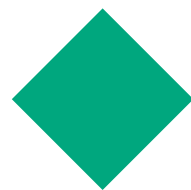




# Infrared Lamps

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for diverse industrial applications



# Defining Infrared Radiation

The heating of a substrate or surface is possible through the application of several thermodynamic mechanisms:

## Conduction

Transmittance by direct contact between a heat source and a lower temperature material

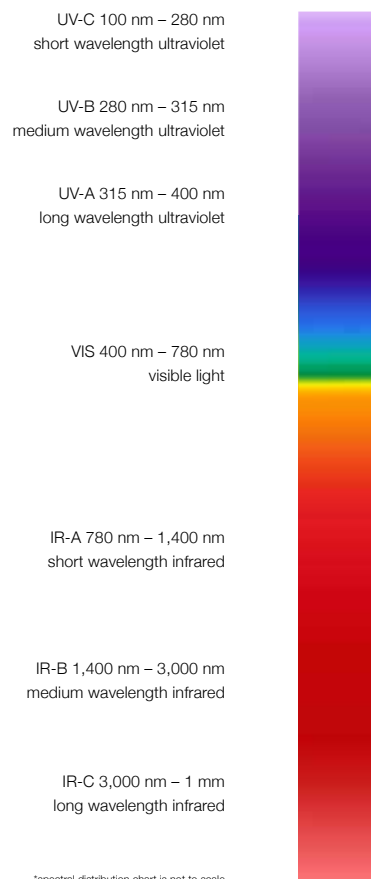
## Convection

Transmittance by direct contact due to mass molecular motion of a heated intermediary

## Radiation

Contact-free transmittance through electromagnetic radiation waves

## Infrared On The EMR Spectrum



## What Is Infrared?

Infrared (IR) is electromagnetic radiation (EMR) occupying a wavelength range of approximately 780 nanometres (nm) to 1 millimetre (mm). Ushio's IR emitters are divided into three categories: IR-A, IR-B, and IR-C, as depicted in the spectral distribution diagram below.

## Below Red: Herschel's Hottest Discovery

After proving that the temperature of visible light progressively increases from violet through to red, the German astronomer Frederick William Herschel was shocked to find an even hotter region "below red". His findings, in 1800, heralded the first discovery of light beyond the perception of the human eye.

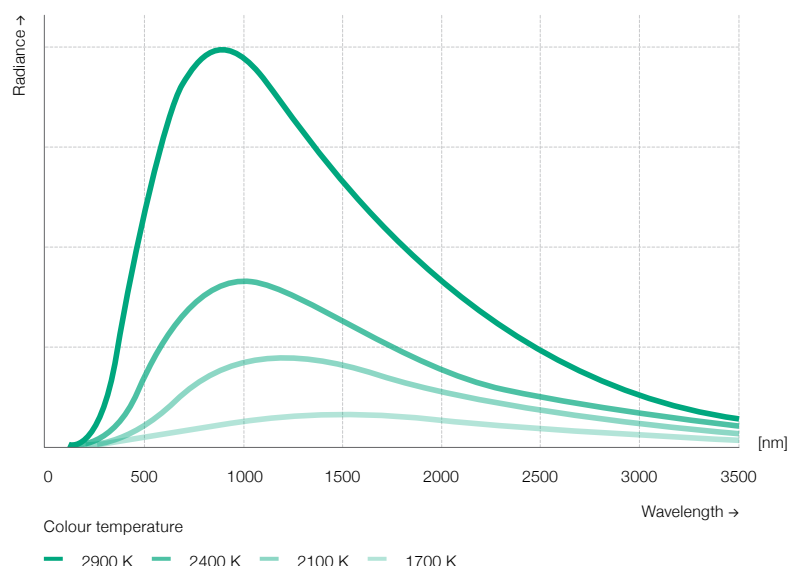
## Contact-Free Heating

A substrate irradiated by short or medium wavelength IR can absorb more than 92% of the radiated energy. This radiation can be retained as heat within the heated object. For maximum efficiency, the substrate must have an absorption coefficient comparable to the spectral wavelength emitted by the IR lamp.

