AET
AQT

Aluminium Extrusion & Quench Thermometer System

User Guide

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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 the 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 Land Instruments International 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 Land Instruments International.

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 Land Instruments International.

Storage

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

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 done as stated in local regulations.

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For further details on all LAND/Ametek offices, distributors and representatives, please visit our websites.

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. They will be able to advise you on the correct returns procedure.

Any item returned to Land Instruments International 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.

Approvals apply in the USA

This instrument complies with current European directives relating to Electromagnetic Compatibility 89/336/EEC, Low Voltage Directive 73/23/EEC, and ATEX Directive 94/9/EC.

The Quality Management System of Ametek Motors (Shanghai) Co. Limited is approved to ISO9001:2008 for the Design and Manufacturing of Motors and the Manufacturing of Gas Analysers.

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 or pneumatic parts of this system. Such changes may also invalidate the standard terms of warranty.

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Fig. A - ***AET/AQT*** Thermometer with ***LMG AE*** Signal Processor 247001

PART A - Application Notes

A1 AET Measurement Problems and Solutions

The LAND Aluminium Extrusion Thermometer System ***(AET)*** has been developed specifically to provide a highly accurate measure of temperature on a wide range of freshly extruded sections for all common extrusion alloys.

The low surface emissivity value of fresh aluminium is well understood, however, the measurement problems lie not only with the low radiant power emission, but also in the high level of reflectivity for stray radiation from other sources.

Whilst it is impractical to try to eliminate these problems completely, it is relatively simple to reduce them to such an extent that their effect upon the measurement is minimal.

The following sections attempt to explain the various sources of error and how to avoid or reduce them to insignificant levels.

The ***AET*** utilises a variety of techniques within the measurement algorithm to compensate automatically for unfilled targets, (e.g. for narrow sections or multicavity dies), cavitous sections (which give rise to emissivity enhancement by multiple reflections) and variations of alloy type.

In addition to the above, the user is also provided with additional settings which may be required for very occasional use, to deal with hard alloys (e.g. 5XXX series) or abnormally cavitous sections such as finned heat exchangers.

Once additional settings have been deduced for these unusual conditions, they may be used repeatedly when required, and are implemented very quickly and easily, either from the front keypad of the ***LMG AE*** processor unit or, more conveniently, by RS232C serial communications from a PC. To facilitate this, a simple program is provided on diskette.

Manually or electronically controlled quick-adjust mountings allow for rapid, small changes of target position to deal with widely-spaced multi-cavity dies, the required alignment being shown quite readily by the ***LMG AE*** processor's effective emissivity indication (measured mean ε value within the target area). This indication of the strength of the infrared energy 'signal' detected by the thermometer also provides the press operator with valuable information as a progressively rising value indicates a deteriorating surface roughness and thus die wear.

Measurement problems encountered are:

- Unfilled target area
- Pick-up by reflection - especially daylight
- Direct pick-up from parasitic sources
- Die cavity changes
- Temperature (and emissivity) variations on large sections

A1.1 Response to Partially Filled Targets

The ***AET*** is capable of measuring accurately even when the target area is only partially filled. It should be obvious however that the detection system does require sufficient radiant input to produce the stable signal levels required for the measurement algorithm. As the natural flat surface value for soft alloys is around 0.08, it is recommended that at least 50% target filling is ensured. The effective emissivity value as displayed on the signal processor front panel (which is a measure of the actual surface value x fractional target filling) should thus be maintained at $\geq$0.04 for reliable measurement.

Unless measurement is being attempted on a very small section, a low value usually indicates that a small correction of alignment is required for the thermometer head, which can be achieved very quickly using either the quick adjust ***AET*** mounting as shown in Fig. A1 or the ***AET*** Actuator.

A very low value of effective emissivity (less than 0.01 at typical extrusion temperatures) is indicated by a flashing temperature display on the processor.

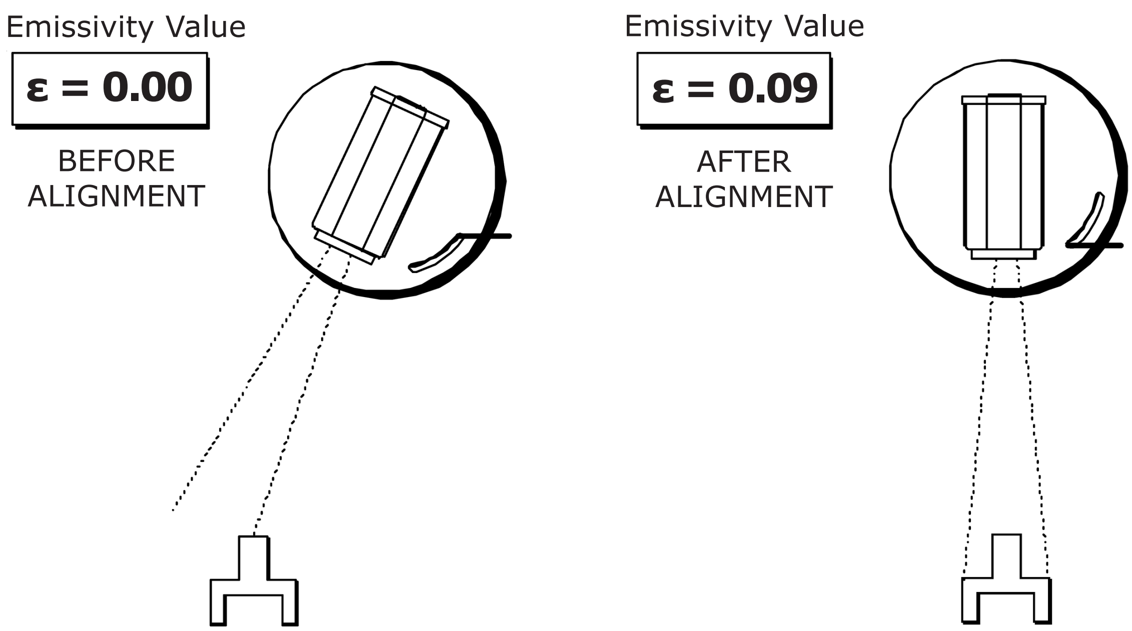


Fig. A1 - Using the Quick-adjust Mount

247002

A1.2 Pick-up of Stray Radiation by Reflection

The inherent low emissivity of all fresh aluminium surfaces means that they are also excellent reflectors, even more so in the infrared than the visible.

The thermometer head will thus detect not only radiation being emitted by the target surface but also that being reflected by it. Providing such reflections are from relatively cool objects (say <100°C/212°F) they present such minute amounts of radiant power as to give insignificant errors of measurement. Conversely however, reflections from hot objects will give errors and for very hot, bright sources could even swamp the radiant power from the aluminium surface.

The most serious source of error is often from solar radiation (i.e. the infrared component in daylight); either direct reflections of the sun or of bright, white clouds. Other strong sources are bright bulbs (often used for tunnel inspection or roof lights), high pressure sodium vapour lamps (factory lighting) and radiant heaters.

It is wrong to assume that, just because stray reflections are not a problem for one particular section, this will be true in general. Very cavitous sections will tend to be less affected, whereas a convex or cylindrical surface viewed by the thermometer may reflect radiation from over a very wide range of angles, as shown in Fig. A2.

Most of these can be overcome very easily. Ensure that tunnel inspection lamps are switched off during the run cycle and for roof daylight panels or lamps a simple lightweight overhead screen providing a shaded target area will suffice.

One method that has been successfully employed is illustrated in Fig. A3. Here the thermometer viewing axis is deliberately angled towards the tunnel so that the target lies just inside and thus in a shaded area. This method can only be used for presses with a considerable length (>2m/6.56ft) between the die face and the tunnel exit as the die is also very hot (and high emissivity) and the thermometer can easily pick up reflections from it.

In general, it is recommended that the thermometer optical axis is inclined slightly inwards towards the tunnel, rather than away from it, as this minimises the possibility of picking up stray radiation from roof lights and daylight sources.

