Chipsmall Limited consists of a professional team with an average of over 10 year of expertise in the distribution of electronic components. Based in Hongkong, we have already established firm and mutual-benefit business relationships with customers from,Europe,America and south Asia,supplying obsolete and hard-to-find components to meet their specific needs.

With the principle of “Quality Parts,Customers Priority,Honest Operation,and Considerate Service”,our business mainly focus on the distribution of electronic components. Line cards we deal with include Microchip,ALPS,ROHM,Xilinx,Pulse,ON,Everlight and Freescale. Main products comprise IC,Modules,Potentiometer,IC Socket,Relay,Connector.Our parts cover such applications as commercial,industrial, and automotives areas.

We are looking forward to setting up business relationship with you and hope to provide you with the best service and solution. Let us make a better world for our industry!

Contact us

Tel: +86-755-8981 8866 Fax: +86-755-8427 6832
Email & Skype: info@chipsmall.com Web: www.chipsmall.com
Address: A1208, Overseas Decoration Building, #122 Zhenhua RD., Futian, Shenzhen, China

The SF11 is a compact, lightweight laser altimeter for above-ground-level measurement from small fixed wing or multi-rotor craft.

The SF11 laser altimeter is ideal for automated landings, precision hovering and terrain following.

The SF11 is directly compatible with the Pixhawk and other flight controllers.

The SF11 laser altimeter makes accurate distance measurements to solid surfaces up to an altitude of 120 meters and water up to 40 meters.

Features:

- *Very compact and lightweight - 35 grams.*
- *Accurate AGL altitude measurements on ground, foliage and water.*
- *Fast update rate of 16 readings per second.*
- *Includes serial, I2C, USB and analog interfaces with programmable capabilities.*
- *Easy to configure using the built-in menu and LightWare Terminal software.*
- *Fully calibrated and ready to run.*
- *Compatible with Pixhawk, APM compatible and other flight controllers.*
- *Accurate, reliable altitude measurements in sunlight or dark conditions.*
- *Not affected by: speed; wind; changes in barometric pressure; noise; ambient light; terrain or air temperature.*

www.lightware.co.za • info@lightware.co.za

Table of contents

Table of figures

www.lightware.co.za • info@lightware.co.za

1. Overview

The light-weight, SF11 laser altimeter is an essential addition to any unmanned aircraft that needs fast, accurate and reliable AGL altitude measurements over solid ground and water.

Operating from a regulated 5 V DC supply, the SF11 includes both analog and digital interfaces that can be easily connected to a Pixhawk flight controller or other standard processing platform. Each interface on the SF11 can be configured using a simple software menu that is accessible through the built-in, micro USB port.

The SF11 works by measuring the time it takes for a very short flash of laser light to travel to the ground and back again. The accuracy of the measurement is not affected by the colour or texture of the ground nor the angle of incidence of the laser beam. The SF11 is virtually immune to background light, wind and noise making it the ideal AGL altimeter for all kinds of terrain.

