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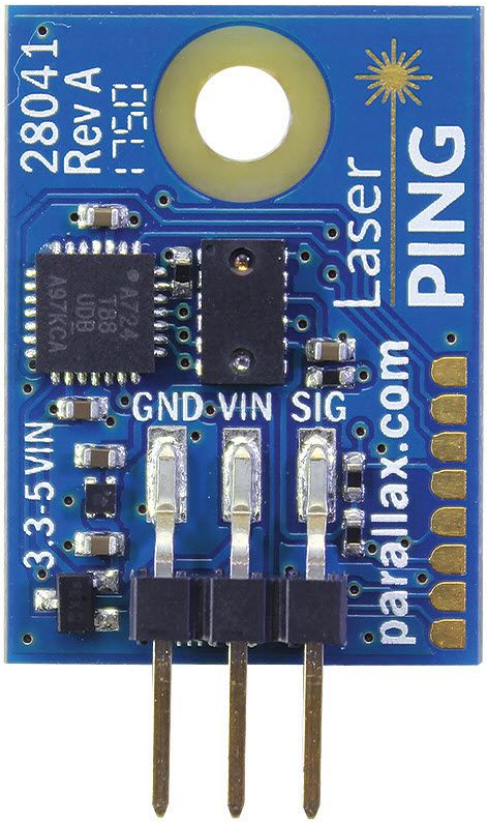
LaserPING Rangefinder Module (#28041)



The LaserPING 2m Rangefinder provides an easy method of distance measurement. This near-infrared, time-of-flight (TOF) sensor is ideal for taking measurements between moving or stationary objects.

A single I/O pin is used to both query the LaserPING sensor for its latest distance measurement, and to read the reply.

The LaserPING 2m Rangefinder can be used with nearly any microcontroller, utilizing its PWM mode or optional serial mode. It is designed to be circuit- and code-compatible with the PING))) Ultrasonic Distance Sensor, making applications adaptable where different environmental conditions need to be considered. Measurements can even be taken through an acrylic window to protect the sensor.

The sensor's built-in co-processor ensures the right logic levels. Its I/O connections operate at the same voltage supplied to the VIN pin, for compatibility with 3.3V and 5V microcontrollers.

Features

- Non-contact distance measurement with a 2 –200 cm range
- Factory pre-calibrated for accuracy with 1 mm resolution
- Eye-safe invisible near-infrared (IR) illumination using a class 1 laser emitter
- Reverse polarity protection if VIN and GND are accidentally swapped
- Onboard microprocessor handles complex sensor code
- Compatible with 3.3V and 5V microcontrollers
- Breadboard-friendly 3-pin SIP form-factor with mounting hole

Application Ideas

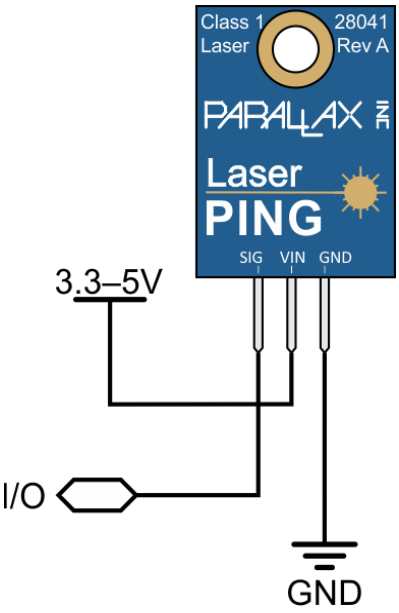
- Physics studies
- Security systems
- Interactive animated exhibits
- Robotics navigation and parking assistant systems
- Interactive applications such as hand detection and 1D gesture recognition
- Volume or height detection in process control systems

Key Specifications

- Laser: 850 nm VCSEL (Vertical Cavity Surface Emitting Laser)
- Range: 2–200 cm
- Resolution: 1 mm
- Typical refresh rate: 15 Hz PWM mode, 22 Hz serial mode
- Power requirements: +3.3V DC to +5 VDC; 25 mA
- Communication: PWM (idle low) or serial 9600 baud (idle high); logic level = VIN
- Operating temperature: +14 to +140 °F (-10 to +60 °C)
- Laser eye safety: near-infrared Class 1 laser product
- Field of illumination: 23° degrees
- Field of view: 55° degrees
- Form factor: 3-pin male header with 0.1" spacing
- PCB dimensions: 22 x 16 mm

Getting Started

Connect the LaserPING sensor's pins to power, ground, and your microcontroller's I/O pin as shown in the diagram. Note that the diagram shows the back of the sensor; point the component side toward your target object.



The LaserPING sensor is supported by BlocklyProp blocks, Propeller C libraries, and example code for the BASIC Stamp and Arduino Uno. It is circuit- and code-compatible with applications for the PING))) Ultrasonic Distance Sensor (#28015).

