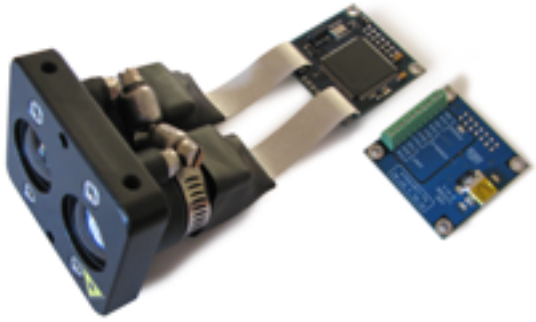
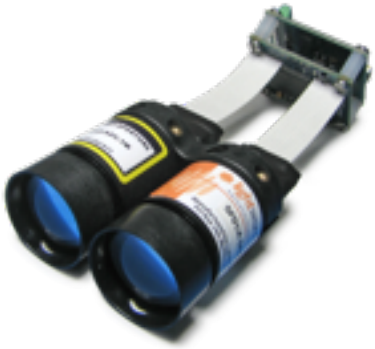


SF01 and SF01 INT



SF01/A

SF01/H

The SF01 laser rangefinder product family provides a fast and accurate, distance measuring capability.

Each family member is optimised for specific applications:

- The SF01 (INT) can be integrated into existing products.
- The SF01/A is a lightweight altimeter for UAVs.
- The SF01/H is designed for industrial applications.

The SF01 modules comprise all the necessary optical and electronic components along with embedded software for a pulsed laser, time-of-flight, distance measuring instrument.

Its configurable features and standard hardware interfaces make the SF01 an easy to understand and use add-on to prototypes or professional products.

Features:

- *A laser based rangefinder modules suitable for OEM applications.*
- *Accurately measures the distance to most surfaces and objects.*
- *Can detect targets over 60 meters away with a resolution of 1 centimeter.*
- *Updates at 8 readings per second.*
- *Includes digital and analog interfaces with programmable capabilities.*
- *Easy to configure using the built-in menus.*
- *Fully calibrated and ready to run.*
- *Accessory cards with standard interfaces speed up embedded development.*
- *Available in single units or in production quantities.*
- *Available with IP67 housing.*

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1. Overview

The SF01 laser rangefinder product family are prototyping and production modules designed to be integrated into products and systems that need fast, accurate and reliable distance measuring capability. The module comprises all the optical components, electronics and software for a pulsed laser, time-of-flight, distance measuring instrument. The SF01/H includes an IP67 housing.

Operating from a single 5V DC supply, the SF01 includes analog, digital and UART interfaces that can be easily connected to an embedded controller or a standard processing platform such as Arduino® or Raspberry Pi®. Each interface can be configured using simple software menus and the measurement data can be read from a UART connected to your host controller.

The SF01 works by measuring the time it takes for a very short pulse of laser light to travel to a target surface and back again. The distance to the target is half of this time multiplied by the speed of light. This distance is measured with a resolution of 1cm and the accuracy is not affected by the distance to the target, the colour of the surface or the angle of incidence of the laser beam to the surface.

The SF01 is designed to be integrated into many different products in order to add accurate distance measuring capability. There are literally thousands of possible uses and here are few examples:

- Hobby electronics - The SF01 can be incorporated into autonomous robots, AGVs or UAVs to help with navigation and obstacle avoidance.
- Safety - The SF01 can be used to create light barriers that detect when people, vehicles or machinery intrude into hazardous areas.
- Industrial - The SF01 can be incorporated into industrial equipment that measures the distance to moving machinery or the level of solid materials in silos.
- Scientific - The SF01 can be used to monitor erosion in environmentally sensitive areas or measure the height of trees in cultivated or natural forests.
- Industrial - The SF01 can be used to measure distance or level to many different types of surface.

Laser rangefinders fall into the category of “non-contact, active sensors.” By using laser light to sense the distance to an object or surface, these devices aren’t affected by noise, wind or air temperature so the results are very stable and repeatable. In addition, the parallel laser beam travels long distances without loosing energy and so the sensing range is also long.

Another advantage of laser rangefinders is that they are able to measure natural materials and surfaces at any angle. This means that the return signal is practically constant no matter what angle the laser beam strikes a surface. In “real world” conditions, this means that reliable and consistent measurements can be made to many different types of surface - smooth, rough, granular, sloping, undulating or flat.

