

THERMOCOUPLES VS CYCLOPS L PORTABLE PYROMETERS

FREQUENTLY ASKED QUESTIONS AND OTHER INFORMATION

Thermocouples are commonly used for temperature measurement in metal manufacturing, supporting quality during liquid metal applications. However, they lack precision, and the need to regularly replace thermocouple tips can be a significant ongoing cost. Using a portable pyrometer such as the Cyclops L delivers a faster, more accurate reading, has no consumables, eliminates the time spent replacing tips, and increases safety for operators.

In this document, we look at the benefits and drawbacks of the two solutions, and answer some of the most common questions about the Cyclops L in liquid metal applications.



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COMPARING THERMOCOUPLES WITH PORTABLE PYROMETERS

There are several different types of thermocouples, and the temperature range and accuracy depend on the type being used. For example, Type R/S thermocouples have a temperature range of 540°C to +1750°C. Accuracy can vary from $\pm 1.5^\circ\text{C}$ to $\pm 2.5^\circ\text{C}$.

The lifespan of a thermocouple depends on the type being used and the conditions in which it is used. In general, thermocouples can last for several years if they are properly maintained and used in a suitable environment.

To maintain thermocouples, it is important to keep them clean and free of dust and debris, to avoid bending or twisting the wires, and to store them properly when not in use. It is also important to regularly check and calibrate the thermocouples to ensure that they are providing accurate temperature measurements.

Thermocouples are often used to make temperature measurements by dipping them into the liquid metal. This delivers an average temperature for the liquid metal within a few seconds. However, this measurement is typically performed manually and requires the operator to be very close to the hot, dirty, and smoky atmosphere, creating a safety hazard.

Additionally, the thermocouple readings are likely to be inconsistent – two or three different thermocouple measurements are likely to produce two or three different results – so accuracy will be an issue.

A further disadvantage of this technique is that the dipping tips for each thermocouple need to be replaced after one or two measurements, so there is a continual consumption of these tips and an ongoing cost.



The temperature range and accuracy of a portable radiation thermometer (*pyrometer*) also vary depending on the specific device. Typically, they have a range of -20°C to $+2000^\circ\text{C}$ or higher, and an accuracy of $\pm 1\%$ to $\pm 2\%$ of the measured temperature, and can operate effectively for several years if they are properly maintained and used in a suitable environment.

Non-contact measurements of the liquid metal can be taken on the surface of the metal or on the metal pouring/tapping stream using a handheld portable pyrometer.

Portable radiation thermometers must be kept clean and free of dust and debris, not exposed to extreme temperatures, and stored properly when not in use. It is also important to regularly check and calibrate the device to ensure that it is providing accurate temperature measurements.

Portable radiation thermometers are typically easy to use, by pointing the device at the object whose temperature is to be measured, and then taking a reading. For the Cyclops L, this is accomplished by a simple trigger pull.

The Cyclops 055L model is designed for liquid metal applications, and takes a fast non-contact measurement, within a second or two. The operator can be positioned five or six metres away from the molten metal, increasing safety and reducing risk.

Four simultaneous modes are available, including Continuous, Peak, Valley, and Meltmaster, to meet specific requirements, providing highly accurate measurements of liquid metal temperatures in the range of 1,000 to 2,000 °C (1,832 to 3,632 °F), with high repeatability.

Precision sighting is ensured by the clear, wide-angle field of view and small, clearly defined measurement area. A single device can store up to 9,999 readings, and the Cyclops 055L can be used continuously throughout the pouring process.

THERMOCOUPLES

Working on the principle of the thermoelectric effect, a thermocouple is a temperature sensor consisting of two dissimilar metal wires that are joined at one end. When the junction of the two wires is heated or cooled, a small electrical voltage is generated which can be measured and used to determine the temperature of the junction.

Thermocouple Advantages:

Thermocouples are highly accurate across a wide temperature range and offer a fast response time. Rugged and durable, they have a low cost of ownership and can be used in harsh environments and inaccessible areas. They are immune to electromagnetic interference and can be used for both contact and non-contact temperature measurements.

