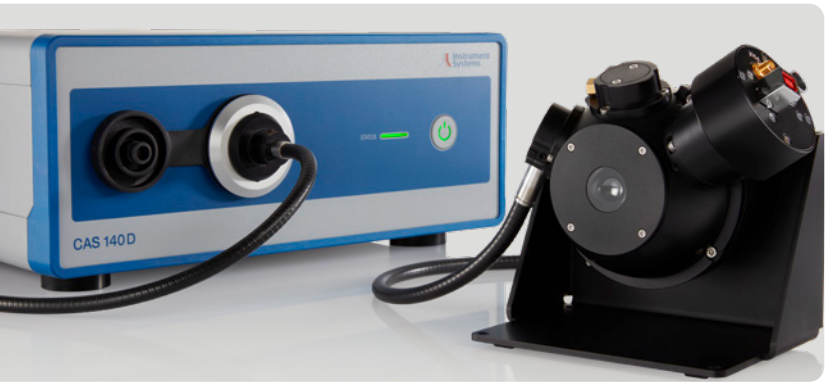
SYSTEMS & SOLUTIONS

IR Measurement Portfolio & Solutions





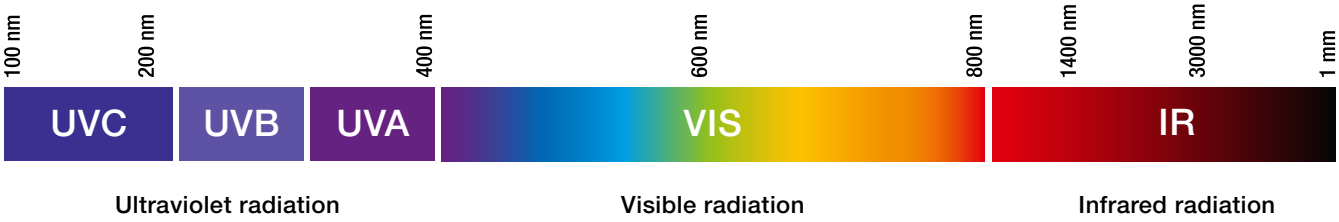
For
Infrared
Light Sources

Instrument Systems
KONICA MINOLTA Group

01 \\ Introduction

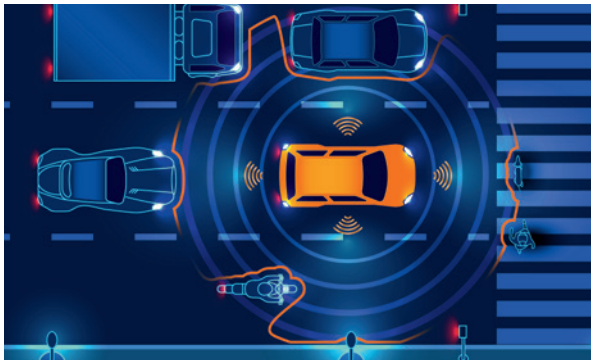
Infrared (IR) is defined as electromagnetic radiation (800 nm – 1 mm range) with wavelengths longer than those of visible light. The relevant range for radiation measurement is the near-infrared range (NIR) from 800 – 1400 nm and the short-wavelength IR (SWIR) from 1400 – 3000 nm.

Especially the use of VCSEL (surface emitting lasers) has enabled many new applications for consumer equipment and in the field of 3D sensing.



IR application examples

- 3D sensing in consumer electronics:
  - Time-of-Flight (ToF)
  - Facial recognition (structured light)
- 3D sensing in automotive / industry:
  - LiDAR
  - In-cabin driver monitoring systems
  - Occupancy monitoring systems
- Optical under-display fingerprint sensor (e.g. 1380 nm)
- Proximity sensors and 1D Time-of-Flight
- Eye tracking and gesture recognition (AR / VR)
- Optical sensing for healthcare wearables
- Night vision (IR illumination for cameras)
- Data transmission
- Sunlight / solar simulators



