DUPLEXER

INSTRUCTION MANUAL

MOTOR PROTECTION ELECTRONICS, INC.

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Operating Program Revision: 7

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DUPLEXER

APPLICATIONS

- Duplex Pumping Stations that Control Liquid Level
- Pump Down (Empty a Tank) or Pump Up (Fill a Tank)
- Where Connection to a SCADA System is Required

STANDARD FEATURES

- Float or Conductance Probe Level Inputs
- Duplex Alternation
- Level Input Indication
- Pump Call Indication
- High Alarm Indication with Latch Feature
- Power On Indication
- Level Simulation Push-Button
- HOA and Lead Select Switches
- Pump Call and High Level Alarm Relays
- Surge Protected Level Inputs
- 10 second Power Up Delay
- Adjustable Lag Pump Delay
- RS232 Serial Port with Modbus RTU Protocol
- Setup and Troubleshooting Features Available using a Separately Supplied Touch Screen Interface Device

SPECIFICATIONS

Input Power:	120 VAC ±10%, 10 VA max
Relay Outputs:	6 A Resistive @ 120 VAC 3.6 A Inductive @ 120 VAC
Agency Approval:	UL 508, CAN/CSA UL FILE #: E101681
Operating Temp:	-20 °C to +60 °C
Storage Temp:	-45 °C to +85 °C
Indicators:	LED
Sensor Output Voltage:	±12 V Square wave
Sensor Output Current:	±1.2 mA max (per sensor)
Color:	White with Blue Lettering
Enclosure Material:	Lexan

ORDERING INFORMATION

Part Number: **010 - 120 - 122 P**

TOUCH SCREEN INTERFACE DEVICE

The Touch Screen Interface Device (TSID) is a optional piece of equipment that is used to perform troubleshooting and customization of the DUPLEXER for specific applications. It provides full access to all the setup and diagnostic parameters. It also has a screen designed to demo the SCADA capabilities of the DUPLEXER.

TSID FUNCTIONS

- View Status of Float Switch / Level Probe Inputs
- View Level Input Out of Sequence Data
- Setup of the Following Parameters:
  - Alarm Reset Mode
  - Lag Pump Delay
  - Pump Up / Down Mode
  - Level Input Sensitivity
  - Remote Control Command Cancel Delay
  - Communication Setup for use in SCADA System
- View and Reset Fault Codes
- Demo SCADA features

TSID COMMUNICATION WITH DUPLEXER

The **Touch Screen Interface Device** communicates with the DUPLEXER through its RS232 serial port. The serial port setup of both devices must match the following:

Baud Rate = 9600 bps Parity Mode = 0 Stop Bits = 2 Slave Address = 1

To make the DUPLEXER's serial port settings match the TSID's serial port settings, hold down the push-button on the controller for 22 seconds. (This will also temporarily make the Register Access Mode = 1.)

When all the work using the TSID is done and the TSID is disconnected from the controller, you must wait 5 seconds before connecting the controller to a SCADA system. The 5 seconds of no communication is required to signal the controller that it is time to start using the serial port settings you programmed into it for the custom application.

The Touch Screen Interface Device (TSID) consists of a 6 inch Touch Screen panel made by Automation Direct, housed in a durable carrying case with a power cord and an interface cable for connection to the serial port. It is programmed as a Modbus Master that continually polls the DUPLEXER.

ORDERING INFORMATION

Part Number: **TSID**

H-O-A TOGGLE SWITCHES

The H-O-A (HAND-OFF-AUTO) toggle switches provide control over the pumps for maintenance or testing purposes. When a pump's H-O-A switch is placed in the "HAND" position the pump will be called to run. When placed in the "Auto" position the respective pump will be turned on and off as needed to maintain the wet well level, based on the level inputs. Placing a pump's H-O-A in the "Off" position disables the pump from operating.

PUMP ON INDICATORS

The Pump ON indicators are turned on when the respective pump call relay is energized, in either "HAND" or "AUTO" mode.

POWER INDICATOR

The controller monitors the internal power supply and turns on the "POWER" indicator whenever there is sufficient electrical power for the unit to function. When the "POWER" indicator is off, the power supply voltage is too low for the unit to function. The Duplexer requires at least 100 VAC, but it can ride through a brief brown out.

