# L-GAGE® LT3 Long-Range Time-of-Flight Laser Sensor

Self-contained Class 2 laser distance sensor, analog and discrete outputs

Features

- Extremely long range: 5 m with white targets, or 3 m with gray targets

- Banner's unique scalable analog output automatically distributes the output signal over the width of the programmed sensing window

- Analog and Discrete (switched) outputs in each sensor, with independent window limits†

- Discrete output can be used for precision background suppression

- Choose NPN or PNP discrete output, plus 0 to 10V dc or 4 to 20 mA sourcing analog output

- Fast, easy-to-use integrated push-button TEACH-mode programming; no potentiometer adjustments

- Remote TEACH function for security and convenience

- Output response is programmable for three speeds

- Choose 2 m or 9 m unterminated cable, or 8-pin Euro-style swivel QD connector

- Rugged construction withstands demanding sensing environments; rated IEC IP67, NEMA 6

CE c**UL**us

DIFFUSE LASER
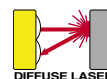
WARNING . . .
Not To Be Used for Personnel Protection

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.

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

Models

Models	Sensing Distance	Cable*	Supply Voltage	Discrete Output	Analog Output
LT3PU		2 m (6.5') 8-wire		PNP (Sourcing)	Analog Voltage (0 to 10V dc)
LT3PUQ		8-pin Euro-style QD		PNP (Sourcing)	Analog Voltage (0 to 10V dc)
LT3NU	300 mm to 5 m (11.8" to 16.4') 90% reflectivity white card (see specifications for more information.)	2 m (6.5') 8-wire	12 to 24V dc	NPN (Sinking)	Analog Voltage (0 to 10V dc)
LT3NUQ		8-pin Euro-style QD		NPN (Sinking)	Analog Voltage (0 to 10V dc)
LT3PI		2 m (6.5') 8-wire		PNP (Sourcing)	Analog Current (4 to 20 mA)
LT3PIQ		8-pin Euro-style QD		PNP (Sourcing)	Analog Current (4 to 20 mA)
LT3NI		2 m (6.5') 8-wire		NPN (Sinking)	Analog Current (4 to 20 mA)
LT3NIQ		8-pin Euro-style QD		NPN (Sinking)	Analog Current (4 to 20 mA)

* 9 m cables are available by adding suffix "**W/30**" to the model number of any cabled sensor (e.g., **LT3PU W/30**). A model with a QD connector requires a mating cable; see page 10.

† NOTE: See Banner website for information on diffuse and dual-discrete models at: www.bannerengineering.com

L-GAGE® LT3 Long-Range Time-of-Flight Sensor – Analog/Discrete Outputs

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 output value. The analog output provides a variable signal (4 to 20 mA or 0 to 10V dc, depending on model) that is proportional to the target's position within the user-programmed analog window limits. The discrete (switched) output energizes whenever the target is located between the user-programmed discrete window limits. Window limits for the analog and discrete outputs may be the same, or they may be programmed independently.
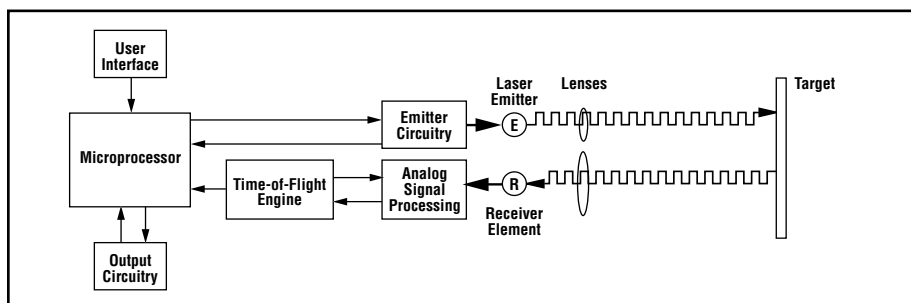

Figure 1. Theory of operation

Programming

The L-GAGE LT3 laser sensor has three selectable response speeds and can be programmed in several ways for specific window limits.

Response Speed
Prior to setting window limits, use the sensor's Speed push button to toggle between the three response speed settings. The selected speed will be indicated by one of the three Response Speed indicator LEDs (see Figure 2). See page 5 for further information.

