



The SF30 is a high speed, light weight laser rangefinder for mapping and obstacle detection by robotic vehicles such as UAVs.

The SF30 can take up to 18317 readings per second and can be incorporated into scanning systems to create 2D SLAM maps or 3D images.

The configurable features and multiple hardware interfaces make the SF30 easy to connect with different types of controllers.

The SF30 uses a time-of-flight system to make very fast and accurate distance and speed measurements to natural or artificial surfaces.

#### Features:

- *Very fast update rate of 18317 readings per second on all models.*
- *Measuring range > 100 m (SF30/C only).*
- *Configurable to measure distance or speed.*
- *Serial port, analog voltage, alarm and USB interfaces.*
- *USB port to change the alarm set-point, update rate and resolution.*
- *The host controller can change settings on the fly via the serial port.*
- *Compact and lightweight - 35 grams.*
- *Easy to configure using the built-in menu and LightWare Terminal software.*
- *Fully calibrated and ready to run.*
- *Accurate, reliable measurements in sunlight or dark conditions.*
- *Not affected by: speed; wind; changes in barometric pressure; noise; ambient light; terrain or air temperature.*

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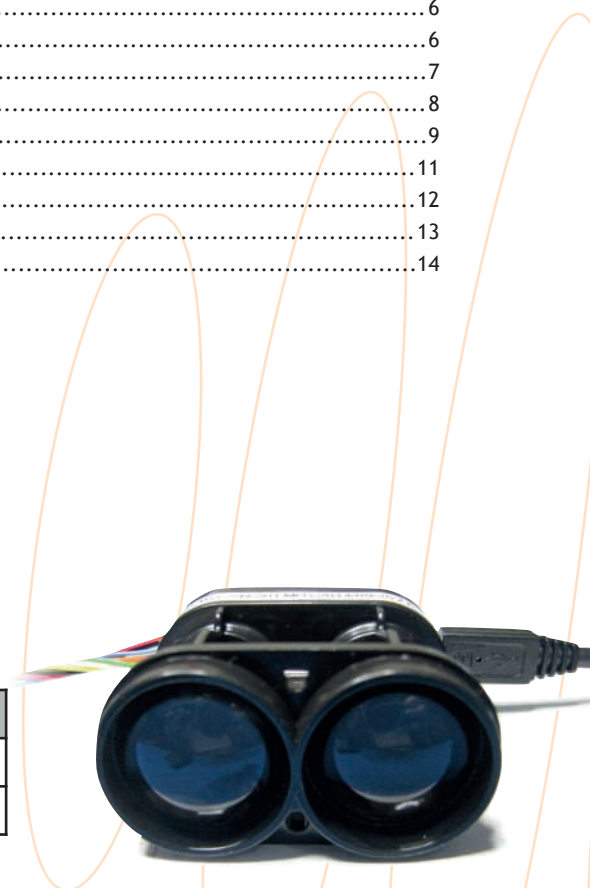
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## Product ordering codes

Model family	Model name	Model description
SF30	SF30/B (50 m)	Accelerated laser rangefinder, max 50 m
SF30	SF30/C (100 m)	Accelerated laser rangefinder, max 100 m



## Disclaimer

Information found in this document is used entirely at the reader's own risk and whilst every effort has been made to ensure its validity neither LightWare Optoelectronics (Pty) Ltd nor its representatives make any warranties with respect the accuracy of the information contained herein.

## 1. Overview

The SF30 high speed laser rangefinder is designed to detect obstacles or create maps from moving ground-based or arial vehicles. It works by measuring the time it takes for a very short flash of laser light to travel to a surface and back again. The accuracy of the measurement is not affected by the colour or texture of the surface, nor the angle of incidence of the laser beam. The SF30 is virtually immune to background light, wind and noise, making it an ideal sensor to detect unexpected obstacles.

Operating from a regulated 5 V DC supply, the SF30 includes analog and digital interfaces that can be easily connected to a flight controller or a standard processing platform. Each interface on the SF30 can be configured using a simple software menu that is accessible through the built-in, micro-B USB port. The interfaces are as follows:

Serial port:	Provides distance readings and other communications to an embedded host controller
Synchronisation:	A logic level signal that provides a time marker for the serial port data
Analog port:	An analog voltage proportional to the distance reading
Alarm:	A logic level signal that warns when the distance measured is below a preset value
USB port:	Connects to a Terminal application on a PC to allow settings to be entered.

Readings can be taken as isolated “snapshots” at a moment determined by the update rate setting, or they can be combined using a digital filter into a smoothed time series. At the full speed of 18317 readings per second, a single flash of laser light is used to take a measurement. The synchronisation signal marks the instant of the laser flash ensuring that the time of the measurement is known precisely.

There are two members of the SF30 family: the SF30/B has a maximum measuring range of 50 meters; and the SF30/C has a maximum measuring range of 100 meters. Both SF30 models have settings to smooth the distance measurements if higher resolution is required or use the raw results if higher speed is needed.

