LED
Microsensor NT

NEAR AND MIDDLE INFRARED OPTOELECTRONICS
1000 - 5000 nm

LEDs - Photodiodes - Minispectrometers

CONTENTS

Rev. 280518

HEAD OFFICE **LED Microsensor NT, LLC** and R&D CENTRE **Microsensor Technology, LLC**
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LED Microsensor NT LLC is a company focused on developing and manufacturing optoelectronic devices for optical analysers and sensor systems. The company offers a wide range of Light Emitting Diodes (LEDs), LED matrices and Photodiodes (PDs) that cover the near and middle infrared (IR) range from 1000 to 5000 nm, related electronic devices and systems on their basis.

Our key technology is the epitaxial growth of narrow-band-gap semiconductors based on GaSb-InAs solid solutions.

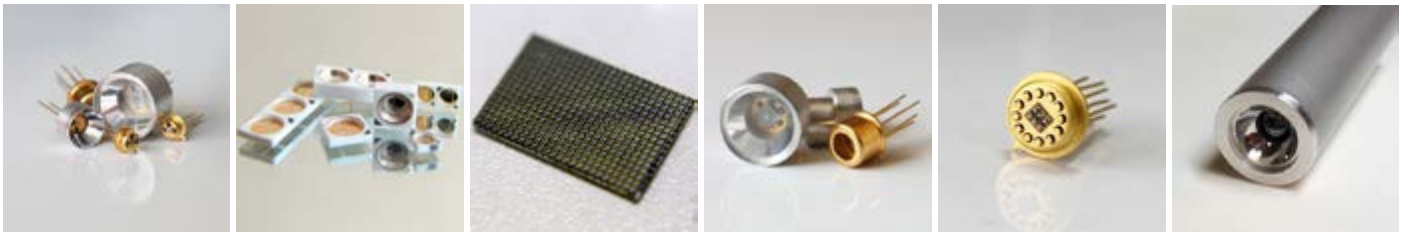
The company has a professional team of leading Russian scientists with more than 15 years' experience in research and development of heterostructures for the infrared spectral range, design of optoelectronic devices, customer service and support.

In 2011, Rusnano Corporation made an investment in LED Microsensor NT in order to expand the production volume of infrared LEDs and photodiodes. In 2012 a spin-off R&D company Microsensor Technology LLC was founded, focusing within itself the intellectual capacity and the necessary basis for research and development of the new products – LED matrices, optical cells and modules. The company became a resident of the Skolkovo Innovation Centre and carries out numerous challenging R&D projects.

We propose our product as a new powerful base for optical absorption analysis. One of the greatest advantages of this method is that virtually any sample in virtually any state may be studied: liquids, gases, films, powders and surfaces can all be examined with a proper choice of sampling technique. Using LED-PD optopairs for the infrared spectral range has allowed the development of portable sensors with high reliability, fast response time and very low power consumption that can be successfully applied in different areas for matter analysis purposes.

Standard products

Light Emitting Diodes (LEDs), Photodiodes (PDs), LED matrices



Electronic devices, evaluation kits and systems

LED driver

Synchronous detector

Multichannel driver with synchronous detector

Evaluation kits for CH_4/CO_2 detection

NEW LED Minispectrometer

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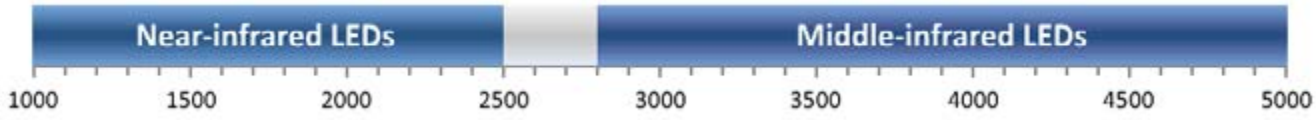
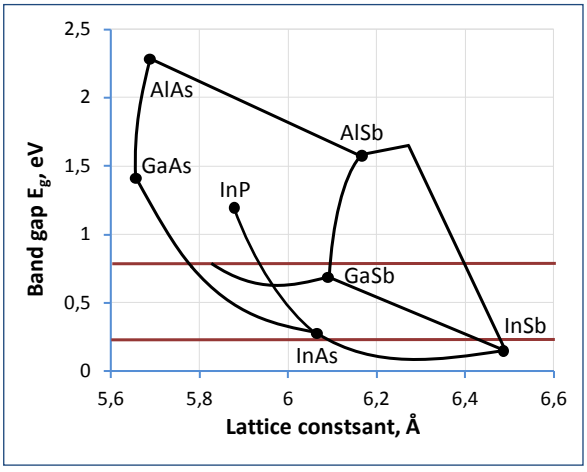
Our products came into existence as a result of intensive investigations in semiconductor physics. First laser heterostructures in the world were created at the end of the 1960th in the Ioffe Physical-Technical Institute by Zhores Alferov, who was awarded the Nobel Prize in physics in 2000 for this invention.

LED and photodiode heterostructures are formed by sequential epitaxy of semiconductor layers on the surface of a crystal substrate. The emission wavelength of an LED and the spectral response of a photodiode are determined by the energy band gap of the material used in the active layer. Narrow band gap structure based on GaSb-InAs solid solutions enabled the creation of emitters and detectors that operate in the near-infrared and middle-infrared spectral ranges.



Nowadays, semiconductor optoelectronic devices are widely used for lighting and telecommunications. The near-infrared and middle-infrared ranges are remarkable as many chemical agents have absorption bands here: CH_4, H_2O, CO_2, CO, C_2H_2, C_2H_4, C_2H_6, CH_3Cl, HCl, HOCl, HBr, H_2S, HCN, NH_3, NO_2, SO_2, glucose and many others. LEDs and PDs operating in the range from 1000 nm to 5000 nm possess great potential for use in optical analysing systems. Great interest in these components is due to the need of compact, cost-effective, durable sensors with very low power consumption and fast response time.



Using GaInAsSb/AlGaAsSb-based heterostructures lattice matched to GaSb substrate allowed us to create LEDs and PDs for 1.6-2.4 μm spectral range; heterostructures based on InAsSb/InAsSbP-based lattice matched to InAs substrate enabled creation of LEDs and PDs for 2.7-5.0 μm spectral range. The gap from about 2.4 to 2.7 μm is caused by the existence of immiscibility region for GaInAsSb-based solid solutions which depends on the epitaxy temperature and the compound composition.

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- A line of standard LEDs (LED chip with a top contact) with peak wavelengths (µm):

1.03-1.07	1.25-1.33	1.40-1.49	1.50-1.59
Lms10LED	Lms13LED	Lms14LED	Lms15LED

1.60-1.69	1.70-1.76	1.80-1.89	1.90-1.99	2.00-2.09	2.10-2.19	2.20-2.29	2.30-2.39
Lms16LED	Lms17LED	Lms18LED	Lms19LED	Lms20LED	Lms21LED	Lms22LED	Lms23LED

2.70-2.79	2.83-2.90	3.30-3.44		3.45-3.52	3.53-3.69	3.70-3.75	3.76-3.94	3.95-4.09	4.10-4.30
Lms27LED	Lms28LED	Lms34LED	Lms34LEDhp	Lms35LED	Lms36LED	Lms37LED	Lms38LED	Lms41LED	Lms43LED

- A line of LEDs with glass covering (increased output optical power up to 5 times) with peak wavelengths (µm):

2.70-2.79	2.83-2.90	3.30-3.44	3.70-3.94	4.10-4.30
Lms27LED-CG	Lms28LED-CG	Lms34LED-CG	Lms38LED-CG	Lms43LED-CG

- A line of wide band photodiodes with sensitive area of Ø0.3, 0.5 and 1.0 mm and cut-off wavelengths (µm):

2.4	2.5		3.6		4.0	4.1	
Lms24PD-03	Lms25PD-05	Lms25PD-10	Lms36PD-03	Lms36PD-05	**NEW** Lms40PD-05	Lms41PD-03	Lms41PD-05

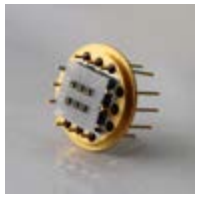
4.6		4.9
Lms43PD-03	Lms43PD-05	**NEW** Lms49PD-05

- A line of wide band photodiodes with glass covering (increased responsivity up to 5 times) cut-off wavelengths (µm):

3.6		4.0	4.6		4.9
Lms36PD-03-CG	Lms36PD-05-CG	**NEW** Lms40PD-05-CG	Lms43PD-03-CG	Lms43PD-05-CG	**NEW** Lms49PD-05-CG

- Multi-element LED matrices – a number of similar or different LED chips mounted in a single compact package.

LEDs, LED matrices and PDs are provided in standard TO packages (SMD and customized packages could be provided under request):

TO packages	TO-18	TO-18 with PR	TO-5	TO-5 with PR	TO-8
	with/without window		with/without thermoelectric module		
					
Applied to	LED, PD, LED-matrix		LED, PD, LED-matrix		LED-matrix
TO packages with glass covering	TO-18 with glass covering				
					
Applied to	LED, PD				
SMD packages (under request)	3.0 x 2.0 mm	3.5 x 3.5 mm		5 x 5 mm for a 3-element matrix	
					
Applied to	LED, PD			LED-matrix	

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LED drivers	D-41i	D-51i	mD-1c	mD-1p	MCD
					
Applied to	Single-element LEDs				LED matrices
PD electronics	PAb preamplifier	PD with a built-in preamplifier		SDM	
					
Applied to	photodiodes			photodiodes with a built-in preamplifier	
Evaluation kits and systems	CDK/CDK-c	MDK/MDK-c	MDS-5/ CDS-5		
					
Applied to	Evaluation kits for CO_2 detection	Evaluation kits for CH_4 detection	CH_4 and CO_2 evaluation systems		
NEW LED Minispectrometer	LMS-R				
					

- D-41i, D-51i LED drivers; mD-1c, mD-1p minidrivers – unpackaged drivers that provide LED power supply in different pulse modes; D-51i additionally enables monitoring LED intrinsic temperature judging by current-voltage dependence.
- PAb photodiode preamplifier – converts photocurrent into a voltage pulse output signal with amplification. It is also available together with a PD built in a metal tube – LmsXXPD-XX-R(W)-PA and LmsXX-PD-XX-CG-R-PA series;
- SDM synchronous detector – enables coordinated operation of the systems that include photodiode with preamplifier and LED driven by D-41i, D-51i, mD-1c or mD-1p driver; it measures voltage signal from the output of a photodiode preamplifier and converts it to DC voltage signal proportional to the amplitude of voltage from input;
- MCD multichannel driver – a single board that combines functionality of a power supply for multi-element LED matrices, enabling driving of up to 8 LEDs at pulse mode, and synchronization device for signals detection with a one photodiode.
- Evaluation kits, systems and sensor modules:
  - MDK-c, MDK – kits for CH_4 detection; CDK-c, CDK – kits for CO_2 detection;
  - MDS-5 – system for CH_4 detection; CDS-5 – system for CO_2 detection.
- **NEW** LMS-R LED minispectrometer – new ultra compact, lightweight instrument for spectral analysis in the near-infrared range 1.3 – 2.4 µm.

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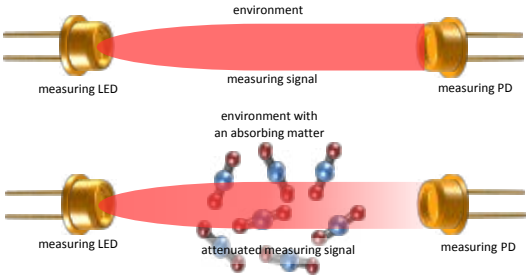
Infrared optical analysis is based on the vibrations of molecules. Infrared radiation passes through a sample and the fraction of the incident radiation that is absorbed at a particular energy is determined. The energy at which any change in the absorption occurs corresponds to the frequency of a vibration of a molecule that is analysed.

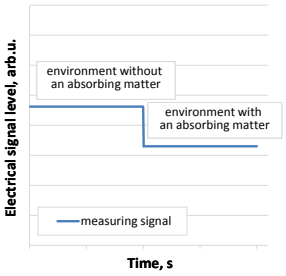
Principle of optical sensing based on LED – PD optopair

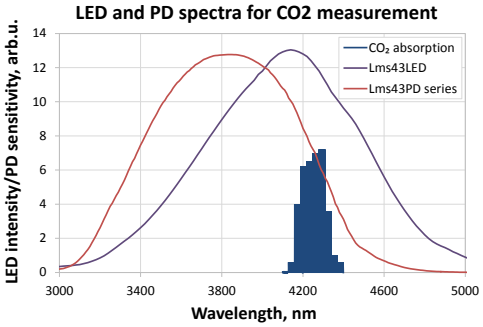
Several measurement schemes can be used for optical sensing depending on the exact application and conditions.

One-channel measurement scheme

Basic measurement technique includes one LED and one photodiode. The LED emits radiation at a specific wavelength that corresponds to the absorption band of the analyte, the spectrally-matched photodiode detects it and puts out an electrical signal. Presence of the analyte in the environment between the LED and the photodiode causes attenuation of the photodiode signal and, based on the level of attenuation, it is possible to estimate the concentration of the analyte.







Advantages:

- makes it possible to design low-cost solutions;
- enables simple and compact sensor design;
- provides decent results in normal conditions.

This technique is used in most of our evaluation systems and sensor modules.

The influence of temperature change on the measured signal is substantial and may cause certain measurement errors. There are several ways to offset this influence:

- use the packages with built-in Peltier thermocoolers and/or thermistors;

- monitor the intrinsic LED temperature, judging by LED current-voltage dependence. Our standard electronics (D-51i LED driver and electronics used in on-board sensor modules) enable this option and puts out signals that carry information about the temperature changing. These signals can be used for the further arranging of the temperature compensation.

Two-channel measurement scheme with one LED and two PDs (measuring and reference)

This scheme includes an additional PD apart from a measuring LED-PD optopair. The additional photodiode is a reference one and is introduced in order to compensate influence of irrelevant effects unrelated to the analyte absorption. Measuring photodiode provides the measuring signal sensitive to presence and concentration of analysed matter, while signal from reference PD remains practically unaffected. Processing of measuring and reference signals allows obtaining stable and reliable measurement results even in harsh environmental conditions thanks to the fact that photodiodes react in the same manner to the external conditions.