## Spectrum of the IR Range

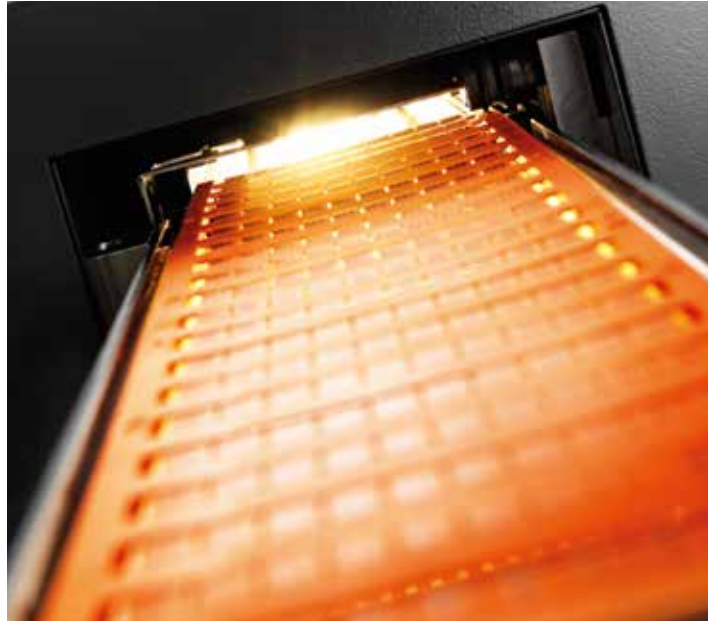
It is customary to use the terms short wave, medium wave, and long wave to classify IR lamps. These definitions are easily remembered, but from a technical point of view they are inaccurate. Solid state or monolithic lamps, i.e. incandescent lamps, continuously emit radiation within two of the aforementioned wavelength ranges.

## Typical spectrum of an incandescent lamp at various colour temperatures



# Expertly Applied To Your Field

- ◆ Activation of Adhesives / Glues
- ◆ Annealing
- ◆ Catering
- ◆ Chemical Processing
- ◆ Copy Toner Fixing
- ◆ Curing of Coatings
- ◆ Development of Films
- ◆ Deburring of Plastic Parts
- ◆ Drying of Fillers and Varnishes
- ◆ Embossing
- ◆ Evaporation of Solvents
- ◆ Evaporation of Water
- ◆ Epitaxy
- ◆ Food and Beverage Packaging
- ◆ Food Processing and Manufacturing
- ◆ Furnacing
- ◆ Germicide by Heat
- ◆ Hardening of Resins and Cements
- ◆ Heating
- ◆ Humidity Control
- ◆ Lamination
- ◆ Material Testing
- ◆ Medical Science
- ◆ Metal Welding
- ◆ Microelectronic Circuit Integration
- ◆ PET Blow Moulding
- ◆ Plastic Welding
- ◆ Preheating of Composite Materials
- ◆ Print Drying
- ◆ Temperature Regulation
- ◆ Tempering
- ◆ Thermal Oxidation
- ◆ Thermoforming
- ◆ Rapid Thermal Processing (RTP)
- ◆ Sintering of Printed Electronics
- ◆ Solder Reflow (PCB)
- ◆ Solar Cell Production
- ◆ Spot Welding
- ◆ Shrinking of Foils
- ◆ Vacuum Forming
- ◆ and many more...



Ushio is the premier manufacturer of customisable IR lamps. We have spent over 55 years developing our cutting edge technology and tailoring it to the needs of each unique client. With a legendary commitment to quality and flexibility, we have remained unsurpassed as the world leading manufacturer of specialist lighting solutions since our foundation in Tokyo, 1964.

Our specially trained engineers at Ushio's production facilities in Germany and Poland devise, build, and test each device with a unique design for each client. This ethos results in lamps which perfectly align with your requirements, each and every time.

# Double Ended Single Tube

Ushio's single tube infrared lamps are active and effective in the vast majority of industrial applications. These versatile emitters are available in various shapes, sizes, colour temperatures, power levels, and can be delivered with or without a flame-sprayed reflective coating.

Like the majority of our products, these lamps are part of Ushio's full in-house customisation service. All Ushio IR lamps are available with a wide range of base configurations, filaments, and quartz types to choose from. The wide variety of design alternatives includes segmented lamps for uniform heating, as well as special filaments.

Ushio also offers the opportunity to select 'doped' ruby red quartz glass which excludes visible wavelengths. This is especially effective as a safety measure in industrial applications where the lamp operator may otherwise suffer prolonged exposure to high brightness, visible wavelength lamp glare.