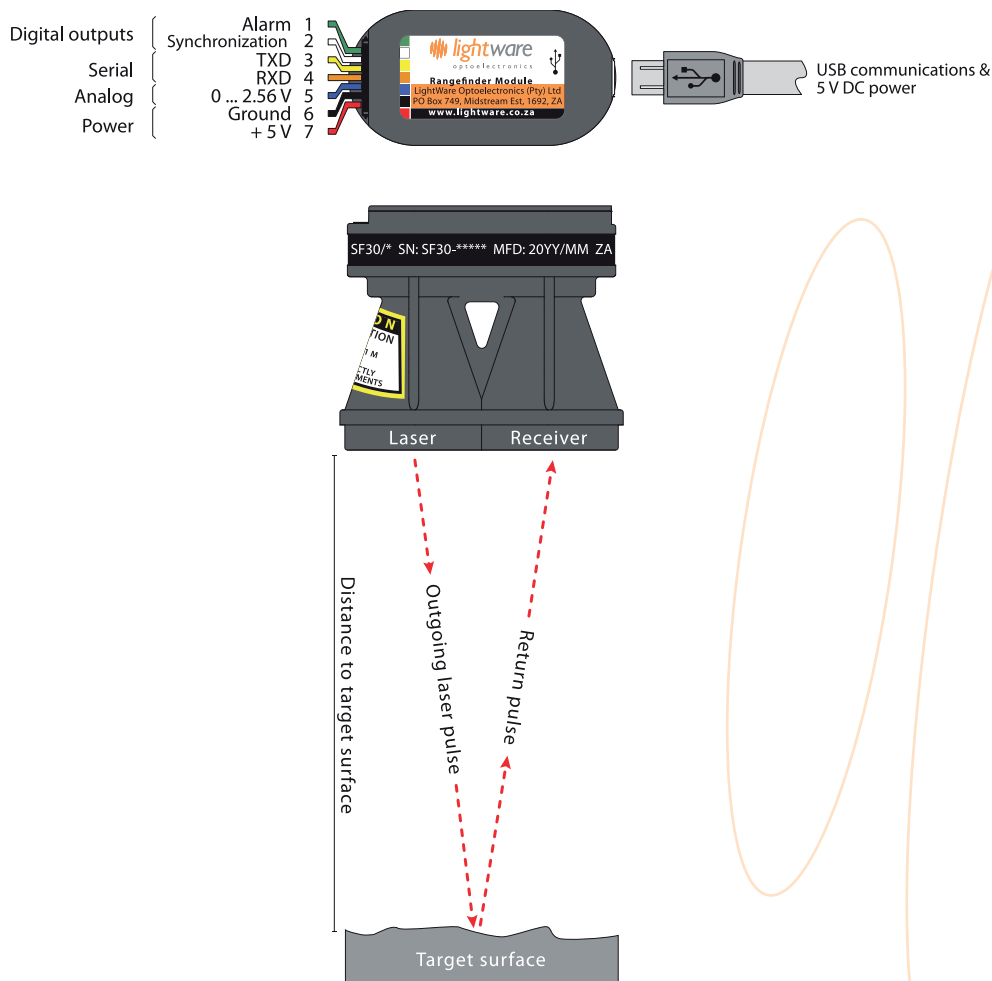


Figure 1 :: The main features of the SF30

## 2. Quick start guide

1. CAUTION - The SF30 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. Download *LightWare Terminal* software from [www.lightware.co.za](http://www.lightware.co.za) > Library > Documents > Software onto your PC. Open the installer package and follow the installation instructions. Everything needed for communicating with SF30 will automatically be installed.
3. Plug the “micro-B to type A” USB cable provided into the SF30’s micro USB connector and connect the other end to your PC. This provides both power and communication to the unit.
4. Start the *LightWare Terminal* software and click the “Connect” icon to open a communications port.
5. If the connection isn’t made automatically, click the “Laser” icon and select the correct USB port from the list shown.
6. Press the <SPACE> key to display the main menu. This menu includes a list of all the settings that can be changed in the SF30.
7. Menu item number “1: Active data port” selects which port will output the distance data. The value toggles between “Serial” and “USB”. Set this to “USB” by pressing the <1> key.
8. Press the <SPACE> key to start taking distance measurements. The results will be displayed in the Terminal window.
9. Information regarding the other menu items, and how to use them for your application, is contained in the body of this manual.
10. Press the “Disconnect” icon before unplugging the USB cable.

