

Introduction

The capacitance type Electromagnetic flowmeter, model LF511/LF541, employs the surface electrode system outside the alumina ceramic tube, therefore, the electrodes do not come in contact with the process fluid. Its unique technology and mechanical design make it available for use not only on conventional applications but also on new applications such as low conductivity, abrasive and high concentration slurry. Furthermore, this meter gives a stable flow measurement even though the insulation solid adheres to the wall of alumina ceramic tube.

The electromagnetic flowmeter uses Faraday's Law of electromagnetic induction to measure the process flow. The device consists of two units: a detector, through which the fluid to be measured flows and in which low-level signals proportional to flow rates are obtained; and a converter, which supplies excitation current to the detector, and amplifies the signals from the detector and then processes and converts the signals into the 4–20mA_{dc} current signal.

The LF511 detector can mount with the LF541 converter as combined type.

The alumina ceramic tube for LF511 detector is highly resistant to extreme temperatures and negative pressure. The multi-functional LF541 converter has an unique noise-suppression circuit with superior signal processing capabilities, therefore, this flowmeter is highly resistant to noise and provides a stable output even for fluids containing slurries.

The AF900 hand-held terminal (HART^{*1} communicator) can be used to communicate with the flowmeter from remote places. See the following page for the HART communications protocol. PROFIBUS-PA^{*2} interface is available as an option.

^{*1}: HART protocol (Highway Addressable Remote Transducer) is a communication protocol for industrial sensors recommended by the HCF (HART Communication Foundation).

^{*2}: PROFIBUS is the communications protocol for factory automation and process automation that the PROFIBUS Organization recommends. Instead of analog control with a conventional analog signal (4–20mA), it is one kind of the fieldbus which digitizes all signals. Flowmeters support PROFIBUS-PA.

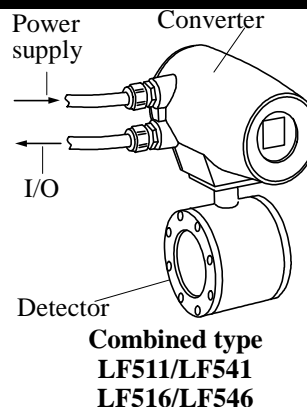


Figure 1. Configuration



**Figure 2. LF511/LF541
LF516/LF546**



Certification number
Z01207

Specifications

■ Overall Specifications

Measurement range in terms of flow velocity:

0 - 0.5 m/s to 0 - 10 m/s
(0 - 1.64 ft/s to 0 - 32.8 ft/s)

Accuracy: See the following table.

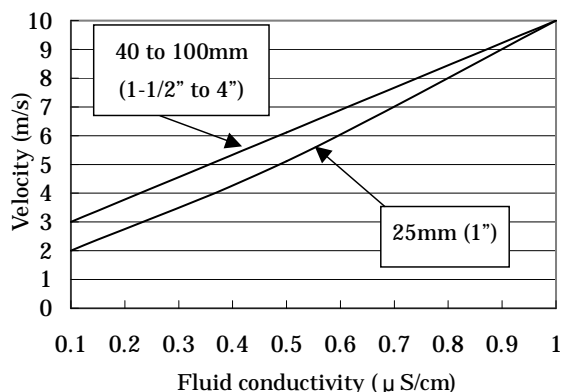
Flow rate as a percent of range	Accuracy	
	0.5 - 1.0 m/s (1.64 - 3.28 ft/s)	1.0 - 10 m/s (3.28 - 32.8 ft/s)
0 - 50%	±0.5 %FS	±0.25 %FS
50 - 100%		±0.5 % of rate

Note: The accuracy above is measured under standard operating conditions using the weighing method at Toshiba's flow calibration facility.

Fluid conductivity: 0.01 μ S/cm minimum

Note 1: Refer to the following relationship between conductivity and fluid velocity.

Note 2: Please contact Toshiba before ordering when the fluid conductivity is under 0.1 μ S/cm.



Fluid temperature:

- 10 to 120 °C (14 to 248 °F)

Ambient temperature:

-10 to 50 °C (14 to 122 °F)

Note: Contact Toshiba before ordering when the ambient temperature is over 50 °C (122 °F).