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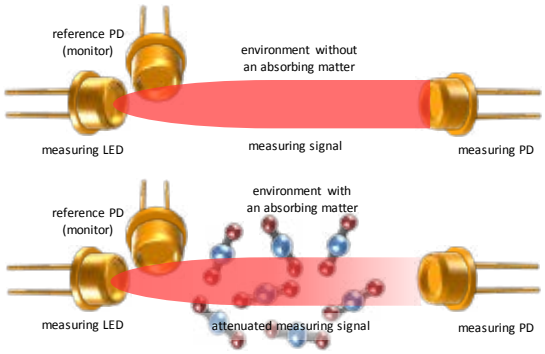
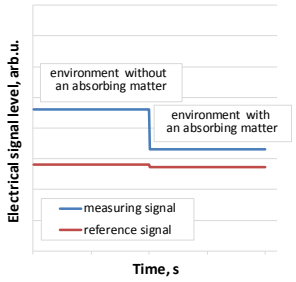
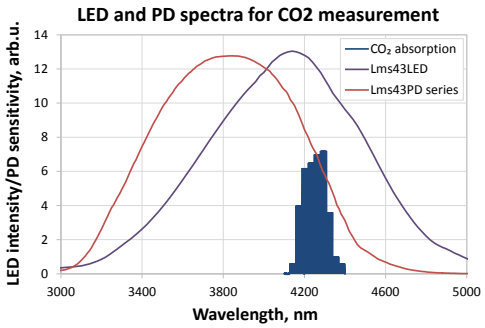
This scheme can be realised using 2 approaches:

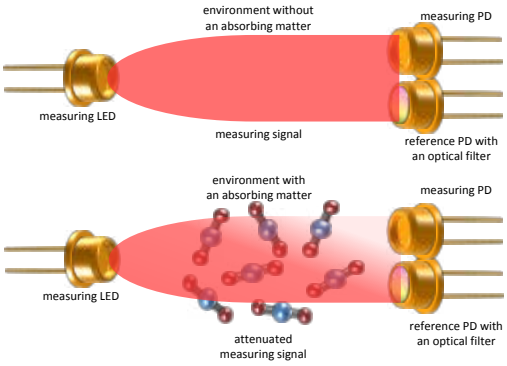
a. the reference (monitor) photodiode with the same sensitivity spectrum as the measuring PD is deposited close to the LED, thus ensuring the minimal signal attenuation due to short length of an optical path:

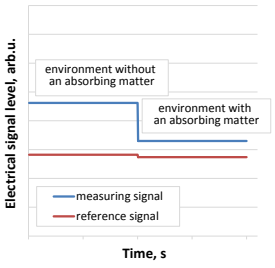


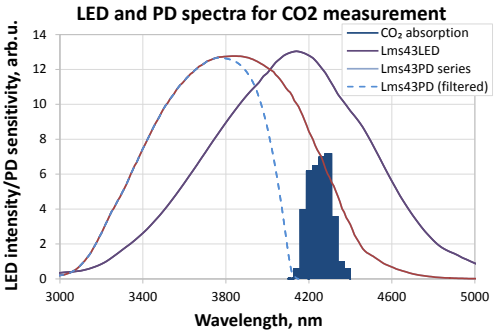




b. the reference photodiode with a spectrum insensitive to a given analyte is deposited close to the measuring PD. This scheme should include an LED with a spectrum broad enough to provide the emission for two photodiodes with different wavelengths - measuring and reference, or two similar photodiodes with additional optical filters to differentiate the measuring and the reference wavelengths.

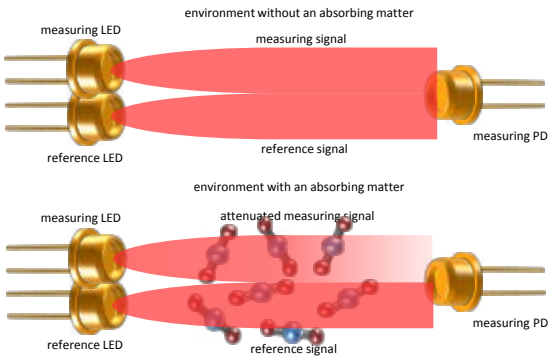


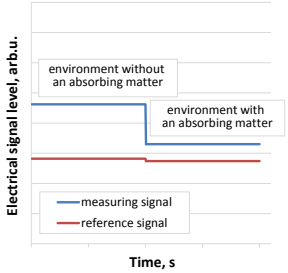


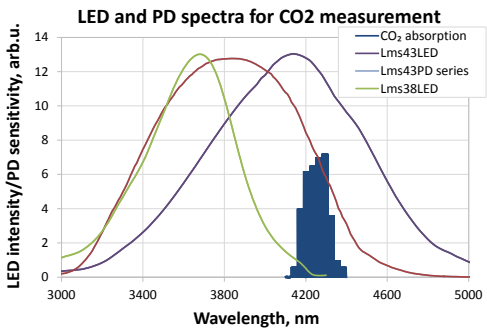


Two channel measurement scheme with two LEDs (measuring and reference) and one PD

This technique includes an additional LED apart from a measuring LED-PD optopair. The measuring LED emits radiation at the wavelength corresponding to the maximum absorption of the analyte. The reference LED emits at the wavelength not absorbed by the analyte. Signal difference between the measuring LED, which is affected by the analyte absorption, and the reference LED is proportional to the concentration of the analyte.







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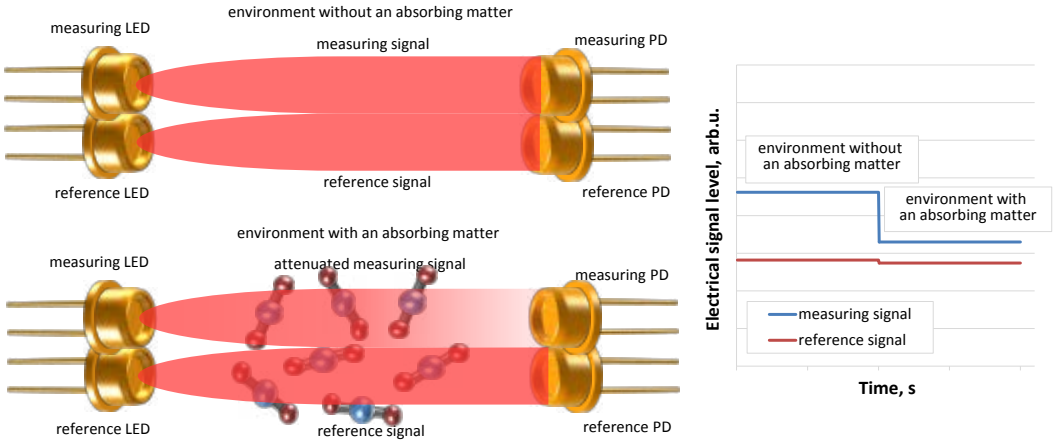
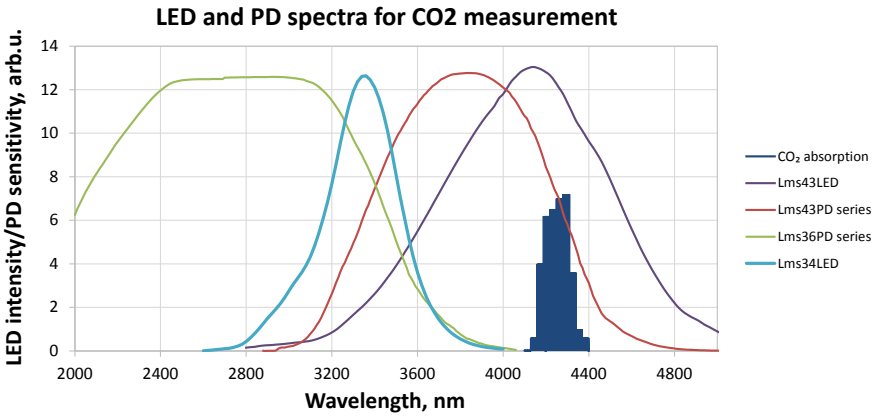
2-channel measurement scheme with 2 LEDs (measuring and reference) and 2 PDs (measuring and reference)

This approach is similar to the previous one with the only difference: an additional photodiode is introduced for reference signal detection. The overall scheme includes 2 independent channels: the measuring LED-PD optopair (corresponds to the absorption wavelength(s) of the analyte) and the reference LED-PD optopair (operates at wavelength(s) away from the analyte absorption). Concentration of the analyte is defined by the signal difference between the measuring and reference PDs.

Common advantages of 2-channel schemes:

- enable compensation of the effects unrelated to the analyte absorption;
- provide better stability of the measurement results comparing to the 1-channel scheme;
- require less frequent calibration than systems based on 1-channel measurement scheme.





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Range of applications

Control of technological processes:

- in-line control of paper moisture;
- detection of water concentration in oil and oil products, monitoring of the content of oil products and defining deviations from the etalon;
- thickness measurement (in-line plastic thickness control);
- monitoring of the content of pharmaceutical products.

Ecological monitoring and industrial safety:

- control of carbon dioxide, exhaust gases content in the atmosphere;
- control of methane, propane leakage;
- control of hydrocarbons in water.

Medical diagnostics:

- out-breath control (measurement of carbon dioxide, acetone concentration);
- analysis of bioliquids (control of glucose in blood, urine, saliva);
- personal medicine using wearable devices and smartphone integrated sensors.

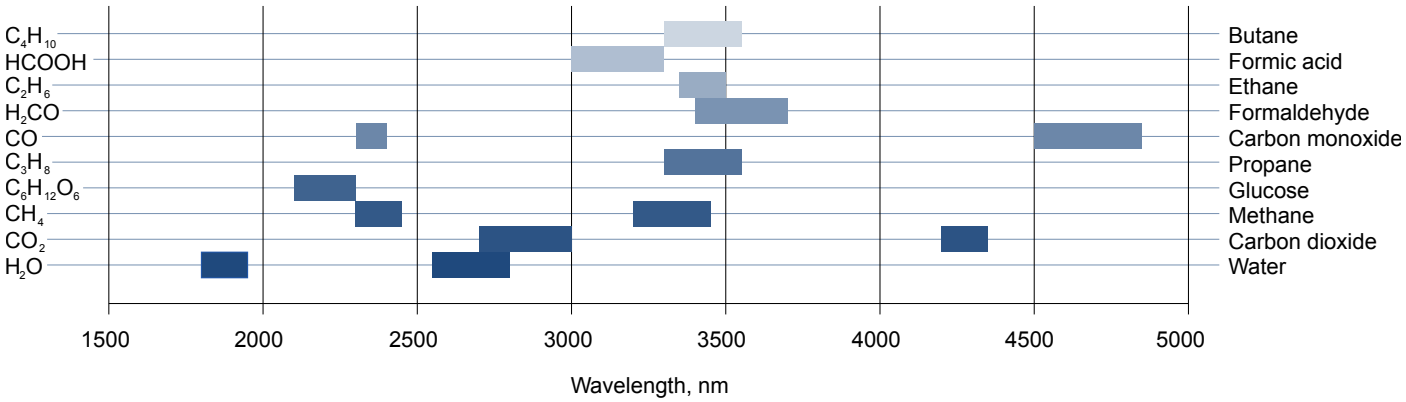
Food industry and agriculture:

- control of water, fiber, protein concentration in grains, humidity control of coffee beans, corn;
- control of sucrose and fructose concentration;
- control of fat and protein in milk;
- analysis of cotton and wool moisture.

Every molecule is a composition of diverse atoms interconnected in different ways. These interconnections are called bonds; all the bonds vibrate causing absorption of infrared radiation. The exact absorption spectrum is a unique "fingerprint" of a molecule and depends on its structure, namely, on a set of atoms, a number of bonds between them, bonds' lengths and strengths.

An absorption spectrum consists of the main absorption bands, which are strong, and the overtone bands, which are substantially weaker. The absorption intensity also varies with the molecule, so, different path lengths should be provided in order to obtain adequate absorption for a specific matter in a required sensitivity range. Small measuring cells are applicable to either strong absorption bands or measurement of high concentrations of a matter. Optical cells that enable multiple pass or long pass of the emission through the analyte can be used for detection of either very small concentrations or weak absorption bands.

There are strong absorption bands of many chemical agents in the near-infrared and mid-infrared spectral range that allow their detection with sensor devices based on the LED-PD optopairs or using LED Microsensor NT photodiodes in combination with other sources of infrared radiation. Some of these chemical agents and their absorption bands are presented here.



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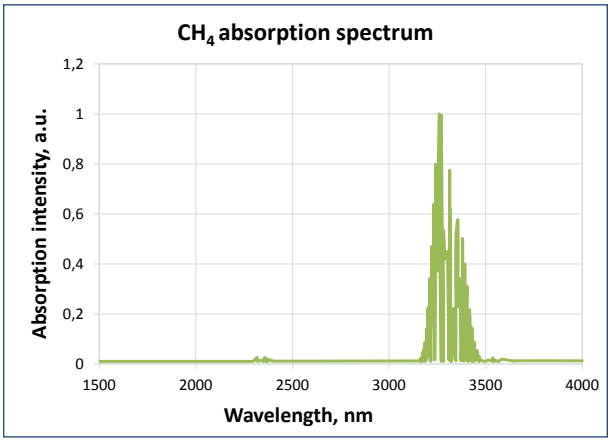
Methane detection

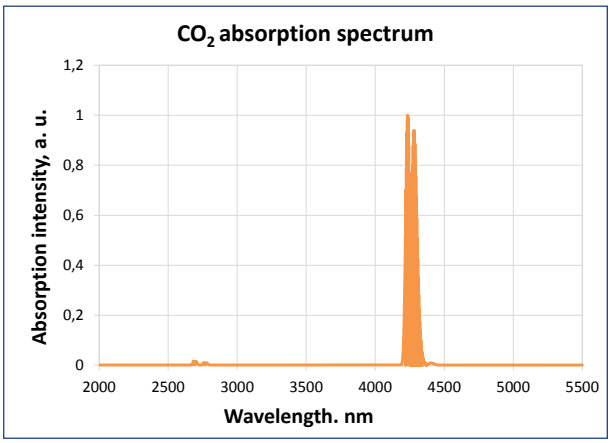


Methane has the main absorption band at 3200-3450 nm. Weaker absorption bands are located around 2300 nm and 1650 nm (the data are taken from HITRAN Catalogue).

For the development of compact optical cells for detection of small methane concentrations we recommend using: Lms34LED and Lms36PD photodiode series. In case of two-channel measurement scheme it is possible to use Lms34LED for the measuring channel, Lms38LED for the reference one and Lms40PD photodiode to detect emission from both channels.

For the systems with a long optical path or detection of high methane concentrations the pair: Lms23LED and Lms24PD/Lms25PD photodiode series could be used. In case of arranging a two-channel measurement scheme we recommend using Lms20LED and Lms24PD/Lms25PD photodiode series for the reference channel.

Carbon dioxide detection



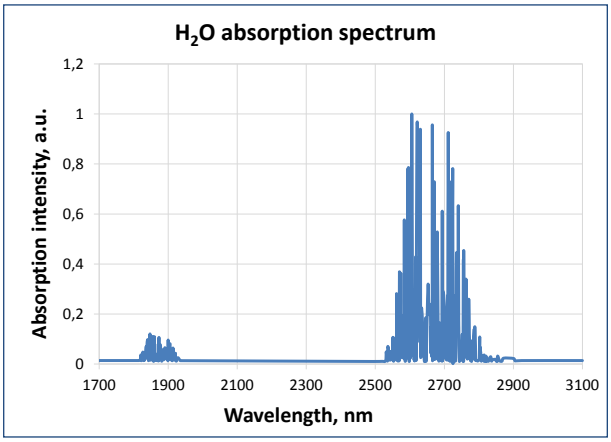
Carbon Dioxide has a strong absorption band at 4200-4320 nm spectral range and weaker bands around 2700 nm and 2000 nm (the data are taken from HITRAN Catalogue).

For the development of compact optical cells or detection of small carbon dioxide concentrations we recommend using: Lms43LED and Lms43PD/Lms49PD photodiode series. In case of two channel measurement scheme it is preferable to use a combination of Lms38LED and Lms43PD/Lms49PD photodiode series for the reference channel.

For the systems with a long optical path or detection of high carbon dioxide concentrations the pair: Lms20LED and Lms24PD/ Lms25PD photodiode series could be used. For two-channel scheme we recommend using Lms23LED with Lms24PD/Lms25PD photodiode series as a reference optopair.

Carbon dioxide detection at ~2700 nm is quite complicated due to the strong water absorption in the same spectral region.

Water detection



Water has strong absorption bands at spectral ranges 2550-2800 nm and 1830-1940 nm (the data are taken from HITRAN Catalog).