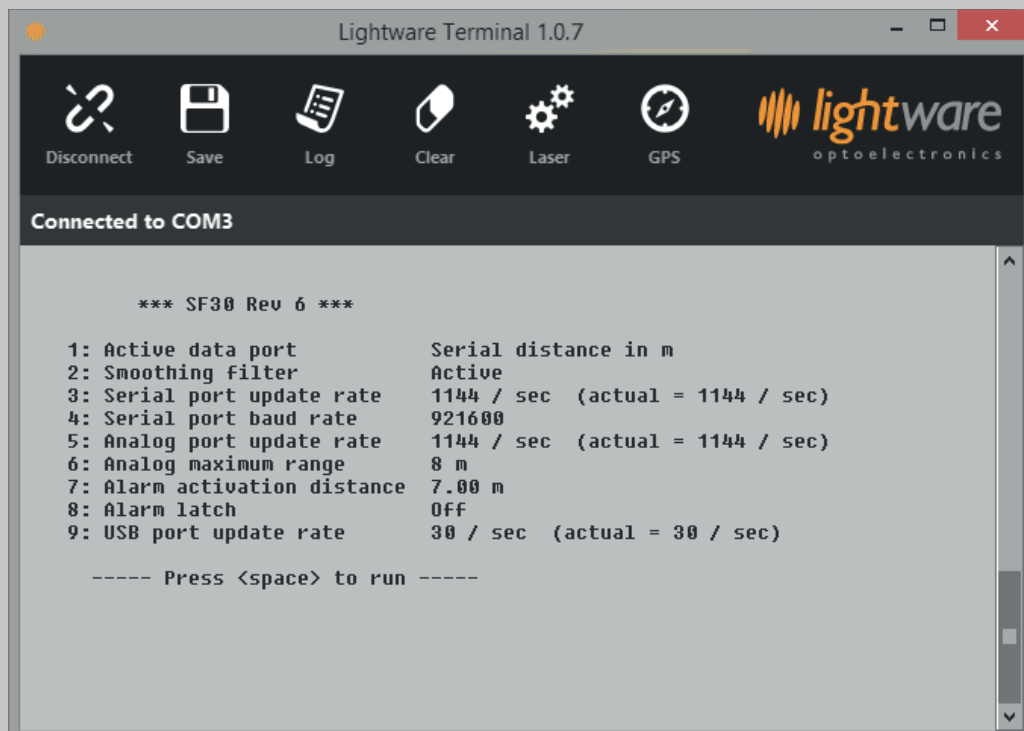


Figure 2 :: *LightWare Terminal* showing menu options

A summary of the settings available through the USB port is given in the table below:

Setting		Values	Description
1: Active data port		Serial distance in m <-> Serial speed in m/s <-> USB distance in m <-> USB distance plus speed in m/s <-> USB speed in m/s <-> USB speed in kph <-> USB analog voltage <->	Selects the serial or USB port to output distance or speed data.  The speed function is active only when the resolution is set to "0.03 m" or "Smoothed". At all other resolutions the speed result is zero.
2: Resolution / Smoothing filter		0.25 m <-> 0.12 m <-> 0.06 m <-> 0.03 m <-> Smoothed	Selects the resolution of each reading taken or activates the digital filter to smooth the output.
3: Serial port update rate	@ 0.25 m	1 ... 18317 / sec	Sets the rate at which new results are output from the serial port when it is selected using "1. Active data port".  The actual value may be lower than the entered value depending on the setting "2: Resolution / Smoothing filter".  Only whole number fractions of 18317 will give an exact match between the entered and actual values.
	@ 0.12 m	1 ... 9158 / sec	
	@ 0.06 m	1 ... 4579 / sec	
	@ 0.03 m	1 ... 1665 / sec	
	@ Smoothed	1 ... 1665 / sec	
4: Serial port baud rate		9600 ... 921600	Selects the baud rate for the serial port. If the "3. Serial port update rate" setting is too high for the selected baud rate then a warning notice will be displayed.
5: Analog port update rate	@ 0.25 m	1 ... 18317 / sec	Sets the rate at which the analog port and the alarm signal are updated with distance readings.  The actual value may be lower than the entered value depending on the setting "2: Resolution / Smoothing filter".  Only whole number fractions of 18317 will give an exact match between the entered and actual values.
	@ 0.12 m	1 ... 9158 / sec	
	@ 0.06 m	1 ... 4579 / sec	
	@ 0.03 m	1 ... 1665 / sec	
	@ Filter	1 ... 1665 / sec	
6: Analog maximum range		256 m <-> 128 m <-> 64 m <-> 32 <-> 16 m <-> 8 m	Selects the maximum distance that produces 2.56 V on the analog port. This value changes the scale of the analog output.
7: Alarm activation distance		0.5 m ... 254 m	Sets the distance below which the alarm signal will change to a low state. There is hysteresis on this setting equal to the "2: Resolution / Smoothing filter" setting or 0.06 m whichever is the greater value.
8: Alarm latch		Off <-> Active	Enables the alarm signal latch. This keeps the alarm in the active low state after an alarm event until it is cleared by sending the "#X" command to the serial port, or by pressing <X> on the keyboard.
9: USB port update rate		1 ... 832 / sec	Sets the rate at which new results are output from the USB port when it is selected using "1. Active data port".  The maximum value is limited to 832 readings per second.  Only whole number fractions of 18317 will give an exact match between the entered and actual values.

### 3. Powering up the SF30

The SF30 gets power from either a regulated +5 V DC supply on the main connector or via the USB port when it is connected to a PC. There are a number of digital and analog interfaces on the main connector and either one or a combination of interfaces may be connected to a host controller. The built-in micro-B USB port can be used to input settings and to test the performance of the SF30.

#### Power supply option 1: USB

The SF30 can be powered directly from the USB port of a PC or laptop. This is particularly useful for testing the SF30 before it is installed in your system and also for changing the settings in readiness for the final application.

