

# ILM Laser Modules

## User manual

H-2201-5000-01-F





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# INTRODUCTION

# 1 Customer information

## 1.1 Carlson Software

Founded in 1983, Carlson Software specializes in CAD design software, surveying hardware, and machine control products for the land surveying, civil engineering, construction, and mining industries worldwide, providing one-source technology solutions from data collection to design to construction.

ILM modules are designed and built with Carlson's world-class levels of detail, quality and innovation.

Carlson's renowned dedication to customer service is unique in the industry.

For any technical support issues related to your ILM, contact Carlson directly or, alternatively, contact your local Carlson-approved service and support centre. Details of all contacts are on our website: [www.carlsonsw.com](http://www.carlsonsw.com).

To ensure the best service when contacting Carlson about your ILM, please make a note of the serial number. This can be found on a permanent sticker on the laser housing.

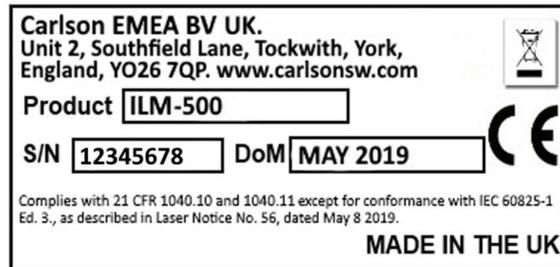


Figure 1 ILM serial number sticker

## 1.2 User manual

The ILM is designed to be easy to operate. However, please take the time to read these operating instructions carefully before using the system and always keep them with the instrument.

This manual was written with reference to software version 2.1.0.2 and firmware version 2.2.1.2.

This manual is divided into three main parts:

- **ILM Overview:** a description of the ILM's laser measurement characteristics and measurement technique.
- **Hardware:** a description of the ILM hardware and accessories.
- **Software:** a guide to the supplied ILM Configuration Tool software.

This manual is also available via the **About** screen in the ILM Configuration Tool.

This document has been compiled with care. However, should you discover any errors, we would be grateful if you could contact Carlson directly.

Reproduction of this document in whole or in part, including utilisation in machines capable of reproduction or retrieval, without the express written permission of Carlson is prohibited. Reverse engineering is also prohibited.

The information in this manual is subject to change without notice.

For any feedback or comments, or if there are questions about the ILM which are beyond the scope of this manual, contact Carlson Software.

## 2 ILM overview

### 2.1 System overview

The integrated laser module (ILM) is an OEM laser module designed to be integrated into third party products which require raw distance measurement. ILM modules may be configured to output distance measurements, speed or digital triggers.

The ruggedised nature of the ILM makes the module capable of being integrated in products used in demanding environments such as transport, law enforcement, mining, quarrying, military and drones.

### 2.2 ILM Variants

There are four hardware varieties of ILM: the ILM-35, ILM-150, ILM-500 and ILM-1200.

Hardware model	Range	Laser class
ILM-35	35 m	Class 1M
ILM-150	150 m	Class 1M
ILM-500	500 m	Class 1M
ILM-1200	1200 m	Class 1M

For all module cases listed above, the optional accessory of the addition of a visible red laser pointer is offered.

Product designation for ILMs with an incorporated red laser pointer is defined by the initial part number, together with the addition of a further "P"-suffix.

Hardware model	Range	Laser class
ILM-35-P	35 m	Class 2
ILM-150-P	150 m	Class 2
ILM-500-P	500 m	Class 2
ILM-1200-P	1200 m	Class 2

All ILM units run the same firmware and the setup of each ILM can be reconfigured using the ILM Configuration Tool.

Note that customised ILMs are available. These are based on one of the four hardware varieties and may have modified hardware or firmware. These products will have their own product code. Contact Carlson for information on customised ILM modules.

## 3 ILM range measurements

### 3.1 Time of flight measurement

An ILM may be configured in various ways – to stream ranges, to act as a trigger, or to calculate speed – but in all cases the output from the module is dependent on accurate distance measurements.

ILM modules use an infra-red laser and time-of-flight technology to measure ranges.

A pulse of infrared laser light is sent out from the ILM's transmitting optics. The pulse of light hits the targeted surface and is scattered. The aim is that a tiny part of the scattered light finds its way back to the ILM's receiving optics. A timing chip in the ILM measures the time taken for the pulse of light to make its journey from, and back to, the optics.

The range is determined by halving this time, and multiplying the result by the speed of light.

### 3.2 Maximum ranges

Each laser has a maximum range specification. Achieving this specification is conditional on the targeted surface being:

- Perpendicular to the laser beam.
- Of a bright colour, specifically 90% reflectivity (such as Kodak white card).
- Of a size at least as big as the footprint of the laser at the attempted range. The footprints of each laser at different distances are recorded in section 23.

### 3.3 Null ranges

If no (or insufficient) light from the despatched pulse is received back, then it will be impossible to compute a range.

As any laser beam propagates, it diverges and the amount of light hitting any given point is reduced. Thus, smaller targets, or targets at longer distances, may not reflect sufficient light to be detected by the ILM's receiving optics.

A range may not be computed if the targeted surface is:

- Beyond the specified range. In this case, the amount of light returned will probably be too small to be registered by the detector.
- At an acute angle with respect to the laser beam. The laser will tend to bounce off at a reciprocal angle so most of the scattered light is directed away from the ILM.
- Very dark. In this case the surface may absorb the laser light rather than scattering it. Note that the darkness of the target surface is relevant, but the ambient lighting conditions do not affect the performance or range of the ILM.
- Very small with respect to the footprint of the laser. In this case, not enough light may be returned.
- Highly reflective. A mirror-like surface will reflect the light away from the ILM at a reciprocal angle, rather than scattering it.

### 3.4 Incorrect ranges

An incorrect range may be computed in certain situations:

- If the targeted surface is highly reflective, the light may bounce off it before hitting a secondary surface. This will scatter the light which may then return back to the ILM via the original reflective surface. This phenomenon returns a false, long range.
- When the targeted surface is very small with respect to the footprint of the laser, there may be a secondary surface behind it. If this returns enough light, a false, long range may be computed.
- A false, short range may be returned due to a secondary surface in front of the target which may not be immediately apparent. For example, strands of foliage, a wire fence or glass.
- If the vicinity is very dusty or humid, then dust or vapour particles in the air may scatter the light back to the source ILM before it hits the targeted surface. In this case, a false, short range may be computed.
- If the ILM is pointed towards the sun, or other very bright light source, spurious, unpredictable ranges may be generated. Note that this can also damage the sensitive detecting optics on the ILM.

### 3.5 Ranges to reflective targets

Ranges which are significantly greater than the ILM's quoted maximum range may be achieved if the targeted surface is very reflective. Examples of such surfaces are:

- Car number plates.
- Reflective strips on clothing.
- Survey prisms.
- Foil targets.

Such surface types can be used to deliberately extend the range of the ILM. However, care should be taken if these surfaces are unintentionally within view of the laser. In this case the reflective surface may return a much stronger signal than that returned by an unreflective targeted surface. Thus, ranges may be computed to the wrong surface.

### 3.6 Multiple returns ('first hit' and 'last hit')

It is possible for the laser to receive more than one return back from a target. For example, in the following situations, both a 'first hit' and a 'last hit' may be received: one return from the targeted surface and another from a secondary surface.

- A targeted surface has a chain link fence or foliage in front of it which also produces some returns to the ILM.
- The laser is fired through a window and the ILM receives a return from the window as well as from the target beyond the window.
- A highly reflective surface such as a person wearing a Hi-Vis jacket is located near to a targeted surface, and also generates a return to the ILM.
- The light hits a reflective target such as a wet surface and bounces off onto a secondary surface. A return may be received from both surfaces.
- The targeted surface is very small with respect to the footprint of the laser and there is a secondary surface behind it which returns a reflection to the ILM.

In all these cases the ILM generates and stores two ranges from one single pulse.

It is possible to make use of either of these ranges by requesting in the ILM Configuration Tool that the first or last hit be output or used for the computed output, or as a secondary output.

In the first example above, the first range generated (the quickest to return to the ILM and thus the shortest range) is from the chain link fence and the last range (the longest time to return to the ILM and thus the longest range) is from the targeted surface. Thus, in the case, the last hit is most relevant to the application and might be selected as the primary output.

In the last example above, the first range generated is from the targeted surface and the last range is from a background object. In this case, the first hit is most relevant to the application.

Note that last hit mode should be avoided when shooting to a reflective prism, as incorrect ranges may result.

### **3.7 Accuracy**

For best results, allow the unit to be powered ON for five minutes prior to collecting data. This allows the ILM to warm up and produce the optimum level of accuracy.

## 4 ILM output

The data output from the ILM can be configured using the ILM Configuration Tool.

ASCII data or binary data can be output and varying combinations of range, speed temperature etc can be produced.

See section 15.2 for details on configuring ASCII and binary outputs.

The ILM can also output a trigger, when certain pre-defined criteria are met, such as receiving a range over a configured set maximum distance.

See section 18 for configuring trigger conditions.

### 4.1 Rangefinder mode

Computed ranges can be output in a continuous stream of data or in a single shot mode.

If running in continuous mode, the output can be configured to be between 1-1000 Hz.

Whenever a single pulse from the ILM hits a surface and is received back into the ILM optics, a raw range is generated.

A range output is displayed as:

00103.34m

Secondary values can be output along with the range.

If no range is detected, this is displayed as:

99999.99m

The ranging reference point is the front face of the ILM. A user offset can be applied to adjust this reference point.

### 4.2 Gating and filtering data

Most commonly, returned ranges are computed by averaging a user-defined number of raw ranges from single laser pulses. In this way, one averaged range is computed. Additionally, outliers can be discarded prior to averaging taking place.

This filtering process may help in situations where there may be unpredictable returns from in front of, or behind, the targeted surface.

For some applications, data can be gated: i.e. hard limits are set to determine which ranges are returned. For example, if the ILM is shooting perpendicularly across a road to detect traffic, range limits can be set which match the near and far kerb lines. In this case, anything that passes in front of the ILM laser beyond either kerb, is ignored.

### 4.3 Speed mode

Range measurements are the primary function of ILM modules. These range measurements can be used for the secondary function of speed measurements.

The ILM measures speed by computing two ranges to a moving target, each range taken at a precisely timed occasion. The change in the distance between this pair of ranges is used to calculate the speed that the target is moving, relative to the ILM.

When power is applied to the laser it will go through a short start-up routine and then start to take range measurements and output speed.

A range value can also be output along with the speed. An example data string is:

```
044.99kph,0010.46m
```

## 4.4 Trigger mode

Range measurements are the primary function of ILM modules. These range measurements can be used for the secondary function of triggering a digital pulse along the supplied orange trigger wire. When in trigger mode, the ILM produces range data and secondary data as in the Rangefinder mode above.

In addition, the ILM produces a digital trigger output pulse when certain user-defined conditions are met. The conditions maybe that the range output has fallen inside or outside certain range windows, or a signal strength criterion has been met.

For example, an ILM focused on a door may generate a trigger signal when the door is opened and returns range greater than a pre-defined limit.

# HARDWARE

## 5 ILM hardware configuration

There are four models of ILM. Each is broadly the same design, but built to different sizes.

The ILM-35 and ILM-150 are the same size. The ILM-500 and ILM-1200 are progressively bigger.



Figure 2 ILM modules – ILM-1200, ILM-500, ILM-150/35

The ILM is housed in a black anodised aluminium casing.

The receive (Rx) and transmit (Tx) lenses are located on the front face of the ILM.

The infra-red light is emitted through the Tx optics and any returns are received through the Rx optics.

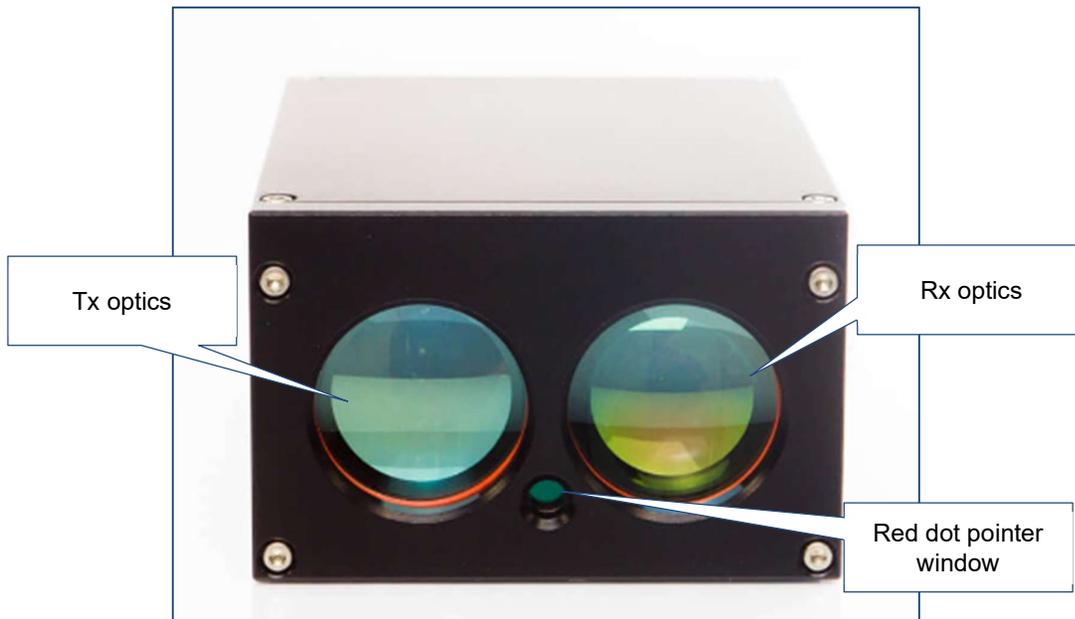


Figure 3 ILM Tx and Rx optics

Between the lenses is a space for the optional, red laser pointer to be fitted. The red laser pointer window is visible on all ILM-500 and ILM-1200 units, whether or not the pointer has been installed. The red laser pointer is only present behind the window if it has been specifically requested. The red laser pointer can also be installed in an ILM-35 and ILM-150 on request.

A Fischer connector protrudes from the rear face of the ILM. This is the connection point for the supplied power /data cable.

## 5.1 Power / Data cable

A 2m combined power / data cable is supplied with each ILM.



