UV 400 AND UVR 400

True wafer surface temperature and reflectance instrumentation for GaN-based epitaxy.

The UV 400 and UVR 400 systems are the next generation of temperature sensors developed specifically for GaN-based MOCVD epitaxy processes. These pyrometers allow direct measurement of the wafer surface temperature instead of the traditional susceptor/pocket temperature.

PRODUCT HIGHLIGHTS

- Improved yield through accurate true wafer temperature measurement
- Measure temperature directly on the GaN layer using UV wavelength instrumentation
- Obtain reliable wafer temperature with PL wavelength correlation
- Capture real time reflectance measurement using a fast pulsing light source
- Prevent residue temperature oscillation as seen in NIR emissivity-compensated pyrometers
- Prevent data skew due to delayed sampling (no shutter on and off)
- Minimize noise in measurement using true photocounting instrumentation

TYPICAL APPLICATIONS

- GaN-based MOCVD epitaxy processes

AT A GLANCE

Temperature Ranges

650 to 1300°C

Spectral Range

383 to 410 nm (10% of values)

Measurement Uncertainty

< 1000°C: 3°C
> 1000°C: 0.3% oR

Repeatability

0.1% oR + 0.1°C

Optics

Fixed optics

Field of View

min 8:1 (9.8 mm)

Exposure Time t_{90}

Integration time: min of 8 ms

Output

0/4 to 20 mA, RS485

OVERVIEW

Direct measurement allows for more accurate control of the wafer temperature leading to an improved yield. These systems are setting a new standard for LED production processes with results showing reliable correlation between process temperature and final product wavelength.

The UVR 400 includes an additional reflectometer at 635 nm with 0.5 kHz measurement speed. This enables measurement of deposition thickness.

The U400 predecessor, the TR 2100, was the first pyrometer with the integrated reflectometer (in 2001), establishing the industry standard for active emissivity compensation for using 950 nm and fiber optics. Advances in sapphire light-pipe sensors and in-situ blackbody calibration sources provide a complete temperature measurement solution.

TECHNICAL DATA

Measurement Specifications	
Temperature Range	650 to 1300°C
Sub Range	Any range adjustable within the temperature range, minimum span 51°C
Spectral Ranges	383 to 410 nm (10% of values)
Detector	Photomultiplier, dark count range < 1% of the raw value at 650°C
Latency Time Between 2 Measurements	< 1 µs
Resolution	0.1°C at interface
	< 0.025% of the set partial measurement range at the analog output (12 bits)
Emissivity ε	0.100 to 1.000 in steps of 1/1000
Transmittance τ	0.100 to 1.000 in steps of 1/1000
T Integration Time	Min of 8 ms
Measurement Uncertainty[1] ($\varepsilon = 1$, $t_{90} = 1$ s, $T_{hous.} = 28$°C)	< 1000°C: 3°C
	> 1000°C: 0.3% oR
Repeatability ($\varepsilon = 1$, $t_{90} = 1$ s, $T_{hous.} = 28$°C)	0.1% oR + 0.1°C

Electrical	
Power Consumption	Max 5 W
Load (analog output)	0 to 500 Ω
Isolation	Power supply, analog output, and digital interface are electrically isolated from each other

Environmental Specifications	
Protection Class	IP 40 IEC 60529
Vacuum and Gas Conditions	Device withstands an atmosphere of nitrogen and a vacuum (< 10 mbar).
	Housing has air opening
Installation Position	Any
Operating Temperature	10 to 38°C on the housing
Storage Temperature	-20 to 50°C
Relative Humidity	Non-condensating conditions

TECHNICAL DATA (CONTINUED)

Environmental Specifications	
Weight	2.5 kg (instrument without adapter)
Housing	Black anodized aluminum
CE Label	According to EU directives about electromagnetical immunity

Interface	
Connections	M12 (8-pin) plug connector for the power supply, RS485 and analog output of the measurement temperature
	M12 (4-pin) plug connector for the analog output of reflectance measurement
Parameters	Adjustable via interface: Emissivity ε, Transmittance τ, setting time t_{90}, delete time t_{cl}, 0 to 20 or 4 to 20 mA analog output (switchable), sub range
	RS485: address, baud rate, wait time t_W
	Readable via interface: Internal detector temperature in 0.1°C