Water absorption band at 2550-2800 nm overlaps with CO_2 absorption band, so that we recommend using Lms19LED and Lms24PD/ Lms25PD photodiode series to detect water around 1940 nm. In case of two-channel measurement scheme Lms16LED and Lms24PD/Lms25PD photodiode series could be used for the reference channel.

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Many different substances have absorption bands in the middle infrared range, but most of analysis and detection tasks are related with measuring only few compounds – water, carbon dioxide, methane and other hydrocarbons:

	CH_4 and other hydrocarbon sensors	• gas industry: natural gas leakage control; • metallurgy and mining: methane concentration control with appropriate ventilation management; • plastic industry: control of plastic bottles' thickness and composition; • waste recycling: methane concentration control at landfills; • agriculture: methane emission control in pastures.
	CO_2 sensors	• ecological monitoring: CO_2 control indoors and outdoors; • agriculture: CO_2 control in greenhouses; • construction: CO_2 control for welding works; • mining: CO_2 level measurement in mines with appropriate ventilation management; • medical equipment: CO_2 out-breath control (as an element of capnograph); • automotive industry: exhaust gas control and monitoring of combustion processes inside the engine;
	H_2O sensors	• oil & gas: oil quality control, water in oil analysis; • agriculture: measurement of crops and soil moisture level; • textile industry: humidity measurement of different textile fabrics; • food and beverages: fryers and roasters tuning; • tobacco production: humidity control of dried leaves; • space and aviation: humidity control at high altitudes to assess the degree of icing of an aircraft.

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The major rivals to infrared sensors are electro-chemical devices and semiconductor surface effect sensors, both of which have relatively low unit cost compared with the present infrared solutions but have disadvantages in selectivity, fail-safety, etc. There is a growing trend towards the use of infrared technology.

Present infrared absorption technology utilises several types of emission sources:

- broad-band light sources – filament black body emitters, planar filaments in thin technology – used together with crude and simple optics such as light pipes followed by filters, provide low modulation range (~8 Hz), less suitable for miniaturized sensing devices, low-cost;

- narrow-band sources – laser sources – lead-salt lasers (PbSnSe, PbSSe material systems) with wavelengths up to 14 μm and peak power in the Watt range in continuous wave (CW) mode, require complex, frequently, cryo cooling; quantum cascade lasers with Bragg feedback gratings (based on GaAs/AlGaAs, GaInAs/AlInAs material systems) allow currently CW-power in the Milliwatt range. Lasers enables detection with a very high resolution, distinguishing different absorption lines, but require accurate frequent tuning of the laser wavelength and precise temperature stabilization and have high cost.

For many applications there is no need to distinguish each absorption line, and a group of lines (bands) can be used. New optoelectronic devices for the middle infrared spectral range provide completely new possibilities for the creation of portable sensors. Using mid-infrared LED-PD optopairs has allowed the development of an instrument that is smaller, less expensive, and more versatile.

Main advantages that mid IR LEDs and PDs bring for optical sensing:

- ✓ Low power consumption
- ✓ Compact size
- ✓ Low cost

- ✓ Long lifetime
- ✓ No need in frequent calibration

- ✓ Short response time

- ✓ Multi-element LED design
- ✓ Scalability

Ability to design autonomous wireless sensors (as a part of remotely controlled systems)

Ability to analyse objects requiring immediate attention (paper/ plastic during fabrication; medical applications)

Cutting system maintenance costs (DCV, HVAC systems)

Ability to arrange multiwavelength emitters and compact cost-effective LED spectrometers on their basis

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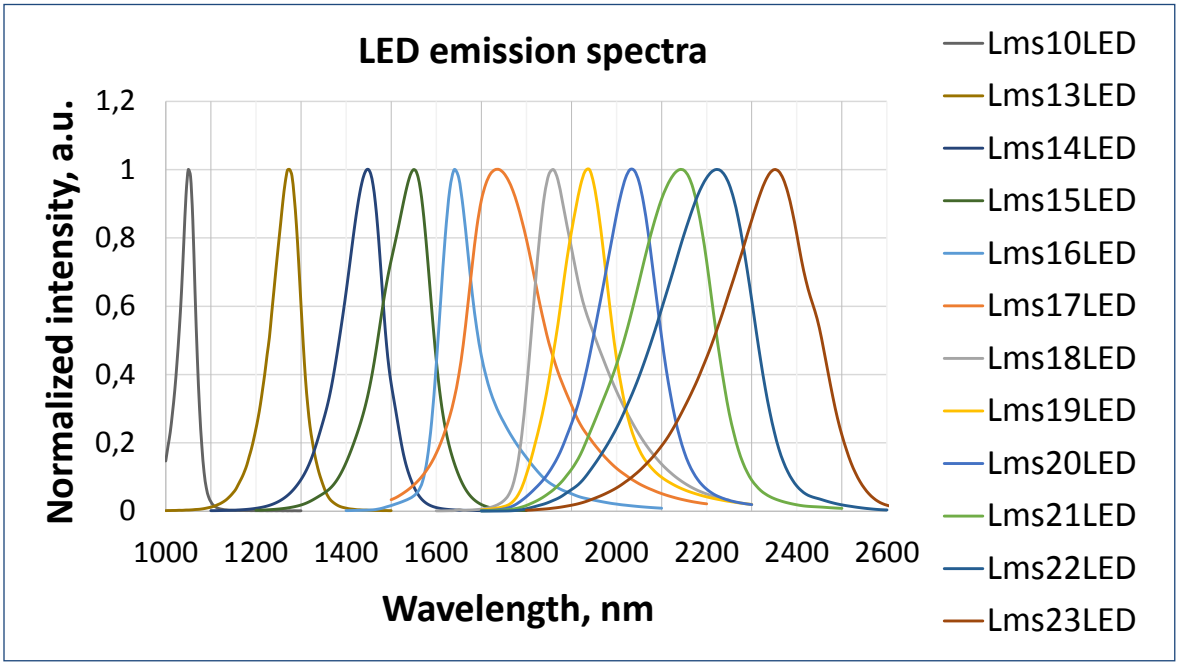
Light Emitting Diodes for 1.0 - 2.3 µm spectral range



Standard LED models - Lms MIR LED (1.0 – 2.3 µm)												
Model	Peak emission wavelength [µm]		FWHM of the emission band [nm]		Optical power [mW]				Voltage[*1] [V] (200 mA)	Maximum operating current [mA]		Operating/ storage temperature range[*4] [°C]
					QCW mode[*1] (200 mA)		Pulse mode[*2,3] (1 A)					
	min	max	min	max	min	typ	min	typ	min-max	QCW mode[*1]	Pulse mode[*2]	
Lms10LED	1.03	1.07	30	50	12	14	30	33	1.1-1.4	200	1000	from -60 to +90
Lms13LED	1.25	1.33	70	100	10	12	25	29	0.9-1.2			
Lms14LED	1.40	1.49	90	120	7	9	20	24	0.8-1.1			
Lms15LED	1.50	1.59	110	140	7	10	20	26	0.8-1.1			
Lms16LED	1.60	1.69	120	150	7	9	20	24	0.7-1.1			
Lms17LED	1.70	1.76	160	220	5	7	15	17	0.7-1.1			
Lms18LED	1.80	1.89	90	200	0.7	0.9	7	8.5	0.5-2.5	250	2000	
Lms19LED	1.90	1.99	100	200	0.8	1	7.5	9	0.5-2.5			
Lms20LED	2.00	2.09	150	250	0.8	0.9	7.5	8.5	0.5-2.5			
Lms21LED	2.10	2.19	150	250	0.8	0.9	7.5	12	0.5-2.5			
Lms22LED	2.20	2.29	150	250	0.8	1.0	7.5	9	0.5-2.5			
Lms23LED	2.30	2.39	170	270	0.6	0.7	6	7	0.5-2.5			

[*1] Repetition rate: 0.5 kHz, pulse duration: 1 ms, duty cycle: 50%

[*2] Repetition rate: 0.5 kHz, pulse duration: 20 µs, duty cycle: 1%

[*3] Parameter tested for representative sampling; all other parameters are tested for each device

[*4] Temperature range may vary for different packaging types

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For the applications that don't require high optical power we offer LED models in TO18 package with flexible pricing, so that you can order LEDs with lower power for significantly lower prices:

Standard LED models – Lms MIR LED (1.8 – 2.3 µm)					
Model	Peak emission wavelength, µm		Power, mW QCW mode[*1]	Category	Price Discount
	min	max	min		
Lms18LED	1.80	1.89	0.7	A	standard
			0.5	B	-40%
			0.3	C	-70%
Lms19LED	1.90	1.99	0.8	A	standard
			0.6	B	-40%
			0.3	C	-70%
Lms20LED	2.00	2.09	0.8	A	standard
			0.6	B	-40%
			0.3	C	-70%
Lms21LED	2.10	2.19	0.8	A	standard
			0.6	B	-40%
			0.3	C	-70%
Lms22LED	2.20	2.29	0.8	A	standard
			0.6	B	-40%
			0.3	C	-70%
Lms23LED	2.30	2.39	0.6	A	standard
			0.45	B	-40%
			0.3	C	-70%

[*1] Repetition rate: 0.5 kHz, pulse duration: 1 ms, duty cycle: 50%, current: 200 mA

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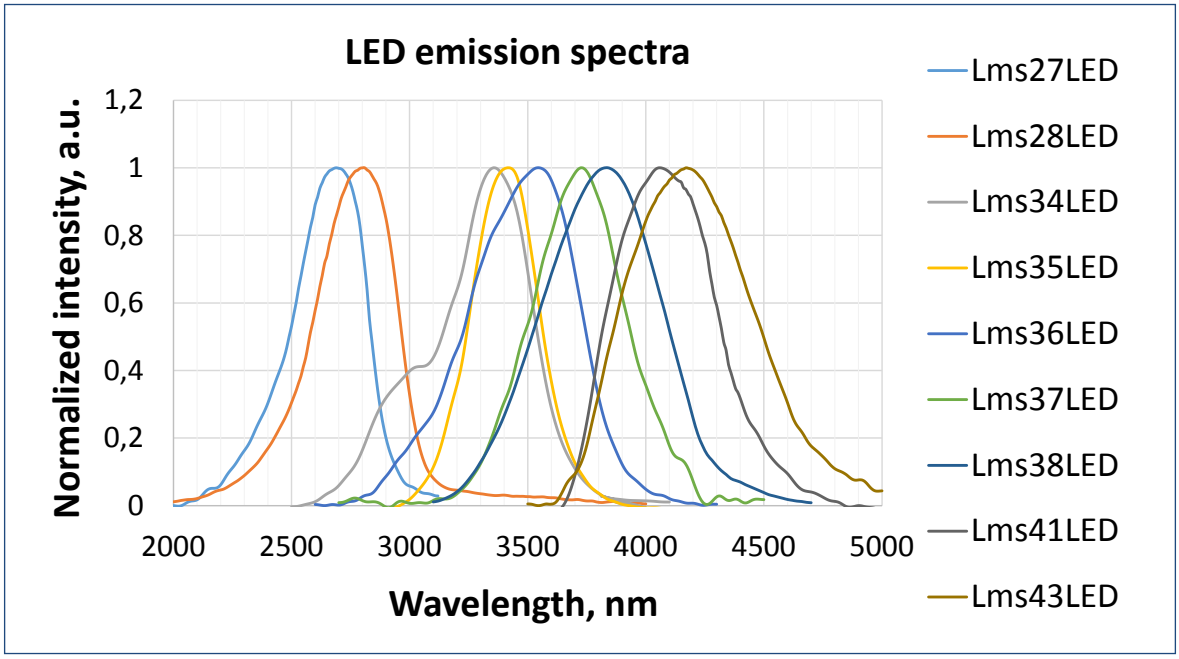
Light Emitting Diodes for 2.7 - 5.0 µm spectral range



Standard LED models – Lms MIR LED (2.7 – 5.0 µm)												
Model	Peak emission wavelength [µm]		FWHM of the emission band [nm]		Optical power [µW]				Voltage [V] (200 mA)	Maximum operating current [mA]		Operating temperature range [°C]
					QCW mode*1 (200 mA)		Pulse mode*2,3 (1 A)					
	min	max	min	max	min	typ	min	typ	min-max	QCW mode*1	Pulse mode*2	
Lms27LED	2.70	2.79	300	500	12	25	100	180	0.2-1.0	250	2000	from -60 to +90
Lms28LED	2.83	2.90	300	500	20	40	150	300	0.2-1.0			
Lms34LED	3.30	3.44	250	600	20	25	150	180	0.2-1.3			
Lms34LEDhp	3.30	3.44	250	600	45	50	350	370	0.2-0.8			
Lms35LED	3.45	3.52	300	600	20	40	150	300	0.2-0.8			
Lms36LED	3.53	3.69	300	600	15	40	120	300	0.2-0.8			
Lms37LED	3.70	3.75	300	600	12	20	100	150	0.2-0.8			
Lms38LED	3.76	3.94	400	700	12	40	100	300	0.2-0.8			
Lms41LED	3.95	4.09	400	1200	12	20	100	150	0.2-0.8			
Lms43LED	4.10	4.30	400	1200	15	30	120	200	0.2-0.8			
LED models with a glass cover – Lms MIR LED-CG (2.7 – 4.3 µm)												
Lms27LED-CG	2.70	2.79	300	500	50	150	370	1000	0.2-1.0	200	1000	from 0 to +50
Lms28LED-CG	2.83	2.90	300	500	100	300	700	2000	0.2-1.0			
Lms34LED-CG	3.30	3.44	250	600	100	300	700	2000	0.2-1.3			
Lms38LED-CG	3.70	3.94	400	700	80	180	500	1500	0.2-0.8	250	2000	
Lms43LED-CG	4.05	4.30	400	1200	80	180	500	1500	0.2-0.8			

*1 Repetition rate: 0.5 kHz, pulse duration: 1 ms, duty cycle: 50%

*2 Repetition rate: 0.5 kHz, pulse duration: 20 µs, duty cycle: 1%

*3 Parameter tested for representative sampling; all other parameters are tested for each device

*4 Temperature range may vary for different packaging types

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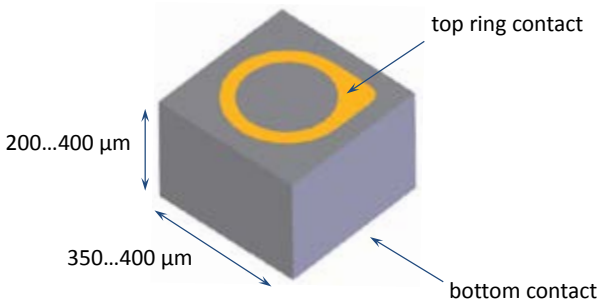
Standard LED chip



This shape of LED chip is typical for most of LED Microsensor NT standard LED models (Lms18LED, ... Lms43LED series).

Main features are:

- small size of the LED chip (close to point source);
- effective heat dissipation from the active layer;
- uniform current distribution in the active region;
- cost effective (due to small size).

