BANNER®
more sensors, more solutions

L-GAGE® LT7 Long-Range Time-of-Flight Laser Sensor

Self-contained retroreflective- and diffuse-mode laser distance sensors

CE

Features

- Extremely long range: diffuse model up to 10 m with white target, up to 7 m with gray target, up to 3 m with black target; up to 250 m for retroreflective models
- Visible pilot laser for easy alignment
- Multiple outputs in each model:
  - Discrete outputs can be used for precision background suppression
  - Alarm outputs together with display provide easy troubleshooting

  Diffuse models: Two discrete (PNP) plus 2 alarm outputs, and 4-20 mA analog

  Retroreflective models: Two discrete (PNP) plus 2 alarm outputs
- Fast, easy-to-use TEACH-mode programming via integrated push-buttons or serial interface (no potentiometer adjustments)
- Ongoing LCD display of sensing distance (selectable in hundredths of an inch or millimeters)
- RS422- or SSI-compatible serial connection options

Models

Models	Sensing Mode	Laser Class	Cable*	Sensing Range**	Supply Voltage	Discrete Outputs	Analog Output	Serial
LT7PIDQ	Diffuse	Class 2 Pilot Laser, Class 1 Sensing Laser	Integral 12-pin M16 QD connector	0.5 to 10 m (20" to 33')	18 to 30V dc	2 PNP plus 2 Alarm	4-20 mA	RS422 or SSI
LT7PLVQ	Retroreflective			0.5 to 250 m (20" to 820')			N/A	

* Requires a mating cable; see page 20.
** Diffuse-mode range specified using a 90% reflectance white card.
Retroreflective-mode range specified using the appropriate specified retro target; see page 22.

WARNING . . . Not To Be Used for Personnel Protection

Never use these products as sensing devices for personnel protection. Doing so could lead to serious injury or death.

These sensors do NOT include the self-checking redundant circuitry necessary to allow their use in personnel safety applications. A sensor failure or malfunction can cause either an energized or de-energized sensor output condition. Consult your current Banner Safety Products catalog for safety products which meet OSHA, ANSI and IEC standards for personnel protection.

L-GAGE® LT7 Long-Range Time-of-Flight Sensor

Overview

The sensor has an LCD display and 3 push buttons, which control all programming functions. Serial interface programming can also be accomplished, via SSI or RS422.

Four status indicator LEDs on the sensor front/top provide ongoing status of power and outputs.

Button	Functions
Enter	• **Run mode:** Switches from Run mode to Programming mode • **Programming mode:** Selects function and switches one menu level down • **Programming mode:** Records value and switches one menu level up • **Manual adjust:** Moves cursor one position to left or ends entry when cursor is at the far left.
Left Arrow	• **Run mode:** Press to light display • **Programming mode:** Scrolls to the next menu position to the left (Figure 7) • **Manual adjust:** Decreases current digit by 1 • **QuickSet menu:** Enables teach-in of Q1
Right Arrow	• **Run mode:** Press to light display • **Programming mode:** Scrolls to the next menu position to the right (Figure 7) • **Manual adjust:** Increases current digit by 1 • **QuickSet menu:** Enables teach-in of Q2
ESC Left and right arrow buttons	• **Escape:** Cancels active function and switches to one menu level above (Figure 7) without saving new values Important: Both arrows must be pressed *simultaneously*. Previous value is unchanged.

The sensor has a 2-line LCD display and 4 LED indicators for ongoing indication of sensing status: Power ON, Alarm, and Outputs 1 and 2.

In Run mode, the current measured value is displayed in the top line of the sensor's display, in millimeters or hundredths of an inch, as selected.

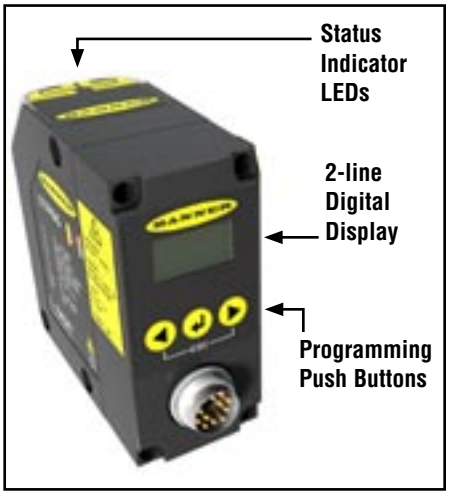


Figure 1. Sensor features

Sensing Options

Sensing Beam. The sensor uses an infrared Class 1 laser for sensing, and a visible red Class 2 laser (or Pilot laser) for alignment. Both lasers are aimed at the identical target spot. The laser beams are collimated to focus a compact spot, even at long sensing distances (see Figure 2).

