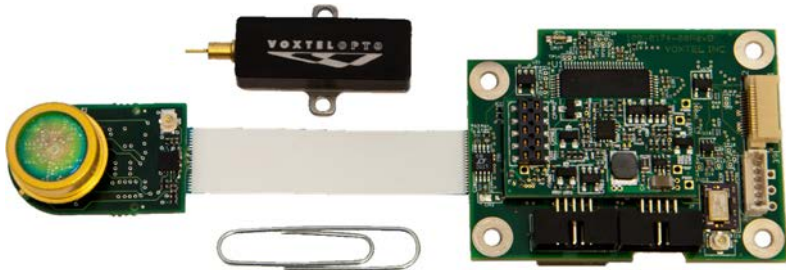


LASER RANGEFINDER (LRF) SYSTEM- INTEGRATOR KIT

INCLUDES INGAAS APD PHOTORECEIVER, 1534-NM
DPSS LASER, TDC & CONTROL ELECTRONICS



Voxtel's *Laser-rangefinder (LRF) System-Integrator Kit* gives system designers a turnkey laser-ranging solution for thermal, electro-optical, and optical scope integration. Each kit includes Voxtel's ROX™ avalanche photodiode (APD) photoreceiver, which offers best-in-class sensitivity enabling long-standoff range performance with less laser pulse energy. The ROX photoreceiver is paired with Voxtel's small-form-factor 1534-nm diode-pumped solid-state (DPSS) erbium-glass laser transmitter, programmable time-to-digital converter (TDC), and programmable controller board. The result is a compact, lightweight highly-reliable ranging module with excellent performance.

Each Kit is factory calibrated. To provide optimal performance over a -50 °C to +65 °C temperature range, four operating modes are included: bias for best noise equivalent input (NEI) operation; bias for optimal sensitivity for a 10-Hz to 350-Hz false alarm rate (FAR); stable photoreceiver responsivity; and stable gain ($M = 1$). The Kit is easily programmed using commands from a flexible serial communications library, communicated over a simple serial UART interface.

Other user-programmable features include: • time-variable-threshold (TVT), used to reduce false alarms due to nearfield scattering, • time-over-threshold (TOT) range walk correction, used to reduce amplitude-dependent range-walk errors • autocalibration, used to set the threshold to achieve a user-defined FAR given ambient background optical radiation conditions • multi-pulse processing, used to enhance range and resolution • passive operation, used to measure the pulse-repetition frequency of external lasers.

The LRF System-Integrator Kit can optionally include laser-collimating optics and photoreceiver optics. For integration with user provided lasers, kits are available without the lasers (APD photoreceiver and laser ranging control electronics only). Also available is an optional auxiliary board that includes an Integrated attitude and heading reference system (attitude and heading reference system, AHRS) module with a 9-axis IMU and a Bluetooth low-energy communications module.

Voxtel Literature LRF System Integrator Kit 12Apr2019 ©. Voxtel makes no warranty or representation regarding its products' specific application suitability and may make changes to the products described without notice.

1.5-MICRON LASER RANGEFINDER SYSTEM- INTEGRATOR KIT

EAR 99: NOT ITAR CONTROLLED

FEATURES

- **Turnkey:** Integrates DPSS erbium-glass laser, high-performance InGaAs APD, and programmable pulse-processing electronics
- **Low Excess Noise:** Impact-ionization engineered InGaAs APD
- **Eyesafe:** Class 1, 1534-nm laser
- **High Precision:** 500-mm single-pulse; 100-mm multi-pulse
- **Near Diffraction-limited Laser Beam Quality:**
 $M^2 < 1.15 \times$ diffraction limit
- **Excellent NEI:** as low as 45 photons
- **Low Power:** < 1 mW w/ LRF disabled
- **Long Lifetime:** > 50 million shots

OPTIONS

- **Integrated Optics:** Receiver ($f/1$; 21-mm and 50-mm aperture) and laser collimator (17x magnification)
- **Auxiliary Board:** AHRS and Bluetooth communications
- **Turnkey LRF Modules:** Available as original equipment manufacturer (OEM) modules or as robust electro-optical assemblies
- **APD Photoreceiver and Laser Ranging Control Electronics:** Available without laser and pointer

