DL3 Digital Level Transmitter

The *DL3* digital level transmitter, shown in figure 1, is designed to sense the level of a liquid, the level of an interface between two liquids, or the density of a liquid in a vessel, and produce a standard 4-20 mA analog output signal proportional to the process variable. The *DL3* is HART® compliant.

The transmitter comes complete with a wafer-style sensor which can be flange-mounted to the top of a vessel or installed in a customer-supplied cage or chamber, as shown in figure 5.

Unless otherwise noted, all NACE references are to NACE MR0175–2002.

Figure 1. DL3 Digital Level Transmitter Shown Installed in a Typical Customer-Supplied Cage

Features

- **Installation Versatility**— With the integration of a wafer-style liquid level sensor and transmitter into one product, the *DL3* enables users to install digital level transmitters to a variety of industry standard or custom process vessel connections. Installing the *DL3* in a customer-supplied external cage gives process equipment designers freedom to select the best process vessel connection location and configuration to meet specific application requirements.

- **HART / AMS Compliant**— The *DL3* uses the HART protocol to interface to the 275 HART Communicator, or 375 Field Communicator for field operations interface. Advanced user-interface capabilities are enabled by AMS® Suite: Intelligent Device Manager (see figure 3), including database management, remote calibration, comprehensive views of configuration, alarm, status, compensation tables, and troubleshooting parameters, as well as retaining access to the diagnostic procedures via pull-down menus.

- **Increased Accuracy**— When a process temperature is input via HART protocol, the *DL3* can automatically compensate for any specific gravity changes of the process fluid caused by temperature variability.

- **NACE Compliant**— The materials used in the *DL3* wafer-style sensor (see table 2) meet the metallurgical requirements of NACE MR0175 2002. Environmental limits may apply.

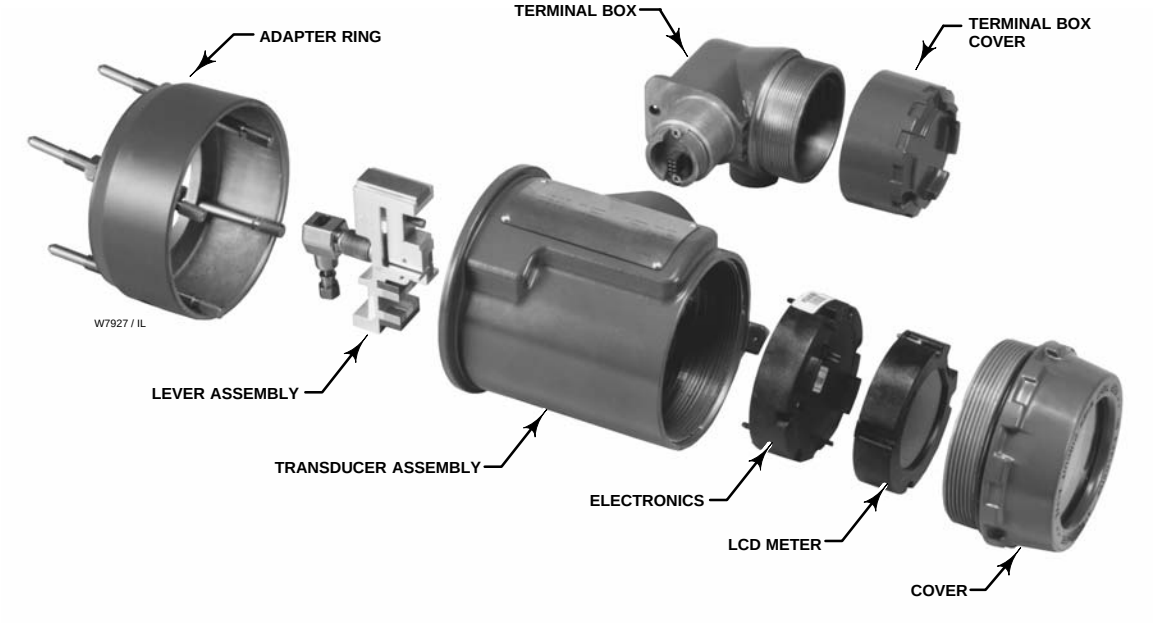


Figure 2. DL3 Digital Transmitter Electronics Assembly

- **Corrosion Protection**— Acrylic enamel-based paint and encapsulated electronics in the transmitter provide protection and reliability in hostile environments.