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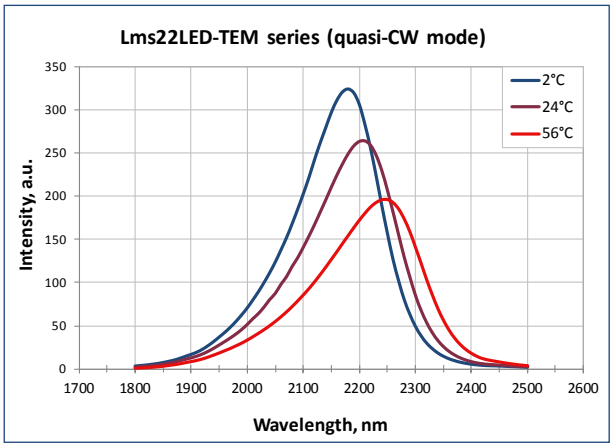
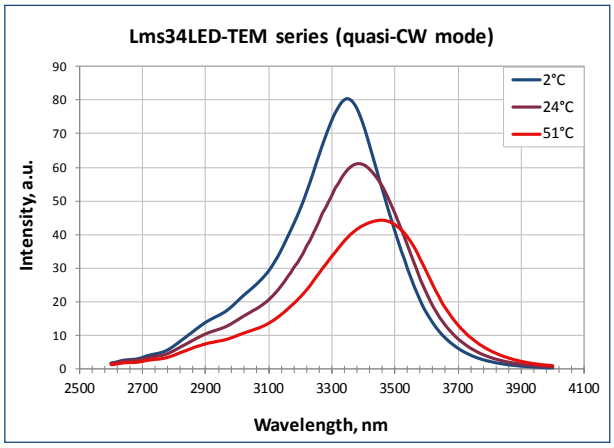
Temperature dependences of optical characteristics

It is typical for all semiconductor radiation sources to have intensity decreasing with temperature rise. This decrease of the emission intensity is related to several temperature-dependent factors, including non-radiative recombination via deep levels, surface recombination and carrier loss over heterostructure barriers. In addition to this, peak wavelength shifts to longer wavelengths when the temperature increases.

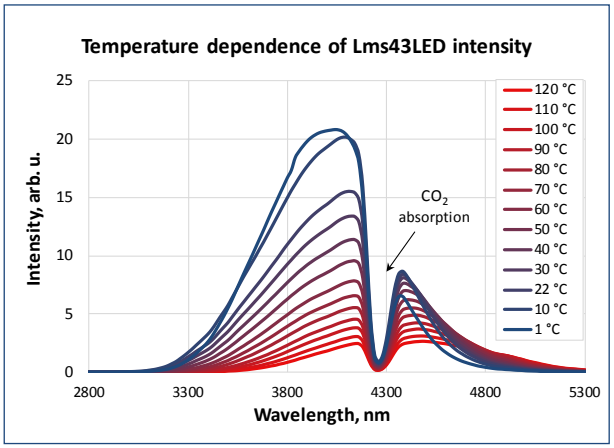
We can offer several ways to control LED temperature:

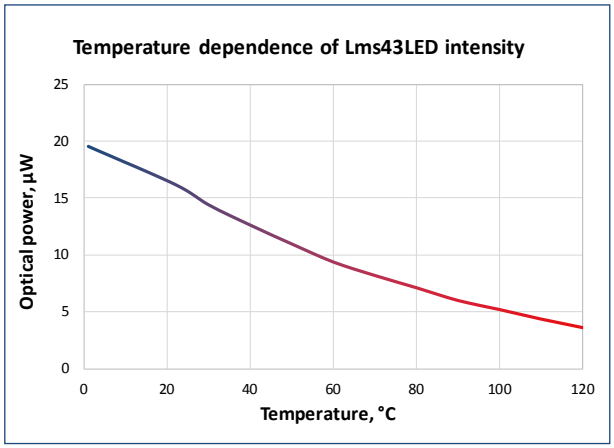




- Mounting of an LED chip into a package with a thermoelectric module (Peltier element) enables stabilisation of the temperature of an LED chip, providing wavelength tuning in a certain wavelength range.
- Monitoring the intrinsic LED temperature judging by the LED current-voltage dependence:
  short current pulse is applied and corresponding voltage is measured, this voltage value depends on LED (p-n) junction temperature. Temperature compensation scheme can be further arranged considering this dependence. This option is provided by D-51i LED driver produced by LMS NT (see section Electronics of the Catalogue and/or manual for D-51i LED driver).

Our LEDs can operate in a wide temperature range, which certainly broadens their field of application. As an example, Lms43LED spectra at 1 - 120°C temperature range are presented below.





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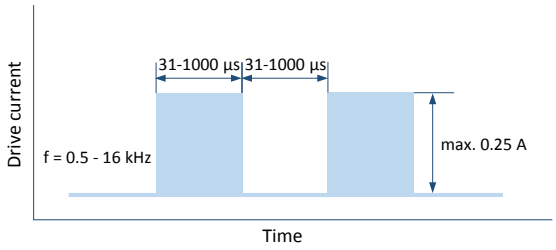
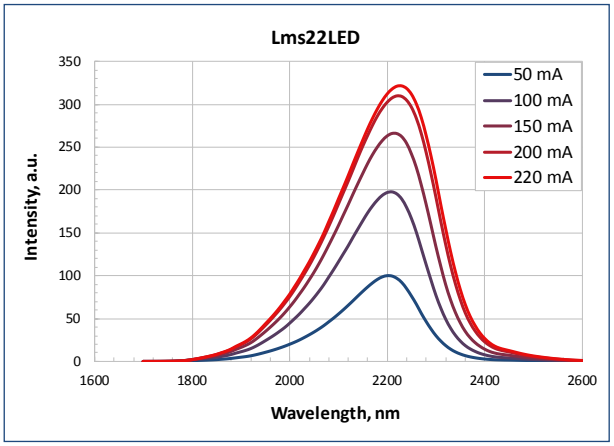
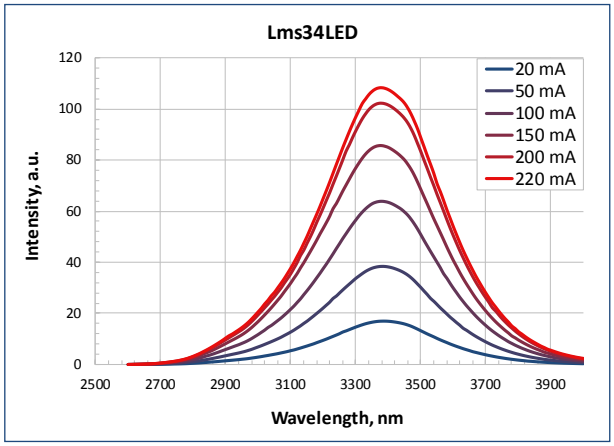
LEDs offer numerous benefits due to the possibility of applying different operation modes. The optical parameters of an LED strongly depend on the operation mode you choose. To receive maximum average power, we recommend using pulse modes with a 25% or 50% duty cycle (quasi-continuous wave mode). These modes provide signal modulation at a certain frequency and allow obtaining higher output intensity than in the case of using hard CW (continuous wave) mode, which is not recommended. To obtain the maximum peak optical power, we recommend using short pulse modes (less than 50 µs).

Quasi-continuous wave (quasi-CW) mode:

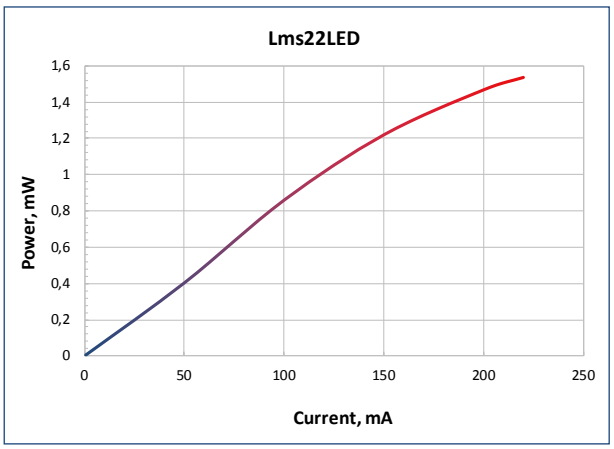


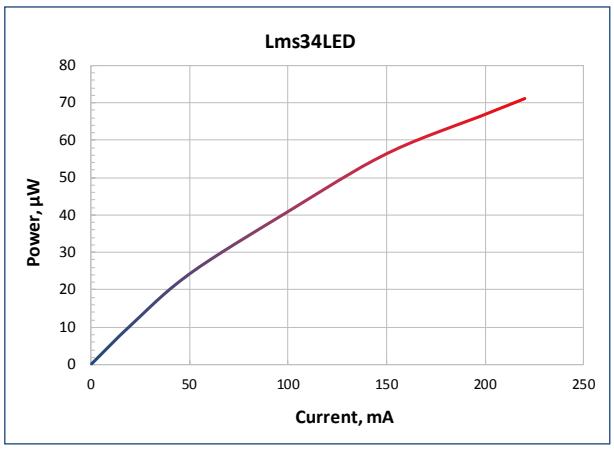
Spectra at different currents in the quasi-CW mode (frequency 0.5 kHz, duty cycle 50%):





Power dependence on current in the quasi-CW mode (frequency 0.5 kHz, duty cycle 50%):





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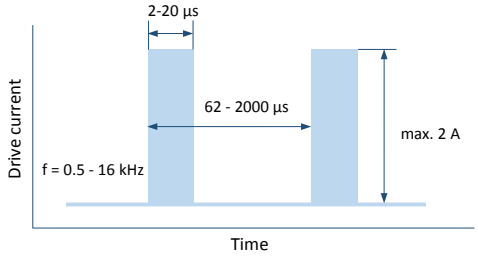
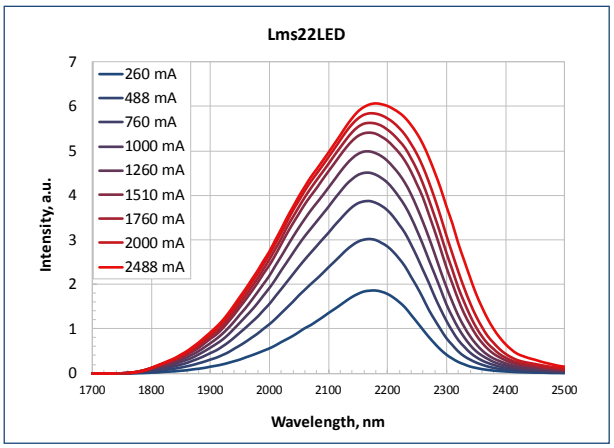
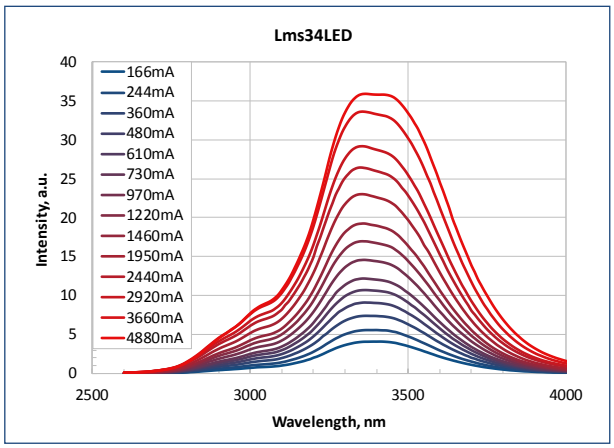
High peak optical power can be achieved at operation mode with short current pulses.

Pulse mode:

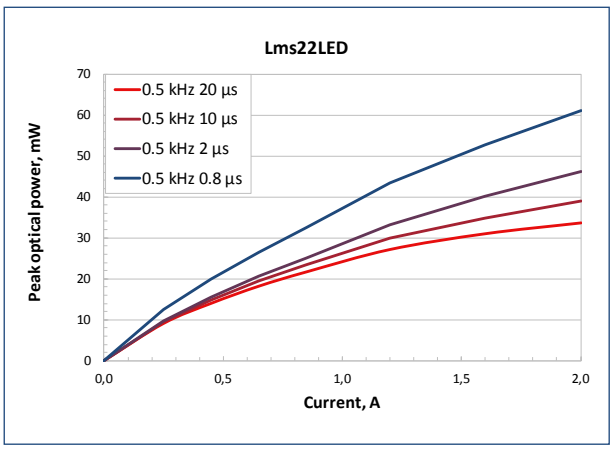


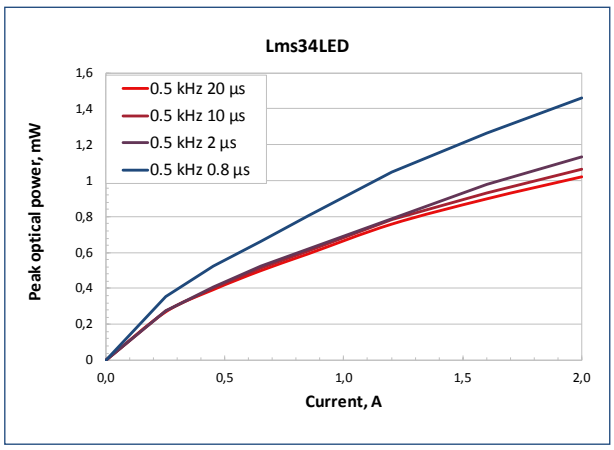
Radiation spectra at different currents in the pulse mode (pulse duration 2 µs, frequency 8kHz):





Optical power dependence on the drive current in the pulse mode:





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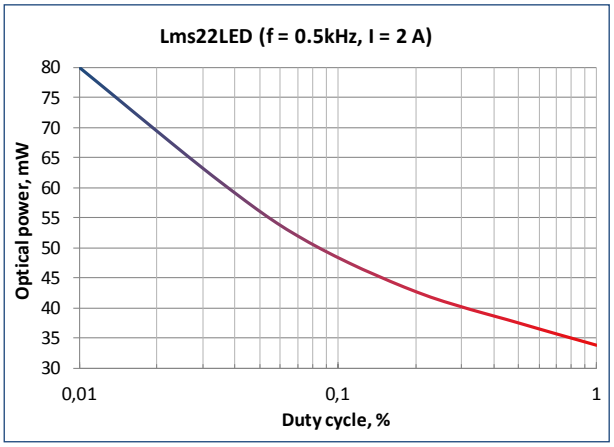
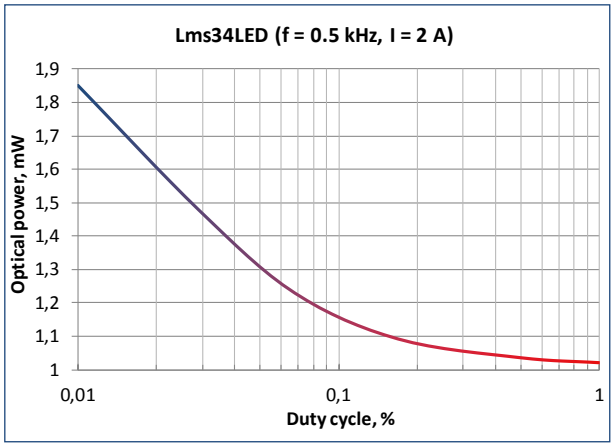
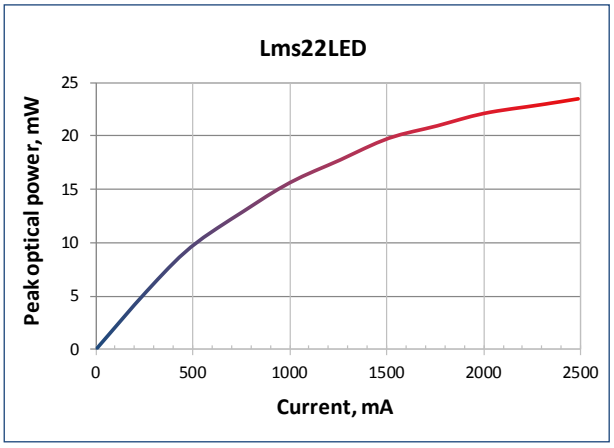
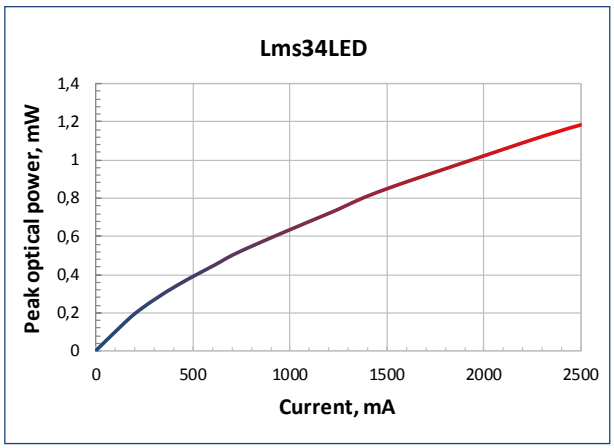
Power dependence on the duty cycle (duty cycle = pulse duration/pulse period):





