HART® Field Device Specification: Fisher™ FIELDVUE™ DLC3100 Digital Level Controller

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Section 1: Introduction

1.1 Scope

The Fisher FIELDVUE DLC3100 Digital Level Controller, revision 1 complies with HART Protocol Revision 7. This document specifies all the device specific features and documents HART Protocol implementation details (e.g., the Engineering Unit Codes supported). The functionality of this Field Device is described sufficiently to allow its proper application in a process and its complete support in HART capable Host Applications.

1.2 Purpose

This specification is designed to complement other documentation (e.g., the DLC3100 instruction manual, D104213X012) by providing a complete, unambiguous description of this Field Device from a HART Communication perspective.

1.3 Who should use this document?

The specification is designed to be a technical reference for HART capable Host Application Developers, System Integrators and knowledgeable end users. It also provides functional specifications (e.g., commands, enumerations and performance requirements) used during Field Device development, maintenance and testing. This document assumes the reader is familiar with HART Protocol requirements and terminology.

1.4 Abbreviations and definitions

ADC	Analog to Digital Converter
CN	Capacitance Number; capacitance as a multiple of 5000pF
DD	Device Description
EEPROM	Electrically-Erasable Read-Only Memory
FRAM	Ferroelectric RAM, a type of non-volatile memory
NVM	Non-Volatile Memory
RAM	Random Access Memory
RTD	Resistance Temperature Detector
SIS	Safety Instrumented System

1.5 References

- HART Smart Communications Protocol Specification, HCF_SPEC-12. Available from the HART Communication Foundation.
- Fisher DLC3100 Instruction Manual (D104213X012). Available from your Emerson sales office.
- Fisher DLC3100 Quick Start Guide (D104214X012). Available from your Emerson sales office.

Section 2: Device Identification

Manufacturer Name:	Emerson	**Model Name(s):**	DLC3100
Manufacture ID Code:	19 (13 Hex)	**Device Type Code:**	15 (0F Hex)
HART Protocol Revision	7	**Device Revision:**	1
Number of Device Variables	10		
Physical Layers Supported	FSK		
Physical Device Category	Transmitter		

Figure 1. Fisher FIELDVUE DLC3100 Digital Level Controller

Section 3: Product Overview

The Fisher FIELDVUE DLC3100 digital level controller is a HART communicating instrument that is used with level sensors to measure liquid level, level of the interface between two liquids, or liquid density (not applicable to DLC3100 SIS tier). The DLC3100 converts this measurement into 4 to 20 mA transmitter signal.

Section 4: Product Interfaces

4.1 Process Interface

Primary Variable Sensor Interface

Fisher DLC3100 digital level controllers mount on a wide variety of Fisher caged and cageless 249 level sensors. They can also mount on other manufacturers' displacer type level sensors with mounting adaptors. The field device is provided with a lever that carries a set of magnets across a Hall-Effect Sensor to transform angular position into voltage. The lever is coupled to the sensor's pilot shaft by a clamping bolt and nut. Nominal design rotation of the buoyancy sensor for a full span change of water level at room temperature is 4.4°. To best utilize the accuracy of the transmitter, the amount of input rotation used should be close to this range. For applications that would develop a very small proportional band with standard hardware, (e.g., interface level measurements where the difference between the densities of the two phases is quite small), custom sensor configurations may be specified to improve the mechanical gain.

The available lever travel in the device is approximately ±6° from the neutral or 'locked' position. This allows right- or left-hand-mounted sensors to be used without mechanical changes to the transmitter. It also allows the device to be used with sensors having mechanical gain slightly higher than nominal by physically coupling at the center of sensor travel instead of at the lowest process condition.