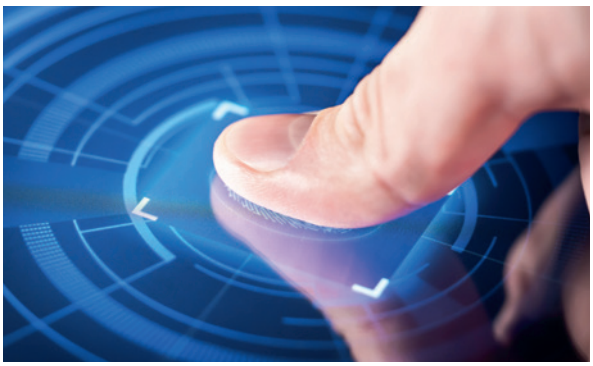
3D sensing in automotive (LiDAR)



Face ID (structured light),
eye tracking & gesture recognition (AR/VR)



Broadband IR sources
(sun light / solar generators)



Optical fingerprint detection

02 \\ Measurement systems

We offer an extensive portfolio covering IR radiation measurement as well as other aspects related to the control of the device under test (DUT).
Our key benefits are highest accuracy combined with a high modularity and therefore high flexibility.

Based on the application requirements we create a system solution by combining hardware and software. The table below shows the key items of a system.



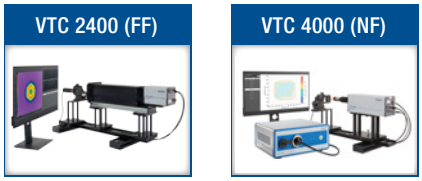
Software

- Controls measurement equipment and other system components
- Provides results and reporting



Radiometric 1D measurement equipment & calibration

- Measurement with spectroradiometer and optical probes, i.e. integrating sphere
- Photodiode for fast power measurement



2D measurement equipment & calibration

- Camera based measurement
- Near-field and far-field options



Device under test (DUT) control

- TEC Control:
  temperature control and measurement
- Power Source:
  driving and electrical measurements

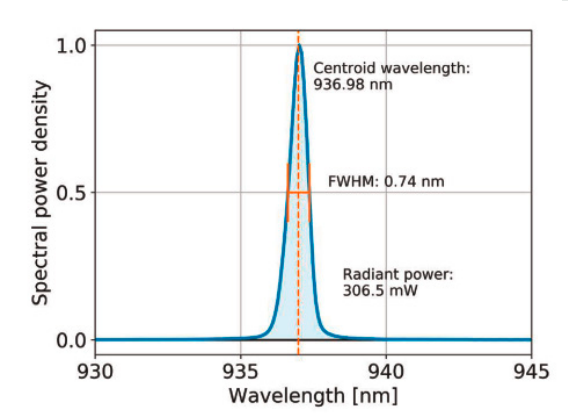


Audit concept

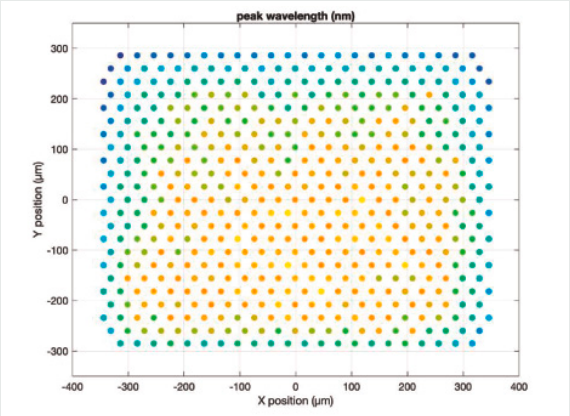
- Ensures traceability and error budget
- Worldwide service partners

Our systems are used to test IR sources in lab applications as well as during the production process. There is a wide range of measurements as shown below:

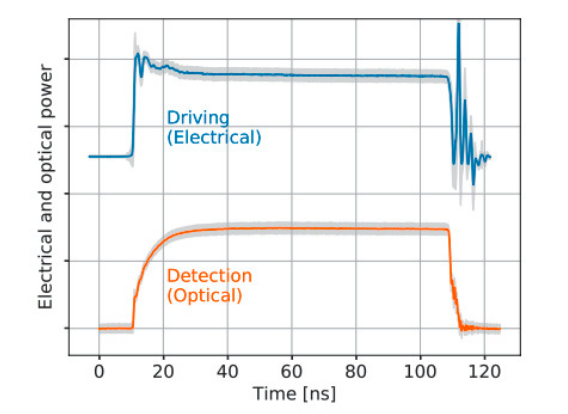
Spectral and power measurement



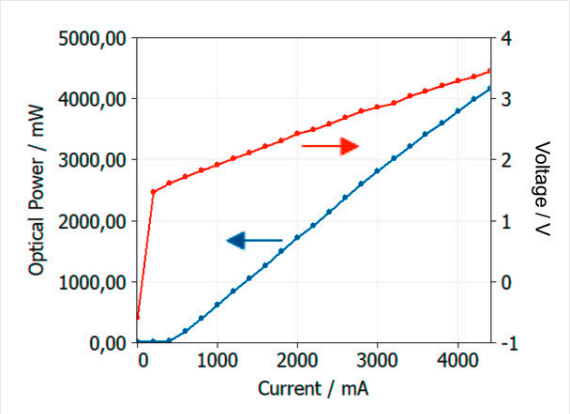
Single emitter uniformity (2D)



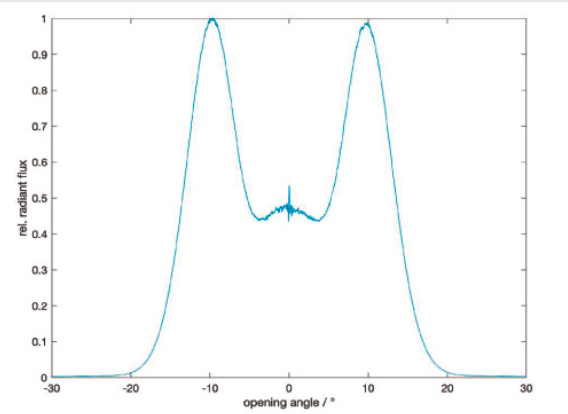
Time-resolved optical output measurement



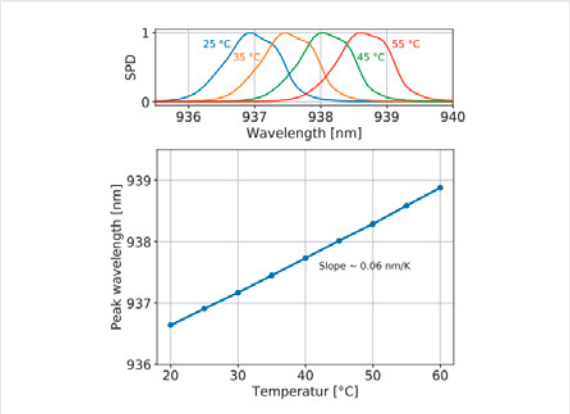
Optical output as function of current/voltage (LIV curve)



Angular-resolved measurement



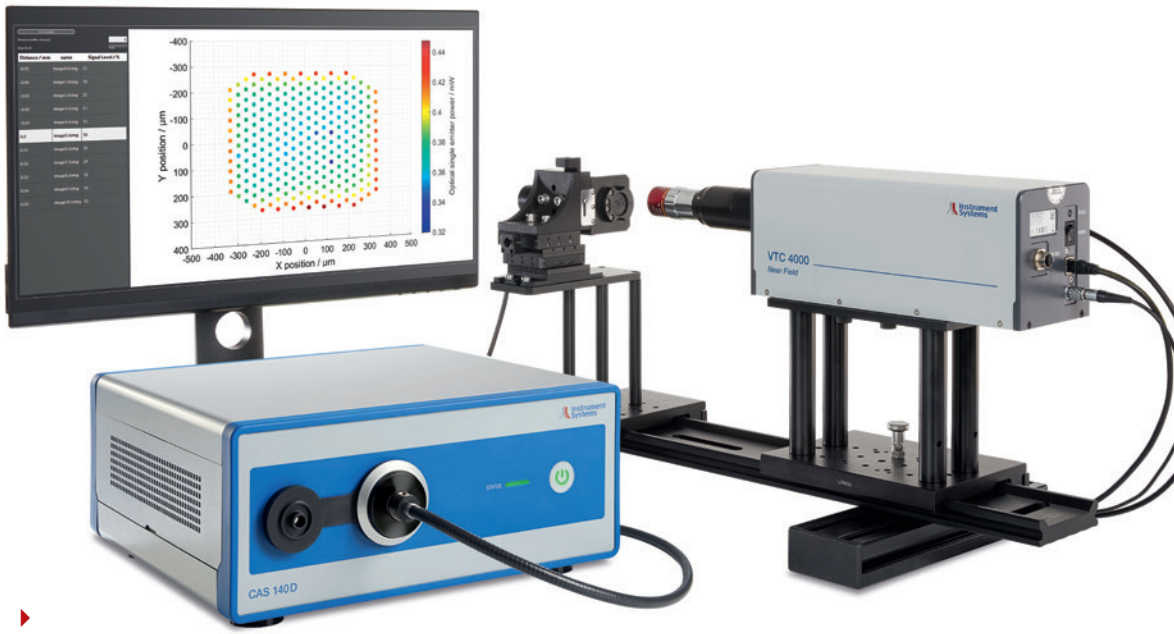
Temperature dependence of the optical output



