

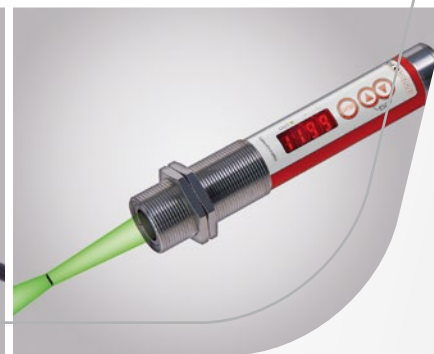
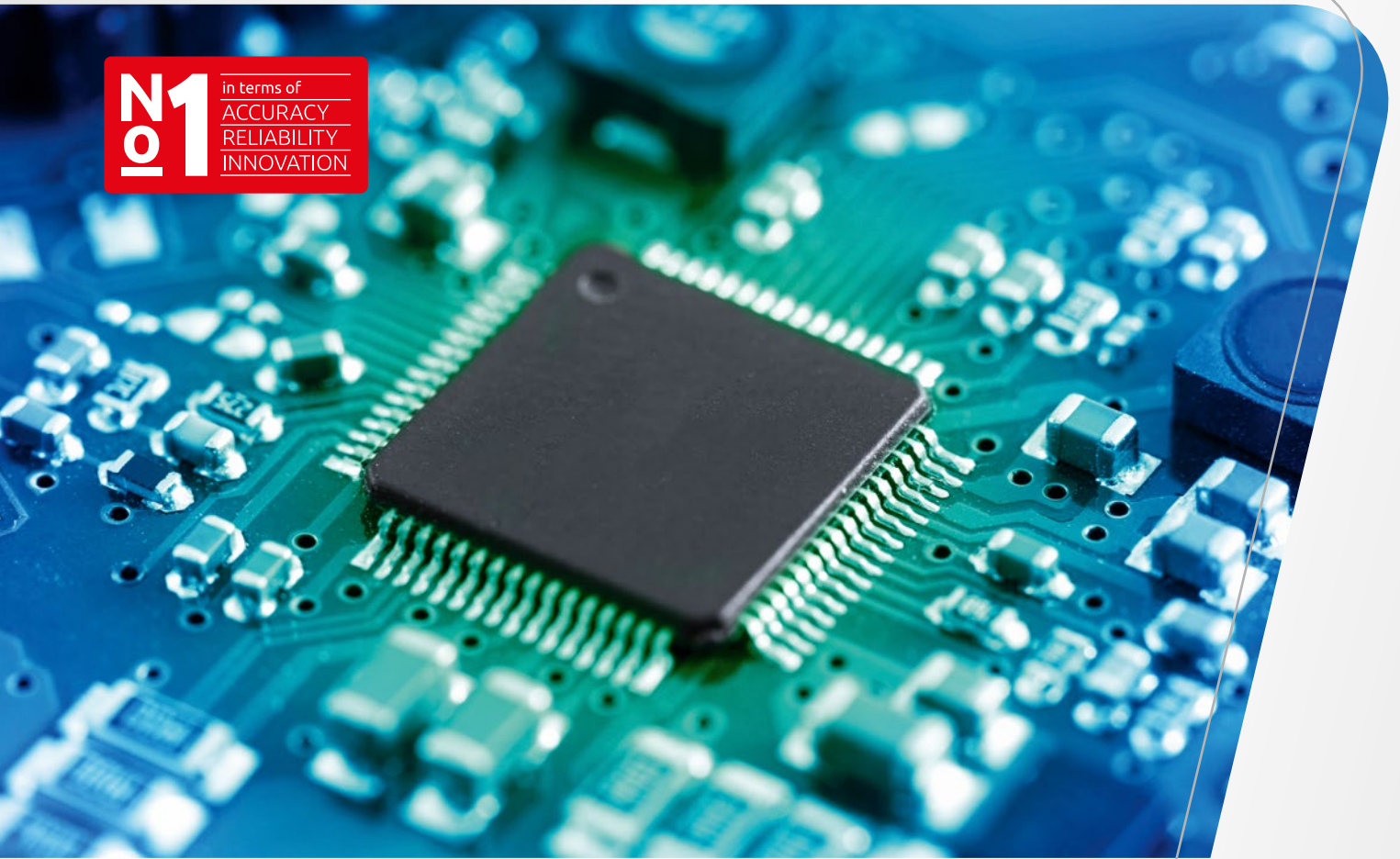
**KELLER**