Power dependence on current in the pulse mode (pulse duration 8 µs, repetition rate 2 kHz):

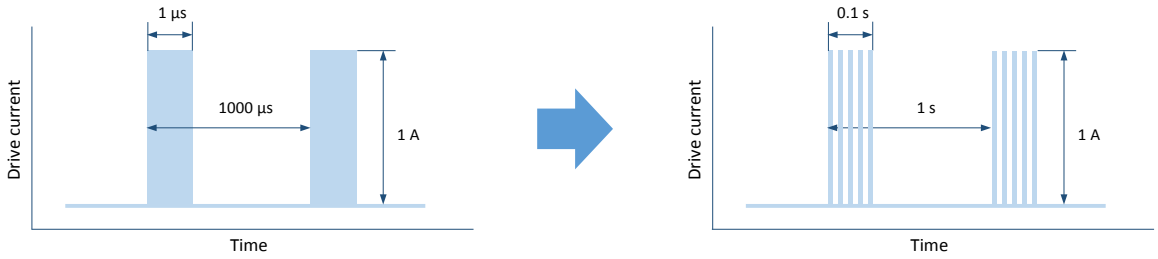




Pulse operation mode provides high peak optical power and also enables **decreasing power consumption essentially.**
For example, LED with 3.4 µm peak wavelength is driven at pulse mode:

- current amplitude 1 A;
- pulse duration 1 µs;
- frequency 1 kHz (period 1 ms);
- LED forward voltage at 1 A is about 0.5 V.

Average power consumption during pulse period: 1 A x 0.5 V x 1 µs / 1000 µs = 0.5 mW. Further decrease of power consumption up to 0.05 mW can be achieved by applying packets of pulses: 100 pulses in a packet, duration of one packet – 0.1 s, pause between packets - 0.9 s.



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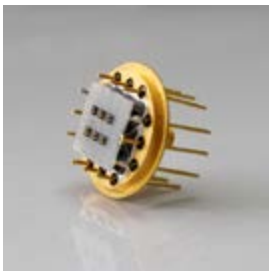


Small size of an LED chip (0.4 × 0.4 mm), narrow-band emission spectrum, short response time and low thermal flux enables the creation of very compact multi-element LED matrices emitting at one or different wavelengths.

Parallel connection of several LED chips that emit at the same wavelength and driving them together can provide significant increase of the total optical power.

Connecting LED chips that emit at different wavelengths and driving them independently, or applying short current pulses sequentially to each chip, enables scanning of a certain spectral range with the help of a very compact radiation source.

Currently we offer two standard LED matrix types - 4-element one-wavelength matrices and 6-elements multi-wavelength matrices.

Standard 4-element one-wavelength LED matrices

4-element LED matrix with one peak wavelength at 3.4 µm or 4.3 µm.

Standard one-wavelength LED matrix models												
Model	Peak emission wavelength [µm]		FWHM of the emission band [nm]		Optical power [µW]				Voltage per chip*1 [V] (200 mA)	Maximum operating current [mA]		Operating temperature range*4 [°C]
					QCW mode*1		Pulse mode*2,3					
	min	max	min	max	min	typ	min	typ	min-max	QCW mode*1	Pulse mode*2	
Lms34LED-4M	3.30	3.44	250	600	70	100	500	700	0.3-1.0	1000	8000	from -60 to +90
Lms43LED-4M	4.10	4.30	400	1200	50	100	400	700	0.3-0.7			

*1 Repetition rate: 0.5 kHz, pulse duration: 1 ms, duty cycle: 50%

*2 Repetition rate: 0.5 kHz, pulse duration: 20 µs, duty cycle: 1%

*3 Parameter tested for representative sampling; all other parameters are tested for each device

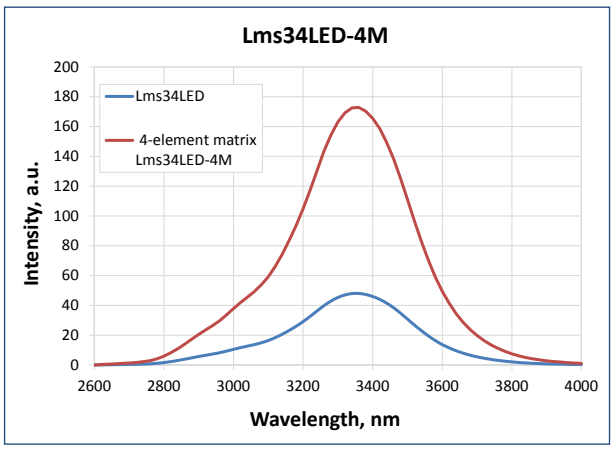
*4 Temperature range may vary for different packaging types

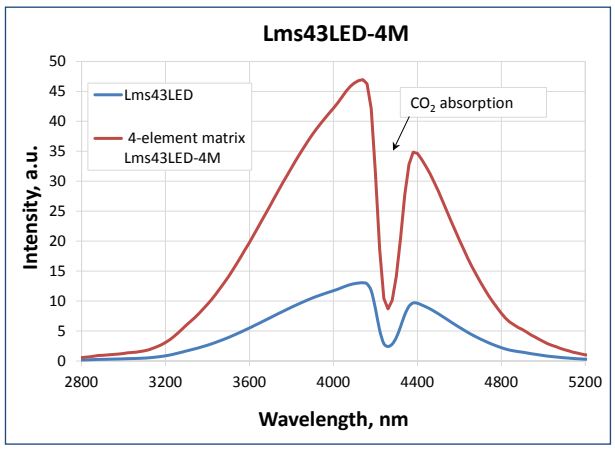
These matrices are available in the following packages:

TO-18 with a cap (without a glass window) or reflector (with/without a glass window) - models: LmsXXLED-4M, LmsXXLED-4M-R and LmsXXLED-4M-RW;

TO-5 with a thermoelectric module with a cap (with a glass window) or reflector (with a glass window) - models: LmsXXLED-4M-TEM, LmsXXLED-4M-TEM-R.

Output intensity of the 4-element matrices





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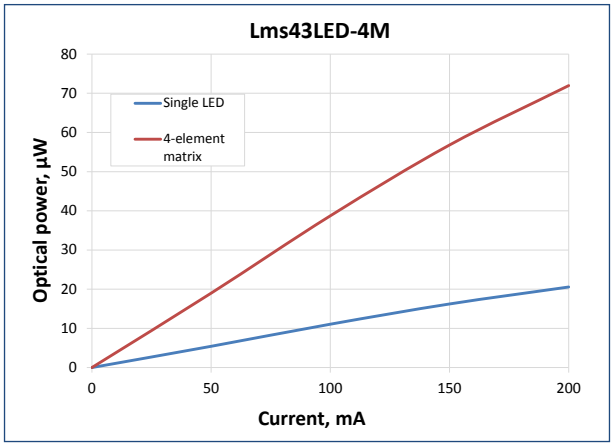
Power dependence on current in the QCW mode (frequency 0.5 kHz, duty cycle 50%)



Lms13-14-16-17-19-21LED-6M 6-element multi-wavelength LED matrix*

Main LED chip parameters for Lms13-14-16-17-19-21LED-6M matrix									
LED chip #	Peak emission wavelength [µm]		FWHM of the emission band [nm]		Optical power [mW] Pulse mode*1		Voltage [V] (1 A)	Max operating current*1 [mA]	Operating/ storage temperature range*2 [°C]
	min	max	min	max	min	typ	min-max		
Lms13LED	1.25	1.33	70	100	15	17	1.3-1.6	1000	from +5 to +90
Lms14LED	1.40	1.49	90	120	12	14	1.2-1.5		
Lms16LED	1.60	1.69	120	150	12	14	1.1-1.4		
Lms17LED	1.70	1.79	160	220	9	10	1.1-1.4		
Lms19LED	1.90	1.99	100	200	5	6	1.2-2.8		
Lms21LED	2.10	2.19	150	250	5	7	1.2-2.8		

All parameters refer to an LED matrix in the TO-5 package at ambient temperature 25°C.

*1 Repetition rate: 0.5 kHz, pulse duration: 20 µs, duty cycle: 1%.

*2 LED matrix design for different temperature range can be considered under request.

*LED dies included in the matrix can be changed by the manufacturer

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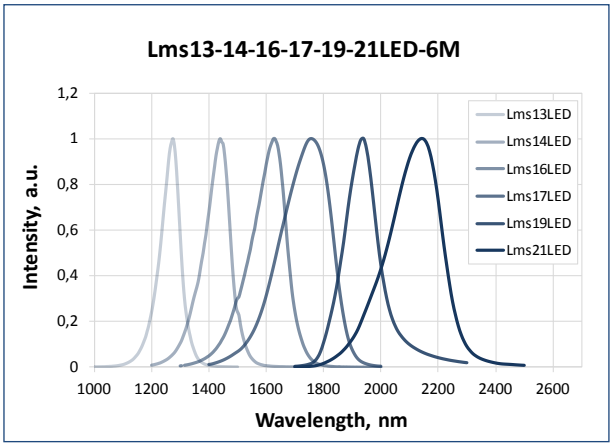
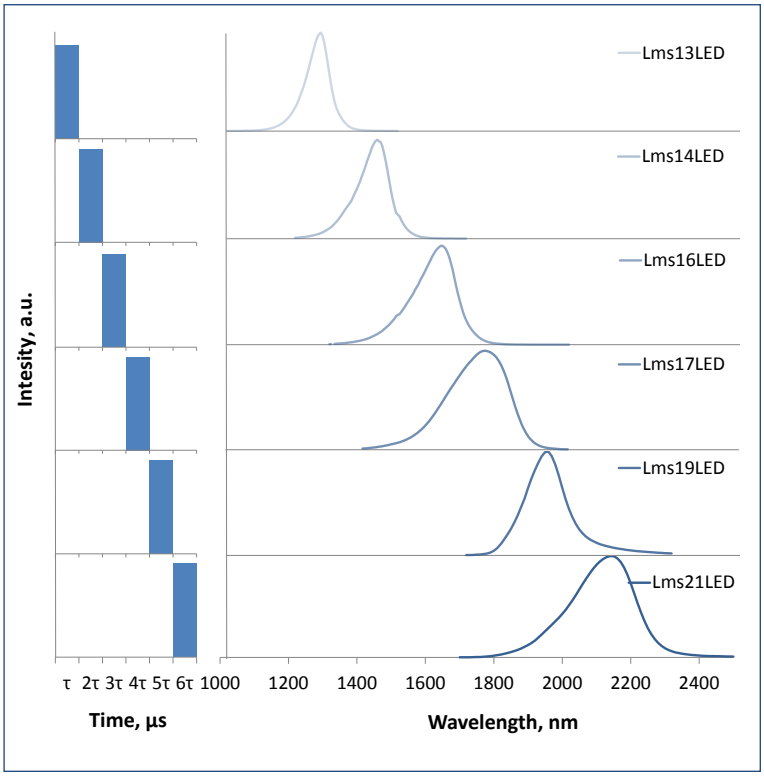
LED matrix spectra



Possibility of driving LED dies independently allows scanning of the spectral range from 1.3 µm to 2.1 µm. Such approach is used in our device - LED analyzer (LA-T), which contains an 8-element multi-wavelength LED matrix and a wide-band photodiode (see p. 47 for more information).



6-element multi-wavelength LED matrix is available in the following packages:

- TO-5 with a cap (with a glass window) - Lms13-14-16-17-19-21LED-6M;
- TO-8 with a thermoelectric module with a cap (with a glass window) - Lms13-14-16-17-19-21LED-6M-TEM;

These standard matrix types are the basic versions that are designed mainly to give an idea of the possible matrix arrangement and evaluate its feasibility and performance in terms of a specific application. We are always open to consider a special solution for the exact customers' needs.

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For custom matrices the number of the included elements depends on the application and the chosen package type. For instance, standard TO-type packages provided by RMT Ltd. are commonly used, among which there are models with built-in thermoelectric modules (Peltier elements) used for temperature stabilisation of LED chips. Using these packages allows arranging different variations of LED matrices, some of them are presented below.

LED matrix type	Package type			
	TO-18	TO-5	TO-5 TEM	TO-8 TEM
One-wavelength LED matrices				
LmsXXLED-2M	✓	✓		
LmsXXLED-2M-TEM			✓	
LmsXXLED-3M	✓	✓		
LmsXXLED-3M-TEM			✓	
LmsXXLED-4M	✓	✓		
LmsXXLED-4M-TEM			✓	✓
LmsXXLED-6M		✓		
LmsXXLED-6M-TEM				✓
LmsXXLED-9M		✓		
LmsXXLED-9M-TEM				✓
LmsXXLED-12M		✓		
LmsXXLED-12M-TEM				✓
LmsXXLED-16M		✓		
LmsXXLED-16M-TEM				✓
Multi-wavelength LED matrices				
Lms X1-X2 LED-2M (2 peak wl)	✓	✓		
Lms X1-X2 LED-2M-TEM (2 peak wl)			✓	
Lms X1-X2-X3 LED-3M (3 peak wl)		✓		
Lms X1-X2-X3 LED-3M-TEM (3 peak wl)			✓	✓
Lms X1-X2 LED-4M (2 peak wl)	✓	✓		
Lms X1-X2 LED-4M-TEM (2 peak wl)			✓	✓
Lms X1÷X4 LED-4M (4 peak wl)		✓		
Lms X1÷X4 LED-4M-TEM (4 peak wl)				✓
Lms X1÷X6 LED-6M (up to 6 peak wl)		✓		
Lms X1÷X6 LED-6M-TEM (up to 6 peak wl)				✓
Lms X1÷X9 LED-9M-TEM (up to 9 peak wl)				✓

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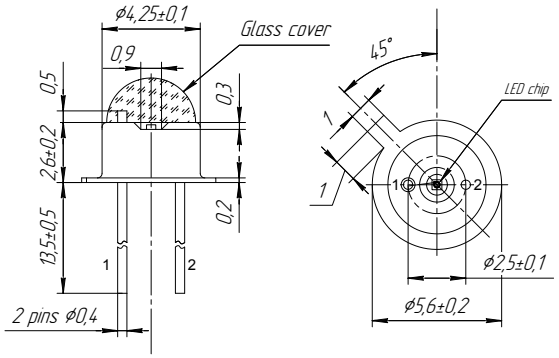
Generally, LEDs are mounted in a package that has two electrical leads, a transparent optical window for the emission output, and heatsink. An LED chip is soldered or glued to the package surface that is connected to the one of the lead wires. Top contact of the chip is connected to the other lead with a bonding wire.