- **Ease of Calibration / Configuration**— The *DL3* comes factory-calibrated for SG = 1.00 and 21°C (70°F). The Setup Wizard enables a straight forward and fast reconfiguration to the user's application. Changing the SG of the liquid, switching to interface or density mode, or re-ranging the output can all be accomplished by simple data entry.

- **Modular Design**—The stab-in design of the field terminal box allows the easy removal of the instrument for repair or maintenance, without disconnecting field wiring. The modular design of the transducer assembly and the encapsulated electronics board, the separate LCD assembly, and the terminal box, add ease to any maintenance required by the instrument. See figure 2. The terminal box and LCD assembly are passive so re-calibration is not required when they are replaced.

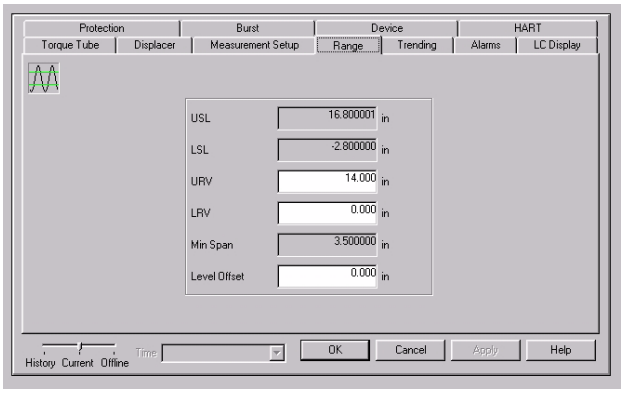


Figure 3. AMS® Suite: Intelligent Device Manager Configuration Screen

Principle of Operation

The sensor consists of a wafer body, torque tube assembly and displacer (see figure 4) and is rated for CL150, 300, and 600. The wafer body mounts between NPS 3 or 4 raised-face flanges.

The torque tube assembly consists of a hollow torque tube with a shaft welded inside it at one end and protruding from it at the other end.

The unconnected end of the tube is sealed by a gasket and clamped rigidly to the torque tube arm, permitting the protruding end of the shaft to twist and therefore transmit rotary motion. This allows the interior of the torque tube to remain at atmospheric pressure, thus eliminating packing and the disadvantages of packing friction. This is a proven and reliable seal.

A change in liquid level, interface level, or density/specific gravity buoys up the displacer by a force equal to the weight of the liquid displaced. Corresponding vertical movement of the displacer results in angular movement of the displacer rod around the knife-edge. Since the torque tube assembly is a torsional spring which supports the displacer and determines the amount of movement of the displacer rod for a given displacement change, it will twist a specific amount for each increment of buoyancy change.

The rotary motion of the torque tube is transferred to the transmitter lever assembly (see figure 2). 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 a varying electronic signal, which is processed digitally to provide linearity corrections, sensitivity adjustment, and temperature compensation.

The signal is interpreted as a buoyancy change by reference to the stored torque rate, coupling point, and moment arm data. The buoyancy change in turn is interpreted as a level, interface, or density change by reference to stored displacer volume, specific gravity, and displacer length data. In level or interface modes, the correction for displacer motion is then added, as well as user-supplied offset to change the PV reference from the bottom of the displacer or correct for a coupling point error.

The resultant primary variable (PV) is then compared to PV alarm thresholds (if enabled) and used to set status bits and/or trigger the analog alarm current. If the alarm is not triggered, the PV is used to generate 4-20 mA analog and 0-100% range digital signals by reference to the stored upper and lower range values. The resultant analog command is limited at the saturation values to allow discrimination between saturated and alarm signals.