Structure: NEMA 4 (IP 67) Watertight

Power consumption: approximately 15W(24VA)

Approved hazardous location certifications :

Model: LF516/LF546

cFMus Nonincendive for use in

hazardous (classified) locations:

Class I, II, III, Division 2, Groups A-G

Detector and converter combination:

LF511/LF541: Combined type for standard specification.

LF516/LF546: Combined type with Ex approval of Class I, II, III, Division 2 (cFMus).

■ Model LF511 and LF516 Detector

Mounting style: Wafer type

Fluid pressure: -0.1 to 2.0MPa
(Depending on each flange standard)
(-15 to 300psi, or -1.0 to 20 bar)

Note: The test pressure before shipping from the factory is equal to twice the nominal pressure rating of the customer specified flange connection for a duration of 15 minutes.

Connection flange standards: ANSI 150, ANSI 300, JIS10K, JIS16K and JIS20K

Principal materials:

Case — Stainless steel

Linings — Alumina Ceramic tube

Grounding rings — 316 stainless steel (std.)

Note: See Table 2 for optional materials and other related information.

Coating — no coating (stainless steel body)

Heat shock resistance — for a ceramic tube detector

Heating: $\Delta T \leq 150$ °C 0.5sec (302 °F /0.5sec)

Cooling: $\Delta T \leq 100$ °C /0.5sec (212 °F /0.5sec)

Note: The above means that the ceramic tube detector withstands the shock of sudden heating (temperature difference 150 °C or less per 0.5seconds) and sudden cooling (temperature difference 100 °C or less per 0.5seconds).

Dimensions and weights: See Figure 3.

■ Model LF541 and LF546 Converter

Input signals

Digital input DI

Signal type: 20 to 30Vdc voltage signal

Input resistance: 2.7 k

Number of inputs: one point

DI function — One of the following functions can be assigned to the DI signal.

Range switching — Selects either the higher or lower range in the unidirectional or bidirectional 2-range setting.

Totalizer control — Start/Stop and Reset/Start operation in built-in totalizer.

Fixed-value outputs — Outputs fixed-values for current and pulse outputs.

Zero adjustment — Executes zero adjustment (on-stream at zero flow rate).

Output signals

Current output:

4-20mA_{dc} (load resistance 0 to 750 Ω)

Digital outputs — 2 points are provided as standard.

Digital output DO1:

Output type: Transistor open collector

Number of outputs: One point

Output capacity: 30Vdc, 200mA maximum

Digital output DO2:

Output type: Solidstate relay output (non polarity)

Number of outputs: One point

Output capacity: 150Vdc, 150mA maximum or 150 Vac (peak to peak), 100mA maximum

DO1 and DO2 functions — One of the following functions can be assigned.

• **Pulse output (available only for DO1)**

Pulse rate: 3.6 to 10,800,000 pulses/hr

Pulse width: 0.3 to 500ms (but less than half of the period for 100% flow rate)

• **Multi-range selection outputs (Note 1)**

• **High-high, high, low and/or low-low limit alarm outputs (Note 2)**

• **Preset count output**

• Converter failure alarm output (Note 2)

Note 1: Two outputs (DO1 and DO2) are needed for 4-range switching and forward/reverse 2-range switching.

Note 2: Normal Open (default set) or Normal Close is selected for alarm outputs when programming.

Communications output — Digital signal is superimposed on 4–20mA_{dc} current signal (conforms to HART protocol)

Load resistance : 240 to 750

Load capacitance : 0.25 μ F maximum

Load inductance : 4 mH maximum

Note: HART (Highway Addressable Remote Transducer) protocol is a communications protocol for industrial sensors recommended by HCF (HART Communication Foundation).

PROFIBUS communication(opt.):

Protocol: PROFIBUS-PA

Baud rate: 31.25kbps

Bus voltage: 9-30VDC

Consumption electric current of bus: less than 16mA

Manufacture Ident-No.: 093B_{HEX}

Standard Ident-No.: 9740_{HEX}

Slave address: 0-126 (Default address is 126)

Profile: Profile Ver.3.01 for Process Control Devices

Function blocks: AI(Flow) \times 1 , Totalizer \times 1

Note: When the PROFIBUS communication specification is selected, current output signals (DC4-20mA) are not available.

