SPOT+ FAMILY

USER GUIDE

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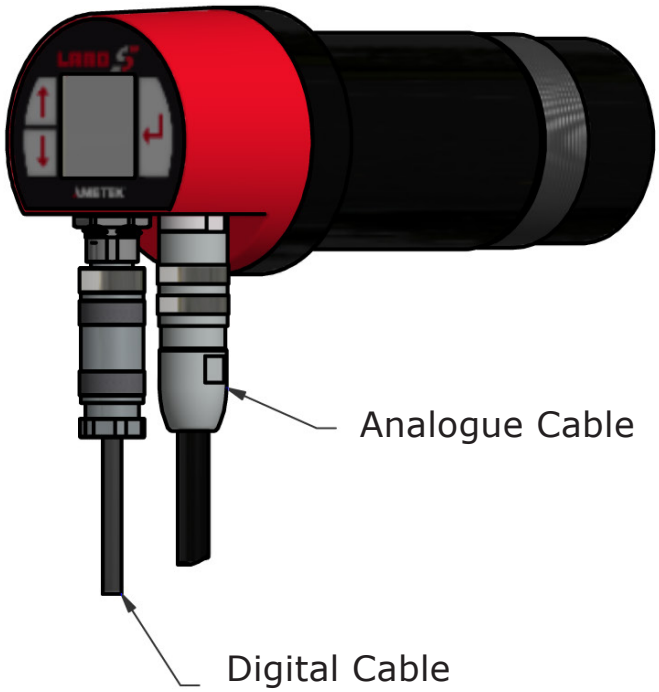
Advanced Digital Pyrometer Series

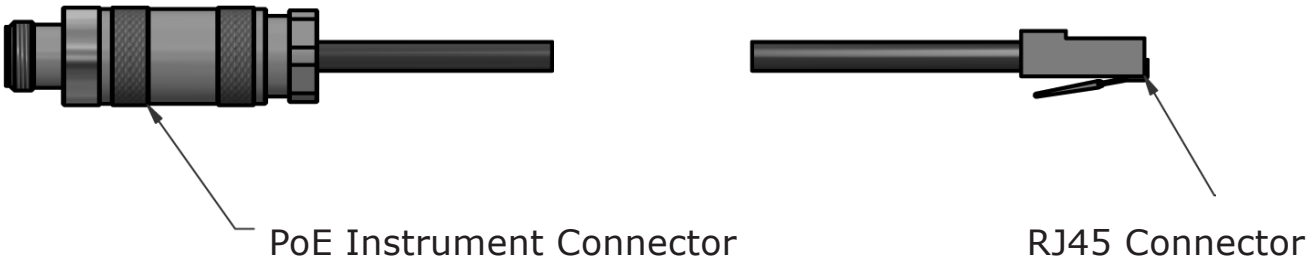
LAND
AMETEK®

QUALITY CUSTOMER SOLUTIONS

QUICK-START CONNECTIONS



Digital Cable



Default IP Address: 10.1.10.50
Default Password: SPOT+ Serial Number (6 digits)

Digital Cable Options	
Digital Cable Part No.	**Cable Length (m)**
807944	5.0
807945	20.0
807946	100.0

Analogue Cable

Analogue cable can be connected to plant system through an optional Analgue Connection PCB (Part No. 807943)

Analogue Cable Options	
Analogue Cable Part No.	**Cable Length (m)**
807950	5.0
807951	20.0
807952	*100.0

* Note: When using the 100 m cable, the power supply voltage must be +30 V ±10 %

Analogue Cable Pin Out Details	
Wire Colour	**Pin Out**
Red	+24 V
Black	0V
Brown	+mA Out1
Blue	-mA Out1
Purple	Relay / +mA Out2
Green	Relay / -mA Out2
Yellow	Trigger In + / +mA In
White	Trigger In - / -mA In
** Screen	Screen

** Note: It is highly recommended that the Screen is connected to Ground

IMPORTANT INFORMATION - PLEASE READ

Health and Safety Information

Read all of the instructions in this booklet - including all the WARNINGS and CAUTIONS - *before* using this product. If there is any instruction which you do not understand, DO NOT USE THE PRODUCT.

Safety Signs

WARNING
Indicates a potentially hazardous situation which, if not avoided, could result in death or personal injury.

CAUTION
Indicates a potentially hazardous situation which, if not avoided, could result in minor or moderate injury to the user or users, or result in damage to the product or to property.

NOTE
Indicates a potentially hazardous situation which, if not avoided, could result in damage or loss of data.

Signs and Symbols used on equipment and Documentation


Caution, risk of electric shock.


Caution, attention to possibility of risk of damage to the product, process or surroundings. Refer to instruction manual.


Caution, hot surface.


Protective Conductor Terminal.


Observe precautions for handling electrostatic discharge sensitive devices.

Equipment Operation

Use of this instrument in a manner not specified by AMETEK Land may be hazardous. Read **and understand** the user documentation supplied **before** installing and operating the equipment.

The safety of any system incorporating this equipment is the responsibility of the assembler.

Protective Clothing, Face and Eye Protection

It is possible that this equipment is to be installed on, or near to, machinery or equipment operating at high temperatures and high pressures. Suitable protective clothing, along with face and eye protection must be worn. Refer to the health and safety guidelines for the machinery/equipment before installing this product. If in doubt, contact AMETEK Land.


Wear Protective Gloves


Wear Protective Clothing


Wear Eye Protection


Wear Ear Protection


Wear Safety Boots


Wear Face Protection

Electrical Power Supply

Before working on the electrical connections, all of the electrical power lines to the equipment must be isolated. All the electrical cables and signal cables must be connected exactly as indicated in these operating instructions. If in doubt, contact AMETEK Land.

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For further details on all AMETEK Land offices, distributors and representatives, please visit our website.

Storage

The instrument should be stored in its packaging, in a dry sheltered area.

The maximum storage temperature is 10 °C (18 °F) higher than the maximum operating temperature.

The minimum storage temperature is 10 °C (18 °F) lower than the minimum operating temperature.

Refer to the Technical Specification for details of the operating temperature limits.

Unpacking

Check all packages for external signs of damage. Check the contents against the packing note.

Lifting Instructions

Where items are too heavy to be lifted manually, use suitably rated lifting equipment. Refer to the Technical Specification for weights. All lifting should be carried out in accordance with local and national regulations.

Return of Damaged Goods

IMPORTANT If any item has been damaged in transit, this should be reported to the carrier and to the supplier immediately. Damage caused in transit is the responsibility of the carrier not the supplier.

DO NOT RETURN a damaged instrument to the sender as the carrier will not then consider a claim. Save the packing with the damaged article for inspection by the carrier.

Return of Goods for Repair

If you need to return goods for repair please contact our Customer Service Department for details of the correct returns procedure.

Any item returned to AMETEK Land should be adequately packaged to prevent damage during transit.

You must include a written report of the problem together with your own name and contact information, address, telephone number, email address etc.

Design and Manufacturing Standards

The Quality Management System of Land Instruments International is approved to BS EN ISO 9001 for the design, manufacture and on-site servicing of combustion, environmental monitoring and non-contact temperature measuring instrumentation.

Registered ISO 9001 Management System approvals apply in the USA.

UK Calibration Laboratory: UKAS 0034.

USA Calibration Laboratory: ANAB Accredited ISO/IEC 17025.

National Accreditation Board for Testing and Calibration Laboratories approvals apply in India.

Operation of radio transmitters, telephones or other electrical/electronic devices in close proximity to the equipment while the enclosure doors of the instrument or its peripherals are open, may cause interference and possible failure where the radiated emissions exceed the EMC directive.

The protection provided by this product may be invalidated if alterations or additions are made to the structural, electrical, mechanical, pneumatic, software or firmware components of this system. Such changes may also invalidate the standard terms of warranty.

Copyright

Contents

1 INTRODUCTION

This User Guide gives you instructions on how to install and operate a LAND SPOT+ Thermometer.

1.1 About the SPOT+ Thermometer

SPOT+ Thermometers are high precision pyrometers, featuring advanced integrated processing capabilities and IIoT connectivity.

Combining EtherNet/IP, REST API, web server, Modbus TCP, image streaming, analogue and alarm outputs within one device, SPOT+ makes non-contact temperature measurement accurate, flexible and easy to use.

All essential operator information can be viewed either on the sensor's rear display panel, or remotely in a control room, via a Web Server or via AMETEK Land SPOTPro or IMAGEPro software.

Features

- Single person installation at sensor location - no need to verify control room readings
- Rear display
- Target focusing, temperature reading and set-up through simple menu-driven software
- Through-the-lens integrated camera (not fitted on Fibre-optic Thermometers)
- Easy target alignment in low and high temperature environments
- LED Sighting - no laser safety requirements; the sensor confirms the focus distance and spot size; pulsing green/red LED simplifies sighting on all targets. This feature is available on both standard body and Fibre-optic thermometers
- Choice of industry standard 0 to 20 mA or 4 to 20 mA temperature outputs
- Single Sensor Solution - Ideal for use with customer PLCs or DCS systems; no requirement for a separate processor
- Intelligent interfaces for IIoT: EtherNet/IP, REST API and Modbus TCP/IP
- Integrated Web Server
- Password protection option to prevent unauthorized access
- Power over Ethernet (PoE) operation

The focus display LED pattern is a unique feature which provides a precise confirmation of the thermometer focus distance and target spot size at that distance. This function replaces target size tables, and takes the math or guesswork out of this calculation.

Flexible design provides multiple form factors, resulting in simplified replacement of older thermometers.

SPOT+ is designed to be fully interchangeable with existing LAND fixed spot thermometers e.g. System 4.

SPOT+ pyrometers can be used with SPOTPro or IMAGEPro software. IMAGEPro is recommended for logging of images from the SPOT+ visible light camera alongside temperature data, or when the SPOT+ is used within a thermal imaging system. SPOTPro is recommended if the SPOT+ thermometer is used with an Actuator, or if data logging at at less than 100ms intervals is required

Visit www.ametek-land.com.

CAUTION

Points to Note on Installation

Note: The SPOT+ is shipped with the MODBUS and EtherNet/IP comms disabled, and the web server in "Secure" mode. To change this, use the rear controls of the instrument or the web server (the default password is the instrument's Serial Number). See section 2.6 for more details

Security - Password Setting

The SPOT+ device is initially delivered in a secure mode, ensuring the encryption of its firmware. Additionally, it provides the flexibility to secure or disable each Ethernet communication protocol to thwart unauthorised access. By default, all communication protocols are set to either "Secure" or "Off."

	Security Mode Options **Default Settings**	
Webserver and REST API	Secure	OPEN
Modbus TCP/IP	OFF	OPEN
EtherNet/IP	OFF	OPEN

In Secure mode, the default password is the instrument's 6-digit serial number, which can be located on the instrument label or in the webserver view mode. It is strongly recommended to change this default password to a more secure one.

To reset the password back to its default settings, follow these steps:

1. Access the Security menu in the network settings of the instrument.
2. Click on the "Change Password" option.
3. Choose "Reset Password."

For additional details regarding SPOT+ communication through various Ethernet Protocols, you can refer to the User Guides, available for download on the AMETEK Land website at: www.ametek-land.com/products/spot

2 GETTING STARTED

2.1 System overview

A typical temperature measurement system incorporating a SPOT+ thermometer will include:

- SPOT+ Thermometer: either a standard body thermometer, or a fibre-optic thermometer comprising a thermometer body connected to an optic head via a fibre-optic lightguide
- A thermometer mounting accessory, such as a mounting bracket or water cooled jacket
- A computer using a standard browser to open the pyrometer internal Web server, or using the IMAGEPro / SPOTPro software
- Cable(s) connecting the thermometer to the computer. Cable details are given in Figs 2-1 and 2-2.

2.2 Installing the Optic Head (Fibre-optic Thermometers only)

CAUTION

Points to Note on Installation

Do not pick up the Fibre-optic thermometer by the lightguide, as this could result in permanent damage to the lightguide. Always pick up the Fibre-optic thermometer by the optic head and thermometer main body.

The minimum bend radius of the lightguide is 100 mm / 4 in.

Take care not to bend the lightguide more tightly or to twist the end during installation.

2.2.1 Positioning the Optic Head

In many cases, there are few options on location of the optic head, as this is generally dictated by the particular measurement application. Observe the following precautions:

1) If your thermometer is an 'M' series thermometer (e.g. M160F), it must be positioned such that, at the chosen target distance, the target is large enough to completely fill the optic head's field of view.
2) The field of view of the Fibre-optic thermometer optic head is 100:1 i.e. at a target distance of 300 mm, the target diameter is 3 mm; at a target distance of 100 in, the target diameter is 1 in etc.

3) The field of view of the optic head can be displayed accurately by activating the sighting LED. The LED is activated from the Advanced menu in the thermometer software.
4) Ensure that the angle between the optic head's line of sight and the target area is as near to 90° as possible. However, if this is not possible, a viewing angle of up to 45° is acceptable.
5) If the optic head is located in an atmosphere containing a high proportion of dust/smoke etc, an air purge must be used in conjunction with the optic head. This prevents the lens from becoming dirty. Refer to the Installation Guide supplied with the mounting/purge assembly.
6) The thermometer body temperature must not exceed the maximum specified i.e. 5 to 60 °C to specification (0 to 70 °C operational). Maximum temperature for the lightguide and optic head is 200 °C.

2.2.2 Optic Head installation

The optic head is designed to be used in conjunction with one of the range of Land Fibre-optic thermometer mountings.

Refer to the Installation Guide supplied with the Fibre-optic mounting for installation information.

Alternatively, if you want to mount the optic head into a plate:

1) The hole in the plate must be 22.5 to 23 mm (0.89 to 0.91 in) diameter. The maximum plate thickness is 10 mm (0.4 in).
2) Refer to Fig. 2-3. Unscrew the clamp nut on the optic head.
3) Pass the optic head through the hole in the plate.
4) Re-attach the clamp nut onto the optic head. Tighten the nut so that the optic head is held securely in the mounting plate.