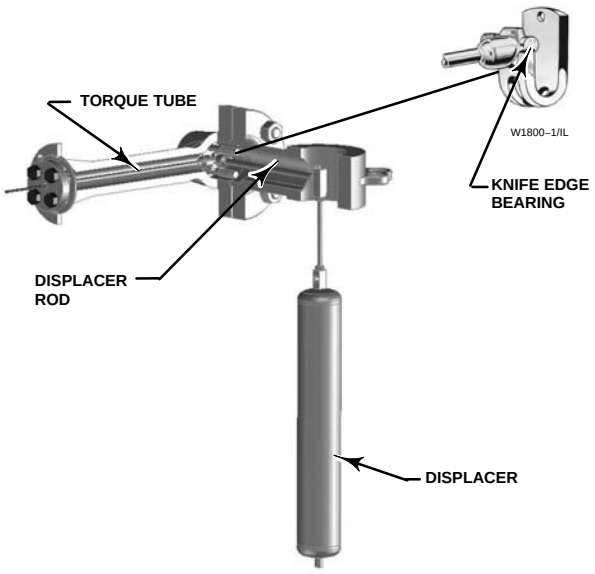


Figure 4. DL3 Wafer-Style Sensor

Ordering Information

When ordering, specify:

Wafer-Style Sensor Construction

- **Size**—NPS 3 or 4 raised-face flange wafer-style sensor suitable for CL150 through 600 flange rating
- **Material**— Steel or stainless steel

Notes

All *DL3* digital level transmitters are factory calibrated for: SG = 1.00 and 21°C (70°F).

Right-hand mounting is standard, and can be field configured to left-hand mounting as required by installation.

During shipment, displacers are detached from the sensors.

Equalizing piping, stillwells, or other equipment may be required for installation. Emerson Process Management does not provide this equipment.

Instruction manuals used with the *DL3* digital level transmitter are: FIELDVUE® DLC3000 Digital Level Controllers (D102748X012) and 249W Cageless Wafer Style Level Sensor (D102803X012).