LCD display: 128x128 full dot-matrix LCD display (back-light provided)

Parameter settings: Parameters can be set by infrared rays switches at the LCD board. The AF900 hand-held terminal is available for setting parameters from remote places.

Note: Products are shipped in such a status where major parameters that affect flow measurement may not be set and changed in advance for sealing specification.

Note: When the PROFIBUS communication specification is selected, the handheld terminal AF900 is not available.

Counter control: If the digital input is set for counter control, counter control is available for the integrated value and the pulse output.

Zero adjustment: Zero point adjustment can be started by pressing the switch in the converter.

Damping: 1 to 200 seconds (selectable in 1 second increments)

Zero and span calibration:

Built-in calibration signal source allows converter unit check.

Conditions when power fails:

The outputs and display will remain as follows when power fails. Parameter setting values are stored in non-volatile memory and the values will be restored when the power returns to normal condition.

- Current output: 0 mA
- Digital output: OFF
- LCD display: No display

Power supply:

- 100 to 240Vac, 50/60Hz
(allowable voltage 80 to 264Vac)

Surge protection: Arresters are installed in the power supply, and current signal output circuit.

Case: Aluminum alloy

Coating: Acrylic resin-baked coating, pearl-gray colored

Cable connection ports:

Cable glands —

LF511/LF541 without cFMus Approval:
Provided as standard, G(PF) 1/2 female screws, Nylon 66 material.

LF516/LF546 with cFMus Approval:
Not provided, 1/2-14NPT male screws are required.

Applicable diameter — 11 to 13mm.
(0.433 to 0.512 inch)

Note: The compatible outer diameter of the signal cable glands is ϕ 6 to 8mm for the one equipped with the PROFIBUS communication function. The power cable glands have the same compatible outer diameter (ϕ 11 to 13mm) as the standard size. Give a separate instruction if you need one with the standard compatible outer diameter (ϕ 11 to 13mm) for signal cable glands.

Vibration resistance:

No resonance to the following levels of vibration:

- 10 to 150Hz with acceleration of 9.8m/s²
- Acceleration of 29.4m/s² at 30Hz for 2 hours in each X, Y, and Z axis.

Note: Avoid using the flowmeter in an environment with constant vibration.

MTBF:

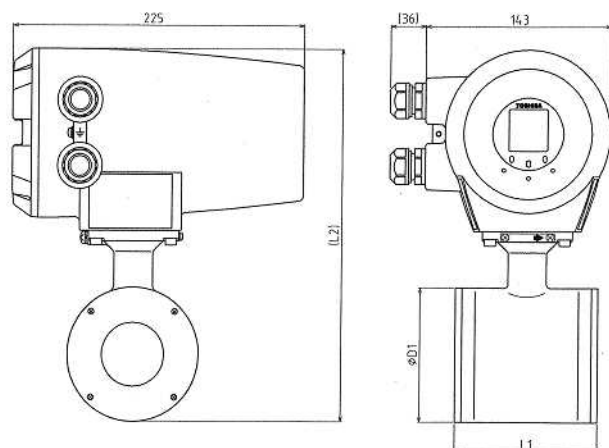
110,000 hours at 25 °C (77 °F) based on MIL-HDBK-217F

Terminal block: 10 poles(M4 screw)

Installation

■ Dimensions

Unit : mm



JIS10K , JIS16K , JIS20K dimensions:

Meter size (mm)	L1 (mm)	(L2) (mm)	D1 (mm)	Weight (kg)
25	80	214	66	Approx. 5
40	100	264	85	Approx. 6
50	110	280	102	Approx. 7
80	110	306	127	Approx. 8
100	180	338	159	Approx. 13

ANSI class 150 and class 300 dimensions:

Meter size (inch)	L1 (inch)	(L2) (inch)	D1 (inch)	Weight (lb)
1"	3.15	8.43	2.60	Approx. 12
1-1/2"	3.94	10.39	3.35	Approx. 14
2"	4.33	11.02	4.02	Approx. 16
3"	4.33	12.05	5.00	Approx. 18
4"	7.09	13.31	6.26	Approx. 29

Note: 1 inch = 25.4mm

**Figure 3. LF511/LF541 and LF516/LF546 combined type
Meter sizes 25 (1") to 100mm (4")**

External Connections

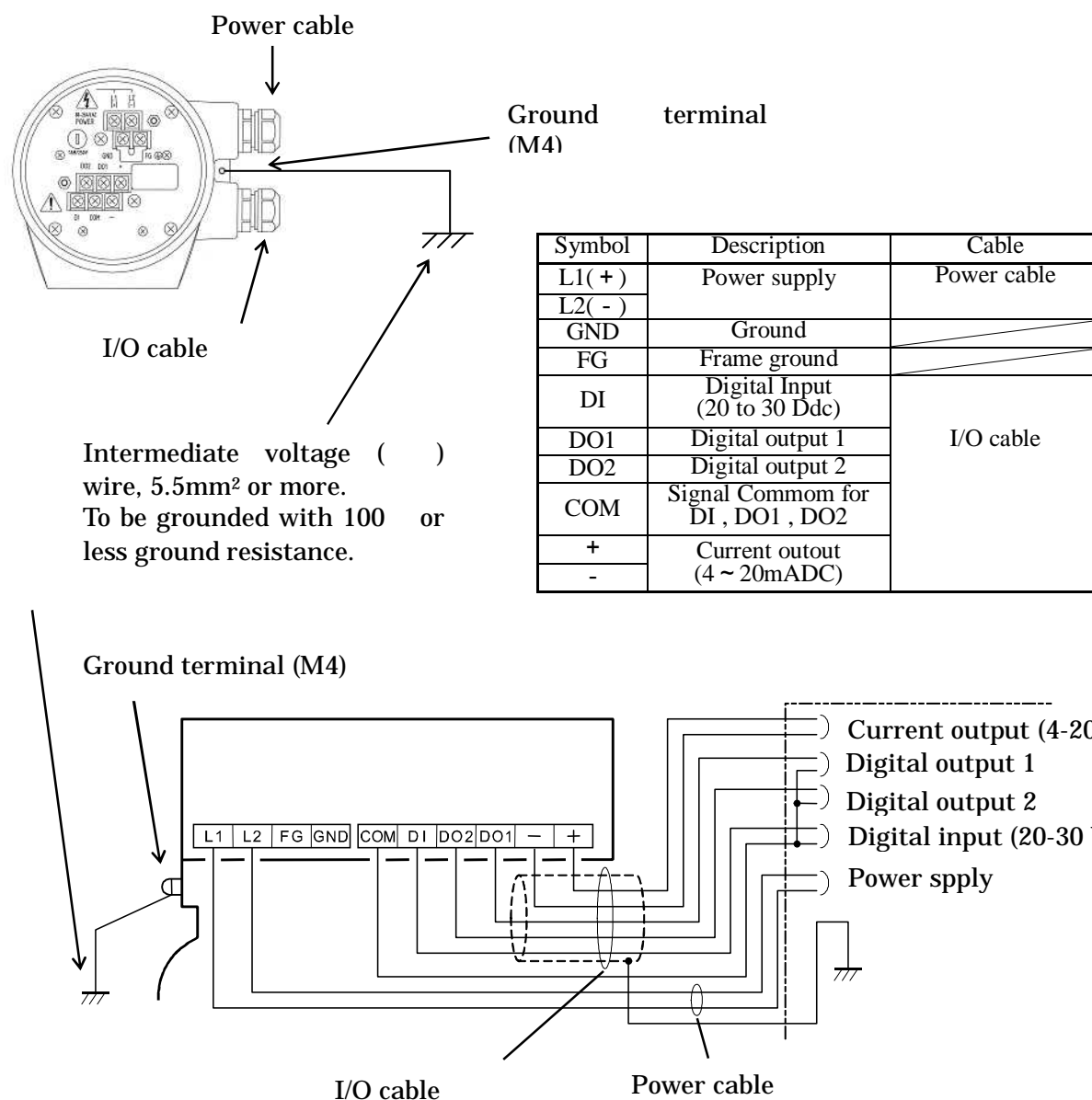


Figure 4. LF511/LF541 and LF516/LF546 flowmeter Wiring Diagram

■ Piping Precautions

- (1) Design the LF511/LF541 piping to keep the filled condition inside the pipe.
- (2) The electromagnetic flow meter detector LF511-type does not have a loose mechanism. Place a loose short pipe if required.
- (3) The LF511/LF541 requires the following straight pipe length for both upstream and downstream.