LEAD SELECT TOGGLE SWITCH

For normal automatic alternation of the pumps set the Lead Select toggle switch to the "AUTO" position. In cases where one of the two pumps is not available for service or has maintenance issues, the other pump may be selected as lead by setting the Lead Select toggle switch to either "1" or "2" .

HIGH LEVEL ALARM

High Alarm & Relay

The indicator labeled "HIGH ALARM" is turned on whenever the ALARM input is closed or covered. The ALARM relay contact will also be closed. As soon as the ALARM input is opened or uncovered the HIGH ALARM indicator will be turned off and the ALARM relay contact will open. This indicator and the ALARM relay does not latch on and is not effected by the alarm latch/reset feature discussed below.

Level Status - Alarm

The indicator under "LEVEL STATUS" labeled "ALARM" is turned on whenever the ALARM input is closed or covered. It is part of the row of indicators that provides level indication. The alarm indication will remain latched on to provide a record of the condition, provided the Alarm Reset Mode is set for manual reset.

Alarm Reset

To reset the latched "ALARM" indication, press the push-button on the front of the unit. To reset the alarm indication remotely through the SCADA system, momentarily set Coil 7 in Register 40001.

Alarm Reset Mode

The **Alarm Reset Mode** may be changed using the **Touch Screen Interface Device**.

	Setting
Manual Reset - Reset by pressing the push-button (Default Setting):	1
Auto Reset - Resets when the level drops below the alarm level:	2

PUMP DELAYS

Power Up Delay

Whenever electrical power is lost and then restored, immediate pump operation is prevented by a fixed ten second "Power Up Delay" which must first expire before a pump is called to run.

Lag Pump Delay

Any time one of the pumps is called to run, the Lag Pump Delay must first expire before the other pump may be called to run.

The **Lag Pump Delay** setting may be changed using the **Touch Screen Interface Device**.
The delay has a setting range of from 1 to 255 seconds. It has a default setting of 5 seconds.

LEVEL SIMULATION

Entering the Level Simulation Mode

To enter the Level Simulation mode press and hold the push-button, on the front of the unit, for three seconds or until one or more of the level indicators are turned on.

Increasing the Simulated Level

To increase the simulated level, hold the push-button until the desired level is indicated on the level status indicators. There is a three second delay between levels. With the H-O-A's in the "Auto" position, the pumps will be called to run as the level is increased to the Lead and Lag levels.

Decreasing the Simulated Level

To decrease the simulated level, release the push-button. The level will decrease by one level every three seconds.

Exiting the Level Simulation Mode

To exit the Level Simulation mode, release the push-button and wait until all the level indicators are turned off. Three seconds after the last level indicator is turned off, the unit exits the Level Simulation mode.

PUMP UP / DOWN MODE

The controller may be used in either a Pump Down (empty a tank) or Pump Up (fill a tank) level control application. The level inputs may be connected to either four float switches, four single point conductance probes, or selected points on a ten point conductance probe.

Where float switches are used, the float switch contacts must be the Normally Open type that close as the liquid level rises to cover or tilt the float switch.

Where a conductance probe is used, care must be taken to ensure that liquid is grounded and that the Level Input Sensitivity setting is correct for the liquid being controlled. See the section in this manual on the "Level Inputs".

Note: When operated in the Pump Up mode, the Off, Lead, and Lag level status indicators will turn on as the level drops below the respective level input points.

The **Pump Up / Down Mode** may be changed using the **Touch Screen Interface Device**.

	Setting
Down - Empty a tank (Default Setting):	1
Up - Fill a tank:	2

REMOTE PUMP CONTROL

Disable Pumps

The pumps may be disabled through the SCADA system by setting Coil 1 or 2 in Register 40001.
To return a pump to normal control clear Coil 1 or 2 in register 40001.

Force On Pumps

The pumps may be forced on through the SCADA system by setting Coil 3 or 4 in Register 40001.
To return a pump to normal control clear Coil 3 or 4 in Register 40001.

Remote Control Command Cancel Delay

If communication is lost while the pumps are being controlled remotely, the remote control commands will be automatically canceled upon the expiration of the Remote Control Command Cancel Delay. Momentarily turning off the electrical power to the controller will also cancel the remote control commands.

The **Remote Control Command Cancel Delay** may be changed using the **Touch Screen Interface Device**. The delay has a setting range of from 1 to 254 minutes. It has a default setting of 1 minute. The automatic cancel feature may also be disabled by setting it on 255.