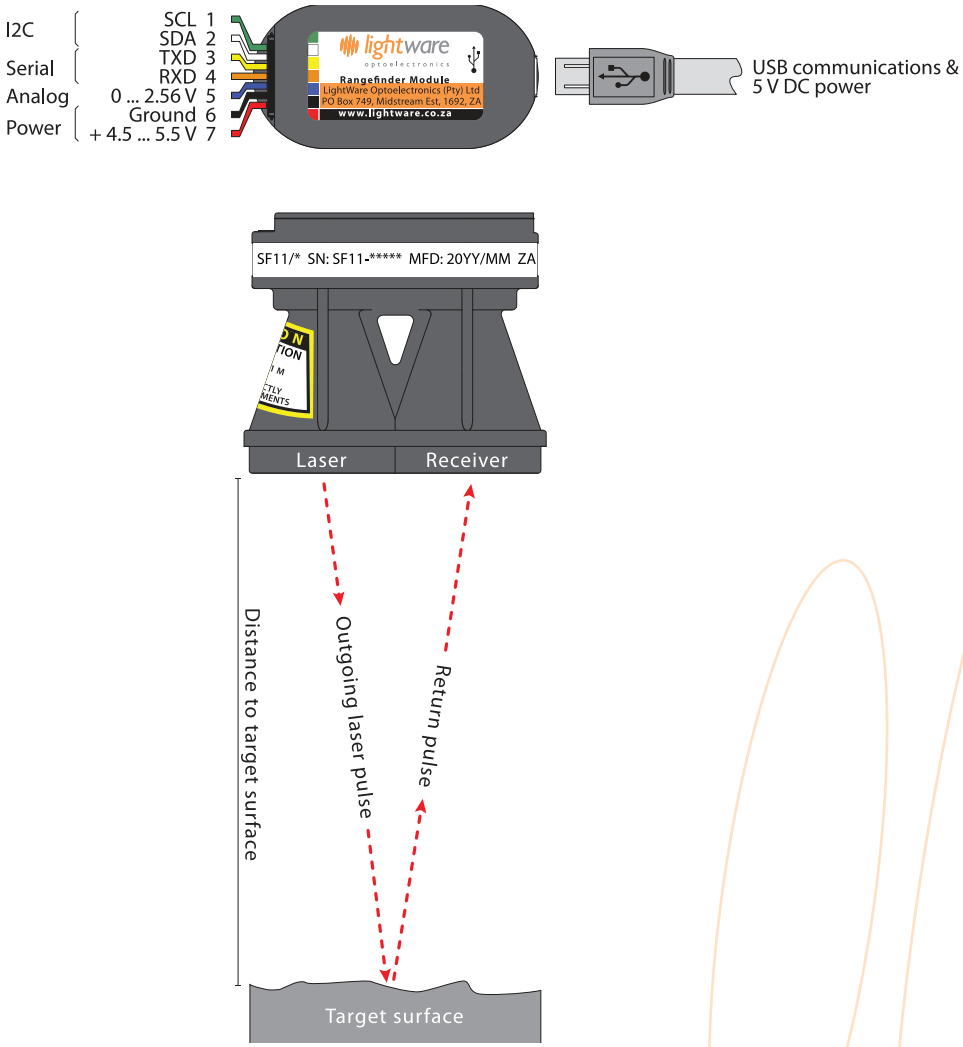


Figure 1 :: The main features of the SF11

2. Quick start guide

1. CAUTION - The SF11 laser altimeter contains a laser and should never be aimed at a person or an animal. Do not look at the beam directly with optical instruments.

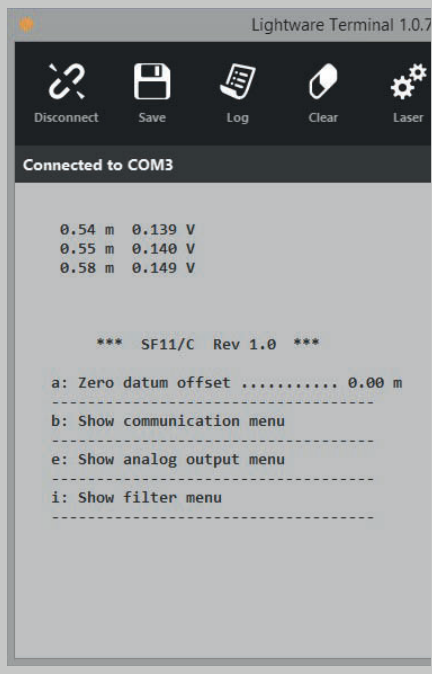
2. Download LightWare Terminal software from www.lightware.co.za > Library > Documents > Software onto your PC. Open the installer package and follow the installation instructions. Everything needed for communicating with the SF11 will automatically be installed.

3. Plug the "micro-B to type A" USB cable provided into the SF11'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 SF11. A summary of the settings is given below:



Setting	Range of values	Description
a: Zero datum	-10.00 m ... +10.00 m	Adjusts the zero point from which measurements are taken.
b: Hide / Show communication menu		
> c: Serial port baud rate	9600 ... 115200	Sets the baud rate for the serial port.
> d: I2C bus address	0 ... 7F	Sets the I2C address.
e: Hide / Show analog output menu		
> f: Analog distance range	1.00 m ... 120.00 m	Sets the distance at which the voltage output will show either 2.56 V or 3.30 V.
> g: Analog voltage range	0.00 V ... 2.56 V or 0.00 V ... 3.30 V	Selects the maximum output voltage of the analog output: either 2.56 V or 3.30 V.
> h: Analog polarity	0.00 m = 0.00 V | 25.60 m = 2.56 V or 25.60 m = 0.00 V | 0.00 m = 2.56 V	Selects the polarity of the analog output so that the maximum voltage selected using menu item **<g>** occurs at the maximum distance set using menu item **<f>** or at 0.00 m as required.
i: Hide / Show filter menu		
> j: Output on lost signal	10 m ... 130.00 m	Sets the distance output on all ports when out of range.
>> k: Confirm lost signal	0.0 ... 120.0 seconds	Sets how long the signal may be lost before the out of range distance is output.
> l: Confirm recovered signal	1 ... 120 results	Sets how many valid readings must be obtained before a signal is confirmed as usable.
> m: Median filter	ON / OFF	Enables the Median smoothing filter.
>> n: Median filter size	3 ... 32 results	Sets the number of results included in the median filter.
> p: Adaptive filter	ON / OFF	Enables the Adaptive filter.

7. Once you have confirmed your settings, press the **<SPACE>** key to start taking distance measurements and the results will be displayed in the *Terminal* window.
8. Press the "Disconnect" icon before unplugging the USB cable.
9. There are several interface options available on the main connector. These connections are used to integrate the SF11 into your system and details of all the options are explained later in this document.

www.lightware.co.za • info@lightware.co.za

3. Making connections to the SF11

The SF11 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 USB port can be used to input settings and to test the performance of the SF11.

Power supply option 1: USB

The SF11 can be powered directly from the USB port of a PC or laptop. This is particularly useful for testing the SF11 before it is installed in your system and also for changing the settings in readiness for the final application.

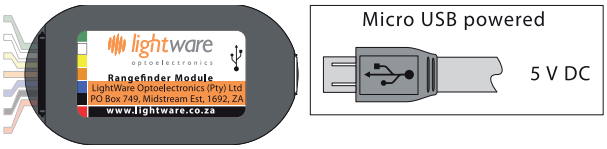


Figure 2 :: Power from the USB port

Power supply option 2: Regulated +5 V DC

The second power supply option is to connect a regulated voltage of 5 V ± 10% DC to the main connector. If the power wires are more than 30 cm long, we recommend using a decoupling capacitor of 100 µF, or other noise suppression components to reduce the chance interference being picked up on the power wires. It is important that this voltage is stable and well regulated.