The following table provides an overview of four different system solutions: The modular test system and the camera-based systems VTC 2400 and VTC 4000 and the scope of measurement possible with each. A more detailed description of each solution will be given in the next sections.

	Modular test system	VTC 2400	VTC 4000
DUT (device under test)	VCSEL, LED, other	VCSEL	VCSEL
Spectral-resolved	●	–	○
Radiant power	●	●	●
Time-resolved: microsecond (µs)	●	–	–
Time-resoved: nanosecond (ns)	–	–	–
Angular-resolved: 4pi	○	–	–
Angular-resolved: < 2pi	●	●	–
Single emitter uniformity (2D)	–	–	●
LIV curves (optical-electrical)	●	–	–
Temperature dependency	●	–	–

● Possible
○ Optionally available



VTC 4000 VCSEL testing camera for comprehensive near-field analysis of complete VCSELarrays.

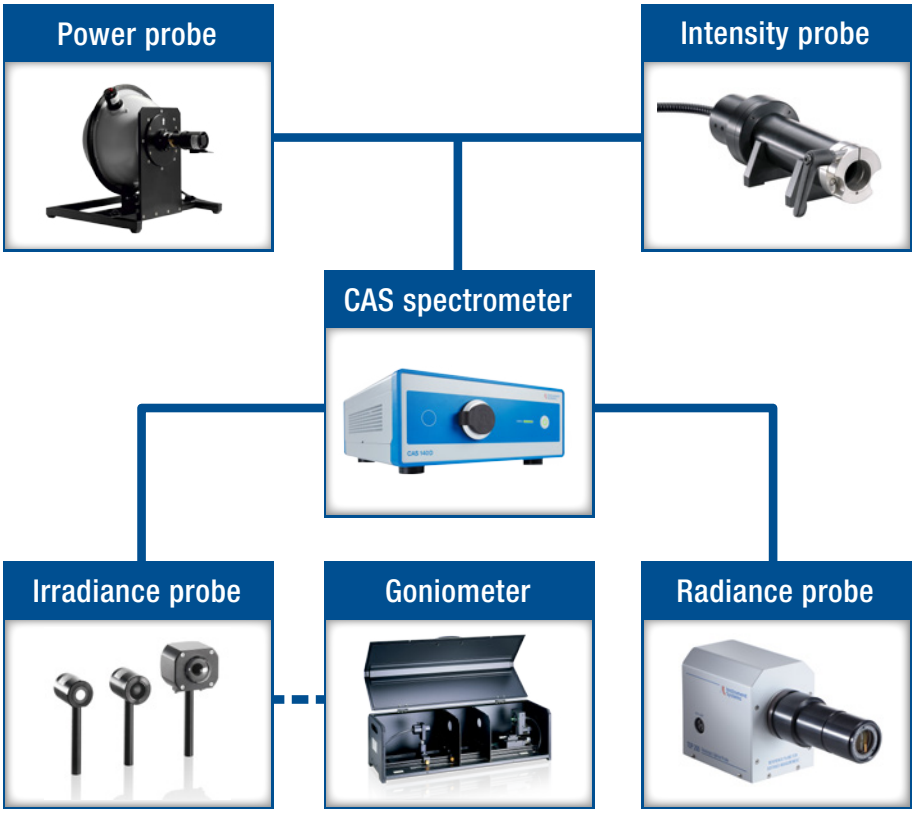
2.1 Modular test system

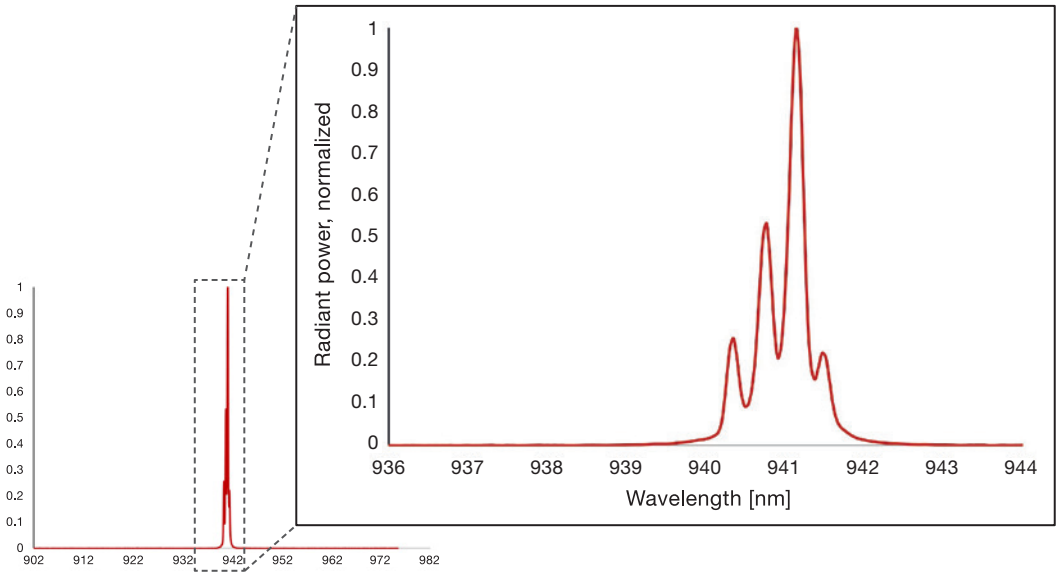
Our modular spectroradiometers can be combined with a wide range of interchangeable measurement probes that are connected by a fiber bundle and serve as “light collector” (see image). Depending on the physical quantity to be measured, e.g. luminous flux, different optical probes must be used. Each measurement probe is calibrated together with the spectroradiometer in our ISO 17025 accredited testing lab. This allows the traceable measurement of the calibrated optical quantity together with the spectral data and a specified error budget.