CONTACT INFO

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SPECIFICATIONS

LRF System-Integrator Kit without T0 detector	EUKK-N00C	EUMK-J00C	EUMK-N00C	EUNK-N00C
Voxtel laser model number	LAK0-E00C	LAM0-F00C	LAM0-F00C	LAN0-F00C
Voxtel APD photoreceiver model number	RUC1-NIAC	RUC1-JIAC	RUC1-NIAC	RUC1-NIAC
Transmitter wavelength	1534 nm			
Laser peak power (typical) ^{1,2}	29 kW	48 kW	48 kW	115 kW
Transmitter pulse spectral width ¹	4 ns	7 ns	7 ns	5 ns
Transmitter beam width (FWHM)	0.02 nm			
Wavelength shift ¹	+0.014 nm/+°C			
Transmitter beam diameter	250 µm	300 µm	300 µm	450 µm
Transmitter beam divergence, full angle (1/e ²)	12 mrad	8 mrad	8 mrad	6 mrad
Transmitter beam quality (<i>M</i> ²)	1.15 x DL			
APD collection aperture	200 µm	75 µm	200 µm	200 µm
Noise equivalent input ¹	45 photons	45 photons	45 photons	45 photons
Total dynamic range	70 dB			
Linear dynamic range	25 dB			
APD gain range (<i>M</i>)	1 – 20			
APD responsivity (<i>M</i> = 1)	1.1 A/W			
Number of returns per pulse, maximum	20			
Target separation, minimum ³	5 m			
Range accuracy (single-pulse/multi-pulse) ^{1,3,4}	500 mm / 100 mm			
Minimum range ⁵	20 m			
Power consumption, LRF disabled	< 1 mW			
Power consumption, standby	250 mW			
Power consumption, 1-Hz continuous ranging ¹	700 mW	900 mW	900 mW	1400 mW
Timing, power-on to standby	45 ms			
Timing, standby to range	180 ms			
Communications interface	Serial commands, UART 3.3V CMOS Logic			
Analog signal (peak to peak)	150 mV			
Operating humidity (relative humidity)	90%			
Operating temperature ⁶	-50 °C to +65 °C			
Storage temperature	-55 °C to +85 °C			
Lifetime (MTTF)	50 million shots			
Weight				
Base Unit ⁷	37.2 g	38.3 g	38.3 g	53.4 g
Options (See Ordering Information for part numbers)				
With Integrated T0 Detector	+0.2 g	+0.2 g	+0.2 g	+0.2 g
With Auxiliary Board	+5.0 g	+5.0 g	+5.0 g	+5.0 g
With 17x Laser Beam Expander/Collimator	+51.3 g	+55.6 g	+55.6 g	+58.1 g
With 21 mm Optics	+46.8 g	+46.8 g	+46.8 g	+46.8 g
With 50 mm Optics	+61.0 g	+61.0 g	+61.0 g	+61.0 g
Exclusions (See Ordering Information for part numbers)				
Without Laser & Laser Driver Board	-18.3 g	-19.4 g	-19.4 g	-34.5 g

With Laser Collimating Optics

Laser collimator magnification	17x	17X	17X	17X
Collimated beam divergence	0.7 mrad	0.5 mrad	0.5 mrad	0.4 mrad

With 21-mm Receiving Optical Mechanical Module

Receiver aperture	21 mm	21 mm	21 mm	21 mm
Receiver <i>f</i> /number	<i>f</i> /1	<i>f</i> /1	<i>f</i> /1	<i>f</i> /1

With 50-mm Receiving Optical Mechanical Module

Receiver aperture	50 mm	50 mm	50 mm	50 mm
Receiver <i>f</i> /number	<i>f</i> /1	<i>f</i> /1	<i>f</i> /1	<i>f</i> /1

¹ 25 °C

² 1534 nm

³ Target return level <= 10x NEI

⁴ When calibrated with time-over-threshold (1 σ)