Sensor Power Up/Laser Enable
Allow 30 minutes after power-up to allow the sensor's internal temperature to stabilize, before operating or attempting to program the sensor. If the sensor will be used in applications where the temperature is several degrees higher or lower than ambient, allow the sensor to stabilize in that condition before programming the window limits. (Range will decrease as the sensor warms up.)

The laser enable feature allows the sensor to be continually powered, and enabled only when being used. This eliminates the need for the extended warm-up period between uses. See page 6 for indicator status.

The sensor's red Signal LED indicates the condition of the received signal from the object being measured. When programming window limits, this LED must be ON solid (not flashing) for the sensor to accept the setting. To ensure that the received signal will not be marginal during operation, move the target object 300 mm beyond the furthest desired setpoint during setup, and verify that the signal LED is still ON solid.
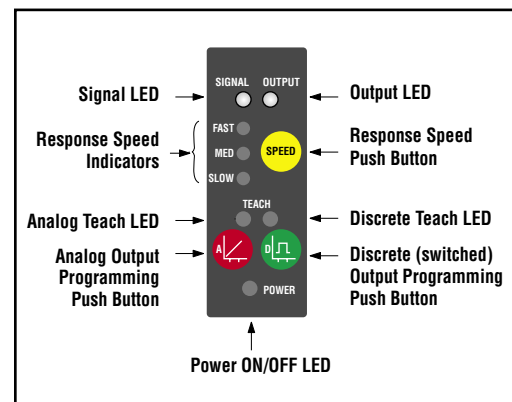

Figure 2. LT3 Time-of-Flight Sensor features
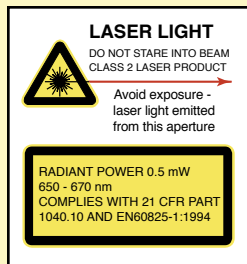
Class 2 Safety Notes

Low-power lasers are by definition incapable of causing eye injury within the duration of the blink, or aversion response, of 0.25 seconds. They must also emit only visible wavelengths (400-700 nm). Therefore, an eye hazard can exist only if an individual overcomes the natural aversion to bright light and stares directly into the laser beam. These lasers are required to have a "hazard" label and to have an indicator light to indicate that laser emission is occurring.

When operating a class 2 laser:

• Do not permit a person to stare directly into the beam

• Do not point the laser at a person's eye at close range

Beam Paths:

The beam emitted by a class 2 laser product should be terminated at the end of its useful path. Open laser beam paths should be located above or below eye level, where practical.

LASER LIGHT
DO NOT STARE INTO BEAM
CLASS 2 LASER PRODUCT

Avoid exposure - laser light emitted from this aperture

RADIANT POWER 0.5 mW
650 - 670 nm
COMPLIES WITH 21 CFR PART 1040.10 AND EN60825-1:1994

Window Limits
Window limits may be taught to the sensor in several ways, either using the push buttons on the top of the sensor or via a remote switch.

Remote Programming
To program the sensor remotely or to disable the keypad, the Remote Programming function may be used. Disabling the keypad prevents accidental or unauthorized adjustment of the programming settings. Connect the yellow wire of the sensor to +5 to 24V dc, with a remote programming switch connected between them.

NOTE: The impedance of the remote teach input is 55 kΩ.

Programming is accomplished by following a sequence of input pulses (see pages 4 and 5). The duration of each pulse (corresponding to a push button "click"), and the period between multiple pulses, are defined as "T": 0.04 seconds ≤ T ≤ 0.8 seconds.

Analog Output Slope
The L-GAGE LT3 Sensor may be programmed for either a positive or a negative output slope, based on which condition is taught first (see Figure 3). If the near limit is taught first, the slope will be positive; if the far limit is taught first, the slope will be negative. Banner's unique scalable analog output (patent pending) automatically distributes the output signal over the width of the programmed sensing window.

In the event of analog signal loss for longer than 2 seconds, the analog output goes to 0V dc or 3.6 mA, which may be used to trigger an alarm.

Teaching Analog Limits Using the Auto-Zero Feature (Analog Output)
For some analog applications, a sensing distance set point centered within a sensing window may be required. The TEACH procedure is simple: teaching the same limit twice causes the sensor to program a 1 m window centered on the position taught (taught position ± 0.5 m).

Teaching Discrete Limits for Background Suppresson
For some applications, ignoring objects beyond a certain distance may be required. To suppress the background, place a target object at the selected distance, and teach the position twice. The sensor's discrete output will activate when an object is detected between the sensor's minimum sensing distance and the taught position.