We offer an extensive portfolio of spectroradiometers that cover a broad spectral range. Specifically designed for VCSEL measurements we offer a high-resolution version (HR) that can achieve a spectral resolution down to 0.09 nm to resolve narrow laser spectrum (see image).

Goniometer systems additionally enable angle-resolved determination of the radiation pattern.

For production line applications where every ms matters, photodiodes can be incorporated into the system. Attached to the integrating sphere this allows fast power measurement. A traceable calibration ensures correct absolute values.





Spectral radiant power of a 940 nm VCSEL. It was measured with a CAS 140D-HR model with a spectral range of 902 to 982 nm and corresponding spectral resolution of 0.2 nm (FWHM).

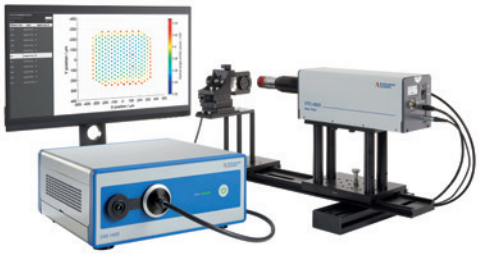
	Modular Test System
Applications	
	◢ For laser sources / VCSEL, LEDs and other emitter ◢ Range 200 – 1700 nm ◢ Pulse driving and time-resolved measurement > 1 µs possible ◢ High flexibility thanks to modularity
Software	
For lab (GUI)	SpecWin Pro / Light
For integration/production	SDK (CAS-DLL)
Radiometric measurement equipment	
Spectrometer	◢ CAS Series spectrometer (range 200 – 1700 nm) ◢ Various probes
Photo Diode	◢ For power measurement (range 400 – 1100 nm or 900 – 1700 nm) ◢ For time-resolved measurement (> 1 µs)
Goniometer (angular distribution)	◢ LEDGON ◢ LGS
DUT Control	
Power source	◢ Keithley SourceMeter ◢ Vektrex SpikeSafe SMU ◢ Constant power or pulse driving (> 1 µs)
TEC Control	◢ Arroyo TEC driving ◢ Temp. range 15 – 150 °C
Calibration standard	
	◢ ACS NIR standard for radiant flux (860 / 950 nm)

