LV401, LV402, LV403, LV404

Non-Contact Ultrasonic Level/Distance Transmitters

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SECTION 1 INTRODUCTION

1.1 GENERAL DESCRIPTION

OMEGA's LV400 Series non-contact ultrasonic distance transmitter measures, displays and transmits the distance of objects located in front of the sensor in the range from 0.5 to 30 feet, with an accuracy of up to 1%. It is suitable for measuring liquid levels in tanks open to the air (0 internal PSIG), certain solid levels (consult Flow department for details), as well as other general distance measurements. All units feature a 4-digit LED display with 0.1 inch resolution. Versions are available with one or two alarm relays, analog 4-20 mA, 0-3, or 0-10 VDC outputs, RS-232 or RS-422 two-way computer communications, and a remote transducer with up to 40 feet of cable.

Setting the limits of the LV400 alarms and analog output can be performed manually by presenting targets at the desired setpoints, or by entering the exact distance value (in inches) by computer communication. Alarm setpoints equal the analog output span. Temperature compensation for variations in air temperature is done automatically by placing a reference target at an exact distance away from the sensor.

1.2 FEATURES

- Manual or Computer Programmable
- Relay Output, Analog Outputs
- Serial ASCII, 9600 Baud Communications
SECTION 2 INSTALLATION

2.1 UNPACKING

Remove the packing list and verify that all equipment has been received. If there are any questions about the shipment, please call OMEGA Customer Service Department at 1-800-622-2378 or (203) 359-1660.

1.3 AVAILABLE MODELS

- 4-Digit LED Display
- Optional Remote Sensor

LV401 Unit with high relay ONLY
LV402 Unit with high relay and 4-20 mA output
LV403 Unit with high relay and 0-3 VDC output
LV404 Unit with high relay and 0-10 VDC output

Add suffix “-RS232” or “-RS422” for communication option. Add suffix “-R” for additional low relay output. Add suffix “-RS” to reverse action of analog output (increasing output with decreasing distance from the sensor face). Add suffix “-RT(*)” for remote sensor, replacing asterisk with cable length in feet up to 40.

To display height, reverse the distance display with option “-ZO”. For extended range measurement, displays in feet (0.1) up to 60-ft., add suffix “-ER”.

LV401 Unit with high relay ONLY
LV402 Unit with high relay and 4-20 mA output
LV403 Unit with high relay and 0-3 VDC output
LV404 Unit with high relay and 0-10 VDC output

Add suffix “-RS232” or “-RS422” for communication option. Add suffix “-R” for additional low relay output. Add suffix “-RS” to reverse action of analog output (increasing output with decreasing distance from the sensor face). Add suffix “-RT(*)” for remote sensor, replacing asterisk with cable length in feet up to 40.

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SECTION 2 INSTALLATION

2.1 UNPACKING

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2.2 INSTALLATION AND WIRING

Mount the instrument as is appropriate for your application. Refer to Figure 2-1. The transmitter’s 12 degree beamwidth should be aimed as squarely as possible at the intended target. The transducer of the LV400 must NOT be mounted where it will be exposed to vapors which will attack the nylon, Kapton, or stainless steel construction of the transducer. Materials which attack the transducer include, but are not limited to, alkyd solvents (such as found in some printing inks) which attack Kapton and acids, such as HCL, which attack the stainless steel. In addition, the transducer must NOT be exposed to condensing vapors, such as those found above a tank of heated liquid (including water).

Connect the 12 VDC power source using the labeled leads: red (+) and black (-). Be sure the polarity is not reversed or damage to the instrument may result.
Figure 2-1. Mounting Dimensions
For relay, analog output. RS-232 and RS-422 interface connections using the standard 12-conductor cable, refer to Table 2-1.

For connections using a 15-conductor cable, refer to Table 2-2.