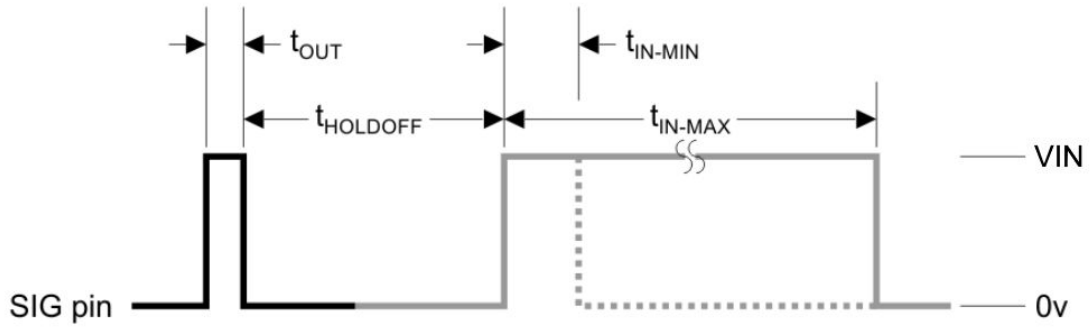
Look for downloads and tutorial links on the sensor's product page; search "28041" at www.parallax.com.

Communication Protocol

The sensor emits an infrared (IR) laser pulse which travels through the air, reflects off of objects and then bounces back to the sensor. The LaserPING module accurately measures how long the reflected laser pulse takes to return to the sensor, and converts this time measurement into millimeters, with a 1 mm resolution. Your microcontroller queries the LaserPING module for the latest measurement (which is refreshed about every 40 ms) and then receives the value back on the same I/O pin, as either a variable-width pulse in PWM mode, or as ASCII characters in serial mode.

PWM Mode

PWM default mode is designed to be code-compatible with PING))) Ultrasonic Distance Sensor (#28015) code. It can communicate with 3.3 V or 5 V TTL or CMOS microcontrollers. PWM Mode uses a bidirectional TTL pulse interface on a single I/O pin (SIG). The SIG pin will idle low, and both the input pulse and echo pulse will be positive high, at the VIN voltage.



	Host Device	Input Trigger Pulse	t_{OUT}	2 µs (min)
	LaserPING Sensor	Holdoff	$t_{HOLDOFF}$	750 µs
		Return Pulse Minimum	t_{IN-MIN}	115 µs
		Return Pulse Maximum	t_{IN-MAX}	15 ms
		Delay before next measurement		65 ms

Pulse width	Condition
115 to 290 µs	Reduced accuracy measurement
290 µs to 12 ms	Highest accuracy measurement
13 ms	Invalid measurement — target too close or too far
14 ms	Internal sensor error
15 ms	Internal sensor timeout

The pulse width is proportional to the distance, and does not significantly change with the ambient temperature, pressure, or humidity.
To convert the pulse width from time, in µs, to mm, use the following equation:

Distance (mm) = Pulse Width (ms) × 171.5

To convert the pulse width from time, in µs, to inches, use the following equation:

Distance (inches) = Pulse Width (ms) × 6.752

Serial Data Mode

Serial data mode works at 9600 baud with a bidirectional TTL interface on a single I/O pin (SIG), and can communicate with 3.3 V or 5 V TTL or CMOS microcontrollers. The SIG pin will idle high in this mode, at the VIN voltage.

To switch from the default PWM mode to serial mode, drive the SIG pin low, then send three high 100 µs pulses with 5 µs, or longer, low gaps between. This can be done by transmitting a capital 'I' character.

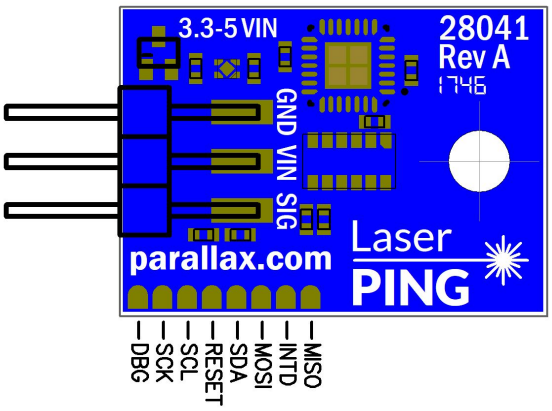
Tip: For use with microcontrollers that do not support bidirectional serial, the LaserPING module can be configured to wake-up in serial mode. In this case, only a single serial-rx input is required at your microcontroller! Refer to the section "Enabling Serial on Start-up" below.

In Serial mode, LaserPING will constantly send new measurement data in ASCII format. The value will be in millimeters, and followed by carriage return character (decimal 13). A new value will be transmitted each time the sensor receives a valid reading, typically once every 45 ms.