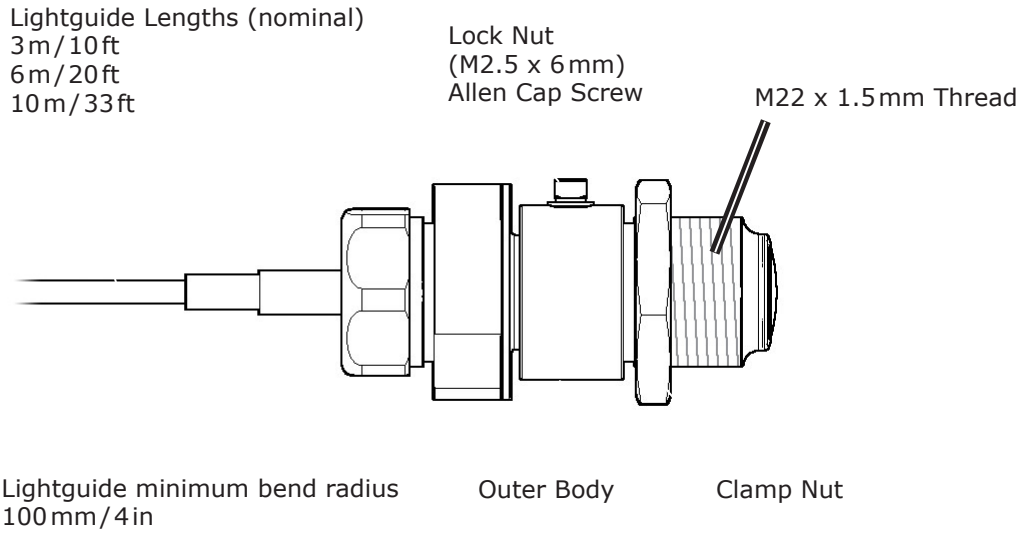


Fig. 2-3 SPOT+ Fibre-optic thermometer optic head installation dimensions

2.2.3 Focusing the Optic Head

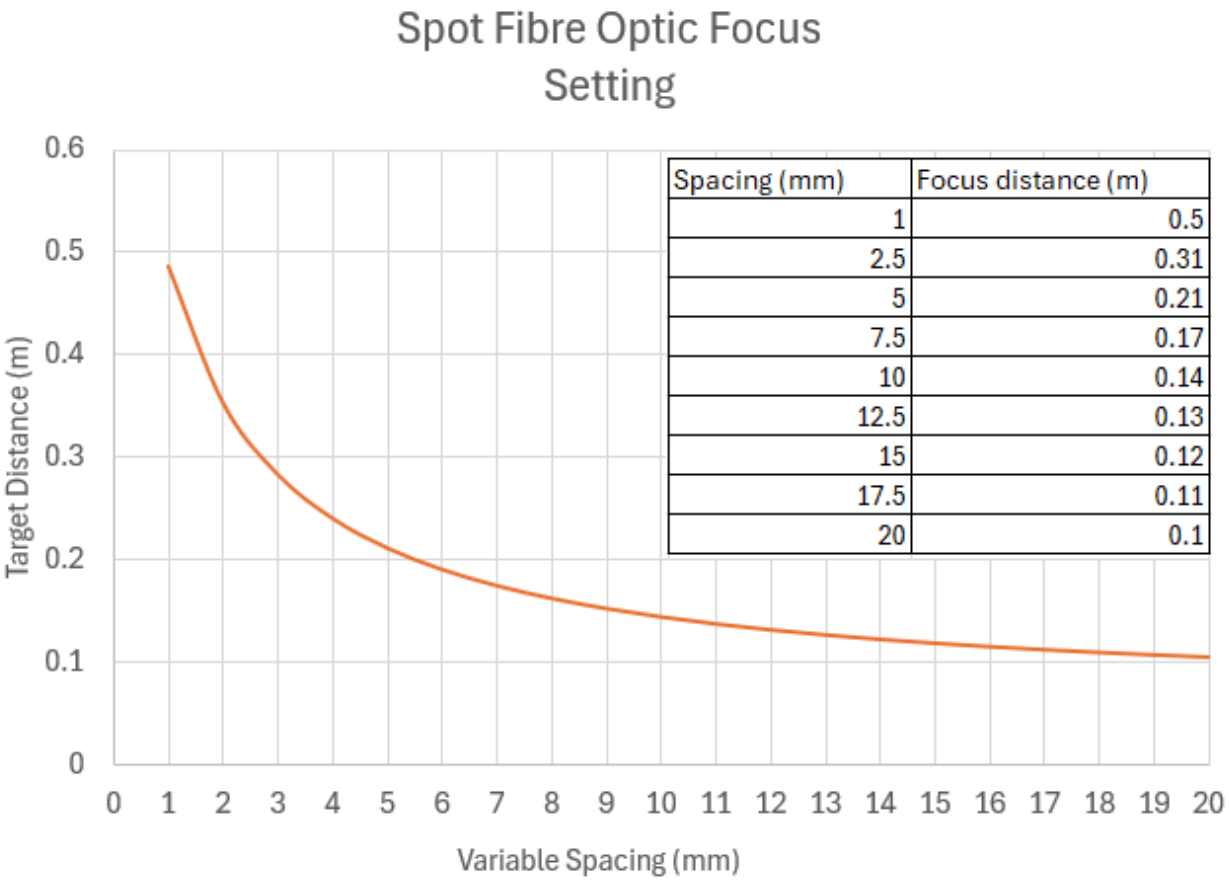
The optic head can be focused on the target with the aid of the integral LED in the Fibre-optic thermometer.

The LED is activated via the **Focus** menu option in the Thermometer/Web Server menu system (Refer to Section 4.5).

When the LED is activated, a circle of red light is emitted from the optic head. The circle is aligned with the infrared detector and represents the temperature measurement area.

1) To adjust the focus, loosen the M2.5 lock nut on the optic head outer body (See Fig. 2-3).
2) Slide the thermometer outer body gently along the inner body to adjust the size of the target SPOT+. There is a range of movement of approximately 18 mm / 0.7 in.
3) When the target SPOT+ is the required size, tighten the M2.5 lock nut. The optic head is now focused on the target.

2.2.4 Fiber Optic Focus Setting



Spacing (mm)	Focus distance (m)
1	0.5
2.5	0.31
5	0.21
7.5	0.17
10	0.14
12.5	0.13
15	0.12
17.5	0.11
20	0.1

2.3 Installing the Thermometer Body

If you are using a mounting accessory for the thermometer main body, refer to the accessory's Installation Guide for help on choosing a location for the thermometer, mounting dimensions, and aligning the thermometer on the target.

Installation drawings for frequently used accessories are given in Section 8.

Fig. 2-4 shows a thermometer installed in a Mounting Bracket.

Fig. 2-4

2.4 Connecting the Thermometer to a Control System

This section describes how to connect your thermometer using a Digital Cable and/or an Analogue Cable. SPOT+ pyrometers can be powered by 24V DC or Power over Ethernet (PoE), and they require up to 10W of power. Digital and analogue I/O can interface with a local control system via the Analogue Cable. Remote control is also available over Ethernet (using the embedded Web Server, AMETEK Land software, or the REST API, Modbus TCP/IP or EtherNet/IP protocols) via the Digital Cable. Local and remote control systems can be used at the same time if both cables are connected.

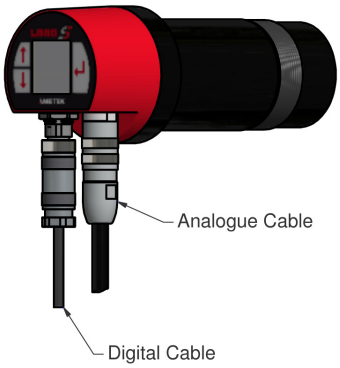


Fig. 2-5

2.4.1 Using the Analogue Cable

1) Connect the M16 end of the M16-Free 8 Way Analogue Cable into the connector on the thermometer.
2) Connect the Free end of the M16-Free 8 Way Analogue Cable to the control system, according to the functional requirements as explained in the table below. An optional Analogue Connection PCB is available.

*SPOT's with new (actual) PCB electronics

I/O Function	SPOT+ MXXX	SPOT+ RXXX Ratio	SPOT+ Application	Values / Ranges
	CMD IN (Input)			
Sample & Hold	✔	✔	✔	rising/falling edge 0V - 24V or 24V to 0V
Reset Peak Picker	✔	✔	✔	rising/falling edge 0V - 24V or 24V to 0V
LED on/off	✔	✔	✔	rising/falling edge 0V - 24V or 24V to 0V
mA Emissivity	✔*	✔*	✔	4mA to 20mA (only), representing user specified range of emissivities within 0 – 1.2
mA Non-greyness	✘	✔*	✔	4mA to 20mA (only), representing user specified range of non-greyness within 0 – 1.2
mA Background	✔*	✔*	✔	4mA to 20mA (only), representing user specified range of background within 0 - 5000C or 0 - 5000F
Scan (Actuator)	✔	✔	✔	SPOT Actuator connected (R Scan activated)
	CMD OUT (Output)			
Alarms	✔	✔	✔	Relay open or relay closed
Watchdog	✔	✔	✔	
mA Sig%	✘	✔*	✔	0/4-20mA representing user specified range 0 – 100%
mA E1	✘	✘	✔	0/4mA to 20mA, representing user specified range of emissivity within 0 – 1.2
mA E2	✘	✘	✔	
mA T1	✘	✔*	✔	0/4mA to 20mA, representing user specified temperature range within 0 – 5000C or 0-5000F
mA T2	✘	✔*	✔	
mA Tinst	✔*	✔*	✔	
Scan (Actuator)	✔	✔	✔	SPOT Actuator connected (R Scan activated)

2.4.2 Using the Digital Cable

1) Connect the M12 end of the RJ45 to M12 Digital Instrument Cable into the connector on the thermometer.
2) If the SPOT+ is to be powered over PoE, connect the RJ45 end of the RJ45 to M12 Digital Instrument Cable into the 'Power and Data Out' connector of a PoE Injector. Connect the computer to a 'Data In' port of the PoE Injector using a standard RJ45 ethernet cable.
3) If the SPOT+ is to be powered separately using the Analogue Cable, connect the RJ45 end of the RJ45 to M12 Digital Instrument Cable directly to the RJ45 port of the computer.

2.5 Network Connection and IP Addresses

In order for the thermometer to communicate with the computer, the IP address of the computer must be similar to, but not the same as, the IP address of the SPOT+ thermometer. SPOT+ thermometers are shipped with a default static IP address of 10.1.10.50.

2.5.1 Changing the IP Address on a SPOT+ Thermometer

If the SPOT+ is to be used on a managed network, the SPOT+ can be set to use a DHCP via the **Network** menu on the back panel of the instrument as explained in section 4.4. In this case the network router will assign a compatible IP address to the SPOT+ on first connection. The new IP address of the SPOT+ thermometer will be shown on the rear display of the instrument when assigned.

The **Network** menu can also be used to set the SPOT+ to a different compatible static IP address.

Note that changes to the IP settings of the SPOT+ on the Network menu are only applied on power cycling the SPOT+ thermometer.

2.5.2 Changing the IP Address on a Computer

In some cases it is preferable to change the IP address of the computer. In this case

1) Open the Start menu and select the Settings option.
2) Select the Network and internet option.
3) Select the Ethernet connection that is used by the SPOT+.
4) Click on the Edit button in the IP Assignment section.
5) Set the IP address of the computer to one similar to, but not the same as, the IP address of the thermometer. The current IP address of the SPOT+ thermometer will be shown on the rear display when in temperature measurement mode.
6) Set the Subnet mask to 255.255.0.0 and click OK.

You will now be able to view the Web Server of the SPOT+ thermometer via a web browser (eg. Google Chrome). Open a web browser and type the IP address of the SPOT+ thermometer into the address bar. More details about the Web Server features are given in the following sections.

2.6 Configuring Ethernet Communications

The SPOT+ thermometer offers full remote display and control via its own embedded Web Server, with essential inputs and outputs also available over REST API, Modbus TCP/IP and EtherNet/IP protocols.

The SPOT+ is shipped in a secure mode such that the Web Server and REST API are read-only until the Password is entered, and Modbus TCP/IP and EtherNet/IP communications are switched off.

The correct configuration for the customer control system should be set on first connection, using the back panel of the SPOT+ or via the Web Server. Each ethernet protocol should be set to Secure, Open or Off according to the requirements of the customer control system.

Further details about the Network security settings are given in section 4.4.

See the individual Programmers Guides for each protocol for further instructions and example code.

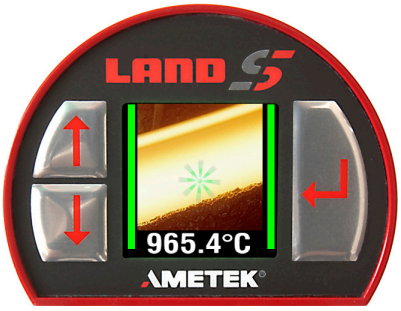
Note that the default Password for Secure mode is the 6-digit serial number of the instrument. It is recommended that this is changed to a unique user Password on first connection via the Web Server.

It is possible to reset the Password to the default value via the back panel of the instrument.

2.7 Aligning a SPOT+ Thermometer on the target

There are several methods of aligning your SPOT+ thermometer on the required target:

- Using the built-in LED;
- Viewing the live camera image on the back panel;
- Capturing a JPG image in the Viewer or Web Server software;
- Maximising the infrared signal from the target.



Note that the beam path may not be aligned exactly with the outer case of the instrument or the water cooling jacket.

2.7.1 Using the built-in LED

In applications where the LED image is visible during alignment, it is the simplest to use. The LED is aligned precisely with the infrared, and passes through the same optics as the infrared so that alignment with the target SPOT+ is exactly maintained at all focal distances. The LED pattern clearly indicates that the instrument is in focus.

See Section 4.7 **Focus** for more information.

2.7.2 Viewing the live camera image on the back panel

The camera image on the back panel is also quick and easy to use, and is especially useful for alignment of the thermometer in closed applications. The camera is aligned so that the infrared SPOT+ is approximately central to the image (within a few pixels across the focal range of the instrument) but the camera does not use the same optics as the infrared.

If you view the camera image whilst the LED is activated, the LED pattern can be seen in the camera images that coincide with a flash (i.e. 50% of the time the LED is activated). The LED position within the camera image shows the actual target position.

2.7.3 Viewing Camera Images Remotely

If you are unable to view the rear panel of the thermometer directly, you can use the Web Server or IMAGEPro software to view live video images from the visible light camera at the front of the SPOT+ thermometer. SPOTPro can also be used to capture still images as jpg files. Note that, if you capture an image whilst the LED is activated, there is a 50:50 chance that the image will show the LED.