Upstream	90 degree bent pipe, T-tube, reducer or full admission condition using slice valve	L=5D
	Other valves	L=10D
Downstream	Unless the valve comes into the pipe of detector	L=0

L: Required straight pipe length -----

Straight pipe length plus half length of detector.

D: Nominal diameter.

- (4) Design piping so that the liquid pressure does not exceed the standard flange pressure.
- (5) Select one from the size, length and quantity of the compatible bolts and nuts are different depending on the bore diameter and the flange specification.
- (6) Insulate piping so that the temperature around the transformer may not exceed 50° C when the high-temperature fluid passes.

■ Wiring Precautions

- (1) Connect the grounding wire (IV wire 5.5mm² or more) to a good earth ground (100 ohm or less ground resistance). Make the wire as short as possible. Do not use a common ground shared with other equipment where earth current may flow. An independent earth ground is recommended.
- (2) DO1, DO2, and DI use the same common terminal (COM). This COM cannot be connected to other equipment which have their own ground terminal.
(Power supply for connecting to DI or DO, etc...) Need to wire separately.

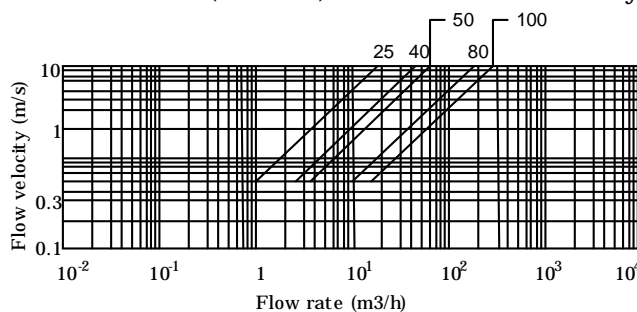
■ Meter Size

To select the meter size:

See Figure 5 and find meter sizes within the velocity of 0.5 to 10 m/s (1.64 to 32.8 ft/s) for a specified full-scale (measuring range high limit) flow.

- When the fluid conductivity is 1 uS/cm or smaller, the maximum flow velocity becomes 10 m/s (32.8 ft/s) or slower. Need to confirm its availability by referring to this figure.
- Make sure the full-scale flow rate used

for the final planning stage stays within 10 m/s (32.8 ft/s) in terms of flow velocity.



For SI unit

Unit: m³/h

Meter size (mm)	Flow rate		
	0.5 m/s	1 m/s	10 m/s
25	0.884	1.767	17.67
40	2.262	4.523	45.23
50	3.534	7.067	70.67
80	9.045	18.09	180.9
100	14.14	28.27	282.7

For English unit

Unit: gal/min

Meter size	Flow rate		
	1.64 ft/s	3.28 ft/s	32.8 ft/s
1	3.900	7.780	77.80
1-1/2	9.953	19.91	199.1
2	15.55	31.12	311.2
3	39.81	79.65	796.5
4	62.22	124.5	1245

Figure 5. Flow rate and Flow velocity

■ Calibration Range

If the calibration range is not specified, the standard range as shown below will be used. If the range is specified, we will use the specified range for calibration.

Table 1. Standard Flow Range

Meter size mm (inch)	Standard flow range		
	Flow rate (m ³ /h)	Flow velocity (m/s)	Flow rate (gal/min)
25 (1)	6	3.395	75
40 (1 1/2)	15	3.316	175
50 (2)	25	3.537	300
80 (3)	60	3.316	650
100 (4)	100	3.537	1000

Note: The unit of "gal/min" is not exchanged (converted) by "m³/h".