Serial Value	Condition
50 to 2000	Highest accuracy measurement in millimeters
1 to 49	Reduced accuracy measurement in millimeters
2001 to 2046	
2047	Reflection detected beyond 2046 millimeters
0 or 2222	Invalid measurement (No reflection; target too close, too far, or too dark)
9998	Internal sensor error
9999	Internal sensor timeout

To stop serial mode and return to the default PWM mode:

- Assert the SIG pin low, and hold low for 100 ms
- Release the SIG pin (typically set your I/O pin that is connected to SIG back to high-impedance input mode)
- LaserPING will now be in PWM mode



Enabling Serial on Start-up

The 2 SMT pads marked DBG and SCK can be shorted together to change the default data mode, enabling serial mode on start-up. The LaserPING module checks the status of the DBG/SCK pins at power-up.

- DBG and SCK open = Default to PWM mode (factory default mode)
- DBG and SCK shorted together = Default to Serial Data Mode

To short the two pins, a 0402 resistor < 4 k-ohm, a zero ohm link, or a solder blob may be soldered across the pads. See SMT Test Pad Descriptions below for details on these pads.

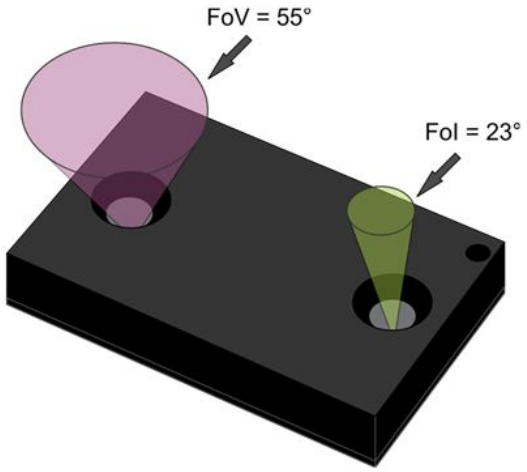
In serial mode upon startup, the sensor takes about 100 ms to initialize, after which the LaserPING will automatically start sending serial ASCII values at 9600 baud to the SIG pin. Data will arrive in a continuous CR (decimal 13) terminated ASCII serial stream, with each new reading arriving approximately every 45 ms. This 45 ms interval will vary slightly, as according to the distance measured, the time required for the sensor to detect, count and process the data will also vary slightly.

Maximum Ranging Distance and Ranging Accuracy

The table below shows the ranging accuracy specifications of the device, with data obtained with the device operating at room temperature and no cover glass on the device. The device may operate outside of these ranges at reduced accuracy.

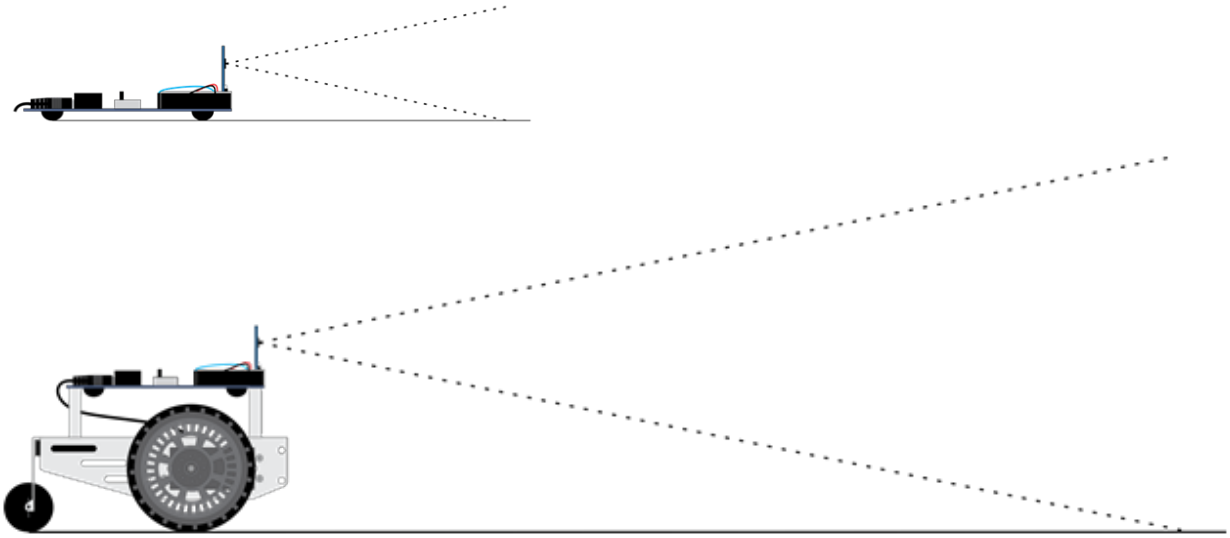
Target Reflectance Covering Full Field of View (FoV)	Range Accuracy		
	50 to 100 mm	100 to 1500 mm	1500 to 2000 mm
White Target (90%)	+/- 15%	+/- 7%	+/- 7%
Gray Target (18%)	+/- 15%	+/- 7%	+/- 10%