**TABLE2-1**
WIRING CONNECTIONS, 12-CONDUCTOR CABLE

<table>
<thead>
<tr>
<th>DC POWER IN</th>
<th>DC RETURN</th>
<th>N.O. RELAY</th>
<th>N.C. RELAY</th>
<th>COMMON RELAY</th>
<th>ANALOG OUT (mA/VDC)</th>
<th>ANALOG RETURN</th>
<th>RS232XMIT/RS422 RECV-</th>
<th>RS232 RECV/RS422 RECV+</th>
<th>RS422 COMMON</th>
<th>RS422 XMIT+</th>
<th>RS422 XMIT-</th>
</tr>
</thead>
<tbody>
<tr>
<td>+12VDC</td>
<td>Red</td>
<td>BLACK</td>
<td>BLACK</td>
<td>BLACK</td>
<td>BLACK</td>
<td>BLACK</td>
<td>BLACK</td>
<td>BLACK</td>
<td>BLACK</td>
<td>BLACK</td>
<td>BLACK</td>
</tr>
<tr>
<td>*DC GND</td>
<td>RLYNO</td>
<td>BROWN</td>
<td>N.O. RELAY</td>
<td>N.O. RELAY</td>
<td>N.O. RELAY</td>
<td>N.O. RELAY</td>
<td>N.O. RELAY</td>
<td>N.O. RELAY</td>
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<td>N.O. RELAY</td>
<td>N.O. RELAY</td>
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<tr>
<td>RLYCOM</td>
<td>AN+</td>
<td>WHITE</td>
<td>COMMON RELAY</td>
<td>COMMON RELAY</td>
<td>COMMON RELAY</td>
<td>COMMON RELAY</td>
<td>COMMON RELAY</td>
<td>COMMON RELAY</td>
<td>COMMON RELAY</td>
<td>COMMON RELAY</td>
<td>COMMON RELAY</td>
</tr>
<tr>
<td>AN+</td>
<td>AN-</td>
<td>ORANGE</td>
<td>ANALOG OUT (mA/VDC)</td>
<td>ANALOG OUT (mA/VDC)</td>
<td>ANALOG OUT (mA/VDC)</td>
<td>ANALOG OUT (mA/VDC)</td>
<td>ANALOG OUT (mA/VDC)</td>
<td>ANALOG OUT (mA/VDC)</td>
<td>ANALOG OUT (mA/VDC)</td>
<td>ANALOG OUT (mA/VDC)</td>
<td>ANALOG OUT (mA/VDC)</td>
</tr>
<tr>
<td>TX-</td>
<td>TX+</td>
<td>PURPLE</td>
<td>RS422 XMIT+</td>
<td>RS422 XMIT+</td>
<td>RS422 XMIT+</td>
<td>RS422 XMIT+</td>
<td>RS422 XMIT+</td>
<td>RS422 XMIT+</td>
<td>RS422 XMIT+</td>
<td>RS422 XMIT+</td>
<td>RS422 XMIT+</td>
</tr>
<tr>
<td>TX-</td>
<td>TX+</td>
<td>YELLOW</td>
<td>RS422 XMIT-</td>
<td>RS422 XMIT-</td>
<td>RS422 XMIT-</td>
<td>RS422 XMIT-</td>
<td>RS422 XMIT-</td>
<td>RS422 XMIT-</td>
<td>RS422 XMIT-</td>
<td>RS422 XMIT-</td>
<td>RS422 XMIT-</td>
</tr>
</tbody>
</table>
### TABLE 2-2
WIRING CONNECTIONS, 15-CONDUCTOR CABLE

| +12 VDC | RED | DC POWER IN |
| DC GND  | BLACK | DC RETURN |
| RLYNO #1| BROWN | N.O. RELAY #1 |
| RLYNC #1| GREEN | N.C. RELAY #1 |
| RLYCOM #1| WHITE | COMMON RELAY #1 |
| AN+     | ORANGE | ANALOG OUT (mA/VDC) |
| AN-     | BLUE | ANALOG RETURN |
| TX/RX-  | WHITE/BLACK | RS232 XMIT/RS422 RECV- |
| RX/RX+  | GRAY | RS232 RECV/RS422 RECV+ |
| COM     | WHITE/RED | RS232 COMMON |
| TX+     | PURPLE | RS422 XMIT+ |
| TX-     | YELLOW | RS422 XMIT- |
| RLYNO #2| WHITE/BROWN | N.O. RELAY #2 |
| RLYNC #2| WHITE/YELLOW | N.C. RELAY #2 |
| RLYCOM #2 | WHITE/ORANGE | COMMON RELAY #2 |

**DC GND** and **AN** are internally common; thus, 2 separate power supplies are recommended in order to power the unit and to power the analog.
SECTION 3 OPERATION

3.1 POWER ON

The LV400 Series begins operating and making measurements as soon as power is applied. This is indicated on the numeric display which reads in inches. Echo loss or measurements that are out of range (greater than 60 feet) are indicated by four dashes (----) in the display.

3.2 PROTOCOL COMMANDS

LV400 Series commands are ASCII characters:

"L" "L123.4" sets the LOW limit to 123.4 inches.
"R" "R234.5" sets the HIGH limit to 234.5 inches.
"E" Enables LV400 Series control of the relay.
"D" Disables LV400 Series control of the relay.
"O" Opens relay if control has been disabled.
"C" Closes relay if control has been disabled.
"S" LV400 transmits status.

(Example: Terminal sends "S", LV400 returns 123.4, 234.5, EN, CL: LOW limit set at 123.4", HIGH limit set at 234.5", relay control enabled, relay closed.)

"U" Command returns the raw count. It must be multiplied in the receiving computer by the scale factor .00732421875 to convert to inches.
3.3 SETTING LIMITS

Measurement limits which control the condition of the relay can be set both manually or by computer commands (for units with serial interface). If a target is found inside this range, the relay is actuated, otherwise the relay remains in its normal condition.

The limits can be displayed by momentarily depressing either the “HIGH” or “LOW” limit switches. The current measurement display will be suspended for a few seconds while the limit is displayed.

Manual limit setting is performed by placing a target at the desired setpoint and pressing and holding the limit switch (LOW or HIGH) until the display reads the desired setting. The limits can be changed as often as necessary but not greater than 10,000 times. Limit setting via the serial port is accomplished using the protocol commands.

Analog signals represent the measurements and are set to maximum at or above the “HIGH” limit. They are set to minimum at or below the “LOW” limit and are scaled as 256 steps within the HI/LO range.

