The information contained in this document is believed to be correct, but OMEGA accepts no liability for any errors it contains, and reserves the right to alter specifications without notice.
General Information
General Information ........................................................................................................Page 4
Features ...........................................................................................................................Page 4
Specifications ..................................................................................................................Page 5
Dimensions .....................................................................................................................Page 6
Accuracy ..........................................................................................................................Page 7
Flow Rate .........................................................................................................................Page 7
Installation
Straight Pipe Recommendations .....................................................................................Page 8
Full Pipe Recommendations ..........................................................................................Page 9
Positioning the Meter .......................................................................................................Page 10
Installing Gaskets ............................................................................................................Page 10
Tightening Flange Bolts ....................................................................................................Page 11
Equalization and Grounding (Metal and Plastic Pipe) .....................................................Page 11
Connections
General Cable Information ...............................................................................................Page 12
Cable Gland Opening and Sealing ....................................................................................Page 12
Cable Installation ............................................................................................................Page 13
Wiring Diagrams .............................................................................................................Page 14
Cable Wiring Table ..........................................................................................................Page 16
Configuration
Sourcing Mode Output Application ..................................................................................Page 17
Sinking Mode Output Application ..................................................................................Page 17
Analog (4-20mA Current Loop) Output Application .........................................................Page 17
Cable Shield ...................................................................................................................Page 18
Pulse Output ....................................................................................................................Page 18
Analog (4-20mA) Output ................................................................................................Page 19
Operation
Changing Flow Meter Settings - Changing Total Direction/Resetting Totalizers ..............Page 20
Changing Flow Meter Settings - Entering Menu System ................................................Page 20
Changing Flow Meter Settings - Making Selections ........................................................Page 20
Changing Flow Meter Settings - Standard Menu Options ..............................................Page 21
Changing Flow Meter Settings - Special Submenu .........................................................Page 21
To Change a Passcode .....................................................................................................Page 22
Power Indicators .............................................................................................................Page 22
Battery Powered Units ....................................................................................................Page 23
Troubleshooting & Error Messages
Problem ............................................................................................................................Page 24
Probable Cause ..............................................................................................................Page 24
Things to Try ....................................................................................................................Page 24
Error Messages ...............................................................................................................Page 24
The **FMG470 Series** is a spool-type electromagnetic flowmeter for use in irrigation applications in 3” to 12” pipe. With no moving parts, these meters provide unobstructed flow and are resistant to wear from debris found in ground or surface water. Little maintenance is required because there are no bearings to wear out or propellers to stop turning. Minimal straight pipe requirements allow FMG470 meters to be used in piping configurations where there is little space between the meter and an elbow.

The standard FMG470 is battery powered with an available pulse output. Both rate and total indication show on the meter mounted display. Bidirectional flow reading is standard with totals available in forward, reverse, net flow, batch forward flow, and batch reverse flow. Batch totals can be reset. Built-in data logging is available as an option for secure flow logging.

The FMG470 is also available with external DC power. With an externally powered FMG470 an additional output can be added, such as 4-20mA.

The FMG470 Series is CE certified and IP68 for burial, or applications where the meter may be under water for prolonged periods of time. All meters are provided with a security seal to protect against unauthorized access. The seal can be broken by an authorized agent to replace the battery pack or field install a power/output cable. The cable is field installed where external power is available and/or an output is needed.

### Features

- **Rate and total indicator with light sensor button controls**
- **Power and Output cable port access**
- **Equalization lug**
- **Santoprene/Polypropylene Liner (Noryl® Liner, 3” only)**
- **Welded steel epoxy-coated flow tube (Ductile cast iron flow tube, 3” only)**
- **316SS electrodes (Inside)**
- **Data logger port (right side, not shown)**
- **User access lid**
- **Hinged cover**
- **Powder-coated diecast aluminum electronics housing**
- **No moving parts!**
- **Protective faceplate cover and lanyard**