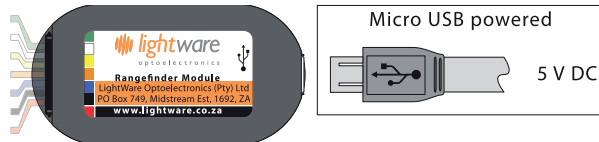


Figure 3 :: Power from the USB port

#### Power supply option 2: Regulated +5 V DC

The second power supply option is to connect a regulated voltage of  $5 \pm 10\%$  V DC to the main connector. If the power wires are more than 30 cm long, we recommend using a 100uF, 6.3V decoupling capacitor, or other noise suppression components to reduce the chance interference being picked up or transmitted by the wires.

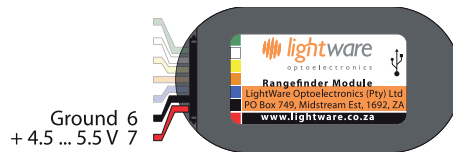


Figure 4 :: Regulated +5 V DC power supply connections

#### 4. Communicating with the USB port

The SF30 has a micro-B USB port that can be used to communicate with *LightWare Terminal* software on a PC. This connection also gives power to the unit providing a quick way to test and configure the SF30. The *LightWare Terminal* software will automatically detect the USB port that is connected to the SF30 and communications can be established by clicking on the “Connect” icon. If more than one compatible device is present, click the “Laser” icon to select which USB port should be active.

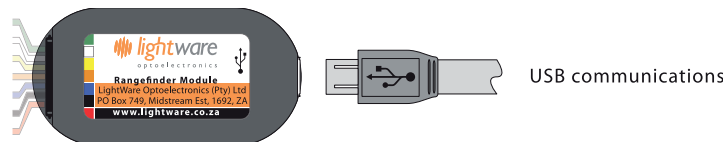


Figure 5 :: USB communications

Once communication has been established, settings can be changed by pressing the <SPACE> key to access the menu and then selecting the menu item that needs changing. Pressing the <SPACE> key again restarts the measuring process. The results outputted during measuring include the distance, the analog voltage and the alarm status. At high update rates of greater than 350 readings per second, only the distance is outputted. More details of the menu items are discussed in the sections that follow.

If you want to use a different serial emulation program then the USB serial protocol should be set to 115200 baud with 8 data bits, 1 stop bit and no parity or handshaking (8N1). All communications are in standard ASCII format.

#### 5. System configuration

There are two settings that provide the overall system configuration for the SF30 and these affect the behaviour of each of the interfaces.

Setting	Values	Description
1: Active data port	Serial distance in m <-> Serial speed in m/s <-> USB distance in m <-> USB distance plus speed in m/s <-> USB speed in m/s <-> USB speed in kph <-> USB analog voltage <->	Selects the serial or USB port to output distance or speed data.  The speed function is active only when the resolution is set to “0.03 m” or “Smoothed”. At all other resolutions the speed result is zero.
2: Resolution / Smoothing filter	0.25 m <-> 0.12 m <-> 0.06 m <-> 0.03 m <-> Smoothed	Selects the resolution of each reading taken or activates the digital filter to smooth the output.

The “1: Active data port” selection directs the results to one of the two available data ports, either the serial port or the USB port. Only one of these ports can be active at a time.

**USB option:** When connected to a PC with the USB cable, it is convenient to have the results displaying in the Terminal window. Results are available in the following formats: distance in m; distance plus speed in m/s; speed in m/s; speed in kph or analog voltage. The results from the analog port are displayed continuously while the SF30 is running.

**Serial option:** When connected to a host controller the results should be directed to the serial port. The menu system is still available using the USB port but readings (distance in m or speed in m/s) will not be displayed when the SF30 is running.

The “2: Resolution / Smoothing filter” selection affects the way that distance readings are taken and presented to the output ports.

**Resolution:** This selection offers 4 alternative resolution settings from 0.25 m down to 0.03 m. The lowest resolution selection allows for the highest speed measurements whilst better resolution reduces the measuring speed. Results are updated on the interface ports at the time specified by their associated update rate settings. Each reading is given as a “snapshot” of the latest result at that time.

**Smoothing filter:** This selection swathes on a digital smoothing filter that uses historical values of previous results to smooth the output. This presents higher resolution and less result-to-result variation but also slows down the rate at which distance readings can change.



## 6. Communicating with the serial port

The serial port is used to transmit distance readings to an embedded host processor such as the flight controller in a UAV. The hardware interface uses 3.3 V logic levels and can be connected directly to any similar, compatible interface. The serial port protocol should be set to 8 data bits, 1 stop bit and no parity or handshaking (8N1).

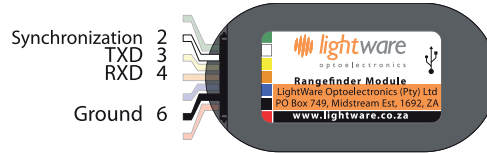


Figure 6 :: Serial interface connections

Distances and speeds are output as two binary coded bytes:

Data format	Conversion to distance in meters
Byte_L,Byte_H	Distance or speed = Byte_H + Byte_L / 256

Setting	Values	Description
3: Serial port update rate	@ 0.25 m	1 ... 18317 / sec
	@ 0.12 m	1 ... 9158 / sec
	@ 0.06 m	1 ... 4579 / sec
	@ 0.03 m	1 ... 1665 / sec
	@ Filter	1 ... 1665 / sec
4: Serial port baud rate	9600 ... 921600	Selects the baud rate for the serial port. If the "3: Serial port update rate" setting is too high for the selected baud rate then a warning notice will be displayed.