Communication	
Analog Output	0 to 20 mA or 4 to 20 mA, linear (via digital interface)
Digital Interface	RS485 addressable (half-duplex)
	Baud rate: 1200 to 38400
Maximum Value Storage	Built-in single or double storage.
	Clearing with adjusted time t_{clear} (off; 0.01 s; 0.05 s; 0.25 s; 1 s; 5 s; 25 s), via interface

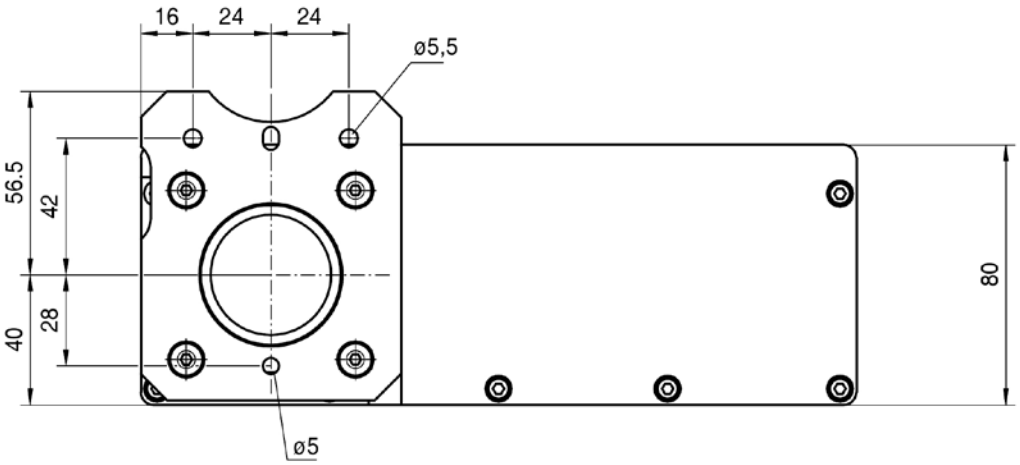
Reflectance Measurement (UVR 400 only)	
Measuring range	0 to 100%
Speed	1000 Hz
Light Source	Laser diode
Detection wavelength	635 nm ±5 nm
Measurement Uncertainty	2% of range
Repeatability	0.5% of range
Acceptable tilt tolerance of wafer	0.3°
Optical working distance a	100 mm
Analog output	0 to 20 mA or 4 to 20 mA (linear); switchable
Load	0 to 500 Ohm

1 The pyrometer must be in operation for 30 minutes before these values are valid.

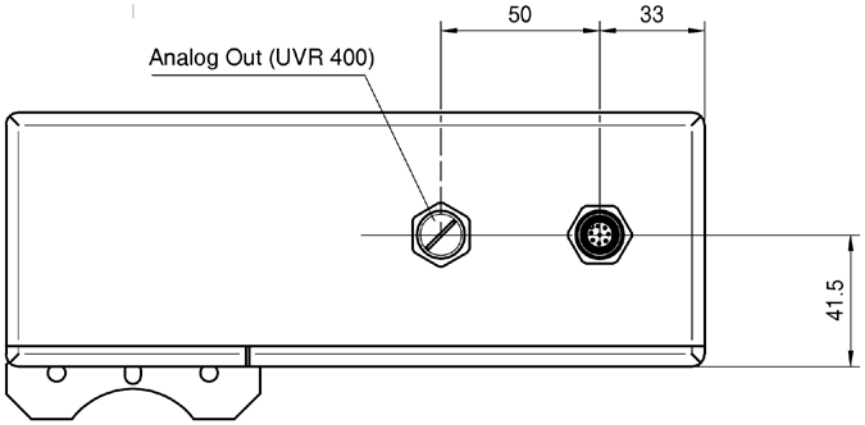
2 MB is a shortcut used for temperature range (in German: Messbereich).
The determination of the technical data of this pyrometer is carried out in accordance with VDI/VDE IEC TS 62942-2, the calibration / adjustment in accordance with VDI/VDE 3511, Part 4.4.