---

*Page 4*
## Specifications*

<table>
<thead>
<tr>
<th>Feature</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pipe Sizes</strong></td>
<td>3&quot;, 4&quot;, 6&quot;, 8&quot;, 10&quot;, 12&quot;</td>
</tr>
<tr>
<td><strong>Flanges</strong></td>
<td>150 lb. ANSI Pattern</td>
</tr>
<tr>
<td><strong>Pressure</strong></td>
<td>150 psi (10.3 bar) line pressure</td>
</tr>
<tr>
<td><strong>Temperature</strong></td>
<td>Operating: 10° to 140° F (-12° to 60° C)</td>
</tr>
<tr>
<td><strong>Storage</strong></td>
<td>(-40° to 158° F (-40° to 70° C)</td>
</tr>
<tr>
<td><strong>Accuracy</strong></td>
<td>±0.75% of reading on FMG480 and FMG490 (±1.0% FMG470), ±0.025% of full-scale flow from low flow cutoff to maximum flow rate of 10 m/sec</td>
</tr>
<tr>
<td><strong>Low Flow Cutoff</strong></td>
<td>0.5% of maximum flow rate</td>
</tr>
<tr>
<td><strong>Material</strong></td>
<td><strong>Body (3&quot; only)</strong> Ductile cast iron, powder coated</td>
</tr>
<tr>
<td><strong>Body (4&quot;-12&quot;)</strong></td>
<td>Welded steel, epoxy-coated</td>
</tr>
<tr>
<td><strong>Liner (3&quot; only)</strong></td>
<td>Noryl*</td>
</tr>
<tr>
<td><strong>Liner (4&quot;-12&quot;)</strong></td>
<td>Santoprene flange/Polypylene liner body</td>
</tr>
<tr>
<td><strong>Electronics Housing</strong></td>
<td>Powder-coated diecast aluminum</td>
</tr>
<tr>
<td><strong>Electrodes</strong></td>
<td>316 stainless steel</td>
</tr>
<tr>
<td><strong>O-ring (3&quot; only)</strong></td>
<td>EPDM</td>
</tr>
<tr>
<td><strong>Display</strong></td>
<td><strong>Type</strong> 128x64 dot-matrix LCD</td>
</tr>
<tr>
<td><strong>Digits</strong></td>
<td>5 Digit Rate</td>
</tr>
<tr>
<td><strong>Rate Volume Units</strong></td>
<td>Gallons, Liters, Barrels(42 gal), Cubic Feet, Cubic Meters</td>
</tr>
<tr>
<td><strong>Million Gallons</strong></td>
<td>Imperial Gallons, Million Imperial Gallons</td>
</tr>
<tr>
<td><strong>Rate Time Units</strong></td>
<td>Gallons, Gallons x 10, Gallons x 1000, Million Gallons, Liters</td>
</tr>
<tr>
<td><strong>Total Volume Units</strong></td>
<td>Barrels (42 gal), Cubic Meters, Cubic Feet x 1000, Million Imperial Gallons, Kilo Liters, Second Foot Day, Mega Liters, Million Cubic Feet, Fluid Ounces</td>
</tr>
<tr>
<td><strong>Bidirectional</strong></td>
<td>Forward Total, Reverse Total, Net Total, Batch Forward Total, Batch Reverse Total (Batch totals can be reset)</td>
</tr>
<tr>
<td><strong>Power</strong></td>
<td><strong>DC Power</strong> 9-36 Vdc @ 250 mA max, 30 mA average</td>
</tr>
<tr>
<td><strong>Battery Backup</strong></td>
<td>DC powered units: Two lithium 3.6V ‘D’ batteries, replaceable. AC powered units: One 9V alkaline battery, replaceable.</td>
</tr>
<tr>
<td><strong>AC Power</strong></td>
<td>85-264Vac, 50/60Hz, 0.12A</td>
</tr>
<tr>
<td><strong>Battery (FMG470 only)</strong></td>
<td>One lithium 7.2V ‘D’ size battery pack, replaceable.</td>
</tr>
<tr>
<td><strong>Scaled Pulse Output</strong></td>
<td>Current sinking pulse, isolated, 36 Vdc at 10 mA max</td>
</tr>
<tr>
<td><strong>Pulse Rates</strong></td>
<td>User-scalable from 0.1 to 99,999.9 volume units/pulse. Pulse width is one-half of pulse period with minimum pulse width of 2.5 ms, 200 pulses/sec max. For battery option meters, pulse width varies with frequency. 150 pulses/sec max.</td>
</tr>
<tr>
<td><strong>Options</strong></td>
<td>4-20mA Current Loop Isolated, passive, 24Vdc, 650 Ω maximum current loop</td>
</tr>
<tr>
<td><strong>Cable</strong></td>
<td><strong>Power/Output Cable</strong> 20ft (6m) standard length polyurethane jacketed cable—for power and outputs (lengths up to 200' available).</td>
</tr>
<tr>
<td><strong>Remote Display Cable</strong></td>
<td>20ft (6m) standard length polyurethane jacketed cable—for connection between meter and remote display (lengths up to 200' available).</td>
</tr>
<tr>
<td><strong>Conductivity</strong></td>
<td>&gt;20 microSiemens/cm</td>
</tr>
<tr>
<td><strong>Empty Pipe Detection</strong></td>
<td>Hardware/software, conductivity-based</td>
</tr>
<tr>
<td><strong>Regulatory</strong></td>
<td>CE (EN 61326)</td>
</tr>
<tr>
<td><strong>Environmental</strong></td>
<td>NEMA 6P, IP68 (10ft (3m) depth, continuously)</td>
</tr>
</tbody>
</table>

---

* Specifications subject to change.  
1. If forward and reverse flow data needs to be sent to another device, either the Digital or Modbus output is required.  
2. Rate Time Unit is available in Day only.

---

Modbus is a registered trademark of Schneider Electric.
Install security seal during installation if regulations require.

### Dimensions

<table>
<thead>
<tr>
<th>AG3000 Meter Size</th>
<th>L (inch)</th>
<th>L (mm)</th>
<th>H (inch)</th>
<th>H (mm)</th>
<th>T (inch)</th>
<th>T (mm)</th>
<th>ID (inch)</th>
<th>ID (mm)</th>
<th>Shipping Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>3”</td>
<td>12.25</td>
<td>311.15</td>
<td>7.08</td>
<td>179.8</td>
<td>.68</td>
<td>17.25</td>
<td>2.6</td>
<td>66.04</td>
<td>38 lbs 17 Kg</td>
</tr>
<tr>
<td>4”</td>
<td>10.24</td>
<td>260</td>
<td>8.3</td>
<td>211</td>
<td>.62</td>
<td>15.7</td>
<td>3.12</td>
<td>79</td>
<td>33 lbs 15 Kg</td>
</tr>
<tr>
<td>6”</td>
<td>12.27</td>
<td>312</td>
<td>9.1</td>
<td>231</td>
<td>.69</td>
<td>17.5</td>
<td>5.05</td>
<td>128</td>
<td>49 lbs 22 Kg</td>
</tr>
<tr>
<td>8”</td>
<td>14.24</td>
<td>362</td>
<td>10.1</td>
<td>257</td>
<td>.69</td>
<td>17.5</td>
<td>6.44</td>
<td>164</td>
<td>70 lbs 32 Kg</td>
</tr>
<tr>
<td>10”</td>
<td>18.18</td>
<td>462</td>
<td>11.2</td>
<td>284</td>
<td>.69</td>
<td>17.5</td>
<td>8.61</td>
<td>219</td>
<td>130 lbs 59 Kg</td>
</tr>
<tr>
<td>12”</td>
<td>19.68</td>
<td>500</td>
<td>12.2</td>
<td>310</td>
<td>.81</td>
<td>20.6</td>
<td>10.55</td>
<td>268</td>
<td>170 lbs 77 Kg</td>
</tr>
</tbody>
</table>