NOTE: The sensor allows for some forgiveness in this procedure. If the two limits are not exactly the same (but less than 20 mm apart), the sensor will put the set point at the "average" of the two limits.
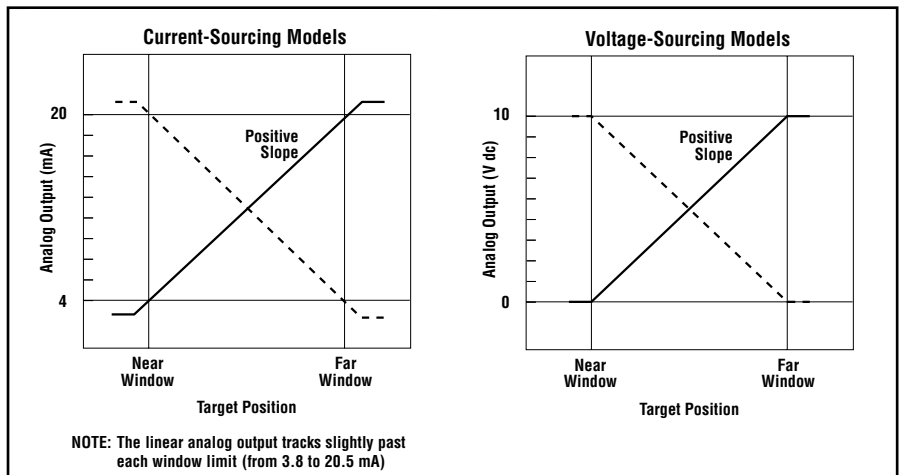

Figure 3. Analog output as a function of target position

Teaching Limits for Either Analog or Discrete Output

Either output may be programmed first.

|	Push Button 0.04 ≤ "click" ≤ 0.8 sec.		Remote Wire 0.04 sec. ≤ T ≤ 0.8 sec.	
	Procedure	**Result**	**Procedure**	**Result**
Programming Mode	• Push and hold push button for Analog or Discrete output > 2 seconds*	• Appropriate TEACH LED turns ON • Sensor is waiting for first limit	No action required	
Teach First Limit	• Position the target for the first limit** • "Click" the same push button	• TEACH LED flashes • Sensor learns first limit and waits for second limit	• Position the target for the first limit** **Analog Output** • Double-pulse the remote line **Discrete Output** • Single-pulse the remote line	• Appropriate TEACH LED turns ON then flashes at 2 Hz • Sensor learns first limit and waits for second limit
Teach Second Limit	• Position the target for the second limit • "Click" the same push button	• TEACH LED goes OFF • Sensor learns second limit and returns automatically to RUN mode	• Position the target for the second limit • Single-pulse the remote line	• Appropriate TEACH LED goes OFF • Sensor learns second limit and returns automatically to RUN mode
Program Second Output	Repeat for other output, if a second output is desired.			

  * Sensor will return to RUN mode if first TEACH condition is not registered within 120 seconds.

** Press and hold the same push button (or hold the remote line high) > 2 seconds (before teaching the second limit) to exit PROGRAM mode without saving any changes. The sensor will revert to the last saved program.

Teaching Limits for Analog and Discrete Outputs Simultaneously

Both Analog and Discrete outputs will have identical limits.

	Push Button 0.04 ≤ "click" ≤ 0.8 sec.		Remote Wire 0.04 sec. ≤ T ≤ 0.8 sec.	
	Procedure	Result	Procedure	Result
Programming Mode	• Push and hold either push button for > 2 seconds*	• Corresponding TEACH LED turns ON	No action required	
	• Briefly "click" the other button	• Corresponding TEACH LED turns ON • Sensor is waiting for first limit		
Teach First Limit	• Position the target for the first limit** • "Click" either push button	• Both TEACH LEDs flash at 2 Hz, alternating Red and Green • Sensor learns first limit and waits for second limit	• Position the target for the first limit** • Triple-pulse the remote line	• Both TEACH LEDs turn ON • Sensor learns first limit and waits for second limit • Both TEACH LEDs flash at 2 Hz, alternating Red and Green
Teach Second Limit	• Position the target for the second limit • "Click" either push button	• Both TEACH LEDs go OFF • Sensor learns second limit and returns automatically to RUN mode	• Position the target for the second limit • Single-pulse the remote line	• Both TEACH LEDs go OFF • Sensor learns second limit and returns automatically to RUN mode

  * Sensor will return to RUN mode if first TEACH condition is not registered within 120 seconds.