*infrared  
temperature  
solutions*

**ITS**

**NO1**

in terms of  
**ACCURACY  
RELIABILITY  
INNOVATION**



# Application Semiconductor industry

Optical temperature measurement in  
crystal growth and wafer processing

## Products and processes in the semiconductor industry

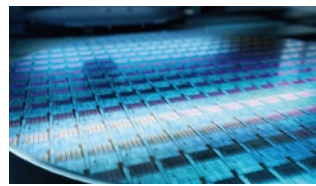
The semiconductor industry is a rapidly growing market with increasing demands on the performance and production costs of its products, such as **photovoltaic cells, microchips, LEDs and lasers**. The process chains for producing these products include the extraction of a pure semiconductor substrate with a crystal lattice that is as flawless as possible and its further processing. This further processing includes the thermal treatment and coating of wafers.

## Importance of temperature measurement

The process temperature is a decisive factor in the semiconductor production. In crystal growth and wafer processing, specific temper-



Crystal growth



Wafer processing

ature ranges must be observed in order to avoid defects and thus achieve a high yield. Real-time temperature measurement is thus of crucial importance. Optical temperature measurement with pyrometers is the ideal method to quickly determine the exact process temperature from the infrared radiation of the semiconductors without contact. The demanding and multiple measurement tasks require optimally customized pyrometer solutions.





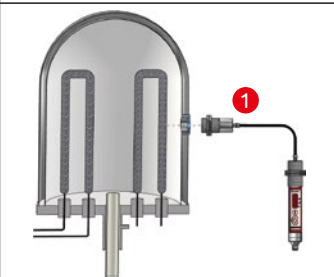
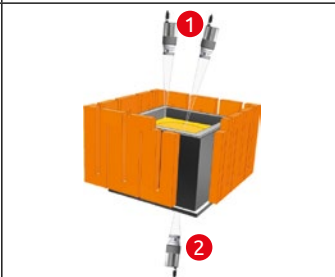
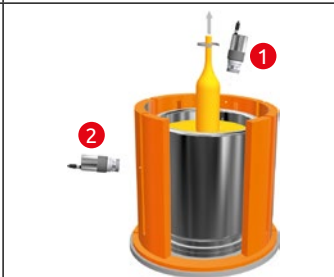
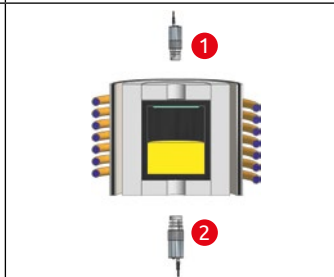
## KELLER pyrometers



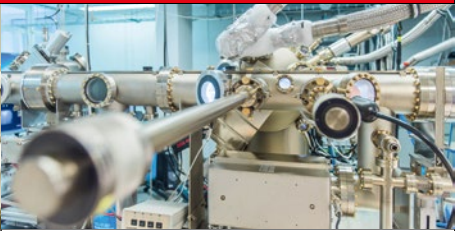
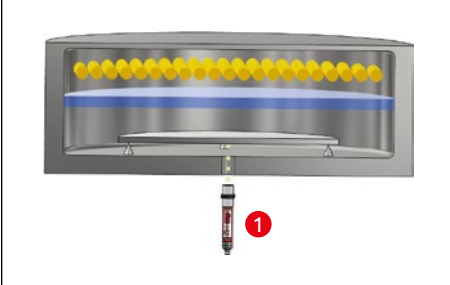
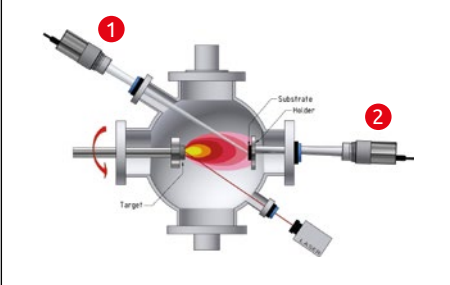
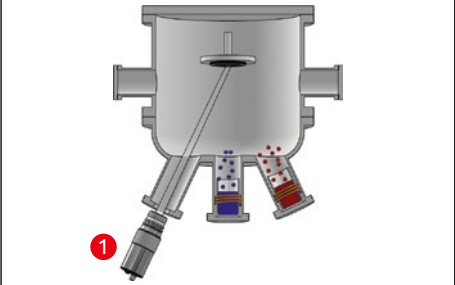
KELLER ITS has more than 50 years of experience in precise optical temperature measurement and offers special pyrometers for a wide range of processes in the semiconductor industry.