Flanges: Standard ANSI 150 lb. drilling

Cable 1 lb.
Flow Rate (3” - 12”)

<table>
<thead>
<tr>
<th>Pipe Size (Inches in diameter)</th>
<th>3”</th>
<th>4”</th>
<th>6”</th>
<th>8”</th>
<th>10”</th>
<th>12”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max Flow Rate (Gallons/Minute)</td>
<td>723</td>
<td>1285</td>
<td>2891</td>
<td>5140</td>
<td>8031</td>
<td>11565</td>
</tr>
<tr>
<td>Cut-off (min) Flow Rate</td>
<td>3.62</td>
<td>6.43</td>
<td>14.46</td>
<td>25.70</td>
<td>40.15</td>
<td>57.82</td>
</tr>
<tr>
<td>Max Flow Rate (Liters/Second)</td>
<td>46</td>
<td>81</td>
<td>182</td>
<td>324</td>
<td>507</td>
<td>730</td>
</tr>
<tr>
<td>Cut-off (min) Flow Rate</td>
<td>0.23</td>
<td>0.41</td>
<td>0.91</td>
<td>1.62</td>
<td>2.54</td>
<td>3.65</td>
</tr>
<tr>
<td>Max Flow Velocity (Meters/Second)</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
</tbody>
</table>
Straight Pipe Recommendations (X = diameter)

**NOTE:** These configurations are to be used as general guidelines and do not cover every possible installation. A combination of two or more obstructions will require additional straight pipe. If there is any concern about the length of pipe required for a specific application, please contact your local dealer.
Full Pipe Recommendations

- **Recommended:** Keep pipe full at meter for accuracy
- **Not Ideal:** Allows air pockets to form at meter
- **Recommended:** Keeps pipe full at meter for accuracy
- **Not Ideal:** Post-valve cavitation can create air pocket
- **Recommended:** Allows air to bleed off
- **Not Ideal:** Air can be trapped
- **Recommended:** Improved accuracy results from unimpeded electrodes
- **Not Ideal:** Air bubbles and sediment on the electrodes can affect accuracy
Positioning the Meter

CAUTION: These flow sensors are not recommended where installation may expose the flow sensor to boiler pressure and temperature. Maximum recommended operating temperature is 130°F.

These meters can be installed horizontally, vertically (with upward flow), or in any radial position. Using a check valve on the upstream side of the meter, and/or an air vent (vacuum relief valve) in the same, unobstructed run of pipe as the meter, is required in any installation where the meter may be exposed to suction when the system is not in normal operation. Suction can cause damage to the liner. Liner damage caused by suction, without the use of a check valve and/or air vent, may void the warranty.

Straight Pipe Recommendations. The FMG470 requires straight pipe before and after the meter for best accuracy. However, the ability of electromagnetic meters to average the flow across the entire pipe allows for shorter straight pipe recommendations than most mechanical meters (see page 8).

Full Pipe Recommendations. To prevent false readings, this meter is designed to indicate ‘EMPTY PIPE’ if one or more electrodes is exposed. For highest accuracy, install the meter so that the pipe will be full when there is flow. If air bubbles may be present in the pipe or sludge accumulation is an issue, rotate the meter by one flange hole to position the control housing at a 45° angle (see diagrams on page 9).

Fittings. The FMG470 has ANSI 150 lb. drilled flanges and will mate with any other ANSI 150 lb. flanges. See table on page 11 for flange bolt tightening torque specifications.

Calibration. The FMG470 is factory-calibrated and will not require any form of field calibration.

Chemical Injection. When the FMG470 is used in a chemical injection application, the chemical injection point must be placed downstream of the magmeter OR far enough upstream for complete mixing to occur before the fluid reaches the meter. When unmixed chemical alternates with water passing through the meter, the rapid changes in conductivity may cause sudden spikes and drops in the meter’s reading, resulting in inaccurate measurement. The magmeter will re-stabilize, however, with a steady flow of fluid of uniform conductivity.

CAUTION: In chemical injection applications, install chemical injection point downstream of magmeter, or far enough upstream to allow complete mixing of fluids.

Installing Gaskets

1. Be sure all mating surfaces are smooth and free of debris.
2. Install provided gaskets, or equivalent, on each end of meter as shown in diagrams below. If using grounding rings, install one gasket on each side of the grounding ring.
3. Failure to install gaskets will void warranty.

CAUTION: In chemical injection applications, install chemical injection point downstream of magmeter, or far enough upstream to allow complete mixing of fluids.
Tightening Flange Bolts

NOTE: Mating pipe flanges must be ANSI 150# full face (FF) and/or raised face (RT).

1. Tighten flange bolts in an alternating pattern.
   - Tighten left flange bolt-1 to 20% recommended torque.
   - Tighten right flange bolt-1 to 20% of recommended torque.
   - Repeat steps a and b for each bolt in an alternating order, such as shown at right, tightening to 40%, then 60%, then 80%, and then 100%.

2. Test for leaks.

3. If needed, tighten further in 10% increments until leaking stops. **DO NOT over-tighten. Over-tightening can cause serious damage to the flow meter.**

4. Recheck after 24 hours, adjusting if needed.

---

Equalization and Grounding

**WARNING: ELECTRICAL SHOCK HAZARD**

When the FMG470 is installed in a plastic piping system, or when externally powered, the piping system must be grounded to meet national and local electrical safety codes. Failure to do so can result in electrocution.