⁵ 10 m possible with lower-energy laser models

⁶ Custom to +75 °C also available upon request

⁷ Base Unit includes DPSS Laser, Laser Driver Board, ROX InGaAs APD Photoreceiver mounted on Socket Board, LRF System Board, and 2" Flex Ribbon Connector

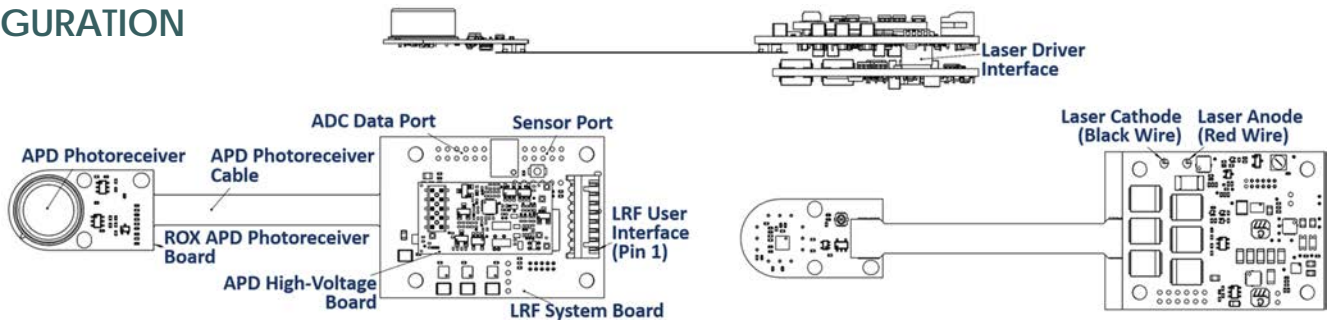
ORDERING INFORMATION

LRF System-Integrator Kits

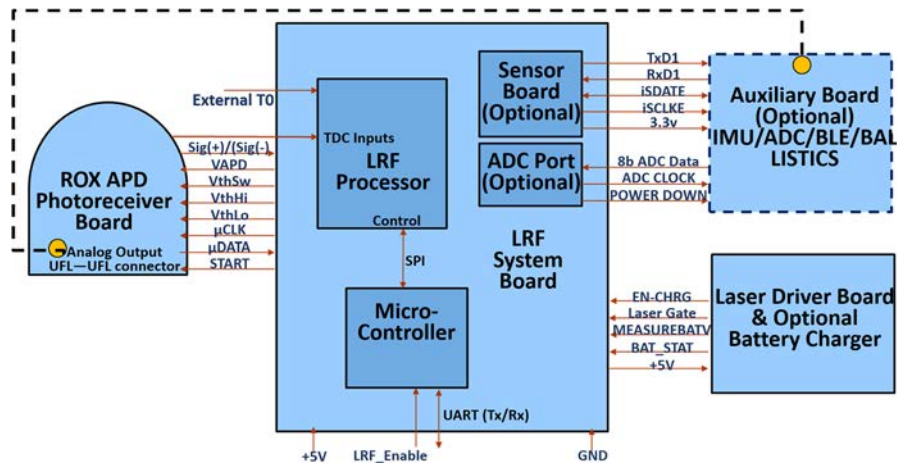
Laser Pulse Energy (Eyesafe DPSS Laser)	Pulse Width	InGaAs APD Photo- receiver	Laser Collimator Module Options	Receiver Optics Module Options	Part Number				
					Without T0 Detector		With T0 Detector Integrated with Laser		
					Without Aux Board	With Aux Board	Without Aux Board	With Aux Board	
No Laser— Photoreceiver & Laser Ranging Control Electronics Only	NA	75 µm	None	None	EU0K-J00C	EU0S-J00C	NA	NA	
		200 µm			EU0K-N00C	EU0S-N00C			
		250 µm CA			EU0K-K00C	EU0S-K00C			
		500 µm			EU0K-P00C	EU0S-P00C			
100 µJ	4 ns	75 µm	None	None	EUKK-J00C	EUKS-J00C	EUPK-J00C	EUPS-J00C	
				Fiber pigtail 62.5- core/125-clad (0.27 NA) FC/PC	EUKK-JQ0C	EUKS-JQ0C	EUPK-JQ0C	EUPS-JQ0C	
				Fiber pigtail 105- core/125-clad (0.22 NA) FC/PC	EUKK-JR0C	EUKS-JR0C	EUPK-JR0C	EUPS-JR0C	
				Fiber pigtail 200- core (0.37 NA) FC/PC	EUKK-JT0C	EUKS-JT0C	EUPK-JT0C	EUPS-JT0C	
		with 17x laser collimator	None	EUKK-J0BC	EUKS-J0BC	EUPK-J0BC	EUPS-J0BC		
			21 mm	EUKK-JCBC	EUKS-JCBC	EUPK-JCBC	EUPS-JCBC		
			50 mm*	EUKK-JHBC	EUKS-JHBC	EUPK-JHBC	EUPS-JHBC		
			None	EUKK-N00C	EUKS-N00C	EUPK-N00C	EUPS-N00C		
	200 µm	None	Fiber pigtail 62.5- core/125-clad (0.27 NA) FC/PC	EUKK-NQ0C	EUKS-NQ0C	EUPK-NQ0C	EUPS-NQ0C		