Figure 2. Fisher 249 Displacer Sensor with FIELDVUE DLC3100 Digital Level Controller

Process Temperature Interface

An external 100 ohm RTD of 2-wire or 3-wire configuration may be installed to provide process temperature instrumentation. The terminals for the RTD are in the lower bank of the instrument terminal box, and are labeled “Rs”, “R2”, and “R1”, from left to right. “Rs” and “R2” are used for the two wires from the same node of a 3-wire RTD and must be shorted with a jumper when a 2-wire RTD is employed. Refer to the instruction manual for additional installation details. When the RTD is installed, configured, and calibrated, and density information is entered by the user, this input will be used to drive density compensation for the level calibration. If the RTD is not installed, the compensation tables can also be driven by a manually entered value of process temperature. The density temperature-compensation can be disabled via configuration.

The process temperature value derived from the RTD may be checked against user-defined alarm thresholds to indicate when the sensor is operating outside of recommended temperature limits.

Electronics Temperature Interface

An internal temperature sensor, mounted on the Hall Sensor PCBA, is utilized to drive factory-configured temperature compensation for magnetic flux and Hall-effect sensitivity variations. It is also checked against user-defined alarm thresholds to indicate when the transmitter is operating outside of recommended temperature limits.

4.2 Host Interface

Analog Output: Primary Variable

The 2-wire 4 to 20 mA current loop is connected on two terminals marked "+" and "-". Refer to the instruction manual for connection details.

This is the only output from this transmitter, representing either the level, interface, or density measurement, linearized and scaled according to the configured range of the instrument. This output corresponds to the Primary Variable. HART Communication is supported on this loop. This device has a CN number of 1.

A guaranteed linear over-range is provided. Device malfunction can be indicated by down-scale or up-scale current. The direction is selectable by the user; see Section 4.3 below. Current values are shown in the table below.

The output of the DLC3100 can either be 2-wire 4 to 20 mA current loop (in point-to-point mode) or 4 mA (in multi-drop mode). This input is connected in the DLC3100's terminal box on two terminals marked "+" and "-". Refer to the DLC3100 quick start guide (D104214X012) for connection details.

	Direction	Values (percent of range)	Values (mA or V)
Linear over-range	Down	-1.25%	3.8 to 4.0 mA
	Up	+103.125%	20.0 to 20.5 mA
Alarm indication	Down: less than	- - -	3.6 mA
	Up: greater than	- - -	21.0 mA
Maximum current			22.0 mA
Multi-Drop current draw			4.0 mA
Lift-off voltage			17.75 V

4.3 Local User Interface and Switches

Local Controls and Displays

This device has an intuitive Local User Interface with four push buttons and LCD to set up and calibrate the device without any external tool. The home screen provides Primary Variable readings in real time. Refer to the quick start guide (D104214X012) for operation details.

Internal Switches

Each digital level controller continuously monitors its own performance during normal operation. This automatic diagnostic routine is a timed series of checks repeated continuously.

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 below 3.6 mA or above 21 mA, based on the position of the alarm switch on the mainboard PCBA. Refer to quick start guide for details.

Section 5: Device Variables

This Field Device exposes 8 Device Variables. These variables represent measurements taken by the device and are all in float format.

Device Variable

Number:	0	Name	Process Level
Classification	Length	Unit Codes	See Table 1. Length Unit Codes
Number:	1	Name	Interface Level
Classification	Length	Unit Codes	See Table 1. Length Unit Codes
Number:	2	Name	Electronics Temperature
Classification	Temperature	Unit Codes	See Table 3. Temperature Unit Codes
Number:	3	Name	Process Temperature
Classification	Temperature	Unit Codes	See Table 3. Temperature Unit Codes
Number:	4	Name	Torque Tube Rate (Compensated)
Classification	None	Unit Codes	See Table 6. Torque Rate Unit Codes
Number:	5	Name	Upper Density (Compensated)
Classification	Density	Unit Codes	See Table 2. Density Unit Codes
Number:	6	Name	Lower Density (Compensated)
Classification	Density	Unit Codes	See Table 2. Density Unit Codes
Number:	7	Name	Percent Range (Copy)
Classification	None	Unit Codes	%
Number:	244	Name	Percent Range
Classification	None	Unit Codes	%
Number:	245	Name	Loop Current
Classification	Current	Unit Codes	mA

Device Family	None		
Device Family Commands	NA		

Device Variable 0: Process Level

When configured as the PV as described in Section 4.1, Primary Variable Sensor Interface, the device will report measured process level based on calibrated range, in engineering units. If interface level is selected as the PV, this device variable will read NaN.