**Metal Pipe Installations.** To equalize the electrical potential of the fluid, the FMG470 meter, and the surrounding pipe, secure the flange plates (factory-installed on the equalization wire) to both pipe flanges at one of the bolt holes, as shown below. Be sure the lock washer fits between the pipe flange and the flange plate. For the best electrical bonding, remove rust and paint to expose clean, bare metal where the equalization flange plate lock washer contacts the pipe flange. Connection must be inspected periodically for corrosion to maintain the necessary low resistance connection.

**Plastic Pipe and Electronically Noisy Installations.** When the FMG470 is installed in plastic pipe or in an electrically noisy system (near a VFD etc.), grounding rings are recommended. As shown in the diagram below, the equalization wires should be solidly connected to the grounding ring tabs instead of the flange bolts as in metal piping installations. Where lightning is a threat, or in severe electrical environments, an optional connection to a nearby equipment ground or ground rod may be advisable.

---

**SUGGESTED FLANGE BOLT TORQUE**

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>Santoprene Liner</th>
<th>ft-lb</th>
<th>Nm</th>
</tr>
</thead>
<tbody>
<tr>
<td>3”</td>
<td></td>
<td>25</td>
<td>34</td>
</tr>
<tr>
<td>4”</td>
<td></td>
<td>20</td>
<td>27</td>
</tr>
<tr>
<td>6”</td>
<td></td>
<td>42</td>
<td>57</td>
</tr>
<tr>
<td>8”</td>
<td></td>
<td>65</td>
<td>88</td>
</tr>
<tr>
<td>10”</td>
<td></td>
<td>73</td>
<td>99</td>
</tr>
<tr>
<td>12”</td>
<td></td>
<td>97</td>
<td>132</td>
</tr>
</tbody>
</table>

---

**Grounding Ring Part Numbers:**

<table>
<thead>
<tr>
<th>Size</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>3”</td>
<td>102157</td>
</tr>
<tr>
<td>4”</td>
<td>100876</td>
</tr>
<tr>
<td>6”</td>
<td>100877</td>
</tr>
<tr>
<td>8”</td>
<td>103288</td>
</tr>
<tr>
<td>10”</td>
<td>100879</td>
</tr>
</tbody>
</table>

---

**Suggested Tightening Sequence**

**Caution:** Improper tightening sequence can cause serious damage to the flow meter.

- Do not tighten one side at a time.
- Do not tighten each bolt completely at one time.
**FMG470 General Cable Information**

In the FMG470 meter, there are a maximum of two Power/Output cables that can be installed. These cables contain the wires for DC power and for any available options (4-20mA, and scaled pulse). (See Sample Cable Wiring Diagrams and Cable Wiring Table.) It is up to the user to decide how to best organize the wiring for the application.

The FMG470 is available in either Battery or external DC versions.

---

### Cable Gland Opening and Sealing

**WARNING:** Improper sealing of glands or cables (or direct connection with conduit to meter) will invalidate any warranty. If plugs or cable glands are removed, reinstall using Teflon pipe sealant, or tape, to ensure maximum moisture protection.

- **Remove plug & o-ring.** Insert cable gland/strain relief. Feed cable through cable gland.
- **Clamp cable with strain relief clips.** Attach drain wire lug to bracket post.
- **CRITICAL!** Torque cable gland sealing nut to 22 in-lbs.
Cable Installation (Wiring)

DC Version or Battery Only Version with external pulse output.

1. Unscrew the display lid and remove it.

2. Remove the 3 screws holding the display assembly and remove it from the meter exposing the internal connectors. Be sure **NOT** to undo any connections to the display assembly as you remove it.

3. The DC version comes with a 15 pin screw connector. Remove this from its bag. (On the battery version, there are two 2-pin connectors already installed.)

4. Remove the plug and o-ring from the cable port(s) where you want to insert the cable(s).

5. Install cable gland(s) using Teflon pipe sealant, or tape, and insert cable end(s).

6. Strip cable jacket and conductors and install the wires into the connectors in their respective locations for your options, Modbus®, pulse, HART, etc. (See Cable Wiring Table for details.)

7. If using the 15 pin screw connector, plug it into its socket. **Be sure all pins align properly and that the connector has not slipped to one side.**

8. Plug the battery cable into the circuit board, as shown:

9. Secure the cables inside the internal strain relief clip and tighten the cable gland sealing nut securely (torque nut to 22 in-lbs). A loose nut could cause moisture ingress and compromise the meter head’s IP68 rating, voiding the warranty.

10. Remount the display assembly, being careful to not pinch any wires, and install the display assembly screws.

11. Reinstall the display lid, being sure to avoid cross-threading the lid.
Wiring Diagrams

Unscrew the display lid and remove it. Remove the 3 screws holding the display assembly and remove it from the meter. Remove the 15 pin screw connector from its bag. Install the wires through the cable glands and into the 15 pin screw connector in their respective locations. Plug the 15 pin screw connector into its socket. 

\((C1 = \text{power/output cable}, C2 = \text{power/output cable 2})\)

Battery Power with Pulse (BXN)

DC Power with Pulse (D5N/D6N)

DC Power with Pulse and 4-20mA (D5I/D6I)
Wiring Diagrams (continued)

Unscrew the display lid and remove it. Remove the 3 screws holding the display assembly and remove it from the meter. Remove the 15 pin screw connector from its bag. Install the wires through the cable glands and into the 15 pin screw connector in their respective locations. Plug the 15 pin screw connector into its socket.  
(C1 = power/output cable, C2 = power/output cable 2)

**Two 2-pin Connectors for FMG470 Battery Version**

**15 Pin Connector for FMG470 DC Versions**

Note that when viewing the connectors from the front of the meter, the labels will be upside down, as shown here, with numbering going from left to right.

Plug the backup battery cable into the circuit board.