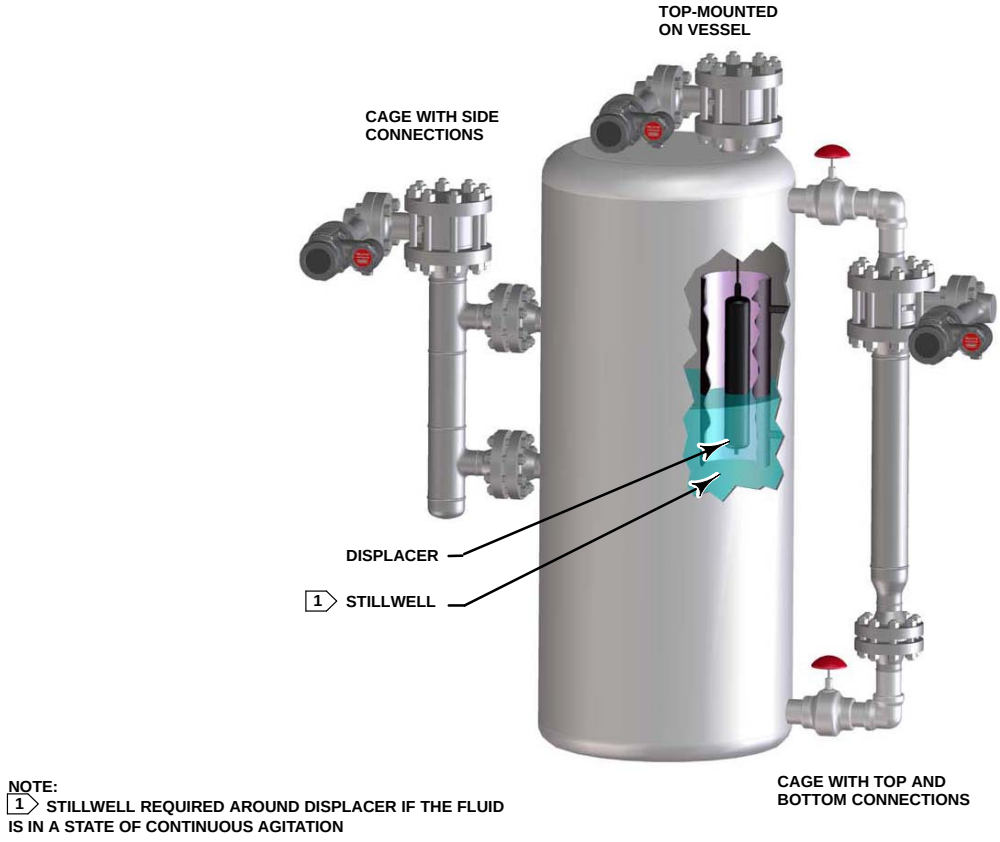


Figure 5. DL3 Mounted on Vessel

Cage Construction

Note

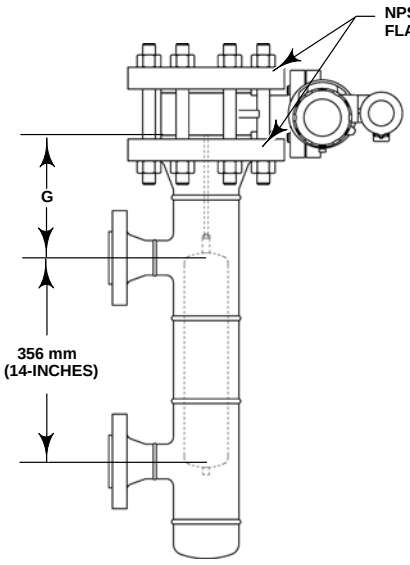
A cage is not supplied with the *DL3*. For a factory built cage-style construction, contact your Emerson Process Management sales office.

Figure 6 provides guidelines for fabricating a cage.

When fabricating a cage or chamber, maintain at least a minimum clearance of 10 mm (3/8-inch) between the diameter of the displacer and the inside diameter of the cage or displacer. Dirty or viscous fluids may require a larger clearance. Provide sufficient cage length below the displacer to ensure that the displacer does not hit the bottom of the cage. When installing the cage, it must be vertically plumb so that the displacer does not strike the side of the cage. See figure 7 for overall envelope dimensions for mounting a *DL3*.