  ** Press and hold the same push button (or hold the remote line high) > 2 seconds (before teaching the second limit) to exit PROGRAM mode without saving any changes. The sensor will revert to the last saved program.

Sensor Setup

Response Speed

Use the Speed push button to toggle between the three response speed settings. The selected speed is indicated by one of three Response Speed indicator LEDs (see Figure 2).

	Discrete Output Response Speed	Analog Output Frequency Response (-3dB)
Slow	100 ms ON and OFF	4.5 Hz (100 ms average/4 ms update rate)
Medium	10 ms ON and OFF	45 Hz (10 ms average/2 ms update rate)
Fast	1 ms ON and OFF	450 Hz (1 ms average/1 ms update rate)

Push Button Lockout

Enables or disables the keypad to prevent accidental or unauthorized adjustment of the programming settings.

	Procedure		Result
	Push Button	**Remote Wire** **0.04 sec. ≤ T ≤ 0.8 sec.**	**Result**
Enable/Disable Push Buttons	• Not available via push button	• Four-pulse the remote line ⊓⊓⊓⊓⊓⊓	• Push buttons are either enabled or disabled, depending on previous condition

Indicators

Power Up/Laser Enable Indicators

When powering up the sensor, the following should occur:

• All LEDs turn ON for 1 second

• Allow 0.6 second delay for Laser Enable at power up. If sensor is already powered up, see table at right for Laser Enable time. Laser Disable time for all speeds is 50 ms.

Selected Response Speed	Laser Enable Time
Slow	150 ms
Medium	60 ms
Fast	51 ms

Signal LED (red) – indicates the strength and condition of the sensor's incoming signal.

Signal LED Status	Indicates
ON	Good signal
OFF	No signal is received, or the target is beyond the range limitations of the sensor (with some tolerance beyond the recommended minimum and maximum sensing distance)
Flashing	Marginal signal strength (can not teach limits)

Output LED (yellow) – lights when a target is sensed within the programmed discrete window limits.

Power ON/OFF LED (green) – indicates the operating status of the sensor.

Power ON/OFF LED Status	Indicates
OFF	Power is OFF
Flashing @ 2Hz	Discrete output is overloaded (RUN mode)
Flashing @ 1Hz	Power ON, Laser is disabled
ON Solid	Sensor is operating normally (power ON, Laser enabled)

Specifications

Sensing Range	**90% White card:** 0.3 to 5 m **18% Gray card:** 0.3 to 3 m **6% Black card:** 0.3 to 2 m
Supply Voltage and Current	12 to 24V dc (10% maximum ripple); 108 mA max. @ 24V dc or [2600/V dc] mA
Supply Protection Circuitry	Protected against reverse polarity and transient voltages
Delay at Power-up	1 second; outputs do not conduct during this time
Sensing Beam	658 nm visible red IEC and CDRH Class 2 laser; 0.5 mW max. radiant output power; typical beam dia: 6 mm (typical laser lifetime 75,000 hours).
Output Protection	Protected against short circuit conditions
Output Configuration	**Discrete (switched):** SPST solid-state switch; choose NPN (current sinking) or PNP (current sourcing) models **Analog output:** 0 to 10V dc or 4 to 20 mA
Output Rating	**Discrete (switched) output:** 100 mA maximum **Off-state leakage current:** < 5 µA **Output saturation NPN:** < 200 mV @ 10 mA and < 600 mV @100 mA **Output saturation PNP:** < 1.2V at 10 mA; < 1.6V at 100 mA **Analog voltage output:** 2.5 kΩ minimum load impedance **Analog current output:** 1 kΩ max. @ 24V; max. load resistance = [V_{CC}-4.5/0.02 Ω]

Output Response Time	**Discrete output**
	  Slow: 100 ms ON and OFF
	  Medium: 10 ms ON and OFF
	  Fast: 1 ms ON and OFF **Analog Voltage output (-3 dB)**
	  Slow: 4.5 Hz (100 ms average/ 4 ms update rate)
	  Medium: 45 Hz (10 ms average/ 2 ms update rate)
	  Fast: 450 Hz (1 ms average/ 1 ms update rate)