Device Variable 1: Interface Level

When configured as the PV as described in Section 4.1, Primary Variable Sensor Interface, the device will report measured interface level based on calibrated range, in engineering units. If process level is selected as the PV, this device variable will read NaN.

Device Variable 2: Instrument Temperature

This is the electronics temperature described in Section 4.1, Electronics Temperature Interface, in engineering units .

Device Variable 3: Process Temperature

This is the process temperature described in Section 4.1, Process Temperature Interface, in engineering units. This Device Variable may be written when the temperature compensation option is configured to 'Manual'. Valid writable range is -325 to +800 degF.

Device Variable 4: Torque Tube Rate (Compensated)

This is the temperature compensated torque rate being used for PV calculation, in engineering units. This is the scale factor between the internal digital representation of the measured pilot shaft rotation and the physical torque input to the sensor.

Device Variable 5: Upper Density (Compensated)

This is the temperature compensated upper density used for process level or interface level calculation, in engineering units. This is the output after factoring the base density with the temperature compensation gain

Device Variable 6: Lower Density (Compensated)

When PV is density, this is the measured density per Section 4.1, Primary Variable Sensor Interface. When PV is process level or interface level, this is the temperature compensated lower density used for process level or interface level calculation, in engineering units. This is the output after factoring the base density with the temperature compensation gain.

Device Variable 7: Percent Range (Copy)

This is a duplicate of 5.8 Device Variable 244 – Percent Range. The reason for this duplication is so that it can be assigned as one of the dynamic variables to be viewed when connected to Emerson's wireless gateway.

Device Variable 244: Percent Range

This is the PV measurement in percent, based on user configured Upper Range Value and Lower Range Value.

Device Variable 245: Loop Current

This reflects the loop current transmitted over the wire.

Section 6: Dynamic Variables

Four Dynamic Variables are supported. The mapping of the Dynamic Variables is configurable.

	Mappable Device Variables Number	Mappable Device Variable Names
PV	SIS device: 0, 1 Non-SIS device: 0, 1, 6	SIS device: Process Level, Interface Level Non-SIS device: Process Level, Interface Level, Lower Density
SV	Device Variables 0 to 7 in Section 5	- - -
TV	Device Variables 0 to 7 in Section 5	- - -
QV	Device Variables 0 to 7 in Section 5	- - -

Section 7: Status Information

7.1 Field Device Status

Bit	Definition	Description
7	Field Device Malfunction	Activated when conditions that warrant any of the following alerts to become active are met (Refer to Section 7.3, Additional Device Status [Command #48]): Hall Sensor Alert Program Memory Failed NVM Error RAM Test Error Alert
6	Configuration Changed	Two such bits exist internally, one for each master. The bit presented here is the copy relevant to the master being addressed. Both copies are set when an operation was performed that changed device's configuration (refer to list of commands to determine the commands that are affected). Cleared by Command #38, separately for each master. The value in both copies is maintained through power cycle or a RESET operation.
5	Cold Start	Two such bits exist internally, one for each master. Both bits are set whenever a RESET sequence is executed or at initial power up. Cleared by the first HART command received.
4	More Status Available	Set when the device's copy of Command #48 data is different from the host's copy.
3	Analog Output Fixed	The Loop Current is being held at a fixed value and is not responding to process variations. Set if the DLC3100 is in tripped state, fixed current mode or in multi-drop mode.
2	Analog Output Saturated	The PV has exceeded the lower or upper range values to the point that the Loop Current saturates at 3.8 mA or 20.5 mA.
1	Non-PV Out Of Limits	The process applied to a sensor other than that of the Primary Variable is beyond the operating limits of the device.
0	PV Out of Limits	The process applied to the sensor for the Primary Variable is beyond the operating limits of the device (refer to Table 7, Command #14).

