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.
### SPECIFICATIONS

<table>
<thead>
<tr>
<th>LRF System-Integrator Kit without T0 detector</th>
<th>EUKK-N00C</th>
<th>EUMK-J00C</th>
<th>EUMK-N00C</th>
<th>EUNK-N00C</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Voxel laser model number</strong></td>
<td>LAK0-E00C</td>
<td>LAM0-F00C</td>
<td>LAM0-F00C</td>
<td>LAN0-F00C</td>
</tr>
<tr>
<td><strong>Voxel APD photoreceiver model number</strong></td>
<td>RUC1-NIAC</td>
<td>RUC1-JIAC</td>
<td>RUC1-NIAC</td>
<td>RUC1-NIAC</td>
</tr>
<tr>
<td><strong>Transmitter wavelength</strong></td>
<td>1534 nm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Laser peak power (typical)</strong></td>
<td>29 kW</td>
<td>48 kW</td>
<td>48 kW</td>
<td>115 kW</td>
</tr>
<tr>
<td><strong>Transmitter pulse spectral width</strong></td>
<td>4 ns</td>
<td>7 ns</td>
<td>7 ns</td>
<td>5 ns</td>
</tr>
<tr>
<td><strong>Transmitter beam width (FWHM)</strong></td>
<td>0.02 nm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Wavelength shift</strong></td>
<td>+0.014 nm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Transmitter beam diameter</strong></td>
<td>250 μm</td>
<td>300 μm</td>
<td>300 μm</td>
<td>450 μm</td>
</tr>
<tr>
<td><strong>Transmitter beam divergence, full angle (1/e^2)</strong></td>
<td>12 mrad</td>
<td>8 mrad</td>
<td>8 mrad</td>
<td>6 mrad</td>
</tr>
<tr>
<td><strong>Transmitter beam quality (M²)</strong></td>
<td>1.15 x DL</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>APD collection aperture</strong></td>
<td>200 μm</td>
<td>75 μm</td>
<td>200 μm</td>
<td>200 μm</td>
</tr>
<tr>
<td><strong>Noise equivalent input</strong></td>
<td>45 photons</td>
<td>45 photons</td>
<td>45 photons</td>
<td>45 photons</td>
</tr>
<tr>
<td><strong>Total dynamic range</strong></td>
<td>70 dB</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Linear dynamic range</strong></td>
<td>25 dB</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>APD gain range (M)</strong></td>
<td>1 – 20</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>APD responsivity (M = 1)</strong></td>
<td>1.1 A/W</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Number of returns per pulse, maximum</strong></td>
<td>20</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Target separation, minimum</strong></td>
<td>5 m</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Range accuracy (single-pulse/multi-pulse)¹,²</strong></td>
<td>500 mm / 100 mm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Minimum range</strong></td>
<td>20 m</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Power consumption, LRF disabled</strong></td>
<td>&lt; 1 mW</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Power consumption, standby</strong></td>
<td>250 mW</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Power consumption, 1-Hz continuous ranging¹</strong></td>
<td>700 mW</td>
<td>900 mW</td>
<td>900 mW</td>
<td>1400 mW</td>
</tr>
<tr>
<td><strong>Timing, power-on to standby</strong></td>
<td>45 ms</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Timing, standby to range</strong></td>
<td>180 ms</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Communications interface</strong></td>
<td>Serial commands, UART 3.3V CMOS Logic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Analog signal (peak to peak)</strong></td>
<td>150 mV</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Operating humidity (relative humidity)</strong></td>
<td>90%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Operating temperature⁶</strong></td>
<td>-50 °C to +65 °C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Storage temperature</strong></td>
<td>-55 °C to +85 °C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Lifetime (MTTF)</strong></td>
<td>50 million shots</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Weight</strong></td>
<td>37.2 g</td>
<td>38.3 g</td>
<td>38.3 g</td>
<td>53.4 g</td>
</tr>
<tr>
<td><strong>Options (See Ordering Information for part numbers)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>With Integrated T0 Detector</td>
<td>+0.2 g</td>
<td>+0.2 g</td>
<td>+0.2 g</td>
<td>+0.2 g</td>
</tr>
<tr>
<td>With Auxiliary Board</td>
<td>+5.0 g</td>
<td>+5.0 g</td>
<td>+5.0 g</td>
<td>+5.0 g</td>
</tr>
<tr>
<td>With 17x Laser Beam Expander/Collimator</td>
<td>+51.3 g</td>
<td>+55.6 g</td>
<td>+55.6 g</td>
<td>+58.1 g</td>
</tr>
<tr>
<td>With 21 mm Optics</td>
<td>+46.8 g</td>
<td>+46.8 g</td>
<td>+46.8 g</td>
<td>+46.8 g</td>
</tr>
<tr>
<td>With 50 mm Optics</td>
<td>+61.0 g</td>
<td>+61.0 g</td>
<td>+61.0 g</td>
<td>+61.0 g</td>
</tr>
<tr>
<td>Exclusions (See Ordering Information for part numbers)**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Without Laser &amp; Laser Driver Board</td>
<td>-18.3 g</td>
<td>-19.4 g</td>
<td>-19.4 g</td>
<td>-34.5 g</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Receiver aperture</th>
<th>21 mm</th>
<th>21 mm</th>
<th>21 mm</th>
<th>21 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Receiver f/number</td>
<td>f/1</td>
<td>f/1</td>
<td>f/1</td>
<td>f/1</td>
</tr>
</tbody>
</table>