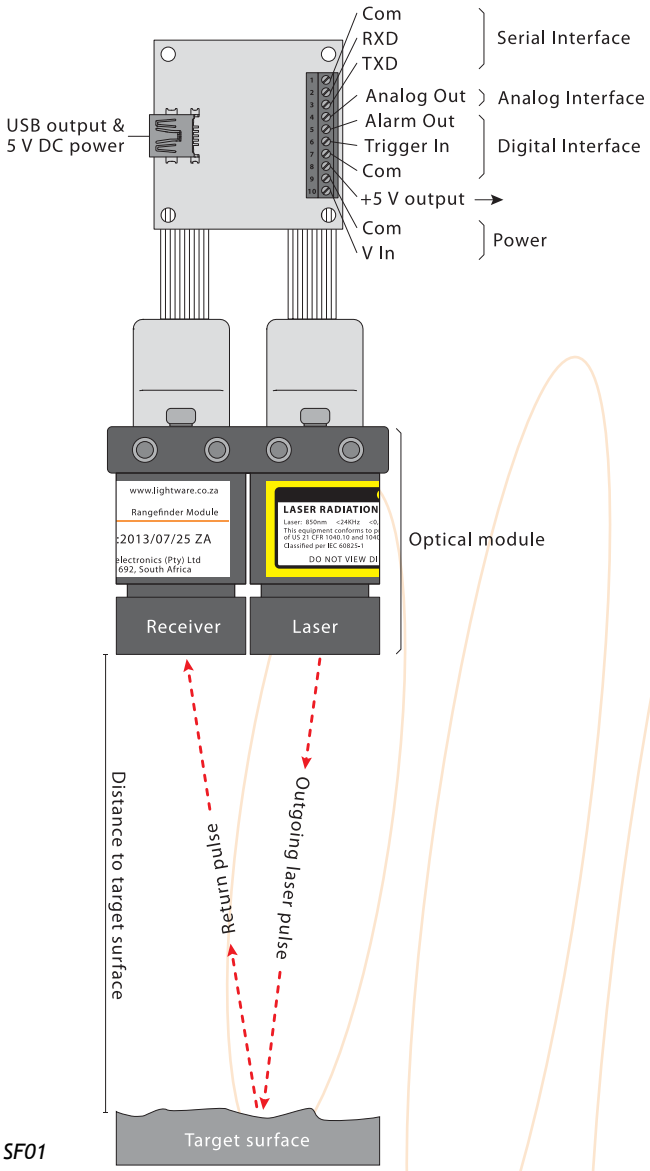

Figure 1 :: The main features of the SF01

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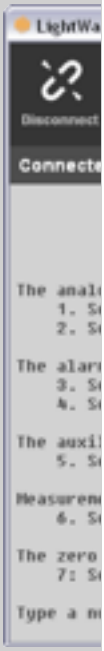
2. Quick start guide



1. CAUTION - The SF01 laser rangefinder contains a laser and should never be aimed at a person or an animal. Do not look at the beam directly with optical instruments.

2. If it's not already connected, add the "Universal Interface" accessory card to the SF01 module. Plug a USB cable into the SF01's mini-B connector and connect the other end into a PC. This provides both power and communication for the unit.

3. Download *LightWare Terminal* software from www.lightware.co.za onto your PC. Open the installer package and follow the install instructions and everything needed for communicating with SF01 will automatically be installed.

4. Start the *LightWare Terminal* software and click the "Connect" icon to open a communications port, the baud rate is configured to 115200 with 8 data bits, no parity, one stop bit and no handshaking. The distance measured in meters and the signal strength as a percentage should begin to scroll in the Terminal window. f the connection isn't made automatically then click the "Laser" icon and select the correct port from the list shown.

5. The configuration menu is accessed by pressing the <SPACE> bar on your keyboard. This stops the measurements and displays the "Home" screen. Use the arrow keys to access different menus and running displays. Select menu items and enter new values as a numeric string or as a toggling selection. A summary of the menus is given below:

Menu	Selection	Range of values	Description
Analog Controls	1. 0.0 V setpoint	0.00m to 60.00m	Sets the distance at which the voltage output will show 0.0V.
	2. 3.3 V setpoint	0.00m to 60.00m	Sets the distance at which the voltage output will show 3.3V.
	3. Fail safe	0.0V 3.3V hold	Sets the output voltage that will occur if the measurement is out of range or if the signal is lost. This voltage will only be seen after the time set by "Fail time".
	4. Fail time	0.0sec to 600.0sec	The time between a lost signal and the voltage output indicating the fail safe value.
	5. Test voltage	0.0V, 1.65V, 3.3V	This option toggles the output voltage between the values indicated.
Digital Controls	1. UART baud	9600 … 115200	Selects the baud rate of the auxiliary UART.
	2. Alarm	0.00m to 60.00m	Sets the distance to the alarm switching point.
	3. Hysteresis	0.00m to 2.00m	Sets the hysteresis of the alarm setpoint. This value is subtracted from the alarm for closing distances and added to the alarm for receding distances.
	4. Test alarm	ON, OFF	This option toggles the alarm output on and off.
Test functions			The keyboard letter 'd' tells the auxiliary UART to output the distance answer.
			The keyboard letter 's' tells the auxiliary UART to output the signal strength.

7. Once you have confirmed your settings, return to the "Home" screen by pressing the arrow keys, then press the <SPACE> bar to restart measuring.

8. Click the "Disconnect" icon and disconnect the USB cable from the SF01.

9. There are several power supply and interface options available on the green connector. These connections are used to integrate the SF01 into your system and details of all the options are explained later in this document.

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3. SF01 Interfaces

Interfaces for the SF01/H are available on request whilst the SF01 comes with a universal interface card connected to the controller board. The interface connector on the SF01 controller board is a 0.1" pitch, 14 pin, dual row, female header with pin 1 located as shown in the picture below.

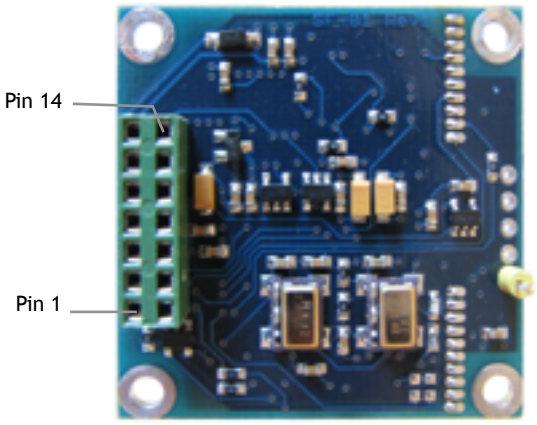

Figure 2 :: SF01 PCB connector orientation

Each pin on the interface header connects to the controller chip of the SF01 and has a specific interface function. Below is a summary of their functions:

Pin	Function	Direction	Protocol	Details
1	Auxiliary UART	RXD	3.3V CMOS	Serial communication channel to an external processor.
2	Auxiliary UART	TXD	3.3V CMOS	Serial communication channel to an external processor.
3	Trigger	Input	0/3.3V/5V	Active low / falling edge trigger to send data out of the auxiliary UART.
4	Main UART	RXD	3.3V CMOS	Configuration communication channel.
5	N/C	--	--	Do not connect.
6	N/C	--	--	Do not connect.
7	Main UART	TXD	3.3V CMOS	Configuration communication channel.
8	Common	--	0V	Common for power and signals.
9	Common	--	0V	Common for power and signals.
10	Interface power	Output	+3.3V DC / 50mA	Power output for external interface hardware.
11	N/C	--	--	Do not connect.
12	Power supply	Input	+5V DC / 150mA	A well regulated and properly decoupled power supply is needed to power the electronics of the SF01.
13	PWM	Output	0/3.3V	A pulse width modulated signal that can be converted into an analog voltage representing the distance to a target surface.
14	Alarm	Output	0/3.3V	Active high alarm signal indicating that the target is closer than a setpoint distance.

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3.1 Interface descriptions

Power supply (pins 12, 8, 9, 10)

The main power to the SF01 should be a well regulated +5V DC source connected to pin 12 of the interface header. The negative rail of this supply should be connected to the common pins 8 and 9. The maximum current draw on the +5V DC supply is 150mA and there is a 10uF decoupling capacitor across the interface terminals. The +5V DC input supplies two linear regulators and two switch-mode regulators so suitable decoupling and noise reduction techniques should be applied to the design of the power supply.

One of the linear regulators on the SF01 produces +3.3V DC which is used by the SF01 electronics and is also made available as an output on pin 10. This supply is suitable for light current circuits that draw less than 50mA and it is intended to support additional interface circuitry where necessary. Any load placed on this line must have low noise characteristics otherwise the performance of the SF01 will be affected. For an example of how to use this supply see the Analog output section later.