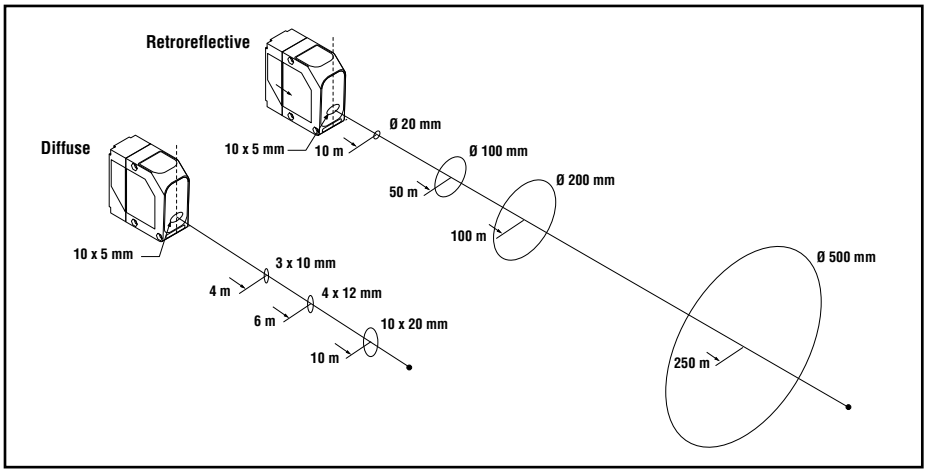


Figure 2. Light spot dimensions

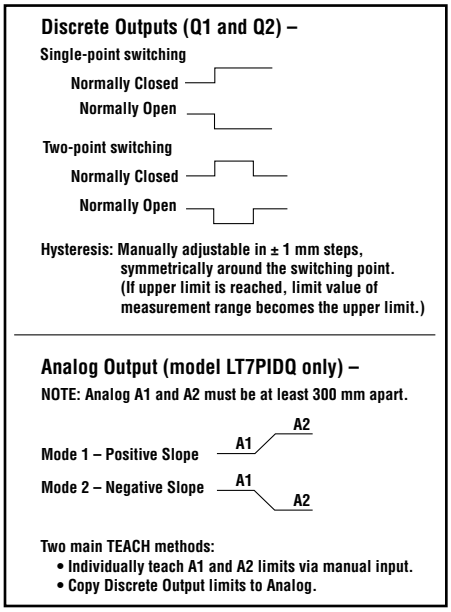


Figure 3. Teach-mode options for each output

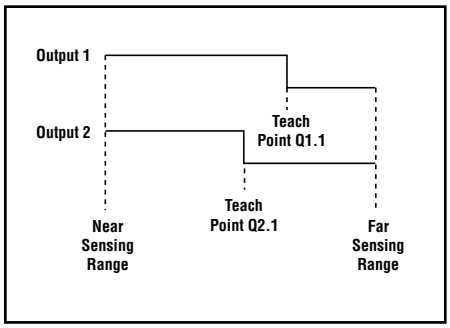


Figure 4. Each discrete output has its own limit for background suppression

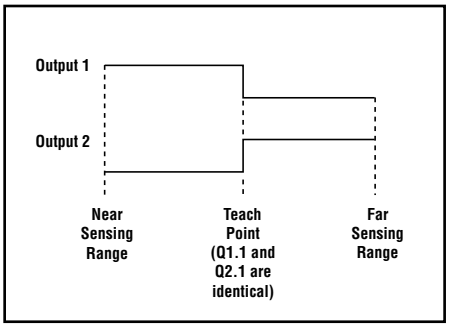


Figure 5. The two discrete outputs share identical limits for background suppression, but are complementary

Password. A Password function is included to provide a measure of security for the sensor settings. If Password is set to ON, the password must be entered before any programming can take place. The password is always "1234"; it cannot be changed. (The security results from the requirement to know the entry procedure and the timeout function. If the password is not entered within approximately 10 seconds, the sensor will return automatically to Run mode.) Measuring continues in the "background" while the password is entered).

Select measurement in millimeters or inches (actually, hundredths of an inch. To "see" whole inches on the display, imagine a decimal point on the display, two spaces in from the right; see Figure 8).

Offset. An offset value can be entered or taught, which increases or reduces the measured value, in order to compensate for a mounting position that does not correspond with the zero point of the device. (For example, 3000 actual distance minus 1200 mm offset value equals 1800 mm adjusted output value.) The offset value can be up to 100,000 mm (or corresponding inch value); the plus or minus is also selectable. The offset value reverts to 0 if the factory preset function is used. The offset value applies equally to all outputs.

Factory Preset. Sensor easily reverts to factory preset conditions:

Teach-In –

Q1 and Q2 (Discrete) – single switchpoint (full sensing range), ± 5mm hysteresis
QA (Analog) – Mode 1, rising (positive slope, full sensing range)
Offset – 0
Unit – mm
Serial – RS422
Password – OFF

Multiple Outputs. The sensing distance can be taught using QuickSet, Teach-In, or by manually entering the distance value(s). Either one or two sensing conditions may be taught for each output (see Figures 4 and 5).

Discrete outputs: The two outputs may be configured identically or they may have completely independent limits and configuration. One or two sensing conditions can be taught for each. If one condition is taught, the output sets a switching threshold, around which the selected hysteresis is applied. The two-point TEACH result differs, depending on whether QuickSet or TEACH-IN is used to set the limits. In QuickSet, the sensor averages the two taught values, then centers a 200 mm window around the averaged point (100 mm to each side). TEACH-IN window limits remain as taught; the window can be any size. The selected hysteresis is applied to each threshold and window near limit and far limit equally, no matter how they are taught.

Analog outputs: Analog limits 1 and 2 must be at least 300 mm apart. Individually teach 4 mA (A1) and 20 mA (A2) points or use the Copy function (selectable in the Analog Output Mode menu) to copy the discrete limits (only the first limits of discrete 1 and 2) to the analog output. (If copying Discrete limits to Analog, Discrete limits 1 and 2 must be at least 300 mm apart, or sensor will not copy those limits.) The order in which they are copied determines the analog output slope. For Mode 1 (positive slope) selected:

Q1, then Q2 – Limit Q1.1 becomes A1 (4 mA); Q2.1 becomes A2 (20 mA)

Q2, then Q1 – Limit Q1.1 becomes A2 (20 mA); Q2.1 becomes A1 (4 mA)

Manual Adjust: After Teach mode, Manual Adjust (or Edit) may be used to adjust the value set for any output. It also can be used instead of Teach mode, to input a precise limit value.

Theory of Operation

A short electrical pulse drives a semiconductor laser diode to emit a pulse of light. The emitted light is collimated through a lens, which produces a very narrow laser beam. The laser beam bounces off the target, scattering some of its light through the sensor's receiving lens to a photodiode, which creates an electrical pulse. The time interval between the two electrical pulses (transmitting and receiving the beam) is used to calculate the distance to the target, using the speed of light as a constant.

Multiple pulses are evaluated by the sensor's microprocessor, which calculates the appropriate position value. The outputs energize whenever the target is located between the user-programmed window limits or when the preset switching threshold is crossed. Outputs may be programmed for a variety of functions.