*Figure 4 ILM power / data cable*

A 5-pin Fischer connector plugs into the back of the ILM.

A 9-way D-type serial connector plugs directly into a serial port on a PC, or into a USB-serial adaptor.

Two flying cables connect to the positive and negative power terminals of an external power supply.

One flying cable provides a trigger signal.

See section 5 for full details about power and data connections.

Custom cable lengths are also available. Contact Carlson for further details.

## 5.2 USB Drive

A USB drive is supplied with the ILM and loaded with:

- The ILM Configuration Tool software.
- This ILM manual.

## 6 Regular checks and preventative maintenance

Carlson recommends that you carry out regular functional testing of the ILM system. Any damage, malfunctions or poor performance detected should be reported to Carlson. Also contact Carlson to arrange a yearly service and calibration.

Where necessary, replacement accessories can be purchased from Carlson or from your local Carlson representative.

Before and after each session, carry out routine checks of the system.

### 6.1 Care of your ILM

The ILM makes use of sensitive optical, electronic and mechanical components and requires appropriate handling.

Do not use paint solvents to clean the instrument. To clean the lenses and optional red dot pointer window, you may use HPLC-grade (>99.8%) iso-propyl-alcohol (propan-2-ol) in combination with lint-free cotton-wool buds or wipes.

If necessary, use a cloth to clean the outer housing with warm soapy water.

Avoid positioning the lenses to point directly into sunlight, or any other intensely radiating light source. The focusing effect of the optics inside the ILM can create a highly concentrated point image with enough energy density to damage the detector inside the unit. Use an external shade or adapt the mounting angle to avoid this problem.

Never apply force or shock to the lenses or to the housing of the instrument. As with other optical instruments, the ILM should be protected from being shaken, knocked or dropped.

Store within the specified environmental temperature limits.

It is important that the instrument temperature should lie between  $-10^{\circ}\text{C}$  and  $+60^{\circ}\text{C}$  when the instrument is switched on.

ILM modules are designed to be water resistant to IP67. This means that the product is dust-proof against particles greater than 1 mm diameter and that it is protected against short periods of immersion in water between 15 cm and 1 m.

# POWER & DATA CONNECTIONS

## 7 Power and Data connections

All of the modules are supplied as standard with a 2 m power/data cable. All power and two-way data communications are delivered through this cable.

A 5-pin Fischer connector plugs into the Fischer connector on the back of the ILM housing.

At the output end of this cable is a 9-pin, D-type connector and 3 short wires.

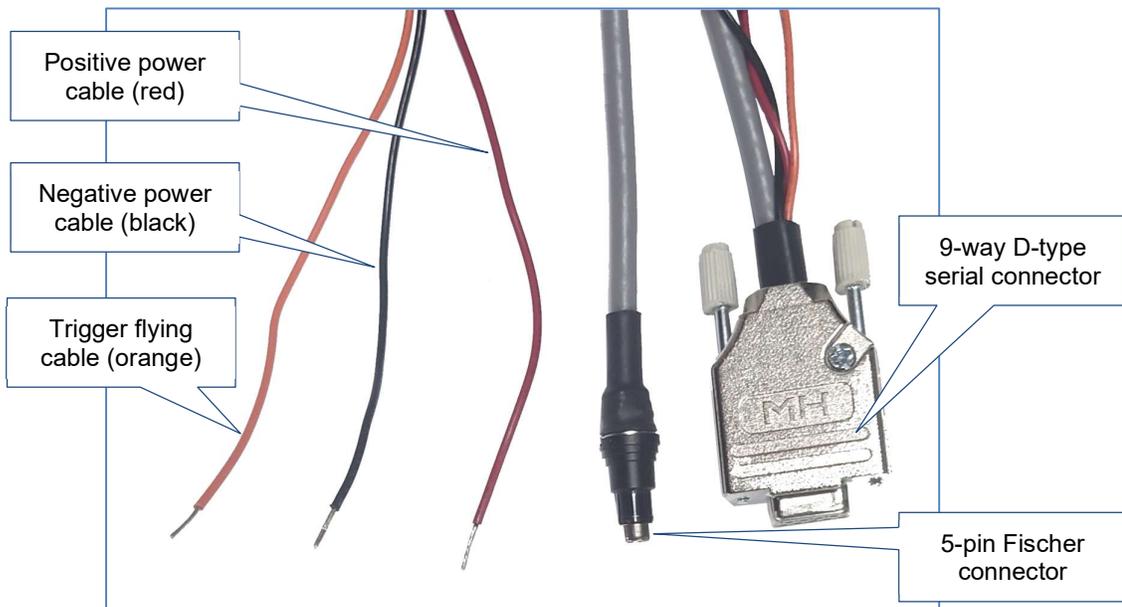


Figure 5 ILM cable ends

### 7.1 Fischer pin-out description

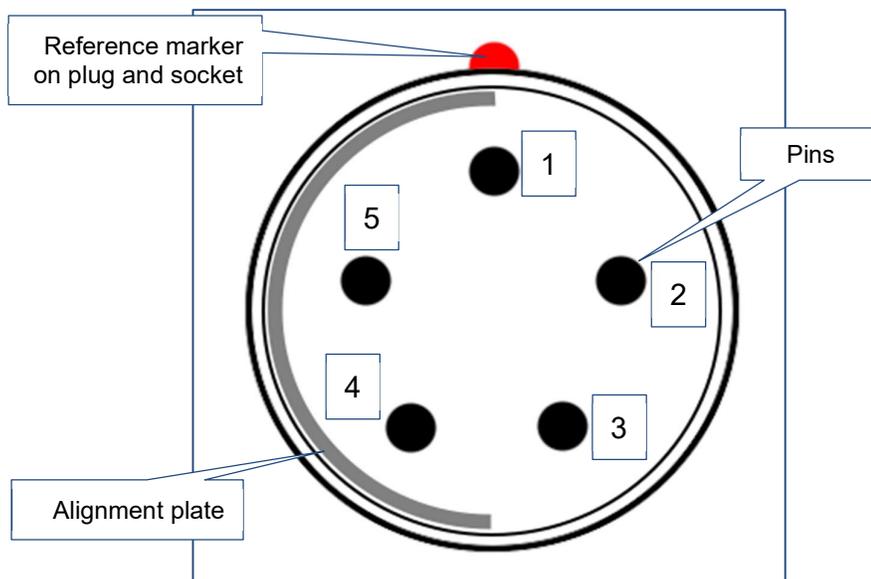


Figure 6 Fischer connector pins- view of front of supplied male cable connector

If you remove the 9-way D-type connector from the end of the supplied cable to add your own custom connector, the six wires are exposed, as outlined below.

Fischer connector pin	Core Colour	Function	D-type serial pin
1	Blue	Positive supply input (+ve)	
2	Black	Data from laser (RS232)	2
3	Red	Data to laser (RS232)	3
4	Yellow	Trigger line for laser	
5	Green	Ground (0 V)	5
Not connected	White	Not connected	

## 7.2 D-type serial connector

The D-type connector is used for the serial RS232 data output which is common to all ILM modules. The D-type connector pin definition is outlined below.

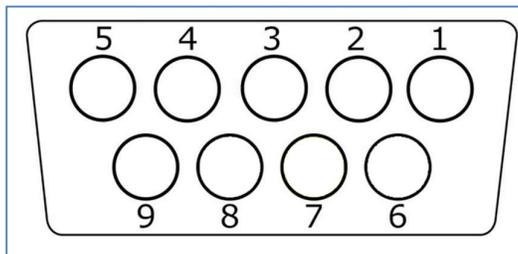


Figure 7 Front face of female 9-way serial D-type connector

Pin	Function
2	Data from laser to PC
3	Data to laser from PC
5	Ground

No other pins in the D-type connector are connected.

## 7.3 Flying leads

The three flying leads are coded as outlined below.

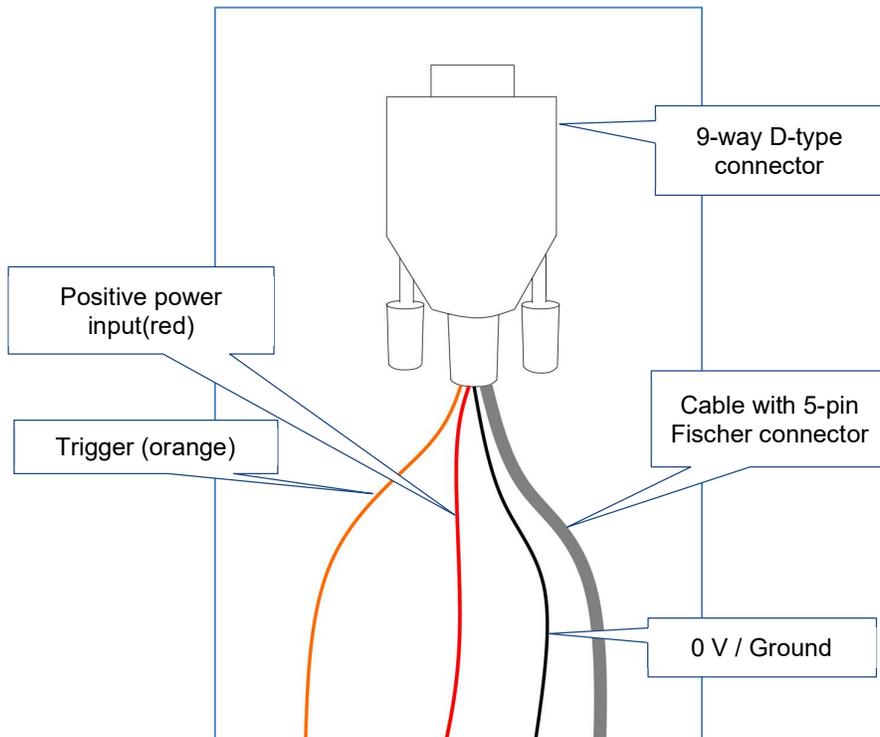
Cable	Function
Red	Positive power (9 – 24 V dc)
Black	Ground (0 V)
Orange	Event trigger

### 7.3.1 Trigger

The orange flying lead is used as a digital output from the system.

When required, this wire should be connected through a 10kΩ resistor to the supply voltage, or to a separate power supply with common ground to the supply voltage.

The laser will output its digital signal by changing the voltage at the output of the orange wire between 0 and the supply voltage. This digital signal can be used as an event trigger for applications such as triggering traffic cameras and intruder detection alarms.



## 8 Direct communication with the ILM

The ILM Configuration software contains functionality to adapt the operation of the ILM to meet the requirements of your project.

If you are producing software to interface with the ILM, then details of direct communications needed to communicate with the ILM are outlined below.

### 8.1 Establishing communication with the ILM

To test interaction with the ILM, connect via an emulator software package such as Putty or Tera Term.

Supply power to the ILM.

Connect the ILM to your PC via the 9-way D-type connector (using a serial-to-USB adaptor if required) or via a customised connection.

By default, the ILM baud rate is set to 9600. This is changeable in the ILM Configuration Tool. Whatever value the baud rate is set to, the connection is always configured at 8 bits, no parity, 1 stop bit.

On power up, the ILM sends a firmware version and serial number.

```
V1.2, 123456
```

If the ILM's **Firing mode** has been set to **Continuous** output, then the data stream will commence immediately.

The output can be customised in the ILM Configuration Tool.

### 8.2 Terminal commands

Available commands are outlined below. All inputs are in upper case characters.

Command	Function
<Ctrl> L	Lock the UART interface
#	Print the serial number
?	Print the date and time at which the code was built
E	Toggle whether the output is printed manually or automatically
F	Stop firing
H	Print help for the user commands
N	Start firing
P	Turn the red dot pointer on, if present
Q	Turn the red dot pointer off, if present
R	Toggle whether the range is also printed in speed mode
S	In single shot mode, fire the laser and report the result
U	When the output is printed manually, report it in binary format
Z	Set the user offset to the current range value
~	Print the hardware version
<Ctrl> A	Reset Auto range offset

# SOFTWARE

## 9 ILM Configuration Tool software

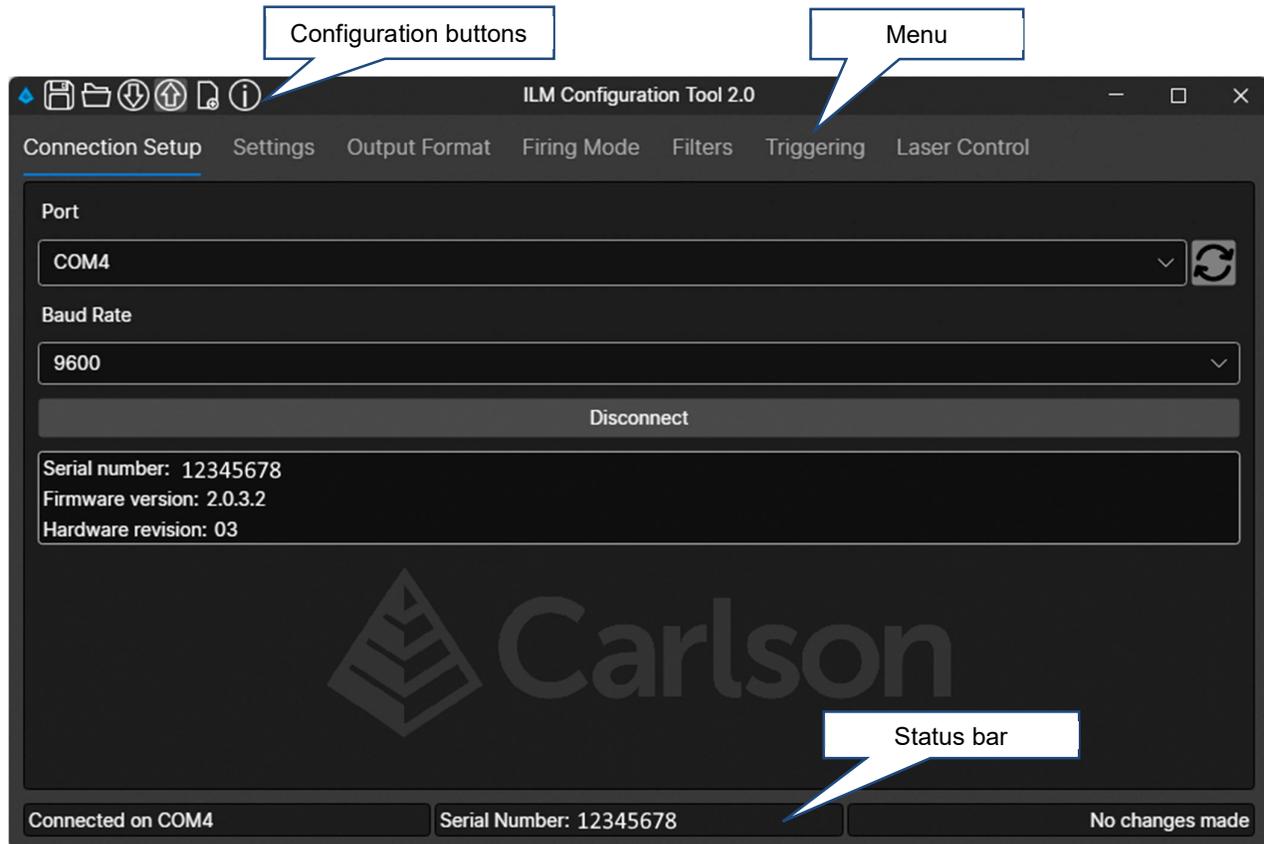
The ILM Configuration Tool is supplied as a portable \*.EXE file and supporting files zipped into a single folder.