2.7.4 Maximising the infrared signal from the target.

For even greater precision, or for applications where the beam path is restricted, it is recommended that the camera and LED are used as a guide but precision alignment is achieved by maximising the infrared measurement signal.

Switch the instrument to one of the Mono temperature measurement modes, if available. The Ratio mode should **not** be used during alignment, as ratio modes are designed to compensate for obscuration.

Adjust the alignment of the thermometer so that the infrared signal is maximised. Then set the correct measurement mode.

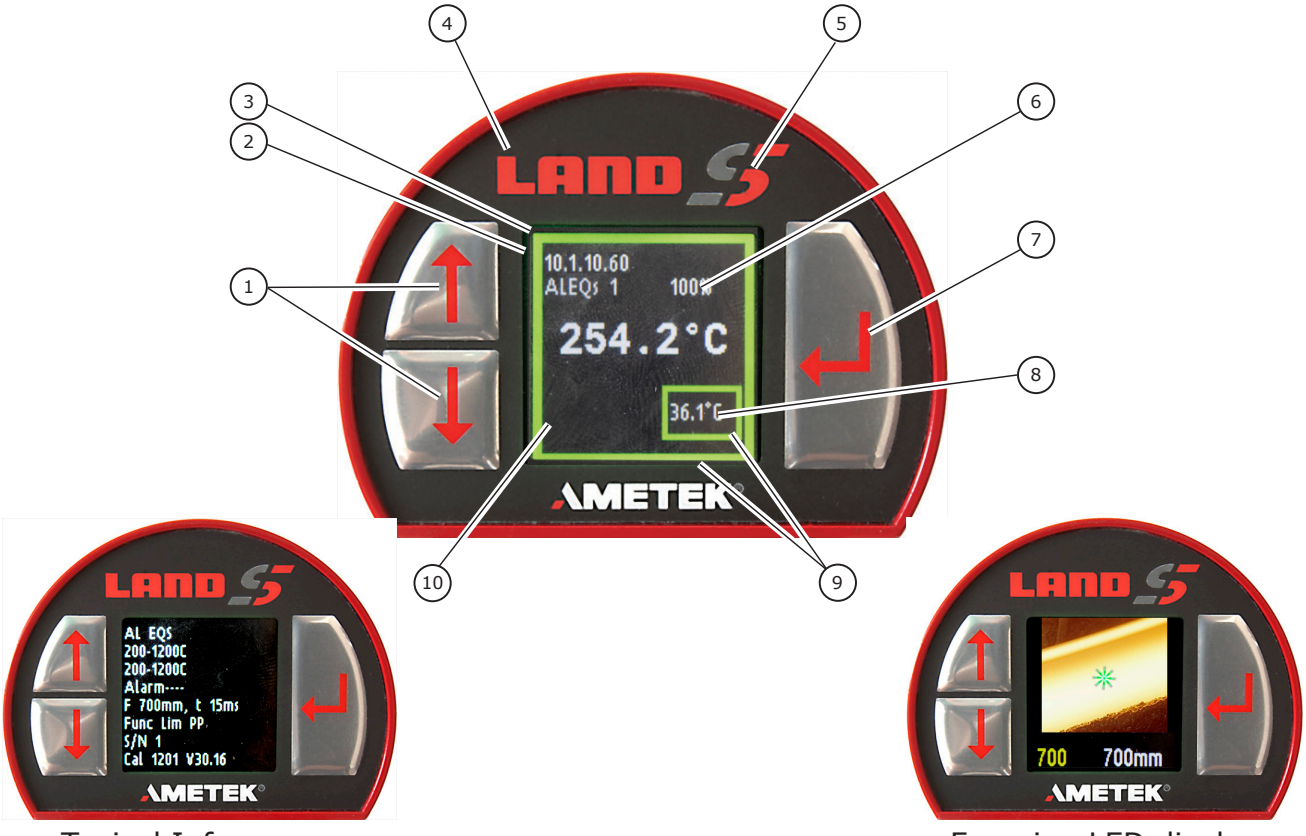
In an Application thermometer, where Mono modes are not available, precise alignment can be achieved by maximising the emissivity outputs.

3 USING THE THERMOMETER CONTROLS

3.1 Using the Display and Keypad

The thermometer has a back panel display which, when used in conjunction with the keypad buttons, can be used to:

- Display the Target temperature and the internal ambient temperature of the instrument (as shown in Fig. 3-1);
- Display the alarm status of the target and the instrument;
- Display an image of the target (from the instrument's internal camera);
- Activate the focusing LED, which can be used to align and focus the instrument on the target;
- Access the instrument menu system, including the Info screen. For more information on the menu system, see Section 4 of this User Guide.



Typical Info screen

Focusing LED display

Fig. 3-1 Rear panel controls and displays
Refer to Section 3.3 for a key to the items

3.2 Using the Web Server Software

The thermometer incorporates Web Server software which allows you to use a web browser to view temperature readings from the thermometer. The browser display updates automatically every 5 seconds, effectively turning the PC into a remote back panel for the thermometer.

The Web Server software interface is designed to mimic the controls on the rear panel of the SPOT+ thermometer and allows you to access the thermometer's menu structure and configure your temperature measurement system to your requirements.

1) Ensure that your thermometer is installed correctly and connected to the PC (Refer to Section 2).

2) Open a web browser window (e.g. Google Chrome) and type the IP address of the thermometer (default **10.1.10.50)** into the address bar.

   The Web Server interface will open (Fig. 3-2). The interface mimics the rear panel of the thermometer shown in Fig. 3-1.

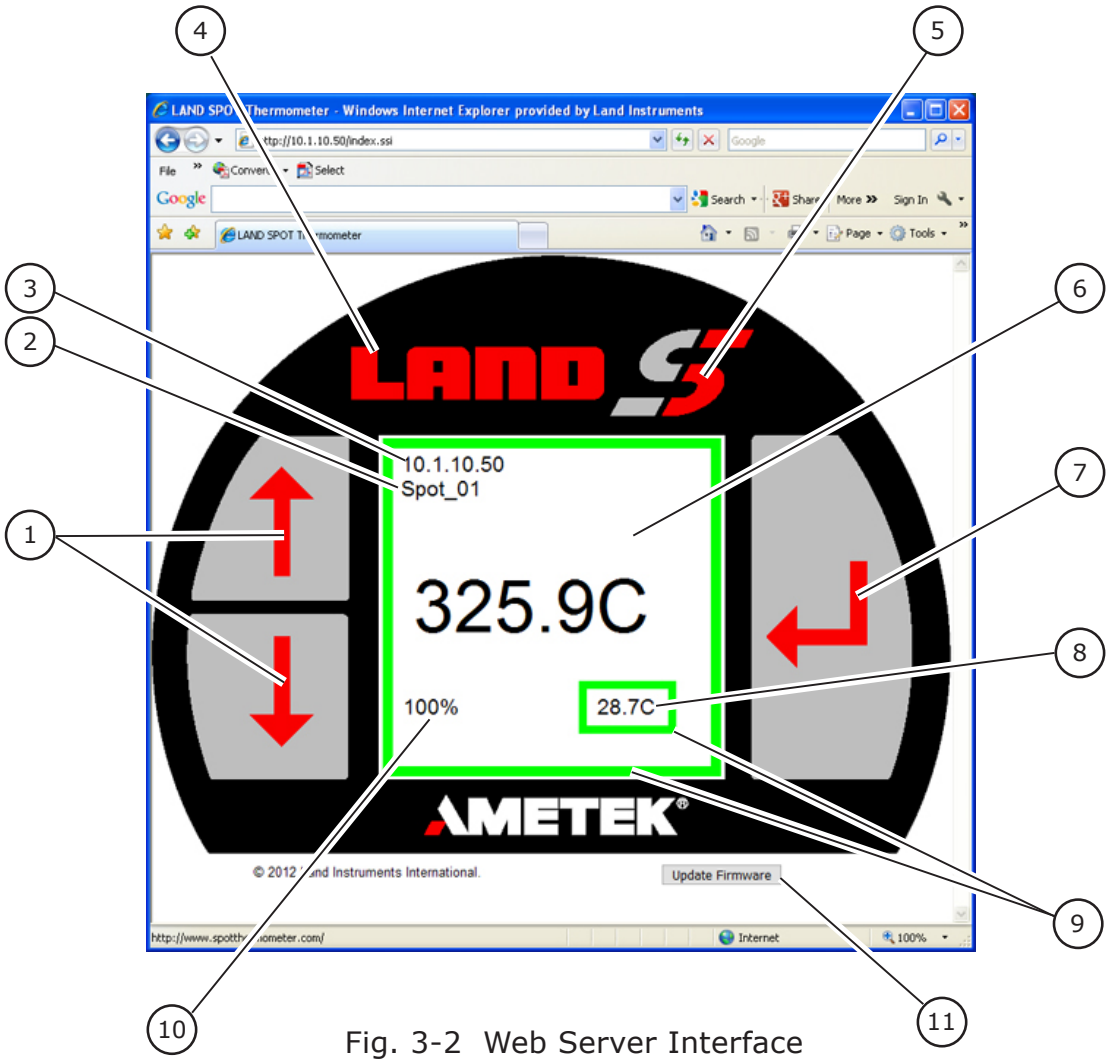


Fig. 3-2 Web Server Interface
Refer to Section 3.3 for a key to the items

3.3 Display and Web Server interface components

The following table describes the items shown in Figs. 3-1 and 3-2.

Item	Name	Description
1	Up/Down Keys	On the 'Home' screen (i.e. Temperature display), pressing either key cycles the temperature display screen, camera view (if the instrument has a camera fitted) and the info screen. The info screen will time-out and revert to the Temperature display. On an instrument fitted with a camera, the instrument streams images, but the web server only displays captured *.jpg images (like a webcam), the speed of these images will depend on the speed of your browser. When in the menu system, pressing either key scrolls up/down to the previous/next menu. When a menu option is selected (highlighted), pressing a key increases/decreases the value of the item accordingly, or scrolls up/down through the options available for that item.
2	Name	User-defined name for thermometer/measurement location.
3	IP Address	The IP address of the thermometer (set by the user or DHCP).
4	LAND logo	**On the Web Server only:** Click to open an online Web Server simulator and help pages.
5	SPOT logo	**On the Web Server only:** Returns you to the Web Server 'Home' screen i.e. Temperature display.
6	Target Temperature & Image* or Menu Display	Displays the target temperature by default. Displays the Info screen if either the Up or Down key is pressed. *If your instrument has a camera fitted, an image of the target is displayed. You can click on the Rotate Image button to rotate the image in steps of 90° To switch to the menu system, press the Enter key.
7	Enter Key	On the 'Home' screen (i.e. Temperature/Info display), pressing the Enter key accesses the menu system. When in the menu system, pressing the Enter key selects the highlighted menu item for adjustment. When a menu item is selected, pressing the Enter key sets the menu item to the selected value. An update to any menu item is confirmed by ✓
8	Internal Temperature Display	Displays the internal temperature of the instrument.
9	Alarm Status Indicators	High and low alarm values for both target temperature and instrument temperature can be set by the user. Colour-coded alarm status: Green = OK, Red = Alarm
10	Signal strength indicator	Only applicable if Ratio or Multi measurement mode is selected. If Emissivities E1 and E2 are set correctly, this value gives a measure of the reduction of signal strength due to obscuration e.g. when viewing through a dirty window. Alternatively, if the view is unrestricted, this value gives a measure of the emissivity variation in the target surface.
11	Update Firmware button	Allows you to update the firmware to the latest version via the SPOT+ Web Server. See Section 3.4

3.4 Updating the Firmware via the Web Server

1) Download the latest firmware SPOT+ from the following web address:
   https://www.ametek-land.com/products/software/spot-firmware
2) Open the SPOT+ Web Server application by entering the device IP address into a web browser.
3) Refer to Fig. 3-2, Item 11. Click the **Update Firmware** button.
4) Click the **Browse** button. Navigate to the downloaded SPOT+ firmware file, and select it.
5) Click **Update Firmware**.
   The Loading bar will show progress of the update.
   When the update is complete, the device will reset and the web browser will navigate back to the main Web Server screen.

4 THERMOMETER/ WEB SERVER MENU

4.1 About the Thermometer menu/Web Server menu system

The SPOT+ thermometer incorporates an internal menu system which can be accessed and viewed via the controls on the rear panel of the thermometer.

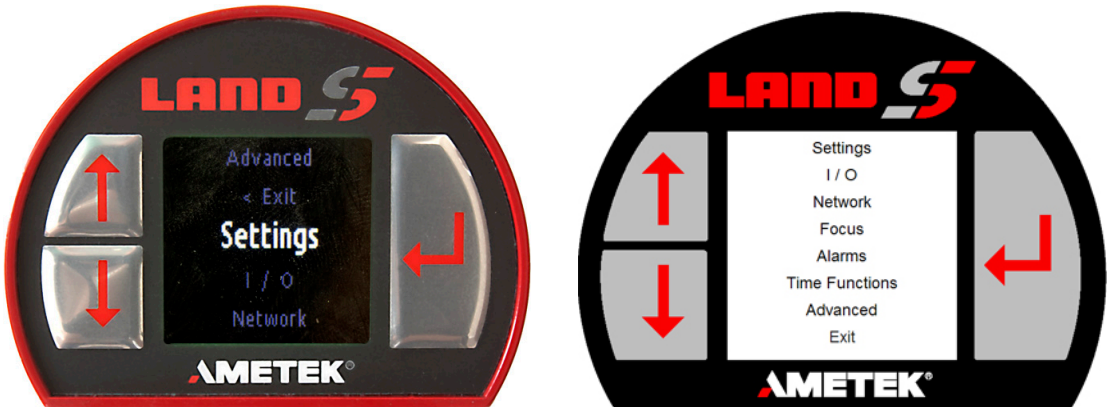
The menu system can also be accessed via the Web Server software built in to the thermometer (Fig. 4-1).

To access the menu system, click on the **Enter** key.

The **Up** and **Down** keys are used to either navigate through the menu system, or to change the value of a selected item on the display.

The **Enter** key is used either to select a menu item, or confirm a new value setting for a selected item.

The main menu gives access to a series of sub-menus which allow configuration of all the instrument settings:



Thermometer menu Web Server menu

Fig. 4-2

A graphical representation of the menu system is given in Fig. 4-2 (overleaf), and the various settings are explained in the following sections.