Main UART (pins 4, 7, 8, 9)

This 3.3V CMOS serial port is the primary configuration interface for the SF01. It has a fixed baud rate of 115200 (no parity, no handshaking) and is intended to be used in conjunction with a USB converter so that a PC can communicate with the menus built into the SF01. The menu system is designed as an HMI (human-to-machine interface) accepting ASCII characters from a terminal emulation program and transmitting ASCII strings to indicate settings and values. An example of a suitable USB interface is provided by the Universal Interface card which is available as an accessory for the SF01. See Appendix C.

Navigation between menus is done using the arrow keys and settings can be changed by selecting a numbered item and then entering a new value or toggling between various options. All settings are automatically stored in permanent memory inside the SF01 and will remain active after the USB interface is removed and the power is cycled.

Menu	Selection	Range of values	Description
Analog Controls	1. 0.0 V setpoint	0.00m to 60.00m	Sets the distance at which the voltage output will show 0.0V.
	2. 3.3 V setpoint	0.00m to 60.00m	Sets the distance at which the voltage output will show 3.3V.
	3. Fail safe	0.0V 3.3V hold	Sets the output voltage that will occur if the measurement is out of range or if the signal is lost. This voltage will only be seen after the time set by “Fail time”.
	4. Fail time	0.0sec to 600.0sec	The time between a lost signal and the voltage output indicating the fail safe value.
	5. Test voltage	0.0V, 1.65V, 3.3V	This option toggles the output voltage between the values indicated.
Digital Controls	1. UART baud	9600 … 115200	Selects the baud rate of the auxiliary UART.
	2. Alarm	0.00m to 60.00m	Sets the distance to the alarm switching point.
	3. Hysteresis	0.00m to 2.00m	Sets the hysteresis of the alarm setpoint. This value is subtracted from the alarm for closing distances and added to the alarm for receding distances.
	4. Test alarm	ON, OFF	This option toggles the alarm output on and off.
Test functions			The keyboard letter 'd' tells the auxiliary UART to output the distance answer.
			The keyboard letter 's' tells the auxiliary UART to output the signal strength.

Auxiliary UART (pins 1, 2, 8, 9)

The second UART on the interface header is a 3.3V CMOS serial port designed to connect to an embedded processor. The baud rate is a selectable menu option (through the Main UART) and the auxiliary UART prints the measured distance when it receives a trigger request from the host processor (the ASCII code for the letter “d”) or an external trigger signal. The output from the UART is an ASCII string giving the distance in meters to 2 decimal places followed by the CR/LF ASCII codes. Distance values are available 8 times per second and the UART waits for the next result to be available after a trigger event before printing the result. There is an additional function triggered by the ASCII code for the letter 's' that tells the auxiliary UART to output the signal strength as a percentage.

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Trigger input (pins 3, 8, 9)

The distance value on the auxiliary UART can also be triggered using the digital trigger input on pin 3 of the interface header. This trigger has 1kΩ pull-up resistor to 3.3V and is active when pulled low. It can be driven by 3.3V or 5V digital logic or by a simple push button switch that pulls the line down to common.

The digital trigger is connected to a falling edge interrupt built into the SF01 so it only needs to be held low for a very short time to guarantee proper detection. If the trigger is tied to common then the auxiliary UART will output distance values continuously.

Alarm output (pins 14, 8, 9)

The alarm output is a 3.3V digital signal that goes high when the measure distance goes below a setpoint value entered through the Main UART. Hysteresis can be added to the setpoint so that small changes in distance don't cause the alarm signal to jitter when successive readings are close to the alarm setpoint. The alarm signal can be connected to a port pin on an embedded processor to act as a proximity warning when objects get too close to the SF01.

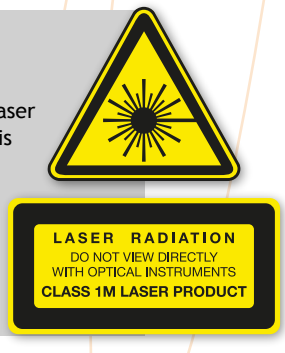
Analog output (pin 13, 8, 9)

Pin 13 of the interface header outputs a pulse width modulated (PWM) signal that can be converted into an analog voltage using a simple low pass filter. The duty cycle of the PWM signal is proportional to the position of the measured target between two setpoints listed in the menus of the Main UART.

The value of the PWM signal is updated every time there is a new distance reading and there are various "fail safe" options in the menus that determine the state of the analog output in the event that the laser signal goes out of range or becomes too weak to be measured reliably.