The "3: Serial port update rate" setting allows the output rate of the serial port to be set to any value within the limits imposed by the snapshot resolution. Values will be rounded in order to give whole number divisors of 18317 and limited automatically if they are too high for the resolution selected.

The "4: Serial port baud rate" selection toggles through all the standard baud rates from 9600 to 921600. If the baud rate is set too low, there won't be enough time for the data to complete a transmission before the next result is ready. A warning notice is given if this situation occurs. Both the transmitted data and any received commands are at the same baud rate.



There is a synchronisation signal that goes into a low state at the instant when a distance measurement is taken. This signal then goes high just before the result is transmitted on the serial port.

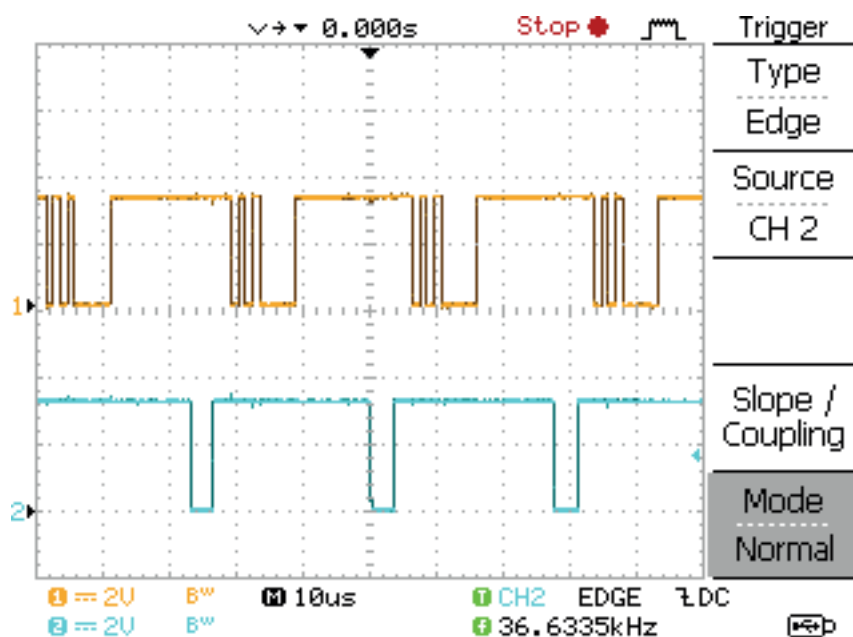


Figure 7 :: An oscilloscope screen capture showing the serial port data on the orange trace and the synchronisation signal on the blue trace

There may be occasions when settings such as the alarm activation distance needs to be changed on the fly and a serial port command set is provided for this purpose. These commands will allow changes to a subset of the settings available through the USB port.

Serial port commands are sent as ASCII encoded characters and are formatted as follows:

#Annnnn:

where:

- # indicates the start of a command
- A indicates the command mnemonic
- nnnnn indicates additional values where necessary
- : indicates the end of a command

The baud rate of both the transmitted distances and the received commands is controlled by the "4: Serial port baud rate" setting in the main menu. This cannot be changed using serial port commands.

A summary of the commands recognised by the serial port is given in the table below:

Command		n values	Description
#Rn:		0 = 0.25 m 1 = 0.12 m 2 = 0.06 m 3 = 0.03 m 4 = Smoothed	Selects the resolution of each reading taken.  For the value 0 to 3 the result is provided as a two byte snapshot.  For a value of 4, the "Smoothing filter" changes the results to a recursive digital filter output.
#Unnnnn:	@ 0.25 m	1 ... 18317	Sets the rate at which new results are output from the serial port.  The actual value may be lower than the entered value depending on the setting "#Rn:" resolution.  Only whole number fractions of 18317 will give an exact match between the entered and actual values.
	@ 0.12 m	1 ... 9158	
	@ 0.06 m	1 ... 4579	
	@ 0.03 m	1 ... 1665	
	@ Filter	1 ... 1665	
#Vnnnnn:	@ 0.25 m	1 ... 18317	Sets the rate at which the analog port and the alarm signal are updated with distance readings.  The actual value may be lower than the entered value depending on the setting "#Rn:" resolution.  Only whole number fractions of 18317 will give an exact match between the entered and actual values.
	@ 0.12 m	1 ... 9158	
	@ 0.06 m	1 ... 4579	
	@ 0.03 m	1 ... 1665	
	@ Filter	1 ... 1665	
#Gn:		0 = 256 m 1 = 128 m 2 = 64 m 3 = 32 m 4 = 16 m 5 = 8 m	Selects the maximum distance that produces 2.56 V on the analog port. This value changes the scale of the analog output.
#Annn:		0.5 ... 254	Sets the distance below which the alarm signal will change to a low state. There is hysteresis on this setting equal to the "#Rn:" resolution setting or 0.06 m whichever is the greater value.
#Ln:		0 = Off 1 = Active	Enables the alarm signal latch. This keeps the alarm in the active low state after an alarm event until it is cleared by sending the "#X" command to the serial port.
#X		No parameters	Clears the alarm latch if it is enabled using the "#L1:" command.
#N		No parameters	Stops the laser from firing.
#Y		No parameters	Starts the laser firing.
#pn:		0 = Serial distance in m  1 = Serial speed in m/s	Selects between the measuring distance or measuring speed.