Fig. 4-2 Thermometer display and Web Server menu structure

4.2 Settings

The **Settings** menu allows you to specify basic measurement options for your system.

Menu Option	Description
Emissivity	In order to obtain accurate temperature measurements, the **Emissivity** value of the target surface must be known. If you are using a single detector thermometer, or using a dual detector thermometer in Mono mode, only one Emissivity setting will be available. If you are using a dual detector (i.e. ratio) thermometer, both the **Emissivity (1)** and **Emissivity (2)** settings will be available. **Automatic emissivity calculation** If you know the exact temperature of the target being measured (e.g. from a measurement taken by a thermocouple) you can set the emissivity value automatically. In the *Web Server Menu only*, on opening the Settings menu, the ↺ button is displayed if the most recent temperature measured is within the range of the thermometer. Press the ↺ button. A dialogue appears in which you enter the target temperature in °C. Press **OK**. If the temperature entered corresponds to a valid emissivity value (i.e. between 0.1 and 1.0). The calculated target emissivity value will be displayed and green tick ✓ is displayed at the bottom of the screen. On a ratio thermometer, both emissivity values will be changed if they are both in range. If only one emissivity value is within range, then only that one will be changed. For more detailed information on emissivity (and non-greyness settings in ratio thermometers) see Section 4.2.1. Guideline emissivity values for a range of common materials are given in Section 5 of this User Guide. If you have a query regarding the emissivity of the target in your measurement application, contact AMETEK Land.
Non-Greyness	If the instrument is used in Ratio mode, the non-greyness is calculated from the Ɛ1 / Ɛ2 value, and is displayed on the Info screen. If you have a query regarding the non-greyness value of the target in your measurement application, contact AMETEK Land.

Menu Option	Description
Mode	The **Mode** menu option allows you to specify the temperature measurement mode of the thermometer. A description of each mode available for SPOT+ is given below. The Mode options available in your thermometer will depend upon the type of thermometer you are using, and the detectors fitted in the thermometer. **Mono 1** - In thermometers with more than one detector fitted, the **Mono 1** option selects the shortest wavelength detector to be used for temperature measurement. **Mono 2** - In thermometers with more than one detector fitted, the **Mono 2** option selects the longest wavelength detector to be used for temperature measurement. **Duo** - In thermometers with more than one detector fitted, the **Duo** option selects the longest wavelength detector at lower temperatures, and switches smoothly and automatically to the shorter wavelength detector at high temperatures. **Ratio** - In thermometers with more than one detector fitted, the Ratio option selects both detectors to be used for temperature measurement. The thermometer will operate as a ratio thermometer, which allows measurement on partially obscured targets, or targets which do not fill the thermometer field of view completely, and of processes where emissivity changes across the wavelength band of both detectors. When the Ratio option is selected, an extra **Signal strength** output is available. **Multi** - This option enables the extended temperature range of a thermometer. It uses the Ratio mode at higher temperatures, where both detectors measure, and uses the longer wavelength detector (coupled with signal measurement from the ratio algorithm) to give a temperature output when measuring below the normal minimum temperature limit. **App (1 - X)** This option allows you to select the particular application-specific temperature measurement mode for your thermometer.
Units	The Units option allows you to specify whether temperature is displayed in **C** (Celsius) or **F** (Fahrenheit).

Menu Option	Description
Background	The **Background** menu option allows you to specify the temperature of the surroundings of the target object being measured. This is especially useful if the surroundings are at a higher temperature than the target object e.g. when measuring a steel slab in a reheat furnace. The **Background** temperature value you set will be used by the thermometer to compensate for the effect of the hot surroundings on the temperature measurement. **Automatic background correction** Automatic background correction uses the thermometer's internal measurement of ambient temperature to set the background temperature. This feature is primarily intended for use with the M210 thermometer, which starts measuring at 50 °C. Background correction is not available in ratio or multi modes. In the *Web Server Menu only*, on opening the Settings menu, the ↺ button is displayed next to the Background value. To use background correction, press the ↺ button. A dialogue appears asking you if you want to use automatic background correction. Press **OK**. Automatic background correction will now be used. When automatic background correction is enabled, a box displays the temperature that is currently being used as the background, and a green tick is displayed on the button ✓ To override automatic background correction, you can type your required set temperature into the box. To stop using background correction, untick the check-box. Alternatively, click on the ↺ button and select **Cancel**.
Process Window	The **Process Window** option allows you to specify whether or not the thermometer is viewing the target through a 'sealed to process' window. If there is a window between the thermometer and the target, there will be a decrease in the signal received by the thermometer due to transmission losses in the window. By specifying that a process window is present in your measurement application, the instrument will compensate automatically for the transmission losses and the correct temperature will be displayed.
Range	The **Range** of the thermometer will depend on the **Mode**, and is displayed for information purposes only. You cannot change the range of the thermometer.

4.2.1 Emissivity and Non-Greyness (Mono and Ratio Pyrometers)

In order to obtain accurate temperature measurements from a single wavelength (monochromatic) thermometer, the **Emissivity** value of the target surface must be known. Emissivity is the ratio of energy emitted by a material to the energy emitted by a black-body (such as a calibration furnace). Guideline emissivity values for a range of common materials are given in Section 5 of this User Guide.

For single detector thermometers, or ratio thermometers in Mono mode, only one Emissivity setting will be available.

The emissivity of an object varies with wavelength. A **Ratio** thermometer uses two detectors at different wavelengths. One detector tends to see more energy than the other. Therefore, a ratio thermometer sees two different emissivity values.

Traditional ratio instruments only require one input of the **Non-Greyness** factor (also known as ε-slope), which is the ratio of two different emissivities from the two wavelengths over which the ratio thermometer measures.

The new SPOT+ algorithm uses both ε1 and ε2 to allow calculation and output of the signal strength.

If you are replacing an existing ratio thermometer with a new SPOT+ ratio thermometer, you can determine the required emissivity values in one of two ways...

Finding ε2 if you know ε1 of your target...

1) Put your SPOT+ thermometer into the **Mono 1** temperature measurement mode.
2) Set the emissivity value of **ε1** to your known value. Record the target temperature measured by the SPOT+ thermometer.
3) Put your SPOT+ thermometer into the **Mono 2** temperature measurement mode.
4) Measure the target temperature and adjust the value of **ε2** until the temperature reading matches the value recorded in Step 2.

Finding ε2 if you know the Non-Greyness value...

1) Put your SPOT+ thermometer into the **Ratio** temperature measurement mode. Make sure that the thermometer has an unobstructed view of the target and is looking through clean, dust-free air.
2) Set the emissivity value of **ε1** to your known Non-Greyness value and set **ε2** to 1.000. Measure and record the target temperature.
3) Look at the **Signal Strength** value (e.g. 90%).

   Signal strength is expressed as a percentage and is displayed in the lower left corner of the thermometer temperature display screen, or on the **Mode** screen of the Web Server interface.
4) If the thermometer has a clear view of the target, multiply your emissivity settings by the signal strength value (i.e. correction factor).

   i.e. for a signal strength of 90%, **ε1** = 0.9 x Non-Greyness, **ε2** = 0.9.

4.2.2 Emissivity and Non-Greyness Calculation (Application Pyrometers)

Application thermometers use special algorithms to automatically detect and compensate for emissivity changes during industrial processes. They detect infrared radiation within multi-spectral bands and automatically calculate the real emissivity and resulting non-greyness values of the target. Each algorithm is based on extensive research of the particular application.

In an Application Pyrometer, The emissivity values used are calculated by the thermometer and displayed on the main temperature display and the Settings menu. You cannot edit the emissivity values when in an application mode, but if you know the 'true' temperature of your target e.g. from a thermocouple reading, you can use this reading to adjust the emissivity values being used by the algorithm using the 'Application' screen of the Webserver.

To access the application screen, click on the >>> link from the Settings menu. The application screen is displayed.

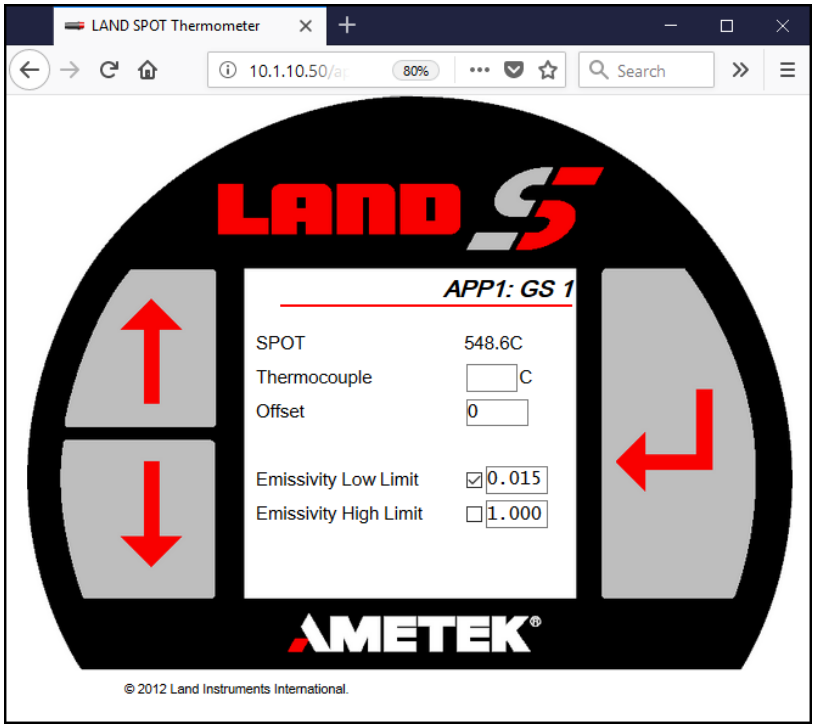


Fig. 4-3 Typical application screen (GS 1 shown)

Menu Option	Description
SPOT	This is a read-only display of the temperature being measured by the thermometer. This value is updated every 0.2 seconds.
Thermocouple	You can use this field to make a small adjustment to the algorithm by entering the 'true' temperature of the product, obtained by a thermocouple. Type in the measured temperature and press Enter. The calculated **Offset** temperature is displayed. **Note:** the thermocouple option is disabled if the thermometer is looking at a target which is outside the 200 to 1000°C / 390 to 1832°F temperature range.
Offset	This field displays the offset calculated when using the **Thermocouple** reading described above. You can input your own offset by typing the required value in this field and pressing Enter. The Offset is a small calibration adjustment to the algorithm. While a negative offset tends to increase the measured temperature value, and a positive offset tends to decrease the measured value, the relationship is not linear.
Emissivity Low Limit & Emissivity High Limit	The SPOT GS thermometer calculates emissivity automatically. You can use these fields to specify the lowest and highest emissivity values considered valid in a particular application. Type in the required value(s) and press Enter.
Scan	Selecting the **Scan** option starts the Actuator (if fitted), and if **mA Scan** has been selected in the **I/O** menu. The actuator moves the thermometer so that its field of view scans across the target. The thermometer takes 101 readings (0 to 100) and returns the thermometer to the position at which the highest signal was obtained. To start the scan, tick the check-box and press Enter. The position of the highest signal will be displayed. You can override the Actuator setting to an alternative position, if required. Enter the position, from 0 to 100, but leave the **Scan** check-box unticked.

The application modes available within each SPOT+ Application Pyrometer are explained in the tables below.

SPOT+ AL and AL LT App Modes

Mode	Recommended For
AL E	**Extrusion Press Exit** A freshly formed aluminium surface immediately starts to oxidise. The initial thin oxide layer consists predominantly of pure aluminium oxide Al2O3, irrespective of alloy composition.
AL Q	**Extrusion Quench Exit** If an extrusion is rapidly quenched within a few seconds after leaving the press exit, the oxide layer is slightly thicker layer but with composition largely unchanged from the press exit position.
AL S	**Rolled Strip** Just after rolling, the strip surface contains a significant proportion of rapidly oxidising fresh aluminium.
AL F	**Furnace Exit – low Magnesium alloys** A thick oxide layer develops during billet or slab re-heating for forging and forming applications, prior to hot rolling, or downstream of an extrusion press without rapid quenching.
AL F Mg	**Furnace Exit – higher Magnesium alloys** If an alloy contains as much as 1% of magnesium, the mature oxide layer after billet or slab re-heating will be disproportionately rich in AlMgO and MgO, even if there is only 1% of magnesium within the bulk alloy mix.
AL L	**Liquid Aluminium Melting or Casting** Measurements during stirring, air blowing or pouring are recommended to ensure a clear view of the liquid aluminium surface. For intermittent flow, time functions are also recommended to select only aluminium temperatures: • the Limiter function to ignore time between pouring or flames • the PeakPicker function to capture the highest temperature during a melt • the MeltMaster function to provide a rolling two-minute modal average

SPOT+ GS App Modes

Mode	Recommended For
GS+	**Zinc Pot Exit** The unique GS+ algorithm models the coated surface from liquid through all stages of solidification after the zinc pot.
GST	**Post-solidification** Fully galvanised or galvannealed solid surfaces

SPOT+ MM App Modes

Mode	Recommended For
MM	**Molten Metal** For intermittent flow, time functions are recommended to select only molten metal temperatures: • the Limiter function to ignore time between pouring • the PeakPicker function to capture the highest temperature during a melt • the MeltMaster function to provide a rolling two-minute modal average

4.3 I/O

The I/O menu allows you to specify the settings for the current inputs and outputs from the thermometer.