2.2 Camera based systems for VCSEL measurement

VCSEL devices typically consist of several hundreds of single emitters being arranged in an array (also referred to as a “VCSEL array”). Instrument Systems offers cameras for two-dimensional characterization of both single emitters (called “near-field”) as well as the beam resulting from the complete array (called “far-field”).

The VTC 2400 is the perfect solution for analyzing the far-field beam profile of the complete VCSEL array/ ensemble. It consists of a light-permeable screen, which is irradiated by the device-under-test, and a camera, which captures the radiant intensity distribution from the other side of the screen. Coming with a PTB-traceable calibration, the VTC 2400 allows absolute measurement of 2D radiant intensity distribution in a defined distance of the device-under-test. This allows analyzing the beam opening angle, the cross-section profile and the identification of the highest intensity spot for laser safety evaluations.

On the other hand, the VTC 4000 is our VCSEL testing camera for the comprehensive near-field analysis of single emitters on a VCSEL array. The camera comes with absolute power and flat-field calibration traceable to national standards. As a results, the VTC 4000 allows absolute and polarization-resolved 2D characterization of all relevant parameters for every single emitter on the array such as position, radiant power, polarization, numerical aperture, beam waist, M^2 value and peak wavelength.

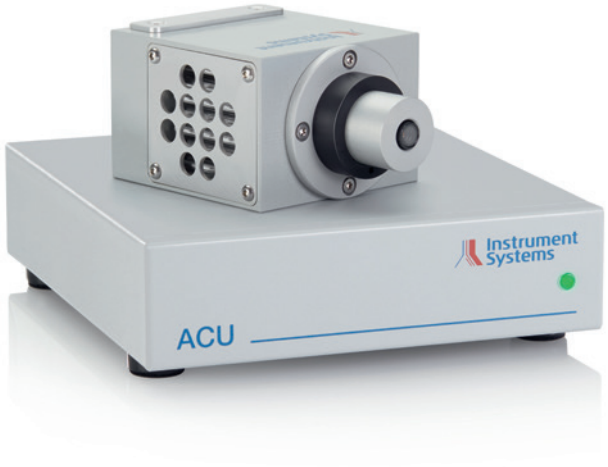
	VTC 2400 for far field characterization	**VTC 4000 for near field characterization**
		
Applications		
	◢ Angular distribution measurement for complete VCSEL arrays/IR LEDs ◢ Range 800 - 1100 nm ◢ Uniformity control of the radiation pattern ◢ Investigation of the absolute radiant power of the device-under-test for eye safety considerations ◢ Suitable for R&D as well as production applications (with light-proof housing)	◢ 2D analysis of single VCSEL emitters on an array with unprecedented measurement accuracy ◢ Range 900 – 980 nm ◢ Defect emitter analysis on wafer or chip level ◢ For VCSEL quality control in production lines and laboratory applications
Measurement results		
	◢ Single-shot absolute radiant flux ◢ Angular and spatial distribution of radiant intensity ◢ Opening angle as well as cross-section profile of the emitted light ◢ Identification of highest intensity spot according to IEC:60825-1 laser safety norm	◢ One-shot single emitter position, absolute radiant power and polarization characteristics (angle and degree) ◢ Divergence, numerical aperture, M^2 value (with z-stage) ◢ Spectral information (e.g. peak wavelength) available as optional extension
Software		
For lab (GUI)	-	-
For integration/production	LumiSuite with VTC GUI	LumiSuite SDK
Radiometric measurement equipment		
Camera	◢ VTC 2400 with light-permeable screen	◢ VTC 4000
Spectrometer	-	◢ HR-CAS spectrometer (range 800 – 1000nm)