7.2 Extended Field Device Status

Bit	Definition	Description
7	Reserved	- - -
6	Reserved	- - -
5	Function Check	Activated when the Command #48 alerts mapped to this category is active if it is the highest priority status.
4	Out of Specification	Activated when the Command #48 alerts mapped to this category is active if it is the highest priority status.
3	Failure	Activated when the Command #48 alerts mapped to this category is active (this is the highest priority status available).
2	Critical Power Failure (N/A)	- - -
1	Device Variable Alert (N/A)	- - -
0	Maintenance Required	Activated when the Command #48 alerts mapped to this category is active if this is the highest priority status.

7.3 Additional Device Status (Command #48)

Command #48 returns 10 bytes of data, with the following status information:

Byte	Bit	Name of Status Bit	Meaning	Class	Device Status
0	7	Program Memory Failed	Program memory fail, program memory is corrupt.	Error	4, 7
	6	Instrument Temperature Sensor Alert	Both mainboard temperature sensors are reporting temperatures outside the ADC linear sensing range, or the temperature reported by the two on-board temperature sensors differ by more than 20 degC.	Error	4
	5	Hall Sensor Alert	Indicates the Hall sensor reading has frozen or has violated one of the hard-coded high/low limits.	Error	4, 7
	4	Hall Diagnostics Failed	Indicates the internal Hall Diagnostics has indicated possible failure in the Hall circuitry.	Error	4
	3	Reference Voltage Limit Failed	Indicates a possible failure in one of the reference voltage circuitries.	Error	4
	2	PV Analog Output Readback Limit Failed	Indicates the output read-back for the Primary Variable has deviated by the hard-coded limit.	Error	4
	1	RTD Diagnostics Failed	Indicates the internal RTD check has indicated possible failure in the RTD circuitry.	Error	4
	0	RTD Sensor Failed	Indicates the RTD sensor reading for the process temperature has violated the hard-coded limits.	Error	4
1	7	Alert Record Not Empty	Indicates that the alert record has entries.	Other	4
	6	Alert Record Full	Indicates that the number of alert events has met or exceeded the storage capacity of the instrument.	Other	4
	5	Calibration in Progress	Set by the firmware when a HART request to BEGIN calibration is accepted. Cleared when a HART request to END calibration is received.	Mode	4
	4	Calibration Validity Alert	Set when a parameter that directly affects PV calculation has changed without going through an appropriate method.	Warning	4
	3	Program Flow Error	Set if any of the critical or non-critical tasks have missed execution for 5 consecutive cycles.	Warning	4

Byte	Bit	Name of Status Bit	Meaning	Class	Device Status
1	2	Instrument Time Not Set	Set if the instrument time has not been set since power up.	Other	4
	1	Lever Assembly Locked	Lever assembly is in locked position and will not respond to level changes.	Mode	4
	0	Not used	- - -	- - -	- - -
2	7	PV Hi Alert	Indicates the PV has violated the user-specified high threshold.	Warning	4
	6	PV Hi Hi Alert	Indicates the PV has violated the user-specified high high threshold.	Warning	4
	5	PV Lo ALert	Indicates the PV has violated the user-specified low threshold.	Warning	4
	4	PV Lo Lo Alert	Indicates the PV has violated the user-specified low low threshold.	Warning	4
	3	Process Temperature Hi Alert	Indicates the process temperature has violated the user-specified high threshold.	Warning	4
	2	Process Temperature Lo Alert	Indicates the process temperature has violated the user-specified low threshold.	Warning	4
	1	Instrument Temperature Hi Alert	Indicates the electronics temperature has violated the user-specified high threshold.	Warning	4
	0	Instrument Temperature Lo Alert	Indicates the electronics temperature has violated the user-specified low threshold.	Warning	4
3	7	Out of Service	Indicates the instrument is Out Of Service.	Mode	4
	6	EEPROM Write Accumulator	Indicates the total number of writes to the EEPROM has exceeded 950,000 cycles.	Warning	4
	5	EEPROM Daily Write Accumulator	Indicates the EEPROM writes has reached 160 times in a day; where a day is 24 hours and is being tracked since power up.	Warning	4
	4	Fluid Value Crossed	Indicates the process fluid density values have crossed. The upper fluid density is too close to, or has become greater than, the lower fluid density.	Warning	4