## 7. The analog voltage interface

The analog interface on the main connector produces a linear voltage of between 0.00 V and 2.56 V that is proportional to the measured distance. A distance reading of zero meters always produces a 0 V output.

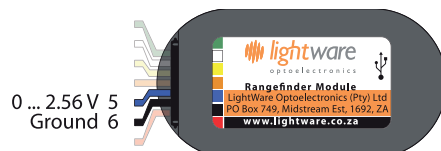


Figure 8 :: Analog voltage connections

Setting		Values	Description
5. Analog port update rate	@ 0.25 m	1 ... 18317 / sec	Sets the rate at which the analog port and the alarm signal are updated with distance readings.
	@ 0.12 m	1 ... 9158 / sec	
	@ 0.06 m	1 ... 4579 / sec	The actual value may be lower than the entered value depending on the setting "2: Resolution / Smoothing filter".  Only whole number fractions of 18317 will give an exact match between the entered and actual values.
	@ 0.03 m	1 ... 1665 / sec	
	@ Filter	1 ... 1665 / sec	
6: Analog maximum range		256 m <-> 128 m <-> 64 m <-> 32 <-> 16 m <-> 8 m	Selects the maximum distance that produces 2.56 V on the analog port. This value changes the scale of the analog output.

The "5: Analog port update rate" setting allows the output rate of the analog port to be set to any value within the limits imposed by the snapshot resolution. Values will be rounded in order to give whole number divisors of 18317 and limited automatically if they are too high for the resolution selected.

The "6: Analog maximum range" selection changes the value in meters that equates to 2.56 V. This can be either: 256 m, 128 m, 64 m, 32 m, 16 m or 8 m depending upon the requirements of the application.

## 8. The alarm interface

The alarm output is a 0 V to 3.3 V signal that becomes active low when the distance reading falls below a preset distance. The distance value used to calculate the alarm state is taken from the analog port settings. However, the maximum range selection of the analog port does not limit the operational range of the alarm.



Figure 9 :: Alarm interface connections

Setting	Values	Description
7: Alarm activation distance	1.5 m ... 254 m	Sets the distance below which the alarm signal will change to a low state. There is hysteresis on this setting equal to the "2: Resolution / Smoothing filter" setting or 0.06 m whichever is the greater value.
8: Alarm latch	Off <-> Active	Enables the alarm signal latch. This keeps the alarm in the active low state after an alarm event until it is cleared by sending the "#X" command to the serial port or by pressing <X> on the keyboard.

The "7: Alarm activation distance" setting determines the distance below which the alarm signal becomes active (low). There is hysteresis on this set point equal to the resolution of the reading or 0.06 m, whichever is the larger.

The "8: Alarm latch" selection turns on or off a latching function that keeps the alarm in an active state until a reset command is received. The reset can be from the serial port (#X) or from the keyboard if the USB cable is connected by pressing the <X> key.

## 9. USB port settings

The "9: USB port update rate" setting allows the user to adjust the update rate of the distance readings to make them more readable in the Terminal window.

Setting	Values	Description
9: USB port update rate	1 ... 832 / sec	<p>Sets the rate at which new results are output from the USB port when it is selected using "1. Active data port".</p> <p>The maximum value is limited to 832 readings per second.</p> <p>Only whole number fractions of 18317 will give an exact match between the entered and actual values.</p>

The USB port also has a number of "hot keys" that allow for immediate control of certain functions, as described below:

- Press <X> on the keyboard to clear the alarm signal latch.
- Press <Y> on the keyboard to start the laser firing.
- Press <N> on the keyboard to stop the laser from firing.

## 10. Instructions for safe use

The SF30 is a laser rangefinder that emits ionizing laser radiation. The level of the laser emission is Class 1M which indicates that the laser beam is safe to look at with the unaided eye but must not be viewed using binoculars or other optical devices at a distance of less than 15 meters. Notwithstanding the safety rating, avoid looking into the beam and switch the unit off when working in the area.

**CAUTION** -- The use of optical instruments with this product will increase eye hazard.

The SF30 should not be disassembled or modified in any way. The laser eye safety rating depends on the mechanical integrity of the optics and electronics so if these are damaged do not continue using the SF30. There are no user serviceable parts and maintenance or repair must only be carried out by the manufacturer or a qualified service agent.

No regular maintenance is required for the SF30 but if the lenses start to collect dust then they may be wiped with suitable lens cleaning materials. Make sure that the SF30 is switched OFF before looking into the lenses.

The SF30 should be mounted using the four holes provided in the circuit board. Do not hold or clamp the lens tubes as this may cause damage and adversely affect the laser safety rating.