Safety warning

Like all devices that contain lasers, caution must be used to keep the beam away from anyone's eyes. The laser beam of the SF01 LRF has very low energy and is normally safe to use (Class 1M). However, because this product may be used for research or experimentation, it is possible that the laser or optical parts may be modified or get damaged. Special precautions should be taken when handling the laser under these conditions. Do not stare into the beam, wear the appropriate protective glasses and take safety precautions. The laser light emitted from the pulsed laser is invisible, with a wavelength of 850nm, an average power of 11mW and a peak power of 14W. To view this beam use a camera, webcam or florescent card. Never look at the beam through a magnifying optical instrument.



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Appendix A :: Specifications

	SF01 and SF01 INT	SF01/A	SF01/H
Range	60 m (natural targets)	60 m (natural targets)	60 m (natural targets)
Resolution	1 cm	1 cm	1 cm
Update rate	8 readings per second	8 readings per second	8 readings per second
Accuracy	±(0.03 + 0.1%) m	±(0.03 + 0.1%) m	±(0.03 + 0.1%) m
Power supply voltage	5.0 V ± 0.5 V DC	9 V or 5.0 V ± 0.5 V DC	5.0 V ± 0.5 V DC
Power supply current	150 mA (maximum)	150 mA (maximum)	150 mA (maximum)
Outputs & interfaces	Analog, serial & digital	Analog, serial & digital	Digital
Dimensions	60 x 52 x 155 (extended) mm	27 x 59 x 151 (extended) mm	70 x 70 x 94 mm
Weight	SF01: 185 g (6,53 oz) SF01 INT: 205 g (7,23 oz)	87 g (3.07)	537 g (18.94 oz)
Connections	Screw terminal: 0.1 in. pitch header	Screw terminal: 0.1 in. pitch header	USB cable
Laser power	14 W (peak) <11 mW (average) Class 1M	14 W (peak) <11 mW (average) Class 1M	14 W (peak) <11 mW (average) Class 1M
Operating temperature	0 ... 40°C	0 ... 40°C	0 ... 40°C