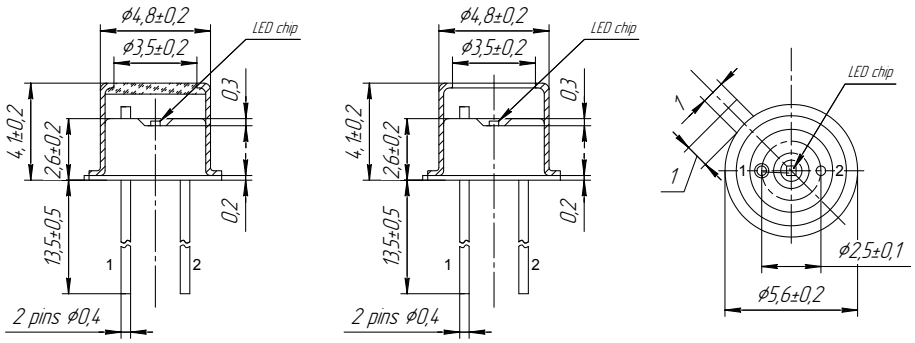
We offer a range of standard packages for LEDs and LED-matrices as follows:

TO-18 package

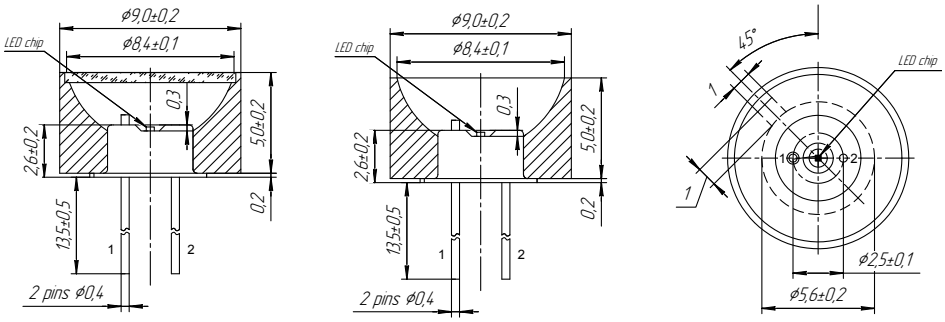
TO-18 package with glass cover



TO-18 with a cap with/without a glass window



TO-18-R and TO-18-RW with a parabolic reflector with/without a glass window



TO-18 package features:

- very miniature packages with limited area for mounting;
- material – kovar, finish – gold/plating;
- the number of lead pins is 2 or 3;
- equipped with a cap (with/without a glass window) or a parabolic reflector (with/without a glass window).

LED models with glass cover are provided without cap/reflector.

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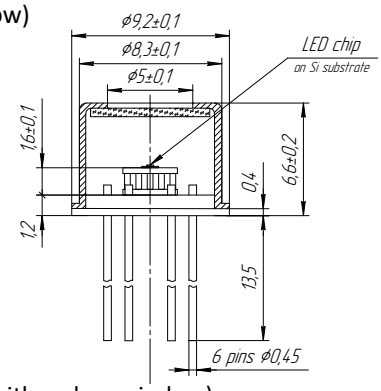
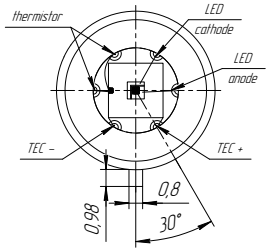
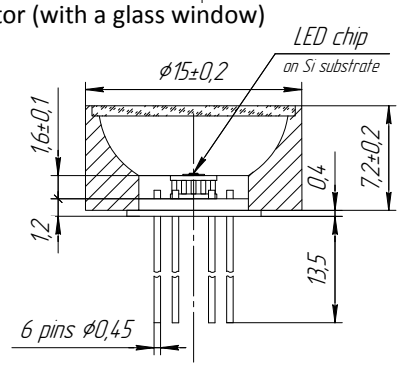
TO-5 package

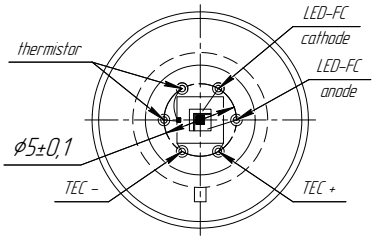
TO-5-TEM with a cap (with a glass window)





TO-5-TEM-R with a parabolic reflector (with a glass window)



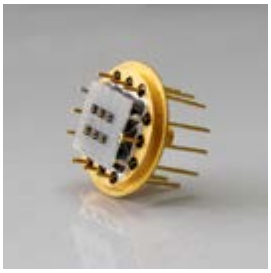


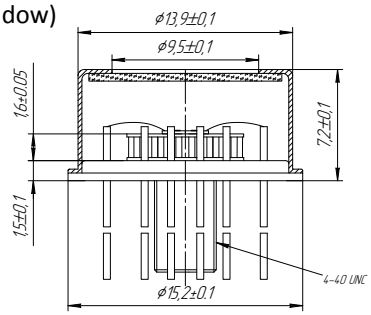
TO-5-TEM package features:

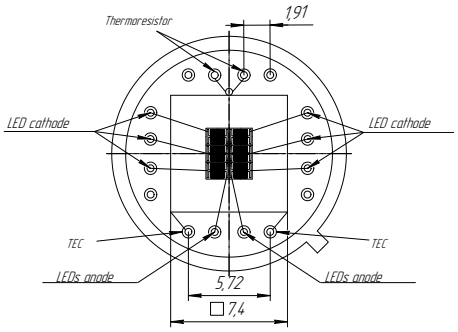
- small packages with 3.2 x 3.2 mm² thermocooler surface open for mounting ;
- header material – kovar, finish – gold/plating; thermocooler ceramics – Al_2O_3;
- the number of lead pins is 6 or 8;
- built-in thermoelectric module (TEM) – thermocooler and thermoresistor – provides LED chip temperature adjustment and stabilization in the range +5 to +55 °C;
- equipped with a cap (with a glass window) or a parabolic reflector (with a glass window).

TO-8 package

TO-8-TEM with a cap (with a glass window)







TO-8-TEM package features:

- compact packages with 7.4 x 7.4 mm² thermocooler surface open for mounting;
- header material – kovar, finish – gold/plating, thermocooler ceramics – Al_2O_3;
- the number of lead pins is 12 or 16;
- built-in thermoelectric module (TEM) – thermocooler and thermoresistor – provides LED chip temperature adjustment and stabilization in the range +5 to +55°C;
- equipped with a cap with a glass window that protects LED device from damage.

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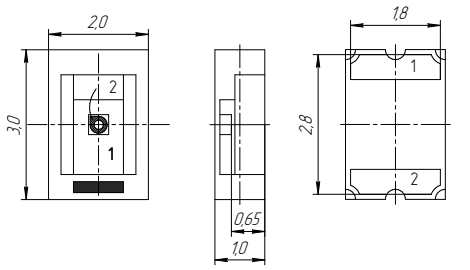
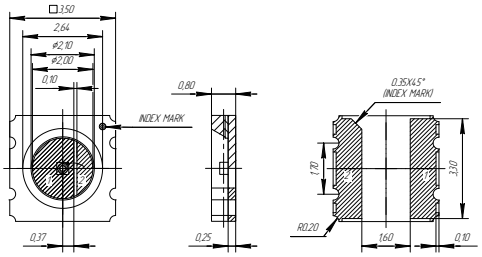
SMD package

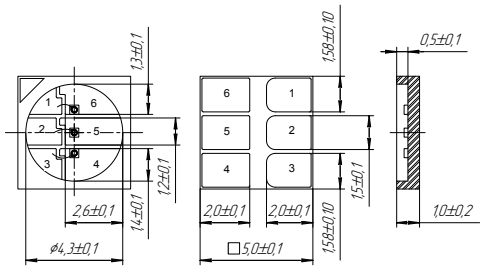
SMD CS3020 3 × 2 mm*



SMD CS35 3.5 × 3.5 mm*



SMD CS5-3M 5 × 5 mm*



*All SMD packages can be substituted by other ones.

SMD package features:

- tiny packages for surface mounting;
- anode and cathode are led to the metalized areas on the back side of the ceramic surface.

In addition to standard packages, we are ready to offer specifically designed solutions according to our customers' needs.

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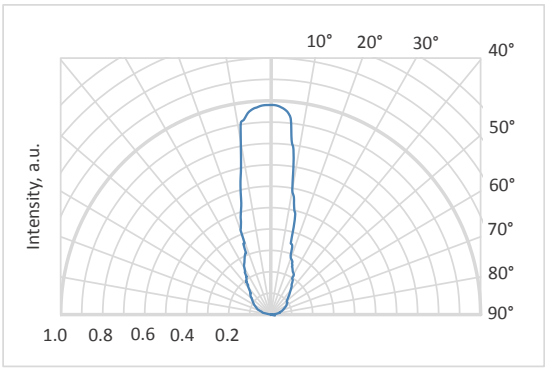
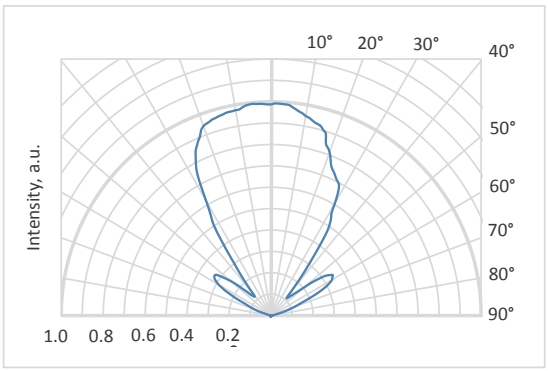
LED in TO-18 package with glass covering*

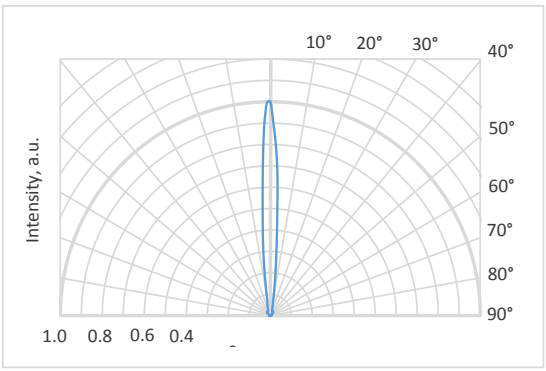


*Variation of beam divergence pattern exists because of the variation of glass shape from sample to sample due to the specificity of glass covering process.

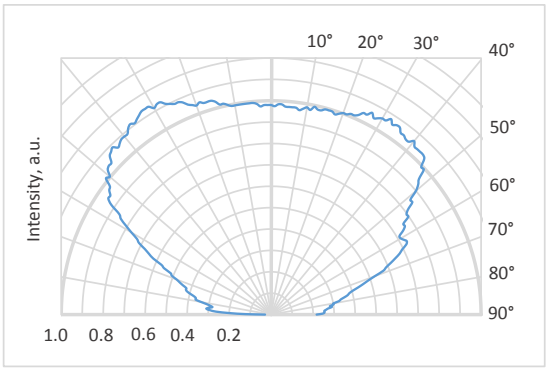
LED in TO-18 package with a cap



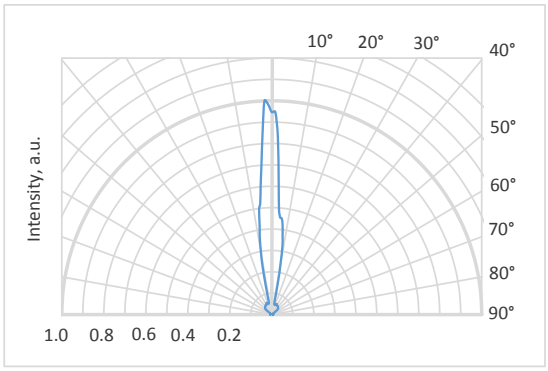
LED in TO-18 package with a parabolic reflector



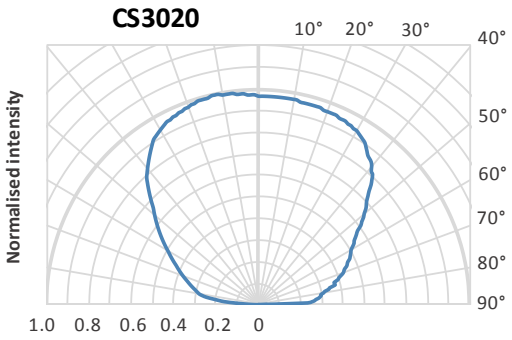
LED in TO-5-TEM package with a cap



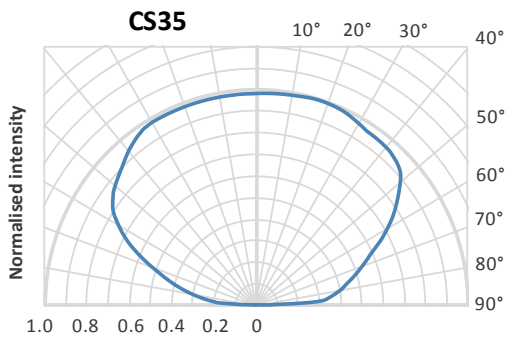
LED in TO-5-TEM package with a parabolic reflector



LED in SMD CS3020 package



LED in SMD CS35 package



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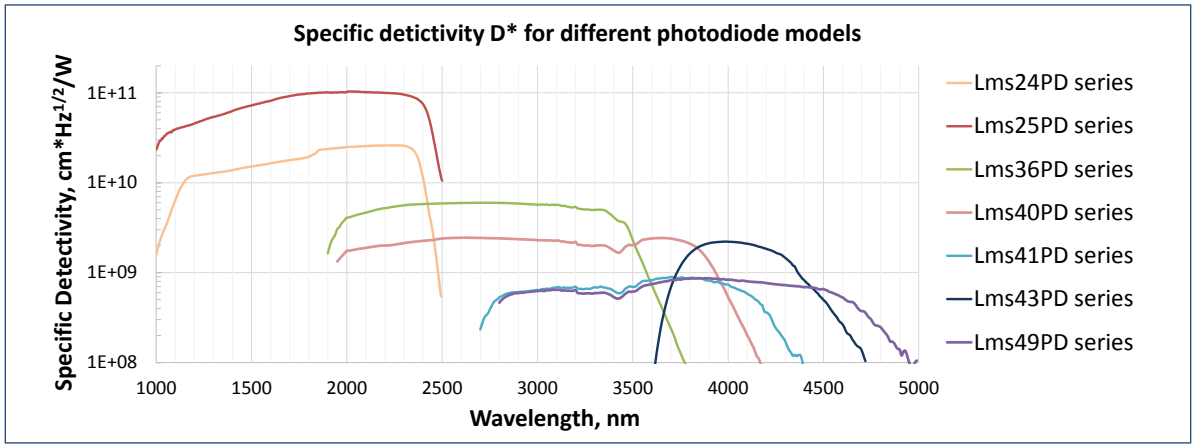
Wideband photodiodes for the spectral range 1.0 - 5.0 µm:



Standard photodiode models – Lms MIR PD									
Model	Chip sensitive area size [mm]	Max. sensitivity range (at 80% level)*1 [µm]	Cut-off wave length (at 10% level)*1 [µm]	Dark current*2,3 [µA]	Shunt resistance*2,4 [kOhm] (10 mV)	Capaci-tance*1,4 [pF]	Photo-sensitivity (at max level)*2 [A/W]	Noise equivalent power*2 [W/Hz$^{1/2}$]	Specific Detectivity [cm×Hz$^{1/2}$/W]
				max (typ)	min (typ)	max (typ)	min (typ)	max (typ)	min (typ)
Lms24PD-03	0.3	1.85-2.30	2.42-2.43	<60 (30)	>5 (10)	<200 (160)	>0.9 (1.1)	$<2.6\times10^{-12}$ (1.2×10^{-12})	$>1.2\times10^{10}$ (2.6×10^{10})
Lms25PD-05	0.5	1.65-2.35	2.5	<7 (4)	>40 (60)	<250 (200)	>1.0 (1.3)	$<6.4\times10^{-13}$ (4.0×10^{-13})	$>6.6\times10^{10}$ (1.0×10^{11})
Lms25PD-10	1.0	1.65-2.35	2.5	<22 (15)	>8 (15)	$<1.1\times10^{3}$ (1×10^{3})	>1.0 (1.1)	$<1.4\times10^{-12}$ (9.5×10^{-13})	$>6.2\times10^{10}$ (9.3×10^{10})
Lms36PD-03	0.3	2.45-3.30	3.7-3.8	<600 (150)	>0.2 (0.6)	<300 (200)	>0.7 (0.8)	$<1.3\times10^{-11}$ (6.5×10^{-12})	$>2.4\times10^{9}$ (4.7×10^{9})
Lms36PD-05	0.5	2.2-3.4	3.6-3.7	$<1\times10^{3}$ (300)	>0.2 (0.5)	$<1.1\times10^{3}$ (800)	>1.0 (1.2)	$<9.1\times10^{-12}$ (4.8×10^{-12})	$>4.6\times10^{9}$ (8.8×10^{9})
NEW Lms40PD-05	0.5	2.3-3.8	4.0-4.1	$<2\times10^{3}$ (1.1×10^{3})	$>35\times10^{-3}$ (50×10^{-3})	-	>1.1 (1.3)	$<2.0\times10^{-11}$ (1.4×10^{-11})	$>2.1\times10^{9}$ (3.0×10^{9})
Lms41PD-03	0.3	3.5-4.0	4.25-4.3	$<6\times10^{3}$ (5×10^{3})	$>12\times10^{-3}$ (15×10^{-3})	-	>0.7 (0.8)	$<5.3\times10^{-11}$ (4.1×10^{-11})	$>5.8\times10^{8}$ (7.4×10^{8})
Lms41PD-05	0.5	3.6-4.0	4.4	$<8\times10^{3}$ (6.5×10^{3})	$>6\times10^{-3}$ (7×10^{-3})	-	>1.1 (1.2)	$<4.8\times10^{-11}$ (4.0×10^{-11})	$>8.8\times10^{8}$ (1.0×10^{9})
Lms43PD-03	0.3	3.8-4.2	4.6-4.7	$<6\times10^{3}$ (4×10^{3})	$>10\times10^{-3}$ (20×10^{-3})	-	>1.6 (2.0)	$<2.5\times10^{-11}$ (1.4×10^{-11})	$>1.2\times10^{9}$ (2.1×10^{9})
Lms43PD-05	0.5	3.55-4.15	4.5-4.7	$<5\times10^{3}$ (4×10^{3})	$>12\times10^{-3}$ (17×10^{-3})	-	>1.0 (1.1)	$<3.7\times10^{-11}$ (2.8×10^{-11})	$>1.1\times10^{9}$ (1.5×10^{9})
NEW Lms49PD-05	0.5	3.55-4.50	4.9-5.0	$<25\times10^{3}$ (17×10^{3})	$>4.5\times10^{-3}$ (6×10^{-3})	-	>0.85 (1.0)	$<7.1\times10^{-11}$ (5.2×10^{-11})	$>6\times10^{8}$ (8×10^{8})

*1 Parameter tested for representative sampling.

*2 Parameter tested for each device.

*3 Measured at $V_{reverse}$=1 V for Lms24PD, Lms25PD models and at $V_{reverse}$= 0.1 V bias for other models.

*4 Measured at $V_{reverse}$=10 mV.

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Model	Chip sensitive area size [mm]	Max. sensitivity range (at 80% level)*1 [μm]	Cut-off wave length (at 10% level)*1 [μm]	Dark current*2,3 [μA]	Shunt resistance*2,4 [kOhm] (10 mV)	Capaci-tance*1,4 [pF]	Photo-sensitivity (at max level)*2 [A/W]	Noise equivalent power*2 [W/Hz$^{1/2}$]	Specific Detectivity [cm×Hz$^{1/2}$/W]
				max (typ)	min (typ)	max (typ)	min (typ)	max (typ)	min (typ)
Standard photodiode models with a glass cover – Lms MIR PD-CG									
Lms36PD-03-CG	0.3	2.4-3.1	3.7-3.8	<300 (80)	>0.4 (1.5)	<300 (250)	-	<9.6×10^{-13} (2.5×10^{-13})	>3.2×10^{10} (1.2×10^{11})
Lms36PD-05-CG	0.5	2.2-3.4	3.6-3.7	<1×10^{3} (120)	>0.2 (0.6)	<1100 (800)	-	<2.1×10^{-12} (6.0×10^{-13})	>2.0×10^{10} (7.0×10^{10})
NEW Lms40PD-05-CG	0.5	2.3-3.8	4.0-4.1	<2×10^{3} (1.1×10^{3})	>35×10^{-3} (50×10^{-3})	-	-	<1.2×10^{-12} (3.6×10^{-12})	>1.2×10^{10} (3.5×10^{10})
Lms43PD-03-CG	0.3	3.8-4.2	4.6-4.7	<6×10^{3} (4×10^{3})	>10×10^{-3} (20×10^{-3})	-	-	<3.4×10^{-12} (1.1×10^{-12})	>9.0×10^{9} (2.7×10^{10})
Lms43PD-05-CG	0.5	3.5-4.2	4.5-4.8	<25×10^{3} (15×10^{3})	>4×10^{-3} (5×10^{-3})	-	-	<1.1×10^{-11} (4.8×10^{-12})	>3.9×10^{9} (8.8×10^{9})
NEW Lms49PD-05-CG	0.5	3.55-4.50	4.9-5.0	<25×10^{3} (17×10^{3})	>4.5×10^{-3} (6×10^{-3})	-	-	<1.0×10^{-11} (5.2×10^{-12})	>4.2×10^{9} (8.0×10^{9})

*1 Parameter tested for representative sampling.

*2 Parameter tested for each device.

*3 Measured at $V_{reverse}$ = 0.1 V bias for other models.

*4 Measured at $V_{reverse}$ =10 mV.

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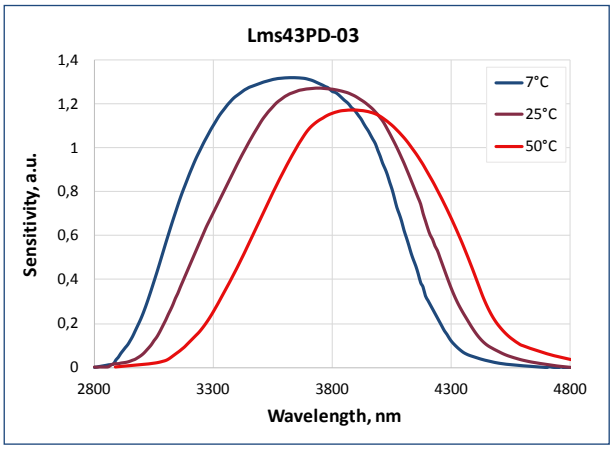
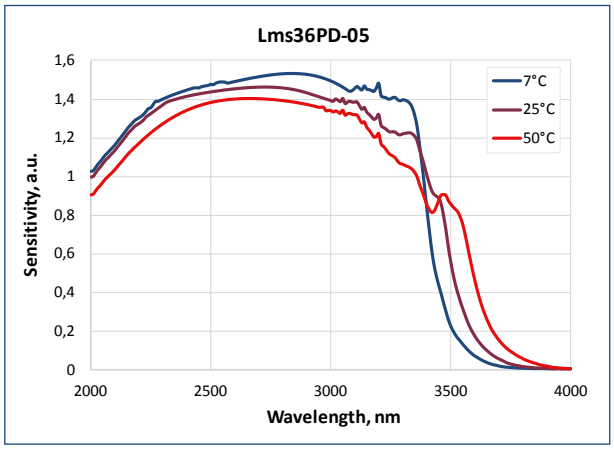
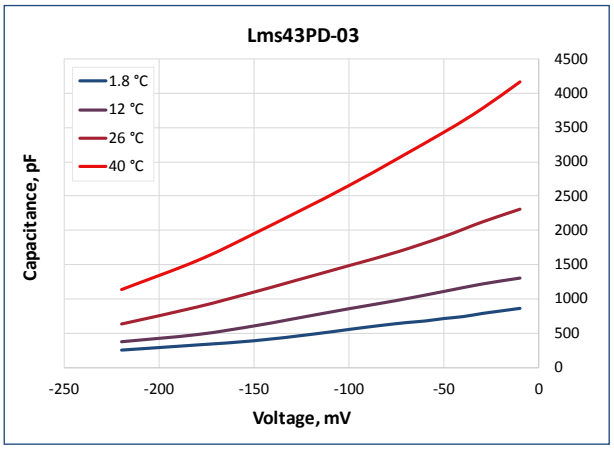
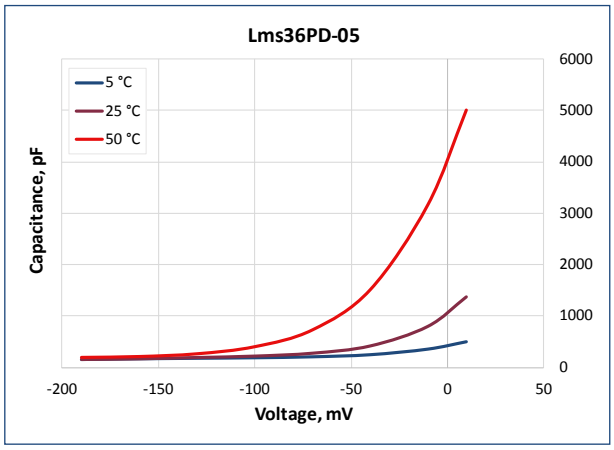
Temperature shift of spectral response



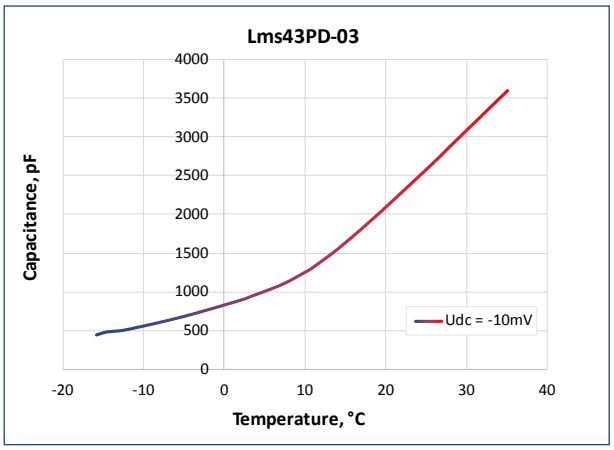


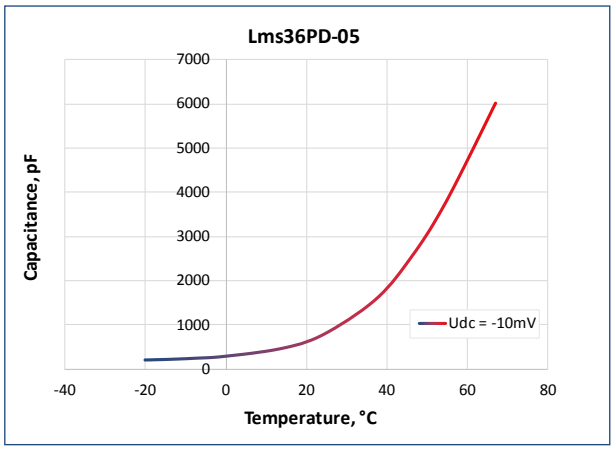
Capacitance vs. reverse voltage





Capacitance vs. temperature (measured at reverse bias 10 mV)





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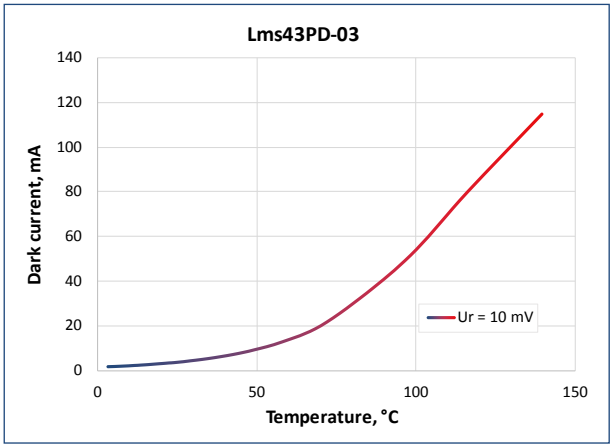
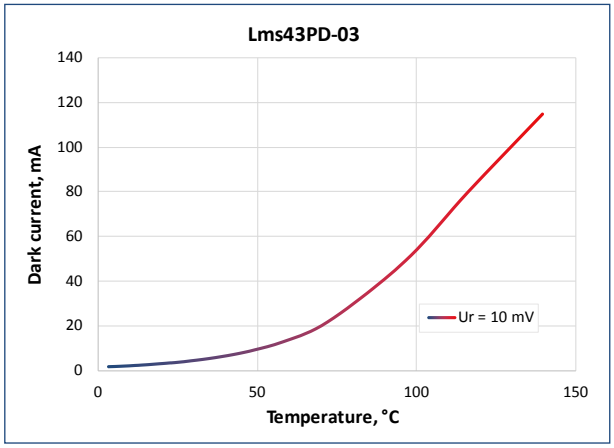
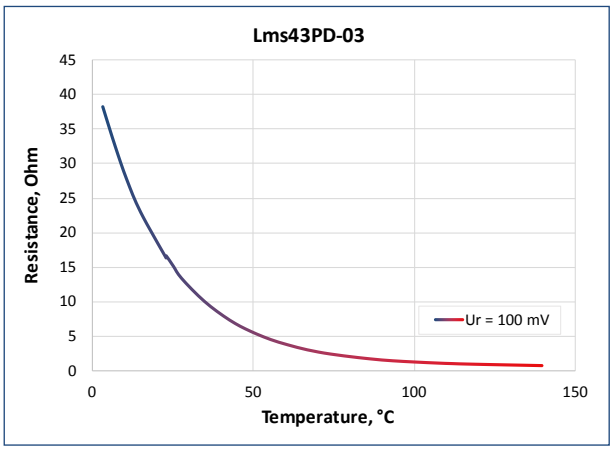
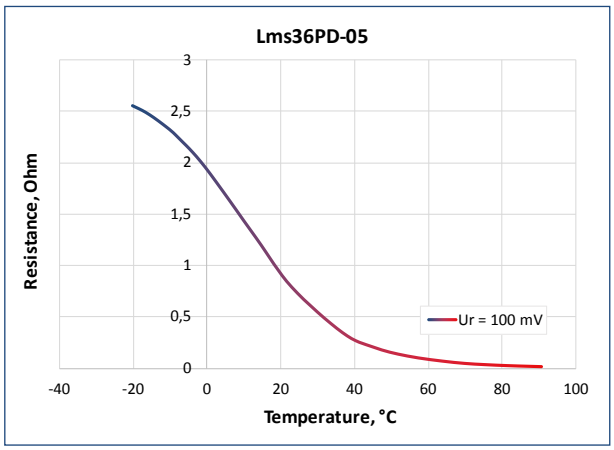
Dark current vs. temperature (measured at reverse bias 10 mV)