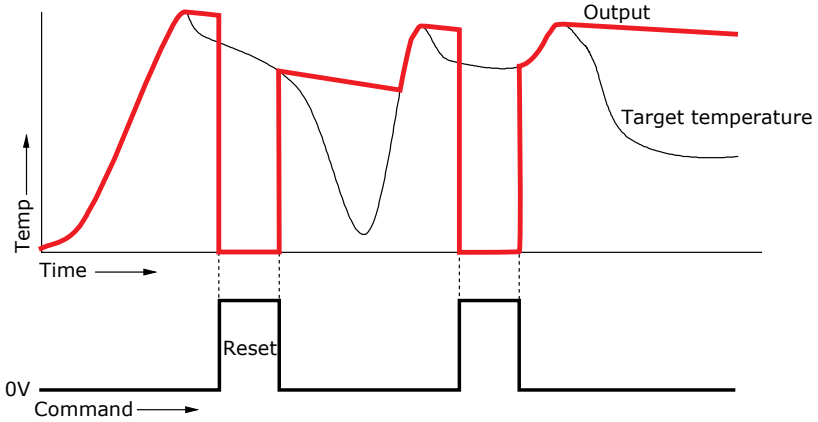
Menu Option	Description
4-20 / 0-20.	The Mode option allows you to specify whether the analogue output is **4-20mA** or **0-20mA**.
Logic	The Logic option allows to specify whether the Command input and output relays are Normally Open (**N-Open**) or Normally Closed (**N-Closed**).
0/4mA T	This option will depend up on the value you selected for the analogue output in the **Mode** option. It allows you to set the lower temperature limit of the analogue current output (i.e. the temperature that corresponds to an output of either 0mA or 4mA).
20mA T	This option allows you to set the upper temperature limit of the analogue current output (i.e. the temperature that corresponds to an output of 20mA).
Scan	When using an Actuator (e.g. wth an AL EQS Thermometer), set **Scan** to **On** on the display or tick the check-box on the Web Server to configure the SPOT+ thermometer to work with the SPOT+ Actuator. If **Scan** is set, the CMD In and CMD Out functions are used to communicate with the actuator and the instrument is set to 4 to 20mA. All other CMD In and CMD out options are therefore disabled on the Web Server and removed from the display menu. An additional button is shown on the Web Server which can be used to trigger a scan 
CMD In	Refer to Section 4.4
CMD Out	Refer to Section 4.5

4.4 CMD In

The CMD In supports a range of functions which can be selected using either the thermometer or the web server menu. Depending on the option selected, additional selections may be available.

CMD In is disabled if the Scan setting is enabled as CMD In and CMD Out are used to interface with the actuator.

mA BgdT	Background temperature When measuring an object in a hot environment, the pyrometer will measure infrared radiation emitted by the object and background radiation reflected from its surface. SPOT+ can correct for the background temperature error using a 4-20 mA signal from a second pyrometer or from a thermocouple.

mA NG	Non-Greyness Non-greyness is described in section 4.2.1. SPOT+ can correct for the known non-greyness using a 4-20 mA signal from an external source.
mA E	Emissivity Emissivity is described in section 4.2.1. SPOT+ can correct for the known emissivity using a 4-20 mA signal from an external source.
LED	Enables and disables the sighting LED via a logic signal. If logic is set to Normally Open, a rising edge switches the LED on, and a falling edge switches it off. If logic is set to Normally Closed, the rising / falling edges are the other way round. The timeout on the LED still applies, so if CMD In goes high and stays high, the LED switches off after 30s (or 15 min if Demo mode is selected). Triggering only on the rising / falling edge means that you can still switch the LED from any other source as well - Web Server, display, or button on manual focus instruments. The instrument responds to the latest LED switching request from any source.
Reset PP	Resets the peak-picker function via a logic signal. A graphical representation of the Reset Peak Picker input is shown below: 
Sample	Resets sample & hold via a logic signal. Refer to section 4.9.
[Blank]	Disables the CMD In.
If one of the mA options is selected, there will be additional menu items	
0/4mA In	Note: 0 to 20 mA input is not supported. Only 4 to 20 mA input can be used. BgdT can be set between 0 and 6380 °C NG can be set between 0.05 and 1.18 E can be set between 0.05 and 1.18
20 mA In	BgdT can be set between and 20 and 6400 °C NG can be set between 0.07 and 1.20 E can be set between 0.07 and 1.20

4.5 CMD Out

Alarm	If any alarms are in use, the CMD Out relay is used as an alarm output.
mA Tinst	Internal temperature of the instrument.
mA T2	For ratio pyrometer, apparent temperature measured by detector 2.
mA T1	For ratio pyrometer, apparent temperature measured by detector 1.
mA E2	For ratio pyrometer, apparent emissivity used by detector 2.
mA E	For ratio pyrometer, apparent emissivity used by detector 1. For mono pyrometer, emissivity used to calculate temperature.
mA Sig%	For ratio pyrometer, signal strength.
W-dog	Watchdog timer. Toggles between open and closed every secont to indicate that the microprocessor is functioning correctly.
0/4mA Out	Note: 0 to 20 mA output is not supported. Only 4 to 20 mA output can be used. mA Tinst can be set between 0 and 980 °C mA T2 can be set between 0 and 6380 °C mA T1 can be set between 0 and 6380 °C mA E2 can be set between 0.05 and 1.18 mA E can be set between 0.05 and 1.18 mA Sig% can be set between 0% and 80%
20 mA Out	mA Tinst can be set between and 20 and 6400 °C mA T2 can be set between and 20 and 6400 °C mA T1 can be set between and 20 and 6400 °C mA E2 can be set between 0.07 and 1.20 mA E can be set between 0.07 and 1.20 mA Sig% can be set between 20% and 100%

4.6 Network and Security

The SPOT+ has its own Web Server which functions as a remote back panel for the pyrometer, offering full remote control. SPOT+ also supports several Ethernet protocols that are widely used in factory automation for IIoT (Industrial Internet of Things) operation. These include EtherNet/IP, REST API and Modbus TCP/IP.

The **Network** menu allows you to specify the mode of network connection, to set the default IP Address for the thermometer, and to configure ethernet protocols and security options.

Menu Option	Description
Mode	The **Mode** option allows to specify whether the network mode is **DHCP** or **Static IP**. The **DHCP** option enables IP addresses to be assigned automatically by the network on which the thermometer is installed. DHCP allows a computer to join an IP-based network without having a pre-configured IP address. DHCP is a protocol that assigns unique IP addresses to devices, then releases and renews these addresses as devices leave and re-join the network. The **Static IP** option allows you to set an IP Address manually. The user-configurable **Default IP** address is used if the Static IP option is selected, and is also used if the network cannot assign one via DHCP.
Default IP	The **Default IP** option allows to specify the default network IP address of the thermometer.
Current IP	The IP address currently in use by the thermometer (Read-only)
MAC	The MAC (Media Access Control) address of the thermometer (Read-only)
Subnet Mask	The Subnet Mask is displayed when the instrument is set to Static IP.
Gateway	When the instrument is set to Static IP, the IP Gateway address can be configured. In most cases, the Gateway can be left at 0.0.0.0. If the instrument is to be accessed from a different network, it may be necessary to enter the router IP address as the Ethernet gateway.

4.6.1 Security

The SPOT+ is designed for secure IIoT operations as many SPOT+ pyrometers control critical infrastructure. Key security features protect data integrity and confidentiality, preventing unauthorized access or data manipulation, and protecting against cyberattacks.

SPOT+ firmware is encrypted and each ethernet communication protocol can be secured or switched off to prevent unauthorized access. All are set to be Secure or Off as default.

	Security Mode Options Default settings	
Webserver and REST API	Secure	Open
Modbus TCP/IP	Off	Open
EtherNet/IP	Off	Open

Secure mode

In Secure mode, the SPOT+ Ethernet write rate is limited to protect against Password hacking. The Password is only transmitted in its entirety during Password change; during subsequent operation the Password is used independently by both client and SPOT+ to validate data in a hashed format based on JSON web token public / private key exchange.

Secure mode is indicated on the Web Server by a padlock symbol. The SPOT+ will operate in Read-only mode indicated by a yellow padlock, until the Password is entered. A green open padlock is then shown and settings can be securely adjusted, with each Ethernet packet protected by JSON web token exchange.

You will be asked to enter the Password if you attempt to change any setting. Alternatively, clicking on the padlock symbol on any page brings you to the Security page to enter the password and enable change of settings.

Open mode

Open mode configures SPOT+ communication to emulate an earlier SPOT model.

In Open mode the SPOT+ will allow unsecured writes at any data rate, leaving the device vulnerable to malicious attacks. Open mode is therefore only recommended within a private network with full firewall protection.

Password Reset

In **Secure mode**, the default password is the instrument's 6-digit serial number, which can be located on the instrument label or in the webserver view mode. It is strongly recommended to change this default password to a more secure one.

To reset the password back to its default settings, follow these steps:

Access the Security menu in the network settings of the instrument.

Click on the "Change Password" option.

Choose "Reset Password."

Further information on SPOT+ communications using different Ethernet Protocol is available in Programmers Guides, which can be downloaded from the SPOT+ page of the AMETEK Land website: **www.ametek-land.com/products/spot**

Menu Option	Description
Web Server	This setting controls the security mode for the embedded Web Server and for communications over the REST API. The default is Secure. In **Secure** mode, the Web Server opens in Read-only mode. Password entry is required to enable secure ethernet writes via the Web Server. Password entry and a 'handshake' based on JSON web token exchange will be required for writes via the REST API. In both cases, writes will be limited to one per second to prevent Password hacking attempts. **Open** communication configures the SPOT+ to allow unsecured writes and is only recommended on an entirely private network. In Open communication mode, the SPOT+ will allow writes at any rate, like an earlier SPOT thermometer.
Modbus TCP	Modbus TCP communications are switched **Off** as default. Switching this setting to **Open** configures the SPOT+ to allow unsecured writes like previous generations of SPOT thermometer, and is only recommended on an entirely private network.
EtherNet/IP	EtherNet/IP communications are switched **Off** as default. Switching this setting to **Open** configures the SPOT+ to allow unsecured writes like previous generations of SPOT thermometer, and is only recommended on an entirely private network.
Password	Password entry enables secure change of settings on the SPOT+ via the Web Server or via the REST API. The default Password for Secure mode is the 6-digit serial number of the instrument. It is recommended that the Password is changed to a unique user alphanumeric string on first connection – follow the link at the bottom of the Security page of the Web Server to change the Password. The Password can be reset to the default value at any time on the back panel of the instrument.

4.7 Focus

The **Focus** menu allows you to adjust the focus and switch on the integral LED which can be used as an aid to focusing the thermometer. The LED will switch off automatically after 30 seconds to avoid internal warming of the SPOT+ thermometer and any associated increase to measurement noise.

Note: Modbus communications may be delayed during motorised focus movement.

Note: The **Set Focus** setting and Current Focus value are **not** available in fibre-optic thermometers.

SPOT+ thermometers have an excellent depth of field - at 1m, the LED focal pattern looks sharp over a range of more than 100 mm. The infrared SPOT+ has identical depth of field, so as long as the outer LED ray pattern is visible, the instrument will be in focus.

Menu Option	Description
LED	The LED check-box allows you to switch on/off the integral LED which can be used as an aid to focusing and aiming the thermometer.
	 In most standard-bodied SPOT+ thermometers, the LED image has a central green circle which is aligned with the infrared detector and represents the temperature measurement area.
	 Some SPOT+ thermometers are specified with a 30:1 field of view. On these thermometers, the LED image does not have a central circle and the field of view corresponds to the OUTER diameter of the image.
	 For a fibre-optic thermometer, the red circle is aligned with the infrared detector and represents the temperature measurement area.
Flash Rate	The **Flash Rate** setting allows you to specify the rate at which the focus LED flashes (when enabled). The Flash Rate can be set to between 1 and 30 Hz.
Set Focus	This option is only applicable to instruments with a motorised focus. This option allows you to set the thermometer focus to any value within the focal range of the thermometer. For details of the focal range of your thermometer, refer to the Focus value in the Specifications (Section 5 of this guide) You can use the up/down keys to set the focus to the required value.

4.8 Alarms

The **Alarms** menu allows you to set high and low alarm temperature values for both the target being viewed and the ambient temperature of the thermometer.

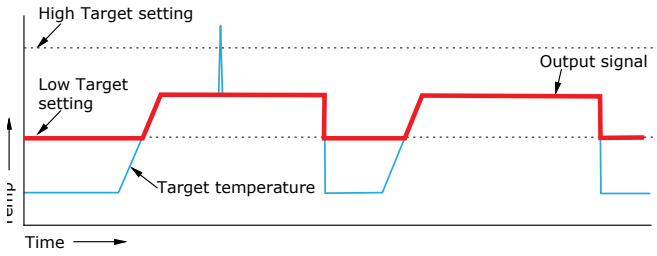
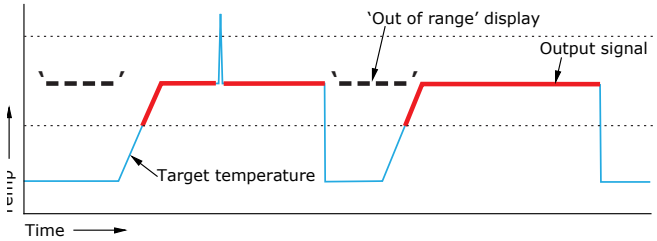
When active, an alarm state is indicated by red bars next to the camera image on the rear panel display, or a red box around the data view on the display or Web Server.

Note: There is only one Alarm relay, but it will be activated by any of the alarm options listed below.

Menu Option	Description
High Target	The **High Target** option allows you to enable and specify a target temperature above which the high temperature alarm is activated.
Low Target	The **Low Target** option allows you to enable and specify a target temperature below which the low temperature alarm is activated.
High Instrument	The **High Instrument** option allows you to enable and specify a temperature above which the instrument's internal high temperature alarm is activated.
Low Instrument	The **Low Instrument** option allows you to enable and specify a temperature below which the instrument's internal low temperature alarm is activated.
Low Signal %	This alarm is only available when the thermometer is in either **Ratio** or **Multi** mode (See **Settings** menu, Section 4.2). In Ratio and Multi mode, the thermometer uses the signal measured by two detectors to calculate whether or not a full strength signal is being received. A low strength signal could be an indication of an obstruction in the field of view, such as a dirty viewing window. The **Low Signal %** option allows you to enable and specify a signal strength below which the low signal alarm is activated.

4.9 Time Functions

The **Time Functions** menu allows you to select which time functions are applied to the thermometer temperature readings. Functions are applied to the measurement in the order they are shown in the menu.