Copy the \*.ZIP file onto your PC and extract the contents. Double-click the \*.EXE file from within the folder to launch the software.

The software is free issue so it can be used on any PC running Windows 10+.

The only hardware requirement is that your PC must have either a serial port, or a USB port with a USB-serial adaptor.

## 10 ILM Configuration Tool – UI



The ILM Configuration Tool home screen is displayed above.

## 11 Configuration buttons

### 11.1 Save config to file



Save the configuration on the connected ILM to a file.

Click the **Save config to file** button and a **Save As** file dialog opens.

As required, navigate to an address on your PC and rename the file. Click **Save**.

The file is saved as an \*.ILMCF text file.

This file can be loaded back onto any ILM using the **Load config from file** button.

### 11.2 Load config from file



Load a previously-saved configuration file onto the connected ILM.

Click the **Load config from file** button and an **Open** file dialog opens.

As required, navigate to an address on your PC and select an \*.ILMCF file. Click **Open**.

All settings in the \*.ILMCF file are uploaded onto the connected ILM.

### 11.3 Get config from laser



Download all configuration settings from the connected ILM into the ILM Configuration Tool.

### 11.4 Send config to laser



Upload all changes made in the ILM Configuration Tool to the connected ILM.

### 11.5 Reset laser config to default



Reset all parameters to the default settings which were configured when the ILM was produced in the factory.

Carlson recommend that you should save a backup of the current configuration before using this feature.

## 11.6 Info



Open an **About** window.



The About screen shows the current ILM Configuration Tool version.

Click **Read EULA** to open the end user license agreement. The EULA is also outlined at the end of this manual.

Click **Open manual** to open a PDF version of this manual.

## 12 Status bar

The Status bar gives information on the current connection.

### 12.1 Connection

The connection status of the ILM. This may read:

- **Not Connected** if no ILM is connected to the software.
- **Connected to COMx** if an ILM is connected on COM port x.
- **Laser connection lost. Disconnected.** If an ILM has been connected but then the connection was dropped.

Other error messages may appear. Contact Carlson support for further information on these messages.

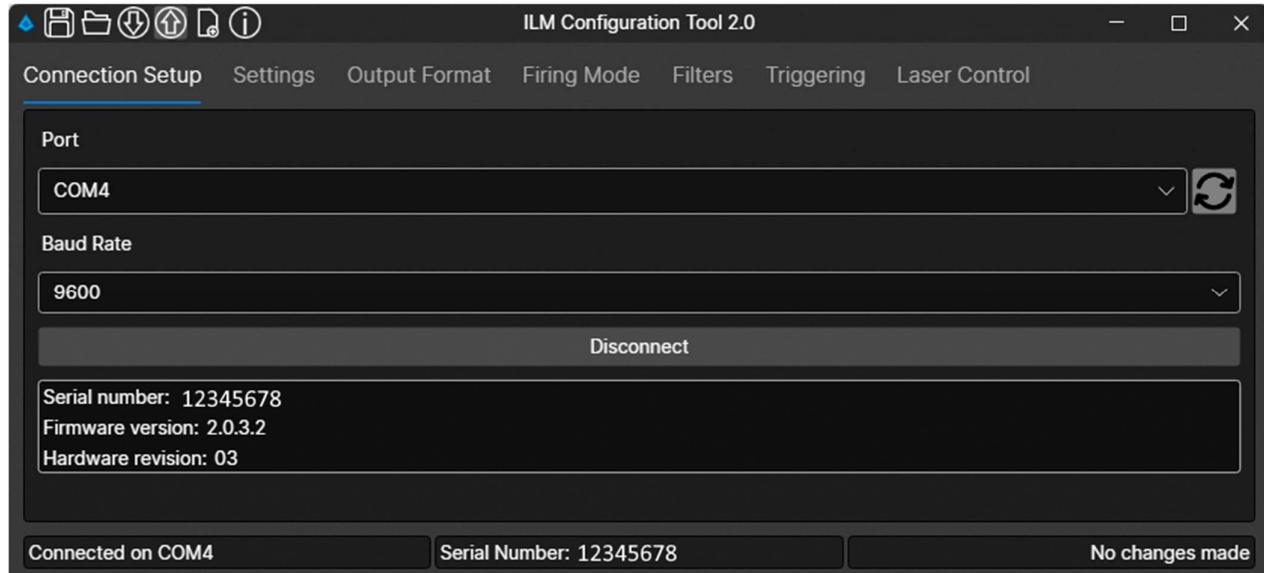
### 12.2 Serial Number

The serial number of the currently connected ILM.

### 12.3 Upload required

Indicates whether any changes have been made to the settings in the ILM Configuration Tool which need to be uploaded to the currently connected ILM.

## 13 Connection Setup



The **Connection Setup** screen enables connection between the ILM and the ILM Configuration Tool. Before progressing, ensure that the ILM is powered ON and connected to your PC.

### 13.1 Port

All valid COM ports on your PC are displayed in the **Port** drop-down list.

Select the serial port (or virtual serial port if you are using a serial-to-USB adaptor) that is being used by the ILM.

If the port configuration has changed since the software was started, click the **Refresh** button to the right of the **Port** drop down list.

### 13.2 Baud Rate

By default, the ILM baud rate is 9600.

From the **Baud rate** drop-down list, select the baud rate that is set in the connected ILM:

- 9600
- 19200
- 38400
- 57600
- 115200

### 13.3 Connect / Disconnect

With the correct baud rate and port selected, click **Connect**.

The status bar shows the connection status.

When the ILM has successfully connected, the status bar shows the serial port through which the ILM is connected. The ILM serial number is also displayed.

If the connection fails, the status bar displays **Connection failed**.

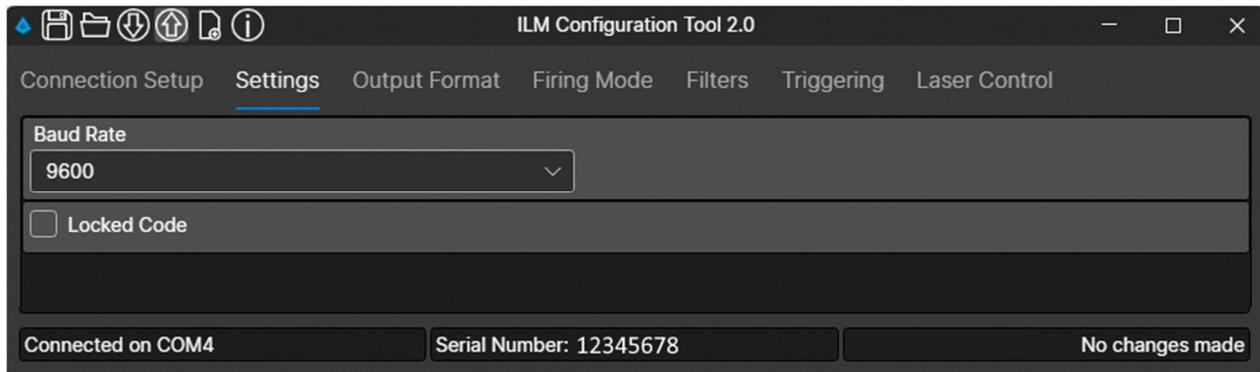
In this case, check that the correct selections have been made under **Port** and **Baud rate**. Also check that the ILM is powered ON.

When the ILM has successfully connected, the **Connect** button becomes a **Disconnect** button. Click **Disconnect** to disconnect the ILM from the ILM Configuration Tool.

Beneath the **Connect / Disconnect** button is displayed:

- The serial number of the ILM.
- The firmware version running on the ILM.
- The hardware revision of the ILM.

## 14 Settings



### 14.1 Baud rate

Use the **Baud Rate** drop down list to set a new baud rate in the ILM.

- 9600
- 19200
- 38400
- 57600
- 115200

Note that if the baud rate is changed, the next time you connect to the ILM, you will need to select the newly established baud rate in the **Connection setup** window.

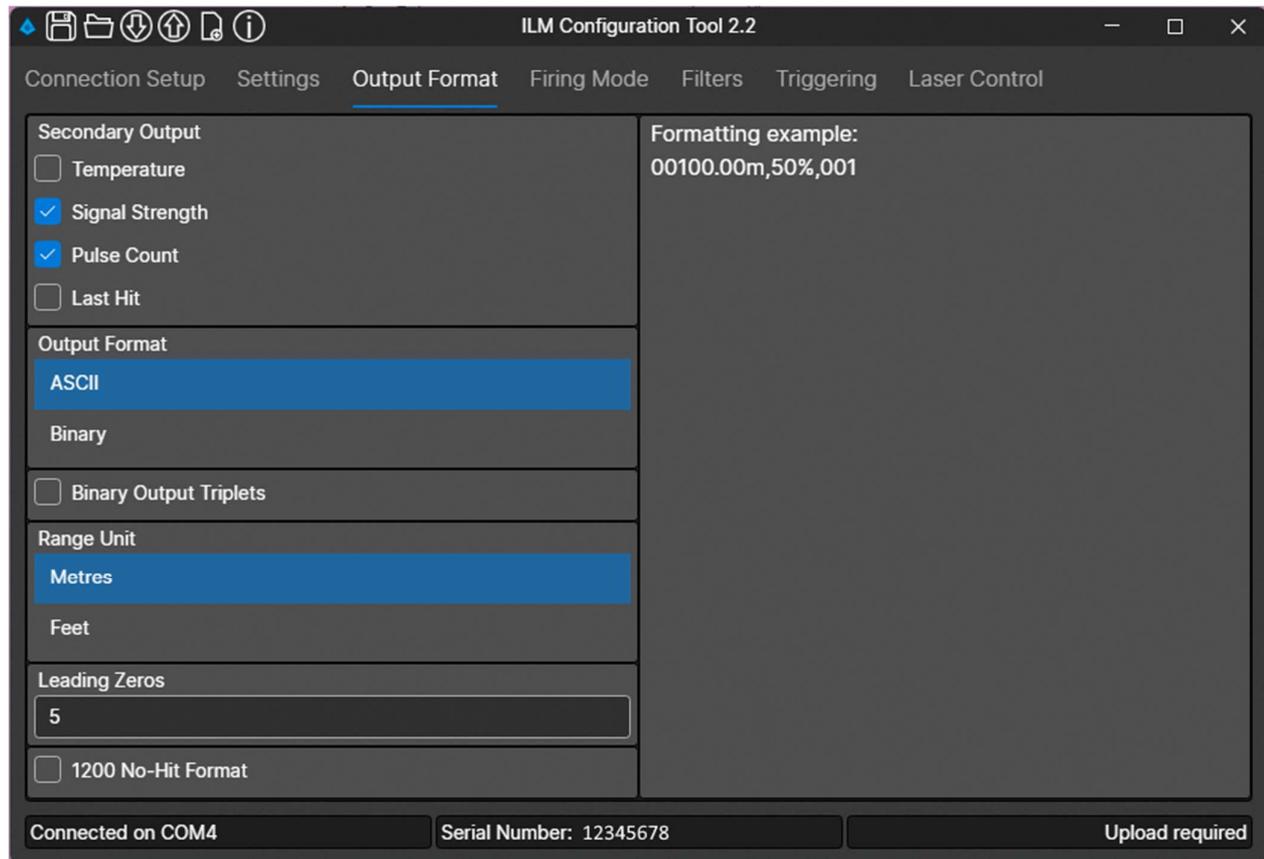
### 14.2 Locked code

Tick the **Locked Code** check box to lock all settings on the ILM.

## 15 Output format

Use the **Output Format** screen to configure the data string which is output by the ILM.

An example of the string that would be output using the current settings in the UI is displayed in the right-hand panel.



### 15.1 Secondary output

In addition to range, secondary outputs can be configured as below.

Note that if the **Output Format** is set to binary, and the **Range Unit** is set to cm, then the secondary outputs are disabled.

#### 15.1.1 Temperature

The temperature measured by a temperature sensor in the ILM is output with each range.

The units are always set to degrees Celsius.

#### 15.1.2 Signal strength

The signal strength is output as a percentage of the maximum signal strength.

### 15.1.3 Pulse count

The number of laser pulses that are used to generate a computed range is output.

### 15.1.4 Last hit

Displays an additional range which is the last hit (and thus the longest range) received from the total raw pulses used for the computed output.

Depending on how the first hit / last hit configuration is set (see section 16.3), the last hit can be swapped for the first hit as a secondary output.

## 15.2 Output format

The output can be set to ASCII or binary.

### 15.2.1 ASCII

If the **Output Format** is set to **ASCII**:

- The **Range Unit** options are **Metres** or **Feet**.
- All **Secondary Outputs** are available.

A formatting example is:

00100.00m, 30.0000'C, 50%, 0020, 100.00

Where:

Value	Field
00100m	Computed range*
30.0000'C	Temperature
50%	Signal Strength
0020	Pulse Count
100.00m	Last Pulse

\* Assuming: Range Units set to 'Metres', Leading Zeros set to '5'.