PRODUCT SCHEMATIC

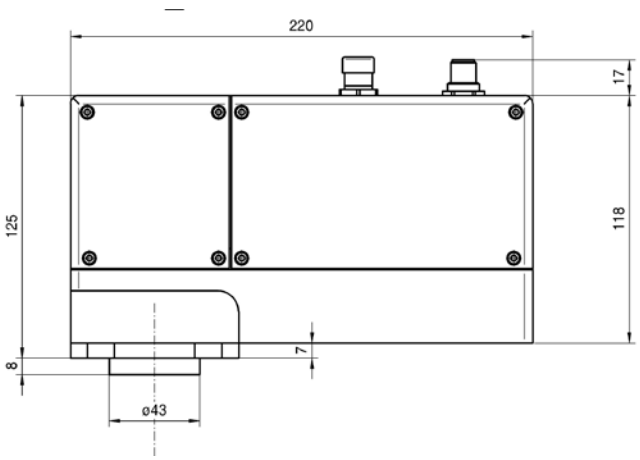
Bottom View



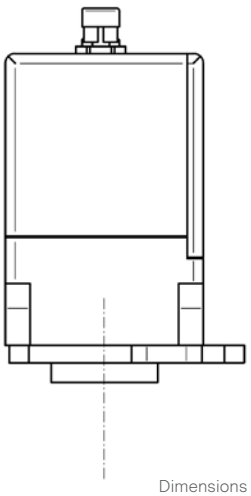
Top View



Side View



Profile View



Dimensions in mm

OPTICS

The pyrometer is equipped with the optics listed below. The optics are focused for a specific distance, which means that at that distance the optics have their smallest possible spot size in relation to the measuring distance. If the distance from the object being measured is increased or decreased, the spot size changes.

The table below shows examples of distances and the corresponding spot diameters:

Aperture D/mm	Quartz window thickness = 10 mm	Distance a [mm]	Spot diameter M [mm]
37 (G5)	with	74	9.8
37 (G5)	without	77	10.2
37 (G4)	with	80	10.0

REFERENCE NUMBERS

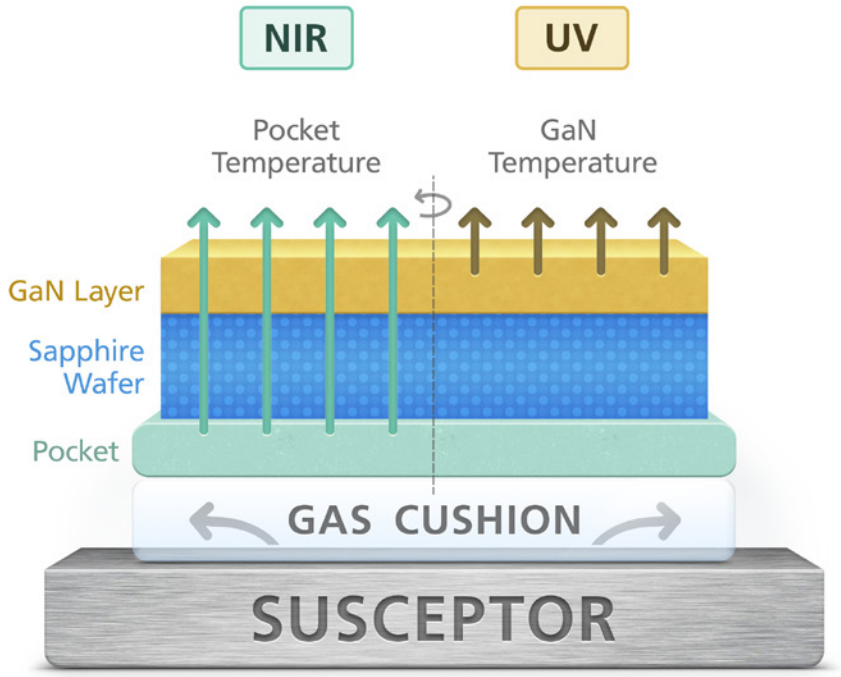
Instruments: 650 to 1300°C (MB 13)		
Type	**Variant**	**Reference Number**
UV 400 Pyrometer	G5	3 905 200
	G4	3 905 220
	Custom	3 905 240
UVR 400 Pyrometer	G5	3 905 210
	G4	3 905 230
	Custom	3 905 250

MEASUREMENT OF THE GAN LAYER

GaN material emits below 400 nm in the ultraviolet spectrum and improvements in short wavelength detectors allow for measurement of the epitaxial layer temperatures.

Unlike NIR measurement, UV measurement only measures the GaN layer. Near 400 nm, a relatively thin GaN layer becomes opaque and the pyrometer does not see through the wafer.

This results in a direct measurement of the wafer surface!