			Fiber pigtail 105- core/125-clad (0.22 NA) FC/PC	EUKK-NR0C	EUKS-NR0C	EUPK -NR0C	EUPS -NR0C		
			Fiber pigtail 200- core (0.37 NA) FC/PC	EUKK-NT0C	EUKS-NT0C	EUPK-NT0C	EUPS-NT0C		
			None	EUKK-N0BC	EUKS-N0BC	EUPK-N0BC	EUPS-N0BC		
		with 17x laser collimator	21 mm	EUKK-NCBC	EUKS-NCBC	EUPK-NCBC	EUPS-NCBC		
			50 mm*	EUKK-NHBC	EUKS-NHBC	EUPK-NHBC	EUPS-NHBC		
			None	EUMK-J00C	EUMS-J00C	EUQK-J00C	EUQS-J00C		
			Fiber pigtail 62.5- core/125-clad (0.27 NA) FC/PC	EUMK-JQ0C	EUMS-JQ0C	EUQK-JQ0C	EUQS-JQ0C		
300 µJ	4 ns	75 µm	None	Fiber pigtail 105- core/125-clad (0.22 NA) FC/PC	EUMK-JR0C	EUMS-JR0C	EUQK-JR0C	EUQS-JR0C	
				Fiber pigtail 200- core (0.37 NA) FC/PC	EUMK-JT0C	EUMS-JT0C	EUQK-JT0C	EUQS-JT0C	
				None	EUMK-J0BC	EUMS-J0BC	EUQK-J0BC	EUQS-J0BC	
				21 mm	EUMK-JCBC	EUMS-JCBC	EUQK-JCBC	EUQS-JCBC	
		with 17x laser collimator	50 mm*	EUMK-JHBC	EUMS-JHBC	EUQK-JHBC	EUQS-JHBC		
			None	EUMK-N00C	EUMS-N00C	EUQK-N00C	EUQS-N00C		
			Fiber pigtail 62.5- core/125-clad (0.27 NA) FC/PC	EUMK-NQ0C	EUMS-NQ0C	EUQK-NQ0C	EUQS-NQ0C		
			Fiber pigtail 105- core/125-clad (0.22 NA) FC/PC	EUMK-NR0C	EUMS-NR0C	EUQK-NR0C	EUQS-NR0C		
	with 17x laser collimator	Fiber pigtail 200- core (0.37 NA) FC/PC	EUMK-NT0C	EUMS-NT0C	EUQK-NT0C	EUQS-NT0C			
		None	EUMK-N0BC	EUMS-N0BC	EUQK-N0BC	EUQS-N0BC			
		21 mm	EUMK-NCBC	EUMS-NCBC	EUQK-NCBC	EUQS-NCBC			
		50 mm*	EUMK-NHBC	EUMS-NHBC	EUQK-NHBC	EUQS-NHBC			
	750 µJ	8 ns	200 µm	None	EUNK-N00C	EUNS-N00C	EURK-N00C	EURS-N00C	
				with 17x laser collimator	None	EUNK-N0BC	EUNS-N0BC	EURK-N0BC	EURS-N0BC
				21 mm	EUNK-NCBC	EUNS-NCBC	EURK-NCBC	EURS-NCBC	
				50 mm*	EUNK-NHBC	EUNS-NHBC	EURK-NHBC	EURS-NHBC	