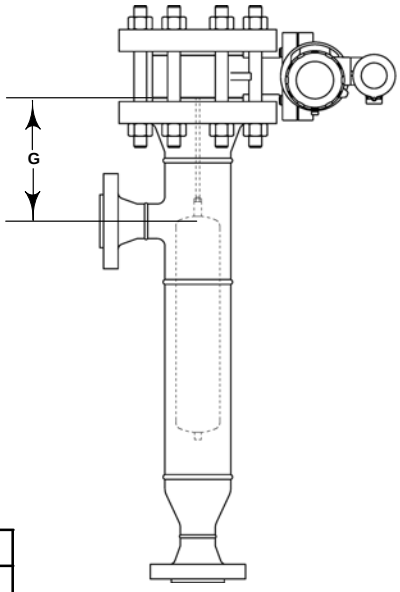
Note

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

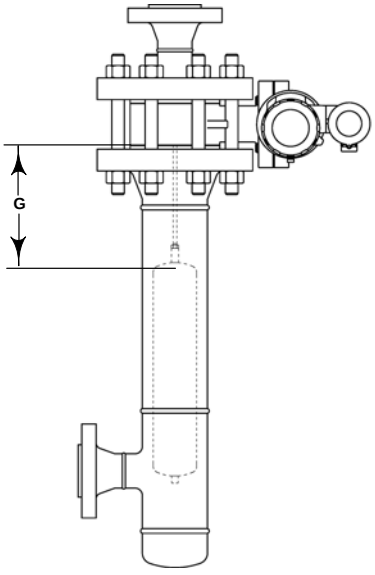


CAGE WITH UPPER AND LOWER SIDE VESSEL CONNECTIONS
GE06687

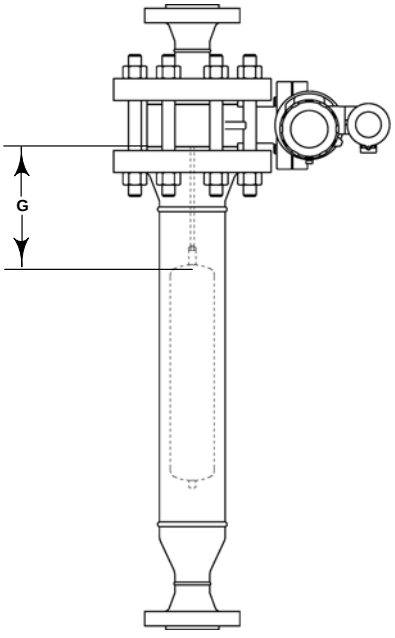
WAFER-STYLE SENSOR SIZE	G	
	mm	INCH
NPS 3	178	7.00
NPS 4	216	8.50



CAGE WITH UPPER SIDE AND BOTTOM VESSEL CONNECTIONS
GE06688



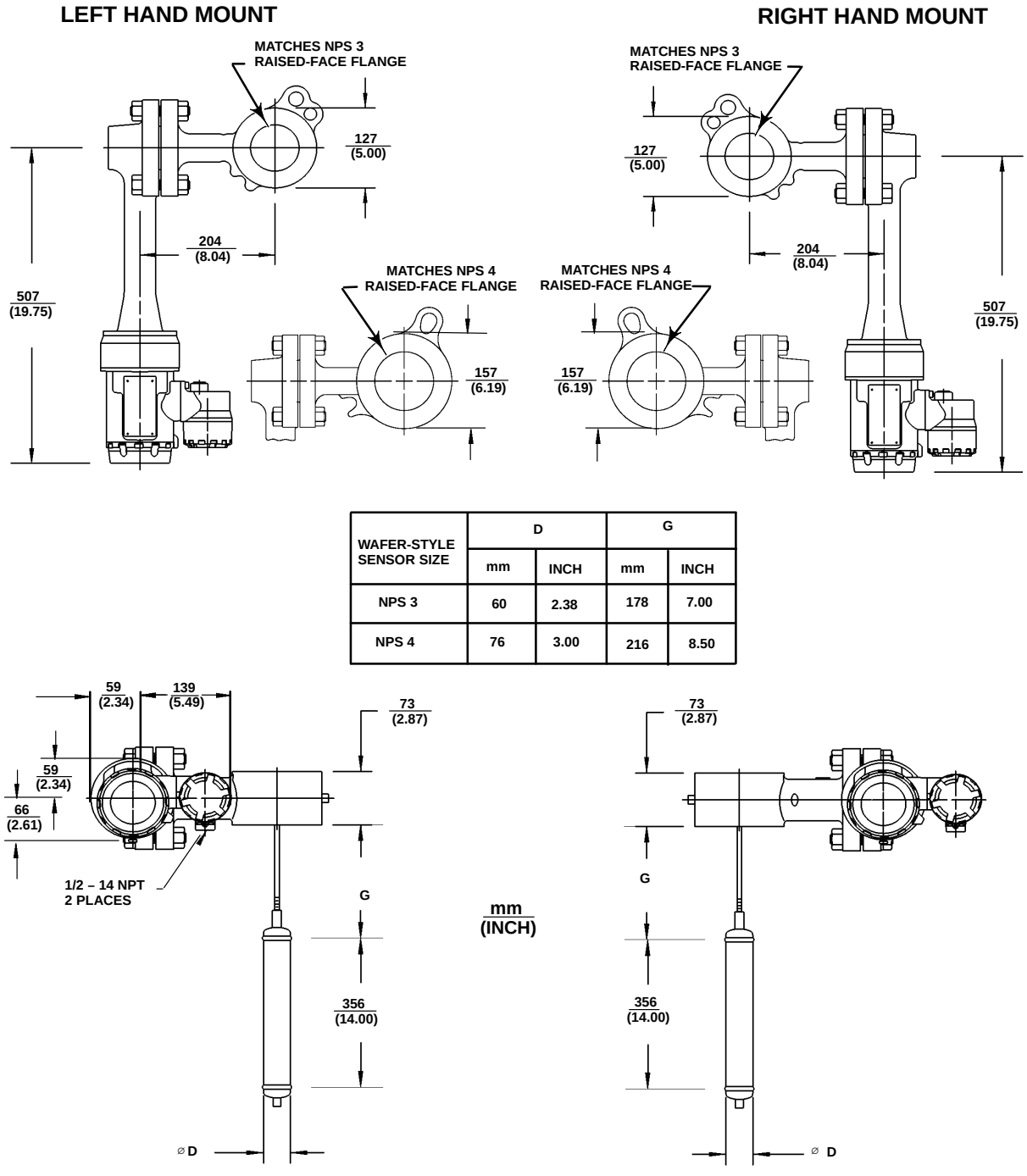
CAGE WITH TOP AND LOWER SIDE VESSEL CONNECTIONS
GE06686