Get in contact with Ushio Europe today, and allow us to advise you on the perfect single tube lamp for your process.

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## Applications

- ◆ Catering
- ◆ Stretch Blow Moulding
- ◆ Ink and Paint Drying
- ◆ Rapid Thermal Processing (RTP)
- ◆ Soldering & Reflow
- ◆ Terrace Heating
- ◆ Thermoforming
- ◆ Wellness Therapies

## Benefits

- ◆ Wide range of customisable design possibilities
- ◆ Simple power and mechanical connection possible with EmitFit
- ◆ Can be fitted with an optional reflective coating



# Double Ended Outer Jacket

Hugely popular in the catering industry, Ushio manufactures a series of single ended IR lamps which feature an additional outer tube 'jacket'. Any type of lamp can suffer a breakage or burst, however this jacketed variety of IR emitter is protected against debris or liquids that may come into contact with it, thereby avoiding premature failure.

The added layer of safety also ensures the emergence of a lamp which is ideal for applications in which foreign body contamination could destroy a product or endanger consumers.

With an Ushio IR lamp, if the main inner tube suffers a failure, the outer tube remains intact to allow safe and timely replacement.



## Applications

- ◆ Catering
- ◆ Process Drying

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# Single Ended Pin Type

Our single-ended, pin type IR lamps are a series of powerful yet compact IR radiation sources. Optionally, some models can be delivered with a reflective coating which focuses the radiation in the desired direction. This offers an improved precision over the alternatives, such as non-contact hot plates.

Bi-Pin style incandescent lamps are particularly useful when the lamp operator requires a higher level of treatment homogeneity and must overcome spatial restrictions. Our clients benefit from Ushio versatility, especially when they are implemented as part of a spot heating bank in applications involving complex contouring, such as plastic welding.



## Applications

- ◆ 3D Printing
  - ◆ Contour Heating
  - ◆ Rapid Heating
  - ◆ Riveting
  - ◆ Spot Welding
-

# Double & Single Ended Twin Tube

IR twin tube lamps are a prime example of the speciality lamp technology perfected by Ushio. A particularly unique characteristic of the twin tube lamp variety is the extraordinary mechanical robustness, a benefit achieved by fusing the two filament tubes together.

The tubes are melted together during production, for enhanced stability in lengthier installations. Twin tube lamps can be single or double ended to ensure easy integration into any machine or production line.

A rapid heat-up time of just a few seconds makes it possible to switch the emitter on and off frequently. Customisation is possible, as Ushio are ready to include modifications such as integrated reflectors, universal burning position, and waterproofing.

## Applications

- ◆ Adhesive Activation
- ◆ Composite Material Pre-Treatment
- ◆ Drying of Varnishes and Paper
- ◆ Food Preparation, e.g. Pre-Flash Freezing
- ◆ Heating and Fusing of Synthetic Materials
- ◆ Heating of Composite Materials
- ◆ Lamination and Shrinking of Foils
- ◆ Semiconductor and Photovoltaics Production
- ◆ Welding of Synthetic Fluid Reservoirs

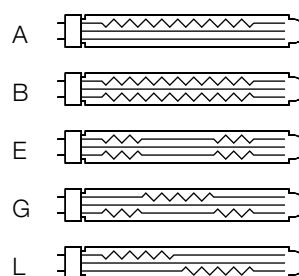
## Benefits

- ◆ High-level radiation density
- ◆ Various filament designs
- ◆ Single or double ended electrical connections available
- ◆ Can be fitted with an optional reflective coating
- ◆ Compact bridge design for maximised heating length

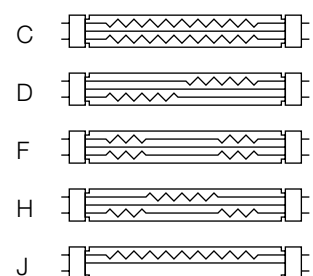


## Twin Tube Lamp Filament Design

### Single Ended



### Double Ended



# Shaped Glass Single & Twin Tube

Our specialist bent quartz lamps are built with a curved tube to ensure your emitter is able to maximise your space potential and focus the infrared radiation where it is needed the most.

Substrates with a non-uniform surface can be difficult to treat evenly with a regular IR lamp. Infrared rays follow a linear path from the point of emission, so a new solution was required.