### 15.2.2 Binary

If the **Output Format** is set to **Binary**:

- The **Range Unit** options available are **cm** or **dm**.
- If the **Range Unit** is set to cm, then the secondary outputs are disabled.

The range data is sent in two (8 bit) bytes as an encoded 12-bit binary word to represent the range data in decimetres or centimetres. The first byte contains the 6 MSB's and the second byte contains the 6 LSB's of the word. The most significant bits are set to '10' for the most significant byte and to '00' for the least significant byte.

For example:

MSB	LSB	Decodes to 12 bits	Range
10101001	00010111	101001010111	2647dm
10101011	00111110	101011111110	2814dm
10000011	00000001	000011000001	193dm
10001101	00101100	001101101100	876dm

If no range is detected the data output is:

MSB	LSB	Decodes to 12 bits	Range
10111111	00111111	111111111111	4095dm

In addition to the range output, it is also possible to have a secondary output such as a pulse counter or the absolute value of the signal strength which is being returned to the laser from the target. If any of these options are turned on, then in addition to the coded range information, two more bytes will follow each range output, encoded as detailed below.

When multiple secondary values are printed, they are printed in the order:

1. Signal strength coded on a non-linear 0 to 2047 scale.
2. Pulse count.
3. Last hit range (in centimetres).
4. Temperature (as a signed number, in sixteenths of a degree Celsius).

The signal strength data is sent in two (8 bit) bytes as a 12-bit binary word. The first byte contains the 6 MSB's and the second byte contains the 6 LSB's of the word of the signal strength. The most significant bits are set to '11' for the most significant byte and to a '01' for the least significant byte.

Example:

MSB	LSB	Decodes to 12 bits	Secondary output
11000111	01000000	000111000000	448
11001011	01101100	001011101100	748

If no range is detected the data output is:

MSB	LSB	Decodes to 12 bits	Secondary output
01000000	11000000	000000000000	0

Note: Since the maximum range that can be expressed in this two-byte binary format is 409.6 m. The ILM-500 and ILM-1200 therefore need to be switched to 115200 baud and ASCII output for longer ranges.

### 15.3 Binary output triplets

When **Binary** output format is selected, print the output in binary triplets.

### 15.4 Range unit

Select the units in which ranges are output.

If the **Output Format** is set to **ASCII** the **Range Unit** options are:

- **Metres**
- **Feet**

If the **Output Format** is set to **Binary** the **Range Unit** options are:

- **cm**
- **dm**

## 15.5 Leading zeros

Sets a fixed number of numerals to be output before the decimal point.

## 15.6 1200 No-hit format

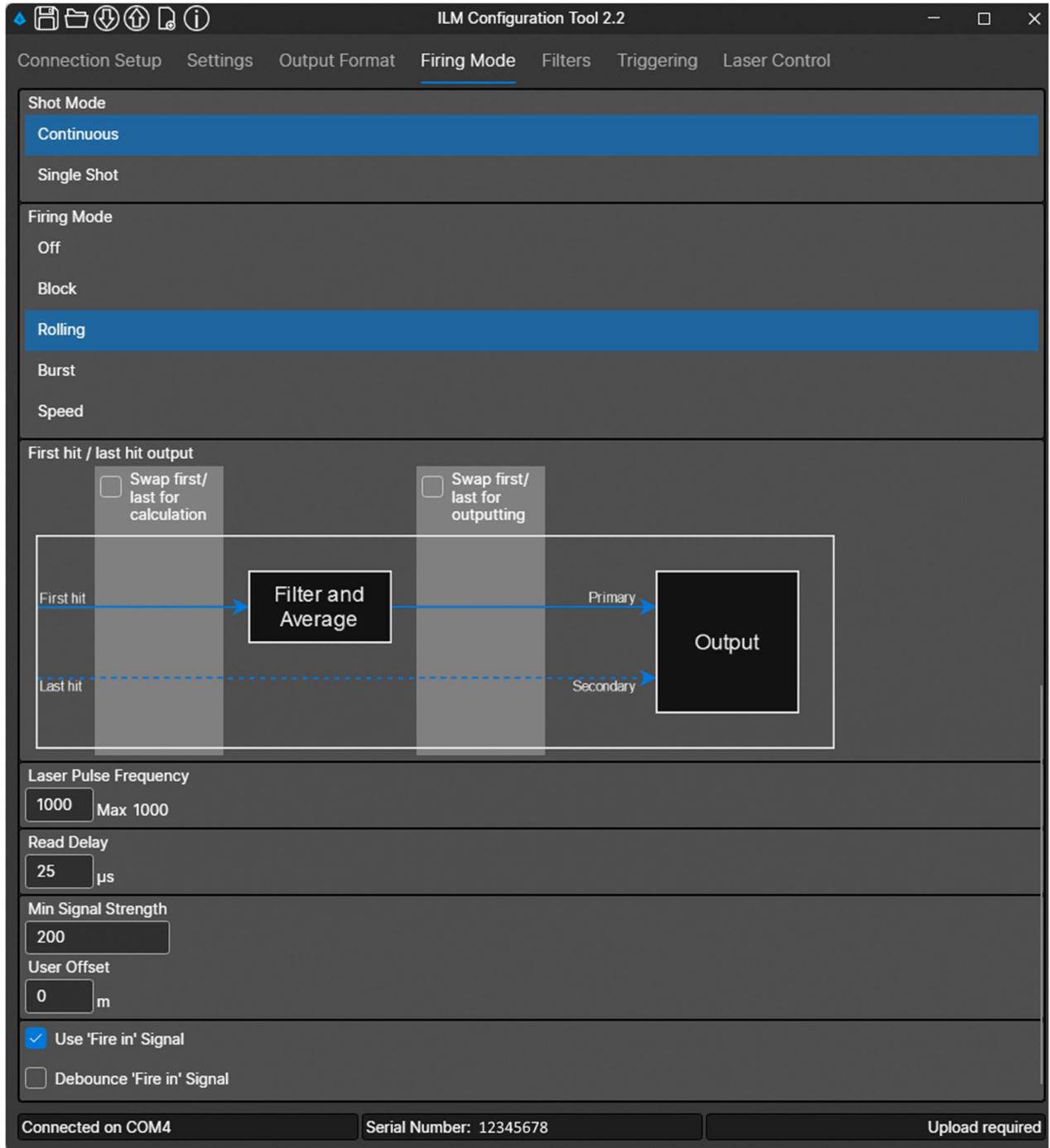
When the **1200 No-hit** format check box is unticked, no-hit ranges from an ILM-1200 unit are output as:

99999.99

When the check box is ticked, no-hit ranges are output as:

999999

## 16 Firing Mode



The screenshot shows the 'Firing Mode' configuration window in the ILM Configuration Tool 2.2. The window has a menu bar with 'Connection Setup', 'Settings', 'Output Format', 'Firing Mode', 'Filters', 'Triggering', and 'Laser Control'. The 'Firing Mode' section is active and shows the following settings:

- Shot Mode:** Continuous (selected), Single Shot
- Firing Mode:** Off, Block, Rolling (selected), Burst, Speed
- First hit / last hit output:** A diagram showing 'First hit' and 'Last hit' inputs. 'First hit' goes through a 'Filter and Average' block. 'Last hit' goes through a 'Filter and Average' block. The outputs are labeled 'Primary' and 'Secondary' respectively, leading to an 'Output' block. There are two checkboxes: 'Swap first/last for calculation' and 'Swap first/last for outputting', both currently unchecked.
- Laser Pulse Frequency:** 1000 (Max 1000)
- Read Delay:** 25  $\mu$ s
- Min Signal Strength:** 200
- User Offset:** 0 m
- Use 'Fire in' Signal
- Debounce 'Fire in' Signal

At the bottom, the status bar shows 'Connected on COM4', 'Serial Number: 12345678', and 'Upload required'.

## 16.1 Shot mode

### 16.1.1 Continuous

In Continuous firing mode, the ILM constantly outputs a computed range, at a speed configured using the ILM Configuration Tool. The output commences as soon as the ILM is power ON.

### 16.1.2 Single shot

In Single shot firing mode, the ILM outputs a computed range only when manually requested to do so.

Send an 'S' command to trigger the range output.

## 16.2 Firing mode

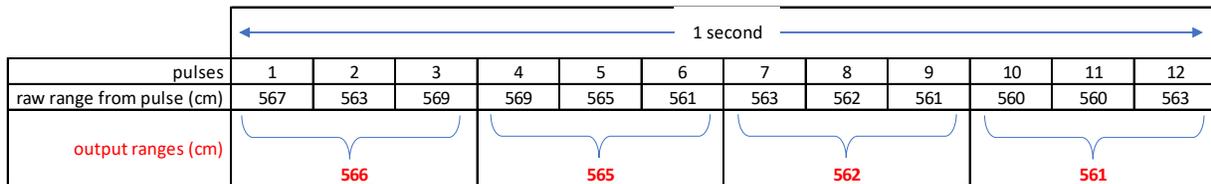
### 16.2.1 Off

Turns the laser OFF so no pulses are transmitted.

### 16.2.2 Block

Where a constant stream of range data is being produced, and each range is to be computed by averaging  $x$  consecutive raw ranges, **Block** mode takes each set of  $x$  raw ranges as a separate, independent group. One computed range is output from a set of  $x$  raw ranges. The next range is computed from the next set of  $x$  raw ranges.

**BLOCK AVERAGE** Laser pulse frequency = 12 Hz  
Averaging = 3 pulses



pulses	1	2	3	4	5	6	7	8	9	10	11	12
raw range from pulse (cm)	567	563	569	569	565	561	563	562	561	560	560	563
output ranges (cm)	566			565			562			561		

The number of computed ranges output each second is equivalent to  $(\text{Laser pulse frequency}) / (\text{Number of averaged values})$ .

### 16.2.3 Rolling

Where a constant stream of range data is being produced, and each range is to be computed from  $x$  consecutive raw ranges, the **Rolling** mode is continually computing a range by averaging the current  $x$  most recent raw ranges returned. Each pulse is used multiple times as the set of raw ranges making up the last  $x$  number of ranges is updated.

**ROLLING AVERAGE** Laser pulse frequency = 12 Hz  
Averaging = 3 pulses

	← 1 second →											
pulse	1	2	3	4	5	6	7	8	9	10	11	12
raw range from pulse (cm)	567	563	569	569	565	561	563	562	557	560	560	563
output ranges (cm)	566			565			561			561		
	567		563		560		etc					
	568			562			559					

The number of computed ranges output each second is equivalent to the defined **Laser pulse frequency**.

### 16.2.4 Burst

A regular burst of pulses is produced by the ILM laser.

The ILM laser is fired at the maximum frequency that the laser allows: 1,000 Hz for ILM modules.

The number of pulses in a burst is determined by the **Number of values** in the **Averaging** frame.

The number of bursts per second is determined by the **Bursts per second** value.

A range is computed by averaging the pulses in each burst.

**BURST** Laser pulse frequency = 12 Hz (in reality ILM = 1,000 Hz)  
Averaging = 3 pulses  
Bursts per second = 2

	← 1 second →											
pulses	1	2	3	-	-	-	4	5	6	-	-	-
raw range from pulse (cm)	567	563	569	-	-	-	563	562	557	-	-	-
output ranges (cm)	566						561					

The number of computed ranges output each second is equivalent to the defined **Bursts per second**.

### 16.2.5 Speed

A speed is computed by the ILM based on a pair of ranges (a 'speed pair'), with each range measured at a known time.

Each speed pair produces a computed speed.

The defined **Speed filter pairs** value determines how many computed speeds are averaged to produce a speed output.

SPEED                      Laser pulse frequency = 12 Hz  
Speed filter pairs = 3

	← 1 second →											
pulses	1	2	3	4	5	6	7	8	9	10	11	12
raw range from pulse (cm)	5668	5601	5560	5515	5470	5431	5380	5336	5301	5259	5214	5171
speed pairs (cm/s) (R1 - R2) / (1/6)	402		270		234		264		252		258	
speed output (cm/s)	302						258					

### 16.3 First hit / last hit output

Some laser pulses return two different raw ranges: a 'first hit' and a 'last hit' (see section 3.6). By default, the first hit is used in filtering and averaging computations and in generating the output range, while the last hit is available as a secondary output (see section 15.1). The **First hit / last hit output** control allows this default arrangement to be changed.

Tick the **Swap first / last for calculation** check box to determine which of the two returns is used for filtering and averaging computations.

Tick the **Swap first / last for outputting** to determine which of the two returns is regarded as the primary or secondary output value.

### 16.4 Laser pulse frequency

The number of pulses that the ILM is transmitting every second. The maximum value for all ILM modules is 1000 pulses per second, or 1 kHz.

If the **Burst** firing mode has been selected, this option is not available. In this case the ILM fires at the maximum frequency during a burst.

### 16.5 Read delay

Defines the time allocated to collecting data after each pulse is transmitted. Since time is used to compute range, this essentially limits the range that can be measured.

If this value is set at 20 μs, this is equivalent to about 6000m. Divided by two (pulse transmitted to the targeted surface and then back to the ILM), this equates to roughly a 3000m maximum range.

### 16.6 Bursts per second

This option is only available the **Burst** firing mode has been selected.

Defines the number of bursts of pulses that the ILM produces each second when it is set to operate in **Burst mode**.

Pulses are fired at the maximum possible rate of 1000 Hz.

The **Number of values** in the **Averaging** frame defines how many pulses are in each burst.

## 16.7 Min signal strength

The lowest signal strength that is accepted as a valid return pulse. Any returns with a signal strength lower than this value is recorded as a no-hit.

Signal strength is measured as a value between 1 – 2047.

## 16.8 User offset

Enter a value to define the zero, origin location of all raw range returns.

A negative value offsets the ILM away from the target so produces a longer range.