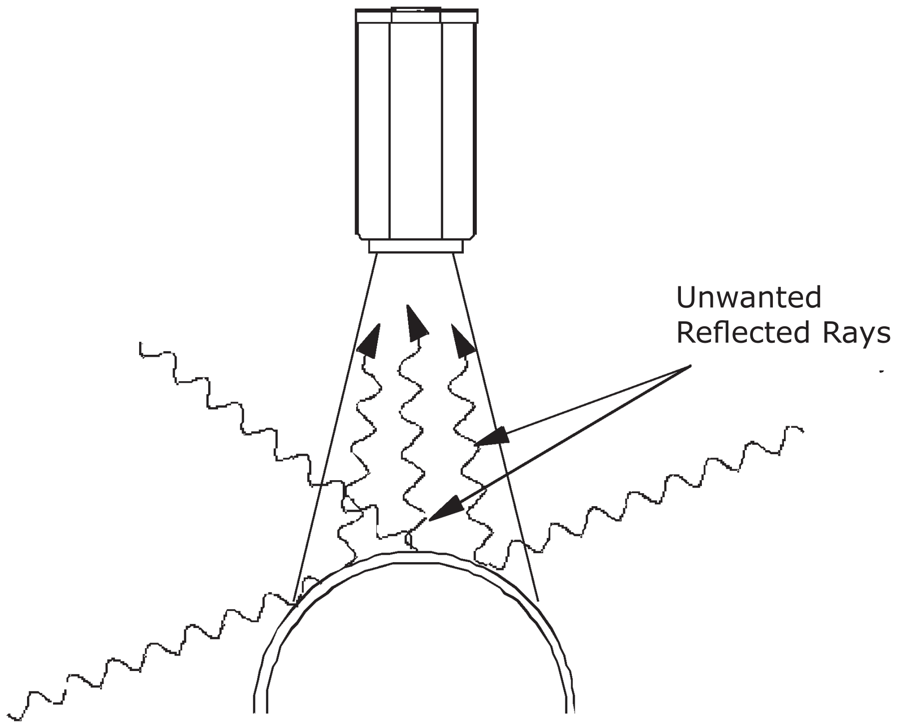


Fig. A2 - Reflection of Radiation on a Cylindrical Surface 247003

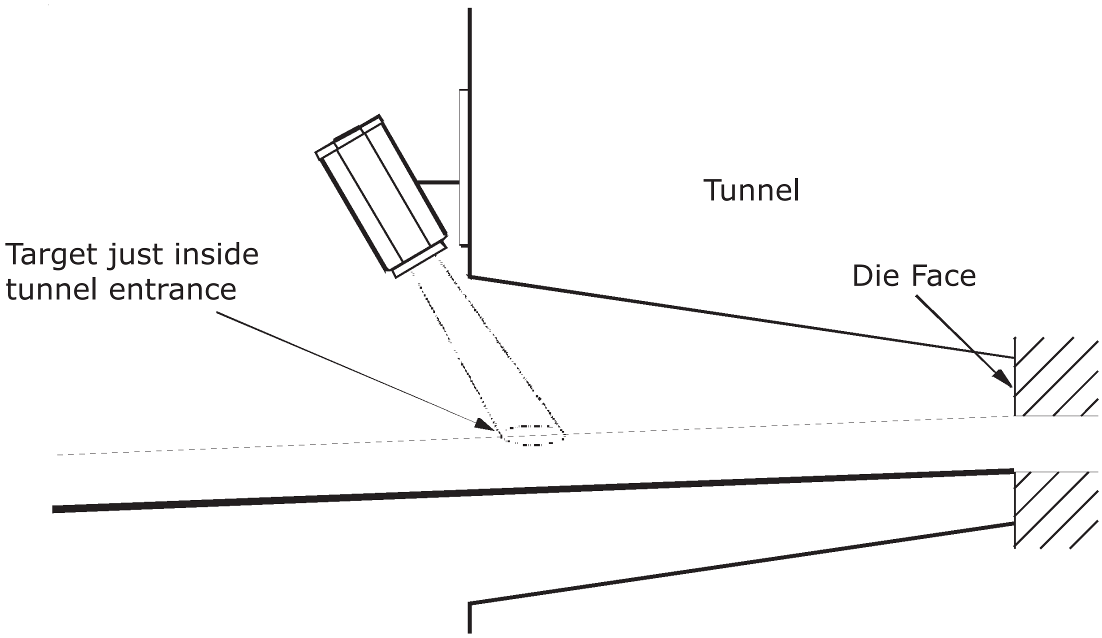


Fig. A3 - Sighting the Thermometer into the Tunnel Exit 247004

A1.3 Direct Pick-up from Parasitic Sources

Most extrusion presses use graphite blocks or rollers to support the sections as they emerge from the tunnel and sometimes also for horizontal “steering” or separation.

Being an excellent conductor of heat these blocks quickly become very hot throughout and are highly emissive. (Note a 300°C/572°F graphite block emits almost as much radiant power as 520°C/968°F aluminium). It is therefore very important that the initial alignment looks at a target area which is well clear of all graphite blocks or any other hot objects, see Fig. A4.

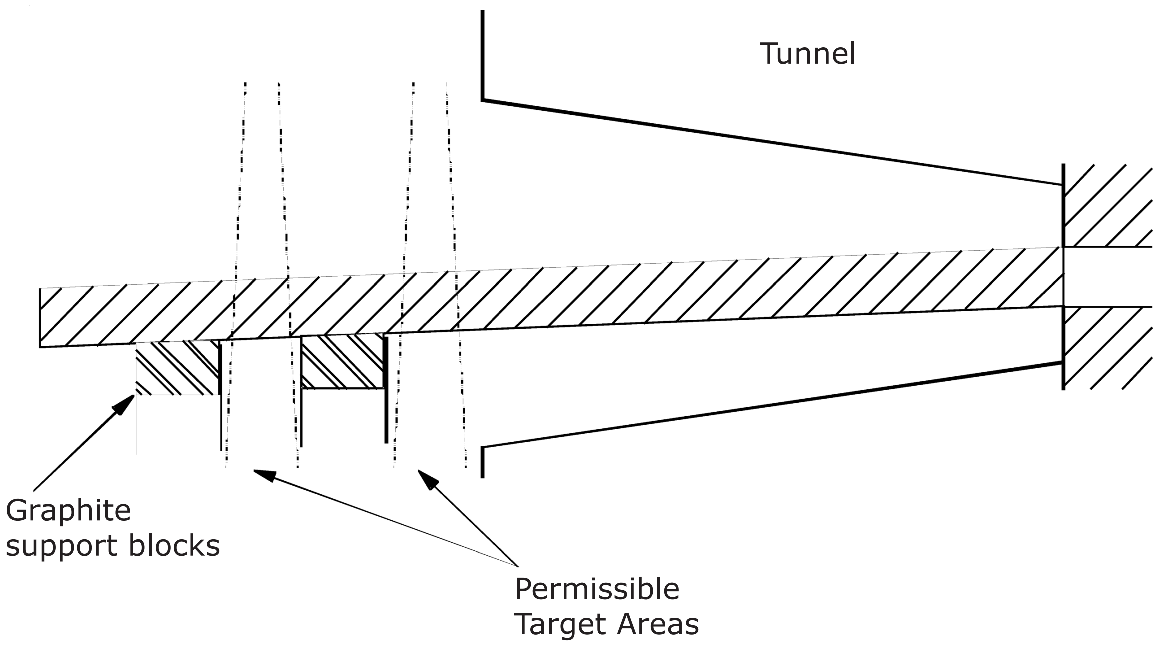


Fig. A4 - Sighting the Thermometer to Avoid Unwanted Sources of Radiation 247005

A1.4 Die Cavity Changes

Single cavity dies are usually well centered on the press mechanical axis, however, some multi-cavity dies (especially 2 cavity) exhibit a wide spacing between the sections. This means that the thermometer may be receiving radiation from only a small fraction of the available target area thus giving rise to measurement errors.

This situation is illustrated in Fig. A5. Using the ***AET***, it will be immediately apparent as the effective emissivity indication will be showing an extremely low, or zero, value.

The quick adjust mounting or actuator should then be altered until a much higher effective emissivity is indicated, implying that at least one strand is now filling a large portion of the target.

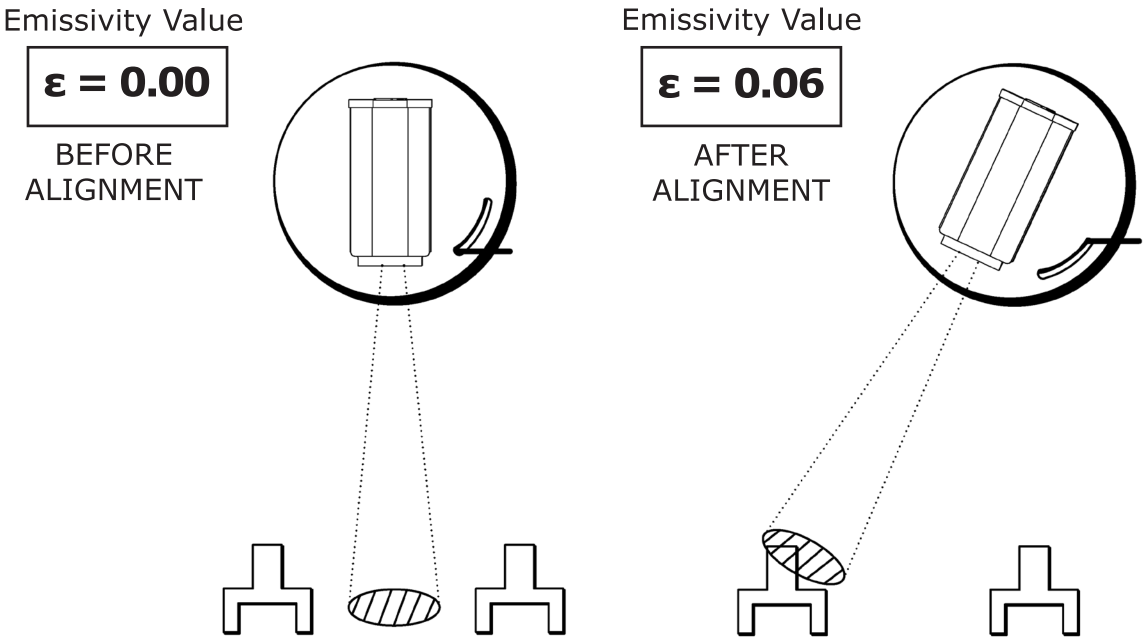


Fig. A5 - Using the Quick-adjust Mount on Multi-cavity Dies 247006

A1.5 Temperature and Emissivity Variations on Larger Sections

Large, or asymmetric, sections can exhibit considerable variations of temperature. Tests have shown up to 30°C/86°F differentials either side to side, or centre to side, due to the effect of shape upon their ability to cool. Fig. A6 illustrates this.

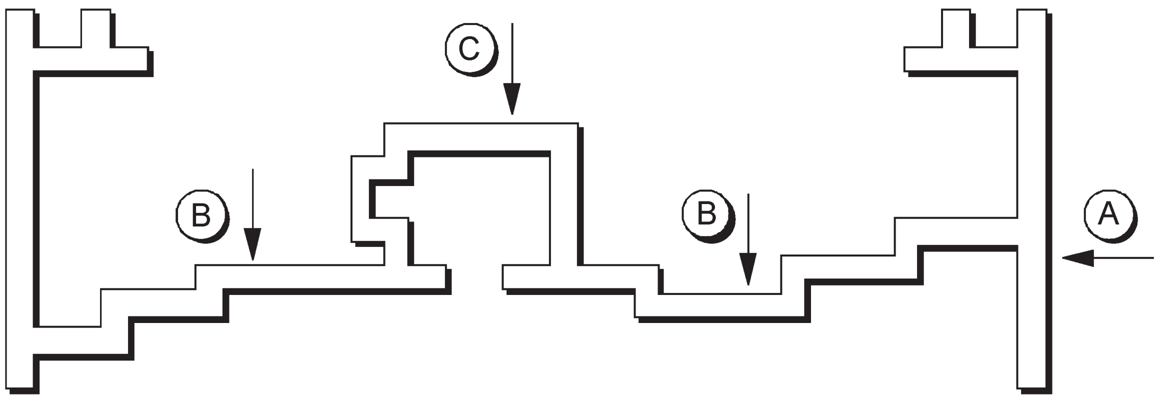
Where the width of the extrusion is larger than the quoted target diameter the press operator thus has some flexibility in his measurement point by use of the quick-adjust mounting or actuator and using the effective emissivity display to indicate the edges of the section where the signal will fall to zero very rapidly.

Where non isothermal sections move laterally within the field of view some change of temperature output will be seen dependant upon positions of such “hot-spots” within the target. In Fig. A6, for example, a maximum temperature output will be seen when the area labelled ‘C’ is near the centre of the target: if the section moves sideways then one of the two areas labelled ‘B’ will tend to fill the target and the reading will fall slightly.

It is also useful to understand the effect of shape on the effective emissivity value. A fresh aluminium surface exiting a die and fully filling the target will show an ε value of around 0.08. If the die wears and definite small ridges can be seen, this value will rise slightly to perhaps 0.10 or 0.12. A gently rising value thus becomes a good indicator of die wear.

Sections which are ‘folded’ round to form channels and boxes will also show much higher emissivity values, generally the deeper the channel, or more enclosed, the higher the value. This effect is caused by the target surface reflecting additional radiation from other parts of the structure which would otherwise not have been directed into the thermometer. Fig. A7 illustrates this.

Because of this effect, different parts of a larger section may show different effective emissivities as illustrated in Fig. A8. This type of information may be used to advantage by press operators wanting to monitor one particular region of the whole section.