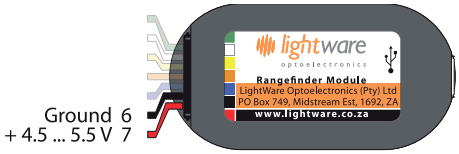


Figure 3 :: Regulated +5 V DC power supply connections

Communications using the USB port

The SF11 has a micro USB port that can be used to communicate with *LightWare Terminal* software on a PC. This connection also provides power to the unit thereby presenting a quick way to test and configure the SF11. The *LightWare Terminal* software will automatically detect the USB port that is connected to the SF11 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.

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. If no settings are entered then the SF11 automatically restarts after two minutes. More details of the menu items are discussed in the "Menu options" section below.

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

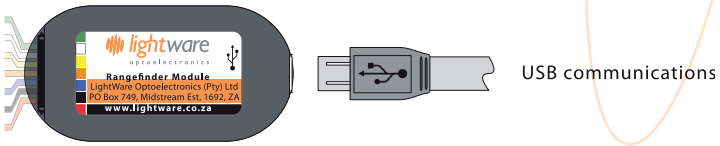


Figure 4 :: USB communications

Analog voltage interface

The analog interface on the main connector produces a voltage proportional to the measured altitude. The scale can be set to deliver a maximum voltage of 2.56 V or 3.3 V depending upon the menu selection. The physical altitude in meters that equates to the high end of the scale can be adjusted through the USB menu system. For example, an altitude setting of 51.20 m would produce a linear voltage output of 50 mV per meter on the 2.56 V scale.

Figure 5 :: Analog voltage connections

Serial interface

The serial interface on the main connector outputs the measured altitude in meters as an ASCII encoded number. This interface uses 3.3 V logic levels and can be connected directly to any similar, compatible interface. Distances are transmitted whenever the SF11 receives an ASCII 'd' character from the host controller. The baud rate for the serial interface is selectable through the USB menu system. The maximum delay between receiving a character and returning the altitude is 25 ms.

Figure 6 :: Serial interface connections

I2C interface

The I2C interface on the main connector outputs a value that represents the altitude in centimetres. This interface operates in "slave" mode and uses 3.3 V logic levels. The I2C address can be set through the USB menu system. The host controller acts as the I2C "master" and sends the address to the SF11 as an 8 bit value (7 address bits plus 1 read bit). The SF11 then returns the altitude as a 16 bit integer. The maximum delay between receiving the address and returning the altitude is 25 ms.

Figure 7 :: I2C interface connections

4. Menu options

The SF11 can be connected through the on-board USB port to a Terminal emulation program running on a PC. The *LightWare Terminal* software is available for download from www.lightware.co.za.

Once the USB connection is made, the Terminal window displays the distance reading from the SF11. Pressing the **<SPACE>** key stops the measuring process and changes the display to a menu that lists all the available settings and configuration options. Pressing the **<SPACE>** key again restarts the measuring process. If no changes are made, the unit will automatically begin to measure again after two minutes.

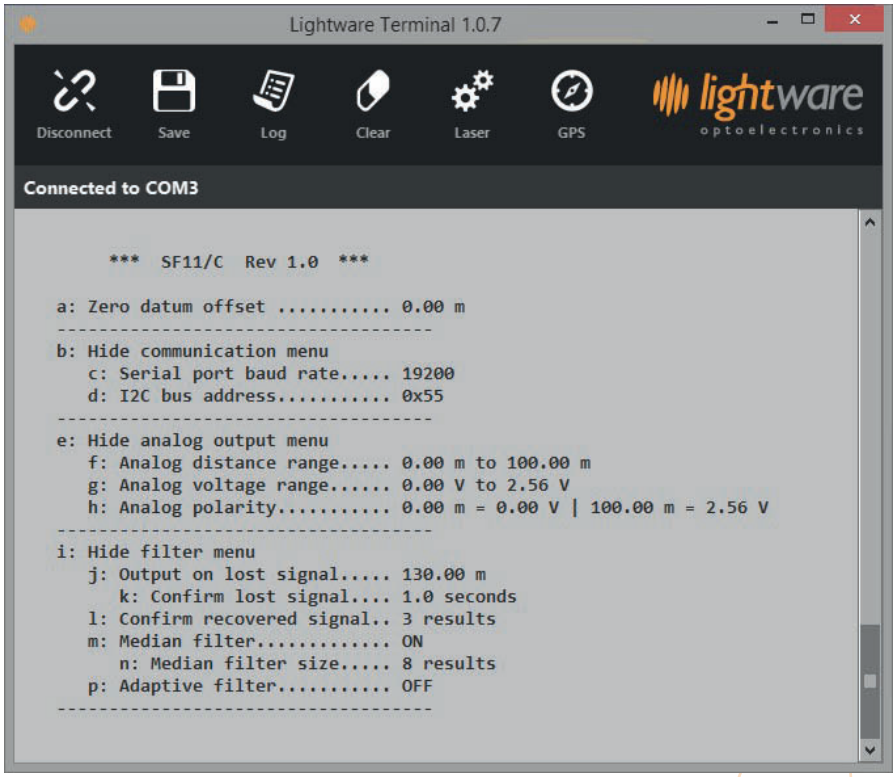


Figure 8 :: LightWare Terminal *showing menu options expanded*

a: Zero datum offset (-10.00 m … +10.00 m)