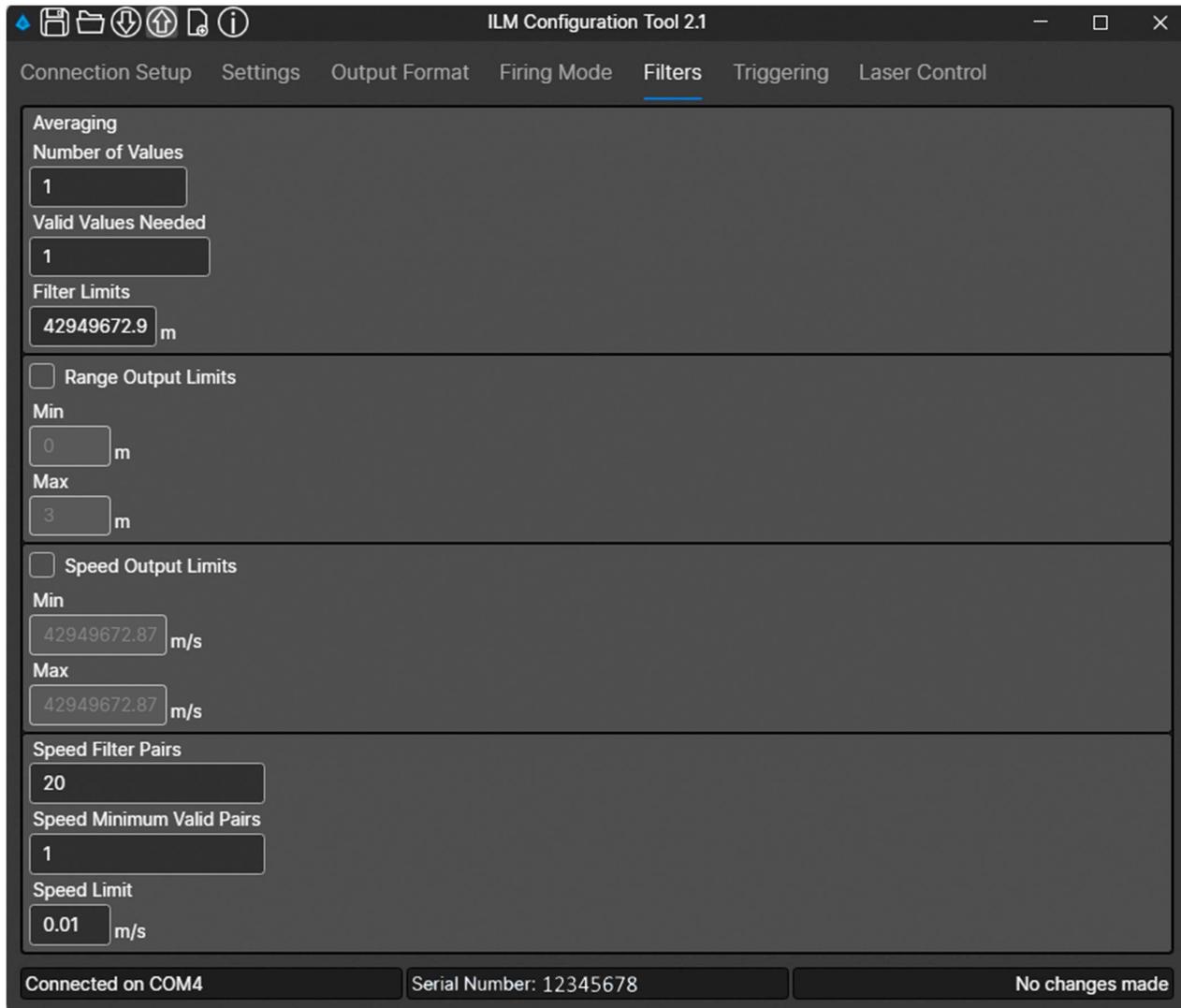
A positive value offsets the ILM towards the target, so produces a shorter range.

## 16.9 Fire-in signal

With the laser in **Single Shot** mode, tick the **Use 'Fire in' Signal** check box. The ILM now fires when it receives a pulse on a 'fire in' line.

Note: the fire-in line requires a non-standard hardware version which is available on request.

# 17 Filters



## 17.1 Overview

To generate a computed, output range, first a set of valid raw ranges (defined by the **Number of values**) are averaged to find the unfiltered average range.

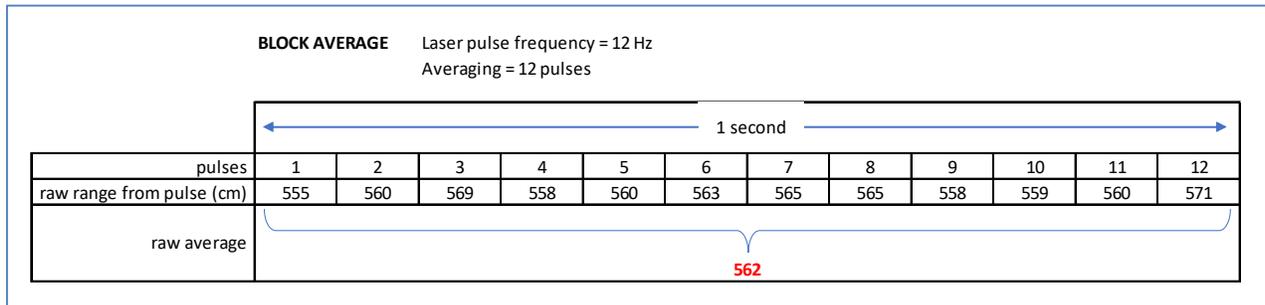
The raw range in this set which is closest to the average is determined and this becomes the central range. The central range defines the centre of the filter window. The window extends a distance in each direction equal to the **Filter limit**. Any ranges outside the filter window are discarded and the remaining ranges (inside the filter window) are counted.

If there are fewer ranges remaining than the **Valid values needed**, then the final average result is a no-hit. Otherwise, the final computed range is the average of the remaining results.

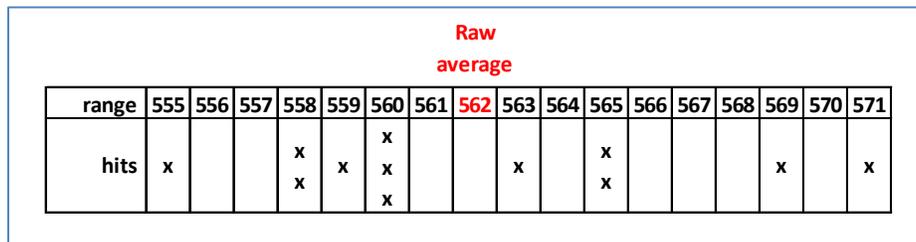
This result is checked against the **Range output limits** and, if it is within limits, the range is output by the ILM.

### 17.1.1 Example

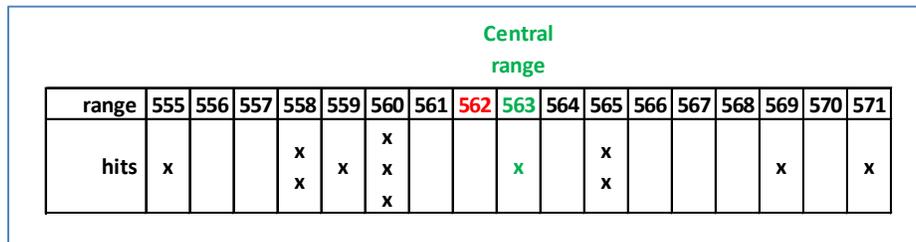
An average is established from 12 raw ranges.



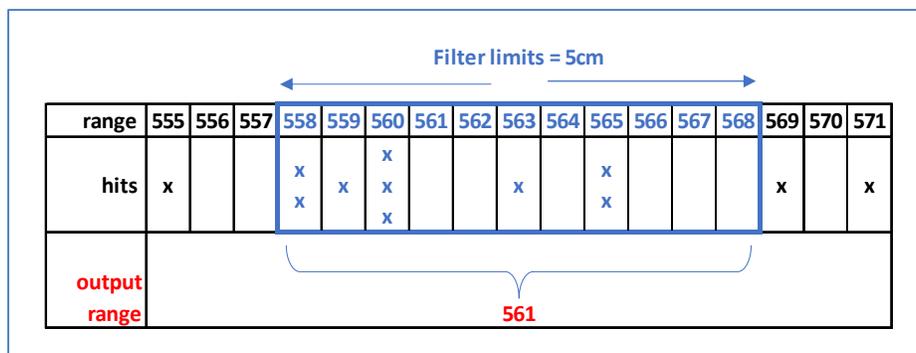
All collected raw ranges are shown arranged in bins with the raw average displayed.



The central range determined as the closest range to the raw average.



Filter limits are laid out with respect to the central range. In this case the Filter limits value is set to 5 cm. The output range is the average of all raw ranges included within the filter limits.



## 17.2 Averaging

### 17.2.1 Number of values

The number of raw ranges that are averaged to produce a computed range that is output by the ILM.

### 17.2.2 Valid values needed

The minimum number of raw ranges that are required in order to generate a computed range that is output by the ILM.

If this number of raw ranges is not received by the ILM, then a null range is recorded.

### 17.2.3 Filter limits

The **Filter limits** value sets the size of a filter window as the distance each direction from the central range in a set of averaged raw ranges. Any ranges outside this filter window are discarded for the purposes of computing a final output range.

## 17.3 Range output limits

Limits the range output by the ILM by rejecting any computed range that is outside defined range limits.

Tick the **Range output limits** check box to activate this filter. If unticked, no computed ranges are rejected by this filter.

The **Range output limits** are applied to whichever range (first hit or last hit) is output as the primary range.

### 17.3.1 Min

Set the lowest accepted computed range value that is output by the ILM.

If the **Min** is set to 5.00 m, then a computed range that is 4.99 m or below is rejected, and no computed range is output.

### 17.3.2 Max

Set the highest accepted computed range value that is output by the ILM.

If the **Max** is set to 10.00 m, then a computed range that is 10.01 m or above is rejected, and no computed range is output.

## 17.4 Speed output limits

Limits the output speed by rejecting any computed speed value that is outside defined speed limits.

Tick the **Speed output limits** check box to activate this filter. If unticked, no computed speeds are rejected by this filter.

### 17.4.1 Min

Set the lowest accepted computed speed value that is output by the ILM.

If the **Min** is set to 0.10 m/s then a computed speed that is 0.09 m/s or below is rejected, and no computed speed

is output.

### 17.4.2 Max

Set the highest accepted computed speed value that is output by the ILM.

If the **Max** is set to 1.00 m/s then a computed speed that is 1.01 m/s or above is rejected, and no computed speed is output.

## 17.5 Speed pairs

A speed is computed by measuring two ranges at different times. Thus, each speed computation requires at least one successive pair of raw ranges, or a 'speed pair'.

The speeds computed from multiple speed pairs can be averaged to generate a single output speed.

### 17.5.1 Speed filter pairs

The number of speed pairs that are used to generate an averaged, output speed.

If this value is set to 3:

- Six pulses producing 6 raw distance ranges are used.
- The 6 raw ranges are used as 3 speed pairs, producing 3 speed values.
- The 3 speed values are averaged to compute a single output speed value.

SPEED		Laser pulse frequency = 12 Hz Speed filter pairs = 3											
		← 1 second →											
pulses		1	2	3	4	5	6	7	8	9	10	11	12
raw range from pulse (cm)		5668	5601	5560	5515	5470	5431	5380	5336	5301	5259	5214	5171
speed pairs (cm/s) (R1 - R2) / (1/6)		402		270		234		264		252		258	
speed output (cm/s)		302						258					

### 17.5.2 Speed minimum valid pairs

The minimum number of speed pairs that must be used to generate an averaged, output speed.

If x speed pairs are defined as the set from which to average an output speed, then there must be at least the defined **Speed minimum valid** speed pairs in this set to produce an output speed.

### 17.5.3 Speed limit

The distance from the mean for which speeds are accepted when filtering outliers during averaging.

# 18 Triggering

ILM Configuration Tool 2.2

Connection Setup Settings Output Format Firing Mode Filters **Triggering** Laser Control

Trigger Length  
 Pulse(s)

Range Triggering

Set Trigger Ranges  Windowed Mode

Min Trigger  m      Min Hit  m      Max Hit  m      Max Trigger  m

← Trigger →      No Trigger      ← Trigger →

Trigger Mode  
 Manual       Auto Range

Auto Range Offset  
 m

Signal Strength Triggering

Trigger When Signal Strength Is...

Less Than

**Greater Than**

%

Trigger Causal  
 Dual Causal Options

Range and Strength

**Range or Strength**

Filter Options

Filtered Range

**Unfiltered Range**

Trigger Filter

Histogram Filter Size

Histogram Trigger Level

Histogram Sum Window Size

No Range Trigger  
 Trigger Behaviour on 'No Hits'

Ignore 'no hits' and maintain last

Reset trigger on 'no hits'

**Trigger on 'no hits'**

Connected on COM4      Serial Number: PRODUCTION      No changes made

The Triggering window allows you to customise the conditions under which the ILM generates a trigger signal.

## 18.1 Trigger length

### 18.1.1 Pulses

The duration, measured in pulse fired by the ILM, of the generated trigger signal.

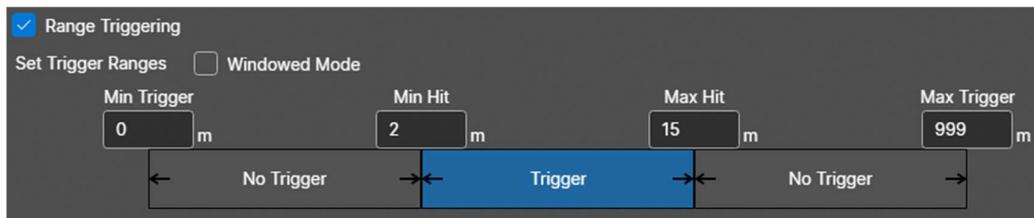
## 18.2 Range triggering

Activates a trigger signal when the output range meets one or more user-defined conditions.

Tick the **Range triggering** check box to activate this function. If unticked, no ranges generate a trigger signal.

### 18.2.1 Set trigger ranges

With the **Windowed mode** check box unticked, set a Min Hit value and a Max Hit value. Ranges falling between these values generate a trigger signal from the ILM.



Tick the **Windowed mode** check box to create two zones in which the ILM is triggered: between **Min Trigger** and **Min Hit**, and between **Max Hit** and **Max Trigger**. Enter four values, increasing from left to right, which define two range windows.



Ranges falling within either of the two windows will generate a trigger signal from the ILM.

## 18.3 Trigger mode

Set the **Trigger** mode to operate in either **Manual** or **Auto range** mode.

### 18.3.1 Manual

Standard range triggering mode.