Ushio has developed an advanced production process which has also seen the arrival of highly sophisticated bent or curved twin tube lamps. The advantage of these lamps is the possibility to combine them in a variety of ways to provide stable and homogeneous heating fields.

If our popular U-shaped glass tube is not quite to your needs, it is possible to request different shaped designs. As always, Ushio is ready to listen to your exact requirements and deliver unique solutions to your infrared industrial lighting applications.



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## Applications

- ◆ Annealing
- ◆ Automotive
- ◆ Coating
- ◆ Contour Heating
- ◆ Drawing of Plastic Fibres
- ◆ Moulded Plastic Deburring
- ◆ PET Blow Moulding
- ◆ Printing
- ◆ Textiles

## Benefits

- ◆ Lamp shape, power, and wavelength are customisable
  - ◆ Perfect for installations with restricted spatial requirements
  - ◆ Excellent mechanical stability
-

# Our Lamp Technology Explained

All Ushio infrared lamps are manufactured using the highest quality materials, and many of them are meticulously handmade by our elite production facilities. Ushio's IR solution range consists of short-wave (IR-A) and medium-wave (IR-B) emitters.

## Adaptable, Application Specific Design

Ushio's IR lamps are designed in such a way to obtain a specific power at a certain voltage. The operational lifetime of your lamp depends directly on that. A frequent load change in voltage can result in a shorter lifetime for your lamp. Operation at overvoltage will decrease the lifetime significantly. Ushio can adapt the production and handling of any IR lamp in such a way that its lifetime will not be affected by load changes. If you let us know early on, our experts can design an IR lamp with your specific needs and application in mind.

## Fully Customisable Specifications

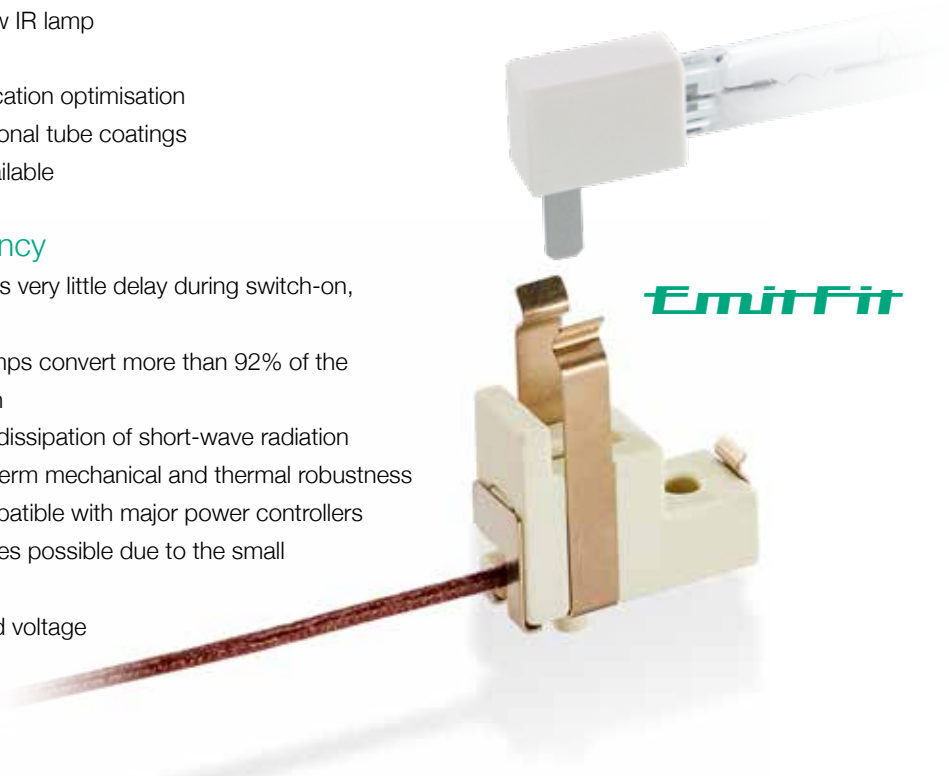
- ◆ Available from 80 W - 16,000 W
- ◆ Colour temperature from 800 K - 3,200 K
- ◆ Specific power densities available from 10 W/cm to 270 W/cm of lamp heating length
- ◆ Precision area heating up to 1000 kW/m<sup>2</sup>
- ◆ Available with or without an integrated reflector, allowing the operator to maximise the use of IR radiation instead of wasting energy through misdirected waves
- ◆ Client-specific modifications or entirely new IR lamp developments are available on request
- ◆ Radiation wavelength adaptation for application optimisation through the use of additional tubes or optional tube coatings
- ◆ Vacuum and water resistant lamps are available

