lightware
o p t o e l e c t r o n i c s

High speed laser altimeter for accurate mapping and obstacle detection.

Features:

- Update rate of 20K readings per second
- Accurate, reliable measurements unaffected by speed, wind, changes in barometric pressure, noise, ambient light, terrain, or air temperature
- Configurable to measure distance or speed
- Serial port, analog voltage, alarm and USB interfaces
- Fully calibrated and ready to run

bsi.
ISO 9001:2015
Quality Management

FM 654831

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Product ordering codes

Model family	Model name	Model description
SF30	SF30/B (50 m)	Laser altimeter, max 50 m
SF30	SF30/C (100 m)	Laser altimeter, 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. Using a time-of-flight system to make very fast and accurate distance and speed measurements, accuracy 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.

The SF30 can take up to 20010 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.

Operating from a regulated 5 V DC supply, the SF30 includes serial port, analog voltage, alarm and USB 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
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 for alarm set-point, update rate and exposure time customisation.

Readings can be taken as isolated "snapshots" at a moment determined by the update rate and exposure time settings, or they can be combined using a digital filter into a smoothed time series. At the full speed of 20010 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.
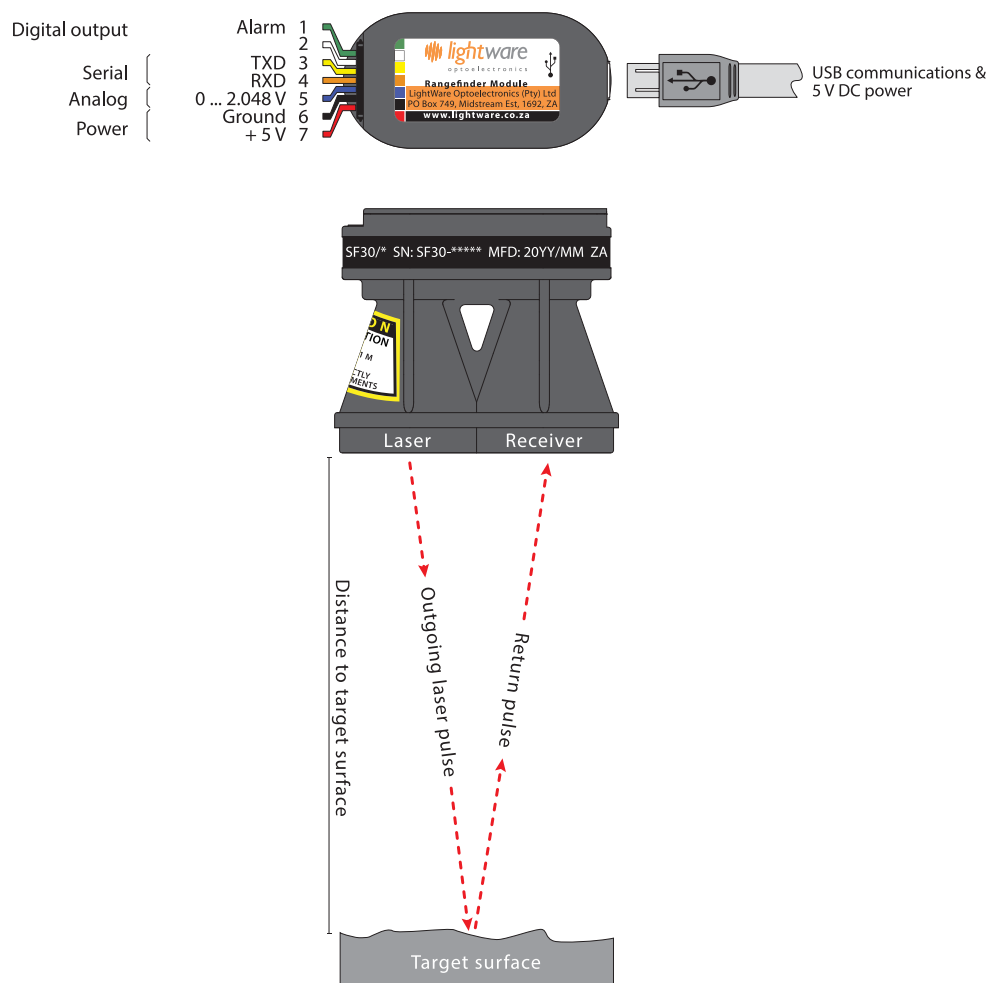