Byte	Bit	Name of Status Bit	Meaning	Class	Device Status
3	3	Temperature Out of Compensation Range	Indicates the compensation temperature has exceeded the compensation limits.	Warning	4
	2	Invalid Custom Table	Indicates the custom process fluid density table or torque tube table being used for temperature compensation is invalid.	Warning	4
	1	Displacer Rise Rate Exceeded	Indicates the device detected a rise rate that exceeded the limit.	Warning	4
	0	Displacer Fall Rate Exceeded	Indicates the device detected a fall rate that exceeded the limit.	Warning	4
4	7	Device Configuration Locked	Device configuration is locked or write-protected copy (duplicate copy of device configuration locked or write-protected in Command 48 Response Byte 8).	Mode	4
	6	Not used	- - -	- - -	- - -
	5	Not used	- - -	- - -	- - -
	4	Not used	- - -	- - -	- - -
	3	Watchdog Reset Executed copy	Duplicate copy of watchdog reset executed in Command 48 Response Byte 8.	Error	4
	2	RAM Error copy	Duplicate copy of RAM error in Command 48 Response Byte 8.	Error	4, 7
	1	NVM Error copy	Duplicate copy of NVM error in Command 48 Response Byte 8.	Error	4, 7
	0	Not used	- - -	- - -	- - -
5	7	Not used	- - -	- - -	- - -
	6	Not used	- - -	- - -	- - -
	5	Not used	- - -	- - -	- - -
	4	Not used	- - -	- - -	- - -
	3	Not used	- - -	- - -	- - -
	2	Not used	- - -	- - -	- - -
	1	Not used	- - -	- - -	- - -
	0	Not used	- - -	- - -	- - -

Byte	Bit	Name of Status Bit	Meaning	Class	Device Status
6	7	Not used	Byte 6 is the Extended Field Device Status as defined by the HART Standard. Alerts in Byte 6 are summaries of device-specific alerts from Bytes 0 through 5. Alerts indicated as not used are not available from the DLC3100 instrument.	- - -	- - -
	6	Not used		- - -	- - -
	5	Function check		Warning	4
	4	Out of specification		Warning	4
	3	Failure		Failure	4
	2	Not used		- - -	- - -
	1	Not used		- - -	- - -
	0	Maintenance required		Warning	4
7	7	Not used	- - -	- - -	- - -
	6	Not used	- - -	- - -	- - -
	5	Not used	- - -	- - -	- - -
	4	Not used	- - -	- - -	- - -
	3	Not used	- - -	- - -	- - -
	2	Not used	- - -	- - -	- - -
	1	Not used	- - -	- - -	- - -
	0	Not used	- - -	- - -	- - -
8	7	Device Configuration Locked	Indicates the device is in write-protect mode.	Mode	4
	6	Electronic error	Activated if any alerts (other than RTD sensor failure) in Command 48 Byte 0 are activated.	Error	4
	5	Not used	- - -	- - -	- - -
	4	Not used	- - -	- - -	- - -
	3	Watchdog Reset Executed	A watchdog reset has been performed.	Error	4
	2	RAM Error	An on-going RAM test has detected possible corruption in the critical data.	Error	4, 7
	1	NVM Error	Data is corrupted in the critical section of configuration memory. The configuration needs to be verified.	Error	4, 7
	0	Variable Simulation Active	The device is in simulation mode and one or more of its device variables are not representative of the process.	Mode	4