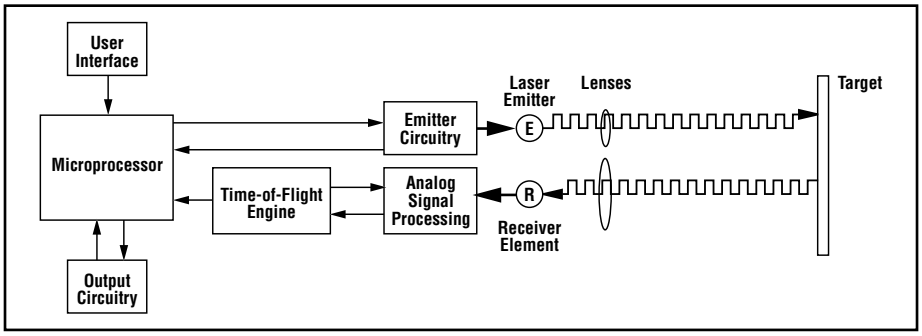


Figure 6. Theory of operation

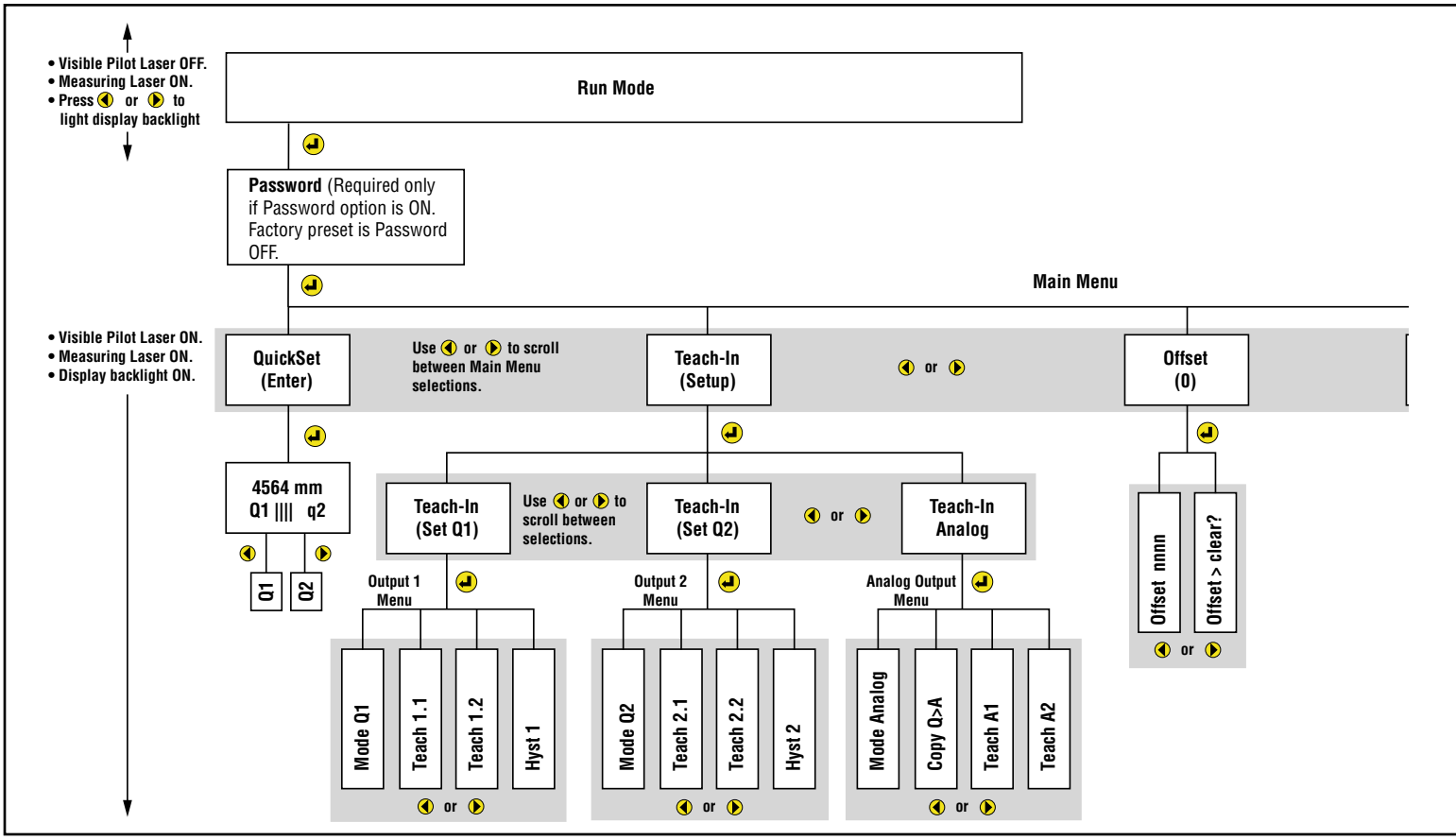


Figure 7. Programming menu tree

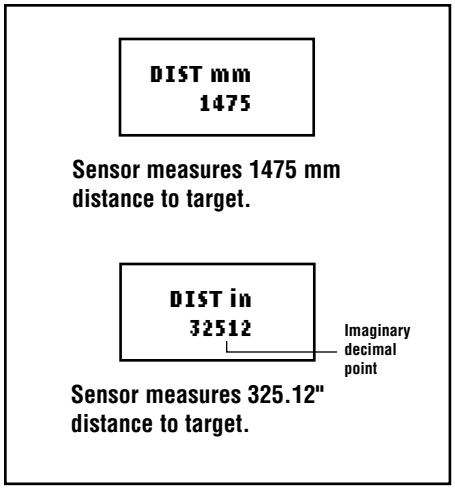


Figure 8. Run mode display

Sensor Programming

The sensor may be programmed using either the on-board push buttons along with the sensor's LCD display, or via a serial interface. For serial interface instructions, see page 14. Sensor TEACH-mode instructions follow.

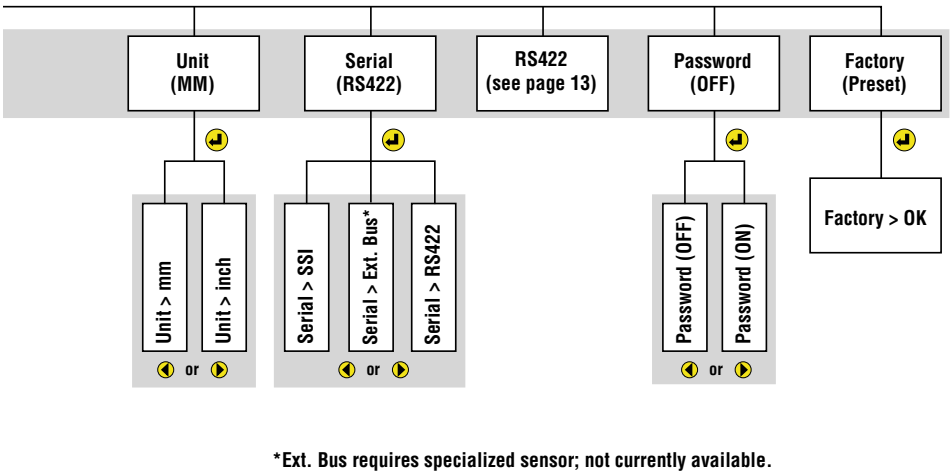
From Run mode, press Enter to access Programming mode. If Password is set to OFF (factory setting), the sensor will proceed to the Main menu (see Figure 7). When the sensor enters Programming mode, several things occur:

- Sensor display lights up.
- Visible red Pilot laser turns ON.
- Measurement laser remains ON, alternating with the Pilot laser.
- Sensor proceeds to QuickSet on the Main menu (see Figure 7).

QuickSet: The received energy value is displayed in the form of a bar graph (the more bars, the stronger the received signal). Outputs Q1 and Q2 are indicated as ON or OFF by the LED indicators on the front of the sensor, and whether the "Q" is capitalized on the display (Q1 = output 1 ON; q1 = output 1 OFF), press to teach the current condition to output Q1, and press to teach the current condition to Q2. (Other Teach properties are programmed in the Teach-In menu.) To quit the menu, use either the Enter button or the Escape function.

Manual Adjust: After Teach-In and pressing Enter to save, press or to activate Manual Adjust (or Edit) mode for any output. The cursor flashes below the right-hand digit of the display; press or to increase or decrease value by one unit. Press to save that digit and move cursor to the next position left, and so on, until the left-most digit is adjusted. Then press to adopt the manually adjusted value and switch one menu level up.

Escape function: Press buttons and simultaneously to escape; sensor will go up one menu level each time, and may not retain new settings, depending on the programming procedure.



*Ext. Bus requires specialized sensor; not currently available.

		Procedure	Example Displays	Result
Programming Mode	No Password	• From Run mode, press ↵	QuickSet <ENTER>	• If password is not required (factory preset condition), sensor proceeds to QuickSet on the Main menu (Figure 7).
	Password Required	• From Run mode, press ↵	PASSWORD _ _ _ _ Blinking Cursor	• Sensor waits for valid password (1234); cursor blinks on right-hand digit. • If no password is begun within 10 seconds, sensor returns automatically to Run mode.
		• Press ▶ button 4 times,* then press ↵	PASSWORD _ _ _ 4	• Sensor inserts a 4 in the right-hand digit, then moves blinking cursor to third position.
		• Press ▶ button 3 times, then press ↵	PASSWORD _ _ 3 4	• Sensor inserts a 3 in the third digit, then moves blinking cursor to second position.
		• Press ▶ button twice, then press ↵	PASSWORD _ 2 3 4	• Sensor inserts a 2 in the second digit, then moves blinking cursor to first position.
		• Press ▶ button once, then press ↵	PASSWORD 1 2 3 4 PASSWORD OK! QuickSet ENTER	• Sensor displays completed password and OK message, then proceeds to QuickSet on the Main menu.

