Introduction

The capacitance type Electromagnetic flowmeter, model LF511/LF541(LF516/LF546) 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.

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 4–20mAdc current signal.

The LF511(LF516) detector can mount with the LF541(LF546) converter as combined type.

The alumina ceramic tube for LF511(LF516) detector is highly resistant to extreme temperatures and negative pressure.

The multi-functional LF541(LF546) converter equipped with its patented Noise-Sentry Original noise-suppression circuit and advanced algorithms. Therefore, this flowmeter is highly resistant to noise and provides a stable output even for fluids containing slurries.

HART*1 communicator can be used to communicate with the flowmeter from a remote place. PROFIBUS-PA*2 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: DevComm2000 Smart Device Communicator available for performing HART device configurations on PC or laptop is available through the supplier.

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

Specifications

- Overall Specifications

Measurement range in terms of flow velocity: 1.64ft/s to 32.8ft/s (0.5m/s to 10m/s)

Accuracy: See the following table.

<table>
<thead>
<tr>
<th>Flow rate as a percent of range</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 50%</td>
<td>+/- 0.25 %FS</td>
</tr>
<tr>
<td>50 – 100%</td>
<td>+/- 0.5 %FS</td>
</tr>
</tbody>
</table>

Note: The accuracy above is measured under standard operating conditions using the weighing method at Toshiba’s flow calibration facility.
**Fluid conductivity:** 0.01 $\mu$ 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 $\mu$ S/cm. **Trial test is highly recommended for the application under 0.1 $\mu$ S/cm.**

**Note:** See Table 3 for optional materials and other related information.

**Coating:** no coating (stainless steel body)

**Heat shock resistance** — for a ceramic tube detector

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

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

**Note:** The above means that the ceramic tube detector withstands the shock of sudden heating (temperature difference 302$^\circ$F or less per 0.5seconds) and sudden cooling (temperature difference 212$^\circ$F 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$\Omega$
- 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:**

- 4–20mAdc (load resistance 0 to 750$\Omega$)

**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. When power failure occurs, unit will be fault to Normal Open.

Communications output
• HART (std.) — Digital signal is superimposed on 4–20mAdc current signal as follows:
  Conforms to HART protocol
  Load resistance : 240 to 750Ω
  Load capacitance : 0.25 µF 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:
  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)×1, Totalizer×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)
  A parameter change will rotate the display.

Parameter settings: Parameters can be set by infrared ray 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)

“Field re-verification” Mag-Prover – Toshiba’s Zero span calibration tools allows unit to be re-calibrated and verified using an internal software program (For more information contact Toshiba International Corp.)

Conditions 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. The outputs and display will remain as follows when power fails.

  • 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 to help protect the meter from lightning and improve personnel safety.

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 threads, Nylon 66 material.
  LF516/LF546 with cFMus Approval:
  Not provided, 1/2-14NPT male threads are required.

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

  Note: The compatible outer diameter of the signal cable glands is φ6 to 8mm for the one equipped with the PROFIBUS communication function. The power cable glands have the same compatible outer diameter (φ11 to 13mm) as the standard size. Give a separate instruction if you need one with the standard compatible outer diameter (φ11 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
• Vibration of 30Hz with 29.4m/s² in 2h in each direction will not cause any defect to unit.

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

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

Terminal block: 10 poles (M4 screw)

Installation

Dimensions

<table>
<thead>
<tr>
<th>ASME B 16.5 class 150 and class 300 dimensions:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meter size</td>
</tr>
<tr>
<td>1”</td>
</tr>
<tr>
<td>1-1/2”</td>
</tr>
<tr>
<td>2”</td>
</tr>
<tr>
<td>3”</td>
</tr>
<tr>
<td>4”</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>JIS B 2220 10K and 16K and JIS20K dimensions:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meter size</td>
</tr>
<tr>
<td>25</td>
</tr>
<tr>
<td>40</td>
</tr>
<tr>
<td>50</td>
</tr>
<tr>
<td>80</td>
</tr>
<tr>
<td>100</td>
</tr>
</tbody>
</table>

Note: 1 inch = 25.4mm

Note1: Cable glands are not provided for LF516/LF546 of cFMus approved type. Refer the details from the description of cable connection ports at page3 of this document.

Figure 3. LF511/LF541 and LF516/LF546 Combined type flowmeter
Meter sizes 1” (25mm) to 4” (100mm)
External Connections

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

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>Cable</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1(+)</td>
<td>Power supply</td>
<td>Power cable</td>
</tr>
<tr>
<td>L2(-)</td>
<td></td>
<td>Power cable</td>
</tr>
<tr>
<td>GND</td>
<td>Ground</td>
<td>I/O cable</td>
</tr>
<tr>
<td>FG</td>
<td>Frame ground</td>
<td>I/O cable</td>
</tr>
<tr>
<td>DI</td>
<td>Digital Input (20 to 30 Vdc)</td>
<td>I/O cable</td>
</tr>
<tr>
<td>DO1</td>
<td>Digital output 1</td>
<td>I/O cable</td>
</tr>
<tr>
<td>DO2</td>
<td>Digital output 2</td>
<td>I/O cable</td>
</tr>
<tr>
<td>COM</td>
<td>Signal Common for DI, DO1, DO2</td>
<td>I/O cable</td>
</tr>
<tr>
<td>+</td>
<td>Current output (4-20mADC)</td>
<td></td>
</tr>
<tr>
<td>-</td>
<td>(4 ~ 20mADC)</td>
<td></td>
</tr>
</tbody>
</table>

Intermediate voltage (IV) wire, 5.5mm² or more. To be grounded with 100Ω or less ground resistance.
**Piping Precautions**

1. Design the LF511/LF541 and LF516/LF546 piping to keep the filled condition inside the pipe.

2. The electromagnetic flow meter detector LF511-type and LF516-type does not have a loose mechanism. Place a loose short pipe if required.