![Backup Battery Cable Connection]

**WARNING: BACKUP BATTERIES ARE NOT INTENDED AS A PRIMARY POWER SOURCE OF A MAINS (DC or AC) CONFIGURED METER.**

---

**Cable Wiring Table**

<table>
<thead>
<tr>
<th>PIN</th>
<th>15</th>
<th>14</th>
<th>13</th>
<th>12</th>
<th>11</th>
<th>10</th>
<th>9</th>
<th>8</th>
<th>7</th>
<th>6</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>O ID</td>
<td>PWR+</td>
<td>PWR-</td>
<td>ISO-</td>
<td>GND</td>
<td>DOUT 2-</td>
<td>DOUT 2+</td>
<td>DOUT 1-</td>
<td>DOUT 1+</td>
<td>B/RX</td>
<td>A/TX</td>
<td>RTS</td>
<td>VISO</td>
<td>4-20 -</td>
<td>4-20 +</td>
<td>PULSE</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SCLD+</td>
</tr>
<tr>
<td>BXX</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D1X/ D2X</td>
<td>RED</td>
<td>BLACK</td>
<td>C1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>C1</td>
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<td>C1</td>
</tr>
<tr>
<td>D1L/ D2L</td>
<td>RED</td>
<td>BLACK</td>
<td>C1</td>
<td></td>
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<td>C1</td>
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<td></td>
<td>C1</td>
</tr>
<tr>
<td>D1H/ D2H</td>
<td>RED</td>
<td>BLACK</td>
<td>C1</td>
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<td>C1</td>
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<tr>
<td>D1S/ D2S</td>
<td>RED</td>
<td>BLACK</td>
<td>C1</td>
<td></td>
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<td></td>
<td></td>
<td>C1</td>
</tr>
<tr>
<td>D1G/ D2G</td>
<td>RED</td>
<td>BLACK</td>
<td>C1</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>C1</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>C1</td>
</tr>
</tbody>
</table>

(C1 = power/output cable 1  C2 = power/output cable 2)

**Option IDs**

<table>
<thead>
<tr>
<th>O ID</th>
<th>POWER SOURCE / OUTPUT(S)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BXN</td>
<td>BATTERY POWER / PULSE SCALED</td>
</tr>
<tr>
<td>D5N/D6N</td>
<td>DC POWER / PULSE SCALED</td>
</tr>
<tr>
<td>D5I/D6I</td>
<td>DC POWER / PULSE SCALED AND 4-20mA</td>
</tr>
</tbody>
</table>
**Pulse Output Application - Sourcing Mode (Recommended for Rin < 30kΩ)**

[Diagram of Pulse Output Application - Sourcing Mode]

- Open Collector Transistor
- Pin x
- Pin y
- 47k Ω Pull-down Resistor
- Power Source
- Vs = 3-36Vdc
- i_out
- V_out
- R_in
- Current Sourcing Pulse Waveform

**Pulse Output Application - Sinking Mode (Recommended for Rin > 30kΩ)**

[Diagram of Pulse Output Application - Sinking Mode]

- Open Collector Transistor
- Pin x
- Pin y
- Pull-up Resistor
- Power Source
- Vs = 3-36Vdc
- i_out
- V_out
- R_in
- Current Sinking Pulse Waveform

**Analog (4-20mA Current Loop) Output Application**

[Diagram of Analog Output Application]

- Analog Output
- Pin x
- Pin y
- Power Source
- Vs = 6-36Vdc
- 4-20mA Current Output
- R_load
- i_loop

---

**Minimum resistor value is (100 x Vs) ohms. Higher resistances may be used depending on frequency and cable length. Longer cables and high frequencies require lower resistance.**

**Resistor R_load converts 4-20mA current to voltage for voltage input only devices.**
Cable Shield. In general, the cable shield and its bare drain wire should be left unconnected at the user equipment end of the cable to minimize “ground loop” problems.

Pulse Output Configuration. A pulse output is standard on all models. Since this is an isolated output, the external equipment must include a DC power source to regenerate the pulse from the open-collector output (transistor equivalent of a contact closure). A pull-up or pull-down resistor may be needed if not included in the user equipment as shown in the diagrams. Both the power source and resistor may be supplied internally in some types of control and monitoring devices. If not, as for most PLC discrete input modules, they must be added externally at the module input terminals. The pulse output rate in volume units/pulse can be set by the user via the SETP tab on the meter’s setup menus.

Because the pulse output of an FMG470 meter is set by the user, care must be taken to assure the output pulses do not exceed the maximum frequency of the meter while also ensuring a reasonable resolution.

K-factor: Remember that SETP is expressed in units totaled per output pulse (G/P if using gallons) while K-factors are expressed in pulses per gallon (P/G.) To determine K-factor from SETP, divide 1 by SETP (if SETP is expressed in gallons.) Conversely, 1 divided by the K-factor equals SETP

FMG470 meters that were initially configured as battery powered units have a maximum output frequency of 150 Hz. Those that were initially configured as powered units have a maximum output frequency of 200 Hz.

Because all pulse outputs (SETP) are configured in (rate) units totaled per pulse, all sizes of meters can be configured with the same SETP values

For example, if your rate is chosen as gallons per minute (GPM) the table below applies. If your rate is different, simply use your rate label in place of (GPM.) The numerical values will remain the same.

Pulse Units. The units of measure of SETP are independently selectable and are not tied to rate or total. Upon change of the SETP unit, the pulse output may take up to 10 seconds, or the duration of one pulse (whichever is longer) to take effect.

If Pulse Output is Inconsistent. The PDAMP filter may need to be increased.

Pulse Width Timing. The unit and value of SETP must be chosen to keep the duration between meter pulse outputs to less than 500 seconds.