Figure 1 :: The main features of the SF30

2. Specifications of the SF30

	SF30/B (50 m)	SF30/C (100 m)
Range	0.2 … 50 meters (natural targets) 0.2 … 175 meters (reflective targets)	0.2 … 100 meters (natural targets) 0.2 … 175 meters (reflective targets)
Resolution	1 cm	1 cm
Update rate	20010 readings per second (max)	20010 readings per second (max)
Accuracy	±0.10 meters (70% reflective target @ 20°C)	±0.10 meters (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	USB, serial & analog	USB, 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: 1410968-002 (2018/09)	FDA: 1410968-002 (2018/09)

3. Quick start guide

3. 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.

4. Download *LightWare Terminal* software from www.lightware.co.za > Library onto your PC. Open the installer package and follow the installation instructions. Everything needed for communicating with SF30 will automatically be installed.

5. 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.

6. Start the *LightWare Terminal* software and click the "Connect" icon to open a communications port.

7. If the connection isn't made automatically, click the "Laser" icon and select the correct USB port from the list shown.

8. 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.

9. Menu item number "1: Output type" selects which port will output the distance data. The value toggles between "Serial" and "USB". Set this to "USB" by pressing the **<1>** key.

10. Press the **<SPACE>** key to start taking distance measurements. The results will be displayed in the Terminal window.

11. Information regarding the other menu items, and how to use them for your application, is contained in the body of this manual.

12. 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: Output type	Distance over USB Distance and strength over USB Distance over serial Analog voltage over USB	Selects the serial or USB port to output distance data.
2: Exposure time	20010 readings / sec 10005 readings / sec 5002 readings / sec 2501 readings / sec 1250 readings / sec 625 readings / sec 312 readings / sec 156 readings / sec 78 readings / sec 39 readings / sec	Selects the period of time the SF30 will use to capture a single distance measurement. The shorter the exposure time, the higher the update frequency.
3: USB port output rate	39 ... 625 readings / sec	Set the rate at which new results are output from the USB port when it is selected using "1: Output type". The maximum value is limited to 625 readings per second, or the exposure time - whichever is smaller.
4: Serial port baud rate	9600 ... 1440000 bps	Selects the baud rate for the serial port.
5: Serial port output rate	39 ... 20010 readings / sec	Sets the rate at which new results are output from the serial port when it is selected using "1: Output type". If the chosen serial baud rate is too low then this value will be limited. The maximum value is limited to the "2: Exposure time" setting.
6: Analog range	1 m ... 256 m	Selects the maximum distance that produces 2.048 V on the analog port. This value changes the scale of the analog output.
7: Analog port output rate	39 ... 20010 readings / sec	Sets the rate at which the analog port is updated with distance readings. The maximum value is limited to the "2: Exposure time" setting.
8: Alarm activation distance	0.5 m ... 254 m	Sets the distance below which the alarm signal will change to a low state.
9: Alarm hysteresis	0.06 m ... 50 m	The distance the reading needs to travel from the "8: Alarm activation distance" before the alarm is activated or deactivated.
A: Alarm latch	ON or OFF	Enables the alarm signal latch. This keeps the alarm in the active low state after an alarm event until it is cleared by sending "X" over the USB port.