Linearity	± 30 mm from 0.3 to 1.5 m; ± 20 mm from 1.5 to 5 m. See Figure 6. (Specified @24V dc, 22° C using a 90% reflectance white card)
Resolution/Repeatability	See Figure 4.
Color Sensitivity	90% white to 18% gray: <10 mm; 90% white to 6% black: < 20 mm. See Figure 5.
Discrete Output Hysteresis	**Fast:** 10 mm **Medium:** 5 mm **Slow:** 3 mm
Temperature Effect	< 2 mm / °C
Minimum Window Size	20 mm
Remote Teach Input	18 kΩ minimum (65 kΩ at 5V dc)
Remote TEACH	**To teach:** Connect yellow wire to +5 to 24V dc **To disable:** Connect yellow wire to 0 to +2V dc (or open connection) See Remote Programming on page 3.

Adjustments	**Response speed:** Push button toggles between 1, 10 and 100 ms
	Window limits (analog or discrete): TEACH-mode programming of near and far window limits (see programming procedure). Limits may also be taught remotely via TEACH input (see page 3).
	Analog output slope: The first limit taught is assigned to minimum output current or voltage (4 mA or 0V dc).
	Push-button enable/disable (lockout): via remote line (see page 6)
	Factory defaults: 100 ms response speed
	        Analog/discrete window limits 0.3 m - 5 m using a 90% reflectivity white card
	        Positive analog slope
	        Push buttons enabled

Laser Control	Connect red wire to +5 to 24V dc to enable laser beam; connect to 0 to +1.8V dc (or open connection) to disable. See page 6 for delay times on enable.

L-GAGE® LT3 Long-Range Time-of-Flight Sensor – Analog/Discrete Outputs

Specifications, continued

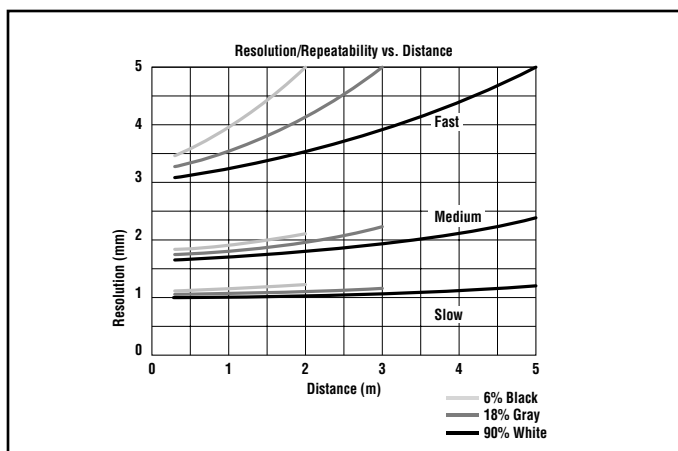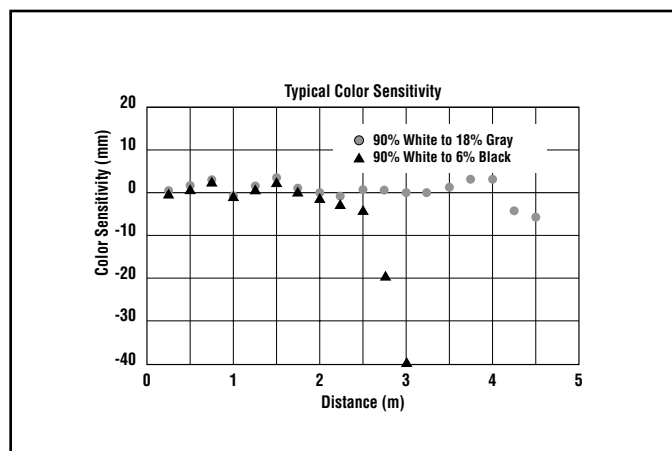|	
Indicators	**Green Power ON LED:** Indicates when power is ON, overloaded output and laser status **Yellow Output LED:** Indicates when discrete load output is conducting **Red Signal LED:** Indicates target is within sensing range and the condition of the received light signal **3 Yellow Speed LEDs:** Indicate the response speed setting **Red/Green TEACH LEDs:** Sensor is in programming mode (red – analog output; green – discrete output) NOTE: See page 6 for more information on indicator behavior.
Construction	**Housing:** ABS **Window:** Acrylic **Quick-disconnect:** ABS/polycarbonate blend
Environmental Rating	IP67, NEMA 6
Connections	2 m (6.5') or 9 m (30') shielded 7-conductor (with drain) PVC-jacketed attached cable or 8-pin Euro-style quick-disconnect
Operating Conditions	**Temperature:** 0° to +50°C (+32° to +122°F) **Maximum Relative Humidity:** 90% at 50°C (non-condensing)
Application Note	Allow 30-minute warm-up before programming or operating (see Sensor Power-up/Laser Enable, page 2)
Certifications	CE c(UL)US