## Unmatched Performance & Efficiency

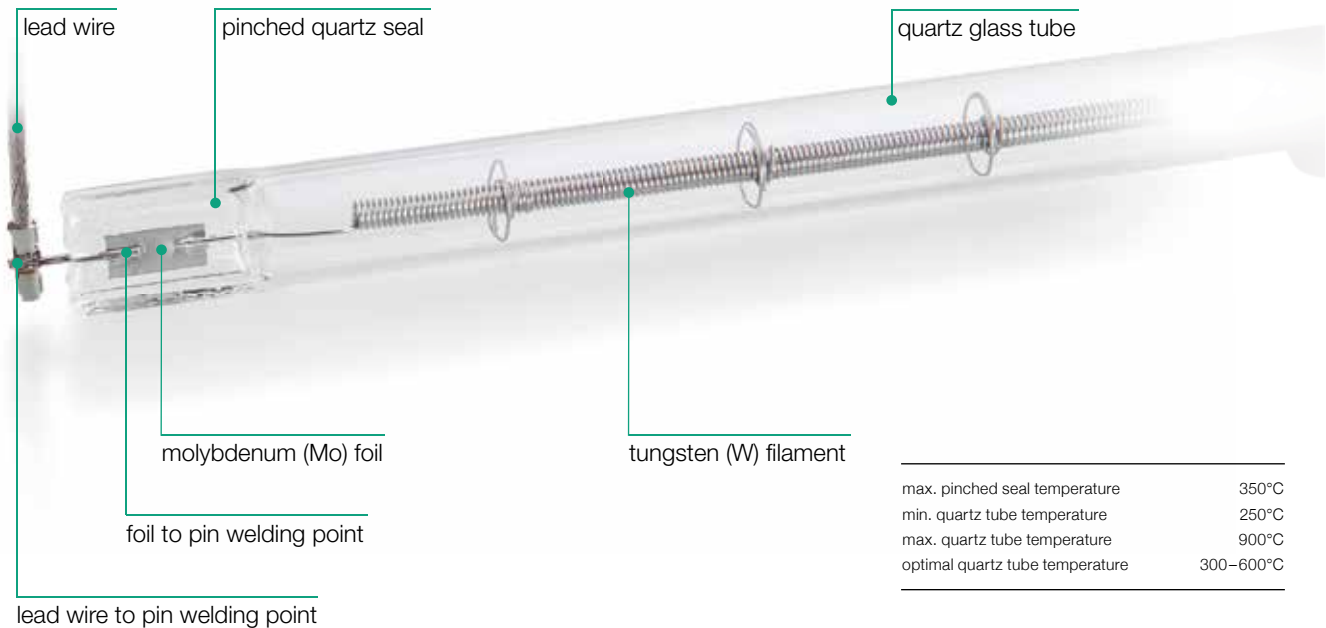
- ◆ Short reaction time: 1 - 3 seconds, ensures very little delay during switch-on, power control adjustments, and switch-off
- ◆ Efficient short and medium wavelength lamps convert more than 92% of the total electrical power input into IR radiation
- ◆ No heating of the surrounding air through dissipation of short-wave radiation
- ◆ High-quality quartz tubes guarantee long term mechanical and thermal robustness
- ◆ All Ushio IR lamps are dimmable and compatible with major power controllers
- ◆ Full integration into compact OEM machines possible due to the small dimensions of the IR lamps
- ◆ Average lifetime up to 5,000 hours at rated voltage

## Plug-And-Play: The EmitFit Way

- ◆ A unique, optional feature of Ushio IR lamps is the proprietary EmitFit 'plug-and-play' technology. With this technology, even the exchange of customised lamps becomes an extremely fast and easy task
- ◆ EmitFit is individually adjustable and combines convenience and functionality. The lamp is both electrically attached and mechanically mounted at the same time







### Only The Highest Quality Quartz Glass

All Ushio IR lamps are made using quartz glass for improved thermal shock resistance and high softening temperature. The mechanical and electronic connection to the lamp base is located at the end of the glass chamber and is fixed by special cement to a pinched or round sealing section of the quartz glass.