CAGE WITH TOP AND BOTTOM VESSEL CONNECTIONS
GE06685

NOTES:
1. VESSEL CONNECTIONS ARE EITHER NPS 1-1/2 OR 2 CL150, 300 OR 600 FLANGES. (VESSEL ENDS CAN BE ALSO SCREWED OR SOCKET WELDED CONNECTIONS).
2. DISPLACER LENGTH IS 14-INCHES.

Figure 6. Typical Cage Constructions



WAFER-STYLE SENSOR SIZE	D		G	
	mm	INCH	mm	INCH
NPS 3	60	2.38	178	7.00
NPS 4	76	3.00	216	8.50

Figure 7. Overall Envelope Dimensions for DL3

DL3 Specifications

Available Configurations

Transmitter: DLC3000 digital level controller

Wafer-Style Sensor: 249W

Matches NPS 3 or 4 raised-face flange, suitable for CL150 through 600 flange rating

Displacer length: 356 mm (14-inch)

Allowable Specific Gravity

Liquid Level: 0.4 to 1.2
Interface Level or Density: 0.08 minimum differential

Output Signal

Analog: 4-20 mA 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(1)

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. For purposes of determining the allowable wiring capacitance, the HART "receive impedance" of the transmitter:

At control frequencies may be modeled as— Rx: 42K ohms and *Cx:* 14 nF

In the HART normal frequency band of 950 –2500 Hz and above— Rx: 21K ohms and *Cx:* 12 nF is a better fit

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

Independent Linearity
NPS 3 sensor: ±0.8% of output span
NPS 4 sensor: ±0.5% of output span
Hysteresis plus Dead band: <1.0% of output span

Repeatability
NPS 3 sensor: ±0.5% of output span
NPS 4 sensor: ±0.3% of output span

At effective proportional band (PB) <100%, linearity, dead band, and repeatability are derated by the factor (100%/PB)

Sensor Working Pressures(2)

CL600 maximum

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 ambient temperature effect on zero and span is less than 0.03% of full scale per degree Kelvin over the operating range –40 to 80°C (–40 to 176°F)

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.

Electromagnetic Interference (EMI): Tested per IEC 61326-1 (Edition 1.1). Conforms to the 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.

–continued–

DL3 Specifications (continued)

Supply Requirements (See figure 8)

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.

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:
Processor free-time monitor.
Writes-remaining in Non Volatile Memory monitor.
User-configurable alarms: Hi and Lo limit process 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, (and degrees of pilot shaft rotation).*

Electrical Classification

Hazardous Area:

Intrinsic Safety, Explosion proof, Dust-Ignition proof

Intrinsic Safety, Explosion proof, Non-incendive, Dust-Ignition proof

ATEX Intrinsic Safety, Flameproof, Type n

IECEx Intrinsic Safety, Type n

SAA Flameproof

Intrinsic Safety, Flameproof, Dust-Ignition proof

Refer to tables 3, 4, 5, 6, 7, and 8 for additional approvals information.

Electrical Housing: Designed to meet NEMA 4X, IEC 60529 IP66

Construction Materials

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

Sensor: See table 2

Mounting Positions

Mounts on top of vessel or on customer supplied cage (see figure 5), can be field-mounted right- or left-of-displacer.