4. 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.
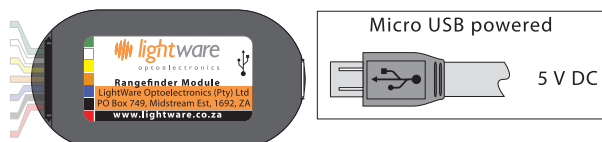
Figure 3 :: Power from the USB port

Power supply option 2: Regulated +5 V DC

The second power supply option is to connect a regulated voltage of 5 ± 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.
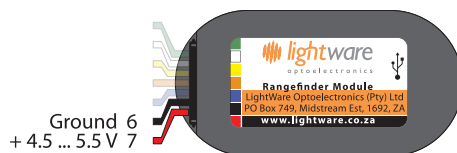

Figure 4 :: Regulated +5 V DC power supply connections

5. 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.
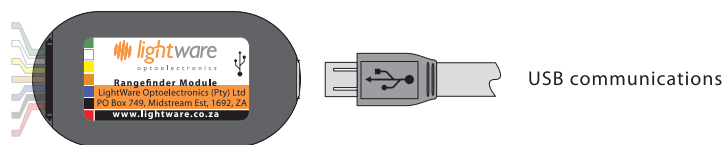

USB communications

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. 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.

6. 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: Output type	Distance over USB Distance and strength over USB Distance over serial Analog voltage over USB	Selects the serial or USB port to output distance data.
2: Exposure time	20010 readings / sec 10005 readings / sec 5002 readings / sec 2501 readings / sec 1250 readings / sec 625 readings / sec 312 readings / sec 156 readings / sec 78 readings / sec 39 readings / sec	Selects the period of time the SF30 will use to capture a single distance measurement. The shorter the exposure time, the higher the update frequency.

The "1: Output type" 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 signal strength 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 enu 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: Exposure time" selection affects the way that distance readings are taken and presented to the output ports.

Exposure time controls how long a single measurement gathers data for its result. The SF30 always fires 20010 laser shots per second, and it will use as many of these shots per result as the exposure time allows. For example, if the exposure time is set to ~50 microseconds then there is only enough time to use a single shot per result. This can be desired when your target is fast moving and you do not want to risk 'blurring' the result by hitting other targets during the same exposure time. Likewise, by increasing the exposure time you increase the amount of information which can be used to improve accuracy at range, and filter out noisy results.

The USB, serial, and analog output rates are decoupled from the exposure time setting. For example, you can still run with an exposure time of ~50 microseconds, but only output at 40 results per second on the USB port. Each of these results will be made up of a single laser shot, but by limiting the output you don't need to process all 20010 shots on your host controller.

7. 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 are output as a 2 byte binary number. You can identify which byte you are reading by looking at the most significant bit. If the MSB is not set then you have received the low byte, if the MSB is set then you have received the high byte. The high byte is always sent first for an individual reading. The remaining 7 bits in each byte combine to make a 14 bit distance reading in centimetres.

Byte	Description
High byte	MSB (Bit 7) set to 1.
Low byte	MSB (Bit 7) set to 0.

Composition of a reading:

Reading bits	13	12	11	10	9	8	7	6	5	4	3	2	1	0
High byte bits	6	5	4	3	2	1	0							
Low byte bits								6	5	4	3	2	1	0

Example of converting the high and low bytes into a reading:

Reading = ((Byte_H & 0x7F) * 128) + (Byte_L & 0x7F)

Setting	Values	Description
4: Serial port baud rate	9600 … 1440000 bps	Selects the baud rate for the serial port.
5: Serial port output rate	39 … 20010 readings / sec	Sets the rate at which new results are output from the serial port when it is selected using "1: Output type". If the chosen serial baud rate is too low then this value will be limited. The maximum value is limited to the "2: Exposure time" setting.

The "4: Serial port baud rate" selection toggles through all the standard baud rates from 9600 to 1440000.

The "5: Serial port output rate" setting allows the output rate of the serial port to be set to any value within the limits imposed by the exposure time. Values will also be limited by the serial port baud rate.

There may be occasions when settings such as the alarm activation distance need 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.

Note
The serial commands are only available for firmware version 1.5.0 and later.