LEVEL INPUTS

The Off, Lead, Lag, and Alarm level inputs allow the controller to determine the level of the liquid in the wet well. The inputs may be connected to either four float switches, four single point conductance probes, or four selected points on a ten point conductance probe.

The controller sends a ±12V square wave signal to each of the float switches or probe electrodes and monitors the signals. For applications that use float switches, the common side of all the float switches is connected to ground. In applications that use a conductance probe (Level Probe), the liquid must be grounded. When a float switch is closed or liquid covers one of the probe electrodes, the square wave signal is partially or fully diverted to ground, and the respective input's Level Input Status Value changes from a high number to a lower number. The Level Input Status Value associated with the input is then compared to the Level Input Sensitivity setting. When the input's Level Input Status Value is determined to be below the Level Input Sensitivity setting, the input is considered to be closed or covered.

Float Switch Applications

Where float switches are used, the float switch contacts must be the Normally Open type that close as the liquid level rises to cover or tilt the float switch. This type float switch is required for both the Pump Down (empty a tank) mode, and for the Pump Up (fill a tank) mode. When the controller is operated in the Pump Up mode, the state of the Off, Lead, and Lag inputs is inverted by the logic inside the controller, again allowing the use of the Normally Open type float switch.

Conductance Probe Applications

For applications that use a conductance probe, the liquid in the wet well must contain ions which allow the water to conduct electrical current. Sewage contains a lot of ions and is a very good conductor of electricity. However, clean water has a low number of ions, and can be difficult to detect. Using a conductance probe to detect storm water is not recommended. While storm water may start out with enough ions to detect, it usually become more difficult to detect the longer it rains, as the run off becomes cleaner.

Grounding The Liquid

When used with a conductance probe the liquid in the wet well must have an electrical connection to the control panel ground. Where a submersible pump is present, the grounded housing of the pump is sufficient. In the absence of any other path to ground, a single point probe, or the bottom electrode of a ten point probe, may be placed low in the wet well and connected to the control panel ground.

Level Input Sensitivity

The **Level Input Sensitivity** may be changed using the **Touch Screen Interface Device**.

	Recommended Setting
Float Switch (Default Setting)	100
Typical Sewage (Default Setting)	100
Light Sewage	150

To determine the best setting for your application perform the following procedure:

1. Ensure that the "Off" electrode is covered with liquid.
2. Use the **TSID** to read the Level Input Status Value for the "Off" level input.
3. Add about 40 to the Level Input Status Value of the covered input. (For example typical sewage will produce a value of around 60 or less. When you add 40 to that value, you have a recommended setting of 100, which is the default setting for typical sewage.)

ELAPSED TIME METERS

The Elapsed Time Meters may be read through the SCADA system at Registers 40006 and 40007. The values read from these Registers are intended for use in comparing the pump run time of one pump with the run time of the other pump, for the purpose of checking for uneven run times, not for pump warranty purposes. (Uneven run times is an indication of a maintenance problem with one of the pumps.) Periodically the comparison of run times should be made and the Registers should be reset to zero. The ETM data is stored in non-volatile memory registers at the end of each pump run cycle. The latest addition to the run time may be lost if a power outage occurs while a pump is called to run. To reset one of the ETMs to zero, momentarily set Coil 5 or 6 in Register 40001. The Elapsed Time Meter registers have a range of 0.0 - 6553.5 hours, where the decimal point must be inserted by the HMI.

OUT OF SEQUENCE - Pump Operation - Pump Down Mode

In the Pump Down Mode the out-of-sequence logic detects when an input fails to close in the correct order and provides the modified pump operation described below:

Out-Of-Sequence Condition	Pump Operation
OFF INPUT - Out-Of-Sequence **Lead** and **Lag** Inputs Close Before the **Off**.	Turns on 1st pump when the **Lead** and **Lag** inputs close. Turns on 2nd pump when **High** input closes.
LEAD INPUT - Out-Of-Sequence **Off** and **Lag** Inputs Close Before the **Lead**.	Turns on 1st pump when the **Off** and **Lag** inputs close. Turns on 2nd pump when **High** input closes.
LAG INPUT - Out-Of-Sequence **Off**, **Lead**, and **High** Inputs Close Before the **Lag**.	Turns on 1st pump when the **Off** and **Lead** inputs close. Turns on 2nd pump when **High** input closes.
OFF and LEAD INPUTS - Out-Of-Sequence **Lag** and **High** Inputs Close Before the **Off** and **Lead**.	Turns on both pumps when the **Lag** and the **High** inputs close.
OFF and LAG INPUTS - Out-Of-Sequence **Lead** and **High** Inputs Close Before the **Off** and **Lag**.	Turns on both pumps when the **Lead** and the **High** inputs close.
LEAD and LAG INPUTS - Out-Of-Sequence **Off** and **High** Inputs Close Before the **Lead** and **Lag**.	Turns on both pumps when the **Off** and the **High** inputs close.
HIGH INPUT - Out-Of-Sequence **High** Input fails to Open Before **Off, Lead** & **Lag** Inputs Open. (High Input Always Closed.)	Turns on both pumps when either the **Off**, **Lead** or **Lag** inputs close.