The point from which altitude measurements are taken can be adjusted using menu item **<a>**. The range of values that can be entered are from -10.00 m to +10.00 m and this value is subtracted from the altitude reading before it is made available on any of the interfaces. The zero datum offset can be used to compensate for the mounting position of the SF11 in the airframe, where distance readings may best be interpreted from a suitable point on the landing gear, rather than from the front face of the SF11.

b: Show or hide the communications menu

Menu item **<b>** is used to expand or hide the communications menu. The settings available in this menu relate to the serial port and the I2C port.

c: Serial port baud rate (9600 … 115200)

The serial port transmits a serial string of ASCII encoded data from the SF11 to the host controller. The baud rate of transmission is selected by menu item **<c>** and toggles through the standard baud rates from 9600 to 115200. There are 8 data bits, 1 stop bit and no parity or handshaking on this serial port.

The ASCII string representing the altitude is in floating point format with two decimal places followed by the analog voltage, carriage return and line feed:

"22.48 m 1.045 V\r\n"

where carriage return and line feed are given by the hexadecimal ASCII characters:

\r = 0x0D
\n = 0x0A

The altitude is sent out of the serial port when the 'd' ASCII character is transmitted by the host controller to the SF11.

d: I2C bus address (0x00 … 0x7F)

The I2C bus operates in slave mode and accepts a 7 bit address (7 address bits plus 1 read bit) before responding with a 16 bit, binary coded integer that is the altitude in centimetres. The address can be set by selecting menu item **<d>** and is entered as a 7 bit, hexadecimal number.

e: Show or hide the analog output menu

Menu item **<e>** is used to expand or hide the analog output menu. The settings available in this menu relate to the analog voltage port.

f: Analog distance range (1.00 m … 120.00 m)

The distance at which the maximum analog output of 2.56 V or 3.3 V occurs can be set by selecting menu item **<f>**. The output voltage can be converted back into a distance by using the formula:

d = v / g * f

where:
d = measured distance
v = voltage measured by the ADC of the host
g = 2.56 V or 3.3 V scale
f = maximum distance setting

The analog voltage output updates 16 times per second and has a 12 bit resolution.

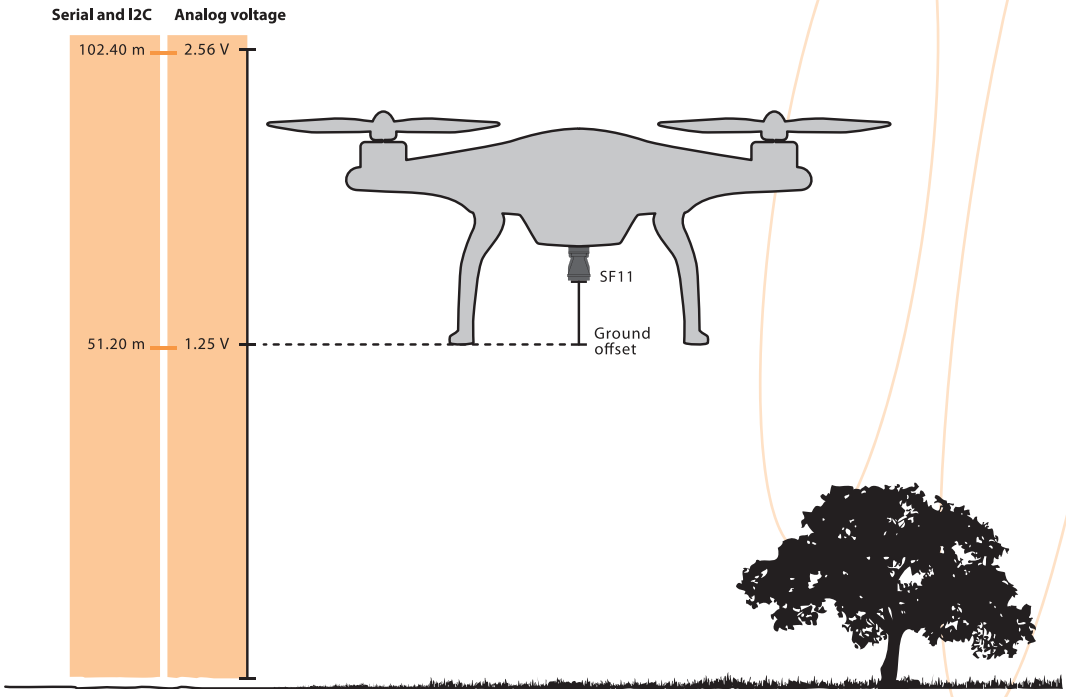


Figure 9 :: Altitude represented by distance (Serial / I2C) and analog voltage

g: Analog voltage range (0.00 V … 2.56 V or 0.00 V … 3.30 V)

Selects the scale of the analog output voltage - either 2.56 V or 3.30 V - by selecting menu item <g>.

h: Analog polarity (0.00 m = 0.00 V | 25.60 m = 2.56 V or 25.60 m = 0.00 V | 0.00 m = 2.56 V)

Selects the polarity of the analog output so that the maximum voltage selected using menu item <**g**> occurs at the maximum distance set using menu item <**f**> or at 0.00 m as required.

i: Show or hide the filters menu

Menu item **<i>** is used to expand or hide the numerical filter menu. The settings available in this menu relate to providing smoothed data to all the output ports and rejecting momentary changes in altitude caused by trees, fences, lost signals and out of range conditions.