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

Command	N values	Description
#Rn:	0 = 20010 readings / sec 1 = 10005 readings / sec 2 = 5002 readings / sec 3 = 2501 readings / sec 4 = 1250 readings / sec 5 = 625 readings / sec 6 = 312 readings / sec 7 = 156 readings / sec 8 = 78 readings / sec 9 = 39 readings / sec	Selects the period of time the SF30 will use to capture a single distance measurement. The shorter the exposure time, the higher the update frequency.
#Un:	0 = 20010 readings / sec 1 = 10005 readings / sec 2 = 5002 readings / sec 3 = 2501 readings / sec 4 = 1250 readings / sec 5 = 625 readings / sec 6 = 312 readings / sec 7 = 156 readings / sec 8 = 78 readings / sec 9 = 39 readings / sec	Sets the rate at which new results are output from the serial port. If the chosen serial baud rate is too low then this value will be limited. The maximum value is limited to the exposure time setting
#Vn:	0 = 20010 readings / sec 1 = 10005 readings / sec 2 = 5002 readings / sec 3 = 2501 readings / sec 4 = 1250 readings / sec 5 = 625 readings / sec 6 = 312 readings / sec 7 = 156 readings / sec 8 = 78 readings / sec 9 = 39 readings / sec	Sets the rate at which the analog port is updated with distance readings. The maximum value is limited to the exposure time setting.
#Gnnn:	1 m … 256 m	Selects the maximum distance that produces 2.048 V on the analog port. This value changes the scale of the analog output.
#Annnnn:	0.5 m … 254 m	Sets the distance below which the alarm signal will change to a low state.
#Ln:	0 = Disable latching 1 = Enable latching	Enables the alarm signal latch. This keeps the alarm in the active low state after an alarm event until it is cleared by sending "#X:" over the serial port.

#X:	No parameters	Clears the alarm latch if it is enabled.
#N:	No parameters	Stops the laser from firing.
#Y:	No parameters	Starts the laser firing.

8.   The analog voltage interface

The analog interface on the main connector produces a linear voltage of between 0.00 V and 2.048 V that is proportional to the measured distance. A distance reading of zero meters always produces a 0 V output.

0 ... 2.048 V 5
Ground 6

Figure 7 :: Analog voltage connections

Setting	Values	Description
6: Analog range	1 m ... 256 m	Selects the maximum distance that produces 2.048 V on the analog port. This value changes the scale of the analog output.
7: Analog port output rate	39 ... 20010 readings / sec	Sets the rate at which the analog port is updated with distance readings. The maximum value is limited to the "2: Exposure time" setting.

The "6: Analog range" selection changes the value in meters that equates to 2.048 V. This can be any value between 1 meter and 256 meters depending upon the requirements of the application.

The "7: Analog port output rate" setting allows the output rate of the analog port to be set to any value within the limits imposed by the exposure time.

9. 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.
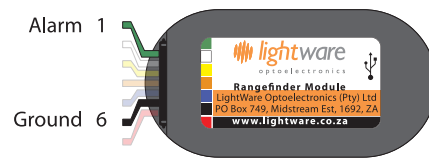

Alarm 1

Ground 6

Figure 8 :: Alarm interface connections

Setting	Values	Description
8: Alarm activation distance	0.5 m … 254 m	Sets the distance below which the alarm signal will change to a low state.
9: Alarm hysteresis	0.06 m … 50 m	The distance the reading needs to travel from the "8: Alarm activation distance" before the alarm is activated or deactivated.
A: Alarm latch	ON or OFF	Enables the alarm signal latch. This keeps the alarm in the active low state after an alarm event until it is cleared by sending "X" over the USB port.

The "8: Alarm activation distance" setting determines the distance below which the alarm signal becomes active (low).

The "9: Alarm hysteresis" setting determines how far the distance needs to travel over the activation distance in order to change state from activated to deactivated or deactivated to activated.

The "A: 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 initiated from the USB port by sending an X.

10. 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
3: USB port output rate	39 … 625 readings / sec	Set the rate at which new results are output from the USB port when it is selected using "1: Output type". The maximum value is limited to 625 readings per second, or the exposure time - whichever is smaller.