2.3 Audit system

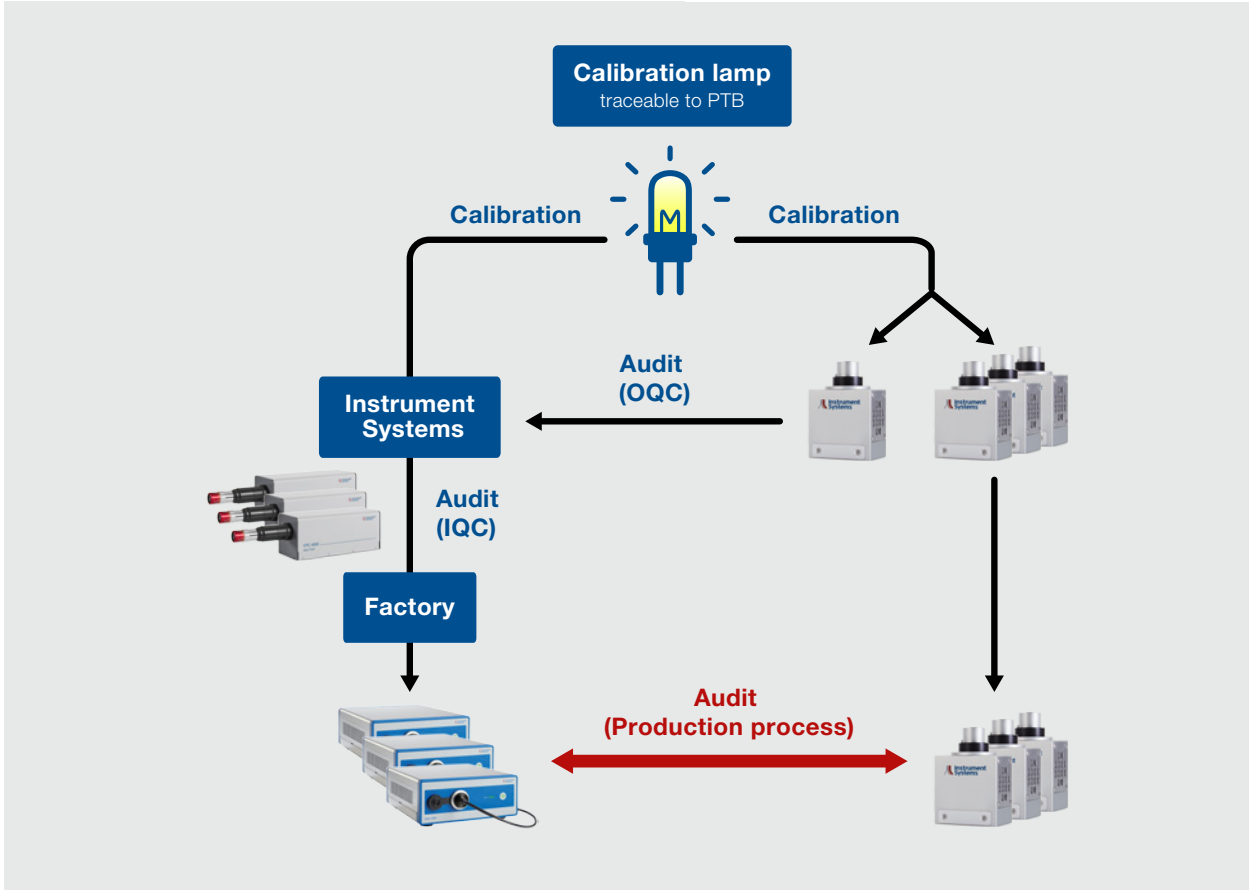
Only regular checks of a measuring system for conformity with its specifications will ensure the proper functioning and quality of the measuring system and the comparability of readings in the long term. For this purpose, the audit portfolio from Instrument Systems offers a large selection of application-specific solutions in factory or lab.

For an audit in the infrared region, Instrument Systems offers calibration standards of ACS 57x series.

These highly stable infrared sources based on LED technology are available in five versions with typical peak wavelengths of 860 nm, 950 nm, 1200 nm, 1300 nm, and 1450 nm. As a service, Instrument Systems provides traceable reference values for radiant flux.