* Either arrow button may be pressed; ▶ button will decrease number by one each time.

Main Menu	Procedure	Example Displays	Result
QuickSet <ENTER>	• Press ◀ or ▶ to scroll through Main menu options	QuickSet TEACH IN OFFSET UNIT SERIAL RS422 PASSWORD FACTORY <PRESET>	• Sensor scrolls through Main menu options. • See following steps for procedures if other than QuickSet is selected.
	• With QuickSet visible on the display, press ↵	QuickSet <ENTER>	• Sensor enters QuickSet program.
	• Press ◀ to teach current condition to Output 1. • Press ▶ to teach current condition Output 2.	196 q1 Q2 • 196 mm to target • Output 1 OFF • Output 2 ON • Bars indicate a strong signal	• Current measured value is displayed on top line; received energy value is indicated by bar graph (the more bars, the stronger the received signal). Outputs Q1 and Q2 are indicated as ON or OFF by the LED status indicators and by whether the "Q" is capitalized on the display (Q1 = Output 1 ON; q1 = Output 1 OFF).
	• Press ↵ – or – • Use **Escape** function*		• Sensor saves settings and returns to Main menu.

* Escape function available throughout Programming mode; returns sensor one step higher in menu.

Main Menu	Procedure	Example Displays	Result
TEACH-IN (Setup) – Discrete	• Press ↵ to enter TEACH-IN menu.	TEACH-IN 〈SETQ1〉	• Sensor displays current output selected.
	• Press ◀ or ▶ to scroll through output options.	〈SETQ1〉 〈SETQ2〉 〈ANALOG〉 (diffuse model only)	• Sensor displays output options.
	• Press ↵ to select displayed output.	MODE Q1 <_ ¯¯ _>	• Sensor displays current output and mode selections.
	• Press ◀ or ▶ to scroll through options for Output 1.	MODE Q1 TEACH1.1 TEACH1.2 HYST 1	• Sensor displays TEACH options for selected output. • See following steps for procedures if other than mode Q1.
	• Press ↵ to view output mode options.	MODE Q1 → ¯¯ _	• Sensor displays arrow to denote options can be viewed.
	• Press ◀ or ▶ to scroll through options.	→ ¯¯ _ → ¯¯ ¯¯ → _ ¯¯ → ¯¯ _	• Sensor displays output mode options.
	• Press ↵ to select displayed output mode.	MODE Q1 <_ ¯¯ _>	• Sensor saves selected option.
	• Press ◀ or ▶ to scroll through options for Output 1.	TEACH 1.1 〈 203〉	• Sensor again displays TEACH options for selected output.
	• Press ↵ to select displayed option.	TEACH 1.1 203	• Sensor is ready to learn limit 1. • Proceed by teaching limit 1.1 target condition or via Manual Adjust
	TEACH1.1 • Press ↵ to teach target condition.	TEACH1.1 〈241〉 ┐ Limit 1 value	• Sensor saves limit 1 setting and returns to Output 1 menu level.
	Manual Adjust • Press ↵ to access Manual Adjust. • Press ◀ or ▶ to decrease or increase value of each digit. • Press ↵ to select and move one digit left. • When cursor is at left-hand digit and value is correct, press ↵	TEACH1.1 241	• Blinking cursor indicates active digit (beginning with right-hand digit). • Sensor saves setting and returns to Output 1 menu level.

Main Menu	Procedure	Example Displays	Result
TEACH-IN (Setup) – Discrete	**TEACH 1.2** • From Output 1 menu, press ↵ to teach 1.2 limit. • Repeat process on previous page for limit 1.2.	TEACH1.2 〈12000〉	• Sensor again displays TEACH options for selected output.
	Hysteresis • Press ↵ to select hysteresis function.	HYST 1 〈 ±005〉	• Blinking cursor indicates active digit (beginning with right-hand digit). • Factory default setting is ± 005 (the minimum setting). • Maximum hysteresis setting is ± 254 mm or ± 9.99".
	• Press ◄ or ► to decrease or increase value of each digit. • Press ↵ to select and move one digit left.	HYST 1 ±254	
	• When cursor is at left-hand digit and value is correct, press ↵	HYST 1 〈±254〉 If value is valid – or – HYST 1 LIMITED! If value is outside accepted limits	• Sensor saves setting and returns to Hyst 1 menu level.
	• Use Escape function to go up one menu level, or use ◄ or ► to return to other Output 1 functions.		• Repeat as desired for Output 2. • Teach processes for Outputs 1 and 2 are identical. • If value is outside accepted limits, sensor does not save new setting.
TEACH-IN (Setup) – Analog; Copy Discrete Limits	**TEACH Analog output individual limits using the same procedures as described above (except that the Analog output has no hysteresis option). The Analog output has one unique function – copying the Discrete output limits (Q1.1 and Q2.1); for this procedure, see steps below.**		
	• From TEACH-IN menu, press ↵ and ◄ or ► to scroll to Analog Teach.	TEACH-IN 〈ANALOG〉	• Sensor is ready to learn analog limits. • Procedure is identical to teaching discrete limits, except for copy/paste function.
	• Select Analog mode, as for discrete limits. ◄ or ► to copy Q to A	COPY Q->A 〈ENTER〉	• Sensor is ready to copy discrete limits to Analog output.
	• Press ↵ • Press ◄ and ► to scroll between options. • Press ↵ to select displayed option.	COPY Q->A ->Q1 & Q2 – or – COPY Q->A ->Q2 & Q1 – or – 〈300 mm If discrete limits are less than 300 mm apart	• The option selected, in combination with the selected mode, determines the analog output slope. For Mode 1 (positive slope): Q1 & Q2 – Limit Q1.1 becomes A1 (4 mA); Q2.1 becomes A2 (20 mA) Q2 & Q1 – Limit Q1.1 becomes A2 (20 mA); Q2.1 becomes A1 (4 mA) For Mode 2 (negative slope), the above is reversed. If discrete limits are not at least 300 mm apart, display will show < 300 mm and sensor will not perform the copy function.