* PRELIMINARY

CONFIGURATION



ELECTRICAL Block Diagram



Connector Pin Assignments

APD Photoreceiver Board

The functionality of the electrical connections to the APD photoreceiver can be found in the *ROX Series InGaAs APD Photoreceivers* datasheet and user manual.

Pin	Name	In/Out	Description	Typ
1	VAPD	Input	APD bias voltage	
2	GND	Input	Ground	GND
3	NC	Input	High voltage isolation	NA
4	GND	Input	Ground	
5	AGND	Input	Analog ground	GND
6	SIG-	Output	1.8V full-swing complementary digital output signal from receiver	1.8V
7	AGND	Input	Analog ground	
8	SIG+	Output	1.8V full-swing complementary digital output signal from receiver	1.8V
9	3.3V	Input	3.3V digital supply	3.3V
10	GND	Input	Ground	
11	VthSW	Input	Threshold voltage switch for TVT—switches between $V_{Th,hi}$ and $V_{Th,lo}$	
12	NC	NA	No connect	NA
13	VthL	Input	Threshold low voltage	
14	GND	Input	Ground	GND
15	VthH	Input	Threshold high voltage	
16	uCLK	Input	i2c clock for photoreceiver (two-wire interface)	
17	AGND	Input	Analog ground	
18	uDATA	Input	i2c data for photoreceiver (two-wire interface)	
19	V _{CMOS2}	Input	5V ROX photoreceiver supply	5VDC
20	START	Input	Receiver mode control	
UFL Connector				
	Analog	Output	Analog Output	1.8 V

LRF System Board User Interface (Hirose DF3-8P-2DS)

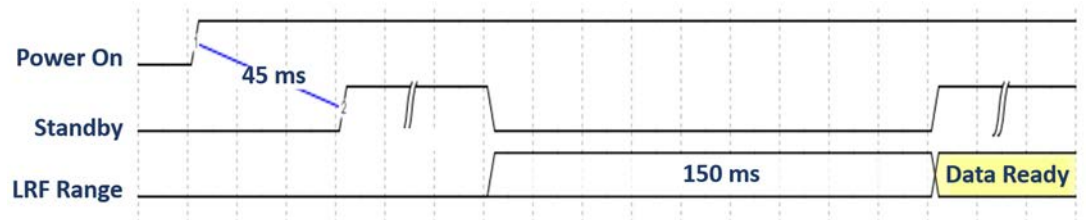
Pin	Name	In/Out	Description	Min	Typ	Max
1	LRF_RANGE	Input	Initiates range measurement when rising edge is detected on this pin.		3.3V	
2	LASERGATE	Output	Laser gate signal to laser-diode driver board. Can be monitored or actively driven.		3.3V	
3	LRF_ENABLE	Input	Active low enable. Pin pull up to 5V w/100 kΩ resistor. Pull low to enable LRF power.			
4	NC	NA	No Connect		NA	
5	GND	Input	System Ground		Ground	
6	TX	Output	UART Transmit		3.3V	
7	RX	Input	UART Receiver		3.3V	
8	5V	Input	System Power Input		5V	