Thermocouple Disadvantages:

Thermocouples require a reference junction at a known temperature, and have limited accuracy at very high temperatures. They can be affected by several factors, including electromotive force interference, thermal gradients, ageing, lead wire resistance, lead wire insulation resistance, wire type and size, and by self-heating when measuring high temperatures. Thermocouples are often installed at a large distance from the measuring device, increasing the prospect of errors in the result. Additionally, dip thermocouples used in liquid metal measurement require regular tip replacement, increasing maintenance and the cost of consumables, and requiring personnel to get close to the process.

PORTABLE OPTICAL PYROMETERS

This temperature sensor detects the thermal radiation emitted by the object and uses that information to determine the object's temperature. This typically involves measuring the intensity of the radiation at different wavelengths. It is a non-contact device, so unlike a thermocouple it does not need to physically touch the object being measured.

Portable Pyrometer Advantages:

Portable radiation thermometers use a non-contact measurement from a safe distance, so are less likely to be damaged by the liquid metal or expose operators to risk. They have a fast response time, wide temperature range measurement, and the ability to measure temperature in inaccessible areas.

Portable Pyrometer Disadvantages:

Portable pyrometers need to have a clear line of sight to the object being measured and can be affected by dust, smoke, steam, or other gases in the environment. They also need to account for the emissivity of the surface being measured and can be affected by light conditions – such as reflections – and ambient temperature.



A PROVEN SOLUTION TO REPLACE THERMOCOUPLES

AMETEK Land provides Cyclops 055L handheld portable pyrometers to high-quality metal product manufacturers around the world. These instruments provide liquid metal measurements during the casting process to support metal quality, replacing the role of dip thermocouples, which are expensive to maintain.

Quality plays a pivotal role for these metal product manufacturers, with components created to meet all customer requirements and specifications. This quality depends on reliable and accurate temperature measurements at the foundry stage.

Using dip thermocouples means that operators

experience high costs for maintenance, calibration, and monthly consumables. These have a long measurement time – typically 13-14 seconds – and require an operator to get quite close to the process.

A portable pyrometer solution such as the Cyclops 055L delivers cost savings as well as better measurement accuracy and user safety. This device takes a non-contact measurement in under two seconds and is ergonomically designed for single-handed use.

Customers who switched from using dip thermocouples to the Cyclops 055L saw a rapid return on investment, often within 9-10 months.

“The Cyclops 055L has been easy to use and provides a fast measurement. It is highly accurate, even while pouring, right up to the last mould. Its performance and excellent return on our investment means we would certainly recommend AMETEK Land for this application.”

Shri Dhirubhai Patel, Managing Director at DN Castech

“Using the Cyclops 055L has significantly reduced the amount we spend on thermocouple tip replacements each month. The instruments are easy to use, provide fast, accurate measurements, and increased safety for the user. We definitely recommend AMETEK Land, both for their liquid metal measurement solution, and for the expert support they have provided.”

Puneet Vinayak, Director at Amar Udyog

“AMETEK Land’s Cyclops Meltmaster infrared, noncontact thermometer is a highly effective solution for accurate temperature measurement of molten metal. It provides easy, accurate point-and-measure temperature readings. Since its introduction, our plant has significantly reduced our expenditure on disposable dip-type thermocouples.”

Mr S Kuppusamy, Vice President of PSG Foundries

KEY QUESTIONS ANSWERED

How many combinations of alloys and emissivity values could be adopted?

The Cyclops L user guide provides emissivity values for 43 of the most common alloys, including oxidised versions. In addition, for many applications it is possible to make a practical determination of the required emissivity setting by comparison with a reference measurement such as a thermocouple reading. See page 8 for more details.

The AMETEK Land website offers an easy-to-use Emissivity and Background Correction Calculator to help Cyclops L users find the correct setting for their application.

Is the Cyclops affected by fumes and non-uniform metal surface/boiling conditions?

Obscuration by smoke, dust, and other fumes will drastically reduce any measured values. The Cyclops requires a clear line of sight to accurately measure the surface temperature of the target. However, since it has a simple point-and-measure operation, and the Meltmaster mode processes the data within milliseconds to deliver the real-time metal temperature, it means the operator can pick a moment when the fumes clear to take a rapid reading.

Normally liquid metal surfaces are non-uniform, and they will be oscillating high when the induction furnace power is kept ON in the foundry metal casting conditions. The Cyclops 055L with dedicated Meltmaster mode will collect data and process the final measured temperature value within a fraction of a second. This should be calibrated against dip thermocouple values for the site conditions with respect to matching the grade of the material emissivity. It's a one-time activity for any foundry furnace, ladle, or pouring stream temperature measurement.