–continued–

DL3 Specifications (continued)

Electrical Connections

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

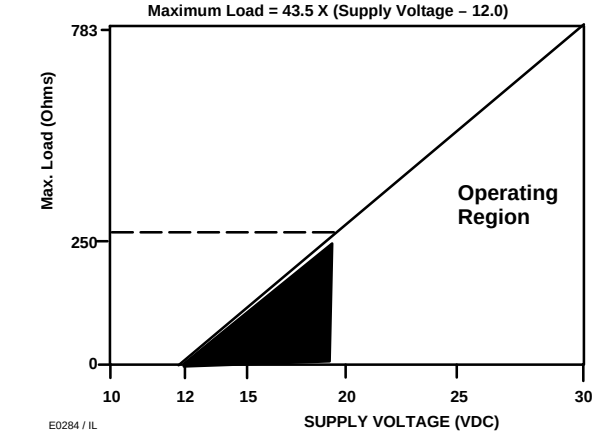
Operating Limits

Allowable Process Temperatures(2)
Maximum: 232°C (450°F). See figure 9.

Ambient Temperature and Humidity

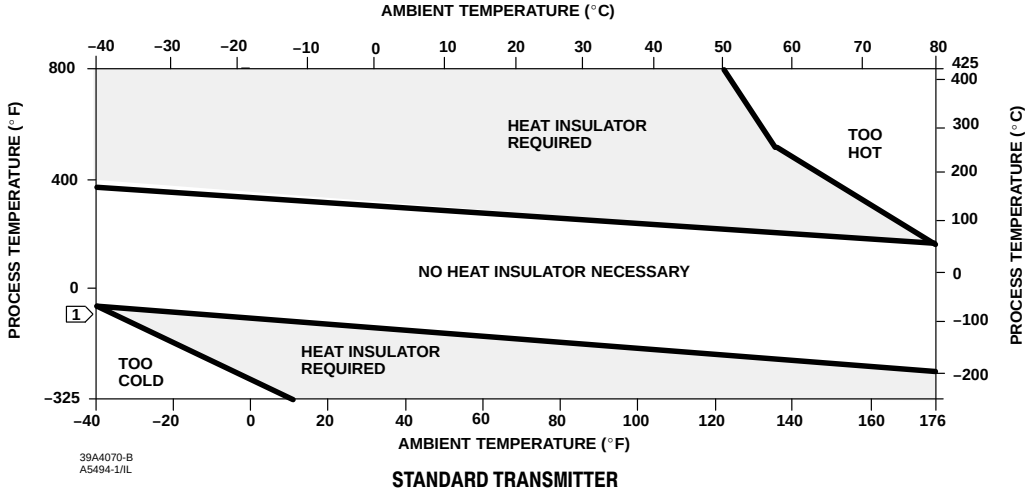
Conditions	Normal Limits(3,4)	Transport and Storage Limits	Nominal Reference
Ambient Temperature	–40 to 80° (–40 to 176°F)	–40 to 85°C (–40 to 185°F)	25°C (77°F)
Ambient Relative Humidity	0 to 95%, (non-condensing)	0 to 95%, (non-condensing)	40%

NOTE: Specialized instrument terms are defined in ANSI/ISA Standard 51.1 – Process Instrument Terminology.
1. Not NAMUR NE 43 compliant If the low alarm level is selected.
2. The pressure/temperature limits in this document and any applicable standard or code limitation should not be exceeded.
3. LCD meter may not be readable below –20°C (–4°F).
4. Contact your Emerson Process Management sales office or application engineer if temperatures exceeding these limits are required.



NOTE:
30 VOLTS IS THE LIMIT IMPOSED BY THE HAZARDOUS AREA APPROVALS. IF USED IN A NON-HAZARDOUS AREA. UP TO 50 VOLTS MAY BE USED.

Figure 8. Power Supply Requirements and Load



NOTES:
1 IF REQUIRED, A HEAT INSULATOR CAN BE ORDERED SEPARATELY.