Laser Driver Board

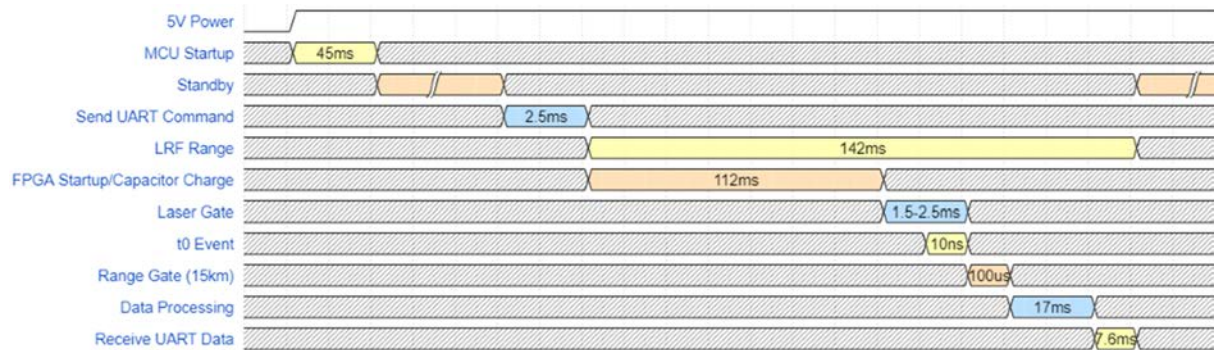
For electrical connections to the laser driver board, see Voxtel's *DPSS Laser Series* datasheet.

Timing Diagrams

Power-up to Range Timing



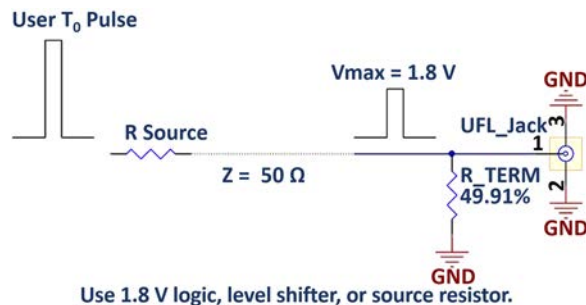
Ranging Operation Timing Diagram—LRF Single-Pulse Range Cycle



Parameters: Capacitor charge time: 100ms, Returns: 7, Max range: 15km, Return string: 40 characters

Configuration for Triggering the Time-to-Digital Converter Using an External Electrical T_0

To configure the LRF to receive an electronic T_0 pulse, users can supply a maximum 1.8V pulse to the UFL connector located on the LRF system board (see *Mechanical Drawings, LRF System Board*) using a 50-ohm terminated cable. The external T_0 pulse is enabled using software commands to configure the board.



SOFTWARE CONTROL

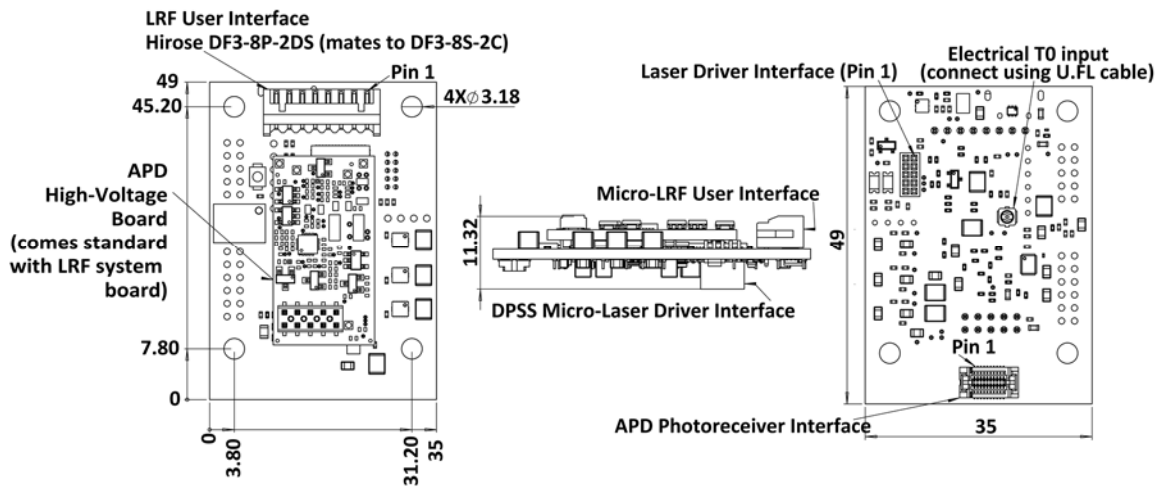
The LRF System-Integrator Kit can be easily programmed using the simple serial communications command set over a simple serial UART interface.