OUT OF SEQUENCE - Pump Operation - Pump Up Mode

In the Pump Up Mode the out-of-sequence logic detects when an input fails to Open in the correct order and provides the modified pump operation described below:

Out-Of-Sequence Condition	Pump Operation
HIGH INPUT - Out-Of-Sequence **High** Input fails to Open Before **Off, Lead** and **Lag** Inputs Open. (High Input Always Closed.)	The **High** level input operates as a redundant Off. If it fails to open as the level drops, it will prevent pump operation until the **Off, Lead** and **Lag** inputs all open, then both pumps will be turned on.
OFF INPUT - Out-Of-Sequence **Lead** Input Open Before the **Off**.	Turns on both pumps when the **Lead** and **Lag** inputs open.
LEAD INPUT - Out-Of-Sequence **Off** and **Lag** Inputs Open Before the **Lead**.	Turns on both pumps when the **Off** and **Lag** inputs open.

Note:
When both pumps are called to run the **Lag Pump Delay** is active to prevent both pumps from coming on at the same time.

OUT OF SEQUENCE - Trouble Shooting

By using the **Touch Screen Interface Device** an operator may view which input the controller determined was out-of-sequence. However, if the power had been cycled since the event, the data is lost.

Currently Out Of Sequence - When inputs are currently out of sequence, the "Currently Out-Of-Sequence" data may be viewed using the Touch Screen Interface Device from SCADA register 40005, Coils 65, 66, 67, and 68.

Latched Out Of Sequence - When an input is out of sequence the data is copied and latched so that later an operator may view which inputs were previously out-of-sequence. The data is labeled "Latched Out Of Sequence" and may be viewed using the Touch Screen Interface Device which reads the data from SCADA register 40005, Coils 69, 70, 71, and 72.

Whenever there is an input with a "Latched Out Of Sequence" condition a "Fault Code" of 21 will also be present in the "Fault Code" SCADA register 40004.

The "Latched Out Of Sequence" data may be erased by cycling the power or by pressing the "Fault Reset" button on the Touch Screen Interface Device, which toggles the "Fault Code - Reset" SCADA register 40001, Coil 8.

FAULT CODES

When the controller detects a fault condition, a Fault Code is generated and placed into Register 40004. The **Fault Code** may be viewed using the **Touch Screen Interface Device**. See the Fault Code Table below for a description of the condition.

Fault Code Table

Fault Code	Description of Condition
0	Normal
1	Communication Fault – Overrun Error reading incoming message.
2	Communication Fault – Time out error reading incoming message.
3	Communication Fault – Time out error responding to message.
4	Communication Fault – Incoming message failed Checksum Test.
5	Communication Fault – Invalid Modbus Function Code.
6	Communication Fault – Trying to preset more than 35 registers using Function Code No. 16.
7	Communication Fault – Trying to force to more than 100 Coils using Function Code No. 15.
8	Communication Fault – Write Attempt to Register Not Marked for "Write" using Function Code No. 05.
9	Communication Fault – Write Attempt to Register Not Marked for "Write" using Function Code No. 06.
10	Communication Fault – Write Attempt to Register Not Marked for "Write" using Function Code No. 15.
11	Communication Fault – Write Attempt to Register Not Marked for "Write" using Function Code No. 16.
12	Communication Fault – Write Attempt made with Register Access Mode Parameter set for Read Only.
13	Communication Fault – The UART detected a Framing Error reading the incoming message. It did not find Stop Bit where expected.
14	Communication Fault – Noise Detected on incoming message.
21	Level Input Out of Sequence.