Figure 4. LT3 resolution

Figure 5. LT3 color sensitivity (typical)
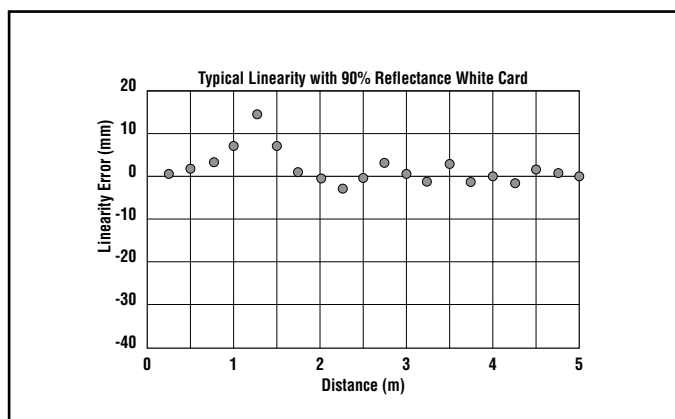

Figure 6. LT3 linearity (typical)

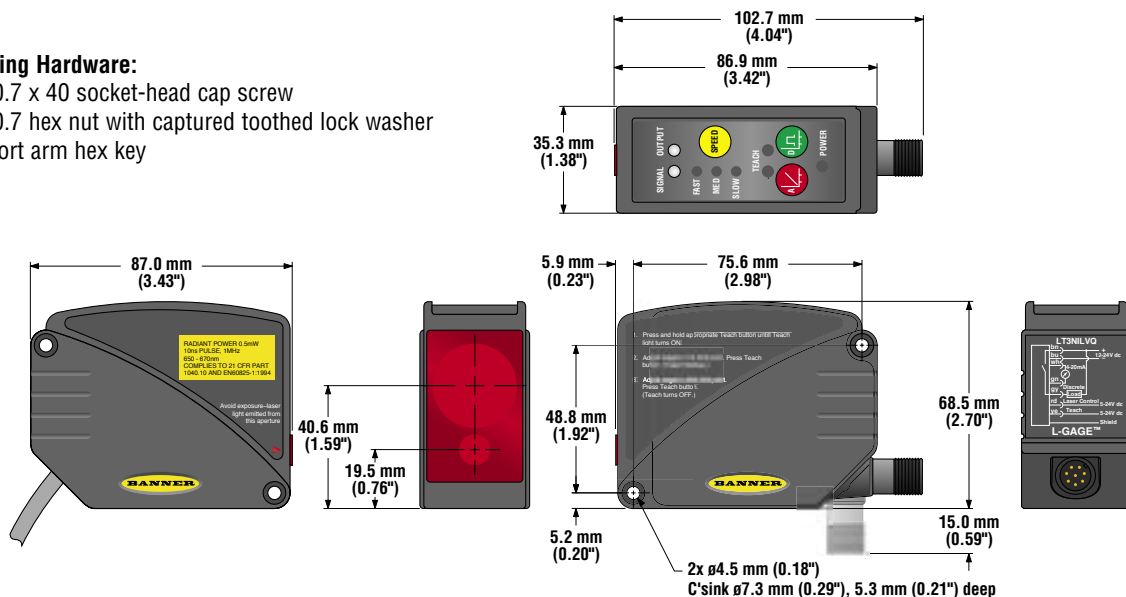# L-GAGE® LT3 Long-Range Time-of-Flight Sensor – Analog/Discrete Outputs