Appendix B :: Dimensions

SF01 (INT) rangefinder module

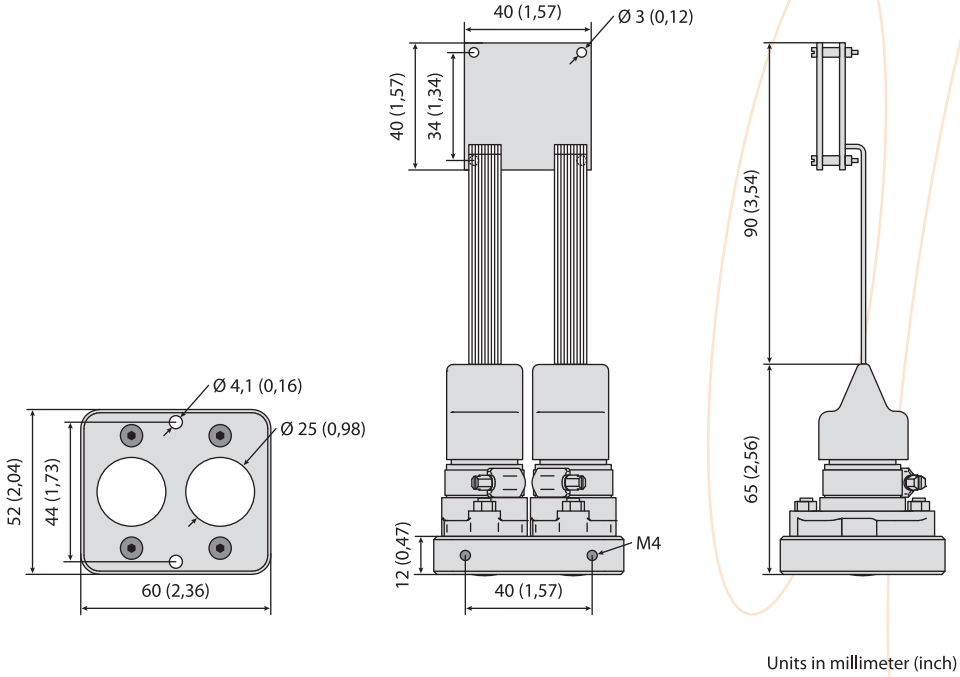

Figure 3 :: SF01 (INT) dimension drawings

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SF01/A rangefinder module

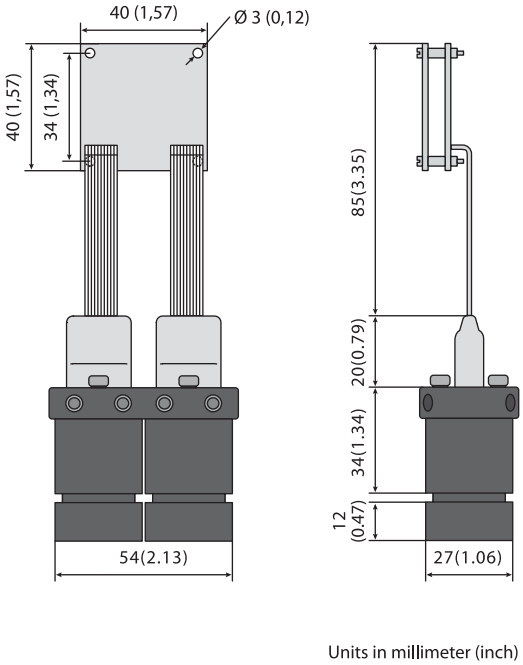

Figure 4 :: SF01/A dimension drawings

SF01/H rangefinder module

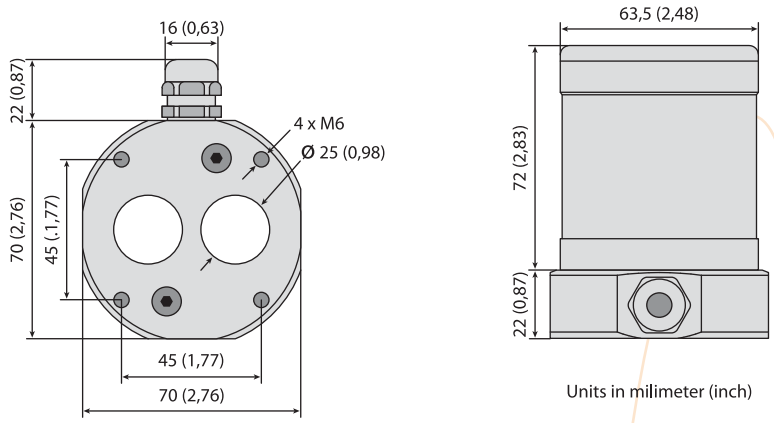

Figure 5 :: SF01/H dimension drawings

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Appendix C :: The Universal Interface Card INT-01

The Universal Interface card provides a USB interface to the Main UART of the SF01 along with connections to the other digital and analog interfaces. The card plugs directly into the interface header of the SF01 and there are holes for M3x10 spacers.

The Mini USB socket can be connected to a PC (see the Quick Start Guide) and provides both communications and power to the SF01. All settings can be adjusted through this interface and the SF01 will operate normally when powered by the USB port of a PC.

The VIN terminal (pins 1, 2) takes 7.5-12V DC. It is the main power terminal for the card and can be connected at the same time as the USB port. When both power sources are available the load is shared between them.

The +5V terminal (pin 3) is an alternative power input and accepts a well regulated +5V DC supply. If this is used then both the VIN terminal and the USB port no longer supply power to the SF01.

The +5V terminal can be used in an alternative way. If the main power comes from the VIN terminal then the +5V terminal can be used as a power source for external circuits. The maximum load is 50mA.

Figure 6 :: INT-01 PCB

The TRIGGER_IN terminal (pin 5) is a negative edge or low level input to the SF01 that instructs the controller to output data on the AUXILIARY_UART terminals.

The ALARM_OUT terminal (pin 6) is a programmable signal that goes high (3.3V) when the measured distance falls below the alarm setpoint.

The VOUT terminal (pin 7) produces a 0-3.3V analog signal that is proportional to the distance reading between the two setpoints configured by the built-in menus of the SF01.

The AUXILIARY_UART terminals (pins 8, 9) transmit the distance whenever a trigger event is detected. This trigger could be an ASCII command on the port or an external trigger signal.

All the GND terminals (pins 2, 4, 10) are connected together at the common 0V potential.

Revision history

Version	Date	Authors	Comments
Rev 4	7 July 2014	TLP	Include Figure 1: The main features of the SF01 (page 3).
Rev 3	8 May 2014	TLP	Include information, specifications, diagrams and photographs for SF01/A.
Rev 2	17 December 2013	TLP	Include information, specifications, diagrams and photographs for SF01/H.
Rev 1	1 August 2013	TLP	Added test functions “d” and “s” (pages 3 and 6).
Rev 0	1 March 2013	JEP	First edition

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