### 18.3.2 Auto range

**Auto range offset:** when the ILM is turned on, the first range designates a fixed value. The Auto range offset sets out a plus/minus range of values from this fixed range. Any computed range within these bounds

generates a trigger signal.

## 18.4 Signal strength triggering

Activates a trigger signal when the returned signal strength meets a user-defined threshold

Tick the **Signal strength triggering** check box to activate this function. If unticked, no signal strength levels generate a trigger signal.

### 18.4.1 Trigger when signal strength is...

- **Less than:** enter a signal strength value. Any output ranges with a signal strength less than this value generates a trigger signal.
- **Greater than:** enter a signal strength value. Any output ranges with a signal strength greater than this value generates a trigger signal.

## 18.5 Trigger causal

### 18.5.1 Dual causal options

- **Range and strength:** a trigger signal can be generated by the defined range limits as well as by the defined signal strength thresholds.
- **Range or strength:** a trigger signal can be generated by either the defined range limits or by the defined signal strength thresholds.

## 18.6 Filter options

Determines whether filters are applied before a range is assessed as a potential trigger value.

### 18.6.1 Filtered Range

A trigger is generated by a raw range from a single pulse.

### 18.6.2 Unfiltered range

A trigger is generated by a computed, filtered range value.

## 18.7 Trigger filter

Tick the **Trigger filter** check box to activate a histogram filter which determines whether a trigger signal is output.

The range of values covered by the histogram is determined by the **Trigger ranges Max** and **Min** values. Each bin within the histogram is 1.0 m wide.

### 18.7.1 Histogram filter size

Old ranges are dropped out of the bins when the total ranges in all bins exceeds the **Histogram filter size**.

## 18.7.2 Histogram trigger level

A trigger signal is output if the total number of ranges across a set of adjacent bins is equal to, or larger, than the **Histogram trigger level**.

## 18.7.3 Histogram sum window size

The number of adjacent bins in a set is defined by the **Histogram sum window size**.

## 18.7.4 Histogram filter example

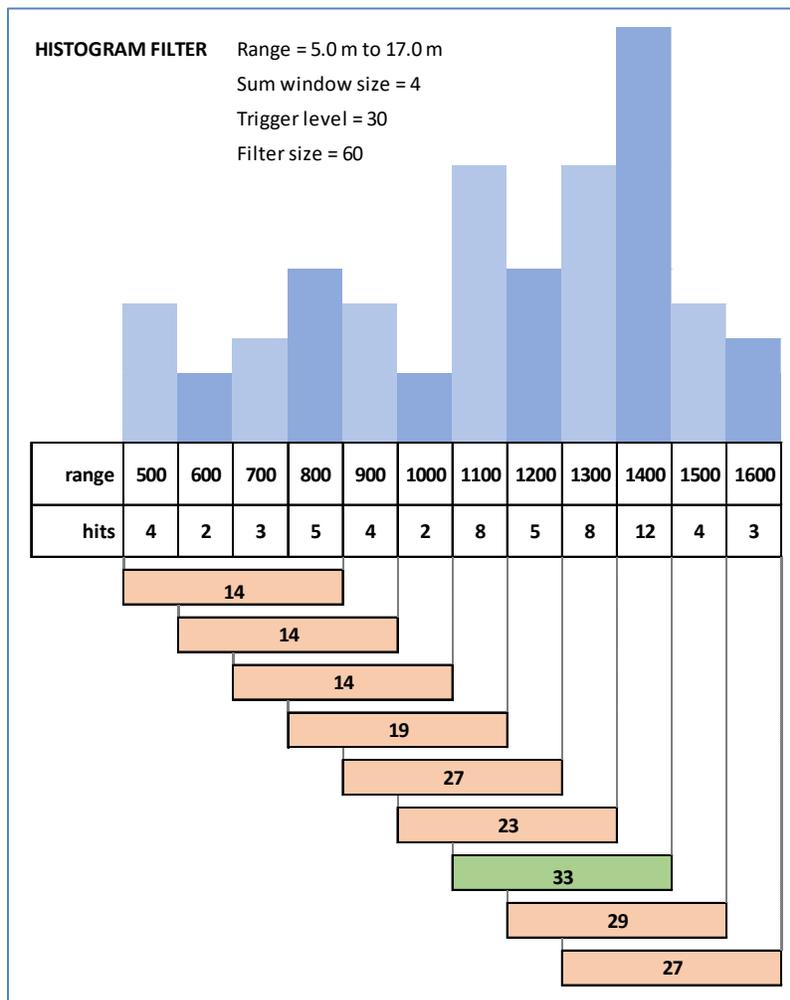
In the example below, ranges between 5 m and 17 m are included in the histogram.

The **Sum window size** is set to 4, so the ranges in each four adjacent bins are totalled.

The **Histogram filter size** is set to 60, so the histogram is composed of the last 60 computed ranges, with each new range pushing out the oldest previous range in the histogram.

The **Histogram trigger level** is set to 30. Any value above this generates a trigger signal.

In this case, a trigger signal is generated as there are 33 ranges between 11 m and 15 m.



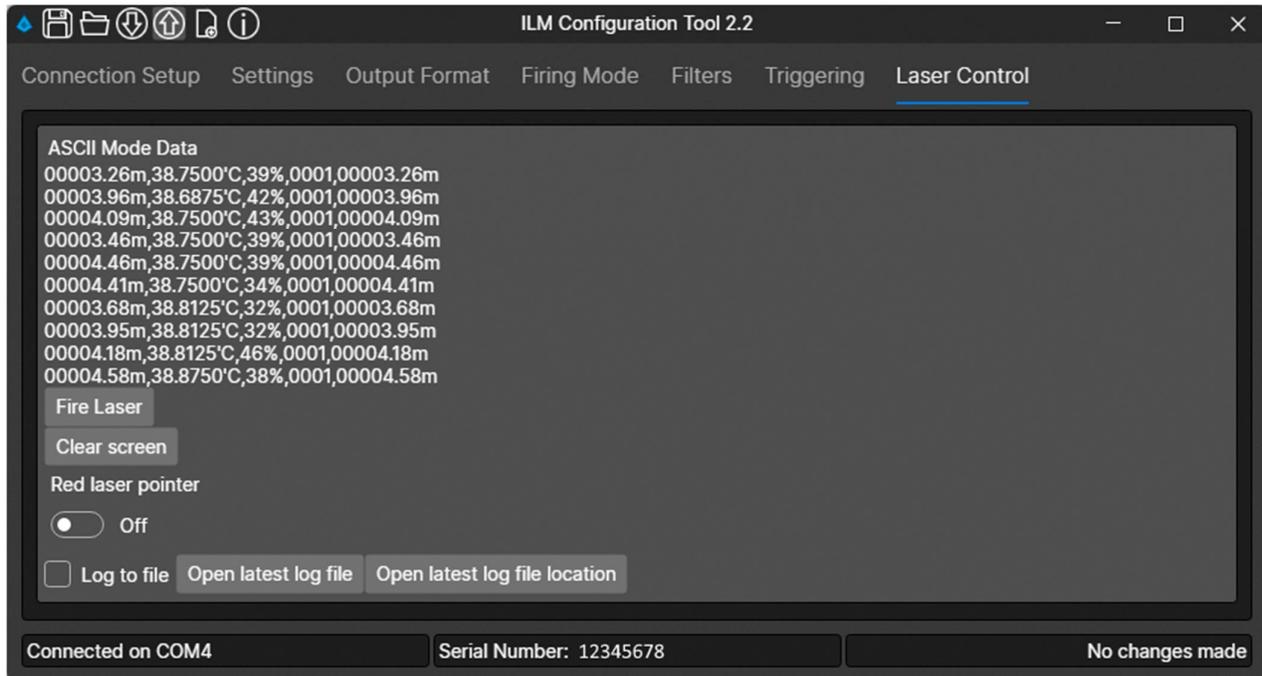
## 18.8 No range trigger

Determines the behaviour of the trigger function when there is a no-hit output.

### 18.8.1 Trigger behaviour on 'No Hits'

- Ignore 'no hits' and maintain last: no-hits do not affect the trigger signal ON/OFF status.
- Reset trigger on 'no hits': if a no-hit signal is received, the trigger signal is reset to OFF.
- Trigger on 'no hits': if a no-hit signal is received, the trigger signal is output.

## 19 Laser Control



The Laser Control screen allows ILM ranging data to be output on screen or saved to a file.

### 19.1.1 Start /stop firing

Click the **Start Firing** / **Stop Firing** buttons to start or stop the ILM laser output.

### 19.1.2 Clear screen

Click the **Clear screen** button to clear any ILM data currently on the **Laser control** screen.

### 19.1.3 Red laser pointer

Toggle the **Red laser pointer** switch to turn the laser pointer ON and OFF.

### 19.1.4 Log to file

To save the ILM output to a text file, tick the **Log to file** check box before clicking the **Start firing** button.

A **Save as** dialog opens. Name the new file and select a location on your PC.

By default, the file is stored in:

```
C:\CarlsonILMConfiguration\logs
```

Data continues to be stored to the selected file as the ILM is stopped and started. To stop data being stored to the file, untick the **Log to file** check box.

When the Log to file check box is ticked again, a new file must be created.

### 19.1.5 Open latest log file

Click **Open latest log file** to open the last created log file.

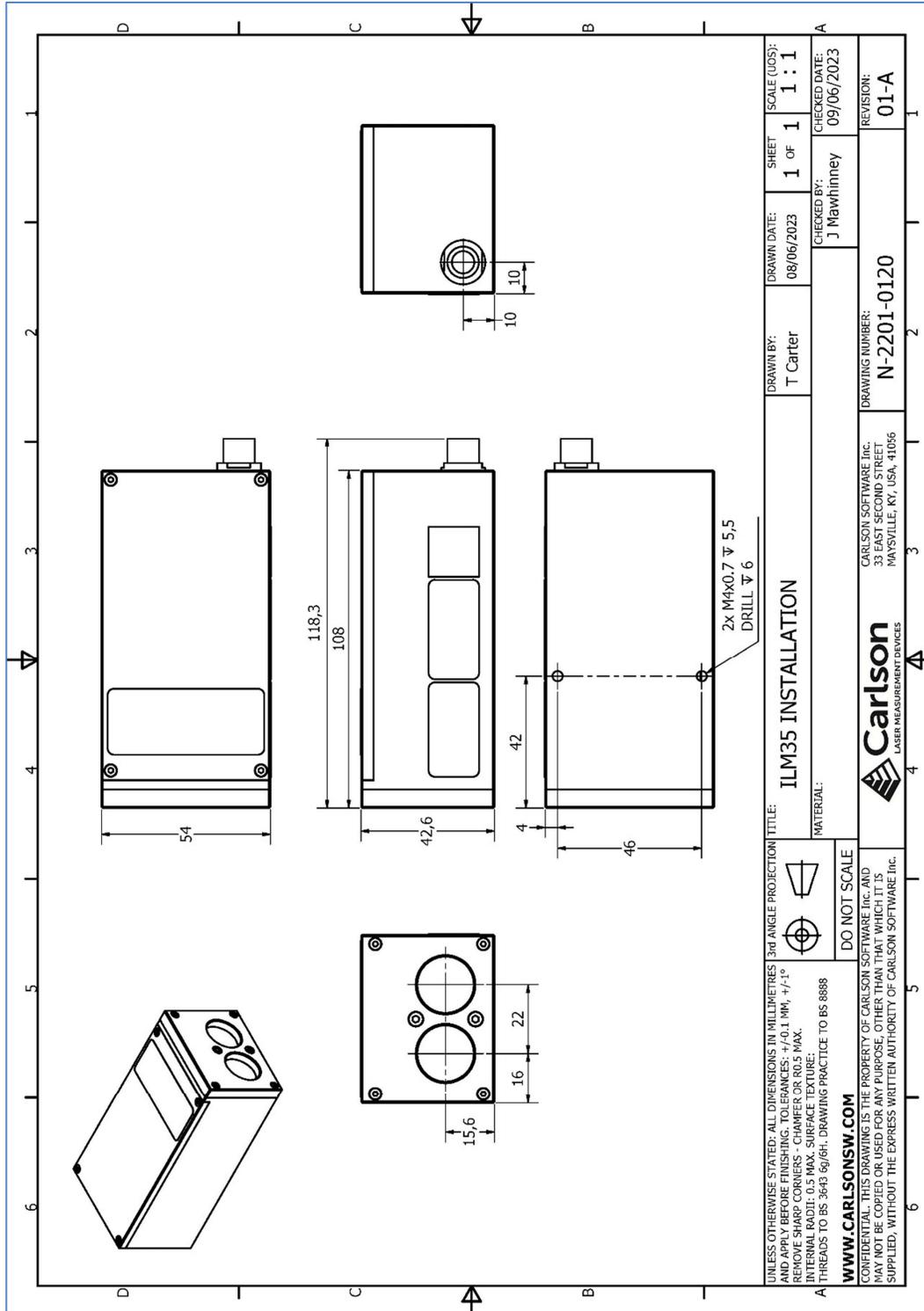
### 19.1.6 Open latest log file location

Click **Open latest log file location** to open Windows Explorer in the directory on your PC where the last created log file was stored.