Field of View (FoV) and Field of Illumination (FoI)



The emitter and receiver elements of the laser sensor form a cone shape. The emitter field of illumination (FoI) is 23°, and the receiver field of vision (FoV) is 55°. The LaserPING sensor will only sense objects within the FoI, but may have reduced sensitivity when bright objects are within the FoV. Readings may also be inaccurate when mirrored surfaces within the FoI scatter light to other objects within the FoI or FoV.

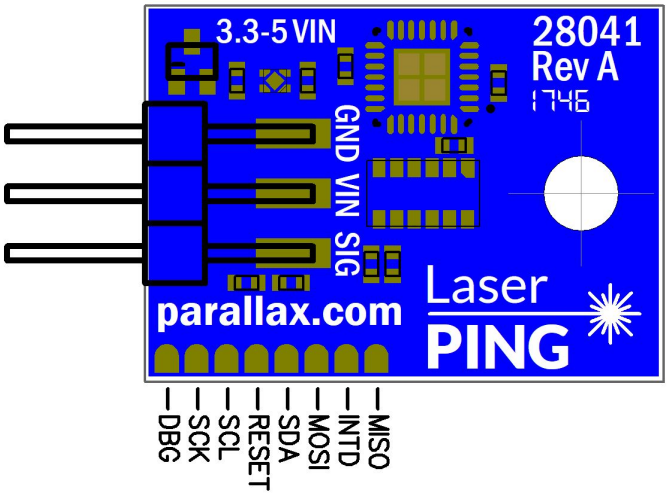
When measuring long distances the sensor should be far enough from any surrounding floors, walls or ceilings to ensure that they do not become an unintentional target, within the FoI. At 200 cm from the LaserPING module, the FoI is an 81.4 cm diameter disk. Elevation above a surface can affect practical sensing range, since some surfaces will reflect rather than deflect:



Pin Descriptions

Pin	Type	Function
GND	Ground	Common Ground (0 V supply)
VIN	Power	The module will operate between 3.3V to 5V DC. The VIN voltage also sets the logic-high level voltage for the SIG pin.
SIG	I/O*	PWM or Serial data input / output

* When in PWM mode, the SIG pin operates as an open collector input, with a 55 k-ohm pull-down resistor, except for response pulses, which are driven to VIN. When in serial mode, the SIG pin operates as a push-pull output.



End-user access of the test pads, beyond changing the default mode upon startup from PWM to Serial, is not supported.

Pad	Type	Function
DBG	Open collector	Coprocessor programming pin (PC1)
SCK	Open collector	Coprocessor programming pin (PB5)
SCL	Open collector	Laser sensor I2C clock with 3.9K pull-up to 3V
RESET	Open collector	Coprocessor programming pin (PC6)
SDA	Open collector	Laser sensor I2C serial data with 3.9K pull-up to 3V
MOSI	Open collector	Coprocessor programming pin (PB3)
INTD	Push Pull (active low)	Laser sensor Data Ready Interrupt Normally logic high, this pin drives low when a new value is available, and reverts to high once the value is read.
MISO	Open collector	Coprocessor programming pin (PB4)

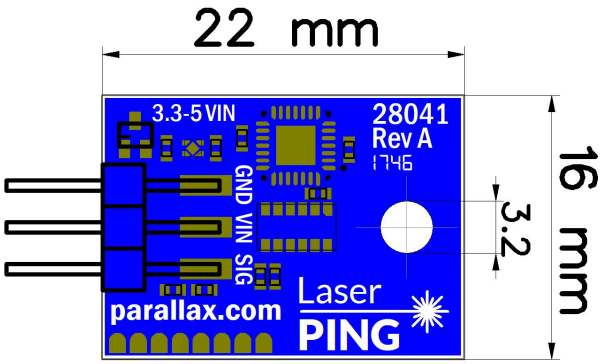
Cover Glass Selection Guide

The LaserPING module has a mounting hole positioned to simplify fitting an optional cover glass. This could be used to protect the sensor in certain applications, or to experiment with the impact of different materials acting as filters on the infrared laser light.

To obtain the best performance, the following rules should be considered for the cover glass:

- Material: PMMA, Acrylic
- Spectral transmittance: T< 5% for λ < 770 nm, T> 90% for λ > 820 nm
- Air gap: 100 µm
- Thickness: < 1mm (the thinner, the better)
- Dimensions: larger than 6 x 8 mm

PCB Dimensions



Revision History

Version 1.0: original release.