Dimensions
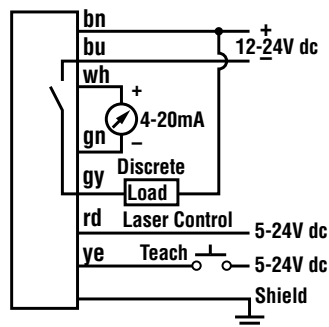
Mounting Hardware:
M4 x 0.7 x 40 socket-head cap screw
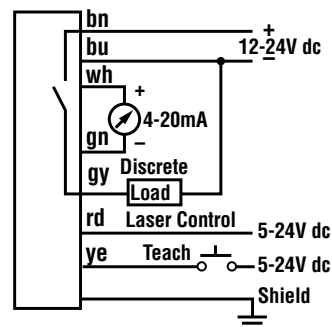M4 x 0.7 hex nut with captured toothed lock washer
M3 short arm hex key

102.7 mm
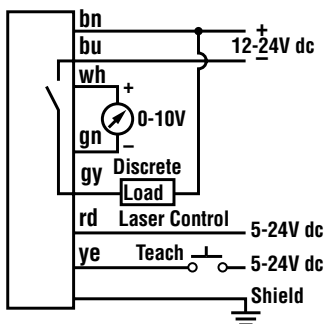(4.04")

86.9 mm
(3.42")

35.3 mm
(1.38")

87.0 mm
(3.43")

RADIANT POWER 0.5mW
10ns PULSE, 1MHz
650 - 670nm
COMPLIES TO 21 CFR PART
1040.10 AND EN60825-11994

Avoid exposure—laser
light emitted from
this aperture

40.6 mm
(1.59")

19.5 mm
(0.76")

5.9 mm
(0.23")

75.6 mm
(2.98")

48.8 mm
(1.92")

68.5 mm
(2.70")

5.2 mm
(0.20")

2x ø4.5 mm (0.18")
C'sink ø7.3 mm (0.29"), 5.3 mm (0.21") deep

15.0 mm
(0.59")

LT3NILVQ

L-GAGE™

Hookups

NPN Analog Current

bn
bu   + 12-24V dc
            –
wh
            + 4-20mA
gn   –
gy   Discrete
      Load
rd   Laser Control   5-24V dc
ye   Teach   5-24V dc
      Shield

PNP Analog Current

bn
bu   + 12-24V dc
            –
wh
            + 4-20mA
gn   –
gy   Discrete
      Load
rd   Laser Control   5-24V dc
ye   Teach   5-24V dc
      Shield

NPN Analog Voltage

bn
bu   + 12-24V dc
            –
wh
            + 0-10V
gn   –
gy   Discrete
      Load
rd   Laser Control   5-24V dc
ye   Teach   5-24V dc
      Shield

PNP Analog Voltage

bn
bu   + 12-24V dc
            –
wh
            + 0-10V
gn   –
gy   Discrete
      Load
rd   Laser Control   5-24V dc
ye   Teach   5-24V dc
      Shield
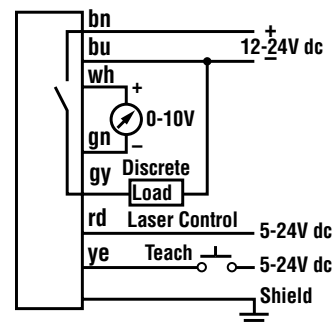
NOTE: Hookups for QD models are functionally identical.

L-GAGE® LT3 Long-Range Time-of-Flight Sensor – Analog/Discrete Outputs

Accessories

Euro-Style Quick-Disconnect Cables

Cable: PVC jacket, polyurethane connector body, chrome-plated brass coupling nut
Conductors: 24 AWG high-flex stranded, PVC insulation, gold-plated contacts
Temperature: -40° to +105°C (-40° to +221°F)
Voltage Rating: 30V ac/36V dc

Style	Model	Length	Connector	Pinout (Female View)
8-Pin Euro Straight	MQDC-806 MQDC-815 MQDC-830	2 m (6.5') 5 m (15') 9 m (30')	M12 X 1 14.2 mm (0.56") 42.0 mm (1.65")	Gray, Yellow, Green, Brown, Red or Pink, Blue, White, Shield