Pulse Timing in Battery Powered Units. The output pulse width in battery powered units is short and varies with pulse frequency. (See table)

<table>
<thead>
<tr>
<th>SETP</th>
<th>Flow Rate at 1 Hz (GPM)</th>
<th>Flow Rate at 200 Hz (GPM) Powered Meters</th>
<th>Flow Rate at 150 Hz (GPM) Battery Powered Meters</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1</td>
<td>6</td>
<td>1200</td>
<td>900</td>
</tr>
<tr>
<td>0.2</td>
<td>12</td>
<td>2400</td>
<td>1800</td>
</tr>
<tr>
<td>0.3</td>
<td>18</td>
<td>3600</td>
<td>2700</td>
</tr>
<tr>
<td>0.4</td>
<td>24</td>
<td>4800</td>
<td>3600</td>
</tr>
<tr>
<td>0.5</td>
<td>30</td>
<td>6000</td>
<td>4500</td>
</tr>
<tr>
<td>0.6</td>
<td>36</td>
<td>7200</td>
<td>5400</td>
</tr>
<tr>
<td>0.7</td>
<td>42</td>
<td>8400</td>
<td>6300</td>
</tr>
<tr>
<td>0.8</td>
<td>48</td>
<td>9600</td>
<td>7200</td>
</tr>
<tr>
<td>0.9</td>
<td>54</td>
<td>10800</td>
<td>8100</td>
</tr>
<tr>
<td>1.0</td>
<td>60</td>
<td>12000</td>
<td>9000</td>
</tr>
</tbody>
</table>

Lower frequency output pulses (1 pulse for some particular number of gallons) can also be set.

Any output frequency can be determined by:
Rate (units/minute) ÷ SETP (units/pulse) = pulse/minute
Hz = pulse/minute ÷ 60 seconds / minutes

Output Pulse Width of Battery Powered Units

<table>
<thead>
<tr>
<th>Output Pulse Frequency</th>
<th>Output Pulse Width as a Percentage of the Pulse Period (Pulse period = 1000 milliseconds/frequency)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zero to 1 Hz</td>
<td>Multiply the pulse period by 0.01 = Output Pulse Width (ms)</td>
</tr>
<tr>
<td>1 to 20 Hz</td>
<td>Multiply the pulse period by 0.05 = Output Pulse Width (ms)</td>
</tr>
<tr>
<td>20 to 100 Hz</td>
<td>Multiply the pulse period by 0.1 = Output Pulse Width (ms)</td>
</tr>
<tr>
<td>100 to 150 Hz</td>
<td>Multiply the pulse period by 0.15 = Output Pulse Width (ms)</td>
</tr>
</tbody>
</table>

Example: If frequency = 20 Hz then the pulse period = 50 milliseconds and pulse width = (.05 x 50 milliseconds) = 2.5 ms

Analog Output (4-20mA) Configuration. (Not available on battery only units.) Since the meter’s analog output is isolated and passive, loop power must be supplied externally as shown previously. (In addition, an external resistor R_L will be needed to convert the loop current to voltage for voltage-only input devices.) The meter’s loop transmitter minimum voltage drop is 6Vdc (8Vdc with HART) which, with wiring resistance and loop power supply voltage, will determine the maximum resistance for R_L. The flow rates corresponding to 4 and 20mA can be set by the user via the SET 4 and SET20 tabs on the meter’s setup menus.
Changing Flow Meter Settings

Home Screen and General Navigation
The HOME Screen displays flow volume, direction of the flow total and flow RATE along with status conditions such as Empty Pipe. Two buttons below the LCD display are used to access menu screens for viewing and changing meter setup parameters.

These two buttons are light sensors which can detect when a finger is covering them and activate upon release. Only three button touch actions are needed to control navigation through the menus, settings changes and back to the home screen.

HORIZONTAL SCROLLING:
Tap right button to scroll horizontally through menu tabs or move horizontally within a tab dialog when applicable.

SELECT:
Tap left button to change a highlighted item within a tab dialog.

ENTER/EXIT:
Hold left button while tapping right button once to enter or exit a tab dialog or to navigate between the HOME and other menu screens.

Changing Total Direction/Resetting Batch Totalizers
On the Main screen, hold and tap 5 times to scroll through the total direction options. Release to select a total direction.

Once BATCH FORWARD or BATCH REVERSE is selected, tap four times to reset batch totalizer.

Entering Menu System
To enter the Menu System perform the hold and tap sequence. The Passcode entry screen will display. The default passcode is 000000. If a different passcode has previously been set, use the and to enter that passcode. In either case, hold and tap again to enter the menu system. (If you enter the wrong passcode, hold and tap again to return to the previous screen. See page 21 for information on how to change a passcode.)

Making Selections
Once in the Menu System, move from tab to tab by tapping the right button. (See the next page for details on the various available tabs.)

Select the parameter. In the screen for the highlighted tab you will see the current parameter value for that tab. Tapping the right button, move to the tab for the parameter you want to change.

In this example, the first line indicates that the current unit for the TOTAL is GALLONS. The next two lines tell you what to do next.

If you would like to change the TOTAL units, just perform the hold and tap sequence to bring up a screen to change the setting.

Select a new setting. Select the new setting by scrolling through a list of selections as in the screen illustration below by tapping the left button to find a different TOTAL unit.

Accept changes. To accept any changes you have made, perform the hold and tap sequence.

When finished making changes. When you are finished making changes, move to the EXIT tab using the right button.

To return to the HOME screen, perform the hold and tap sequence.
Standard Menu Options

Note: Available options will depend on specific meter configuration. Not all options are available on all meters. Options not ordered with your meter will not appear on the meter menu.