Main Menu	Procedure	Example Displays	Results
OFFSET 0 > <	**NOTE: Selected Offset value applies to all outputs equally.**		
	• Press ↵ to enter Offset menu.	OFFSET 0 -then- OFFSET 426 -or- OFFSET ->CLEAR?	• Used to zero sensor to predetermined setting. • Expressed in either mm or hundredths of an inch, depending on Unit selected (see below). • Displayed Offset value is equal to the previously programmed setting, followed by the current sensing distance. • See following steps for procedure if other than Offset Value is selected. • If no value was previously entered, current sensing distance will be displayed; see steps below. • If a value is currently entered, the first option will be Offset Clear?
	• **To Clear Offset**, press ↵	OFFSET CLEARED!	• Sensor clears Offset Value setting and returns to Main menu.
	To Adjust Offset: • If no value was previously entered, current sensing distance will be displayed. • Press ↵ to save current sensing distance. -or- • Use ◄ and ► to activate Offset Value adjustment.	OFFSET 0 -then- OFFSET 426	• Cursor blinks on right-hand digit.
	• Press ◄ or ► to decrease or increase value of each digit; ◄ or ► also toggles left-hand digit between + and -. • Press ↵ to save digit and move blinking cursor one position to left.	OFFSET - 428	• Sensor saves each digit sequentially (including + or - sign).
	• When cursor is at left-hand digit and value is correct, press ↵	OFFSET < -428>	• Sensor saves setting and returns to Main menu.
UNIT < MM >	• Press ↵ • Press ◄ or ► to toggle between mm and inch options.	UNIT ->MM – or – UNIT ->INCH	• Sensor is ready to accept new unit setting. • Select measurement in millimeters or inches (actually, hundredths of an inch. To "see" whole inches on the display, imagine a decimal point, two spaces in from the right.)
	• When correct option is displayed, press ↵	DIST mm <5392>	• Sensor saves setting and returns to Main menu.

Main Menu	Procedure	Example Displays	Results
SERIAL <RS422>	See page 13.		
RS422 <ENTER>	Dependent on serial connection selection; see page 13.		
PASSWORD < OFF >	• Press ↵	PASSWORD ->OFF	• Sensor is ready to accept new password setting. • If Password is set to ON, password must be entered each time Programming mode is entered.
	• Press ◄ or ► to toggle between ON and OFF settings. • Press ↵ to save setting.	PASSWORD < OFF >	• Sensor saves setting and returns to Main menu.
FACTORY <PRESET>	• Press ↵ to enter Factory Preset menu.	F-PRESET ->OK	Returns sensor to factory preset conditions. • **If activated, all previous settings are lost.** • Use Escape function to exit without changing settings. • Factory settings are: **Teach-In** – Limit value of measurement range; Q1 and Q2 single switching, normally open, analog mode 1, rising slope **Offset** – 0 **Unit** – mm **Serial** – RS422 **Password** – OFF
	• Use Escape function to leave settings as they are.	FACTORY <PRESET>	• Sensor returns to Main menu without changing settings.
	• Press ↵ to revert to Factory Preset settings.	F-PRESET OK! FACTORY <PRESET>	• Sensor returns to Main menu with factory preset condtions.
Run Mode	• Use Escape function to return to Run mode.	DIST in 4839	• Sensor returns to Main menu with all saved settings.

Alignment

Wherever the visible pilot laser spot is located, the sensing/measuring laser will be located in the same position. For fine adjustment, use bracket model **SMBLT7** with the fine-adjust accessory kit **SMBLT7F** (see page 22) to provide up to ±3° angle in both X and Y axes.

Aligning the sensor manually (without the alignment aid accessory) – either model:

- Mount the sensor.
- Activate any Programming menu item (see Figure 7), so that the pilot laser is ON.
- Hold the retroreflector or target object at a short distance, for example less than 1 m (3'), and verify that the laser light spot is centered on it.
- Move the reflector or target to its final position; verify that the laser spot is still centered on it. Adjust as necessary.
- Tighten the sensor mountings.

Using the alignment aid. For precise alignment of retroreflective models at long distances, the alignment aid accessory (see Figure 9) is useful. It makes the visible pilot laser spot easier to adjust, even when it is positioned off of the retroreflective target and at a long distance – farther than 50 m (160').

- Mount the sensor.
- Mount the alignment aid on the front of the sensor, over the laser emitters as shown in Figure 9.
- Activate any menu item (see Figure 7), so that the pilot laser is ON.
- Aim the sensor at the reflector.
- Rotating the barrel as needed (depending on sensor mounting location), look into the sight hole from about 2" (50 mm) away.
- Turn the focus screw (opposite the sight hole) to focus the spot as sharply as possible.
- Adjust the sensor or target position until the laser spot is centered on the target.
- Tighten the sensor mountings, recheck alignment; if ok, remove alignment aid.

NOTE: While alignment aid scope is in place, any measurements shown on the display will be inaccurate. Also, the Pilot LED will be visible only through the alignment aid sight hole (red laser light will not be visible to the naked eye on the target or another surface).

Figure 9. Alignment aid, mounted on sensor

Installation Notes

Some targets (those with a stepped plane facing the sensor, a boundary line, or rounded targets) pose specific problems for sensing distances. For such applications, see Figure 10 for suggested mounting orientations.

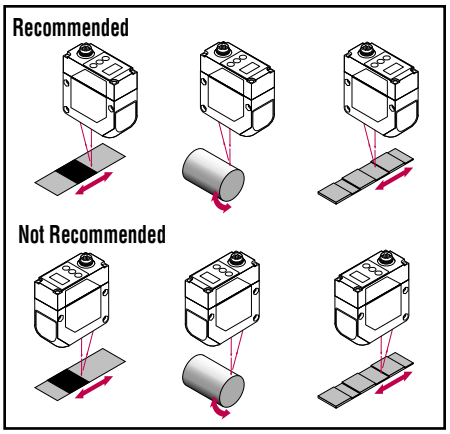


Figure 10. Sensor orientation for typical targets

Serial Communications

Factory delivery status settings are underlined below.

Serial Select (RS422/SSI)
With Serial Select it is possible to select the interface from RS422-compatible, SSI1/10-compatible, or SSI1/8-compatible connections.

RS422-/ or SSI-Compatible
Depending on the setting made in Serial Select, the appropriate interface parameters are displayed or altered. The following settings are possible:

- **RS422**

  Baud rate: 4.8 or 9.6 or 19.2 or 38.4 or 57.6 kBaud

  Data bit: 8 or 7

  Stop bit: 1 or 2

  REPEAT or SINGLE: REPEAT: the sensor continuously sends measured data via the serial interface without waiting for a request.

  SINGLE mode: a string of measured data is supplied only on request.

  Parity: even (but not shown on LCD menu)

- **SSI:** **1/10** = LSB = 0.1 mm (10MIL) or **1/8** = LSB = 0.125 mm (8MIL)

  6 possible codes:

  BINARY24
  BINARY24E
  BINARY25
  GRAY24
  GRAY24E
  GRAY25

Serial Response Speed
The distance measurement inside the sensor is recalculated every 12 ms. It is not a moving average, but rather a new average is calculated for the previous 12 ms of data. With the SSI output, the data can be read every 1.4 ms (likely the “same” reading for 8 or 9 readings, then a change). For most accurate target location prediction, sample at the 1.4 ms read rate of the SSI and see “when” the change happens. Worst case, that data will be for the average target location over the previous 12 ms, plus 1.4 ms delay (i.e., the 12 ms average was changed just after the previous read started).

RS422 Protocol

All commands via the RS422 serial interface have the following structure:

<STX><Command><[Data]><EOT>

The sensor answers all commands as follows:

<NAK> = the command was not recognized or the data is outside the limit values.

or

<ACK> = the command was recognized and executed; the command requires no return data.

or

<Data> = the command was recognized and the requested data has been sent.