SERIAL PORT

The RS232 serial port operates as a MODBUS slave and uses the MODBUS RTU protocol. The serial port may be used to communicate with the **Touch Screen Interface Device**, or it may be used to connect to a SCADA system.

Setup for Connection to a SCADA System

Each controller in the SCADA system must be assigned a unique Slave Address so that it can be polled by the SCADA system Master using that Slave Address. Also, the Baud Rate, Parity Mode and Stop Bits parameter values must be set to match that used by SCADA system.

Before connecting the controller to a SCADA system the following parameters must be setup using the **Touch Screen Interface Device**:

Parameter	Default Value	Setting Definitions
Slave Address	1	Range: 1- 247
Baud Rate	4	1 = 1200 bps 2 = 2400 bps 3 = 4800 bps 4 = 9600 bps
Parity Mode	0	0 = No Parity 1 = Odd Parity 2 = Even Parity
Stop Bits	2	1 = 1 Stop Bit 2 = 2 Stop Bits (The 2nd Stop Bit is available only when No Parity is selected)
Delay Before Response	3 ms	Range: 1 – 100 ms
Register Access Mode	1	1 = Read & Write 2 = Read Only

MODBUS Functions Supported

Function Code	Function Description	Notes
01	Read Coil Status	
02	Read Input Status	
03	Read Holding Registers	
04	Read Input Registers	
05	Force Single Coil	
06	Preset Single Register	
08	Diagnostics - Sub-function 00 (Return Query Data)	
15	Force Multiple Coils	Limited to 100 Coils
16	Preset Multiple Registers	Limited to 35 Registers

SCADA REGISTERS

<table>
<tr><th>Register Address</th><th>Read</th><th>Write</th><th>Description of SCADA Registers</th></tr>
<tr><td>40001</td><td>√</td><td>√</td><td>
<table>
<tr><td>16</td><td>15</td><td>14</td><td>13</td><td>12</td><td>11</td><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>Coil</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Fault Code - Reset</td><td>Level Status - Alarm Latched On - Reset</td><td>ETM 2 - Reset</td><td>ETM 1 - Reset</td><td>Pump 2 - Force On</td><td>Pump 1 - Force On</td><td>Pump 2 - Disable</td><td>Pump 1 - Disable</td><td></td></tr>
<tr><td>15</td><td>14</td><td>13</td><td>12</td><td>11</td><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td><td>Bit</td></tr>
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<tr><td>32</td><td>31</td><td>30</td><td>29</td><td>28</td><td>27</td><td>26</td><td>25</td><td>24</td><td>23</td><td>22</td><td>21</td><td>20</td><td>19</td><td>18</td><td>17</td><td>Coil</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Level Status - Alarm Latched On</td><td>Pump 2 - Called</td><td>Pump 1 - Called</td><td>Level Status - Alarm</td><td>Level Status - Lag</td><td>Level Status - Lead</td><td>Level Status - Off</td><td></td></tr>
<tr><td>15</td><td>14</td><td>13</td><td>12</td><td>11</td><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td><td>Bit</td></tr>
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<tr><td>40004</td><td>√</td><td></td><td>Fault Code</td></tr>
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<tr><td>80</td><td>79</td><td>78</td><td>77</td><td>76</td><td>75</td><td>74</td><td>73</td><td>72</td><td>71</td><td>70</td><td>69</td><td>68</td><td>67</td><td>66</td><td>65</td><td>Coil</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Level Input - Alarm Latched Out of Sequence</td><td>Level Input - Lag Latched Out of Sequence</td><td>Level Input - Lead Latched Out of Sequence</td><td>Level Input - Off Latched Out of Sequence</td><td>Level Input - Alarm Currently Out of Sequence</td><td>Level Input - Lag Currently Out of Sequence</td><td>Level Input - Lead Currently Out of Sequence</td><td>Level Input - Off Currently Out of Sequence</td><td></td></tr>
<tr><td>15</td><td>14</td><td>13</td><td>12</td><td>11</td><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td><td>Bit</td></tr>
</table>
</td></tr>
<tr><td>40006</td><td>√</td><td></td><td>Pump 1 Elapsed Time Meter (hours and 1/10 hours) 0.0 - 6553.5 hours</td></tr>
<tr><td>40007</td><td>√</td><td></td><td>Pump 2 Elapsed Time Meter (hours and 1/10 hours) 0.0 - 6553.5 hours</td></tr>
<tr><td>40042</td><td>√</td><td></td><td>Power Supply Voltage (Volts and 1/10 Volts) Normal Range: 14.4V - 20.4V</td></tr>
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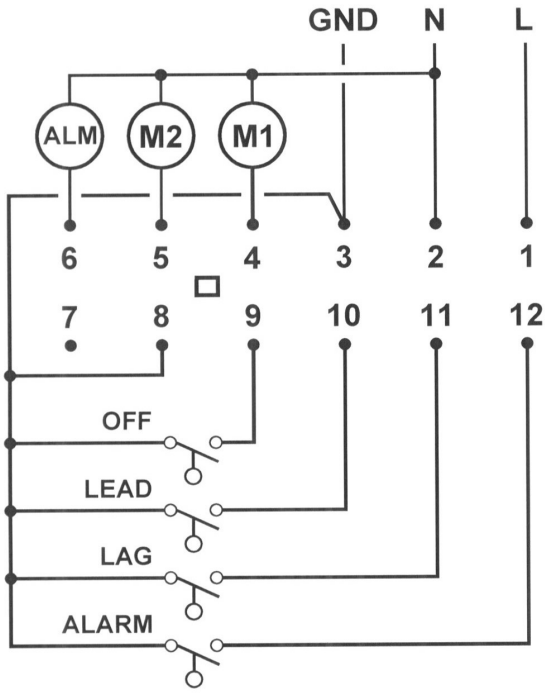
</table>