**T UNIT**
View or change TOTAL volume units

**R UNIT**
View or change flow RATE units

**SET P**
View or change pulse output scaling

**DAMP**
View or change # of samples for rolling average.*

---

**INFO**
Meter model number, serial number, and firmware version.

**COMM**
Modbus® baud rate and parity. *(Not available on battery only units.)*

**MBID**
Modbus® address *(Not available on battery only units.)*

**SAMP**
Sample rate *(Battery powered version only.)*

**HPOLL**
HART Address *(Not available on battery only units.)*

**EXIT**
Return to HOME SCREEN or enter SUBMENU

---

Special SUBMENU for Further Options

The EXIT tab in the MAIN MENU has a second function. If, instead of using the hold and tap sequence to return to the HOME screen, you tap five times, you will be redirected to a SUBMENU screen from which you can access several more options.

Navigation in this SUBMENU is the same as for the MAIN MENU. Whenever you wish, go to the EXIT tab in the SUBMENU and perform the hold and tap sequence to return to the MAIN MENU.

Sub-Menu

---

Sub-Menu - Battery Only Version
OPERATION

To Change a Passcode and Decimal Places

The FMG470 has a passcode system for restricting access to the menus. The FMG470 comes from the factory with the passcode set to 000000. When a user attempts to enter the menu system (see details on page 20), the passcode entry screen will be displayed.

The default passcode is 000000. If a different passcode has previously been set, then the user must enter that passcode at this time. After entering the passcode, or leaving it at 000000 if using the default passcode, the user does the tap and hold sequence to move into the menu system.

To change the passcode, you must use the THIRD MENU screen. Access the THIRD MENU screen as follows:

- Enter the main menu system, as described above.

- On the main menu, tab over to the EXIT tab and tap the up arrow five times. A SUBMENU screen will display.

- On the SUBMENU screen tab over to the EXIT tab and tap the up arrow five times. The THIRD MENU screen will display.

- To set the passcode, hold and tap on SETCD and then use the and to enter the new code.
- Hold and tap again to return to the THIRD MENU screen.
- Tab to EXIT, and then hold and tap to return to the SUBMENU.

To change the number of decimal places in the total

- To set the decimal point, hold and tap on SETD and then use the to move the decimal point.
- Hold and tap again to return to the THIRD MENU screen.
- Tab to EXIT, and then hold and tap to return to the SUBMENU.

PDAMP

PDAMP is used to view or change the number of samples for rolling average of pulse output.

TEST

TEST allows the user to initiate a fully functional, artificial flow rate for the purpose of testing other connected equipment. When TEST is applied, all features of the meter will function at the stated flow rate (in gallons per second).

For TEST to function, the meter must be filled (not EMPTY PIPE).

To enter a value into the TEST feature, navigate to the TEST tab and enter a flow rate value in the VAL screen (in gallons per second only,) then to the VAL box and to the ON screen. This will initiate the TEST feature. The next would bring you to the OFF screen, but you can ‘hold and tap’ the arrows to return you to the sub menu while the feature operates.

After use, the TEST feature must be turned OFF. If the TEST feature is not turned OFF, the stated static flow rate (in gallons per second) will be shown any time the meter is full or in a flowing condition. Flow values recorded by the meter while the TEST feature is operating are permanently recorded in the displayed TOTAL. It may be useful to note that these values are only written to permanent memory every 15 minutes and cycling all power within this 15 minute time frame will return the meter to its previous total.
OPERATION

Power Indicators

A power indicator is displayed in the lower left of the main display window.

Any meter powered from an external power source will display a power plug icon when running on external power. If the connection to external power is lost, the meter will switch to the backup battery and the power icon will switch to a battery symbol.

**OK** on the battery indicator means battery voltage is above 6.4 volts.

**LO** on the battery indicator means the battery is low and should be replaced soon.

Battery Powered Units

To ‘wake up’ a battery powered meter, you may need to hold the up arrow for 5 seconds and release. If the meter does not wake up on the first attempt, repeat the 5 second hold.

The FMG470 meter can come configured with two replaceable 3.6V lithium ‘D’ batteries. In this configuration, the only option/output is the scaled pulse output which comes standard. The scaled output for the battery powered option has a maximum pulse rate of 150 pulses/second. Be sure to set your P value such that the meter will function properly over the flow range in your application. The sample rate of the meter is user selectable through the SAMP tab in the meter’s sub-menu. Sample periods of 1/5, 1/3, 1, 3, 5, 15, 30, and 60 seconds can be selected. (A sample period of 5 seconds—5 year battery life—is the default.)

Larger sample periods will yield longer battery life but slower response time. Care must be taken to select a sample period that is suitable for your application. See the table below for the expected battery life as a function of sample period.

**DAMP Settings for Battery Units**

If SAMP (sample period) is set to less than one second, the DAMP value represents the number of seconds (plus one) used in the rolling average for the display. For example, if SAMP is set at three seconds and DAMP is set to four, then when the meter begins to show a flow rate, the rate displayed is the average of samples one through five (4 plus 1). Note that depending on the settings selected, it may take up to a minute for the displayed rate to take full advantage of the DAMP filter. When starting with an EMPTY PIPE it may take at least 30 seconds to register any flow.

**Battery Life/Sample Period**

<table>
<thead>
<tr>
<th>Sensor sample period(s) (Seconds)</th>
<th>Expected battery life*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/5 (0.2)</td>
<td>1 year</td>
</tr>
<tr>
<td>1/3 (0.33)</td>
<td>1.5 years</td>
</tr>
<tr>
<td>1</td>
<td>2.5 years</td>
</tr>
<tr>
<td>3</td>
<td>4 years</td>
</tr>
<tr>
<td>5</td>
<td>5 years</td>
</tr>
<tr>
<td>15</td>
<td>5.5 years</td>
</tr>
<tr>
<td>30</td>
<td>6 years</td>
</tr>
<tr>
<td>60</td>
<td>6.5 years</td>
</tr>
</tbody>
</table>

*Based on 75% battery capacity at room temperature with no option cards installed.