Accessory Mounting Brackets

SMBLT31	• Right-angle bracket • 300 series stainless steel

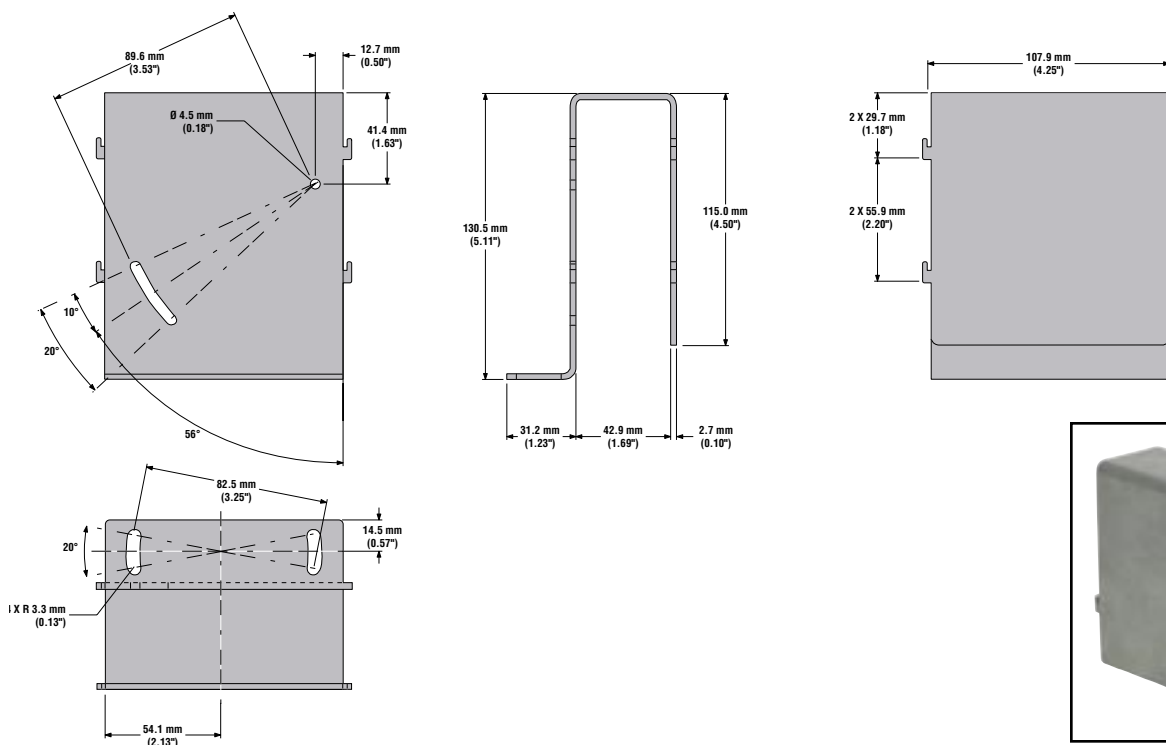## Mounting Brackets, continued

SMBLT32	• Heavy-duty protective bracket • 304 series stainless steel • Mounting hardware included
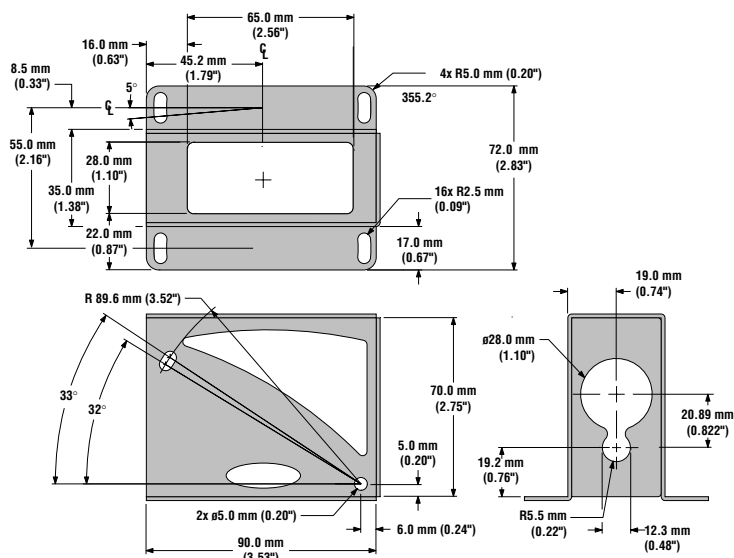
SMBLT3IP	• Replaceable windows for welding environments • Stainless steel construction • Includes 2 weld-resistant windows

more sensors, more solutions