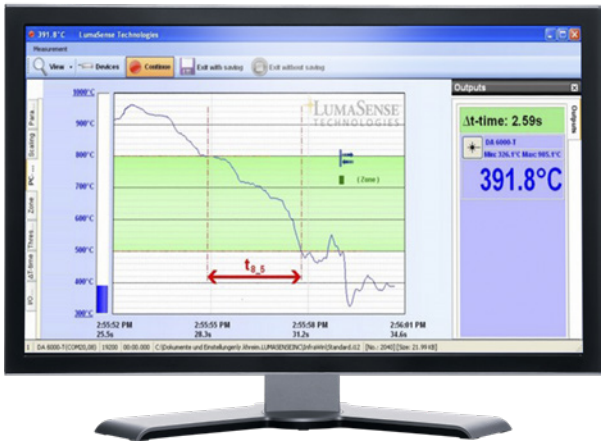


INFRAWIN 5 OVERVIEW

InfraWin is easy-to-use measurement and evaluation software for remote configuration of stationary, digital IMPAC® pyrometers.

This software allows the user to remotely adjust and control settings for one or two pyrometers from a single computer. InfraWin also allows the user to simultaneously monitor and control temperatures.

- Display temperature data as color bars and online graphics
- Capture downstream evaluations as tables, graphics or text files
- Calculate the spot size for different measuring distances
- Features UPP standard (Universal Pyrometer Protocol)



Pyrometer Settings

An IMPAC digital pyrometer connected to a PC will be automatically detected by the software. All available parameters are adjustable, including emissivity, response time, maximum value storage, output signal and sub range.

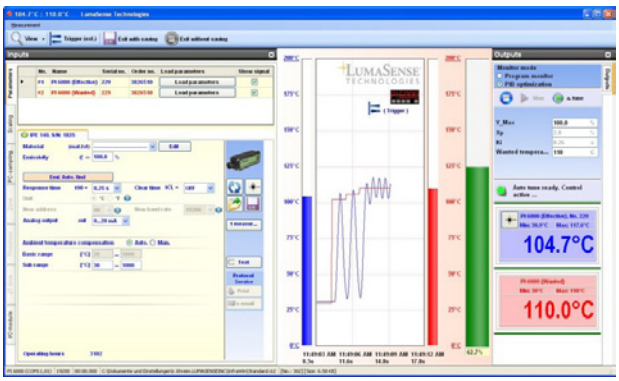
Further special functions are adjustable for example controllers or TV parameters on instruments available with these functions. Changes are transmitted directly to the pyrometer.

Measurement with Color Bar

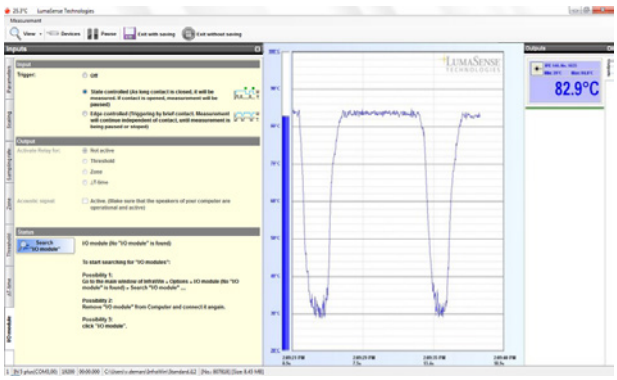
In this window a temperature value for the upper or lower limit can be adjusted numerically or with the mouse.
The acquired minimum and maximum value is indicated as well as the inner temperature of the pyrometer. The emissivity is changeable during the measurement at any time.

Infrared Calculator

After input of the aperture and the focused spot size per datasheet, the calculation of spot sizes at non-focused distances is possible.



Measurement with Internal Temperature of radiation temperature and internal instrument temperature. Parameters can be changed during the measurement.



I/O Module allows users to trigger measurement externally and gives a potential free output contact.

ABOUT ADVANCED ENERGY

Advanced Energy (AE) has devoted more than three decades to perfecting power for its global customers. AE designs and manufactures highly engineered, precision power conversion, measurement and control solutions for mission-critical applications and processes.

AE's power solutions enable customer innovation in complex semiconductor and industrial thin film plasma manufacturing processes, demanding high and low voltage applications, and temperature-critical thermal processes.

With deep applications know-how and responsive service and support across the globe, AE builds collaborative partnerships to meet rapid technological developments, propel growth for its customers and power the future of technology.

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