Will slag affect the Cyclops' temperature values?

In short, yes. The slag or dross layer affects the

emissivity and the temperature of the metal, making it more difficult to achieve an accurate reading. Additionally, the thicker the slag layer becomes, the lower the surface temperature in comparison to the liquid metal temperature.

This makes it important to look for liquid metal applications where it is possible to view the metal surface where it is nearly or completely free of metal oxide. Automated or manual tapping slag or dross processes, where the liquid metal is poured into moulds, provide one such application. The pyrometer is able to measure the temperature of the liquid tapping stream, which typically has a thin oxide layer – a “pouring skin” – on its surface.

This ensures the temperature being measured is that of the liquid metal, as it runs into the mould to create the final product and is the latest and most exact point to measure the temperature of the liquid metal in the tapping/pouring foundry process before it solidifies.

What is the maximum distance the Cyclops can measure with repeatability?

The Cyclops L's precision reflex optical system provides user-focusable sighting and a precise definition of the target spot. The focus range for the Cyclops 055L is fixed at 5 metres. For other models, the specified focal range is 1m/39.4in to infinity. See page 9 for more details.

What is the temperature range?

- Thermocouple tips R/S type – 500-1750 deg C
- Cyclops 055L 2F – 1000-2000 Deg C (specially designed for liquid metal applications)

What is the accuracy compared with thermocouple tips?

- The Thermocouple tip – accuracy $\pm 2^{\circ}\text{C}$
- The Cyclops 055L 2F calibration accuracy is $\pm 1^{\circ}\text{C}$ - when compared with thermocouple tips the accuracy will be $\pm 3- 5^{\circ}\text{C}$

What is the weight of the Pyrometer?

- Thermocouple tips pyrometer Weight of Lance 2-3 Kg
- Cyclops 055L Weight less than 1 Kg (Portable instrument)

Can the Cyclops 055L be able to withstand foundry conditions?

Yes, it is supplied with a thermal jacket to protect from foundry heat and dust

How does the pyrometer operate?

- Thermocouple tips - Battery operated instrument operates with 6 V batteries (1.2 V*4 Nos)
- Mains operated instrument work with 230v supply with additional lance is connect with compensating cable
- Cyclops 055L 2F-9V Li-ion battery

What is the Calibration frequency?

- Thermocouple tips – It is recommended to calibrate every three months, as it is dipping into the metal, and due to induction in the furnace, the resistance values may change
- Cyclops 055L 2F – This in a non-contact pyrometer that we recommend is calibrated every 12 month

What is the calibration standard certification?

- Thermocouple tips – IPTS 68 or IPTS 48
- Cyclops 055L 2f-ITS-90 – UKAS/ANAB/ NABL Certification

Are any consumables required?

- Thermocouple tips – Yes. Tips are required for each measurement. The tips are a huge yearly cost for any foundry
- Cyclops 055L 2F – No consumable required; it is a one-time investment

What is the warranty of the pyrometer?

- Thermocouple tips – 12 months (only for instrument not for dip type consumable)

- Cyclops 055L 2F – 12 Months

Do the pyrometers require any daily maintenance?

Thermocouple tips:

- Yes. Daily changing of the dip-type tips. The heat transfer in the lance will affect temperature accuracy so there is a need to cool down.
- You will also need to charge the battery operated instrument regularly.
- Cyclops 055L – operates with 9V battery. If the 'battery low' indicates on the menu display, you need to change the battery
- The clear lens should be dust free, and cleaned regularly with a soft cloth
- Use Cyclops with a cross sling

What is the display size?

- Thermocouple tips- Battery operated 1 Inch display and mains operated 4-inch display
- Cyclops 055L 2F – LCD display in Cyclops and Bluetooth 6-inch display

Does the pyrometer have 4.0 communication?

- Thermocouple tips – have limited inbuilt storage facility
- Cyclops 055L 2F – Yes this is available. Inbuilt 10000 readings and real-time data can be transferred to a Bluetooth jumbo display and with an 4-20mA output that can be interfaced with PLC system

What is the display size?