j: Output on lost signal (10 m ... 130.00 m)

Menu item **<j>** is used to set the altitude that is output on all ports when the signal has gone out of range. This is set to 130 m by default and is required to ensure that there is a clean transition between out of range results and valid altitude measurements.

k: Confirm lost signal (0.0 ... 120.0 seconds)

Menu item **<k>** is used to set how long a lost signal condition is permitted before the out of range altitude is output. When operating close to the measuring limit of of the SF11 or over water, signals may be lost intermittently. Rather than jumping between the measured altitude and the out of range altitude, this menu item holds the last valid altitude for the entered time. If the out of range condition persists for longer than this time then the out of range altitude is output.

l: Confirm recovered signal (1 ... 120 results)

Menu item **<l>** sets how many times successive good results must occur before transitioning from a lost signal condition to normal altitude measurements. This setting prevents isolated, transient signals from being accepted as good readings. In practice, this setting can be used at a value of 1 when measuring difficult surfaces such as water whilst for most other surfaces a value of 3 provides more reliable results.

m: Enable or disable the median filter menu (ON / OFF)

Menu item **<m>** is used to enable the median filter that can be used to reject transient changes in altitude caused by rough terrain, bushes, fences, ditches or other small obstacles. This improves flight stability during automatic terrain following.

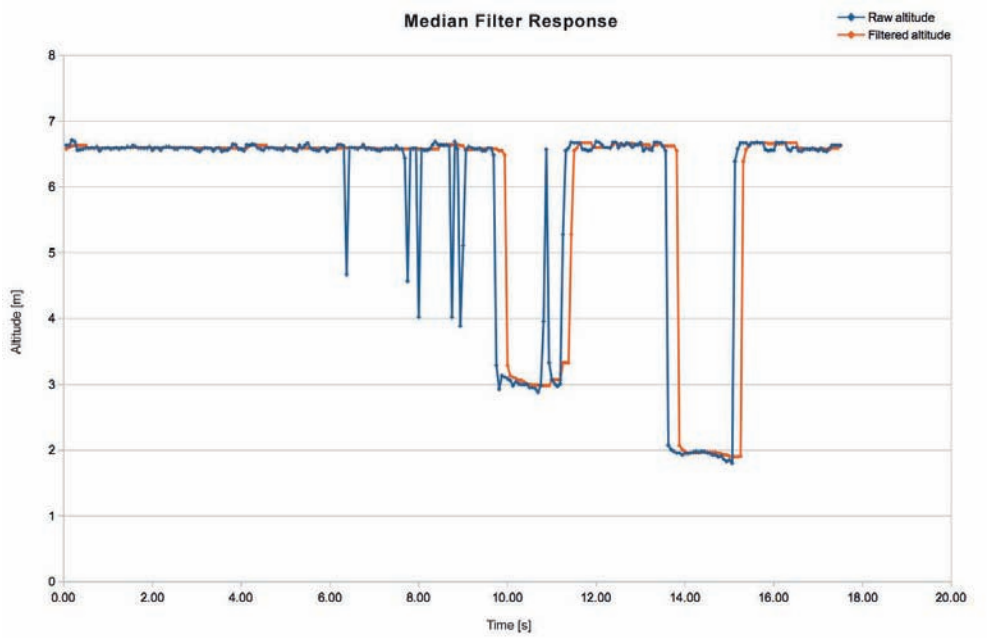


Figure 10 :: Median Filter Response graph

n: Median filter size (3 … 32 results)

Menu item **<n>** sets the number of readings that are used by the median filter. A higher number provides a smoother output but slows down the rate of response of the output to changes in altitude.

p: Enable or disable the adaptive filter (ON / OFF)

Menu item **<p>** is used to enable the adaptive filter that can be used to smooth the altitude readings when operating above flat surfaces such as indoors. This filter adaptively smooths fast changes in altitude but follows slow changes.

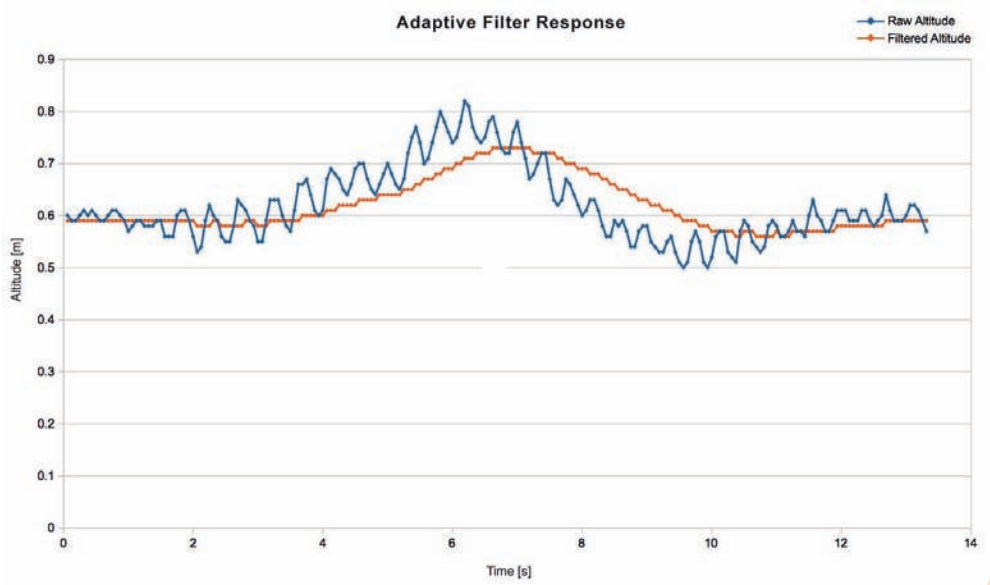


Figure 11 :: Adaptive Filter Response graph

www.lightware.co.za • info@lightware.co.za

5. Instructions for safe use

The SF11 is a laser based altimeter 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 SF11 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 SF11. 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 SF11 but if the lenses start to collect dust then they may be wiped with suitable lens cleaning materials. Make sure that the SF11 is switched OFF before looking into the lenses.