KEY:

A : Open, flat surface = coolest

B : Fairly open surface with slight heat trapping by channel = slightly hotter than A

C : Enclosed surface with little cooling from inside = hotter than A or B

Fig. A6 - Variation of Temperature Across an Asymmetric Profile 247007

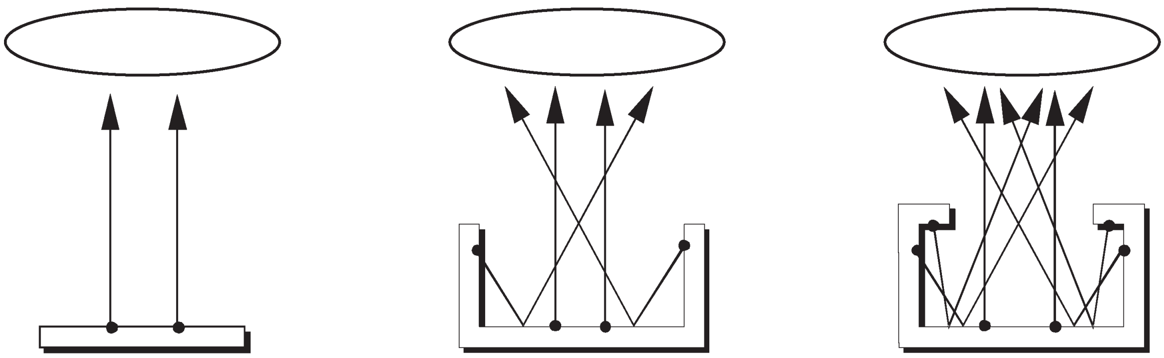


Fig. A7 - Effect of Profile Shape on Reflections 247008

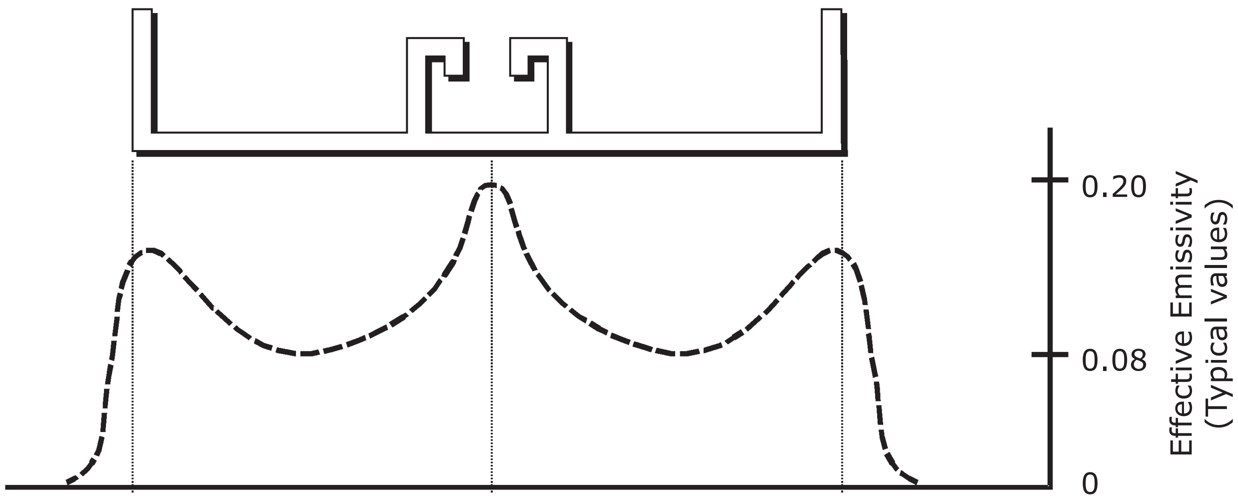


Fig. A8 - Effect of Profile Cross Section on Effective Emissivity 247009

A1.6 Highly Cavitated Sections

The Algorithm used by the ***AET*** is extremely robust and deals very effectively with the vast majority of surface forms.

There are however, occasional forms for which the calculation is slightly less precise without additional input. The most common example of this is very deeply “finned” sections (e.g. heat exchangers) when being viewed into the cavities formed between fins. When the depth of the channels is large compared to the width, large numbers of multiple reflections may be detected giving rise to effective emissivities of 5 to 10 times the normal surface value. Under these circumstances an additional trim may be required using parameter H4.

For this type of highly cavitated section, the value of H4 should be reduced from zero. The effect on the readout (at typical extrusion temperatures) ranges from about +1°C per unit decrease of H4, at effective emissivity of 0.2, to nearly +2°C per unit at effective emissivities of around 0.4.

The required value of H4 should be determined experimentally by comparison against the ***AET*** calibration unit and once found, should be used every time that similar sections are being extruded. The value of H4 should always be returned to zero (the factory setting), for viewing ‘normally’ cavitated surface.

A1.7 Unusual Alloys

The algorithm used by the ***AET*** has been set-up specifically for dealing with the 1000, 6000 and similar soft alloys which form the great bulk of commercial extrusions.

If any high magnesium or very “unusual” alloys are being extruded then a trim may be required to parameter H5 in order to obtain the required accuracy.

For the 5000 series and any similar alloys, for which the natural flat surface emissivity value is considerably higher (i.e. typically double that of soft alloys), the value of H5 should be raised from zero. The effect on the readout (at typical extrusion temperatures) is about -2°C per unit increase of H5.

The value of H5 should be determined experimentally by comparison against the ***AET*** calibration unit and once found, should be used for all sections using that alloy type. The value of H5 should always be returned to zero, (the factory setting), for use on soft alloys.

A2 AQT Measurement Problems and Solutions

The LAND Aluminium Quench Thermometer System (***AQT***) has been developed specifically to provide a highly accurate measure of temperature on a wide range of freshly extruded sections for all common extrusion alloys.

It is well known that the surface emissivity value of fresh Aluminium is low; however, the measurement problems lie not only with the low radiant power emission, but also in the high level of reflectivity for stray radiation from other sources.

Whilst it is impractical to try to eliminate these problems completely, it is possible to reduce them to such an extent that their effect upon the measurement is minimal.

The following sections attempt to explain the various sources of error and how to avoid or reduce them to insignificant levels.

The ***AQT*** utilises a variety of techniques within the measurement algorithm to compensate automatically for unfilled targets, (e.g. for narrow sections or multicavity dies), cavitous sections (which give rise to emissivity enhancement by multiple reflections) and variations of alloy type.

In addition to the above, the user is also provided with additional settings which may be required for very occasional use, to deal with hard alloys (e.g. 5XXX series) or abnormally cavitous sections such as finned heat exchangers.

Once additional settings have been deduced for these unusual conditions, they may be used repeatedly when required, and are implemented very quickly and easily, either from the front keypad of the **LMG AE** processor unit or, more conveniently, by RS232C serial communications from a PC. To facilitate this a simple program is provided on diskette.

Manually or electronically controlled quick-adjust mountings allow for rapid, small changes of target position to deal with widely-spaced multi-cavity dies, the required alignment being shown quite readily by the **LMG AE** processor's effective emissivity indication (measured mean ε value within the target area). This indication of the strength of the infrared energy 'signal' detected by the thermometer also provides the press operator with valuable information as a progressively rising value indicates a deteriorating surface roughness and thus die wear.

The ***AQT*** system has been developed specifically to allow stable and accurate measurement at the lower temperatures that occur on sections exiting a water or high velocity air quench.

Whilst the measurement problems are the same as those encountered at the die exit, it should be understood that radiant power levels are typically 1/20 or less of those being processed by the higher temperature units, thus parasitic radiation errors will inevitably be more prominent.

It is therefore important that the target area be screened as far as possible to prevent pick-up of reflections from daylight or other hot sources.

The following sections must be read and understood prior to installation in order that the system is allowed to provide the level of performance of which it is capable.

Measurement problems encountered are:

- Unfilled target area
- Pick-up by reflection - especially daylight
- Direct pick-up from parasitic sources
- Die cavity changes
- Temperature (and emissivity) variations on large sections
- Water

A2.1 Response to Partially Filled Targets

The ***AQT*** is capable of measuring accurately even when the target is only partially filled. It should be obvious however that the detection system does require sufficient radiant input to produce the stable signal levels required for the measurement algorithm. As the natural flat surface value for soft alloys is around 0.08, it is recommended that at least 50% target filling is ensured. The effective emissivity value as displayed on the signal processor front panel (which is a measure of the actual surface value x fractional target filling) should thus be maintained at $\geq$0.04 for reliable measurement.

Unless measurement is being attempted on a very small section, a low value usually indicates that a small correction of alignment is required for the thermometer head, which can be achieved very quickly using either the quick adjust ***AQT*** mounting as shown in Fig. A9 or the ***AQT*** Actuator.

A very low value of effective emissivity (less than 0.01 at typical extrusion temperatures) is indicated by a flashing temperature display on the processor.

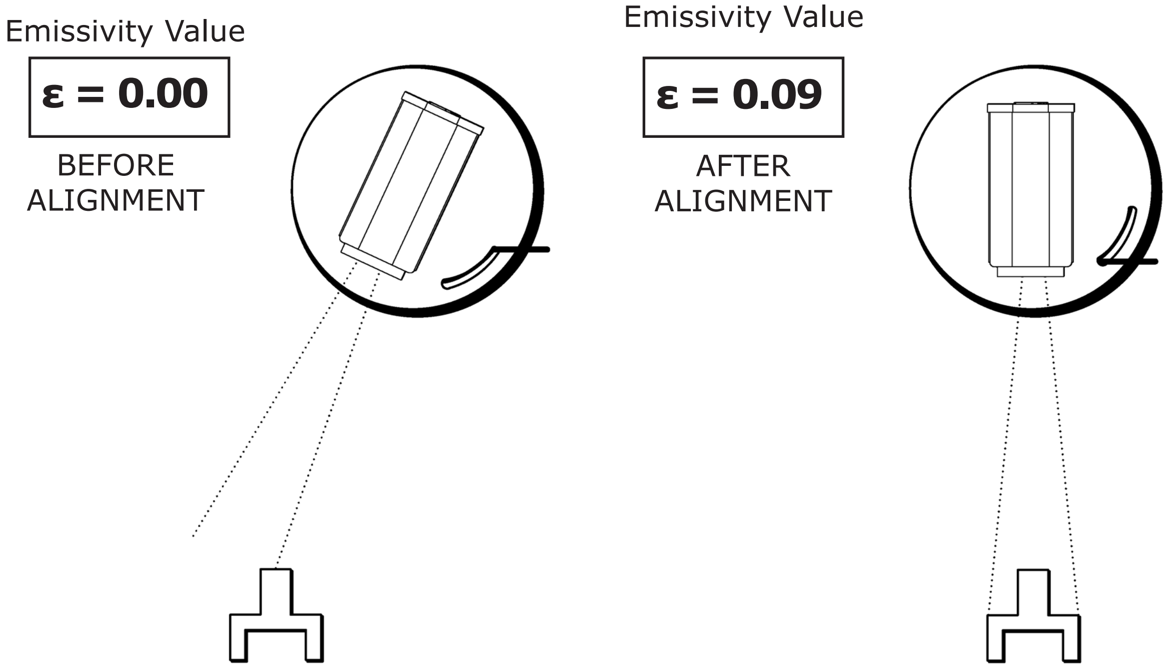


Fig. A9 - Using the Quick-adjust Mount 247010

A2.2 Pick-up of Stray Radiation by Reflection

The inherent low emissivity of all fresh aluminium surfaces means that they are also excellent reflectors, even more so in the infrared than the visible.