### The Molybdenum Foil Bridge

Electricity is able to pass through the seal thanks to the implementation of a molybdenum (Mo) foil bridge welded to the tungsten filament and contact pin. The Mo-foil is required because tungsten (W) possesses a thermal coefficient ten times that of quartz glass, which prohibits a direct bond between the two parts. The introduction of the foil allows a thermally stable, vacuum sealed connection within the quartz glass which will remain intact for the duration of the lamp's operational lifetime.

### Dispersing The Heat Load

The filament and the Mo-foil transmit the current while simultaneously dispersing the heat produced by the emitter during operation. The quartz tube can reach temperatures of 600°C to 900°C, and the persistent channelling of this heat load will raise the temperature of the foil and seal considerably.

### Heat Management Is Key

In order to preserve the operational lifetime of the emitter, the foil and seal must not exceed a temperature of 350°C. However, depending on the application in question and various environmental factors, the end user must implement a suitable cooling system to ensure the maximum operational temperature is not exceeded.

### Ceramic Isolation

At the extremities of the lamp, an outer pin mostly shielded by a ceramic base facilitates the electrical connection. The ceramics used by Ushio have high heat capacity with a high level of heat conduction and, aside from mechanically integrating the lamp to the equipment and power supply, the corrosion-resistant base serves as an electrical isolator.

Alongside the proprietary lamps, Ushio can provide you with complete industrial systems, and a range of optional features such as lamp housings, additional IR modules, power supplies, and electricals for different processes or applications.

# Increased Energy Conversion with integrated reflectors



Flame spraying the quartz tube during lamp production



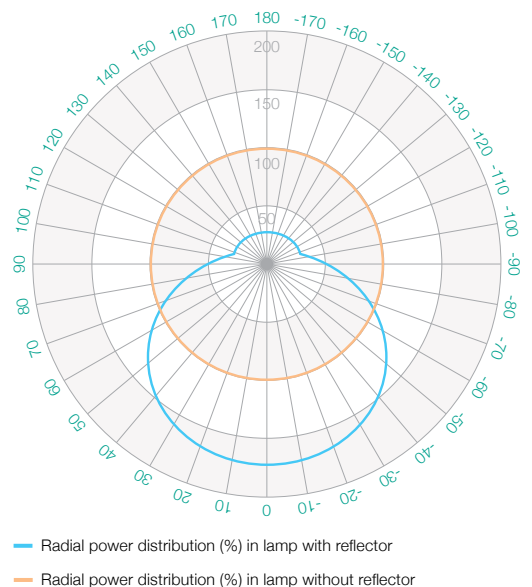
Infrared drying of ceramic bases and connection to the quartz lamp tube

## Integrated Reflectors

Due to the longitudinal dimensions of most IR lamps, the emitted radiation is radial. By using a reflector, the radiation can easily be directed, increasing usable IR power by up to 180%. Integrated or external reflectors can be used depending on the application. Integrated reflectors guarantee high quality, easy handling, and heat protection for the lamp housing.

Integrated reflectors are flame-sprayed directly on to the quartz tube. In most cases, the reflector is made from alumina ceramic ( $\text{Al}_2\text{O}_3$ ), which has a radiance efficiency of approximately 80%. The temperature resistance of the alumina ceramic reflector is higher than that of the quartz tube. This guarantees the reflector's functionality over its intended lifetime, even in applications lacking the benefits of forced air cooling.