Definitions:

STX: start transmission (hex 02 or CTRL B)

EOT: end of text (hex 04 or CTRL D)

NAK: no acknowledgement (hex 15 or CTRL U)

ACK: acknowledge (hex 06 or CTRL F)

Command: 3-digit command (ASCII text)

[Data]: whole numbers (ASCII text)

In ASCII text (command + data), spaces and capitals/small letters are ignored.

RS422 Cable

The RS422 interface is defined as a reliable, serial interface in full duplex mode, with transfer rates up to 10 MBaud; max. cable length 1,000 m (4,000'). The shielded cable is connected to the sensor connector and the ground terminal of the control cabinet.

RS422 User Commands and Their Meanings

Command	Data to LT7*	Data from LT7	Meaning
GAP			**Get All Parameters**
		All parameters in text format:	All sensor parameters are displayed:
		LT7 $Revision ***x.xx$***	• Sensor software revision (number)
		Pilot laser status	• Pilot laser status (ON/OFF/xx seconds ON)
		Serial settings	• Serial settings (see page 13)
		Discrete Output Q1 settings Discrete Output Q2 settings	• Discrete output condition ON: Output high OFF: Output low Output mode (see **IM1**, **IM2**) Limit 1 setting (see **IL1**, **IL2**) Limit 2 setting (see **IL4**, **IL5**) Hysteresis (see **IH1**, **IH2**) Invert status (ON/OFF; see **IN1**, **IN2**)
		Analog Output QA settings	• Analog output condition (Diffuse sensors only) Value (0 to 4095) Limit 1 setting (see **IL3**) Limit 2 setting (see **IL6**) Invert status (ON/OFF; see **INA**)
		Output status	• Output unit of measure (mm or hundredth inch “10MIL”)
		Offset status	• Offset setting (in mm or hundredth inch)
		Password setting	• Password (enabled/disabled)
		Error status	• Error status (see **GSI**)
ECM	—	ACK	**Execute Continuous Measurement** Set and triggered by the next request for measured values
GDB	—	Energy value — 0 to -120dB	**Gain Level** Indicates the amount of receiving energy
GNR	—	xxxxxxxxxx	**Get Serial Number** Emitted as ASCII text (max. 24 characters)

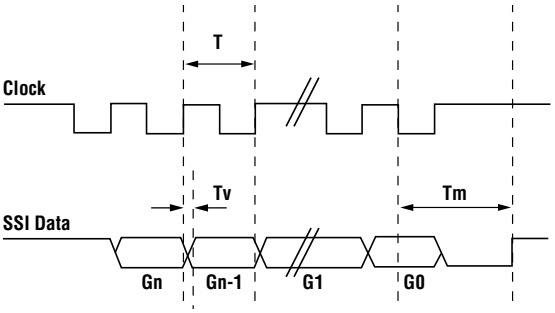
Command	Data to LT7*	Data from LT7	Meaning
GSI	—	**Bit 7** **Bit 6** **Bit 5** **Bit 4** **Bit 3** **Bit 2** **Bit 1** **Bit 0** X X X X X X X X	**Get Error Status** 0: No error 1: Error Bit 7: Transmitter faulty Bit 6: Receiver blinded or faulty Bit 5: Temperature warning: T < -10°C or T > +70°C Bit 4: Target out of range or transmitter faulty Bit 3: Temperature error: T > +85°C Bit 2: Supply voltage too low Bit 1: PLL unlocked Bit 0: Not used
GTE	—	±xxx	**Get Temperature** Internal temperature in °C
GVE	—	LT7 $Revision x.xx$	**Get Version** Software version is displayed
GCM	—	All available commands	**Help Command/Get Commands** All available commands are displayed in text format
ICM	0, 1	ACK	**Input Continuous Measurement Mode** 0: Continuous measurement output 1: Output of single measurement values
IDO	Input desired value	ACK	**Input Offset Setting (All Outputs)** Up to 12,000 mm (plus or minus) or 480.00" (plus or minus)*
IVL	0, 1	ACK	**Enable Visible Laser** 0: Pilot laser OFF 1: Pilot laser ON
ISB	0, 1	ACK	**Input Stand-by** 0: Operation 1: Stand-by
ESM	—	<meas. value>	**Trigger/Execute Single Measurement** Request for measured value with single measurement output
EPW	—	ACK	**Write Parameter Page/Execute Parameter Write** Parameters are stored
Discrete Output Q1			
IH1	000.. 254 or 000.. 999	ACK	**Set Discrete Q1 Hysteresis** 0 - 254 mm or 0" - 9.99"
IL1	Input desired limit value (not including Offset)	ACK	**Input Discrete Q1 Limit 1** 0 - 12,000 mm or 0" - 480.00"* Selected Offset value will be applied to this limit
IL4	Input desired limit value (not including Offset)	ACK	**Input Discrete Q1 Limit 2** 0 - 12,000 mm or 0" - 480.00"* Selected Offset value will be applied to this limit
IM1	0, 1, 2	ACK	**Discrete Output Q1 Mode** 0: Inactive 1: 1 switching point 2: 2 switching points
IN1	0, 1	ACK	**Invert Discrete Output Q1** 0: Q 1: Q inverted

*Decimal point and comma are “imaginary.” Do not input commas or periods in data (e.g., 12000 for mm or 48000 for inches).

Command	Data to LT7	Data from LT7	Meaning
Discrete Output Q2			
IH2	000.. 254 or 000.. 999	ACK	**Set Discrete Q2 Hysteresis** 0 - 254 mm or 0" - 9.99"
IL2	Input desired limit value (not including Offset)	ACK	**Input Discrete Q2 Limit 1** 0 - 12,000 mm or 0" - 480.00"* Selected Offset value will be applied to this limit
IL5	Input desired limit value (not including Offset)	ACK	**Input Discrete Q2 Limit 2** 0 - 12,000 mm or 0" - 480.00"* Selected Offset value will be applied to this limit
IM2	0, 1, 2	ACK	**Discrete Output Q2 Mode** 0: Inactive 1: 1 switching point 2: 2 switching points
IN2	0, 1	ACK	**Invert Discrete Output Q2** 0: Q 1: Q inverted
Analog Output QA (Diffuse sensor models only)			
IL3	Input desired limit value (not including Offset)	ACK	**Input Analog QA Limit 1** 0 - 12,000 mm or 0" - 480.00"* Selected Offset value will be applied to this limit
IL6	Input desired limit value (not including Offset)	ACK	**Input Analog QA Limit 2** 0 - 12,000 mm or 0" - 480.00"* Selected Offset value will be applied to this limit
INA	0, 1	ACK	**Invert Analog Output QA** 0: Q 1: Q inverted

*Decimal point and comma are “imaginary.” Do not input commas or periods in data (e.g., 12000 for mm or 48000 for inches).

SSI-Compatible Interface



T = Duration of clock signal,
minimum 2 µSec = 500 kHz, max. 13 µSec = 77 kHz

Tv = Delay time max. 360 ns

Tm = Minimum time between last rising edge and reloading of SSI approx. 24 µSec.