- Thermocouple tips- Battery operated 1 Inch display and mains operated 4-inch display
- Cyclops 055L 2F – LCD display in Cyclops and Bluetooth 6-inch display

Can the pyrometer measure liquid metal temperature in the furnace?

Thermocouple and Cyclops 055L – Yes, it is possible

Can the pyrometer measure liquid metal temperature in the stream?

- Thermocouple – using thermocouple tip will be difficult in the stream
- Cyclops 055L can able to measure in stream at distance 5 mts

How much accurate and reliable is Cyclops compared with a thermocouple tip?

- Cyclops 055L 2F works with 0.55um wavelength specially designed for liquid metal application
- For Cast iron/SG – Melt it uses a master algorithm
- For Steel casting it uses Peak mode

Furnace on condition will affect temperature accuracy?

- Cyclops 055L 2F – basically it is a non-contact pyrometer where the furnace On/Off condition will not affect temperature accuracy
- Thermocouple tips: The dip-type thermocouple is recommended to use in furnaces off condition. If furnace in ON condition due to induction temperature may vary

Is temperature accuracy affected due to fumes in the furnace?

- Thermocouple tips – will work as it is dipping into the metal
- Cyclops 055L 2F – Yes it affects the temperature, as it cannot aim at the clean metal

What is the maximum distance it measures with repeatability?

- Thermocouple tip – As it is a contact type we need to dip it into metal, so there is a need to stand within 1 meter
- Cyclops 055L 2F- can measure 1mt – 5 mt with the same accuracy

Does the slag affect temperature?

- Thermocouple tips – We dip into the metal slag so it will not affect the temperature accuracy
- Cyclops 055L 2F – Yes ,slag will affect the temperature accuracy, as it is non-contact it may absorb slag radiation. We need to measure in clean metal

Does Cyclops 055L have external display?

Yes the Cyclops 055L 2F can be connected with jumbo display and the Bluetooth range 25-30 mts

What is the total measuring time?

- Thermocouple tips – the entire process from inserting the dip-type thermocouple to take the readings may take 11-12 seconds. Tips will take 3-4 seconds to measure the reading
- Cyclops 055L 2F – within 3-4 seconds it measures the temperature. The simple trigger measures within 1-2 seconds

How much time is needed to press the trigger switch in Cyclops?

- In Melt master Mode, hold for 1 second and release
- In Peak mode hold for 2 seconds, and it will show peak temperature, then release the trigger

Have any Cyclops 055L been supplied to foundries?

- Installation base
- India – 500+ (7+ case studies)
- Turkey- 50+ (1 case study)
- UAE- 30+ installations

CYCLOPS KEY SPECIFICATIONS

| CYCLOPS 055L | |
|---------------------------|---|
| Measurement range | 1000 to 2000 °C / 1832 to 3632 °F |
| Display | 4-digit LCD in viewfinder; external backlit LCD display |
| Measuring modes | Continuous, Peak, Valley and advanced Meltmaster |
| Data logging | 9999 readings and 4 routes internally; Mobile (4GB standard storage) or PC logger software (via Bluetooth® or USB connector) |
| Data logging modes | Classic, Burst, Latched, Route |
| Optical system | 9° field of view; eyepiece adjustable -3.75 to +2.5 diopters |
| Focusing range | Fixed focus, nominally at 5 m / 197 in. from thermometer body datum |
| Minimum target size | Parallel 28 mm / 1.1 in target spot diameter from lens to 5 m / 197 in |
| Spectral response | Nominally 0.55 µm |
| Emissivity adjustment | 0.10 to 1.20 in 0.01 step graduations |
| Response time | 30 ms |
| Display update time | 0.5 s |
| Accuracy | <0.5% (K) of reading |
| Measurement resolution | 0.1 °C / 1 °F |
| Measurement field of view | Fixed Focus |
| Repeatability | <1 °C / 2 °F |
| Operating temp range | 0 to 50 °C / 32 to 122 °F |
| Power requirement | One MN1604 / 6LR61 / PP3 Battery or USB |
| Output | Bluetooth® / USB Connector |
| Weight | 0.83 kg / 1.8 lb. |
| Sealing | IP40 |
| Standard accessories | Lens cap, protection window/filter, battery, wrist strap, USB cable, heat protection jacket |
| Optional accessories | Waterproof carry case, Long eye relief eyepiece |
| Free data-logger software | Available at www.ametek-land.com/products/software/cyclopslogger |

CYCLOPS 055L MELTMASTER MODE

The Cyclops measures and displays the target temperature in four simultaneous measurement types: Peak, Continuous, Average, and Valley. The Cyclops 055L model has an additional Meltmaster processing output, designed for molten metal measurements.