11. 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

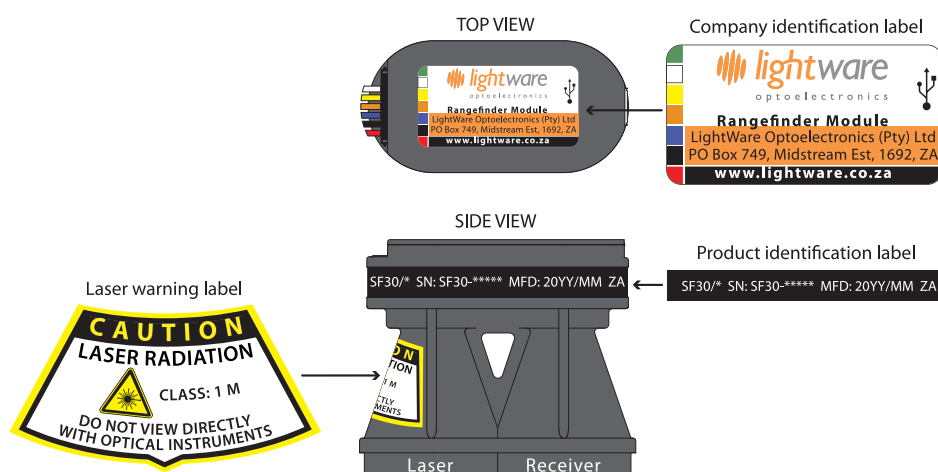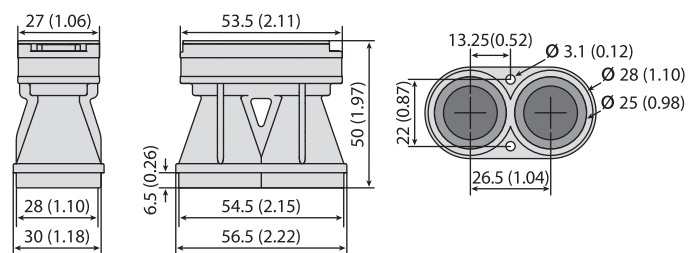| Specification	Value / AEL	Notes
Laser wavelength	905 nm	
Pulse width	< 20 ns	
Pulse frequency	< 36 kHz	
Peak power	< 10 W	50 millimeter aperture at 2 meters
Average power	< 0.6 mW	7 millimeter aperture
Average energy per pulse	< 300 nj	
NOHD	15 m	Distance beyond which binoculars with may be used safely

Figure 9 :: Labelling on the SF30
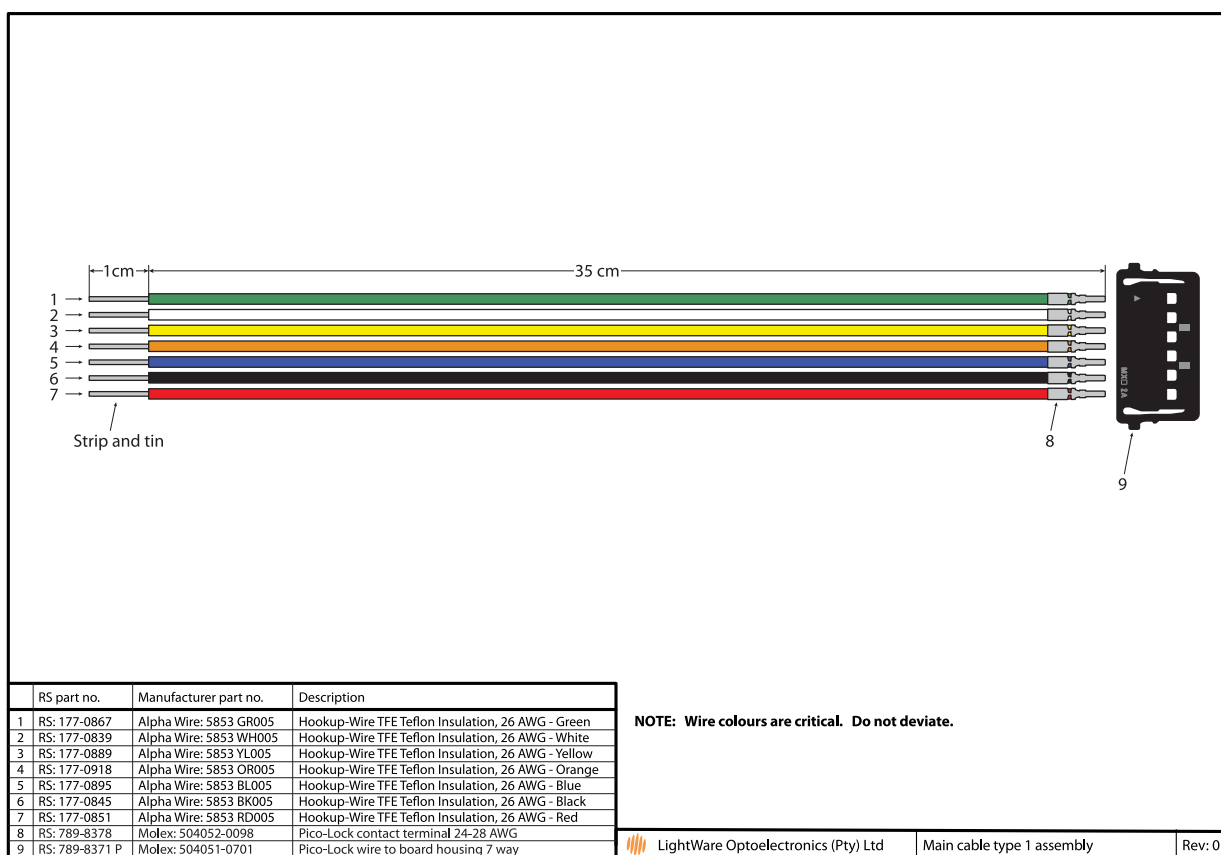
Appendix A :: Dimensions