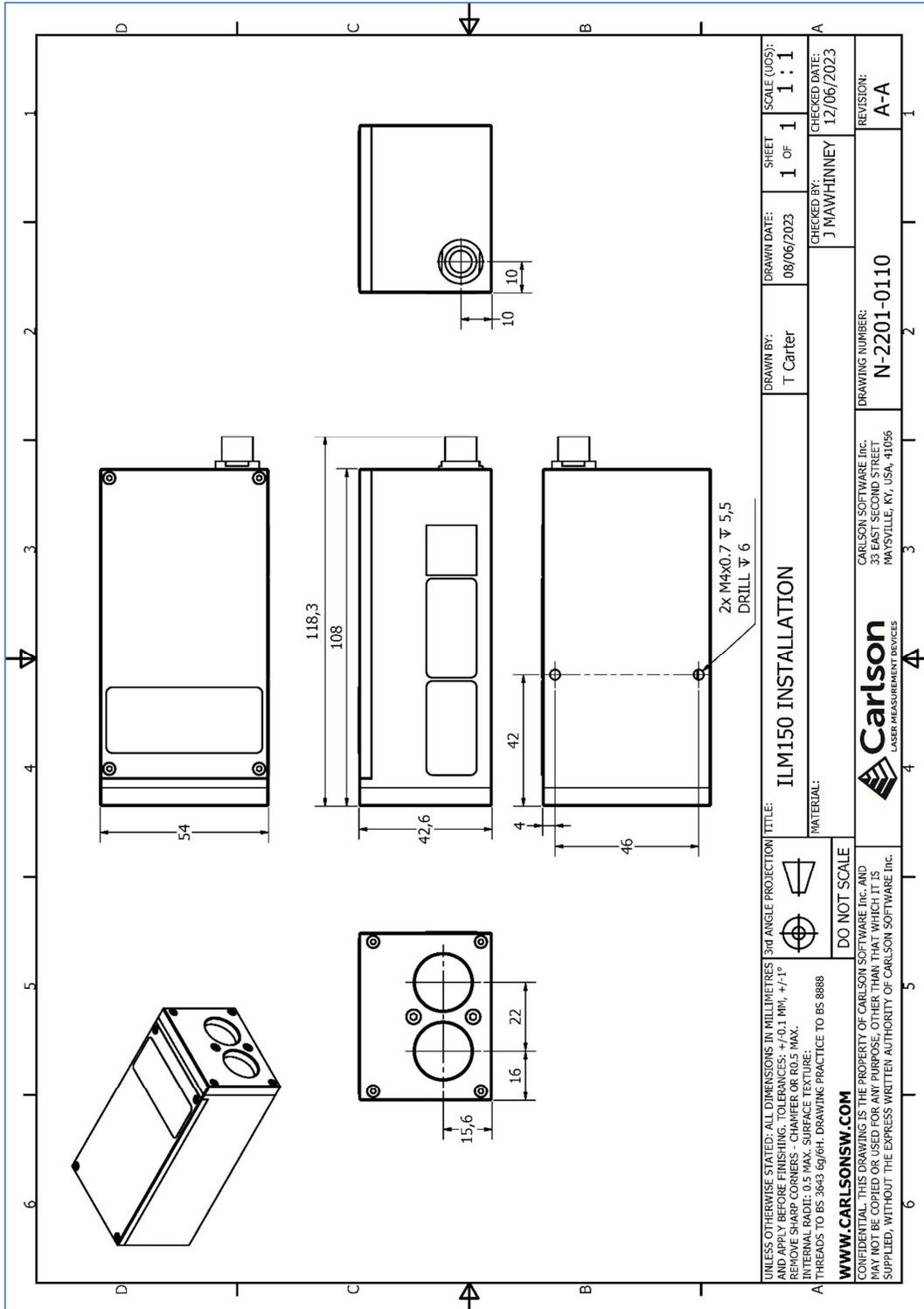
# PRODUCT INFORMATION

# 20 ILM CAD drawings

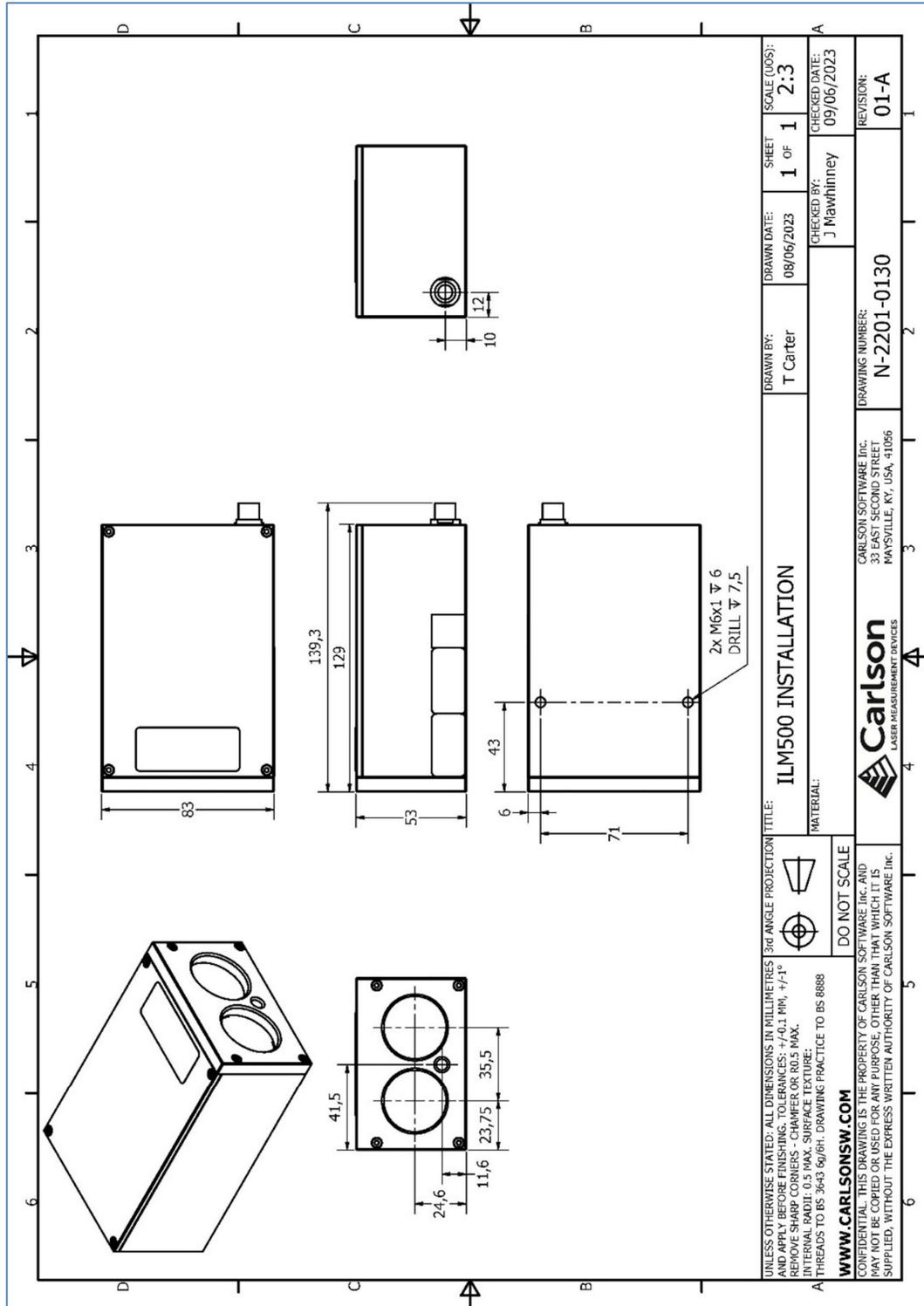
## 20.1 ILM-35



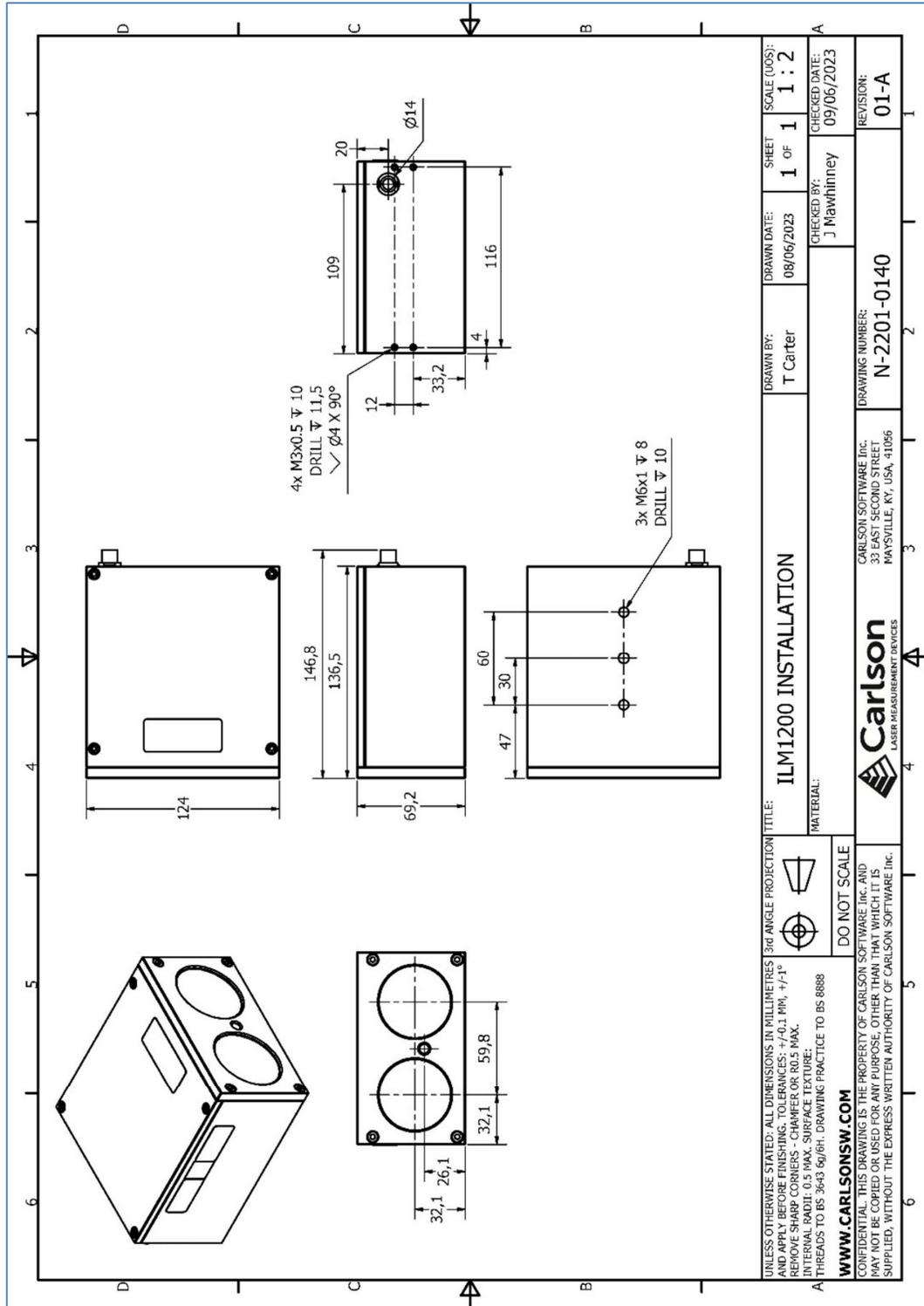
## 20.2 ILM-150



## 20.3 ILM-500



## 20.4 ILM-1200



## 21 Product specifications - physical

Physical		
Outer casing		Black anodised aluminium
Dimensions	ILM-35	108 mm (118.3 including connector) x 54 mm x 43 mm
	ILM-150	108 mm (118.3 including connector) x 54 mm x 43 mm
	ILM-500	129 mm (139.3 including connector) x 83 mm x 53 mm
	ILM-1200	136.5 mm (146.8 including connector) x 124 mm x 69.2 mm
Weight	ILM-35	320 g
	ILM-150	320 g
	ILM-500	710 g
	ILM-1200	1400 g
Communication		
Data output	Serial RS232	
Baud rate	9600 / 19200 / 38400 / 57600 / 115200	
Power / data connection port		
Case connector	5-way Fischer connector	
Cable connector	SE 102 A054 - 130 / 4.15	
Power		
Power input	9 - 24 Vdc	
Power usage	<5 W	
Mains supply voltage fluctuations	N/A	
Overvoltage category	I	
Temperature		
Operating temperature	-10 °C to +60 °C	
Storage temperature	-20 °C to +90 °C	
Environmental		
IP degree of protection	IP67	
Indoor or outdoor use	Indoor and outdoor	
Altitude	<5000 m	
Relative humidity	95% non-condensing	
Wet location	Yes	
Pollution degree of the intended environment	PD3	

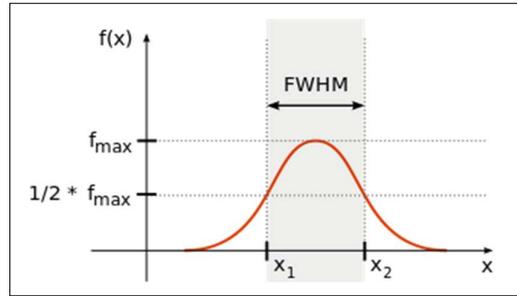
## 22 Product specifications – performance

Laser firing rate		
Maximum firing rate	ILM-35	1000 Hz
	ILM-150	1000 Hz
	ILM-500	1000 Hz
	ILM-1200	1000 Hz
Maximum range	ILM-35	35 m *
	ILM-150	150 m *
	ILM-500	500 m *
	ILM-1200	1200 m *
Range resolution	All ILMs	1 cm
Range accuracy	All ILMs	10 cm @ 50 m range under Carlson test conditions*

\* To Kodak white card (90% reflectivity) positioned perpendicular to the laser beam.

## 23 Product specifications – laser footprint

The beam diameter, beam width or spot size of a laser beam is the diameter along any specified line that is perpendicular to the beam axis and intersects it. Since beams typically do not have sharp edges, the diameter can be defined in many different ways. The American National Standard Z136.1-2007 for Safe Use of Lasers defines the beam diameter as the distance between diametrically opposed points in that cross-section of a beam where the power per unit area is half (0.5) times that of the peak power per unit area. This definition of spot size is known as full width at half maximum or 'FWHM'.



The calculated spot size for the standard ILM-35, ILM-150, ILM-500 and ILM-1200 modules is calculated for specified distances.