Menu Option	Description
Output Time	The **Output Time** option allows you to specify a time interval over which temperature measurements are averaged. The range of possible measurements is 1 to 10,000 milliseconds (10 seconds).
Limiter	The **Limiter** function can be used to specify a band of temperatures to be measured and displayed. Temperatures outside the specified band will be disregarded. For example, if your measurement application is a process in which hot objects pass the thermometer, you can choose to disregard measurements taken when a hot object is not present in the field of view of the thermometer. Similarly, if an object above the 'High target' temperature is detected (e.g. a spark), this reading will also be disregarded. **Mode (Hold or Reset)** **Hold** - in Hold mode, when a hot object leaves the field of view, or a spark passes through it, the temperature display will retain the last temperature value that was within range, until a new measurement within the range is measured. **Reset** - in Reset mode, when an object is detected which is not within the specified temperature measurement limits, the thermometer will show the 'Out of range' display i.e. '**----**'. **High Target** - specifies the upper limit of the range of temperatures to be measured. **Low Target** - specifies the lower limit of the range of temperatures to be measured. **Hold mode**  **Reset mode** 

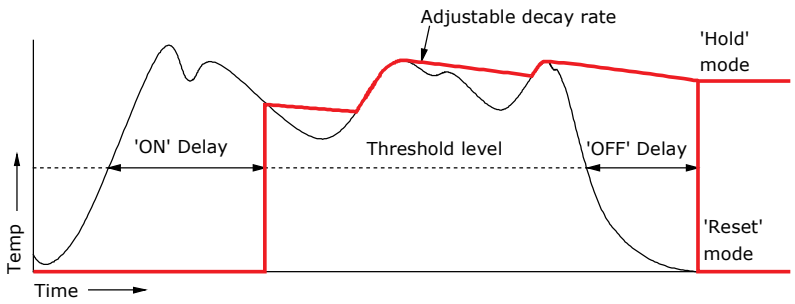
Menu Option	Description
Averager 1 Averager 2	The Averager options allows you to smooth the measurements over a specific number of values. An Averager set to n smooths over n Output Time intervals. The range of possible measurements is 1 to 255 values. Averager1 is applied immediately after the Limiter to smooth out noise or rapid variations in the target temperature readings. Averager2 can additionally be used after the ModeMaster and / or Peak Picker to apply final smoothing to the measurement.
ModeMaster	The **ModeMaster** option is a function which can be used in applications such as viewing a stream of hot metal. In such applications, there is likely to be occasional obscuration of the target by smoke or other interference - this would lead to lower (and extremely variable) temperature readings. Conversely, sparks or cavitation in the metal stream would lead to high (but short-lived) readings. The **ModeMaster** function minimises both types of error by continuously 'buffering' and filtering batches of temperature readings over a specific time period (approx. 2 seconds). The average temperature over this time period is calculated and displayed.

NOTE

It is possible to select any number of the available time functions to be in use at the same time. The time functions will be applied in the order in which they are displayed in the menu.

i.e. Averager >> Filter >> Modemaster >> Peak Picker

However, if you select **Modemaster**, the **Averager** is activated but its values are set by the **Modemaster** algorithm. If you also select **Peak Picker**, it will pick the peaks in the **Modemaster** output data.

Menu Option	Description
Peak Picker	 The **Peak Picker** function can be used to monitor the highest temperature measured by the thermometer. This feature is useful especially for moving targets and/or where the target is obscured partially e.g. a steel slab on a rolling mill where parts of the surface are covered with scale. The 'clean' area will be at the higher (i.e. true) temperature. The Peak Picker has the following features. **Mode (Peaks or Valleys)** **Peaks** - this mode measures and tracks the highest temperature (as illustrated). **Valleys** - this mode measures and tracks the lowest temperature. **Threshold level** - Temperature above which the Peak Picker is active, used in conjunction with the ON and OFF delay. **On Delay** - Time period between the temperature rising above the threshold level and the Peak Picker function switching on. **Decay Time** - A user-adjustable value at which the stored temperature output signal decays. **Off Delay** - Time period between the temperature falling below the threshold level and the Peak Picker function switching off. **Off Mode (Hold, Reset or CMD In Reset)** **Hold** - at the end of the 'Off Delay', the temperature output value is held constant until the temperature input next rises above the threshold level. **Reset** - at the end of the 'Off Delay', the temperature output signal falls to 'under-range' until the temperature input next rises above the threshold level. **CMD In Reset** - Selecting this option allows you to reset the Peak Picker at any time via the command input.

4.10 Advanced

The **Advanced** menu contains items which are likely to be used only occasionally.

These items control the 'look and feel' of the Web Server interface, and may be useful during set up.

Menu Option	Description
Language	This option allows you to select the language for the Web Server interface screens.
LED	This option allows you to switch on the LED which illuminates the thermometer's field of view and defines the target size. This is useful for aligning the thermometer on the required target. You can also define the frequency at which the LED flashes. These controls are also available from the Focus menu.
Demo LED	When the **Demo LED** option is selected, the LED is activated each time a key is pressed on the rear face of the thermometer. The LED switches off automatically after 15 minutes in Demo mode, instead of 30 seconds. **Note:** Demo mode is not recommended during normal operation as the continual LED use causes internal warming of the SPOT+ thermometer and increases measurement noise.
Test Output	This option allows you to switch on a test current output from the thermometer. This is useful for confirming that the thermometer is operating correctly You can also specify the current (in **mA**) for the test output. The test current output switches off automatically after 15 minutes.
Reboot	This option restarts the thermometer.
Factory Settings	This option resets the thermometer settings to factory default values. **Note:** Selecting this option will lose any changes that you have made to the thermometer settings.
Name	This option allows you to specify a name, label, or location identifier for the thermometer connected to the Web Server e.g. Furnace1. The maximum name length is 8 characters.

5

EMISSIVITY TABLES

In order to obtain accurate temperature measurements, the emissivity value of the target surface must be known. This section of the Thermometer User Guide contains emissivity values of the most commonly measured materials for each SPOT+ thermometer. Where no emissivity value is quoted, this means that either the thermometer is not suitable for the measurement application or the temperature of the target is outside the thermometer's measurement span. If you have a query regarding the emissivity of the target in your measurement application, contact AMETEK Land.

The emissivity values are given for each thermometer wavelength available in the SPOT+ range. Refer to the Specification in Section 6 to find the wavelength of your thermometer.

5.1 Refractories

Material		SPOT+ Thermometer Wavelength			
		1 µm	1.2 µm	1.5 µm	2.3 µm
Alumina		0.30	0.30	0.30	0.30
Brick	red	0.80	0.80	0.80	0.80
	white refractory	0.30	0.32	0.35	-
	silica	0.55	0.57	0.60	-
	sillimanite	0.60	0.60	0.60	-
Ceramics		0.40	0.44	0.50	-
Magnesite		-	-	-	0.60

5.2 Alloys

Material	SPOT+ Thermometer Wavelength			
	1 µm	1.2 µm	1.5 µm	2.3 µm
Brass	0.20	0.19	0.18	-
oxidised	0.70	0.70	0.70	0.70
Chromel & Alumel	0.30	0.30	0.30	0.30
oxidised	0.80	0.80	0.80	0.80
Constantin & Manganin	0.25	0.24	0.22	0.20
oxidised	0.65	0.63	0.60	0.60
Inconel	0.30	0.30	0.30	0.30
oxidised	0.85	0.85	0.85	0.85
Monel	0.25	0.24	0.22	0.20
oxidised	0.70	0.70	0.70	0.70
Nichrome	0.30	0.27	0.22	-
oxidised	0.85	0.85	0.85	0.85

5.3 Miscellaneous

Material		SPOT+ Thermometer Wavelength			
		1 µm	1.2 µm	1.5 µm	2.3 µm
Asbestos (board/paper/ cloth)		0.90	0.90	0.90	0.90
Carbon	*graphite*	0.85	0.85	0.85	0.85
	soot	0.95	0.95	0.95	0.95
Cement & Concrete		0.65	0.68	0.70	0.70
Glass	*20mm thick*	0.80	-	-	-

5.4 Metals

Material	SPOT+ Thermometer Wavelength			
	1 µm	1.2 µm	1.5 µm	2.3 µm
Aluminium	0.13	0.11	0.09	0.08
oxidised	0.40	0.40	0.40	0.40
Chromium	0.43	0.40	0.34	-
oxidised	0.75	0.78	0.80	-
Cobalt	0.32	0.30	0.28	-
oxidised	0.70	0.68	0.65	-
Copper	0.06	0.05	0.05	0.04
oxidised	0.85	0.85	0.85	0.85
Gold	0.05	0.04	0.02	0.02
Iron & Steel	0.35	0.33	0.30	-
oxidised	0.85	0.85	0.85	0.82
Lead	0.35	0.33	0.28	-
oxidised	0.65	0.65	0.65	0.65
Magnesium	0.27	0.26	0.24	0.20
oxidised	0.75	0.75	0.75	0.75
Molybdenum	0.33	0.30	0.25	-
oxidised	0.80	0.80	0.80	0.80
Nickel	0.35	0.31	0.25	-
oxidised	0.85	0.85	0.85	-
Palladium	0.28	0.26	0.23	-
Platinum	0.27	0.25	0.22	0.18
Rhodium	0.25	0.23	0.18	-
Silver	0.05	0.04	0.04	0.04
oxidised	0.10	0.10	0.10	0.10
Tin	0.40	0.35	0.28	0.12
oxidised	0.60	0.60	0.60	0.60
Titanium	0.55	0.53	0.50	0.42
oxidised	0.80	0.80	0.80	-
Tungsten	0.39	0.37	0.30	0.20
Zinc	0.50	0.44	0.32	0.10
oxidised	0.60	0.60	0.55	-

END OF SECTION

6 SPECIFICATIONS

	M100	M100 F.O.	M160	M160 F.O.	M210	M390	M3-5
Measurement Range:	500 -1800 °C / 932 - 3272 °F	500 -1800 °C / 932 - 3272 °F	250 -1600 °C / 482 - 2912 °F	250 -1600 °C / 482 - 2912 °F	50 -1100 °C / 122-2012 °F	150 - 1800 °C 302 - 3272 °F	0 - 500 °C 32 - 932 °F
Extended Range:	500 -2500 °C / 932 - 4532 °F	-	-	-	-	-	-
Field of View (>90% of energy):	200:1	100:1; 3 lengths of light guides available	200:1	100:1; 3 lengths of light guides available	60:1	30:1	30:1
Detector Type:	Single Wavelength 1.0 µm		Single Wavelength 1.6 µm		Single Wavelength 2.3 µm	Single Wavelength 3.9 µm	Broadband 3-5 µm
Display:	Local with video streaming	Local display	Local with video streaming	Local display	Local with video streaming	Local with video streaming	Local with video streaming
Settings:	Configure locally using the pyrometer interface or remotely (using the Webserver or SPOTPro or IMAGEPro. Emissivity, mode, current output range, alarm logic output and thresholds, network settings, focus and LED, language and user name (focus and LED on standard body only)						
Sighting Image:	Local display and remote video streaming	Not available	Local display and remote video streaming	Not available	Local display and remote video streaming	Local display and remote video streaming	Local display and remote video streaming
Focus Range:	300 mm / 11.8 in to infinity, locally or remotely adjusted	100 mm / 3.9 in to 500 mm 19.7 in manually adjusted	300 mm / 11.8 in to infinity, locally or remotely adjusted	100 mm / 3.9 in to 500 mm 19.7 in manually adjusted	300 mm / 11.8 in to infinity, locally or remotely adjusted	300 mm / 11.8 in to infinity, locally or remotely adjusted	300 mm / 11.8 in to infinity, locally or remotely adjusted
LED Targeting:	Patented* pulsed green LED focus pattern	Red circle LED	Patented* pulsed green LED focus pattern	Red circle LED	Patented* pulsed green LED focus pattern	Patented* pulsed green LED focus pattern	Patented* pulsed green LED focus pattern
Mounting:	Full range of mountings and accessories available - see Mountings and Accessories Brochure or visit our website						
Measurement Accuracy:	±0.25 % K or 2 K**					±1 % K (T<1100 °C) ±1.5 % K (T>1100 °C)	1 % K or 3 K
Repeatability:	<1 °C						
Resolution:	0.1 °C						
Noise:	<0.5 °C RMS**						
Sealing:	IP65						
Response Time:	1 ms to 10 s						10 ms to 10 s
Analogue I/O:	Two 4-20 mA outputs, One 4-20 mA input, Contact closure input, Relay output						
Communications:	EtherNet/IP, REST API, Modbus TCP/IP, web server						
Processing Functions:	Peak/Valley Picking, Averager, Modemaster, CMD in sampling, CMD out alarms						
Power Req.:	Power over Ethernet or 19 to 30 V DC at the instrument; 8 W max consumption						
Software:	Live configuration and temperature display on any web browser. Optional SPOTPro or IMAGEPro software with datalogging, live and historical data trending, plus remote image capture, control of multiple instruments (image capture not available on fiber-optic versions)						
Languages:	Integrated multiple language selections: English, German, French, Italian, Spanish, Portuguese (Brazilian), Japanese, Chinese (simplified Mandarin), Korean, Russian, Polish						
Ambient Temp. Range:	5-60 °C specified, 0-70 °C operating before cooling required	Optic head up to 200 °C / 392 °F	5-60 °C specified, 0-70 °C operating before cooling required	Optic head up to 200 °C / 392 °F	5-60 °C specified, 0-70 °C operating before cooling required	5-60 °C specified, 0-70 °C operating before cooling required	5-60 °C specified, 0-70 °C operating before cooling required
Warranty:	See our website at www.ametek-land.com for warranty details						

* Patent Number GB2497609
**Measurements within specification over 5-95% of range

Ratio pyrometers allow automatic compensation for reduced or changing obstruction in dusty and smoky atmospheres.