User-programmable features include: • time-variable threshold (TVT), used to reduce false alarms due to nearfield scattering, • time-over-threshold (TOT) range-walk compensation, used to reduce amplitude-dependent timing errors • autocalibration, used to set the threshold to achieve a user-defined FAR given ambient background optical radiation conditions • multi-pulse processing, used to enhance range and resolution • passive operation, used to measure the pulse-repetition frequency of external lasers.

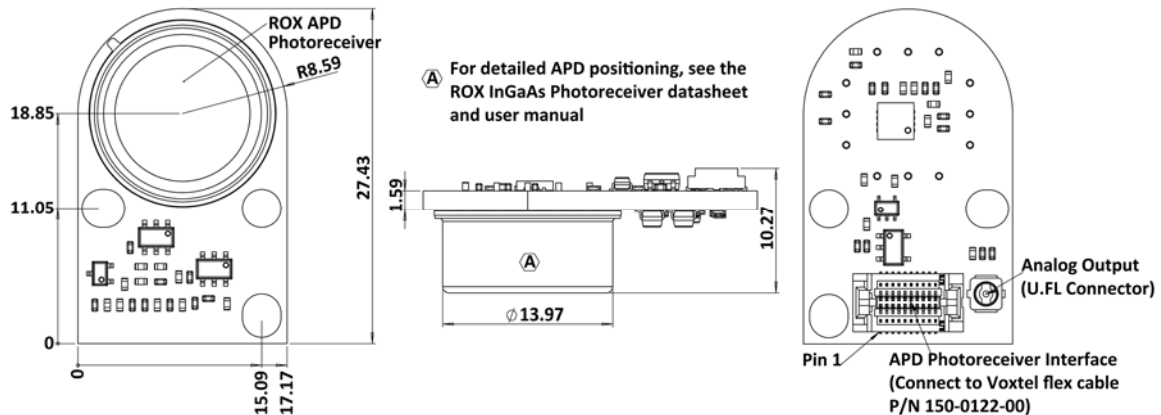
The available commands can be found in the Voxel document: *LRF Software ICD: Modules, Kits, and Components*. To configure and operate the LRF using a terminal emulator of a graphic user interface, see the Quick Start section of the Voxel document: *LRF User Manual: Modules, Kits, and Components*. These documents are shipped with the product and are available at voxel-inc.com. The website can also be used to download software to update device drivers and firmware.

MECHANICAL DRAWINGS

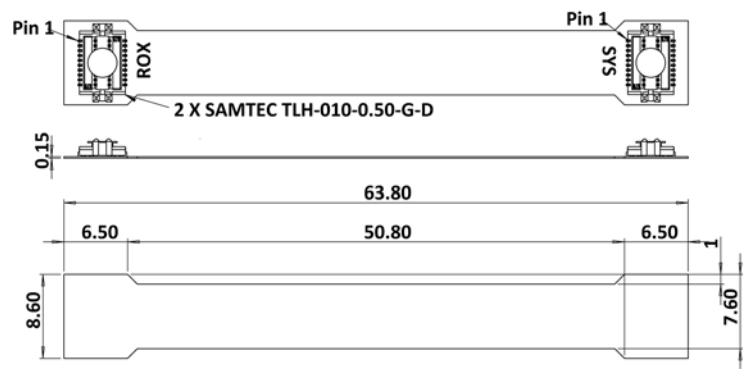
LRF System Board



ROX APD Photoreceiver Board



Ribbon Cable



Laser and Laser Driver Boards

See Voxel datasheet: *DPSS Laser Series*.