The SF11 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

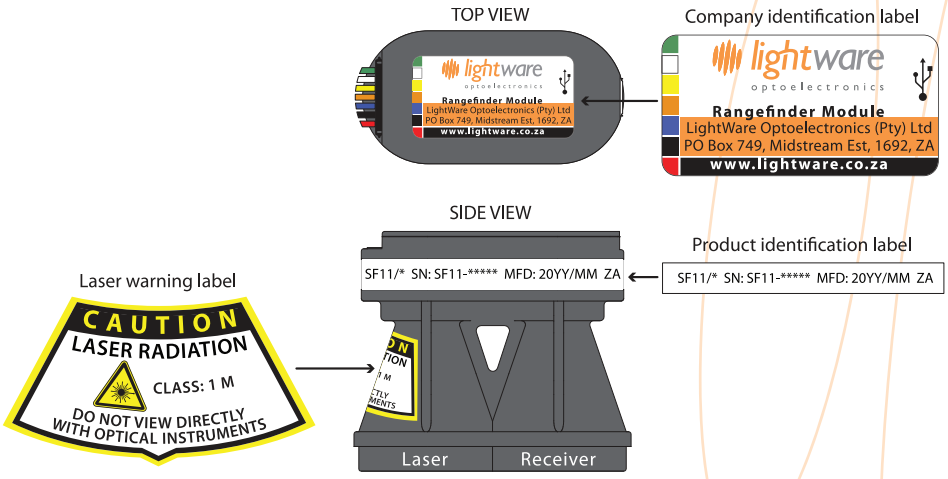


Figure 12 :: Labelling on the SF11

Appendix A :: Specifications

	SF11/C (120 m)
Range	0.1 … 120 meters (natural targets), 2 ... 40 meters (moving water)
Resolution	1 centimeter
Update rate	16 readings per second
Accuracy	±0.1 meter (70% reflective target @ 20°C)
Power supply voltage	5.0 V ± 0.5 V DC
Power supply current	200 mA (maximum)
Outputs & interfaces	Serial, I2C & analog with maximum latency of 65 ms
Dimensions	30 x 56.5 x 50 millimeters
Weight	35 grams (excluding cables)
Connections	Plug & socket, micro USB
Laser power	20 W (peak), <15 mW (average), Class 1M
Optical aperture	51 millimeters
Beam divergence	0.2°
Operating temp.	0 ... 40°C
Approvals	FDA: 1410968-002 (2016/01)

Appendix B :: Dimensions

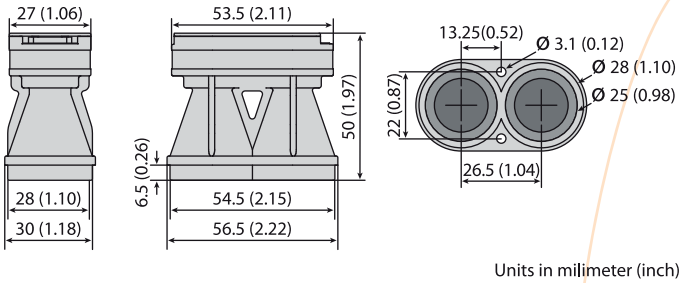
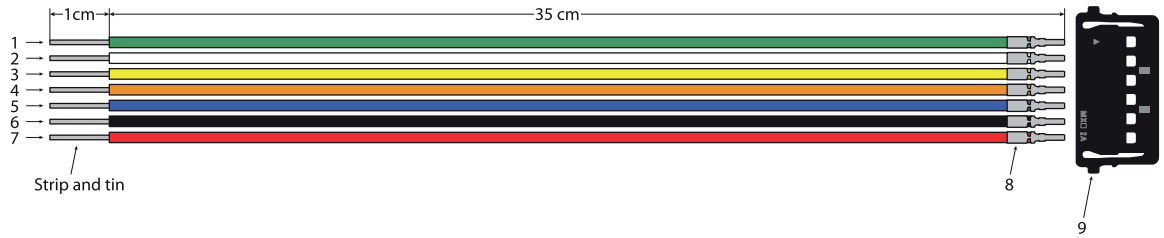