The standard 4-20 mA current sink requires an external voltage.

3.4 TEMPERATURE COMPENSATION MODE

The LV400 Series incorporates a high accuracy self-calibration mode (“CAL” Mode) which can be evoked manually. This mode is selected by depressing both limit
switches at the same time. The display will indicate “CAL” and toggle between “ON” and “OFF” until the switches are released. The last condition displayed before the switches are released will be selected.

3.5 GAIN ADJUSTMENT

The LV400 has been factory-tuned for general purpose level applications, and for the cable length specified at the time of order for the remote transducer (-RT) option. The cable length of the remote transducer can be altered in the field with commercially available RG62 coax cable, but this will require gain adjustment as shown below. In addition, when measuring irregular shaped solids or where dust is present, gain adjustment may also be required.

1. Remove power from the instrument.
2. Remove the front cover of the LV400 by loosening the 4 captive screws.
3. If you have the remote transducer (-RT), connect the transducer & cable to the LV400. If you are performing this adjustment on a bench, set the transducer up so that it is firmly held and is aimed at a target nominally 20’ away. Neither the transducer nor the target should be free to move. Or you may perform this adjustment in the actual application.
4. Set up an oscilloscope such that it is triggered from pin 5 of the 40 controller chip.
5. Monitor pin 7 of the TL852 on the oscilloscope.
6. Apply power to the LV400 and adjust the scope unit the
target echo is displayed and prominent (adjust gain for
.5v p-p max. echo).

7. Locate the variable transformer TX1 found next to the
small white potentiometer in the lower left corner of the
rear PCB.

8. Adjust the transformer tuning slug by turning it
clockwise or counterclockwise until the echo amplitude
is at a maximum. Clockwise is increasing.

9. Replace the front cover and test.

10. Repeat if required.

THIS ADJUSTMENT SHOULD BE MADE BY QUALIFIED
PERSONNEL ONLY AS DAMAGE MAY OCCUR IF THE
INSTRUMENT IS HANDLED IMPROPERLY THEREBY
VOIDING THE WARRANTY.

When using the Temperature Compensation Mode, a wire
target of nominally 1/8 inch diameter must be located 6.22
inches from the face of the LV400 Series transducer.

At room temperature (68°F), prior to selecting the CAL Mode,
a measurement display of 6.4" can be used to indicate the
proper reference point. Once the reference target is in place,
the CAL Mode can be selected. Under these conditions,
measurement accuracies of better than ±1% can be obtained.
SECTION 4 SPECIFICATIONS

RESOLUTION: .007” for analog, RS-232 and RS-422 output, 0.1” display. The analog output is divided into 256 increments between the HI/LO limits. The best possible resolution of the analog output is .007”; the resolution could be much lower, depending upon the span of the HI/LO limits.

TEMPERATURE EFFECT: 1% shift in accuracy for every 18°F away from 68°F air temperature when not using the Auto Temp. Compensation

BEAMWIDTH: 12 degrees; target should occupy one square ft/10ft of distance for optimal performance. Consult Flow Dept. for collimator for small targets at large distance.

UPDATE RATE: 13 measurements per second

RANGE: .5 to 30 feet

WEIGHT: 11 oz.

DIMENSIONS: 1.77” x 3.50” x 4.70”

ELECTRONICS CABLE: 72” length, 12 conductor, stripped ends
| **ELECTRICAL:** | RS-422 or RS-232, 9600 baud, 8 bit data, no parity, 1 stop bit |
| **PROTOCOL:** | All communications are initiated by the host computer or terminal. Commands are sent to and interpreted by the LV400 Series and data is returned. |
| **RELAY:** | .25 amp @ 120 VAC resistive, SPDT |
| **ANALOG OUTPUT:** | 0-3 VDC, 0-10 VDC, or 4-20 mA. 256 steps within setpoints. 4-20 mA requires external 5-50 VDC power supply. Max. loop resistance = (supply voltage -5) x 53. 1000 ohms for 24 VDC supply. Standard output increases with increasing distance from sensor face. |
| **POWER:** | 7.5 to 12 VDC @ 500 mA (LV404 accepts 12 VDC only) |
| **OPERATING TEMPERATURE:** | -20°F to 160°F for sensor; 32°F to 158°F for electronics |
| **STORAGE TEMP.:** | -40°F to 250°F for sensor and electronics |
| **RELATIVE HUMIDITY:** | 5% to 95% for non-condensing |
| **SENSOR CONSTRUCTION:** | 24K gold on Kapton film diaphragm, nylon housing with stainless steel grille |
OMEGA warrants this unit to be free of defects in materials and workmanship and to give satisfactory service for a period of 13 months from date of purchase. OMEGA 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 should malfunction, 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. However, this WARRANTY is VOID if the unit shows evidence of having been tampered with or shows evidence of being 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 which wear or which are damaged by misuse are not warranted. These include contact points, fuses, and triacs.

OMEGA is glad to offer suggestions on the use of its various products. Nevertheless, OMEGA only warrants that the parts manufactured by it will be as specified and free of defects.

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