Units in milimeter (inch)

Figure 10 :: Dimension drawings of the SF30

Appendix B :: Main cable type 1, 35 cm

1cm
35 cm

1 →
2 →
3 →
4 →
5 →
6 →
7 →

Strip and tin

8

9

	RS part no.	Manufacturer part no.	Description
1	RS: 177-0867	Alpha Wire: 5853 GR005	Hookup-Wire TFE Teflon Insulation, 26 AWG - Green
2	RS: 177-0839	Alpha Wire: 5853 WH005	Hookup-Wire TFE Teflon Insulation, 26 AWG - White
3	RS: 177-0889	Alpha Wire: 5853 YL005	Hookup-Wire TFE Teflon Insulation, 26 AWG - Yellow
4	RS: 177-0918	Alpha Wire: 5853 OR005	Hookup-Wire TFE Teflon Insulation, 26 AWG - Orange
5	RS: 177-0895	Alpha Wire: 5853 BL005	Hookup-Wire TFE Teflon Insulation, 26 AWG - Blue
6	RS: 177-0845	Alpha Wire: 5853 BK005	Hookup-Wire TFE Teflon Insulation, 26 AWG - Black
7	RS: 177-0851	Alpha Wire: 5853 RD005	Hookup-Wire TFE Teflon Insulation, 26 AWG - Red
8	RS: 789-8378	Molex: 504052-0098	Pico-Lock contact terminal 24-28 AWG
9	RS: 789-8371 P	Molex: 504051-0701	Pico-Lock wire to board housing 7 way

NOTE: Wire colours are critical. Do not deviate.

LightWare Optoelectronics (Pty) Ltd | Main cable type 1 assembly | Rev: 0

Revision history

Version	Date	Author	Comments
Rev 9	2019/01/21	TLP	Included new section into "7. Communicating with the serial port" relating to serial commands available for firmware version 1.5.0 and later (pages 9, 10).
Rev 8	2018/12/10	TLP	Updated branding and layout of this document has resulted in page number changes to previous revision history entries. Update the maximum readings per second from "18317" to "20010" (pages 3, 4, 6, 8, 9, 10). Removed the sentence "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." (page 3). Update the FDA accession number "1410968-002 (2018/09)" in "2. Specifications of the SF30" (page 4). Update the minimum range of "0.2" in "2. Specifications of the SF30" (page 4). Updated references to the settings available through the USB port. Removed references to "Synchronisation" logic level signal from copy and Illustrations.
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