Byte	Bit	Name of Status Bit	Meaning	Class	Device Status
9	7	Not used	- - -	- - -	- - -
	6	Not used	- - -	- - -	- - -
	5	Not used	- - -	- - -	- - -
	4	Not used	- - -	- - -	- - -
	3	Not used	- - -	- - -	- - -
	2	Not used	- - -	- - -	- - -
	1	Not used	- - -	- - -	- - -
	0	Status Simulation Active	The status bits being returned in the Command 48 response are fixed and may not represent the current state of the device. This alert is permanently enabled and cannot be disabled.	Mode	4

"Not used" bits are always set to 0.

The alerts will be cleared if the corresponding condition that warrants the alert to become active is cleared.

Section 8: Universal Commands

Command #14: Sensor serial number is not used and returns 0.

Command #17: Writing a specific message string will signal the device to transition operation from HART 5 to HART 7 mode and vice versa. To switch HART versions, send one of the following strings. The actual message in the device will not be altered if these strings are encountered. To switch to HART 5 mode: send “HART5” pad with 27 spaces. To switch to HART 7 mode: send “HART7” pad with 27 spaces. You may also use the LUI menu to switch HART mode.

Command #48: device supports bytes 0 to 9.

All writes require write protection to be disabled.

The following write commands require the instrument mode to be out of service: Command 6 and 17 (only for switching HART mode).

Section 9: Common-Practice Commands

9.1 Supported Commands

Command	Command Name	Remarks
33	Read Device Variables	- - -
34	Write Primary Variable Damping Value	Valid values: 0 to 16 seconds. 0 = damping is off.
35	Write Primary Variable Range Values	The span must be at least 5% of sensor range.
36	Set Primary Variable Upper Range Value	The span must be at least 5% of sensor range.
37	Set Primary Variable Lower Range Value	- - -
40	Enter/Exit Fixed Current Mode	Valid range: 3.4 mA to 22.0 mA. A value of 0 exits Fixed Current Mode.
42	Perform Device Reset	- - -
44	Write Primary Variable Units	- - -
50	Read Dynamic Variable Assignments	- - -
51	Write Dynamic Variable Assignments	Refer to Section 6, Dynamic Variables for valid values.
53	Write Device Variable Units	Process temperature and instrument temperature share the same units code so writing new units to one will change the units for the other. This applies to upper and lower density as well.
54	Read Device Variable Information	Sensor Serial Number is not used and always returns zero.
59	Write Number of Response Preambles	5 to 20 response preambles.

Command	Command Name	Remarks
72	Squawk	This command causes the device to display a repeating pattern of "O-" on the LCD for 60 seconds after receiving this command, or until the user deactivates the squawk message locally by pressing on any button. If another squawk command is received before 60 seconds has expired, the squawk screen shall timeout in 60 seconds from the most recent reception of the squawk command. Valid values: 0 – Off 1 – On 2 – Squawk once for 60 seconds (default)
523	Read Condensed Status Mapping Array	- - -
524	Write Condensed Status Mapping	- - -
525	Reset Condensed Status Map	- - -
526	Write Status Simulation Mode	- - -
527	Simulate Status Bit	- - -

All writes require write protection to be disabled.

The following write commands require the instrument mode to be out of service:
Commands 34, 35, 36, 37, 40, 51, 53.

Burst Mode

This Field Device does not support Burst Mode.

Catch Device Variable

This Field Device does not support Catch Device Variable.