ACS-57x series IR LED calibration standards for radiant flux and ACU Control Unit



Audit process in production

03 \\ Portfolio Overview

Spectrometer







Device	Description
CAS Standard Series (CAS 120/125/140D)	◢ Standard UV-VIS-NIR versions ◢ For LEDs and broadband emitter ◢ Detector: CCD or CMOS ◢ Range: 200 – 1100 nm
CAS HR Series (CAS 120-HR/125-HR/ 140D-HR)	◢ High resolution NIR versions ◢ For Laser / VCSEL ◢ Detector: CCD or CMOS ◢ Range: 800 – 1000 nm
CAS IR Series (CAS 140D-IR)	◢ IR versions ◢ For emitter in range above 1100 nm ◢ Detector: InGaAs ◢ Range: 780 – 1700 nm

Radiometer / Photo diode

Device	Description
Standard photo diode	◢ For power and microsecond pulse measurement ◢ For all kind of applications ◢ Keithley multimeter Plugin for SpecWin Pro (DMM 65xx / 75xx)

Camera-based measurement instruments





Device	Description
VTC 2400	◢ Camera combined with a screen to measure the angular intensity distribution. ◢ Faster alternative to a goniometer measurement, especially for production testing.
VTC 4000	◢ Camera with microscope lens to measure the individual emitter on a VCSEL array directly. ◢ Optional with a spectrometer for wavelength measurement.

Light measurement accessories (for spectrometer)













Device	Description
Integrating spheres (ISP-xxx)	◢ Quantity: Power (W) ◢ Measure total light output ◢ Size from 75 mm up to 2 m
Irradiance probes (EOP, ISP 40, LEDGON head)	◢ Quantity: Irradiance (W/m²) ◢ Measure received radiation / illuminated area ◢ Used for goniometer measurement
Intensity probes (LED-4xx, LED 25)	◢ Quantity: Radiant intensity (W/sr) ◢ Measure at a defined distance and angle ◢ I_LED_B geometry
Telescopic Probes (TOP 150/200)	◢ Quantity: Radiance (W/sr/m²) ◢ Measure spot on the emitter surface ◢ Includes view-finder camera
LEDGON	◢ Goniometer for single emitter and small boards ◢ DUT up to 160 mm diameter ◢ Includes a light cover
LGS 350	◢ Goniometer for medium sized samples ◢ DUT up to 740 mm diameter ◢ DUT temperature control option

Calibration and monitoring equipment



Device	Description
ACU 100	◢ Control Unit for ACS-570
ACS 570-15 ACS 570-17 ACS 570-42 ACS 570-44 ACS 570-46	◢ IR-LED standard for radiant flux (860 nm) ◢ IR-LED standard for radiant flux (950 nm) ◢ IR-LED standard for radiant flux (1200 nm) ◢ IR-LED standard for radiant flux (1300 nm) ◢ IR-LED standard for radiant flux (1450 nm)

DUT Electrical driving and measurement







Device	Description
Keithley SourceMeter (W-11x/12x/13x)	◢ 24xx/26xx product range for all kind of DUTs ◢ Model 2601B-Pulse supports 10 µs pulses ◢ Control plugin for SpecWin Pro/Light
Vektrex SpikeSafe SMU	◢ For **microsecond** pulse driving ◢ Control plugin for SpecWin Pro
Short Pulse Unit	◢ For **nanosecond** pulse driving ◢ For 3D sensing applications (LiDAR, ToF) ◢ Special control software

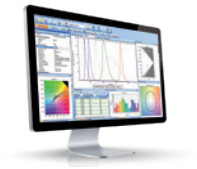
DUT Temperature control and test sockets





Device	Description
Arroyo TEC-Source 53xx (W-210)	◢ TEC Control unit for LED-850/870 ◢ Control plugin for SpecWin Pro
Arroyo TEC-Mount (LED-870)	◢ TEC Fixture with cooling plate for DUT ◢ Test DUT on a board
Test socket with TEC (LED-850)	◢ Mount for packaged LED with TEC control ◢ Includes wiring for DUT driving
Test sockets (LED-5xx and -6xx)	◢ Mount for packaged LED (without TEC) ◢ Includes wiring for DUT driving

Software



Device	Description
SpecWin Pro/Light	◢ For spectrometer related measurements ◢ Plugins for current sources and TEC control
LumiSuite GUI	◢ For camera-based measurement devices
SDK / DLL / LabView driver	◢ Software integration ◢ Automated production testing

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