Achieving a valid non-contact temperature measurement on a stream of molten metal is difficult, due to the large, rapid, and random fluctuations that are observed in the radiation emitted from the stream.

These variations occur for several reasons – most notably, cavitation on the stream surface and emission from sparks, both of which lead to

erroneously high readings, whereas obscuration by smoke will drastically reduce any measured values.

The Meltmaster processing function reduces the influence of these fluctuations and provides a valid estimation of the metal stream temperature.

It is set as the default measurement type for a newly supplied Cyclops 055L, so it is the highlighted temperature type on the side display.

The Meltmaster processing function value is displayed internally within the viewfinder, as well as being output via serial communications.



EMISSIVITY MODE

Easily accessed via the menu system, Operator Emissivity Mode allows users to predefine up to four emissivities, and to easily change between them using the up/down arrow keys.

This mode is ideal for users who need to simplify the operation of a Cyclops and lock out the menu system – the display only shows a single temperature value for the pre-selected time processing function.

To obtain accurate temperature measurements,

the emissivity value of the target surface must be known. The Cyclops User Guide contains typical emissivity values of the most commonly measured materials for each thermometer variant.

For some applications, such as metal alloys, it is not possible to specify a fixed emissivity value. In these cases, it is possible to make an in-situ, practical determination of the required emissivity setting by comparison with a reference measurement such as a thermocouple reading.