The thermometer head will thus detect not only radiation being emitted by the target surface but also that being reflected by it. Providing such reflections are from relatively cool objects (say <100°C/212°F) they present such minute amounts of radiant power as to give insignificant errors of measurement. Conversely however, reflections from hot objects will give errors and for very hot, bright sources could even swamp the radiant power from the aluminium surface.

The most serious source of error is often from solar radiation (i.e. the infrared component in daylight); either direct reflections of the sun or of bright, white clouds. Other strong sources are bright bulbs (often used for tunnel inspection or roof lights), high pressure sodium vapour lamps (factory lighting) and radiant heaters.

It is wrong to assume that, just because stray reflections are not a problem for one particular section, this will be true in general. Very cavitous sections will tend to be less affected, whereas a convex or cylindrical surface viewed by the thermometer may reflect radiation from over a very wide range of angles, as shown in Fig. A10.

Most of these problems can be overcome by the use of simple lightweight screens above the the surface of the sections. These screens should be blackened and placed as close to the target as practical.

The thermal radiation emitted from quenched aluminium surfaces is only a few percent (typically 5%) of that available at the die-exit, however the level of parasitic radiation that may be reflected from the surface remains constant. It is thus obvious that the errors induced by such radiation can be more than an order of magnitude worse and therefore, effective screening is essential to obtain the accuracy available.

For side-on viewing, it is necessary to fabricate a blackened (and preferably corrugated) “light umbrella” which requires mounting just above the run-out table. (See Fig. A11). A further complication is provided by the puller mechanism which may then require that the light screen be retracted or lifted automatically to allow the passage of the puller mechanism.

It may also be necessary to employ additional fixed side screens to mask any direct pathways for light from windows or wall-mounted lamps.

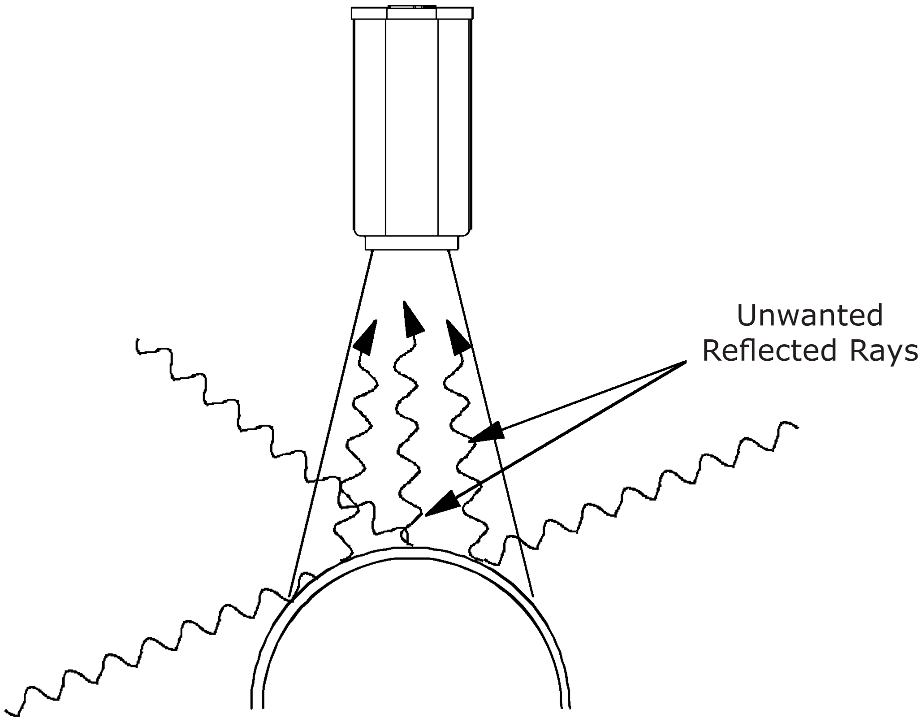


Fig. A10 - Reflection of Radiation on a Cylindrical Surface 247011

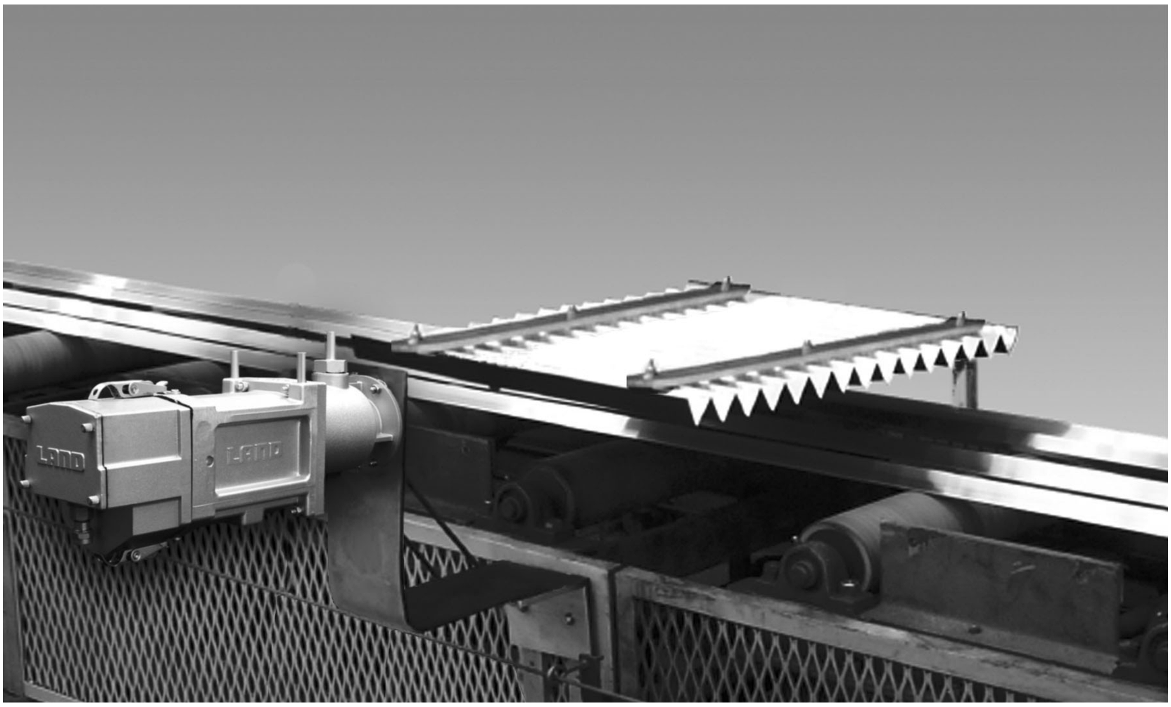


Fig. A11 - Use of a Screen to Minimise Ambient Light Reflection 247012

A2.3 Mounting and Aiming

The lateral position of the section(s) on the run-out table can vary greatly with the ‘bow’ induced during cooling. This becomes especially noticeable on narrower and very asymmetric sections and requires a near side-on aiming in order to retain a large portion of the section within the target area, for the majority of the pull duration.

On presses where this occurs frequently it is suggested that the thermometer’s optical axis is aimed from about 5° to 10° above the horizontal, down onto the centre line of the roll table. In this way, small lateral movements of the section will have no practical effect upon the readout.

Unfortunately this type of alignment often renders the instrument more susceptible to the detection of stray radiation (from roof lights, heaters and daylight) and it becomes very important that an efficient light screen is employed.

A2.4 Direct Pick-up from Parasitic Sources

Most extrusion presses use graphite blocks or rollers to support the sections as they travel along the run-out table and sometimes also for horizontal “steering” or separation.

Being an excellent conductor of heat these blocks quickly become very hot throughout and are highly emissive. (Note a 300°C/572°F graphite block emits almost as much radiant power as 520°C/968°F aluminium). It is therefore very important that the initial alignment looks at a target area which is well clear of all graphite blocks or any other hot objects. See Fig. A12.

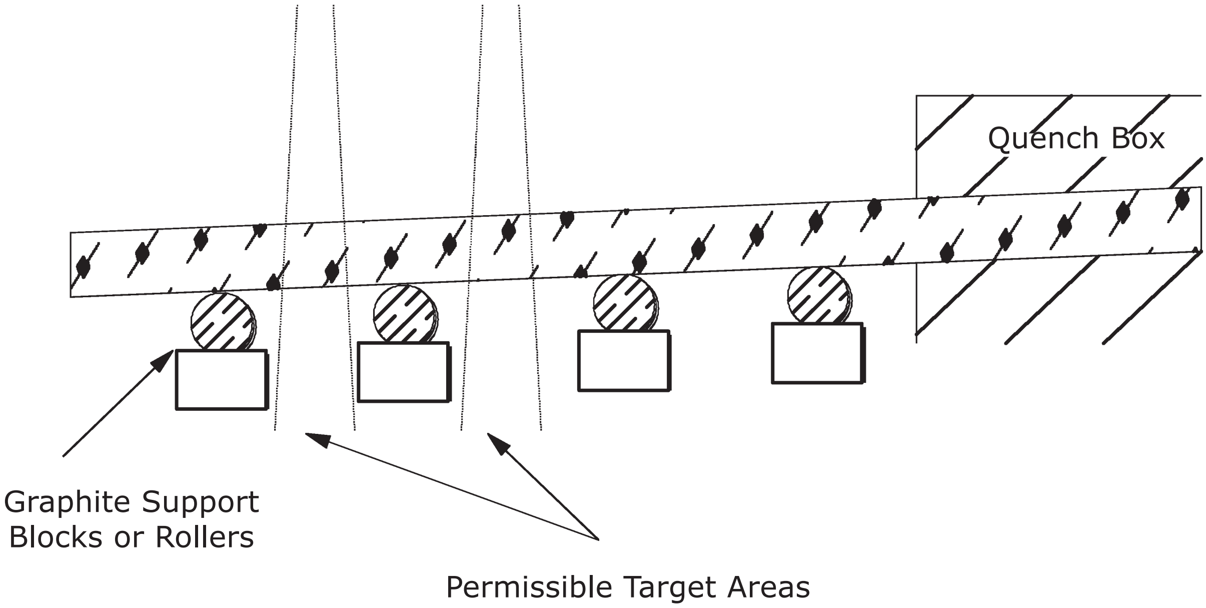


Fig. A12 - Sighting the Thermometer to Avoid Unwanted Sources of Radiation 247013

A2.5 Die Cavity Changes

Single cavity dies are usually well centered on the press mechanical axis, however, some multi-cavity dies (especially 2 cavity) exhibit a wide spacing between the sections. This means that the thermometer may be receiving radiation from only a small fraction of the available target area thus giving rise to measurement errors.