### Special features




- Measuring ranges from -30 to 3,500 °C
- Calibration at the process temperature
- Long-term stability due to minimal self-heating

## Processes and solutions

Crystal growth			
			
Siemens process	Multicrystalline silicon	Czochralski method	SiC (silicon carbide)
			
<b>Process requirements</b>			
<ul style="list-style-type: none"> <li>• Installation of the electronics outside the Ex zone of the plant</li> <li>• Initially thin Si rods require a high-resolution lens with a small measuring field diameter</li> </ul>	<ul style="list-style-type: none"> <li>• Required high measuring accuracy due to calibration at the process temperature</li> <li>• Long-term stable sensors measure reliably over the entire process time</li> </ul>	<ul style="list-style-type: none"> <li>• Required high measuring accuracy due to calibration at the process temperature</li> <li>• Long-term stable sensors measure reliably over the entire process time</li> <li>• Small heating zones require a high-resolution lens with a small measuring field diameter</li> </ul>	<ul style="list-style-type: none"> <li>• Small openings in the insulation require a narrow field of view and a sighting device with precise detection of the measuring position and size of the measuring field</li> <li>• Long-term stable sensors measure reliably over the entire process time</li> <li>• Insensitivity to dirt due to two-colour measuring method</li> </ul>
<b>KELLER solutions</b>			
PKF 66 AF 1	PX 44 AF 4	PX 44 AF 4	PX 45 AF 1

Heat treatment	Coating	
		
RTP (Rapid Thermal Processing)	PLD (Pulsed Laser Deposition)	MBE (Molecular Beam Epitaxy)
		
<b>Process requirements</b>		
<ul style="list-style-type: none"> <li>• Semiconductor wafers require a spectral sensitivity of the pyrometer below the band gap</li> <li>• High-intensity lenses enable the measurement of low process temperatures</li> </ul>	<ul style="list-style-type: none"> <li>• Pulsed laser radiation requires blocking filters and sensors that are not affected by the laser</li> <li>• Small substrates require high-resolution lenses with a small measuring field diameter</li> </ul>	<ul style="list-style-type: none"> <li>• Coated substrates require a short-wave spectral sensitivity of the pyrometer</li> <li>• Changing coating materials require large measuring spans with consistently high measuring accuracy</li> </ul>
<b>KELLER solutions</b>		
PA 38 AF 10, PK 35 BF 1	PX 29 AF 21	PA 20 AF 1, PA 38 AF 10

## Product overview

	Designation	Measuring range	Wavelength	Special features	Other features
	PX 44 AF 4	750 - 2400 °C	0.95 / 1.05 µm	<ul style="list-style-type: none"> <li>• Special calibration for silicon (Si) enables very high measuring accuracy at the process temperature</li> <li>• Precise alignment</li> </ul>	<ul style="list-style-type: none"> <li>• Focusable interchangeable lenses</li> <li>• Optionally with through-the-lens sighting, laser pilot light or video camera</li> <li>• Analog current output and digital interface</li> </ul>
	PX 45 AF 1	900 - 3200 °C	0.9 / 1.05 µm	<ul style="list-style-type: none"> <li>• Narrow beam path</li> <li>• High temperature two-colour pyrometer</li> <li>• Special calibration for SiC</li> </ul>	
	PX 29 AF 21	180 - 1200 °C	1.8 - 2.2 µm	<ul style="list-style-type: none"> <li>• Special blocking filter and sensor against the influence of external radiation</li> </ul>	
	PX 20 AF 1	210 - 2000 °C	1.1 - 1.7 µm	<ul style="list-style-type: none"> <li>• Large temperature measuring range</li> <li>• High-resolution lens for measuring the smallest objects</li> </ul>	
	PA 38 AF 10	450 - 1800 °C	0.82 - 0.93 µm	<ul style="list-style-type: none"> <li>• Special wavelength for silicon wafers</li> <li>• High-intensity lens for measuring low temperatures</li> </ul>	
	PK 35 BF 1	450 - 1400 °C	0.82 - 0.93 µm	<ul style="list-style-type: none"> <li>• Special wavelength for silicon wafers</li> </ul>	
	PKF 66 AF 1	700 - 1800 °C	0.95 / 1.05 µm	<ul style="list-style-type: none"> <li>• Fibre optic cable pyrometer with optical measuring head</li> <li>• Short-wave and narrow-band for temperature measurement of silicon (Si)</li> <li>• High optical resolution</li> </ul>	

Further measuring devices with temperature ranges from -30 to 3,500 °C can be found on our website [www.keller.de/its](http://www.keller.de/its)

# KELLER

Creating Solutions


infrared  
temperature  
solutions

## ITS



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- Sales and Service Center
- Sales abroad



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