Figure 13 :: Dimension drawings of the SF11

Appendix C :: Main cable type 1, 35 cm

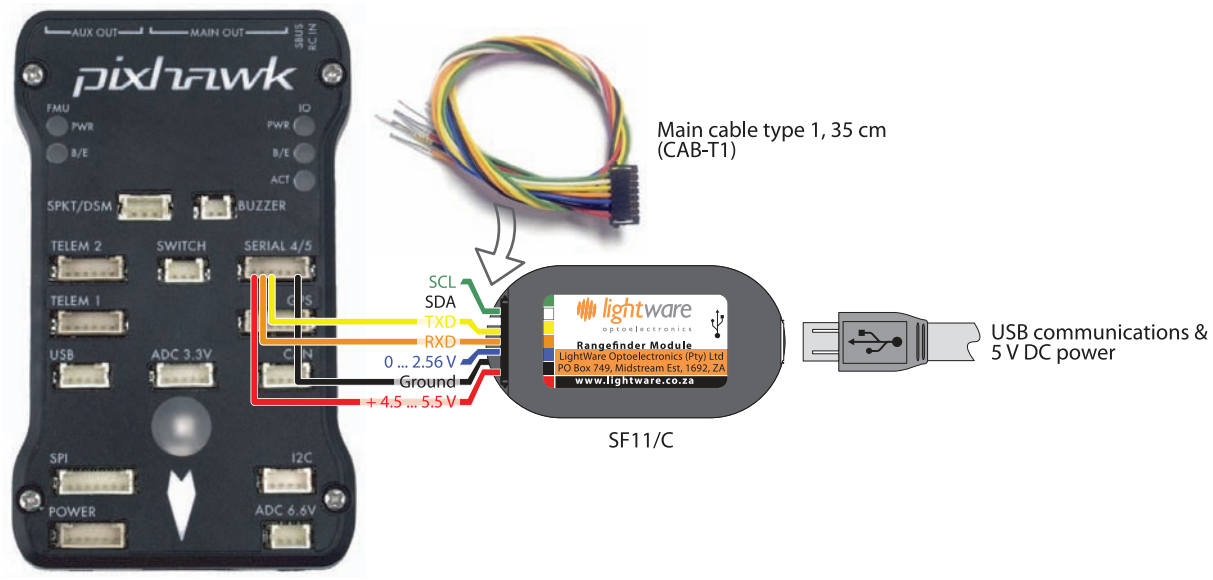


	RS part no.	Manufacturer part no.	Description
1	RS: 177-0867	Alpha Wire: 5853 GR005	Hookup-Wire TFE Teflon Insulation, 26 AWG - Green
2	RS: 177-0839	Alpha Wire: 5853 WH005	Hookup-Wire TFE Teflon Insulation, 26 AWG - White
3	RS: 177-0889	Alpha Wire: 5853 YL005	Hookup-Wire TFE Teflon Insulation, 26 AWG - 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

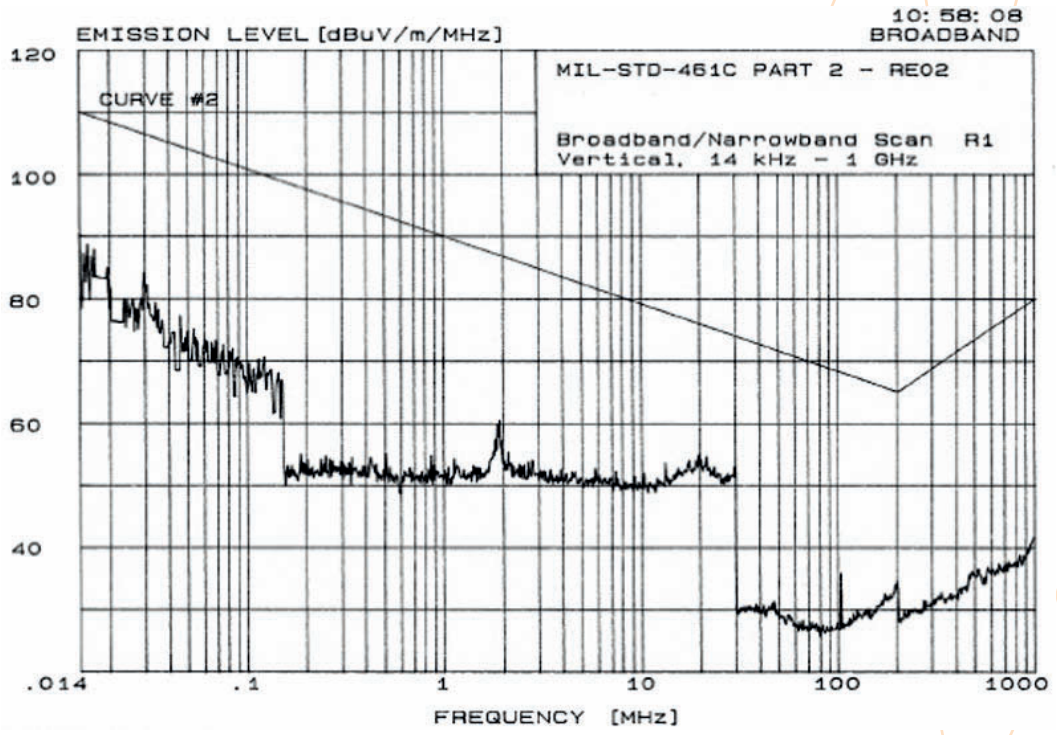
Appendix D :: Connecting to Pixhawk Autopilot using “serial 4”