This situation is illustrated in Fig. A13. Using the ***AQT***, it will be immediately apparent as the effective emissivity indicator will be showing an extremely low, or zero, value.

The quick adjust mounting or actuator should then be altered until the indicator shows a much higher effective emissivity value, indicating that at least one strand is now filling a large portion of the target.

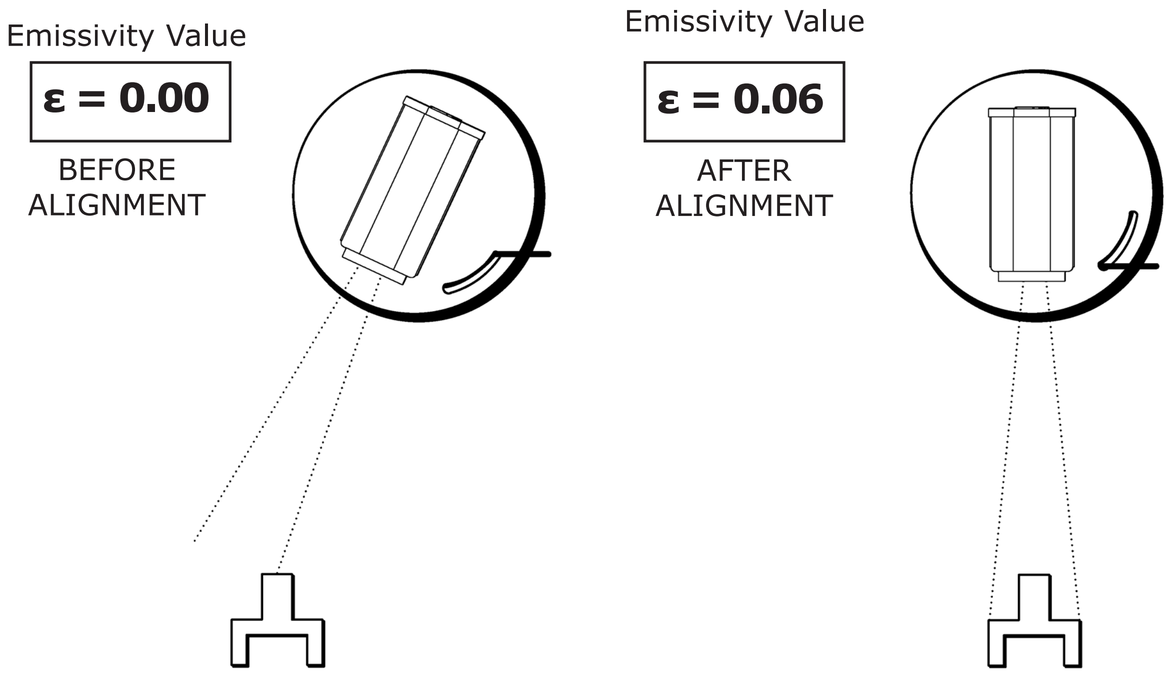


Fig. A13 - Using the Quick-adjust Mount on Multi-cavity Dies 247014

A2.6 Use of Thermocouples

Experience on-site has shown that many extrusions exiting a quench display very large lateral temperature gradients. These tend to be markedly worse than those occurring at die-exits and is due to the air flow and water spray patterns across their surface. More over the gradients often change along the length of a section, especially where a large bow forms or there is lateral movement. It is therefore very important that the exact position of the thermometer target area is known when comparing with a thermocouple reading.

A2.7 Temperature and Emissivity Variations on Larger Sections

Large, or asymmetric, sections can exhibit considerable variations of temperature. Tests have shown up to 30°C/86°F differentials either side to side, or centre to side, due to the effect of shape upon their ability to cool. Fig. A14 attempts to illustrate this.

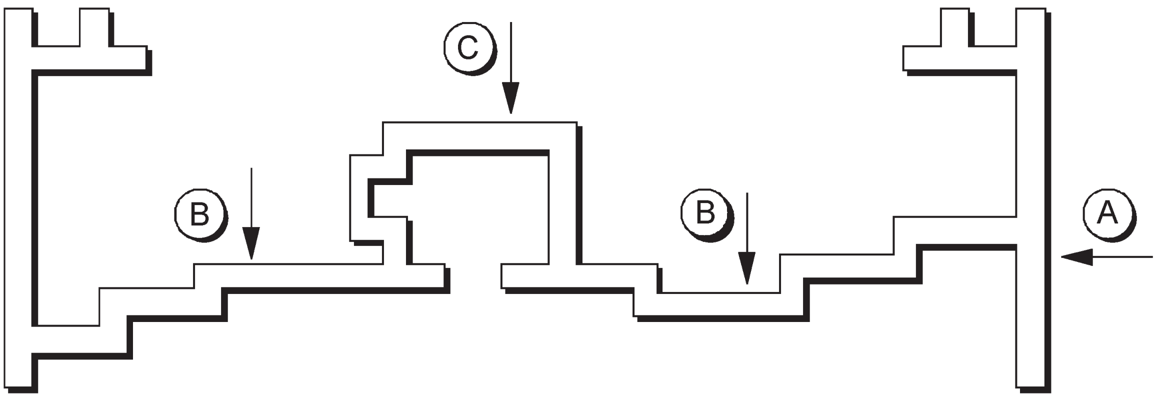
Where the width of the extrusion is larger than the quoted target diameter the press operator thus has some flexibility in his measurement point by use of the fine adjust mounting or actuator and using the effective emissivity indicator to determine the position of the edges of the section where the signal will fall to zero very rapidly.

Where non isothermal sections move laterally within the field of view some change of temperature output will be seen dependant upon positions of such “hot-spots” within the target. In Fig. A14, for example, a maximum temperature output will be seen when the area labelled ‘C’ is near the centre of the target: if the section moves sideways then one of the two areas labelled ‘B’ will tend to fill the target and the reading will fall slightly. Note: these comments apply to natural cooling and may not always apply under forced cooling conditions.

It is also useful to understand the effect of shape on the effective emissivity value. A fresh aluminium surface exiting a die and fully filling the target will show an ε value of around 0.08. If the die wears and definite small ridges can be seen, this value will rise slightly to perhaps 0.10 or 0.12. A gently rising value thus becomes a good indicator of die wear.

Sections which are ‘folded’ round to form channels and boxes will also show much higher effective emissivity values, generally the deeper the channel, or more enclosed, the higher the value. This effect is caused by the target surface reflecting additional radiation from other parts of the structure which would otherwise not have been directed into the camera.
Fig. A15 illustrates this.

Because of this effect, different parts of a larger section may show different effective emissivities as illustrated in Fig. A16. This type of information may be used to advantage by press operators wanting to monitor one particular region of the whole section.



KEY:
A : Open, flat surface = coolest
B : Fairly open surface with slight heat trapping by channel = slightly hotter than A
C : Enclosed surface with little cooling from inside = hotter than A or B

Fig. A14 - Variation of Temperature Across an Asymmetric Profile 247015

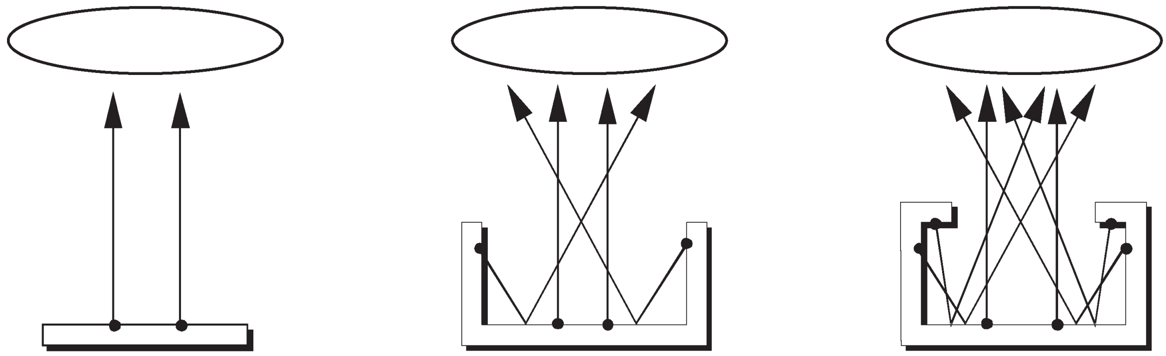


Fig. A15 - Effect of Profile Shape on Reflections 247016

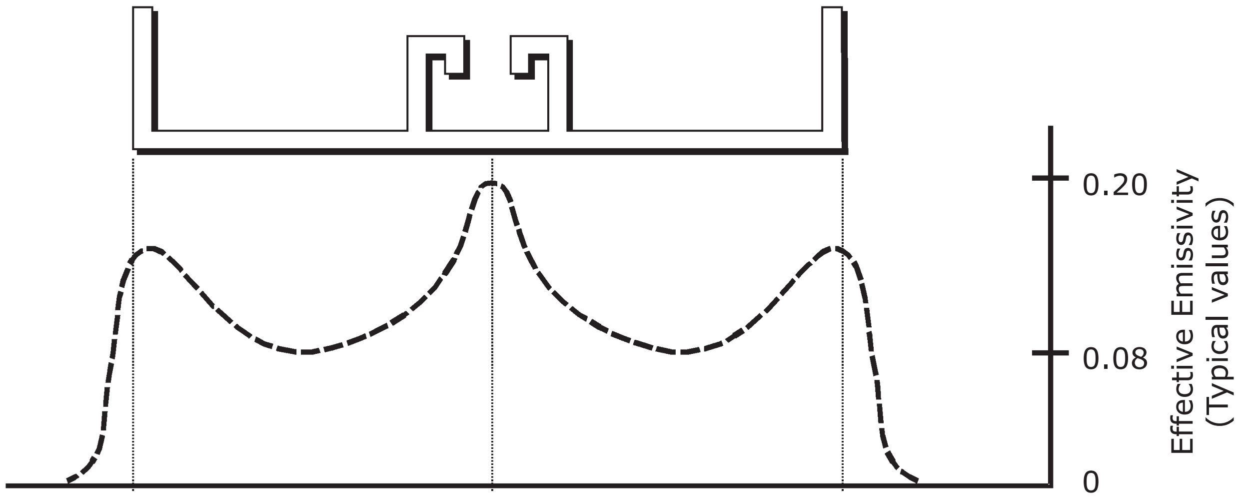


Fig. A16 - Effect of Profile Cross Section on Effective Emissivity 247017

A2.8 Highly Cavitated Sections

The Algorithm used by the ***AQT*** is extremely robust and deals very effectively with the vast majority of surface forms.

There are however, occasional forms for which the calculation is slightly less precise without additional input. The most common example of this is very deeply "finned" sections (e.g. heat exchangers) when being viewed into the cavities formed between fins. When the depth of the channels is large compared to the width, large numbers of multiple reflections may be detected giving rise to effective emissivities of 5 to 10 times the normal surface value. Under these circumstances an additional trim may be required using parameter H4.