3. The LF511/LF541 and LF516/LF546 requires the following straight pipe length for both upstream and downstream.

<table>
<thead>
<tr>
<th>Upstream</th>
<th>90 degree bent pipe, T-tube, reducer or full admission condition using slice valve</th>
<th>L=5D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other values</td>
<td></td>
<td>L=10D</td>
</tr>
</tbody>
</table>

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 50ºC 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 Table 1 to 2 and find meter sizes within the velocity of 1.64 to 32.8 ft/s (0.5 to 10 m/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 32.8 ft/s (10 m/s ) or slower.

Need to confirm its availability by referring to this Table..

- Make sure the full-scale flow rate used for the final planning stage stays within 32.8 ft/s (10 m/s ) in terms of flow velocity.

![Flow rate and Flow velocity (English Unit)](image)

**Table 1. Flow rate and Flow velocity (English Unit)**

<table>
<thead>
<tr>
<th>Meter size</th>
<th>Flow rate 1.64 ft/s</th>
<th>3.28 ft/s</th>
<th>32.8 ft/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3.900</td>
<td>7.780</td>
<td>77.80</td>
</tr>
<tr>
<td>1-1/2</td>
<td>9.953</td>
<td>19.91</td>
<td>199.1</td>
</tr>
<tr>
<td>2</td>
<td>15.55</td>
<td>31.12</td>
<td>311.2</td>
</tr>
<tr>
<td>3</td>
<td>39.81</td>
<td>79.65</td>
<td>796.5</td>
</tr>
<tr>
<td>4</td>
<td>62.22</td>
<td>124.5</td>
<td>1245</td>
</tr>
</tbody>
</table>

**Table 2. Flow rate and Flow velocity (SI Unit)**

<table>
<thead>
<tr>
<th>Meter size (mm)</th>
<th>Flow rate 0.5 m/s</th>
<th>1 m/s</th>
<th>10 m/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>0.884</td>
<td>1.767</td>
<td>17.67</td>
</tr>
<tr>
<td>40</td>
<td>2.262</td>
<td>4.523</td>
<td>45.23</td>
</tr>
<tr>
<td>50</td>
<td>3.534</td>
<td>7.067</td>
<td>70.67</td>
</tr>
<tr>
<td>80</td>
<td>9.045</td>
<td>18.09</td>
<td>180.9</td>
</tr>
<tr>
<td>100</td>
<td>14.14</td>
<td>28.27</td>
<td>282.7</td>
</tr>
</tbody>
</table>
Ordering Information

1. When ordering the LF511/LF541 and LF516/LF546 flowmeter, refer to Tables 3 and 4 (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 3. Specification Code (Capacitance type detector LF511 and LF516 Series)

<table>
<thead>
<tr>
<th>Model</th>
<th>Specification Code</th>
<th>Description</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>L F 5</td>
<td>1 1</td>
<td>Detector of Capacitance type Electromagnetic Flowmeter</td>
<td>●● ●●</td>
</tr>
<tr>
<td>L F 5</td>
<td>1 6</td>
<td>cFMus Hazardous location certification type (Note 5)</td>
<td>● ● ●</td>
</tr>
</tbody>
</table>

**Model**
- E
- F
- G
- H
- J
- L
- C
- D
- J
- K
- L
- A
- B
- C
- D
- E
- H
- D
- E
- F
- A
- A
- A

| Code explanation:  ● Standard, ○ Option |

**Note1:** Same shape of flange standard among ASME B 16.5 class 150 and ASME B 16.5 class 300, EN 1092-1 PN10, EN 1092-1 PN 16, , JIS B 2220 10K, JIS B 2220 16K, and JIS B 2220 20K.

**Note2:** 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.

**Note3:** Consult Toshiba before ordering when choosing materials at the wetting parts.

**Note4:** Cable glands are not provided. Refer to the part of “Cable connection port) at detector and converter.
### Table 4. Specification Code for Converter

<table>
<thead>
<tr>
<th>Model</th>
<th>Specification Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>L F 5 4 1</td>
<td>Combined Converter of Capacitance type Electromagnetic Flowmeter</td>
</tr>
<tr>
<td></td>
<td>L F 5 4 6</td>
<td>Combined Converter of Capacitance type Electromagnetic Flowmeter with cFMus Hazardous location certificate</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Usage</th>
<th>A Usage General purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mounting Structure</td>
<td>A Detector/Converter combined type</td>
</tr>
<tr>
<td>Display</td>
<td>B LCD display provided</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Output</th>
<th>1 4-20mA current, 2 points DO and 1 point DI provided</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communications function</td>
<td>2 Current output + HART communication</td>
</tr>
<tr>
<td>PROFIBUS communication (Note1)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Power supply</th>
<th>1 100 to 240Vac, 50/60Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coating</td>
<td>A A Acrylic resin-backed coating, pewl-gray colored</td>
</tr>
<tr>
<td>Other (option)</td>
<td>Z</td>
</tr>
</tbody>
</table>

Note 1: When PROFIBUS communication is provided, current output(4-20mA) and HART communication cannot be used. Refer Table 5 for more details.

### Table 5. Communication functions and output selection table

<table>
<thead>
<tr>
<th>Selection of Function</th>
<th>Availability of outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Code</td>
<td>Selected Communication</td>
</tr>
<tr>
<td>1</td>
<td>HART</td>
</tr>
<tr>
<td>2</td>
<td>PROFIBUS</td>
</tr>
</tbody>
</table>

Code explanation: ✓:Available X:Not Available

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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.
Printed in Japan 2017-7(TBLS)
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