### Laser radiation information and labels

Specification	Value / AEL	Notes
Laser wavelength	905 nm	
Pulse width	< 20 ns	
Pulse frequency	< 36 kHz	
Peak power	< 10 W	50 millimeter aperture at 2 meters
Average power	< 0.6 mW	7 millimeter aperture
Average energy per pulse	< 300 nj	
NOHD	15 m	Distance beyond which binoculars with may be used safely

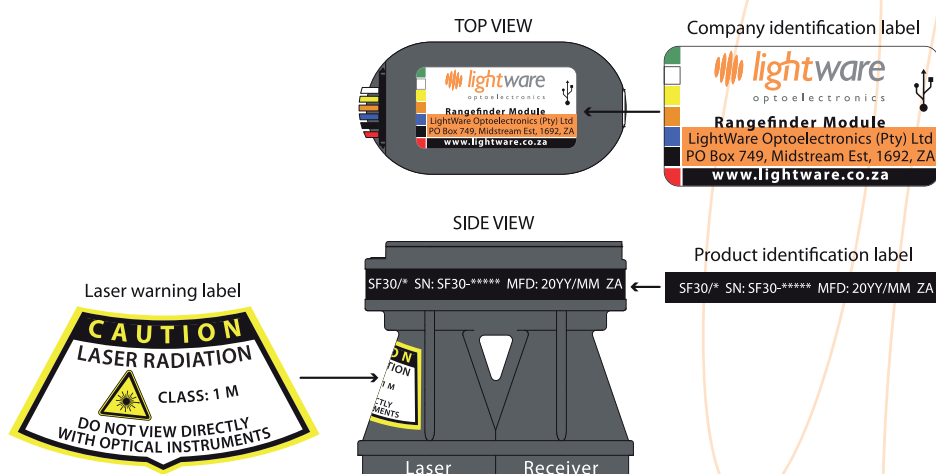


Figure 10 :: Labelling on the SF30

## Appendix A :: Specifications

	SF30/B (50 m)	SF30/C (100 m)
Range	0 ... 50 meters (natural targets) 0 ... 175 meters (reflective targets)	0 ... 100 meters (natural targets) 0 ... 175 meters (reflective targets)
Resolution	0.25 m .... 0.03 m selectable	0.25 m .... 0.03 m selectable
Update rate	18317 readings per second (max)	18317 readings per second (max)
Accuracy	±0.10 m (70% reflective target @ 20° C)	±0.10 m (70% reflective target @ 20° C)
Power supply voltage	5.0 V ± 0.5 V DC	5.0 V ± 0.5 V DC
Power supply current	250 mA (maximum)	250 mA (maximum)
Outputs & interfaces	Serial & analog	Serial & analog
Dimensions	30 x 56.5 x 50 millimeters	30 x 56.5 x 50 millimeters
Weight	35 grams (excluding cables)	35 grams (excluding cables)
Connections	Plug & socket, micro USB	Plug & socket, micro USB
Laser power	20 W (peak), <11 mW (average), Class 1M	20 W (peak), <18 mW (average), Class 1M
Optical aperture	51 millimeters	51 millimeters
Beam divergence	0.2°	0.2°
Operating temp.	0 ... 40° C	0 ... 40° C
Approvals	FDA: 1630995-000 (2016/09)	FDA: 1630995-000 (2016/09)