Gn = MSB (here Gray Code)

24 bit transmission: G1 = second LSB, G0 = LSB

24+E transmission: G1 = LSB, G0 = Error bit

25 bit transmission: G1 = second LSB, G0 = LSB

NOTE: With SSI-compatible transmission, data updates in synchronization with the readout cycle. The data is as up-to-date as the time interval between two readouts. An intermittent readout is therefore recommended. After a longer readout interval, the data contents of the first readout can be “out-of-date” and should be ignored.

Figure 11. SSI-compatible interface timing

SSI Cable

The maximum baud rate for reliable data transfer depends on the cable length (see table). The shielded connection cable is connected to the sensor connector and the ground terminal of the control cabinet.

SSI Cable Length					
Cable Length	**< 25 m**	**< 50 m**	**< 100 m**	**< 200 m**	**< 400 m**
Baud Rate	< 500 kHz	< 400 kHz	< 300 kHz	< 200 kHz	< 100 kHz

CAUTION . . . This sensor contains no user-serviceable components. Do not attempt to repair.
Incorrect component values may produce hazardous laser radiation levels.

Troubleshooting; Error Codes

In the event of errors, corresponding error messages appear on the display and the error outputs Qs and Qp (active low) are set according to the table below.

Multiple errors may simultaneously exist. The error status may be interrogated via the RS422 "GSI" command. (For example, if a too-low supply volatge causes a counter error, the GSI command would report "00000110".)

LCD Error Message	Out (Active Low)		Bit								Meaning
	Qs	Qp	7	6	5	4	3	2	1	0	
BLINDING	Active		0	1	0	0	0	0	0	0	Internal error or ambient light too strong
LAS. ERR.	Active	Active	1	0	0	0	0	0	0	0	Measurement laser faulty – repair or replace sensor
LOW VOLT	Active	Active	0	0	0	0	0	1	0	0	Voltage too low or error in measurement of supply voltage
NO VALUE			0	0	0	0	0	0	0	0	First measurement after switching ON – sensor not yet ready. Message disappears automatically when ready (after 300 ms).
PLL UNLOCKED	Active	Active	0	0	0	0	0	0	1	0	Counter error – repair or replace sensor
	Active		0	0	1	0	0	0	0	0	Temperature out of acceptable range (below -10°C or above +70°C)
OVERTEMP	Active (Laser OFF)	Active (Laser OFF)	0	0	1	0	1	0	0	0	Operating temperature too high (above +85°C within housing); measurement laser switches OFF. Switch sensor off; sensor may operate after a cool-down period.
Dist (mm) > Maximum	Active		0	0	0	1	0	0	0	0	No target in range or sensor badly aligned

L-GAGE® LT7 Long-Range Time-of-Flight Sensor

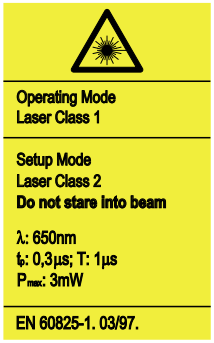
Specifications

	LT7PLVQ	LT7PIDQ
Sensing Range	0.5 to 250 m (using specified reflector)	**6% Black card:** 0.5 to 3 m **18% Gray card:** 0.5 to 7 m **90% White card:** 0.5 to 10 m
Supply Voltage	18 to 30V dc (10% maximum ripple)	
Power Consumption	< 4.5 W @ 25º C	
Supply Protection Circuitry	Protected against reverse polarity and transient over voltages	
Measuring Laser	Infrared, 900 nm, Class 1	
Laser Control	Measurement laser is ON when sensor is ON. Pilot (visible) laser enabled during Programming mode; alternates with measurement laser.	
Spot Size	See Figure 2.	
Pilot Laser	Visible red, 650 nm, Class 2	
Discrete & Analog Output Protection	Protected against continuous overload and short circuit	
Discrete Outputs	(2) 100 mA, PNP	
Discrete Switch Points	Adjustable in 1 mm steps	
Discrete Output Hysteresis	Adjustable, 10 mm min.	
Alarm Outputs	50 mA, PNP (N.O.)	
Analog Output	N/A	4-20 mA
Maximum Cable Length	100 m	
Output Response Time	12 ms	
Linearity	± 10 mm	
Resolution/Repeatability	± 2 mm	± 4 mm
Color Sensitivity (Diffuse Models)	N/A	Contact Factory.
Temperature Effect	< ± 5 mm over the total sensing range	
Minimum Analog Window Size	N/A	300 mm
Adjustments	See pages 2-11. Push-button-directed password enable/disable, measurement unit select, offset value select, output limits set, output mode select, analog output slope select (diffuse models only), and output limit manual adjust.	
Serial Interface	RS422 or SSI compatible	
Serial Measurement Speed	**SSI:** 1.4 ms (SSI cycle 80 µs); **RS422:** 2.9 ms @ 57.6 kBaud	
Indicators	4 LEDs: Green Power ON/OFF, Red Alarm (Error) LED, Orange Output 1 and Output 2 conducting LEDs, 2-line digital LCD display. See page 2 for more information.	
Construction	ABS shock-resistant housing; PMMA window; polycarbonate displays	
Dimensions	93 x 93 x 42 mm; see page 19	
Weight	Approximately 230 g	
Environmental Rating	IEC IP67	
Connections	12-pin M16 connector; 100 m (330') max. cable length; use only cables listed on page 20	
Operating Conditions	**Temperature:** -10° to +50°C (+14° to 132°F) in continuous operation	

Specifications, cont'd

Storage Temperature	-30° to +75° C (-22° to +167° F)
Vibration/Shock	EN 60947-5-2
Application Notes	• All specifications are based on the specified surface at constant ambient conditions and following a minimum operating time of 15 minutes. • For best accuracy, allow a 15-minute warmup before programming or operating • **Crosstalk avoidance:** Light spots must be separated by at least 200 mm. • Also see page 12 for target orientation notes.
Certifications	CE