Range (m)	ILM-35 (FWHM) (mm)	Range (m)	ILM-150 (FWHM) / (mm)	Range (m)	ILM-500 (FWHM) / (mm)	Range (m)	ILM-1200 (FWHM) / (mm)
0	18.0 x 18.0	0	18.0 x 18.0	0	28.0 x 28.0	0	18.0 x 46.0
3	18.6 x 26.3	10	19.9 x 45.8	50	35.5 x 140.5	50	25.5 x 155.2
6	19.1 x 34.7	20	21.7 x 73.6	100	43.0 x 253.0	100	33.0 x 264.4
9	19.7 x 43.0	30	23.6 x 101.3	150	50.5 x 365.5	200	48.0 x 482.9
12	20.2 x 51.3	40	25.4 x 129.1	200	58.0 x 478.0	300	63.0 x 701.3
15	20.8 x 59.7	50	27.3 x 156.9	250	65.5 x 590.5	400	78.0 x 919.8
18	21.3 x 68.0	60	29.1 x 184.7	300	73.0 x 703.0	500	93.0 x 1138.2
21	21.9 x 76.3	70	31.0 x 212.4	350	80.5 x 815.5	600	108.0 x 1356.7
24	22.4 x 84.7	80	32.8 x 240.0	400	88.0 x 928.0	700	123.0 x 1575.1
27	23.0 x 93.0	90	34.7 x 268.0	450	95.5 x 1040.5	800	138.0 x 1793.6
30	23.6 x 101.3	100	36.5 x 295.8	500	103.0 x 1152.5	900	153.0 x 2012.0
33	24.1 x 109.7	110	38.4 x 323.6	-	-	1000	168.0 x 2230.5
35	24.5 x 115.2	120	40.2 x 351.3	-	-	1100	183.0 x 2448.9
-	-	130	42.1 x 379.1	-	-	1200	198.0 x 2667.3
-	-	140	43.9 x 406.9	-	-	-	-
-	-	150	45.8 x 434.7	-	-	-	-

## 24 Laser safety information

### 24.1 ILM-35 / ILM-150 / ILM-500 /ILM-1200 Laser Classification

The ILM-35, ILM-150, ILM-500 and ILM-1200 laser modules are classified as Class 1M laser products in compliance with the International Electrotechnical Commission (IEC) and European standard (EN) for the safety of laser products, IEC / EN 60825-1: 2014.

ILM module	ILM-35	ILM-150	ILM-500	ILM-1200
Type	InGaAs laser diode	InGaAs laser diode	InGaAs laser diode	InGaAs laser diode
Wavelength (typical)	905 nm	905 nm	905 nm	905 nm
Operation	Pulsed	Pulsed	Pulsed	Pulsed
Average power	Up to 250 $\mu$ W	Up to 250 $\mu$ W	Up to 450 $\mu$ W	Up to 1.5 mW
Pulse width	16-20 ns	16-20 ns	16-20 ns	16-20 ns
Pulse energy	250 nJ	250 nJ	450 nJ	1.5 $\mu$ J
Pulse frequency	1 Hz - 1 kHz			



**CAUTION: Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.**



An internal panel of a protective housing which, when removed or displaced, permits human access to laser radiation that does not exceed the AEL for Class 3B, has affixed a label that bears the notices below.

The ILM-35, ILM-150 and ILM-500 laser modules are intended for use only in restricted access areas (where minors are not likely to be present) with only qualified and trained persons assigned to operate the ILM modules. When not in use, the ILM modules should be stored in a location where unauthorised personnel cannot gain access.



**WARNING – Opening the protective housing may result in exposure to Class 3B radiation.**



We recommend that the ILM laser is not directly pointed at people's eyes, especially if they are using binoculars. **Do not unnecessarily look into the transmitter lens of an ILM.**

Do not operate evidently damaged instruments. If the instrument is mishandled, the manufacturer's warranty may be voided.

This product is intended for use in a locale where the emitted radiation is unlikely to be viewed with optical instruments.

The ILM should not be aligned with the lenses of CCD-cameras or infrared night vision devices, as this can result in damage to the system.

## 24.1 ILM-35-P / ILM-150-P / ILM-500-P Laser Classification

Where a red laser pointer has been added to an ILM-35, ILM-150, ILM-500, or ILM-1200, then a -P suffix is added to the product code, producing an ILM-35-P, ILM-150-P, ILM-500-P or ILM-1200-P.

The addition of a visible red laser pointer changes the laser classification.

The ILM-35-P, ILM-150-P, ILM-500-P and ILM-1200-P modules are classified as Class 2 laser products and fully comply with the British and European standards BS EN 60825-1:2014. The following mandatory labels are permanently fixed on the ILM housing, and should be legible and clearly visible during operation, maintenance and service.

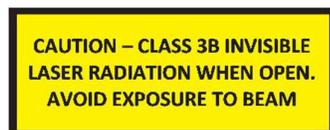


The optical specification of the red laser pointer incorporated into the ILM-35-P, ILM-150-P, ILM-500-P and ILM-1200-P lasers is described below.

Visible laser module	
Type	InGaAsP laser diode
Wavelength (typical)	650 nm
Operation	Continuous wave (CW)
Maximum power	< 0.6 mW

**WARNING: invisible and visible laser radiation. Do not stare into the beam or direct it into the eyes of others. Do not view directly with optical instruments, e.g. binoculars, theodolite or telescope.**

CAUTION: use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure



**WARNING: opening the protective housing may result in exposure to Class 3B radiation.**

Carlson recommends that the ILM laser is not directly pointed at people's eyes, especially if they are using optical instruments. Do not unnecessarily look into the transmitter lens of the ILM laser.

Eye protection, designed to provide adequate protection against specific laser wavelengths (905 nm typically), should be used in all hazard areas. Any exceptions should only be undertaken with the approval of the laser safety officer. All laser protective eyewear shall be clearly labelled with information adequate to ensure proper choice with the particular laser. For the ILM modules, the recommended CE marked laser eyewear shall be marked as "R 905 L1" as specified to EN 207, or equivalent. Note that protection shall be afforded to infrared laser radiation, and not the visible laser radiation. The visible laser is however Class 2 when operated by itself and as such is safe to use without eyewear (unless deliberately stared at).

## 25 System information

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### 25.1.1 Trademarks

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All other brand names and product names used in this document are trade names, trademarks, or registered trademarks of their respective owners.

### 25.1.2 Changes to Carlson products

Carlson reserves the right to improve, change or modify its products and documentation without incurring any obligation to make changes to equipment previously sold or distributed.

Carlson has made considerable efforts to ensure the content of this document is correct at the date of publication but makes no warranties or representations regarding the content. Carlson excludes liability, howsoever arising, for any inaccuracies in the document.

### 25.1.3 Warranty

Equipment requiring attention under warranty must be returned to your equipment supplier.

Unless otherwise specifically agreed in writing between you and Carlson, if you purchased the equipment from a Carlson company, the warranty provisions contained in Carlson's CONDITIONS OF SALE apply. You should consult these conditions to find out the details of your warranty but, in summary, the main exclusions from the warranty are if the equipment has been:

- neglected, mishandled or inappropriately used, or
- modified or altered in any way except with the prior written agreement of Carlson.

If you purchased the equipment from any other supplier, you should contact them to find out what repairs are covered by their warranty.

### 25.1.4 Safety

The ILM range of modules are designed to be integrated into third party products which require raw distance measurement. ILM modules may be configured to output distance measurements, speed or digital triggers. The ruggedised nature of the ILMs makes them capable of being integrated in products used in extremely demanding environments such as transport, law enforcement, mining & quarrying, military and drones.

It is essential that the unit and all accessories are operated in accordance with the instructions in this user manual and it is the responsibility of the user to ensure that, in the event of a failure of any part of the Carlson system, the equipment remains safe. If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

In the case of equipment with powers or speeds capable of causing injury, it is essential that appropriate safety protection measures are included in the machine usage. Further guidance can be found in *BS EN ISO 12100:2010 Safety of machinery – General principles for design – Risk assessment and risk reduction*.

### 25.1.5 Information to the equipment supplier/ installer

It is the equipment supplier's responsibility to ensure that the user is made aware of any hazards involved in any operations involving the ILM, including those mentioned in Carlson product literature.

#### 25.1.6 EC declaration of conformity



Carlson declares that the ILM complies with the applicable standards and regulations.

Contact Carlson or visit [www.carlsonsw.com](http://www.carlsonsw.com) for the full EC declaration of conformity.

#### 25.1.7 Radio-frequency disturbance characteristics

As defined by *BS EN 55011:2016 Industrial, scientific and medical equipment – Radio-frequency disturbance characteristics – Limits and methods of measurement*, the ILM is defined as Group 1, Class A equipment.

The ILM is suitable for use in all locations other than those allocated in residential environments and those directly connected to a low-voltage power supply network which supplies buildings used for domestic purposes. The ILM does not use radio- frequency energy for the treatment of material, for inspection/analysis purposes, or for transfer of electromagnetic energy.



**CAUTION:** This equipment is not intended for use in residential environments and may not provide adequate protection to radio reception in such environments.

#### 25.1.8 FCC (USA only)

#### 25.1.9 Information to the user (47CFR section 15.19)

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference, and
2. This device must accept any interference received, including interference that may cause undesired operation.

#### 25.1.10 Information to the user (47CFR section 15.21)

The user is cautioned that any changes or modifications not expressly approved by Carlson or authorised representative could void the user's authority to operate the equipment.

#### 25.1.11 Information to the user (47CFR section 15.105)

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

### 25.1.12 WEEE directive



The use of this symbol on Carlson products and/or accompanying documentation indicates that the product should not be mixed with general household waste upon disposal. It is the responsibility of the end user to dispose of this product at a designated collection point for waste electrical and electronic equipment (WEEE) to enable reuse or recycling. Correct disposal of this product will help to save valuable resources and prevent potential negative effects on the environment. For more information, please contact your local waste disposal service or Carlson representative.

## 26 End User License Agreement

The SOFTWARE referred to in this EULA is Carlson's ILM Configuration Tool.

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Please read the following Software License Agreement before using the SOFTWARE. Using this SOFTWARE indicates that you have accepted its terms and conditions.

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For good and valuable consideration, including but not limited to license grant in accordance with this Agreement by LICENSOR to End User's covenant regarding LICENSOR's proprietary rights, LICENSOR agrees to permit End User to utilize materials representing LICENSOR's product or products subject to the following terms and

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End User's rights and obligations under this EULA are nonexclusive and personal in nature, and the intellectual property Licensor grants to End User is subject to applicable law other than bankruptcy law. End User may not transfer or assign the SOFTWARE, rights under this EULA or accompanying user documentation, or any updates of the SOFTWARE which may be provided under this EULA, to a third party unless End User receives written consent from Licensor at least 30 days prior to the completion of transfer. Licensor reserves the right to deny transfer or assignment if, in its sole discretion, Licensor determines the transfer not to be a necessity. Whether or not a transfer or assignment is allowed shall be determined in Licensor's sole discretion after taking into consideration certain factors to find the existence of a necessity including, but not limited to, merger or acquisition of an entity, complete asset acquisition, change of control, severe economic hardship, severe loss of human resources or significant loss in business divisions, or winding down of entity affairs.

If Carlson consents to a transfer, such transfer shall be allowed only as a one-time permanent transfer of this EULA and Software to another end user, provided the initial End User retains no copies or previous versions of the Software. The transfer must include all of the Software, including all component parts, any media and printed

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End User agrees that LICENSOR has the right to require an audit (electronic or otherwise) of the LICENSOR Materials and the Installation thereof and access thereto. As part of any such audit, LICENSOR or its authorized representative will have the right, on fifteen (15) days' prior notice to End User, to inspect End User's records, systems and facilities, including machine IDs, serial numbers and related information, to verify that the use of any and all LICENSOR Materials is in conformance with this Agreement. End User will provide full cooperation to enable any such audit. If LICENSOR determines that End User's use is not in conformity with this EULA, End User will obtain immediately and pay for a valid license to bring End User's use into compliance with this EULA and other applicable terms and pay the reasonable costs of the audit. In addition to such payment rights, LICENSOR reserves the right to seek any other remedies available at law or in equity, whether under this Agreement or otherwise.

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Furthermore, the Software Product may contain certain Cloud technology-based features, such as messaging and crew view, where data can be passed freely between End Users using the Software Product. These features will generally be password protected, with no other built security for Software Product usage. Carlson accepts no responsibility for compromised data or loss due to unauthorized messaging or communication through Cloud technology provided in the Software Product.

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LICENSOR may, from time to time, revise the performance of its product(s) and in doing so, incur NO obligation to furnish such revisions to any End User nor shall it warrant or guarantee that any revision to the SOFTWARE will perform as expected by the End User on End User's equipment. At LICENSOR's option, LICENSOR may provide such revisions to the End User.

### **26.1.10 Customer Service**

Although it is the LICENSOR's customary practice to provide reasonable assistance and support in the use of its products to its customers, LICENSOR shall not be obligated to any End User to provide technical assistance or support through this Agreement and may at LICENSOR's sole election charge a fee for customer support.

### **26.1.11 Termination of End User License**

If any one or more of the provisions of this Agreement is breached, the license granted by this Agreement is hereby terminated. In the event of such termination, all rights of the LICENSOR shall remain in force and effect. Any protected health information data of End User maintained on LICENSOR'S data base shall upon reasonable notice to End User and at the discretion of LICENSOR may be destroyed.

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### **26.1.13 Injunctive Relief**

It is understood and agreed that, notwithstanding any other provision of this Agreement, LICENSOR has the unequivocal right to obtain timely injunctive relief to protect the proprietary rights of LICENSOR.

#### **26.1.14 Entire Agreement**

This EULA constitutes the entire agreement between the parties and supersedes any prior agreements. This EULA may only be changed by mutual written consent.

#### **26.1.15 End User Agreement Acknowledgment**

The End User hereby accepts all the terms and conditions of this Agreement without exception, deletion, alteration. End User acknowledges they are authorized to enter this agreement on behalf of any organization for which the license is sought. Any unauthorized use of LICENSOR products will be considered a breach of this Agreement, subject to liquidated damages and otherwise unlawful and wilful infringement of LICENSOR's trade secrets and/or proprietary products.

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#### **26.1.17 Loss/Theft/Misuse**

End user shall promptly report to LICENSOR the theft or other loss of any password and/or user identity required to access SOFTWARE. LICENSOR shall not be responsible for maintaining the integrity of End User data in the event that end user's data base is accessed and/or altered by an unauthorized end user due to the failure of licensed End User to protect its password or user identity. End User shall be responsible for any costs incurred by LICENSOR due to the negligence or reckless disregard of End User's failure to protect its password or user identity.

#### **26.1.18 Civil/Criminal Investigation**

End user shall fully cooperate with LICENSOR and or any person authorized by LICENSOR (including local, state, or federal law enforcement officials) to investigate any alleged theft, misuse or unauthorized use of SOFTWARE or data related thereto.

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#### **26.1.20 Governing Law**

This EULA shall be governed and construed in accordance with the laws of the Commonwealth of Kentucky, USA.