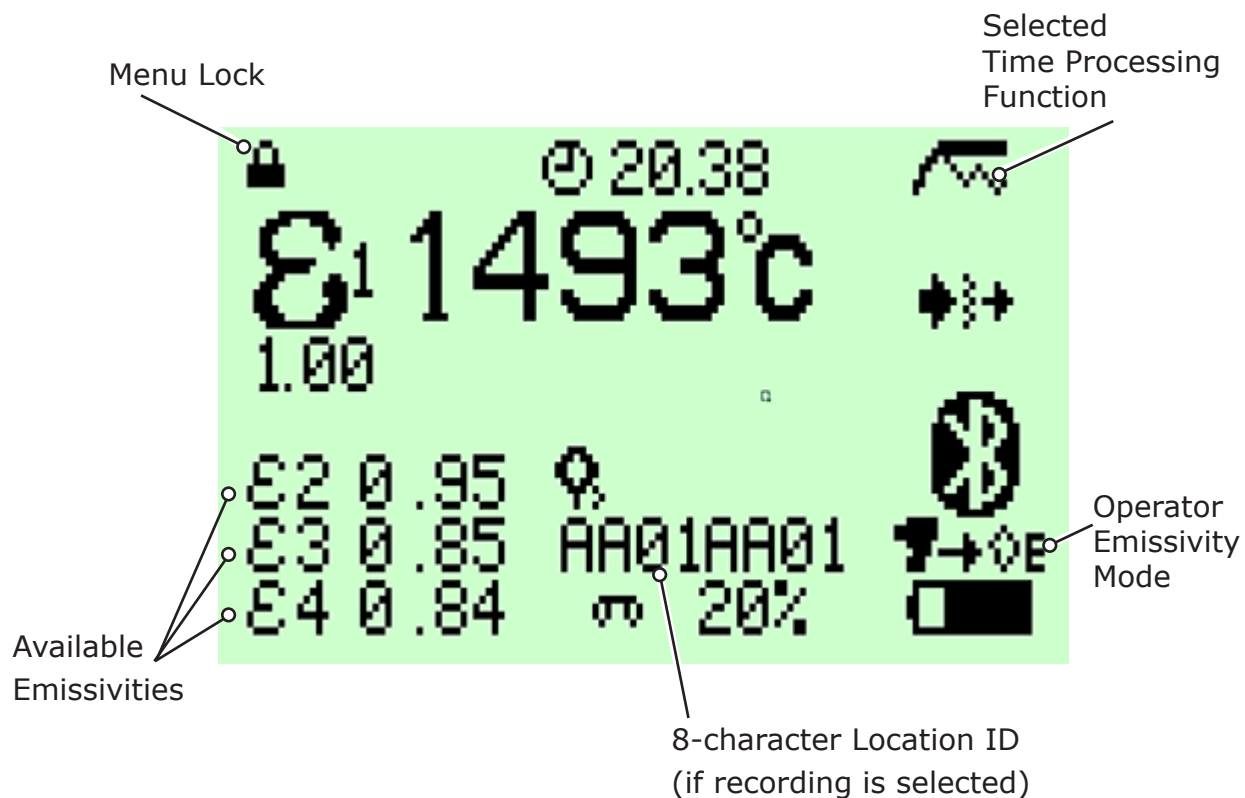


Fig. 1 Typical Operator Emissivity Mode display

EMISSIVITY VALUES FOR CYCLOPS 055L THERMOMETERS

For liquid steels, the emissivity value is typically in the range 0.50 to 0.55. However, this is known to vary slightly with alloy type and will certainly differ for other metals.

The emissivity value may be set relative to a dip thermocouple or other reference measurement by viewing the freshly cleaned surface whilst in the melting furnace. The procedure for obtaining the emissivity value is quick and simple to perform:



1. Sight the Cyclops 055L onto the clean surface of the molten metal, as near to the vertical as possible and press the trigger
2. When the instrument is showing a stable temperature value, obtain a reference reading
3. When the trigger is released, go into 'menu' mode, highlight the 'e' icon, and select it
4. The screen will display the current emissivity value, together with the most recently recorded temperature
5. Adjust the emissivity value up or down until the calculated temperature corresponds as closely as possible with the reference reading
6. Enter the new emissivity value, then return to 'measure' mode – subsequent readings will use the newly set emissivity value

DISTANCE TO SPOT RATIO

The Cyclops 055L has a precision reflex optical system, which provides 'Through The Lens' sighting and gives precise definition of the target spot. The system provides a narrow field of view from the front of the instrument (*180:1 to 98% energy*).

For the Cyclops 100L, 160L and 390L models, the specified focal range is 1m/39.4in to infinity. As the instrument can be focused, an approximate target size can be calculated using the following formula:

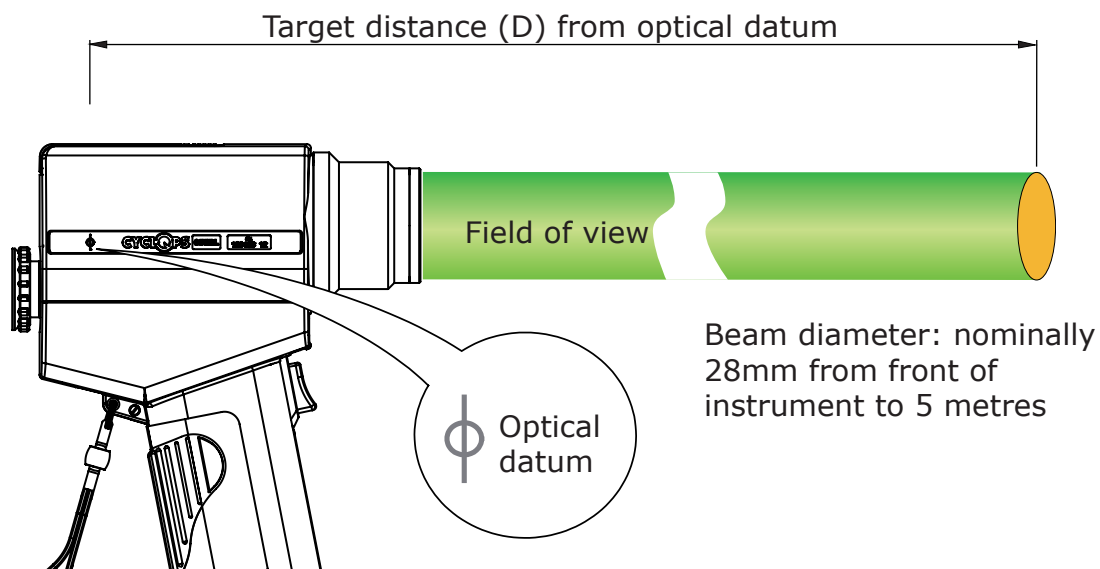


Fig. 2 Cyclops 055L thermometer field of view

Target size (T) (mm) = target distance (D) from optical datum (mm) - 100 field of view (180)
or

Target size (T) (in) = target distance (D) from optical datum (in) - 4 field of view (180)

For the 055L, the focus is fixed at 5 metres. Accurate sighting is ensured by the clear, wide-angle (9°) field of view and small, clearly defined (1/3°) measurement area.