Figure 9. Guidelines for Heat Insulator Usage

Table 1. EMC Immunity Performance Criteria

PORT	PHENOMENON	BASIC STANDARD	TEST LEVEL	PERFORMANCE CRITERIA(1)
Enclosure	Electrostatic discharge (ESD)	IEC 61000-4-2	4 kV contact 8 kV air	B
	EM field	IEC 61000-4-3	80 to 1000 MHz @ 10V/m with 1 kHz AM at 80%	A
	Rated power frequency magnetic field	IEC 61000-4-8	60 A/m at 50 Hz	A
I/O signal/control	Burst	IEC 61000-4-4	1 kV	B
	Surge	IEC 61000-4-5	1 kV (line to ground only, each)	B
	Conducted RF	IEC 61000-4-6	150 kHz to 80 MHz at 3 Vrms	A

1. A = No degradation during testing. B = Temporary degradation during testing, but is self-recovering. Specification Limit = +/– 1% of span.

Table 2. Wafer-Style Sensor Construction Materials

PART	MATERIAL(2)
Wafer body and torque tube arm	NPS 3, WCC or CF8M (316 stainless steel)
	NPS 4, LCC or CF8M
Torque tube	N05500
Displacer	NPS 3, S31600 (316 stainless steel)
	NPS 4, S30400 (304 stainless steel)
Trim(1)	S31600
Bolting	NCF coated steel grade B7 studs or cap screws and grade 2H nuts
Torque tube arm gasket and torque tube end gasket	Graphite/stainless steel

1. Trim parts include displacer rod, driver bearing, displacer stem parts, and stem connection parts
2. NACE MR0175-2002 compliant. Meets the metallurgical requirements of NACE MR0175-2002. Environmental limits may apply.

Table 3. Hazardous Area Classifications—CSA (Canada)

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 ($T_{amb} \leq 80°C$)	4X
	(Explosion Proof) Class/Division Class I, Division 1 GP B,C,D	– – –	T6 ($T_{amb} \leq 80°C$)	4X
	Class I Division 2 GP A,B,C,D Class II Division 1 GP E,F,G Class III	– – –	T6 ($T_{amb} \leq 80°C$)	4X

Table 4. Hazardous Area Classifications—FM (United States)

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	T6 ($T_{amb} \leq 80°C$)	4X
	(Explosion Proof) Class/Division Class I, Division 1 GP A,B,C,D	– – –	T6 ($T_{amb} \leq 80°C$)	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	– – –	T6 ($T_{amb} \leq 80°C$)	4X

Table 5. 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 ($T_{amb} \leq 80°C$)	U_i = 30 VDC I_i = 226 mA P_i = 1.4 W C_i = 5.5 nF L_i = 0.4 mH	T6 ($T_{amb} \leq 80°C$)	IP66
	⟨Ex⟩ II 2 G D Gas EEx d IIC T6—Flameproof Dust T85C ($T_{amb} \leq 80°C$)	– – –	T6 ($T_{amb} \leq 80°C$)	IP66
	⟨Ex⟩ II 3 G D Gas EEx nCL IIC T6—Type n Dust T85C ($T_{amb} \leq 80°C$)	– – –	T6 ($T_{amb} \leq 80°C$)	IP66

Table 6. 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 ($T_{amb} \leq 80°C$)	IP66
	Ex nA IIC T5—Type n	– – –	T5 ($T_{amb} \leq 80°C$)	IP66

Table 7. Hazardous Area Classifications—SAA

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

Table 8. Hazardous Area Classifications—NEPSI

CERTIFICATE	CERTIFICATION OBTAINED	ENTITY RATING	TEMPERATURE CODE	ENCLOSURE RATING
NEPSI	Gas Ex ia IIC T6—Intrinsic Safety Dust DIP A21 T6	U_i = 30 VDC I_i = 226 mA P_i = 1.4 W C_i = 5.5 nF L_i = 0.4 mH	T6 ($T_{amb} \leq 80°C$)	IP66
	Gas Ex d IIC T6—Flameproof Dust DIP A21 T6	– – –	T6 ($T_{amb} \leq 80°C$)	IP66

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