	R100	R100 F.O.	R160	R160 F.O.	R210
Measurement Range:	550 -1800 °C / 1022 - 3272 °F (ratio) 400 -1800 °C / 752 - 3272 °F (overall) 700 to 3500 °C / 1292 to 6332 °F (all modes)†	550 -1800 °C / 1022 - 3272 °F (ratio) 400 -1800 °C / 752 - 3272 °F (overall)	550 -1600 °C / 1022 - 2912 °F (ratio) 250 -1600 °C / 482 - 2912 °F (overall)	550 -1600 °C / 1022 - 2912 °F (ratio) 250 -1600 °C / 482 - 2912 °F (overall)	125 -1100 °C / 257-2012 °F
Field of View (>90% of energy):	200:1	100:1; 3 lengths of light guides available	200:1	100:1; 3 lengths of light guides available	60:1
Detector Type:	Ratio Short Wavelength; Detector 1: 1.0 µm, Detector 2: 1.2 µm		Ratio Short Wavelength; Detector 1: 1.0 µm, Detector 2: 1.5 µm		Ratio Mid Wavelength; Detector 1: 2.1 µm, Detector 2: 2.4 µm
Display:	Local with video streaming	Local display	Local with video streaming	Local display	Local with video streaming
Settings:	Configure locally using the pyrometer interface or remotely (using the Webserver or SPOTPro or IMAGEPro. Emissivity, mode, current output range, alarm logic output and thresholds, network settings, focus and LED, language and user name (focus and LED on standard body only)				
Sighting Image:	Local display and remote video streaming	Not available	Local display and remote video streaming	Not available	Local display and remote video streaming
Focus Range:	300 mm / 11.8 in to infinity, locally or remotely adjusted	100 mm / 3.9 in to 500 mm 19.7 in manually adjusted	300 mm / 11.8 in to infinity, locally or remotely adjusted	100 mm / 3.9 in to 500 mm 19.7 in manually adjusted	300 mm / 11.8 in to infinity, locally or remotely adjusted
LED Targeting:	Patented* pulsed green LED focus pattern	Red circle LED	Patented* pulsed green LED focus pattern	Red circle LED	Patented* pulsed green LED focus pattern
Mounting:	Full range of mountings and accessories available - see Mountings and Accessories Brochure or visit our website				
Measurement Accuracy:	Mono & Duo: ±0.25% K or 2 K** Ratio & Multi: ±0.5% K or 5 K**				
Repeatability:	<1 °C				
Resolution:	0.1 °C				
Noise:	<0.5 °C RMS**				
Sealing:	IP65				
Response Time:	Adjustable 1 ms to 10 s				Adjustable 15 ms to 10 s
Analogue I/O:	Two 4-20 mA outputs, One 4-20 mA input, Contact closure input, Relay output				
Communications:	EtherNet/IP, REST API, Modbus TCP/IP, web server				
Processing Functions:	Peak/Valley Picking, Averager, Modemaster, CMD in sampling, CMD out alarms				
Power Req.:	Power over Ethernet or 19 to 30 V DC at the instrument; 8 W max consumption				
Software:	Live configuration and temperature display on any web browser. Optional SPOTViewer software with datalogging, live and historical data trending, plus remote image capture, control of multiple instruments (image capture not available on fiber-optic versions)				
Languages:	Integrated multiple language selections: English, German, French, Italian, Spanish, Portuguese (Brazilian), Japanese, Chinese (simplified Mandarin), Korean, Russian, Polish				
Ambient Temp. Range:	5 - 60 °C specified, 0 - 70 °C operating before cooling required	Optic head up to 200 °C / 392 °F	5 - 60 °C specified, 0 - 70 °C operating before cooling required	Optic head up to 200 °C / 392 °F	5 - 60 °C specified, 0 - 70 °C operating before cooling required
Warranty:	See our website at www.ametek-land.com for warranty details				

* Patent Number GB2497609
**Measurements within specification over 5-95% of range
† Measurements within specification between 700 - 3000 °C / 1292 - 5432 °F

Application specific pyrometers provide full compensation for changing surface chemistry during specific processes.

	SPOT+ AL	SPOT+ AL LT	SPOT+ GS	SPOT+ MM	SPOT+ TMT
Measurement Range:	200 -900 °C / 392-1652 °F	130 -700 °C / 266 -1292°F 150-700 °C / 302-1292 °F	125 -1200 °C / 257-2192 °F	600 to 1800 °C / 1112 to 3272 °F	300 to 1800 °C / 572 to 3272 °F
Field of View (>90% of energy):	60:1 to 90%	30 :1	60:1 to 90%	200:1 to 90%	230:1 to 90%
Detector Type:	Application-specific selected range of narrow wavelength bands designed to optimise temperature accuracy measurement of Aluminium	Application-specific selected range of narrow wavelength bands designed to optimise temperature accuracy measurement of Aluminium	Application specific selected range of narrow wavelength bands designed to optimise temperature accuracy for the measurement of Gavannealed and Galvanized Strip	Application specific selected range of NIR wavelength bands designed to optimise temperature accuracy measurement of molten metals.	3.9 µm Single Wavelength
Display:	Local display with image streaming				
Settings:	Configure locally using the pyrometer interface or remotely (using the Webserver or SPOTPro or IMAGEPro. Emissivity, mode, current output range, alarm logic output and thresholds, network settings, focus and LED, language and user name (focus and LED on standard body only)				
Sighting Image:	Integrated video with local display and remote image capture.				
Focus Range:	300 mm / 11.8 in to infinity, locally or remotely adjusted	Nominal target spot diameter 10 mm / 0.4 in at 300 mm / 11.8 in focus; 17 mm / 0.7 in at 500 mm / 19.7 in focus; 33 mm / 1.3 in at 1 m / 39.4 in focus. Twice nominal target area is recommended.	300 mm / 11.8 in to infinity, locally or remotely adjusted	300 mm / 11.8 in to infinity, locally or remotely adjusted	300 mm / 11.8 in to infinity, locally or remotely adjusted
LED Targeting:	Patented* pulsed green LED focus pattern				
Mounting:	Full range of mountings and accessories available - see Mountings and Accessories Brochure or visit our website				
Measurement Accuracy:	± 5 °C at 200 °C, ± 2 °C or 0.25 % K at 300 °C and above (extrusion and quench) ± 5 °C or ±0.5 %K (lubricated strip, forming/ forging and liquid metal)	± 5 °C at 150 °C, ± 2 °C or 0.25% K at 300 °C and above (extrusion and quench) ± 5 °C or ±0.5 %K (lubricated strip, forming/ forging)	±5 °C at 200 °C ±2 °C or 0.25 %K at 300 °C and above	±0.5 %K	±1 %K
Resolution:	0.1 °C				
Noise:	5 °C at 200 °C, <0.5 °C at 300 °C and above	5 °C at 150 °C, <0.5 °C at 300 °C and above	5 °C < 200 ° C 1.5 °C at 250 °C, <0.5 °C at 300 °C and above	0.5 °C	0.5 °C
Sealing:	IP65				
Response Time:	Adjustable 15 ms to 10 s	Adjustable 15 ms to 10 s	Adjustable 15 ms to 10 s	Adjustable 1ms to 10 s	10 ms to 10 s
Analogue I/O:	Two 4-20 mA outputs, One 4-20 mA input, Contact closure input, Relay output				
Communications:	EtherNet/IP, REST API, Modbus TCP/IP, web server				
Processing Functions:	Peak/Valley Picking, Averager, Modemaster, CMD In sampling or LED control, CMD Out alarms, emissivity output or actuator control				
Power Req.:	Power over Ethernet or 19 to 30 V DC at the instrument; 8 W max consumption				
Software:	Live configuration and temperature display on any web browser. Optional SPOTPro or IMAGEPro software with datalogging, live and historical data trending, plus remote image capture, control of multiple instruments (image capture not available on fiber-optic versions)				
Languages:	Integrated multiple language selections: English, German, French, Italian, Spanish, Portuguese (Brazilian), Japanese, Chinese (simplified Mandarin), Korean, Russian, Polish				
Ambient Temp. Range:	5 - 60 °C / 41 - 140 °F specified, 0 - 70 °C / 32 - 158 °F operating before cooling required	0 - 45 °C / 32 - 113 °F operating before cooling required	5 - 60 °C / 41 - 140 °F specified, 0 - 70 °C / 32 - 158 °F operating before cooling required	5 - 60 °C / 41 - 140°F specified, 0 - 70°C / 32 - 158 °F operating before cooling required	5 - 60 °C / 41 - 140°F specified, 0 - 70°C / 32 - 158 °F operating before cooling required
Warranty:	See our website at www.ametek-land.com for warranty details				

* Patent Number GB2497609

7 COOLING AND PURGING REQUIREMENTS

A range of accessories are available for the SPOT+ and SPOT pyrometers. For more information please see www.ametek-land.com/spot and the SPOT Mountings and Accessories brochure.

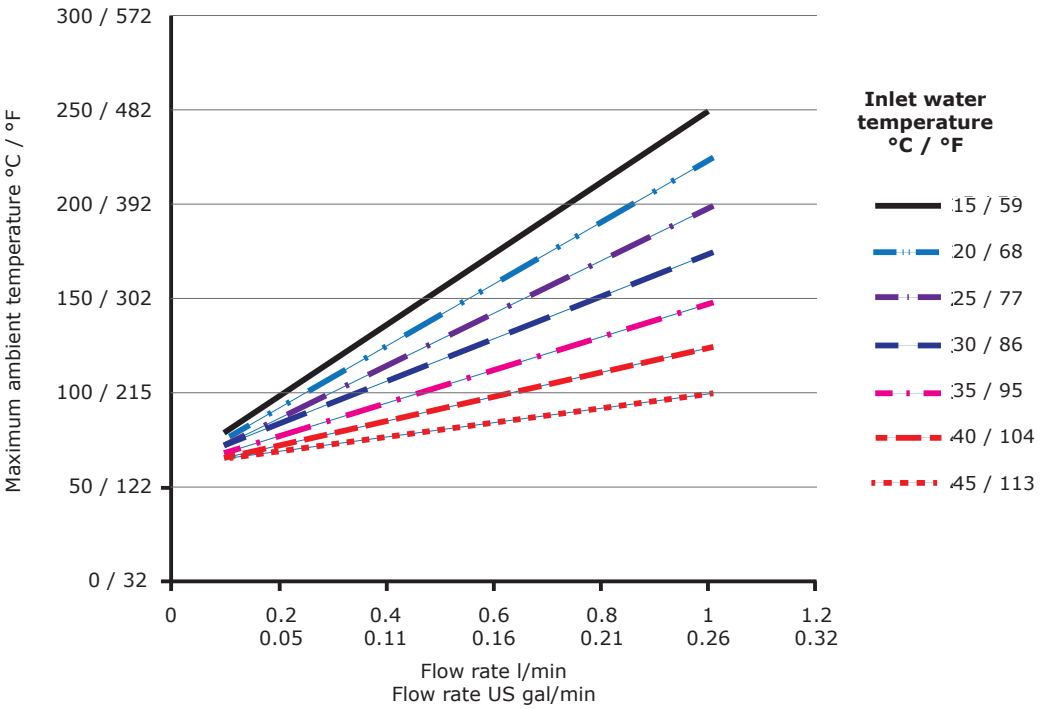
When the SPOT+ is used with the Sealed to Process Water Cooled Mounting the following specifications apply.

7.1 Recommended limits

Water pressure (maximum)	6 bar
Water flow rate	1 litre per min / 0.26 US gal per min
Air pressure (maximum)	3 bar
Air flow rate	60 litre per min / 2.1 cfm
Inlet water temperature	15 to 45 °C / 59 to 113 °F
Outlet water temperature	20 to 50 °C / 68 to 122 °F

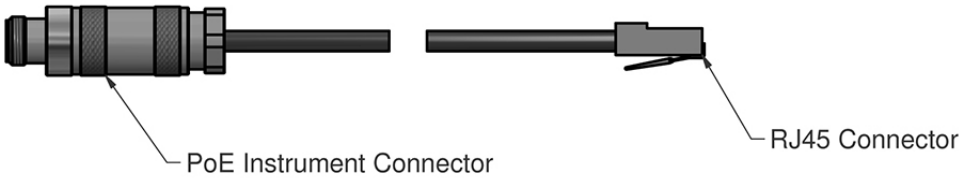
7.2 Maximum ambient temperature

The maximum ambient temperature depends on water inlet temperature and flow rate (See Fig. 2-1).



8 CABLE AND INSTALLATION DRAWINGS

Digital Cable

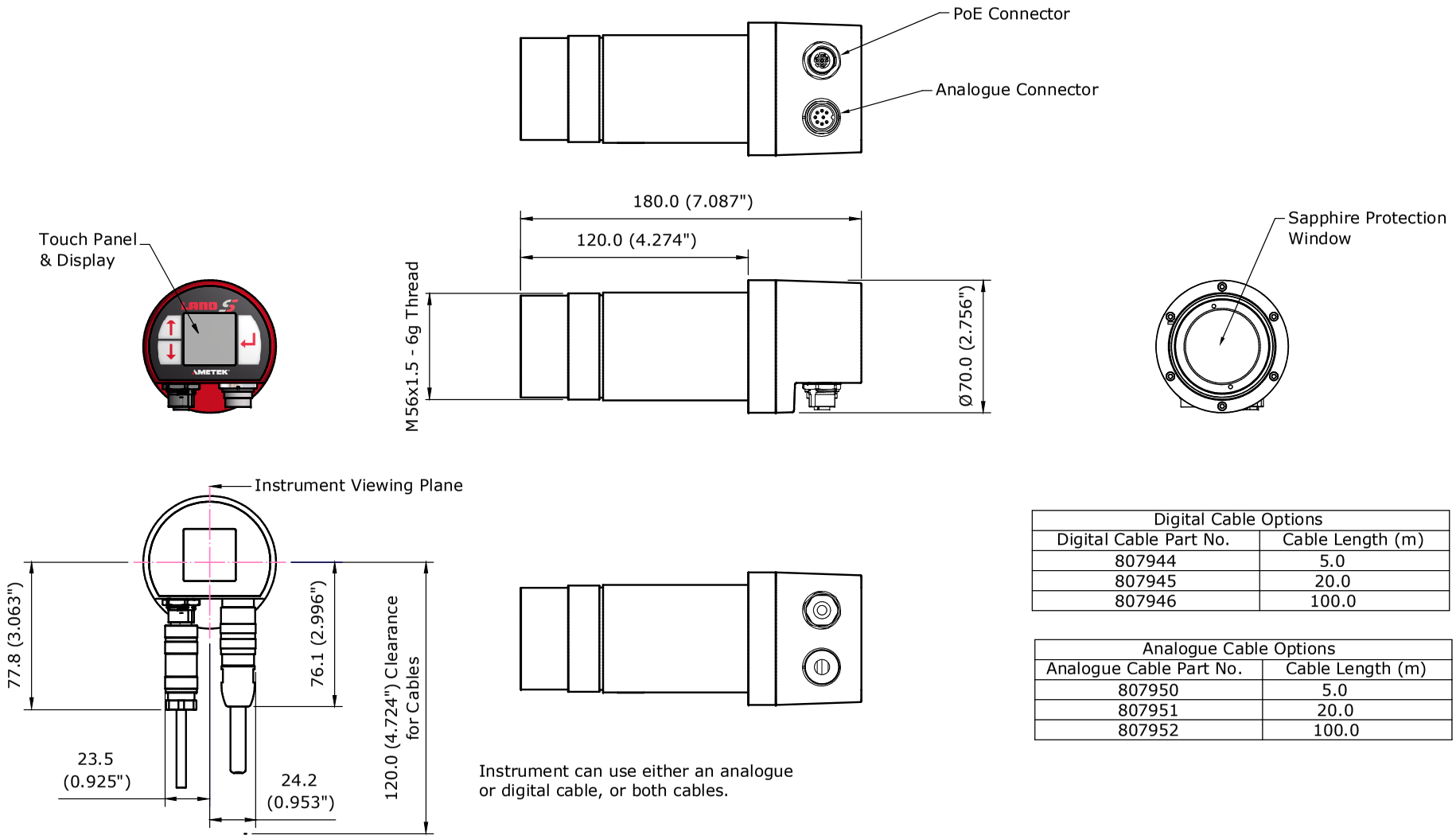


Digital Cable Part Nº	Cable length
807944	5 m / 16 ft 5 in
807945	20 m / 65 ft 7 in
807946	100 m / 328 ft