## Relative, radial power (%) with or without an integrated reflector



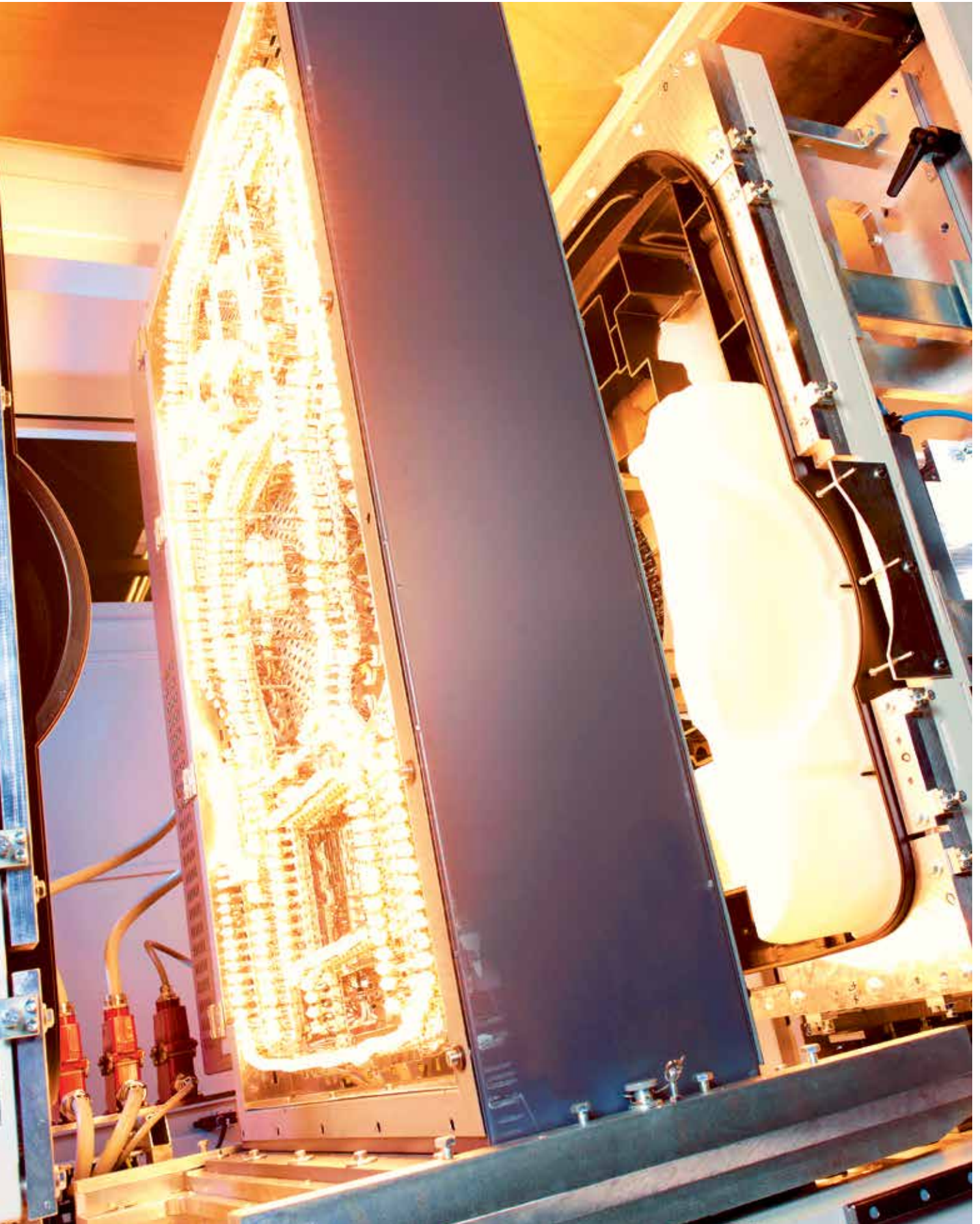
# Ushio Infrared Lamp bases and connections