For this type of highly cavitated section, the value of H4 should be reduced from zero. The effect on the readout (at typical extrusion temperatures) ranges from about +1°C per unit decrease of H4, at effective emissivity of 0.2, to nearly +2°C per unit at effective emissivities of around 0.4.

The required value of H4 should be determined experimentally by comparison against the ***AQT*** calibration unit (see Section E) and, once found should be used every time that similar sections are being extruded. The value of H4 should always be returned to zero (the factory setting), for viewing 'normally' cavitated surfaces.

A2.9 Unusual Alloys

The algorithm used by the ***AQT*** has been set-up specifically for dealing with the 1000, 6000 and similar soft alloys which form the great bulk of commercial extrusions.

If any high magnesium or very "unusual" alloys are being extruded then a trim may be required to parameter H5 in order to obtain the required accuracy.

For the 5000 series and any similar alloys, for which the natural flat surface emissivity value is considerably higher (i.e. typically double that of soft alloys), the value of H5 should be raised from zero. The effect on the readout (at typical extrusion temperatures) is about -2°C per unit increase of H5.

The value of H5 should be determined experimentally by comparison against the ***AQT*** calibration unit and once found, should be used for all sections using that alloy type. The value of H5 should always be returned to zero, (the factory setting), for use on soft alloys.

A2.10 Presence of Water

If the ***AQT*** is to measure the temperature of extrusion exiting a water quench, it is essential that any pools of water are dispersed from the surface before the measurement point. A blower or air-knives system may be required.

PART B - USER GUIDE

B1 Introduction

B1.1 About this Guide

This guide gives the necessary information required to operate LAND ***AET*** and ***AQT*** thermometers. Basic information regarding installation can be found in the ***AET / AQT*** Installation Guide.

B1.2 About the Thermometers

The LAND ***AET*** and ***AQT*** thermometers are highly accurate, non-contact thermometers designed for use in conjunction with LAND ***LMG AE*** processors for applications in the aluminium extrusion industry.

AET and ***AQT*** thermometers utilise a multi-wavelength temperature measurement technique and feature integral laser alignment, directed along the axis of the instrument's field of view.

An air purge, protection jacket and backcap assembly are recommended for use where the thermometer is to be located into a hostile environment.

B1.3 Unpacking the Thermometers

It is important to fully check all equipment with which you have been supplied. The packaging should contain the following items:

- ***AET / AQT*** thermometer Installation Guide
- ***AET / AQT*** thermometer User Guide.
- A binder for all user documentation.
- ***AET*** or ***AQT*** thermometer fitted with protective lens cap.

It is recommended that the protective lens cap is kept attached until thermometer installation is fully complete.

B1.4 Nomenclature

The thermometer detail label is situated on the rear face, below the blanking disk. Make a note of the Instrument type, thermometer serial number and the H6 and H7 values (wavelength trim values) from this detail label as this information will be required when configuring the thermometer to the ***LMG AE*** Processor. Enter the information in the spaces below:

Instrument Type:

Serial Number: / /

H6 Value:

H7 Value:

B2 Specifications

	AET	***AQT***
Overall indication range:	350 to 600°C 650 to 1100°F	200 to 500°C 400 to 900°F
Specification temperature range:	400 to 600°C 750 to 1100°F	220 to 450°C* 430 to 850°F*
(* = subject to ε <1.00 at temperatures above 375°C/700°F)		
Response time:	1sec to 98%	
Resolution:	1°C/2°F**	
(** = subject to appropriate averager at temperatures <250°C/480°F)		
Nominal field of view:	30:1	
Minimum target diameter: (See section B3.2)	N/A	20mm/0.79in
Focus:	Infinity	600mm/23.62in
Alignment of laser with centre of target spot:	<±0.25° angle	
Ambient temperature range:		
Specified:	5 to 45°C/41 to 113°F	
Limits of operation in storage:	0 to 50°C/32 to 122°F	
Absolute accuracy in operation:		
Temperature:	±5°C/±9°F***	±10°C/±18°F***
Emissivity:	±0.02***	
(*** = not applicable at very low signal levels as indicated by flashing display on processor)		
Sealing:	IP65	
Vibration:	3G any axis, 10 to 300Hz	
CE:	EN 50-08-2 (immunity) EN 50-08-1 (emissions) IEC 1010 (electrical safety)	

B3 Installing the Thermometer

This section contains similar information to the ***AET / AQT*** Installation Guide.

If the thermometer is to be used in conjunction with a protection jacket and air purge (recommended), cross-refer to the Installation Guides provided with those accessories.

For extrusion press applications it is expected that the units will be mounted using either the ***AET*** quick adjust mounting (Land Part No. 030.448) or the ***AET*** Actuator (092.678 - 110V / 092.683 - 230V). These provide the capability for rapid re-alignment, as required by either lateral section movement or for changes between multi-cavity dies.

Both types are provided with simple adapters to enable the protection jacket to be mounted directly onto the ball swivel of the mounting.

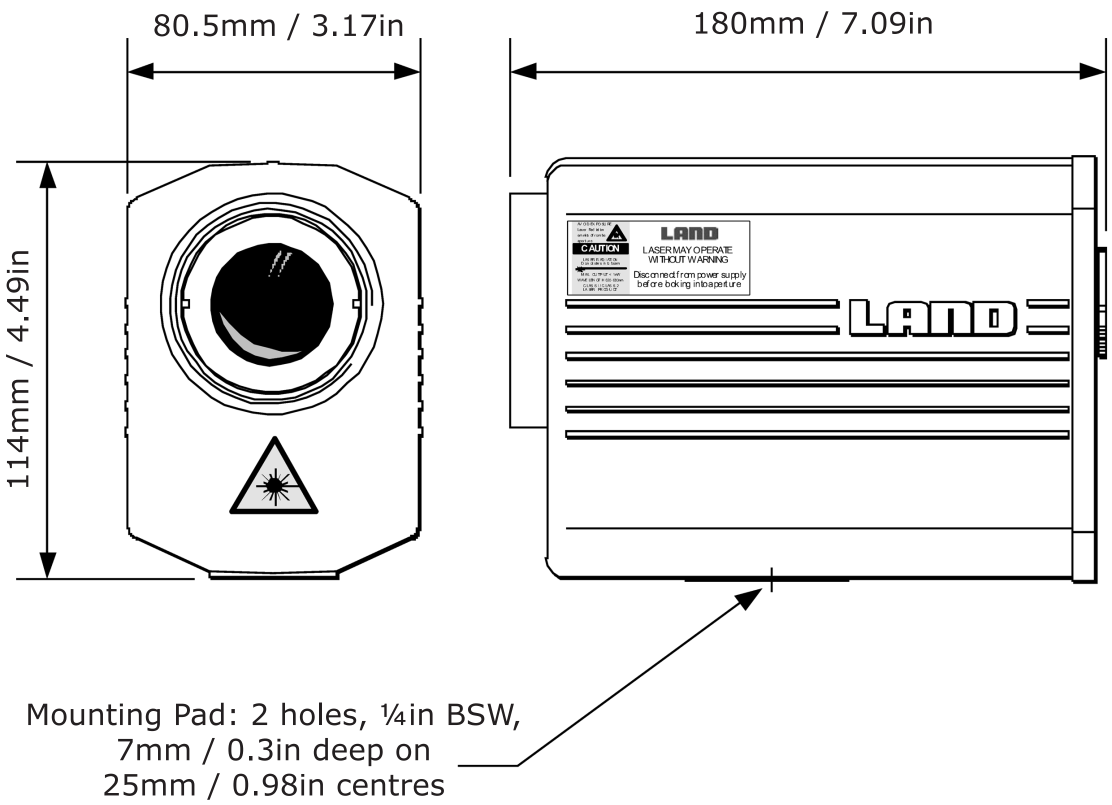


Fig. B1 - Thermometer Installation Dimensions 247018

B3.1 Choosing a Location for the Thermometer

A) Die Exit Measurements.

The ***AET*** (die exit) thermometer is usually mounted on, or very close to the tunnel exit of the press. This not only affords a measurement at the closest practical point to the die, but often allows the target position to be just inside the tunnel mouth. This provides a very simple and effective screen against daylight reflections and other parasitic radiation which may be reflected from the surface of the extruded sections. Ensure that the sight path is clear of pipes and other obstacles.

Further advice and recommendations on positioning and alignment are given in PART A - APPLICATION NOTES.

B) Quench Measurements.

The ***AQT*** (quench exit) thermometer may be fixed directly to either the quench unit or to some convenient part of the run-out table structure. Ensure that the sight path is clear of pipes and other obstacles and in the case of moving quenches, that the sections are visible for all positions of the quench box. Quench thermometers, due to the very low levels of infrared radiation being detected, are particularly vulnerable to errors produced by parasitic radiation and great care must be taken during the initial positioning of the instrument to avoid the possibility of daylight reflections or radiation from other hot sources.

Further advice and recommendations are given in
PART A - APPLICATION NOTES.

NOTE

Cable lengths - The maximum overall resistance of the cable used to connect the thermometer to the processor is 20 ohms. The commonly used cable is 7 x 0.2mm core, which is rated at 92 ohms per km thus allowing a maximum cable length of 217 metres (i.e. 20/92 x 1000 m). This is the maximum total cable length. Therefore we recommend a maximum cable length of 200 metres, including any junction boxes:

e.g. Thermometer > 150m cable > Junction box > 50m cable > Processor

B3.2 Target Sizes

The two thermometer heads (***AET*** and ***AQT***) utilise different optics, each having been determined as more suitable from extensive site tests.

AET

The thermometer is said to be focussed at infinity.

The target size (d) may be calculated for any known distance (D) from the thermometer front as:

Target Size (d) = D/30 + 30 (mm) or D/30 + 1.2 (in)

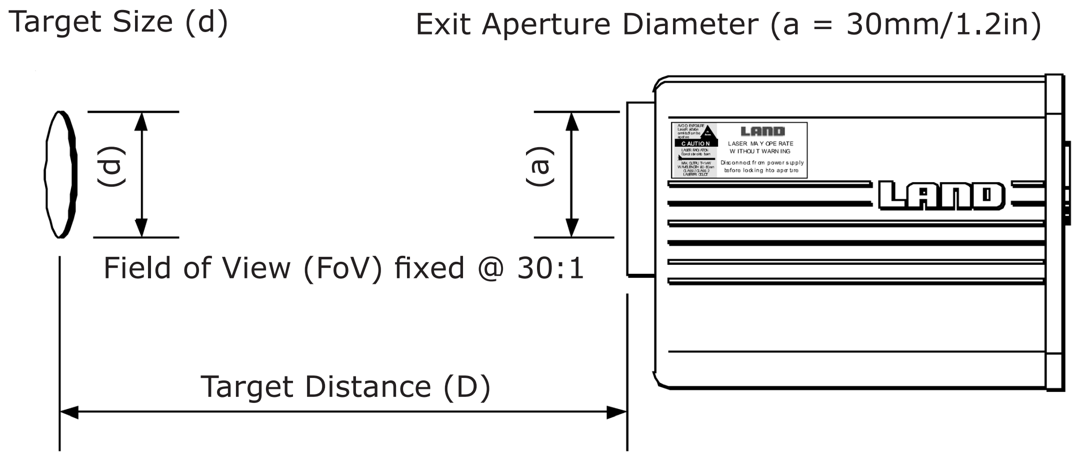
AQT

This thermometer has a fixed focus giving a:

Target Size (d) of 20mm/0.8in at 600mm/24in.