## Appendix B :: Dimensions

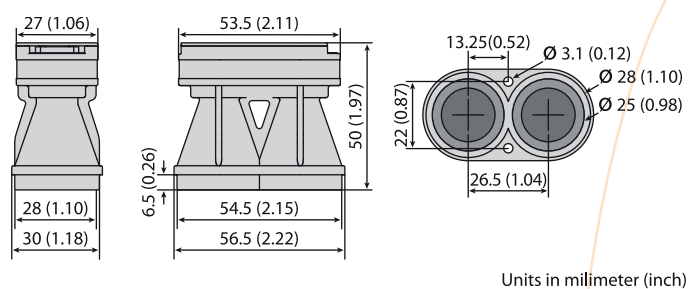
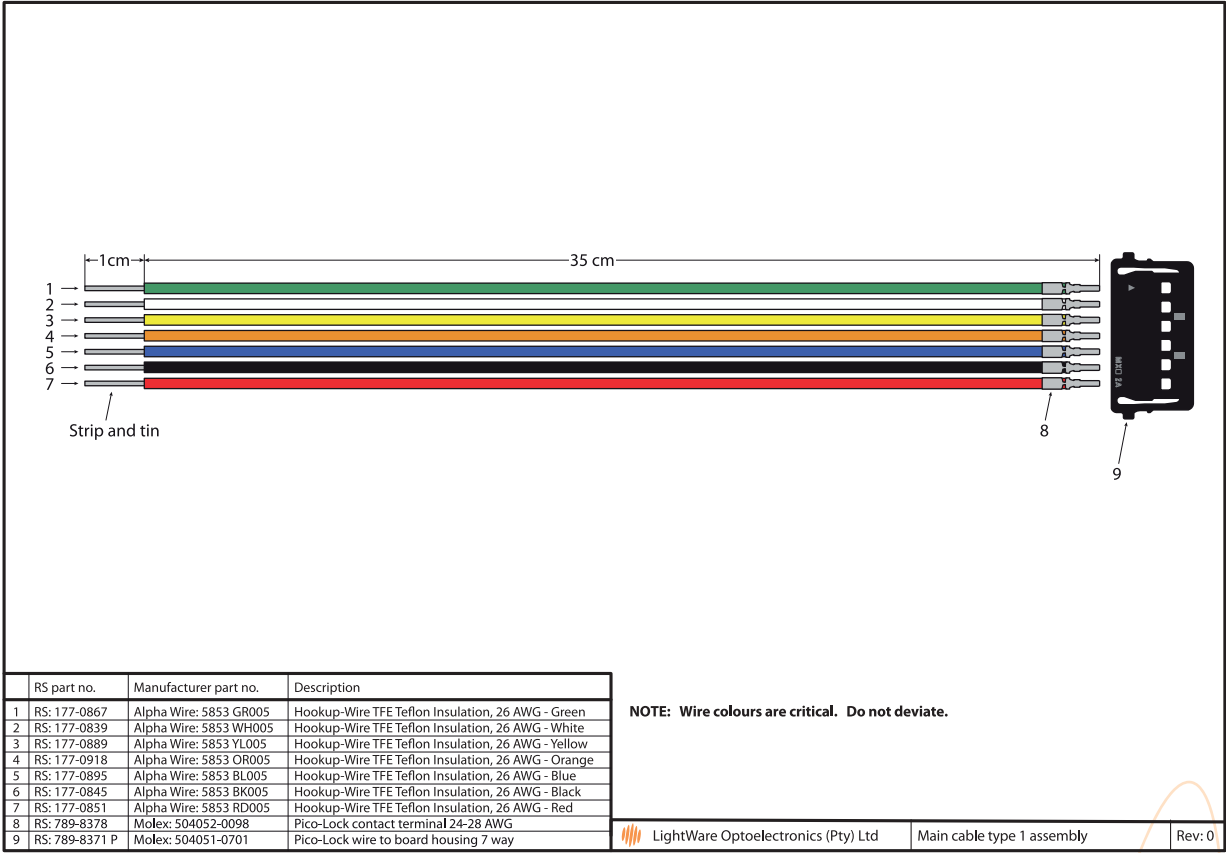


Figure 11 :: Dimension drawings of the SF30

Appendix C :: Main cable type 1, 35 cm



SF30



## Revision history

Version	Date	Authors	Comments
Rev 7	2016/09/13	TLP	Updated FDA accession number "1630995-000 (2016/09)" in "Appendix A :: Specifications" (page 14). Update maximum update rate from "18316" to "18317" readings per second (pages 1, 3, 5, 8, 10, 11, 12, 14). Update rate modified from "2289" to "1665" readings per second (pages 5, 8, 10, 11). Update rate modified from "1144" to "832" readings per second (pages 5, 12).
Rev 6	2016/01/29	TLP	Update FDA accession number "1410968-002 (2016/01)" in "Appendix A :: Specifications" (page 14).
Rev 5	2015/12/17	TLP	Updates to this document revision are applicable from SF30/* SN: S30-00491, firmware revision 7.0. Update rate modified from "36633" to "18316" readings per second (pages 1, 3, 5, 8, 10, 11, 12, 14). Amended the "1: Active data port" values available (pages 5, 7). Amended references of "2: Snapshot resolution" to "2: Resolution / Smoothing filter" (pages 5, 7, 8, 11). Amended the "2: Resolution / Smoothing filter" values available (pages 5, 7, 10). Updated the lowest resolution to 0.25 m (pages 5, 8, 10, 11, 14). Amended references to serial port transmitting two bytes at all update rates (pages 8, 10). Add serial port command "#pn:" (page 10). Updated the resolution and update rate in "Appendix A :: Specifications" (page 14). Amended the values relating to the relationship between update rate and resolution (pages 5, 8, 10, 11). Noted that the speed function is active only when the resolution is set to "0.03 m" or "Smoothed" (pages 5, 7).
Rev 4	2015/11/09	TLP	The amendments to this manual are applicable to SF30 serial numbers "SF30-00470" onwards. Reformatted the "8: Alarm latch" command "#X:" to "#X" (pages 5, 10, 12). Added new serial commands "N" and "Y" (page 10). Added new keyboard "hotkeys" <X>, <Y> and <N> (page 12). Updated the minimum update rate for the serial, analog and USB ports to 1 reading per second (pages 5, 8, 10, 12). Decrease the minimum alarm activation distance to 0.5 meters (pages 5, 10). Amended details of the serial and USB protocol to "8 data bits" and "8N1" (pages 7, 8). Amended details regarding USB outputs at different update rates (page 7).
Rev 3	2015/09/23	TLP	Reformatted the "8: Alarm latch" command "#X:" (pages 5, 10).
Rev 2	2015/09/18	TLP	Update FDA accession number "FDA: 1410968-001 (2015/09)" in "Appendix A :: Specifications" (page 14). Updated height dimension to "56.5 mm" (page 14).
Rev 1	2015/06/09	TLP	Updated product part code "Main cable type 1, 35 cm" (page 15).
Rev 0	2015/05/12	JEP	First edition