Description of Laser Classes



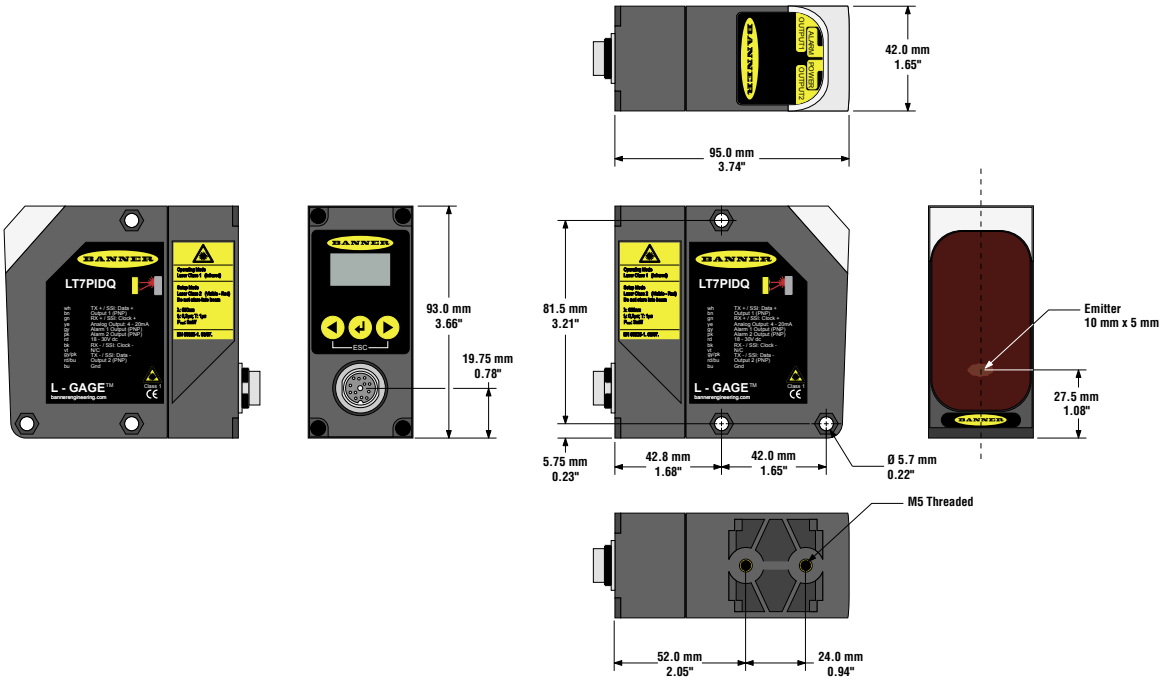
Class 1 (Infrared Sensing Laser)

Lasers that are safe under reasonably foreseeable conditions of operation, including the use of optical instruments for intrabeam viewing.
Reference 60825-1 Amend. 2 © IEC:2001(E), section 8.2.

Class 2 (Visible Pilot Laser)

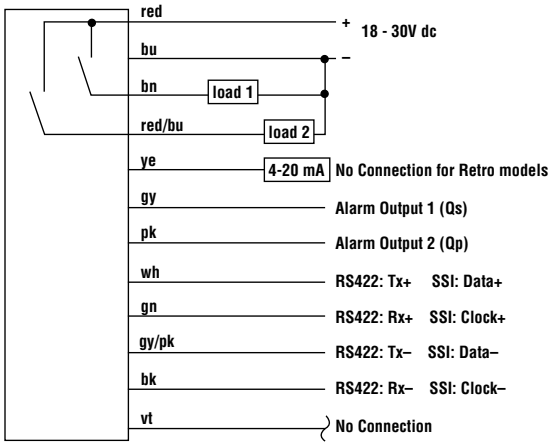
Lasers that emit visible radiation in the wavelength range from 400 nm to 700 nm where eye protection is normally afforded by aversion responses, including the blink reflex. This reaction may be expected to provide adequate protection under reasonably foreseeable conditions of operation, including the use of optical instruments for intrabeam viewing.
Reference 60825-1 Amend. 2 © IEC:2001(E), section 8.2.

Dimensions



L-GAGE® LT7 Long-Range Time-of-Flight Sensor

Hookups

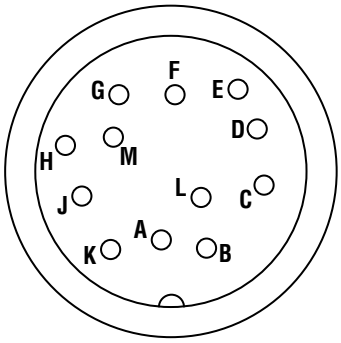


Pin*	Name	Cable Color	Description
A	TX+	White	RS422: Transmitter data / SSI: Data +
B	Q1	Brown	Discrete Output 1
C	RX+	Green	RS422: Receiver data / SSI: Clock +
D	analog	Yellow	Analog Output 4 to 20 mA
E	Qs	Gray	Alarm Output 1
F	Qp	Pink	Alarm Output 2
G	V+	Red	+18 to 30V dc
H	RX-	Black	RS422: Receiver data / SS1: Clock –
J	NC	Violet	
K	TX-	Gray/Pink	RS422: Transmitter data / SS1: Data –
L	Q2	Red/Blue	Discrete Output 2
M	GND	Blue	0V (GND)

*See pinout below.

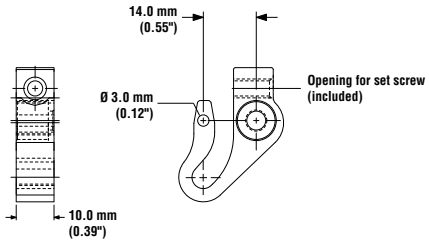
Accessories

Quick-Disconnect Cables

Style	Model	Length	Pinout
12-pin Euro-style right-angle (Rating pending; consult factory)	**MQDC-1210RA** **MQDC-1230RA** **MQDC-1290RA**	3 m (10') 10 m (30') 30 m (90')	 **Refer to hookups above for pin descriptions.**
12-pin Euro-style straight (IP67)	**MQDC-1210ST** **MQDC-1230ST**	3 m (10') 10 m (30')	

Accessory Mounting Brackets

SMBLT7	• Right-angle bracket • 300 series stainless steel • Fine-adjust accessory available (model **SMBLT7F)**	**SMBLT7F**	• Fine-adjust accessory for model **SMBLT7** bracket; bracket sold separately • 304 series stainless steel • Mounting hardware included



Using the Bracket and Fine-Adjust Accessory

Bolt the two accessories to the base and/or angle of the bracket as shown in the photo above, aligning the small pins in the accessory with the small holes in the bracket. Install the sensor on the bracket, and the bracket on the mounting surface, using the bracket's curved slots for rough alignment. Tighten these bolts finger-tight. Tighten or loosen the SMBLT7F set screws to fine-adjust the sensor alignment in each axis; then tighten all bolts.

L-GAGE® LT7 Long-Range Time-of-Flight Sensor

Retroreflectors

Model	LT7 Retro Sensor Range	Description	
BRT-250 **BRT-540** **BRT-700**	50 m (163') 200 m (655') 250 m (820')	Reflector mounted to rigid aluminum backing 250 x 250 mm (9.8" x 9.8") 540 x 540 mm (21.3" x 21.3") 700 x 700 mm (27.6" x 27.6")	
BRT-TVHG-8X10P	For distances up to 100 m (328')	Retroreflective Tape 203 x 254 mm (8" x 10")	NOTE: Retroreflective material has a pressure-sensitive adhesive. For maximum adhesion, surfaces must be clean and dry before applying. For best results, use full-size; target may be trimmed as necessary.

Alignment Aid

Model	Description	
LAT-2	Clip-on attachment for sensor; allows laser spot to be seen easily at long distances ≥ 50 m	

L-GAGE® LT7 Long-Range Time-of-Flight Sensor

more sensors, more solutions

WARRANTY: Banner Engineering Corp. warrants its products to be free from defects for one year. Banner Engineering Corp. will repair or replace, free of charge, any product of its manufacture found to be defective at the time it is returned to the factory during the warranty period. This warranty does not cover damage or liability for the improper application of Banner products. This warranty is in lieu of any other warranty either expressed or implied.

P/N 120244

Banner Engineering Corp., 9714 Tenth Ave. No., Minneapolis, MN 55441 • Phone: 763.544.3164 • www.bannerengineering.com • Email: sensors@bannerengineering.com