It is recommended that the thermometer is mounted as close to 600mm/24in from the axis of the press run-out as possible.

In locations where a large variation of position is seen in the vertical plane it is recommended that the thermometer be positioned to view the sections horizontally i.e. from the side of the press. This requires considerable care to eliminate parasitic radiation pick-up.



AET (Infinite Focus) Target Size (d) = $\dfrac{\text{Target Distance (D)}}{\text{Field of View (FoV)}}$ + Exit Aperture Diameter (a)

AQT (600mm/24in Focus)

Fig. B2 - Target Size Calculations 247019

B4 Thermometer Operation

B4.1 Alignment Laser

Warning

CLASS 2 Laser Product.

DO NOT stare into laser beam. (1.0mW maximum output at 635nm)
DO NOT look directly towards the thermometer window, or into the laser beam during operation.

If the laser is projected onto a highly reflective surface, DO NOT look at the laser spot from a position where a direct ('mirror-like') reflection may enter the eye.

Warning

CLASS 2 Laser Product.

DO NOT attempt to disassemble the laser unit or any of it's mounting components.

Embedded laser has a maximum output of 5mW with a beam divergence of <5mrad.

Caution

Caution - use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

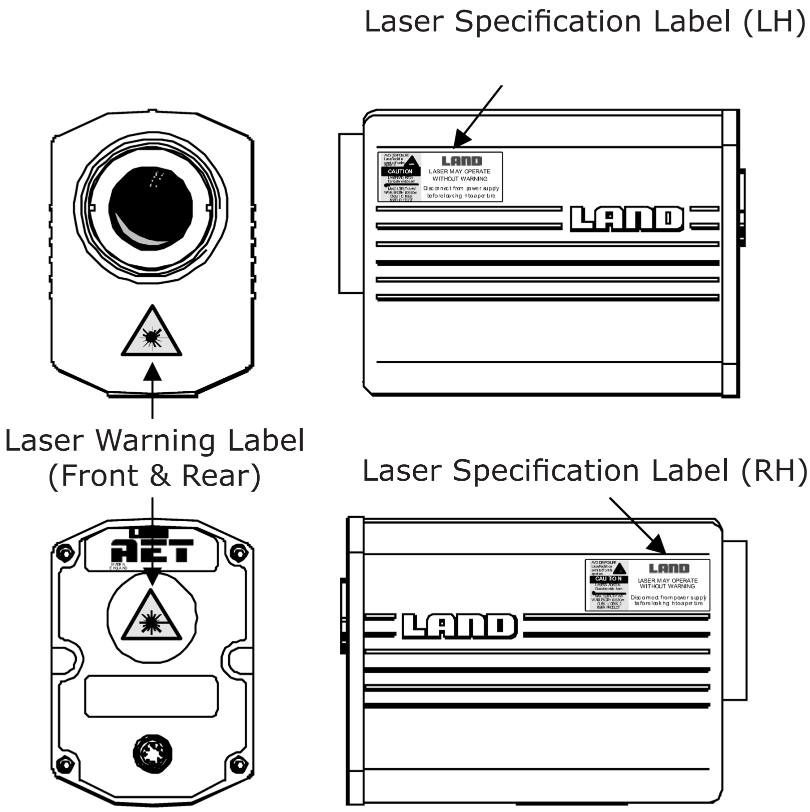


Fig. B3 - Location of Laser Labels 247020

B4.1.1 Alignment Laser Specifications

Operating Wavelength: 635nm

Output Power: <1mW

Laser Safety Classification: Class II / Class 2

B4.2 Aiming the Thermometer at the Target

When the thermometer has been correctly installed in the desired location, it must then be aimed at the target area using the inbuilt Laser Alignment facility.

The ***AET*** and ***AQT*** thermometers are aimed at the section, or in the case of wide sections, at the required measurement zone using the alignment laser.

The laser is triggered into operation by the use of a push button switch which applies a transient signal (changing from a positive voltage to 0V) to the signal 4 terminal. Once activated, the laser remains on, irrespective of the switch position, for a period of between 50 and 60 seconds after which time it automatically switches off. The laser beam has been aligned during manufacture to be coincident with the optical centre of the thermometer's infrared viewing axis. The user is reminded that the measurement target is much larger than the laser spot, the size being defined as in Section 3.2.

There are three different modes of operation of the alignment laser:

Operation from a signal processor (***LMG AE***) mounted near to the press face.

Operation from an auxiliary push button switch when the signal processor is distant from the press face.

Operation from the ***AET*** Actuator handset.

B4.3 Electrical Connections

The electrical connections for the thermometer power supply and temperature outputs are made via the 8-way socket on the rear of the thermometer.

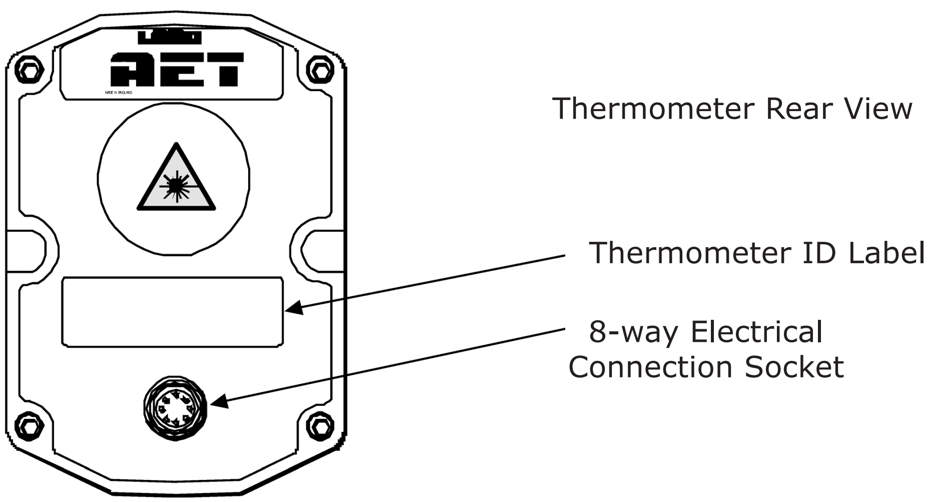


Fig. B4 - Location of 8-way Electrical Connection Socket 247021

NOTE

Cable lengths - The maximum overall resistance of the cable used to connect the thermometer to the processor is 20 ohms. The commonly used cable is 7 x 0.2mm core, which is rated at 92 ohms per km thus allowing a maximum cable length of 217 metres (i.e. 20/92 x 1000 m). This is the maximum total cable length. Therefore we recommend a maximum cable length of 200 metres, including any junction boxes:

e.g. Thermometer > 150m cable > Junction box > 50m cable > Processor

Electrical connections to the thermometer must be made through the pre-wired plug supplied with the thermometer or through the plug housed in the protective jacket back cap.

To connect either plug type to the thermometer socket:

- Align the red marker near the lugs of the plug with the red marker located above the keyway in the thermometer socket.
- Push the plug into the socket, ensuring that the locking sleeve slides forwards, locking the plug to the socket.

To disconnect either plug type from the thermometer socket:

- Grip the locking sleeve portion of the plug.
- Slide the locking sleeve rearwards to release the locking mechanism and disconnect the plug from the thermometer socket.

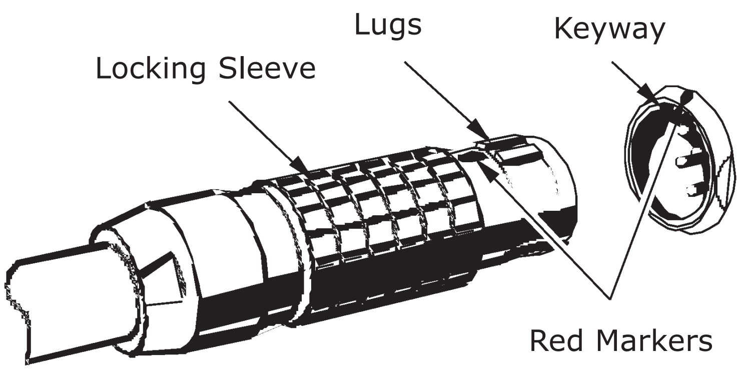
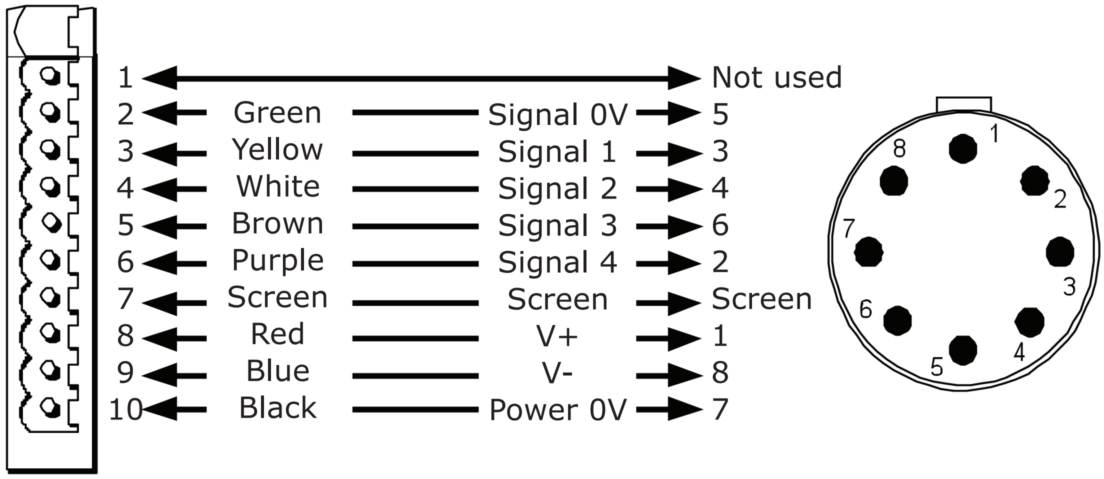


Fig. B5 - Connection of an 8-way Plug to the Thermometer Socket 247022



Processor back plane thermometer connection terminals

Thermometer 8-pin plug (View from solder bucket side of 8-way connector)

NOTE

The screen is connected to the connector shell at the thermometer end of the cable and pin 7 of the processor connector.

Fig. B6 - Connection Schedule for 8-way Plug and Socket 247023

B5 Maintenance

Thermometer maintenance consists mainly of ensuring that the front lens remains clean and free from contamination.

If the lens becomes dirty, it is recommended that a soft, lint-free cloth and a suitable lens cleaning fluid is used to clean any contamination from the lens surface.