**NOTE:** If a large percentage of the meter’s life will be spent below 0.5 meters/second and above cutoff, battery life will be reduced.
## Troubleshooting & Error Messages

### Troubleshooting

<table>
<thead>
<tr>
<th>Problem</th>
<th>Probable Causes</th>
<th>Things to try…</th>
</tr>
</thead>
</table>
| Blank Display | Faulty wiring from power source to meter  
Battery has not been plugged in  
Dead battery | Check for incorrect wiring. Measure voltage with DMM where red and black wires connect to terminal block TB1 on back side of display. Verify correct polarity and confirm that voltage is steady and between 9Vdc and 32Vdc  
Plug in the battery  
Replace battery |
| Flow rate reading fluctuates excessively when flow is unchanging | Excessively turbulent or unsteady flow due to partially closed valves or other flow obstructions  
Pipe not full  
Pulsing flow due to combining multiple upstream flow sources  
Insufficient mixing of upstream chemicals  
Low fluid conductivity < 20 µS/cm  
Noisy electrical environment  
Defective or noisy AC switching power supply | Eliminate or minimize causes of flow disturbances or increase meter damping  
Provide back pressure or other means to ensure pipe is filled  
Move connection point further upstream  
Move chemical injection downstream from meter  
Replace with different type of meter  
Improve grounding at meter and nearby potentially noisy electrical equipment. Increase distance between meter and electrical noise sources.  
Replace power supply |
| Flow Rate appears correct but pulse/frequency output is low, erratic or absent | Wiring incorrect  
External device input impedance too low  
Cable too long | Compare wiring with appropriate wiring recommendations  
Use sourcing rather than sinking interface connection  
Reduce interface pull-up resistance |
| Flow Rate appears correct but pulse/frequency output is erratic and/or too high | Electrical noise sources interfering with pulse frequency signal  
Wrong type of cable  
Grounding problem | Isolate, remove or reduce noise sources. Move meter control cable away from noise sources. Increase pulse damp setting (PDAMP)  
Use only twisted pair cable and ensure both signal wires are on same twisted pair  
Improve or try different grounding method |

### Error Messages

Under certain conditions an error message may be displayed.

<table>
<thead>
<tr>
<th>Message</th>
<th>Description</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>INIT</td>
<td>Initialization is occurring during power up.</td>
<td></td>
</tr>
<tr>
<td>EMPTY PIPE</td>
<td>Fluid is not detected between the sensing electrodes.</td>
<td>Loop output = 22.8mA</td>
</tr>
<tr>
<td>LO in battery icon</td>
<td>Battery is getting low, replace soon. Meter still functions.</td>
<td>Above 6.4V, OK appears in icon</td>
</tr>
<tr>
<td>BATT END</td>
<td>Battery is very low (approx. 6.1V). Totalizer stops updating.</td>
<td>Loop output = 4mA</td>
</tr>
<tr>
<td>LOW VOLT</td>
<td>Incoming external power is very low and backup battery is dead or not connected.</td>
<td>Loop output = 4mA</td>
</tr>
<tr>
<td>COIL FAIL</td>
<td>Coil current too high or too low (short or open).</td>
<td>Loop output = 22.8mA</td>
</tr>
<tr>
<td>COMM FAIL</td>
<td>Communication between transmitter and sensor board fails.</td>
<td>Loop output = 22.8mA</td>
</tr>
<tr>
<td>OVER RANGE</td>
<td>Rate exceeds number of digits that can be displayed. Adjust units.</td>
<td>Loop output = 4mA</td>
</tr>
</tbody>
</table>
WARRANTY/DISCLAIMER

OMEGA ENGINEERING, INC. warrants this unit to be free of defects in materials and workmanship for a period of 13 months from date of purchase. OMEGA's WARRANTY adds an additional one (1) month grace period to the normal one (1) year product warranty to cover handling and shipping time. This ensures that OMEGA's customers receive maximum coverage on each product.

If the unit malfunctions, it must be returned to the factory for evaluation. OMEGA’s Customer Service Department will issue an Authorized Return (AR) number immediately upon phone or written request. Upon examination by OMEGA, if the unit is found to be defective, it will be repaired or replaced at no charge. OMEGA's WARRANTY does not apply to defects resulting from any action of the purchaser, including but not limited to mishandling, improper interfacing, operation outside of design limits, improper repair, or unauthorized modification. This WARRANTY is VOID if the unit shows evidence of having been tampered with or shows evidence of having been damaged as a result of excessive corrosion; or current, heat, moisture or vibration; improper specification; misapplication; misuse or other operating conditions outside of OMEGA’s control. Components in which wear is not warranted, include but are not limited to contact points, fuses, and triacs.

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RETURN REQUESTS/INQUIRIES

Direct all warranty and repair requests/inquiries to the OMEGA Customer Service Department. BEFORE RETURNING ANY PRODUCT(S) TO OMEGA, PURCHASER MUST OBTAIN AN AUTHORIZED RETURN (AR) NUMBER FROM OMEGA'S CUSTOMER SERVICE DEPARTMENT (IN ORDER TO AVOID PROCESSING DELAYS). The assigned AR number should then be marked on the outside of the return package and on any correspondence.

The purchaser is responsible for shipping charges, freight, insurance and proper packaging to prevent breakage in transit.

FOR WARRANTY RETURNS, please have the following information available BEFORE contacting OMEGA:
1. Purchase Order number under which the product was PURCHASED,
2. Model and serial number of the product under warranty, and
3. Repair instructions and/or specific problems relative to the product.

OMEGA’s policy is to make running changes, not model changes, whenever an improvement is possible. This affords our customers the latest in technology and engineering.

FOR NON-WARRANTY REPAIRS, consult OMEGA for current repair charges. Have the following information available BEFORE contacting OMEGA:
1. Purchase Order number to cover the COST of the repair,
2. Model and serial number of the product, and
3. Repair instructions and/or specific problems relative to the product.

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