidrop configuration, or split range application, set the polling address to a value from 0 to 15.

Process Variable (PV)
A physical quality or quantity which is monitored as part of a control strategy. The digital level controller can measure level, interface level between two liquids of different specific gravity, and liquid density.

Protocol
A set of data formats and transmission rules for communication between electronic devices. Devices that conform to the same protocol can communicate accurately.

Random Access Memory (RAM)
A type of semiconductor memory that is normally used by the microprocessor during normal operation that permits rapid retrieval and storage of programs and data. See also Read Only Memory (ROM) and Non-Volatile Memory (NVM).

Read-Only Memory (ROM)
A memory in which information is stored at the time of instrument manufacture. You can examine but not change ROM contents.

Reranging
Configuration function that changes the digital level controller 4 to 20 mA settings.

RTD
The abbreviation for resistance temperature detector. Temperature is measured by the RTD by correlating the resistance of the RTD element with temperature.

Send Data
A Field Communicator command that transfers configuration data from the Field Communicator's working register to the digital level controller memory.

Software
Microprocessor or computer programs and routines that reside in alterable memory (usually RAM), as opposed to firmware, which consists of programs and routines that are programmed into memory (usually ROM) when the instrument is manufactured. Software can be manipulated during normal operation, firmware cannot.

Span
Algebraic difference between the upper and lower range values.

Temperature Sensor
A device within the instrument that measures the instrument's internal temperature.

Upper Range Value (URV)
Highest value of the process variable that the digital level controller is currently configured to measure in the 4 to 20 mA loop.

Upper Sensor Limit (USL)
Highest value of the process variable that the digital level controller can be configured to measure.

Working Register
Memory location in a Field Communicator that temporarily stores data as it is being entered.

A

B

C

D

N

O

P

R

CE

Emerson Process Management

Marshalltown, Iowa 50158 USA

Cernay 68700 France

Sao Paulo 05424 Brazil

Singapore 128461

www.Fisher.com

EMERSON.
Process Management