Should it be found that the lens becomes repeatedly dirty, it may be necessary to utilise an air purge accessory which can be supplied by Land Instruments. Contact Land Instruments International for more information regarding available accessories.

If the thermometer is used in conjunction with a protective cooling jacket, ensure that there is an adequate supply of coolant. The recommended flow rate for coolant is 1 litre per minute (1l/min or 0.035 cu ft/min).

If the thermometer is to be used in conjunction with an air purge accessory, ensure that there is an adequate supply of clean, dry air. The recommended flow rate for purge air is 1 litre per second (1l/sec or 2 cu ft/min).

Caution

'Over-cooling' of the thermometer may cause a build-up of condensation on or inside the instrument. To prevent this, ensure that the water supply temperature is not lower than the local dewpoint temperature.

B6 Accessories

The following section gives information about the range of mountings and accessories available for use with ***AET*** and ***AQT*** thermometer systems. Further information is contained within the ***AET/AQT*** Mountings and Accessories Installation Guide.

If the thermometer is to be used in an environment where the ambient temperature is higher than that specified, or where the atmosphere contains a high proportion of dust/smoke/steam etc, then the thermometer must be housed in a Protective Jacket Assembly.

All system mountings and accessories are available from Land Instruments International.

B6.1 Protective Jacket Assembly

This assembly fully protects the thermometer and thermometer connections from the effects encountered when installed within an hostile environment.

B6.1.1 S4J Protective Jacket (Part No: 091.560)

The S4J Protective Jacket provides an effective air or water cooling facility for the ***AET/AQT*** thermometer. It ensures that the thermometer is protected from the excessive environmental conditions encountered during the aluminium pressing process.

B6.1.2 S4P Air Purge Assembly (Part No: 091.561)

The S4P Air Purge Assembly provides a stream of clean, dry air to the lens of the ***AET/AQT*** thermometer, ensuring that the lens is kept free from condensation, dirt and any other contaminants which may otherwise settle onto and soil the lens surface.

B6.1.3 S4CA End Cap Assembly for AET/AQT (Part No: 092.699)

The S4CA End Cap Assembly ensures environmental protection for the electrical connections to the ***AET/AQT*** thermometer. Connections are made to the terminal strip inside the End Cap cover. Camlock fasteners ensure that the End Cap is securely fastened to the protective jacket.

B6.2 Actuator Assembly (Part No: 092.578 [110V] / 092.582 [230V])

The ***AET*** actuator accessory is used for mounting the ***AET*** (die-exit) thermometer onto the press face or suitable near-by part of the press superstructure. It may also be used, where applicable, for the alignment of an ***AQT*** quench thermometer when mounted at the exit of a quench box or nearby structure, to allow for aiming onto sections exiting the quench.

B6.3 Manual Quick-adjust Mounting Plate (Part No: 030.448)

The quick-adjust mounting plate accessory allows an ***AET/AQT*** thermometer to be rotated quickly and easily, during initial alignment or re-alignment of the thermometer with the target area. When the quick-adjust mounting plate is to be utilised with the protective jacket assembly, an S4MA adapter plate is required, which allows the protective jacket to be directly mounted onto the M12 thread of the quick-adjust mounting plate ball swivel.

B6.4 S4MA Mounting Adapter Plate (Part No: 029.264)

The S4MA adapter plate is utilised when the ***AET/AQT*** thermometer mounting jacket is to be mounted onto the M12 ball swivel of either the manual quickadjust mounting plate or the actuator assembly.

B6.5 Calibration Unit (Part No: 092.530)

The Land ***AET/AQT*** calibration box is a hand-held, surface thermocouple and display unit which has been specifically calibrated to provide an accurate instrument checking device for use with aluminium thermometer systems.

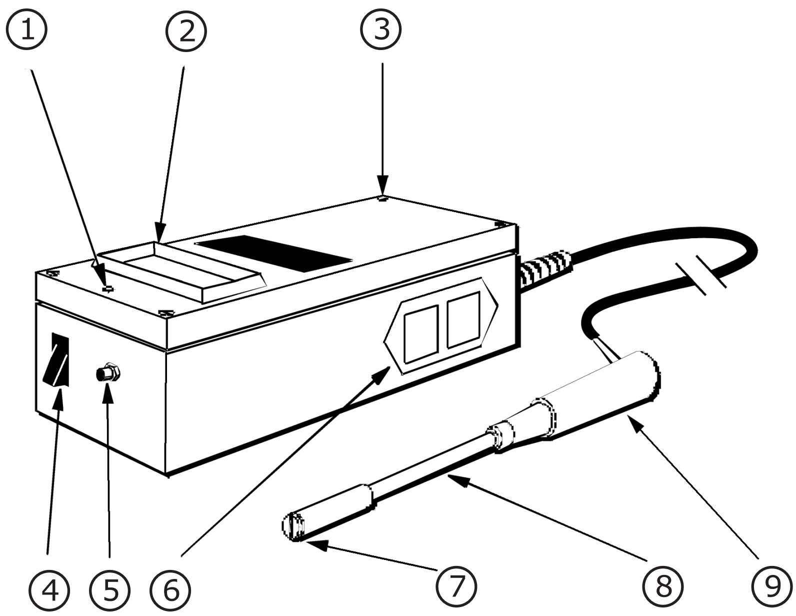


Fig. B7 - Calibration Unit 247024

Item	Description
1	Red LED (Unit ON / Battery LOW Indicator)
2	Surface Temperature Display (°C)
3	Lid Retaining Screws
4	ON / OFF Toggle Switch
5	RESET Switch (Push Button)
6	Battery Compartments
7	Thermocouple Junction
8	Surface Contact Thermocouple
9	Handle

B6.5.1 Basic Operation

To switch on the unit, press the toggle switch (4). The red LED (1) lights up, indicating that the unit is functioning and the battery voltage is sufficient for use. If the red LED starts to flash, this indicates that the batteries are low and they should both be replaced as soon as possible.

To clear any numbers appearing in the display on power-up, press the reset push button (5).

To check the unit, lightly press the thermocouple junction against any hot (<600°C/1112°F) object. The temperature of the surface immediately appears in the display (2). The display has a 'Hold' facility and it is necessary to reset the display, using the Reset push button (5) between readings.

Take care when using the thermocouple. It should not be pressed hard against the surface being measured. Gentle hand pressure, provides sufficient force for a reliable contact. Never rotate the unit whilst in contact with the surface, as this will twist and permanently deform the thermocouple wires.

B6.5.2 Method of Operation

Before each reading is taken, reset the unit using the reset push button. The tip of the thermocouple unit should be pressed lightly onto the aluminium at the required measurement position. Ensure that the mechanical axis of the shaft and handle is approximately normal to the surface.

When measuring on a ridged or uneven section ensure that the area of contact with the thermocouple tip is flat.

A contact time of at least 2 seconds is required to ensure that a true reading is attained and therefore its use is only recommended on stationary or slowly moving sections.

It is also advisable to perform the measurement 2 or 3 times in quick succession to ensure that the value is repeatable.

Always switch the unit off when not in use.

B6.5.3 Maintenance

The unit requires no routine maintenance other than battery replacement.

Battery replacement:

- If the red LED starts to flash, switch the unit off.
- Remove the two battery holders and lift out the old batteries.
- Insert two new batteries, ensuring that their polarity corresponds with that indicated in the holders.
- Replace the holders into their compartments.

Thermocouple care:

- Always store the unit in a clean dry environment and keep the thermocouple tip clean, replacing the protective tip cover when not in use.
- If any dirt accumulates on the junction area, lightly scrape off the dirt with a clean blade (e.g. a scalpel blade).
- The junction area should be 1 to 2 mm/0.04 to 0.08in proud of the ceramic holder.
- If after prolonged use, the thermocouple wires lose some elasticity and lie permanently level with the ceramic face, raise them gently and evenly by inserting a fine pointed blade between the coils and twist the blade slightly.
- If the thermocouple gives very erratic output or no output at all, the junction could be suspect. To check for continuity, use a bench type resistance meter or D.V.M. with a resistance range. The nominal resistance should be 10Ω.
- If a unit reads very high resistance or open circuit, it should be returned to LAND Instruments International for repair and recalibration.

LAND

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PROCESS & ANALYTICAL INSTRUMENTS

PRODUCT WARRANTY

Thank you for purchasing your new product from Land Instruments International. This Land manufacturer's 'back-to-base' warranty covers product malfunctions arising from defects in design or manufacture. The warranty period commences on the instrument despatch date from the Land Instruments International Ltd. factory in Dronfield, UK.

36 MONTHS WARRANTY

Building upon the reputation for reliability and longevity that System 4 and UNO thermometers have earned, Land are delighted to be able to provide our customers with an industry-leading 36 month warranty for the following products:-

- SPOT thermometers, accessories and mountings and special instruments based on SPOT.
- System 4 thermometers, processors, accessories and mountings and special instruments based on System 4.
- UNO thermometers, accessories and mountings and special instruments based on UNO.
- Application-dedicated processors based on LANDMARK® Graphic.
- ABTS/S and ABTS/U
- FTS
- VDT/S and VDT/U
- DTT
- FLT5/A

This 36 month warranty is provided as standard for all orders for the products listed above received from 1st May 2002.

We believe that our customers expect us to set the standard in terms of performance, quality, reliability and value for money. This 36 months warranty, as a part of an on-going program of continuous improvement, is just one way in which Land strive to maintain our position as the temperature measurement partner of choice.

24 MONTHS WARRANTY

The following Land Instruments International products are provided with a 24 months warranty:

- ARC.
- FTI-E
- NIR

12 MONTHS WARRANTY

All Land Instruments International products not provided with either a 36 month or 24 month warranty (see lists above), are provided with a 12 months warranty.

PRODUCT WARRANTY

EXCLUSIONS FROM WARRANTY

It should be noted that costs associated with calibration checks which may be requested during the warranty period are not covered within the warranty.

Land reserve the right to charge for service/calibration checks undertaken during the warranty period if the cause is deemed to fall outside the terms of the warranty.

This Land manufacturer's warranty does not cover product malfunction arising from:-

- incorrect electrical wiring.
- connection to electrical power sources outside the rating of the product.
- physical shock (being dropped, etc.) and impact damage.
- inappropriate routing, support, physical shock & strain protection, etc. of the lightguide (Fibroptic thermometers only).
- environmental conditions exceeding the IP / NEMA rating of the product.
- environmental conditions outside the Ambient Temperature, Humidity and Vibration rating of the product.
- environmental contamination (solvent vapours, deposition of airborne contamination, cooling liquids of non-neutral pH, etc.).
- overheating as a result of interruption of water/air flow through cooling jackets or of incorrect installation.
- inappropriate modification of product (drilling holes in thermometer bodies, etc.).
- inappropriate recalibration which results in product calibration being taken outside specification.
- improper resealing of thermometer following parameter adjustment (UNO, FLT5/A, etc.).
- attempted repair by a non-Land-authorised repair centre.

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