With 50-mm Receiving Optical Mechanical Module

<table>
<thead>
<tr>
<th>Receiver aperture</th>
<th>50 mm</th>
<th>50 mm</th>
<th>50 mm</th>
<th>50 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Receiver f/number</td>
<td>f/1</td>
<td>f/1</td>
<td>f/1</td>
<td>f/1</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Laser Pulse Energy (Eyesafe DPSS Laser)</th>
<th>Pulse Width</th>
<th>InGaAs APD Photoreceiver</th>
<th>Laser Collimator Module Options</th>
<th>Receiver Optics Module Options</th>
<th>Part Number</th>
<th>Without T0 Detector</th>
<th>With T0 Detector Integrated with Laser</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Laser—Photoreceiver &amp; Laser Ranging Control Electronics Only</td>
<td>NA</td>
<td>75 µm</td>
<td>None</td>
<td>None</td>
<td>EUK-J00C</td>
<td>EUK-J00C</td>
<td>EUK-J00C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>200 µm</td>
<td>None</td>
<td>None</td>
<td>EUK-N00C</td>
<td>EUK-N00C</td>
<td>EUK-N00C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>250 µm CA</td>
<td>None</td>
<td>None</td>
<td>EUK-K00C</td>
<td>EUK-K00C</td>
<td>EUK-K00C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>500 µm</td>
<td>None</td>
<td>None</td>
<td>EUK-P00C</td>
<td>EUK-P00C</td>
<td>EUK-P00C</td>
</tr>
<tr>
<td><strong>75 µm</strong></td>
<td>4 ns</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>EUK-J00C</td>
<td>EUK-J00C</td>
<td>EUK-J00C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>75 µm</td>
<td>None</td>
<td>None</td>
<td>EUK-J00C</td>
<td>EUK-J00C</td>
<td>EUK-J00C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>100 µJ</td>
<td>None</td>
<td>None</td>
<td>EUK-J00C</td>
<td>EUK-J00C</td>
<td>EUK-J00C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>200 µm</td>
<td>None</td>
<td>None</td>
<td>EUK-J00C</td>
<td>EUK-J00C</td>
<td>EUK-J00C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>200 µm</td>
<td>None</td>
<td>None</td>
<td>EUK-J00C</td>
<td>EUK-J00C</td>
<td>EUK-J00C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>300 µJ</td>
<td>None</td>
<td>None</td>
<td>EUK-J00C</td>
<td>EUK-J00C</td>
<td>EUK-J00C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>200 µm</td>
<td>None</td>
<td>None</td>
<td>EUK-J00C</td>
<td>EUK-J00C</td>
<td>EUK-J00C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>750 µJ</td>
<td>None</td>
<td>None</td>
<td>EUK-J00C</td>
<td>EUK-J00C</td>
<td>EUK-J00C</td>
</tr>
</tbody>
</table>

* PRELIMINARY
**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.