# Handling & Operation tips for infrared lamps

## General Hints

- ◆ IR Lamps are for heating purposes only and are not intended for illumination purposes or use in other applications.
  - ◆ Before use, take note of the machine manufacturer's operating instructions, as well as the IR lamp operating instructions, which are enclosed with the lamp on delivery and must be observed at all times.
  - ◆ Remove any packaging material before operating the lamp.
  - ◆ IR lamps pose a high risk of burns or other serious injury. Switched off, damaged, or inoperable lamps may still be hot!
  - ◆ The lamp manufacturer does not assume liability in the event of improper lamp handling. Ushio IR lamps are subject to strict quality control measures and are designed not to cause any damage when used according to the instructions.
  - ◆ Secure lampholders and housings to prevent loosening or turning of the lamp during operation.
  - ◆ Slacken power connection wires during installation to prevent mechanical tension and potential separation from the lamp.
  - ◆ During installation and operation, care must be taken to maintain adequate distance between the IR lamp and the heated surface, as well as the reflector / fixture, to avoid damage to the lamp or substrate.
  - ◆ During operation, the IR lamp burning position must be in accordance with the enclosed specification. The burning position is specified for every IR lamp, and may vary depending on the model acquired. If the IR lamp is operated beyond the intended burning position, its lifetime will decrease significantly. Ushio offers IR lamps which are especially designed for vertical use.
  - ◆ To avoid melting of the quartz tube, interruption of the halogen cycle, and oxidation of the molybdenum (Mo) foil during operation of the lamp, care has to be taken to keep the operating temperatures as listed on page 9.
  - ◆ Always protect the lamp against mechanical stress.
  - ◆ Always operate the lamp with a fused and protected fitting.
  - ◆ To avoid lamp breakage, only use fittings which do not cause mechanical stress to the lamp.
  - ◆ IR lamps may only be handled and exchanged when disconnected from the power supply.
  - ◆ Clean gloves must be worn when handling IR lamps to avoid contamination of the quartz glass tube.
  - ◆ Check the fitting and lamp for signs of wear, dirt, charring, and any other damage. Clean or replace, if necessary.
  - ◆ If cleaning is necessary, this should be done using rubbing alcohol or another suitable alcohol.
  - ◆ Protect the machine against heat congestion and, if necessary, implement a suitable cooling system.
-



Spot welding unit with IR Pin-type lamps; image by bielomatik Leuze GmbH & Co. KG



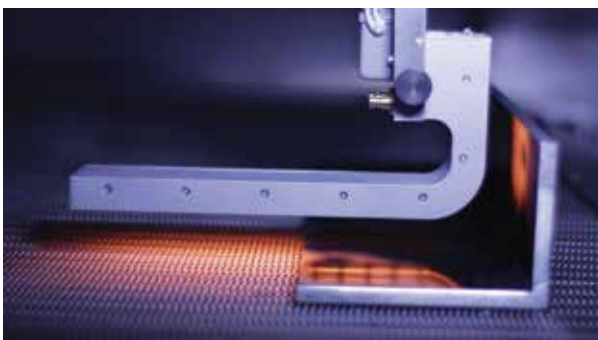
The IRtenser LC220+ is an ultra-flat, L-shaped infrared module which allows two surfaces to be heated simultaneously.

# Ushio Technical Engineering: research as a joint enterprise

With a steadfast commitment to offering every client a unique solution to their needs, Ushio Europe has pledged to involve each customer in the R&D process. Catering for the plethora of requests received at Ushio, our experts have constructed several facilities for the development and testing of vacuum-ultraviolet (VUV), UV, visible light (VIS), and IR lamps.



The completion of the Ushio Application Laboratories in Germany allows every client the opportunity to test our solutions on their own materials under strictly controlled conditions. Located in Steinhöring, Germany, prospective clients are welcome to experiment with industrial IR processes like never before.



The IR lamp engineers at Ushio undertake intensive in-house research, conceptualisation, and design while keeping you in the loop during each phase. Whether your interest lies in stretch blow moulding, or you are searching for the perfectly homogenous heat source for printed circuit board solder reflow, Ushio will lend you its knowledge and experience during the investigatory stages.

Once this crucial exploratory phase has found the best solution to compliment your application, the testing is relocated and repeated at your own production facility. Here the final adjustments can be made in a 'real world' scenario by taking your actual efficiency, environmental conditions, and production intensity into account.

Let Ushio know which industrial or laboratory solution you wish to perfect and the best product development team in the business will experiment with all manner of lamps, doses, and speeds to present you with the perfect IR solution to take your process to the next level.

The Ushio Solution Development Procedure follows a simple set of important steps to implement and maintain your Ushio infrared equipment to the highest possible standard.

## Before

- ◆ Application research and experienced comparison
- ◆ Co-operative conceptualisation
- ◆ In-house design and recommendations
- ◆ Extensive comparative testing simulations

## During

- ◆ 55+ years of speciality lighting expertise
- ◆ One-stop-shop for adjustments and advisements
- ◆ Uncompromisingly focused on impeccable quality

## After

- ◆ Controlled reassessment of solution output results
- ◆ Continued focus on improvement
- ◆ Post-sale performance analysis and alterations

## Developing Solutions Together

Ushio is a partner that listens to your ideas and requirements. Let us optimise your processes according to your specifications and expectations. Use our expertise to develop a tailor-made solution that matches your needs.

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