Ordering Information

1. When ordering the LF511/LF541 and LF516/LF546 flowmeter, refer to Tables 2 and 3 (Type Specification Codes).
An entry must be made for each of the columns in each of these tables.
2. Fluid characteristics:
 - (1) Type of fluid to be measured and its characteristics
 - (2) Fluid temperature
 - (3) Fluid pressure
 - (4) Electrical conductivity of the fluid
3. Measuring range
4. I/O function setting
5. Ordering scope:
Flow calibration data: (required or not)
6. Other items:
Specifications other than standard items

Consult Toshiba before ordering when choose material of grounding ring.

Table 2. Specification Code (Capacitance type LF511 detector)

Model					Specification Code									Description	Category
1	2	3	4	5	6	7	8	9	10	11	12	13	14		
L	F	5	1	1										Detector of Capacitance type Electromagnetic Flowmeter	
L	F	5	1	6										cFMus Hazardous location certification type (Note 5)	
					E									Meter size 25mm (1") 40mm (1 1/2") 50mm (2") 80mm (3") 100mm (4")	
					F										
					G										
					H										
					J										
					L									Mounting Style Detector/Converter combined type (LF510/LF540)	
					C									Connection flange standard (Note 1) ANSI 150 ANSI 300 EN 1092-1 PN 10 EN 1092-1 PN 16 JIS 10K JIS 16K JIS 20K Other (Note 2)	
					D										
					G										
					H										
					J										
					K										
					L										
					Z										
					A									Application Standard	
						A								Lining Material Alkali-resistant ceramic (standard) (Note 3) Acid-resistant ceramic (Note 3)	
						B									
							C							Grounding Ring Material (Note 4) 316 stainless steel (standard) 316L stainless steel Ti (titanium) Hastelloy C (Equivalent) Other (Note 2)	
							D								
							E								
							F							Flow and calibration velocity range / with or without designated setting item Standard range calibration / without designated setting item Specified range calibration Standard range calibration / with designated setting item	
														Excitation and Signal Cables None	
														Coating No coating Other (Note 2)	

Code explanation: : Standard, : Option

Note1: Same shape of flange standard among ANSI 150, ANSI 300, BS10, BS16, DIN10, DIN16, JIS10K, JIS16K, and JIS20K.

Note2: In the case of cord "Z", please refer beforehand.

Note3: The type of material used is alumina ceramic, this is suitable for both acid and alkali liquids.
This ceramic lining is held with seals, there are two types, one for acids, and the other for alkalis.

Note4: Consult Toshiba before ordering when choosing materials at the wetting parts.

Note5: Cable glands are not provided. Refer to the part of "Cable connection port) at detector and converter.

Table 3. Specification Code (Capacitance type LF541 converter)

Model					Specification Code									Description
1	2	3	4	5	6	7	8	9	10	11	12	13	14	
L	F	5	4	1										Converter of Capacitance type Electromagnetic Flow meter
L	F	5	4	6										cFMus Hazardous location
					A									Usage LF541 for General purpose
					A									Mounting Structure Detector/Converter combined type
						B								Display LCD display provided
							2							Output 4-20mA _{dc} current, 2 points DO and 1 point DI provided.
								1 2						Communications function Current output + HART communication PROFIBUS communication(Note)
									1					Power supply 100 to 240V _{ac} , 50/60Hz
										A Z				Coating Acrylic resin-backed coating, pearl-gray colored Other (option)
										A A				For US and Canada
										A B				For other countries

Note: When choosing the PROFIBUS communication current output function is not available to use.
Please refer table 4 for details.

Table 4. Communication function and output selection table

Selection of Function		Availability of outputs			
Code (10 th digit)	Selected Communication	4-20mA _{dc}	DO1	DO2	DI
1	HART	✓	✓	✓	✓
2	PROFIBUS	X	✓	✓	✓

Code explanation: ✓: Available X: Not Available

ISO9001 and ISO14001 are certified.



Misuse of this product can result in damages to property or human injury.
Read related manuals carefully before using this product.

Specifications are subject to change without notice.

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