<table>
<thead>
<tr>
<th>Pin</th>
<th>Name</th>
<th>In/Out</th>
<th>Description</th>
<th>Typ</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>VAPD</td>
<td>Input</td>
<td>APD bias voltage</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>GND</td>
<td>Input</td>
<td>Ground</td>
<td>GND</td>
</tr>
<tr>
<td>3</td>
<td>NC</td>
<td>Input</td>
<td>High voltage isolation</td>
<td>NA</td>
</tr>
<tr>
<td>4</td>
<td>GND</td>
<td>Input</td>
<td>Ground</td>
<td>GND</td>
</tr>
<tr>
<td>5</td>
<td>AGND</td>
<td>Input</td>
<td>Analog ground</td>
<td>GND</td>
</tr>
<tr>
<td>6</td>
<td>SIG-</td>
<td>Output</td>
<td>1.8V full-swing complementary digital output signal from receiver</td>
<td>1.8V</td>
</tr>
<tr>
<td>7</td>
<td>AGND</td>
<td>Input</td>
<td>Analog ground</td>
<td>GND</td>
</tr>
<tr>
<td>8</td>
<td>SIG+</td>
<td>Output</td>
<td>1.8V full-swing complementary digital output signal from receiver</td>
<td>1.8V</td>
</tr>
<tr>
<td>9</td>
<td>3.3V</td>
<td>Input</td>
<td>3.3V digital supply</td>
<td>3.3V</td>
</tr>
<tr>
<td>10</td>
<td>GND</td>
<td>Input</td>
<td>Ground</td>
<td>GND</td>
</tr>
<tr>
<td>11</td>
<td>VthSW</td>
<td>Input</td>
<td>Threshold voltage switch for TVT—switches between Vth,Hi and Vth,Lo</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>NC</td>
<td>NA</td>
<td>No connect</td>
<td>NA</td>
</tr>
<tr>
<td>13</td>
<td>VthL</td>
<td>Input</td>
<td>Threshold low voltage</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>GND</td>
<td>Input</td>
<td>Ground</td>
<td>GND</td>
</tr>
<tr>
<td>15</td>
<td>VthH</td>
<td>Input</td>
<td>Threshold high voltage</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>uCLK</td>
<td>Input</td>
<td>i2c clock for photoreceiver (two-wire interface)</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>AGND</td>
<td>Input</td>
<td>Analog ground</td>
<td>GND</td>
</tr>
<tr>
<td>18</td>
<td>uDATA</td>
<td>Input</td>
<td>i2c data for photoreceiver (two-wire interface)</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>V_CMS2</td>
<td>Input</td>
<td>5V ROX photoreceiver supply</td>
<td>5VDC</td>
</tr>
<tr>
<td>20</td>
<td>START</td>
<td>Input</td>
<td>Receiver mode control</td>
<td></td>
</tr>
</tbody>
</table>

**UFL Connector**

| Analog | Output | Analog Output | 1.8 V |
**LRF System Board User Interface (Hirose DF3-8P-2DS)**

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

**Laser Driver Board**

For electrical connections to the laser driver board, see Voxel’s DPSS Laser Series datasheet.

**Timing Diagrams**

**Power-up to Range Timing**

![Power-up to Range Timing Diagram](image)

**Ranging Operation Timing Diagram—LRF Single-Pulse Range Cycle**

![Ranging Operation Timing Diagram](image)

**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.

![Configuration for Triggering the Time-to-Digital Converter Using an External Electrical \( T_0 \)](image)

Use 1.8 V logic, level shifter, or source resistor.
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 Voxtel 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 Voxtel document: LRF User Manual: Modules, Kits, and Components. These documents are shipped with the product and are available at voxtel-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.