SETUP PARAMETER REGISTERS

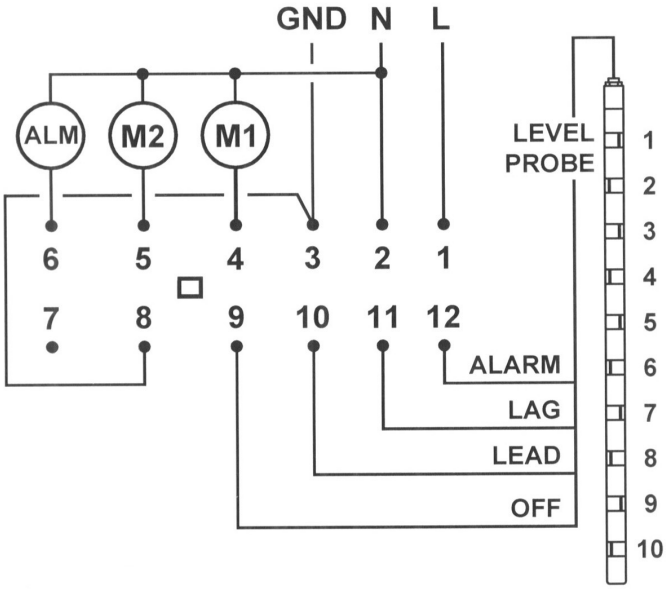
Register Address	Read	Write	Description of Setup Parameter Registers
40016	√	√	Pump Up / Down Mode
40017	√	√	Lag Pump Delay
40018	√	√	Level Input Sensitivity
40019	√	√	Alarm Reset Mode
40020	√	√	Serial Port Setup - Register Access Mode
40022	√	√	Serial Port Setup - Slave Address
40023	√	√	Serial Port Setup - Baud Rate
40024	√	√	Serial Port Setup - Parity Mode
40025	√	√	Serial Port Setup - Stop Bits
40026	√	√	Serial Port Setup - Delay Before Response
40027	√	√	Serial Port Setup - Remote Control Command Cancel Delay