Section 10: Device-Specific Commands

The DLC3100 field device supports device-specific commands. However, these device-specific commands require use of the DD and cannot be utilized outside of this controlled environment.

Section 11: Tables

Table 1. Length Unit Codes

Code	Units
44	Feet
45	Meters
47	Inches
48	Centimeters
49	Millimeters

Internal base unit is inches. Conversion algorithm from inches to other units are:

Value_inch = Value_meter * 39.37007874

Value_inch = Value_cm * 0.3937007874

Value_inch = Value_mm * 0.03937007874

Value_inch = Value_feet * 12.0

Table 2. Density Unit Codes

Code	Units
90	Specific Gravity Units
91	grams/cubic centimeter
92	Kilograms/cubic meter
93	Pounds / gallon
94	Pounds / cubic feet
95	grams / milliliter
96	Kilograms / liter
97	grams / liter
98	Pounds / cubic inch
102	Degrees baume heavy
103	Degrees baume light
104	Degrees API

Internal base unit is Specific Gravity (SG). Conversion algorithm from SG to other units are:

Value_SG = Value_meter_cube * 0.001001803246

Value_SG = Value_grams_per_cm_cube * 1.001803246

Value_SG = Value_kg_per_liter * 1.001803246

Value_SG = Value_grams_per_ml * 1.001803246

Value_SG = Value_grams_per_liter * 0.001001803246

Value_SG = Value_pounds_per_inch_cube * 27.729818

Value_SG = Value_pounds_per_feet_cube * 0.016047349

Value_SG = Value_pounds_per_gallon * 0.120042503

For liquids heavier than water: Value_SG = 145.0 / (145.0 - Value_baume_degrees)

For liquids lighter than water: Value_SG = 140.0 / (130.0 + Value_baume_degrees)

Value_SG = 141.5 / (131.5 + Value_API_degrees)

Table 3. Temperature Unit Codes

Code	Units
32	Degrees Celsius
33	Degrees Fahrenheit
34	Degrees Rankine
35	Kelvin

Internal base unit is Fahrenheit. Conversion algorithm from Fahrenheit to other units are:

Value_degF = Value_degC * 9 / 5 + 32.0

Value_degF = Value_Kelvin * 9 / 5 – 459.67

Value_degF = Value_Rankine – 459.67

Table 4. Weight Unit Codes

Code	Units
60	gram
61	kilogram
63	pound
125	ounce

Internal base unit is Pound. Conversion algorithm from Pounds to other units are:

Value_Pound = Value_kg * 2.204623

Value_Pound = Value_gram* 0.002204623

Value_Pound = Value_ounce * 0.0625

Table 5. Volume Unit Codes

Code	Units
41	Liter
113	Cubic Inches
240	Cubic Millimeters
241	Milliliters (cubic centimeters)

Internal base unit is Cubic Inches. Conversion algorithm from Cubic Inches to other units are:

Value_Inch3 = Value_mm3 * 0.000061023743837

Value_Inch3 = Value_Liter * 61.023743837

Value_Inch3 = Value_ml * 0.061023743837

Table 6. Torque Rate Unit Codes

Code	Units
247	Pound-force Inch / Degree
248	Newton Meter / Degree
249	Dyne Centimeter / Degree

Internal base unit is Pound-force Inch / Degree. Conversion algorithm from Pound-force Inch / Degree to other units are:

Value_pf_inch_per_deg = Value_Nm_per_deg * 8.850745767

Value_pf_inch_per_deg = Value_Dyne_cm_per_deg * 0.0000008850745767

Table 7. Command #14: Read Primary Variable Transducer Information

Reads Primary Variable Sensor Serial Number (0 for DLC3100), Primary Variable Sensor Limits/Minimum Span Units Code, Primary Variable Upper Sensor Limit, Primary Variable Lower Sensor Limit and Primary Variable Minimum Span for the sensor. Primary Variable Sensor Limits and Minimum Span Units Code shall be PV units, i.e. length units for level/interface application and density units for density application. **For level/interface application:** Upper Sensor Limit = Level Offset + displacer length * 1.2 Lower Sensor Limit = Level Offset - displacer length * 0.2 Min Span = 0.05 * Displacer Length **For density application:** fRhowVd = 0.0361 * fDisplacerVol; fMaxUnbuoyedDispWgt = maximum unbuoyed displacer weight at ambient obtained from ES46 Gnorm = Torque tube temperature compensation gain obtained from torque tube tables Upper Sensor Limit (SG) = (fDispWeight / fRhowVd) Lower Sensor Limit (SG)= Max[0, (fDispWeight - Gnorm_ProcTemp * fMaxUnbuoyedDispWgt) / fRhowVd] Min Span (SG) = 0.1 * (fDispWeight / fRhowVd)		
Request Data Bytes: None		
Response Data Bytes:		
Byte	**Format**	**Description**
0-2	Uint24	Normally DLC3100 serial number. Returns 0 as 3 bytes are insufficient to code for the instrument's 16- byte ASCII character coded instrument serial number.
3	Enum	PV sensor limits and minimum span units code.
4-7	Float	PV upper sensor limit.
8-11	Float	PV lower sensor limit.
12-15	Float	PV minimum span.
Command-Specific Response Codes:		
Code	**Class**	**Description**
0	- - -	Success

Section 12: Performance

Power-Up

On power up, the device is initialized and its memory integrity is verified. Startup alerts are also checked and the relevant status bits are set accordingly. This takes approximately 1 second. During this period, the device will not respond to HART commands, and the analog output is set at 3.4 mA.

When the initialization is satisfactorily completed, and the first measurement has been made, the PV value is set, and the analog output moves to a value representing the measurement. The slew rate of this movement is limited by the configured "damping time".

Fixed-current mode is cancelled by power loss.

Reset

Command 42 ("Device Reset") causes the device to reset its microprocessor. The resulting restart is identical to the normal power up sequence. (See Power-Up immediately above).

Self-Test

The self-test procedure is executed every 100ms. Refer to Section 7, Status Information or the instruction manual for the available alerts.

As the self-test is spread over several cycles and each cycle completes within 25 ms, it does not affect device's response.

Command Response Times

The device typically responds within 200 ms.

Busy and Delayed-Response

The device may respond with "busy" status if a configuration command is received while calibration is underway.

Delayed-response is not used.

Long Messages

The largest data field used is in Command 9: Up to 71 bytes including the two status bytes.

Non-Volatile Memory

FRAM is used to hold the device's configuration parameters. New data is written to this memory immediately on execution of a write command.

EEPROM is used to hold calibration log information. It is updated upon successful completion of calibration.

Modes

Fixed current mode is implemented, using Command 40. This mode is cleared by power loss or reset.

Write Protection

Write-protection is provided by manufacturer specific command with password or using LUI menu.

Damping

Damping is standard, affecting only the PV and the loop current signal.

Annex A: Capability Checklist

Manufacturer, model and revision	Emerson, DLC3100, rev. 1
Device type	Transmitter
HART revision	7
Device Description available	Yes
Number and type of sensors	4 (Hall effect sensor, RTD sensor and 2 temperature sensors)
Number and type of host side signals	1: 4 to 20 mA analog
Number of Device Variables	10
Number of Dynamic Variables	4
Mappable Dynamic Variables?	Yes
Number of common-practice commands	19
Number of device-specific commands	Not published
Bits of additional device status	45
Alternative operating modes?	Level, Interface or Density measurement mode
Burst mode?	No
Write-protection?	Yes

Annex B: Default Configuration

Parameter	Default value
Lower Range Value	0
Upper Range Value	14
PV Units	Inch
Sensor type	Level measurement
Damping time constant	0 second
Fault-indication jumper	Up-scale
Write-protect configuration	Not protected
Number of response preambles	5

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