Analogue Cable

Analogue Cable Part Nº	Cable length
807950	5 m / 16 ft 5 in
807951	20 m / 65 ft 7 in
807952	100 m / 328 ft

Wire Colour	Pin Out
Red	+24V
Black	0V
Brown	+mA Out1
Blue	-mA Out1
Purple	Relay / +mA Out2
Green	Relay / -mA Out2
Yellow	Trigger in+ / +mA In
White	Trigger in- / -mA In
Screen	Screen



Digital Cable Options	
Digital Cable Part No.	Cable Length (m)
807944	5.0
807945	20.0
807946	100.0

Analogue Cable Options	
Analogue Cable Part No.	Cable Length (m)
807950	5.0
807951	20.0
807952	100.0

Fig. 8-1 SPOT+ Thermometer Installation Dimensions (*standard bodied thermometer)

** Fibre-optic thermometer dimensions are given in section 2-3*

1. Slide instrument through mounting bracket until body touches back of bracket.
2. Lock in position using lock nut, ensuring cable exit points are vertical to the viewing plane (otherwise the view through the camera will be skewed).

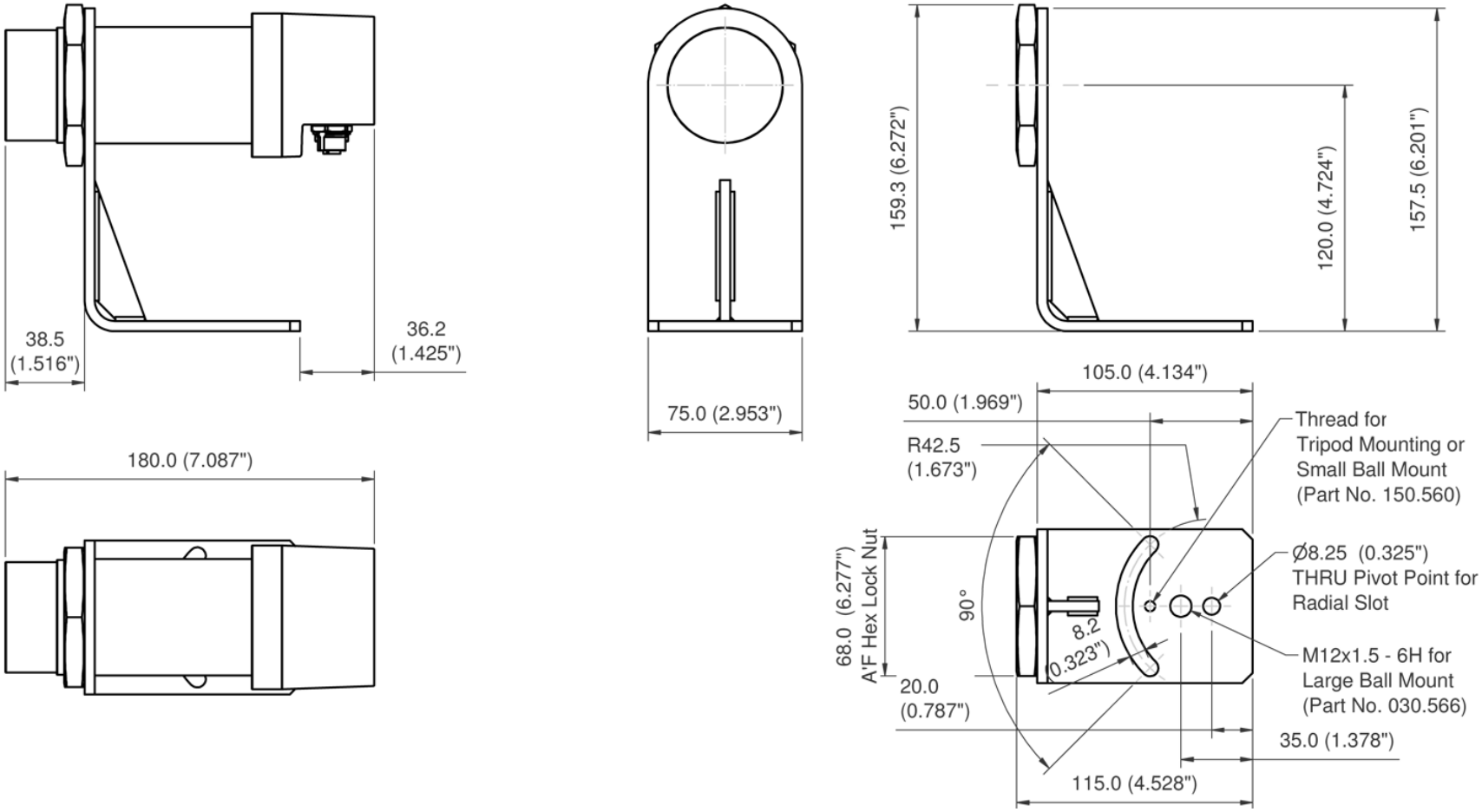


Fig. 8-2 SPOT Angle bracket Installation Dimensions

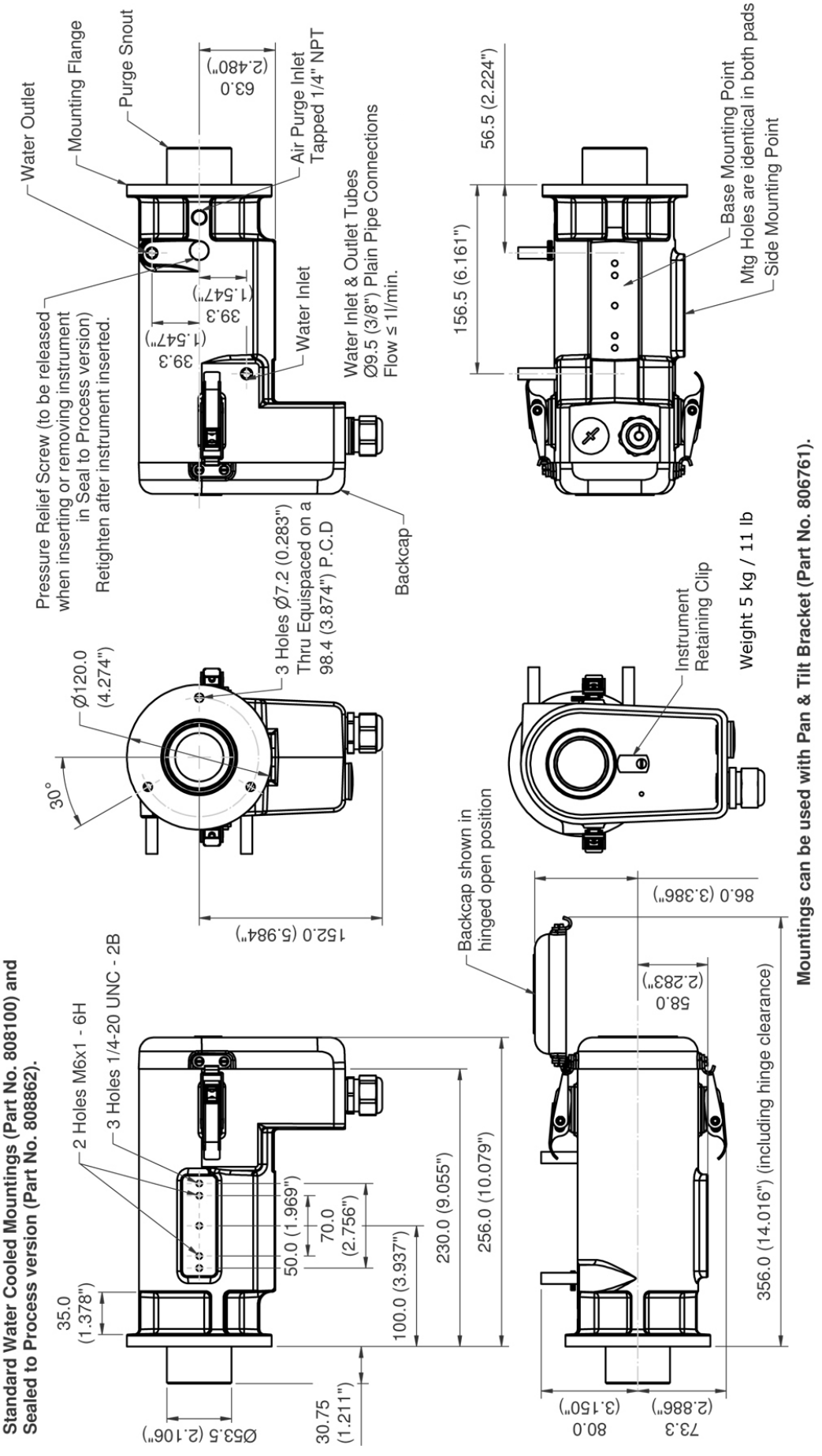
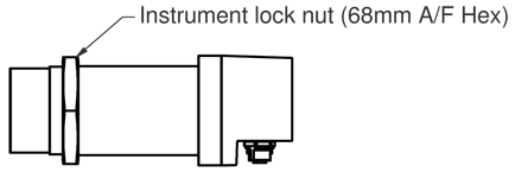
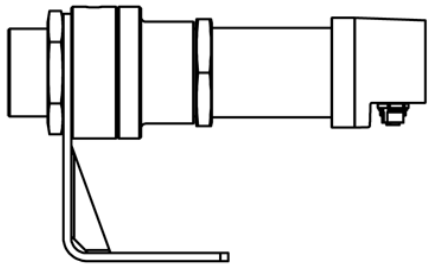


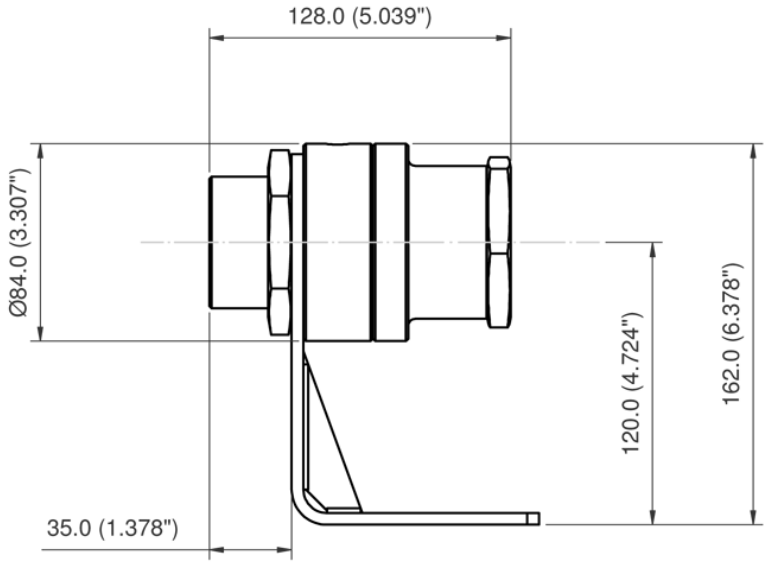
Fig. 8-3 SPOT Water Cooled Jacket Installation Dimensions

Stage 1 - Screw loose lock nut along thread of instrument.



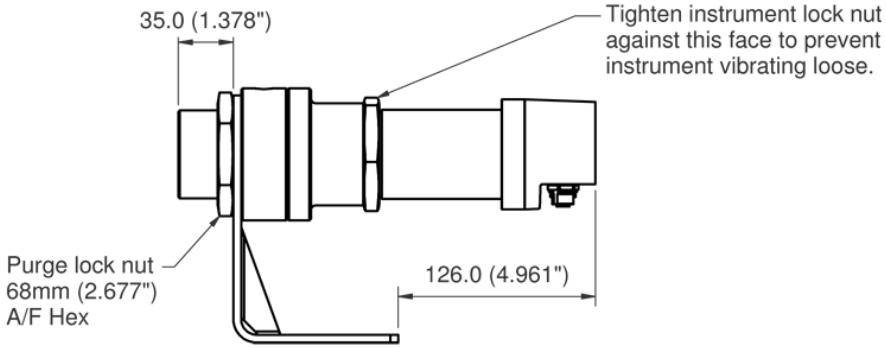
Stage 2 - Screw instrument into light purge unit.





See Sheet 3 for Mounting Bracket Details

Stage 3 - Loosen purge lock nut & twist instrument until cable exit points are vertical to the viewing plane. Tighten purge lock nut. Tighten instrument lock nut against rear face of purge.



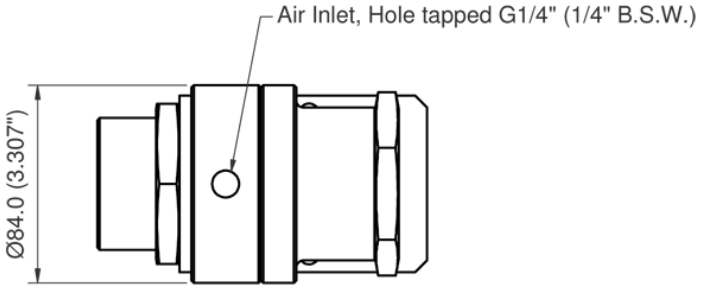


Fig. 8-4 SPOT Light Purge Installation Dimensions

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