CONNECTION DIAGRAMS

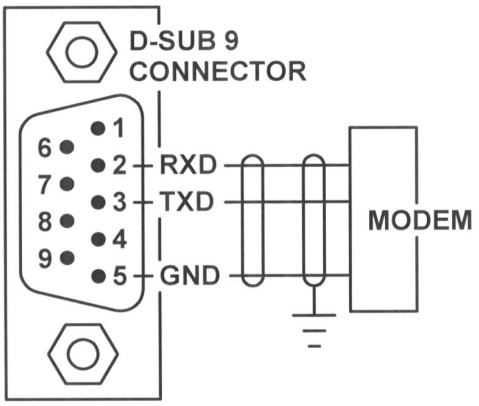
Float Switch Input



Level Probe Input

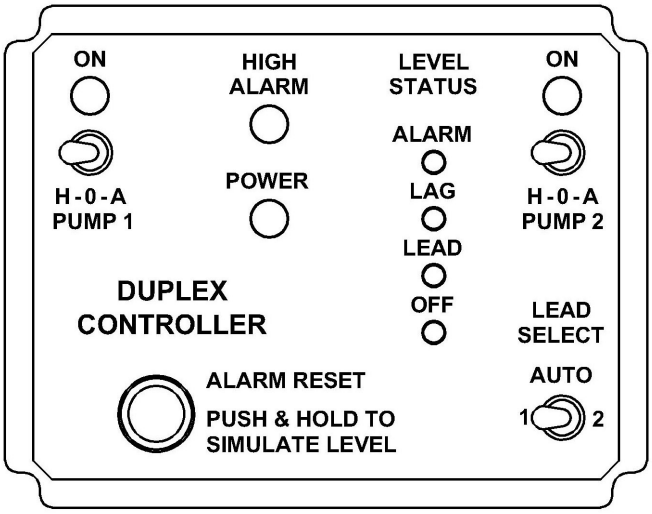


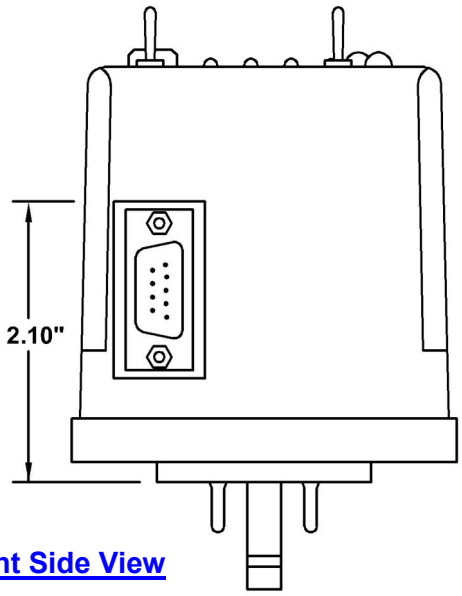
Serial Port



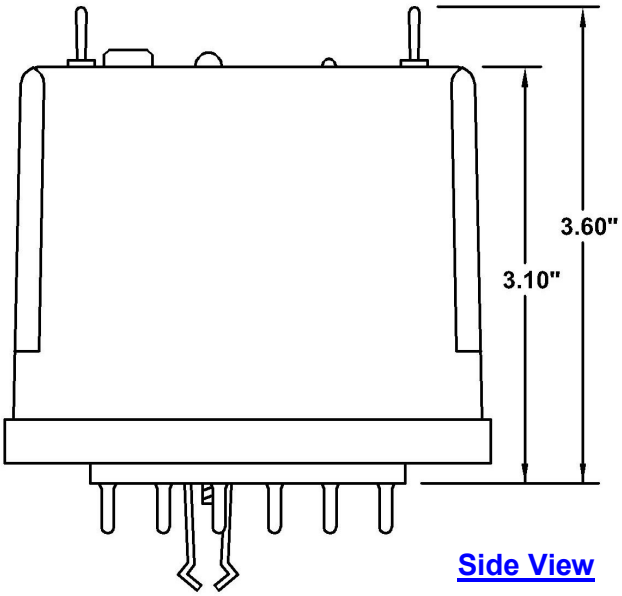
ENCLOSURE MECHANICAL LAYOUT

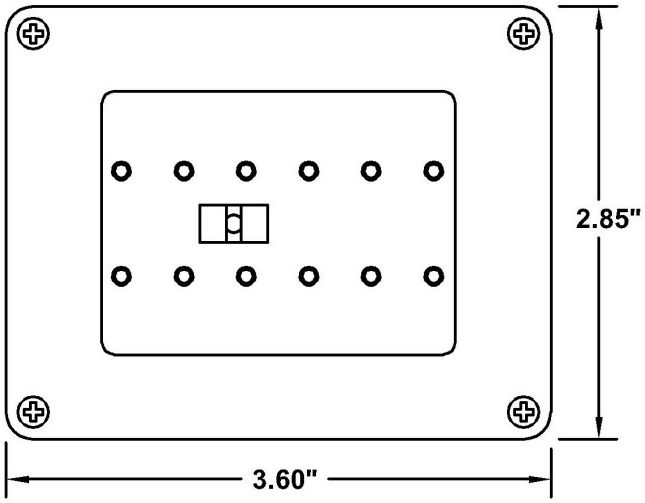
Front View





Right Side View



Side View

Bottom View