BLUETOOTH JUMBO DISPLAY OPTION

The Cyclops 055L can connect wirelessly to a Bluetooth jumbo display for greater convenience when accessing data.

The Model RPI 10000 BT is a four-inch-high, seven-segment, eight-digit LED display unit which displays instant temperature measurement updates from a connected Cyclops device.

Easy visual validation of temperature data allows for simple quality and process control. By using high and out-of-range readings, operators can manage furnace power to optimise foundry performance and output. The internal data logging of the Cyclops L can be used to provide data validation.

The Cyclops L and LED display unit maintain connectivity for up to approximately 50 metres, so the pyrometer can be used easily throughout the foundry, from the furnace location until the end of the last pouring temperature.

As it is wireless, it removes the trip hazard risk posed by pyrometers with cable connections, helping to prevent accidents. Additionally, there are no costly worn or damaged cables to replace.

The LED display unit is compatible with all Cyclops L models and with easily available 9V Li-ion rechargeable batteries and adapter allows for simple, trouble-free operation. It is also fitted with an audible alarm which triggers when the temperature crosses the configured temperature limit.



Optional features:

- Temperature data storage within LED display unit
- Real-time data acquisition software for remote monitoring and data download via a web browser using IP address
- Integration of temperature data with SCADA systems via 4-20mA output from display unit
- Mobile application for real-time monitoring

SERVICE AND MAINTENANCE



What accessories are available for the Cyclops L pyrometer?

AMETEK Land offers a range of accessories. A heat-resistant jacket is standard on every model to provide protection against excessive heat and dust. A waterproof carry case is available as an optional accessory, or as standard with all Premium Kits. For those wearing protective goggles or a hard hat with face shield,

a Long Eye Relief Eyepiece adapter is available, providing a view when you cannot directly see through the eyepiece. For the C100L and C160L models, close-up lenses are offered for the temperature measurement of small targets at close range.

How frequently should I calibrate my Cyclops L?

The Cyclops thermometer has been designed specifically to require very little maintenance. AMETEK Land's worldwide certification laboratories, which have national accreditation, will calibrate the Cyclops L against the ISO/IEC 17025:2017 standard. This free certification is valid for up to 12 months to give you a guarantee of measurement accuracy.

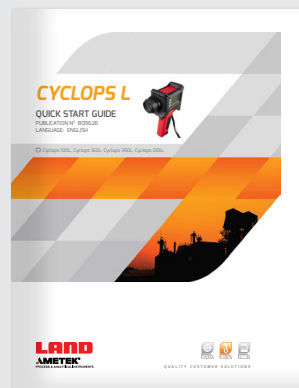
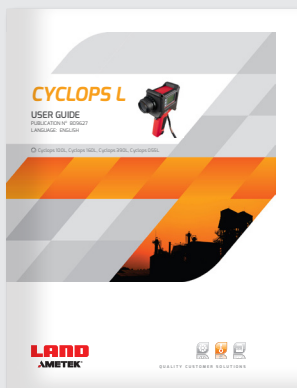
What warranty is available with the Cyclops L?

Due to the high precision craftsmanship that goes into every product, AMETEK Land offers a full back-to-base warranty on all products sold. For the Cyclops L, this is a 12-month warranty that covers against defects in product design or manufacture. To learn more about the warranty offered on your product, please download our warranty document from the AMETEK Land website.

Is local service support available for the Cyclops L?

AMETEK Land's global service network provides unparalleled after-sales services to ensure you get the best performance and value from your AMETEK Land products. Our dedicated service centre teams and on-site engineers are trained to deliver the highest standard of commissioning, maintenance, and after-sales support.

If you're still looking for more information about the Cyclops L range of portable pyrometers, we have extensive resources available to download from the AMETEK Land website:



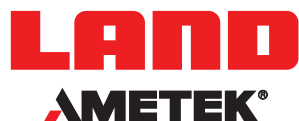
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