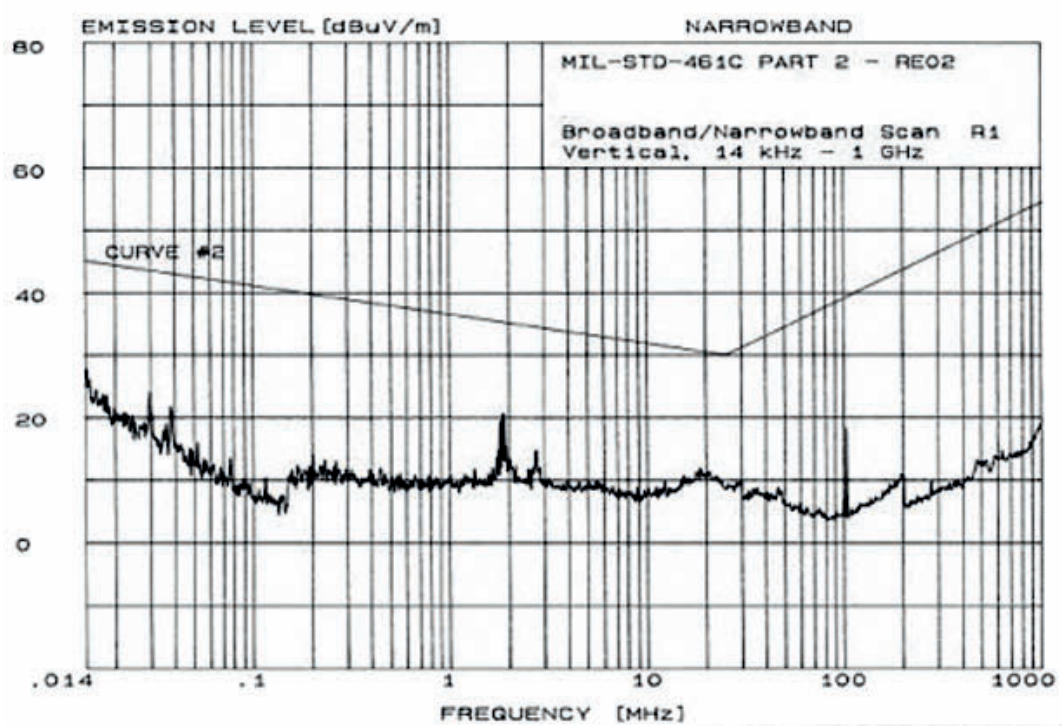
Appendix E :: Electromagnetic interference (EMI) graphs

The SF11 family has been tested for radio frequency interference in accordance with MIL-STD-451C. The results are well within the required limits so that neither direct radiation nor secondary radiation from wiring should cause interference to on-board systems such as GPS and optical flow.

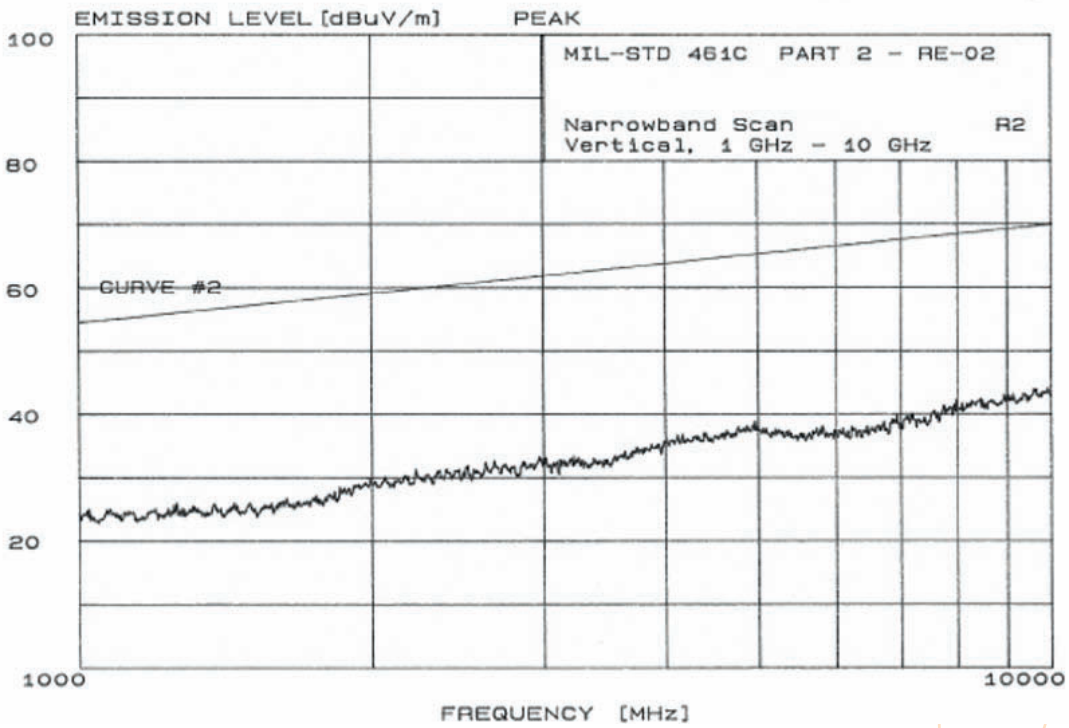
1. 14 kHz to 1 GHz - narrowband



2. 14 kHz to 1 GHz - broadband



3. 1 GHz to 10 GHz - narrowband



Revision history

Version	Date	Authors	Comments
Rev 1	2016/01/29	TLP	Update minimum range on natural targets to “0.1” in “Appendix A :: Specifications” (page 12). Update FDA accession number “1410968-002 (2016/01)” in “Appendix A :: Specifications” (page 12).
Rev 0	2015/11/13	JEP	First edition

www.lightware.co.za • info@lightware.co.za