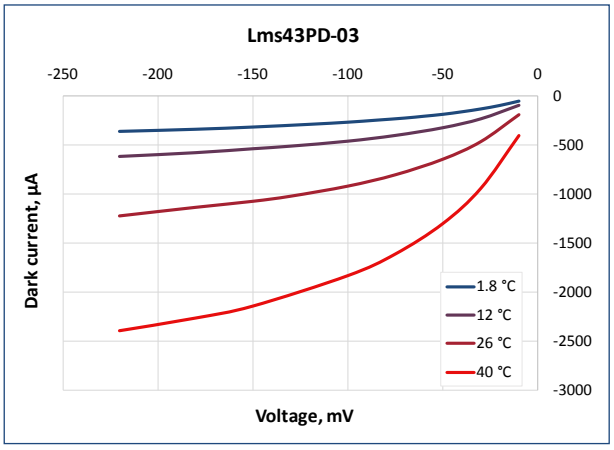


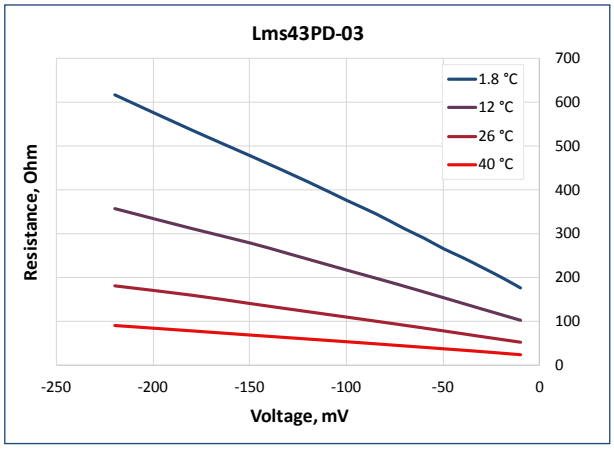
Shunt resistance vs. temperature (measured at reverse bias 100 mV)





Lms43PD-03 dependences of dark current and shunt resistance vs. reverse voltage at different temperatures





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All the above mentioned PD models are available coupled with a preamplifier - PAb type (for more information about PAb please refer to the page 42):

	Model without a glass window	Model with a glass window	Model with a glass cover
	Lms24PD-03-R-PA	Lms24PD-03-RW-PA	-
	Lms25PD-05-R-PA	Lms25PD-05-RW-PA	-
	Lms25PD-10-R-PA	Lms25PD-10-RW-PA	-
	Lms36PD-03-R-PA	Lms36PD-03-RW-PA	Lms36PD-03-CG-R-PA
	Lms36PD-05-R-PA	Lms36PD-05-RW-PA	Lms36PD-05-CG-R-PA
NEW	Lms40PD-05-R-PA	Lms40PD-05-RW-PA	Lms40PD-05-CG-R-PA
	Lms43PD-03-R-PA	Lms43PD-03-RW-PA	Lms43PD-03-CG-R-PA
NEW	Lms49PD-05-R-PA	Lms49PD-05-RW-PA	Lms49PD-05-CG-R-PA

Photodiode models with preamplifiers work in photovoltaic mode (with zero bias) and detect modulated emission signal. Current generated by the photodiode is amplified and converted by a preamplifier into a pulse voltage signal. There is straight correspondence between the PD current and the resulting output voltage. The signal converted by the preamplifier will have the same form, frequency and pulse duration as the photocurrent signal from the photodiode.

Photodiode models with the preamplifiers are equipped with a parabolic reflector with/without a glass window and packaged in an aluminium tube for screening and protection. The parabolic reflector protects a PD chip from damage and directs incident radiation on the sensitive area of the photodiode.

For the further signal conversion and synchronous detection of the signals from photodiodes with preamplifiers, we propose SDM synchronous detectors. The synchronous detector is tuned for optimal operation with LmsXXPD-XX-R-PA/LmsXXPD-XX-RW-PA, LmsXXPD-XX-CG-R-PA models and simplifies signal measurement. For more information regarding SDM synchronous detector please refer to the Electronics Section, p. 43.

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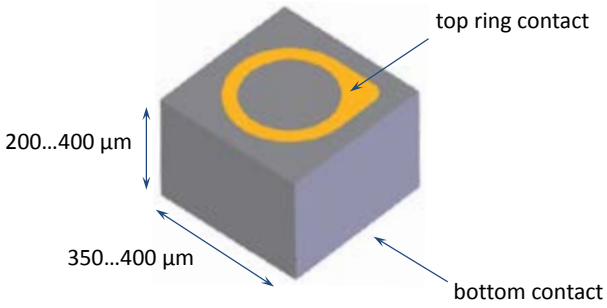
Photodiode chip with 0.3 mm sensitive area

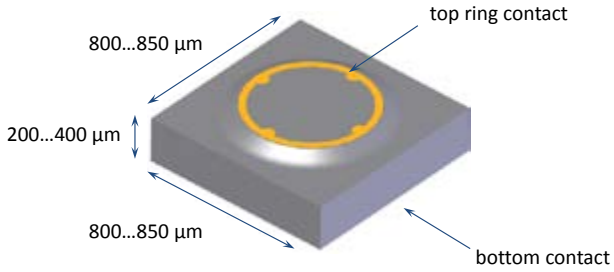


This shape of PD chip is typical for Lms24PD-03, Lms36PD-03, Lms41PD-03, Lms43PD-03 series photodiodes.

Main features are:

- small size of the PD chip;
- cost effective (due to small size).

Photodiode chip with 0.5 mm sensitive area



This shape of PD chip is typical for Lms36PD-05, Lms40PD-05, Lms41PD-05, Lms43PD-05, Lms49PD-05 series photodiodes.

Main features are:

- larger size of the PD active area and, consequently, higher sensitivity;
- mesa shaped structure.

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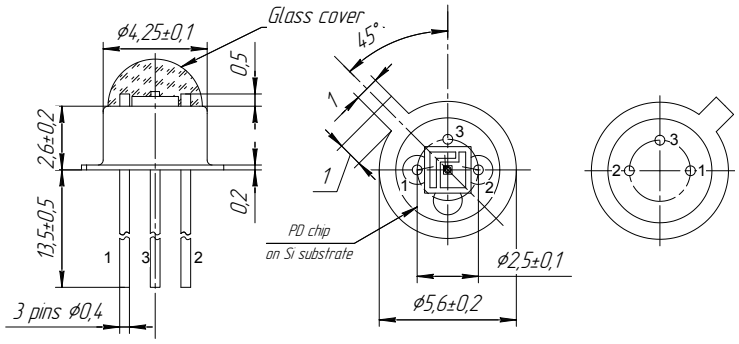
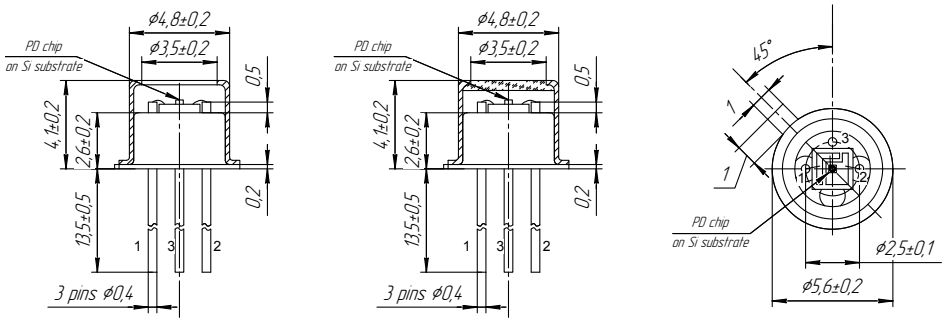
We offer our photodiodes packaged in standard TO-type models.

TO-18 package

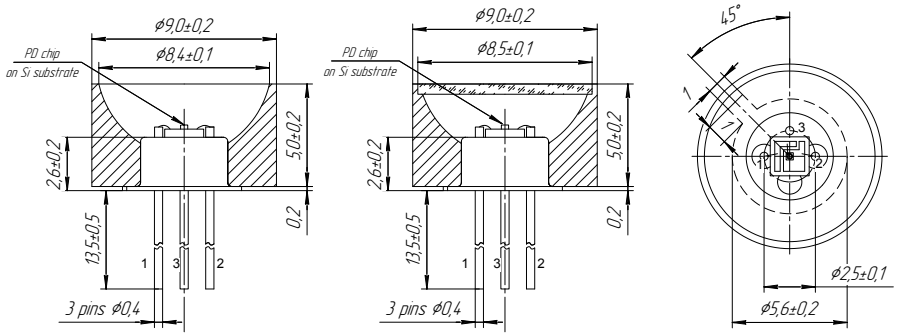
TO-18 with a glass cover



TO-18 with a cap with/without a glass window



TO-18-R and TO-18-RW with a parabolic reflector with/without a glass window



TO-18 package features:

- very miniature packages with limited area for mounting;
- material – kovar, finish – gold/plating;
- the number of lead pins is 2 or 3;
- equipped with a cap (with/without a glass window) or a parabolic reflector (with/without a glass window).

Photodiodes with a glass cover are provided without a cap/reflector.

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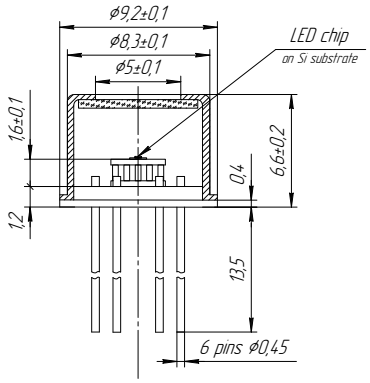
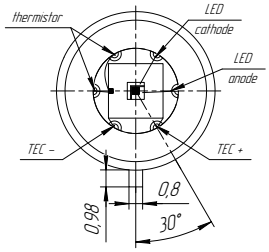
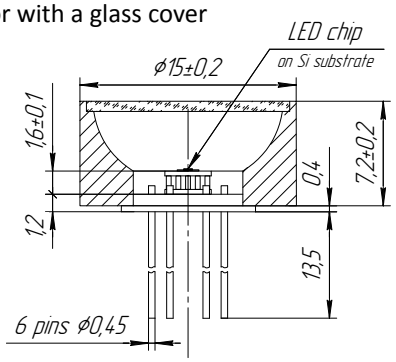
TO-5 package

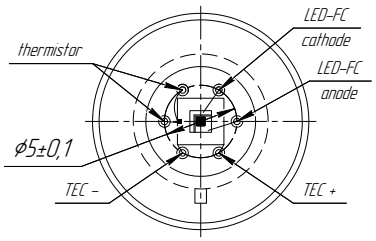
TO-5-TEM with a cap with a glass window





TO-5-TEM-R with a parabolic reflector with a glass cover

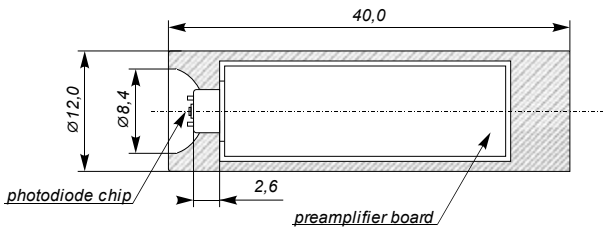


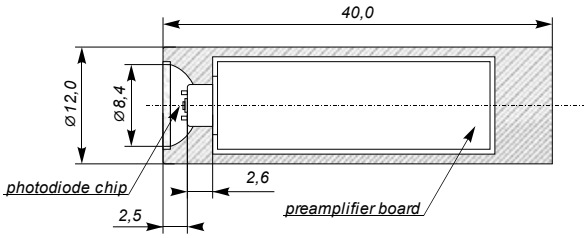


TO-5 package features:

- small packages with 3.2 x 3.2 mm² thermocooler surface open for mounting;
- header material – kovar, finish – gold/plating; thermocooler ceramics – Al_2O_3;
- the number of lead pins is 6 or 8;
- built-in thermoelectric module (TEM) – thermocooler and thermoresistor – provides LED chip temperature adjustment and stabilisation in the range +5 to +55°C;
- equipped with a cap (with a glass window) or a parabolic reflector (with a glass window).

Photodiodes with a built-in preamplifier without a glass window LmsXXPD-XX-R-PA and with a glass window LmsXXPD-XX-RW-PA





Photodiode models with the preamplifier are equipped with a parabolic reflector with/without a glass window and packaged in an aluminium tube for tuning and protection. Parabolic reflector protects a PD chip from damage and directs incident radiation on the sensitive area of the photodiode.

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In response to customers' requests we have developed different models of electronic units oriented for optimal operation with our LEDs and Photodiodes. Drivers and amplifiers allow the arrangement of a very flexible and easy to use set-up to carry out initial experiments concerning optical absorption measurements of gases, liquids and solid materials in the infrared spectral range. The available operational regimes can be selected to attain maximum benefits of using the new IR LEDs and PDs.

For LED power supply we produce and offer the following driver series:

LED driver D-41i – provides Pulse operation mode.
LED driver D-51i – provides Pulse operation mode; has an additional temperature control (monitoring) feature.
Minidriver mD-1c – provides qCW operation mode with fixed signal data parameters.
Minidriver mD-1p – provides Pulse operation mode with fixed signal data parameters.

For Photodiode signal processing we offer several solutions:

PAb preamplifier board – converts the output current of a photodiode into a pulse voltage signal with amplification. It is also available along with a photodiode in a single metal-tube packing: LmsXXPD-XX-R(W)-PA and LmsXXPD-XX-CG-R-PA models.

SDM synchronous detector – measures voltage signal from the output of a photodiode preamplifier and converts it to the DC voltage signal proportional to voltage amplitude from the input.

Single unit for LED matrix power supply and signal processing with a one Photodiode:

MCD multichannel driver – provides driving of up to 8 LEDs and synchronization with a one photodiode. Available in two configurations with a built-in preamplifier circuitry (preadjusted for the exact photodiode type) or without preamplifier for operation with an external photodiode preamplifier (with LmsXXPD-XX-R(W)-PA and LmsXXPD-XX-CG-R-PA PD models).

You can select the appropriate electronic device for your experiments using the following tables:

LED models compatibility with drivers

LED\electronic device	D-41i	D-51i	Minidriver mD-1c	Minidriver mD-1p	MCD
Lms XX LED (-R; -RW)	✓	✓	✓	✓	✓*
Lms XX LED-TEM (-R)	✓	✓	✓	✓	✓*
Lms34LED-4M (-R; -RW)	✓	✓	×	×	×
Lms34LED-4M-TEM (-R)	✓	✓	×	×	×
Lms43LED-4M (-R; -RW)	✓	✓	×	×	×
Lms43LED-4M-TEM (-R)	✓	✓	×	×	×
Lms13-14-16-17-19-21LED-6M	×	×	×	×	✓
Lms13-14-16-17-19-21LED-6M-TEM	×	×	×	×	✓

*Under the preliminary coordination with the manufacturer.

PD models compatibility with preamplifier and synchronous detector (SDM)

PD\electronic device	PAb	SDM
LmsXXPD-XX (-R; -RW; -CG)	✓	×
LmsXXPD-XX-TEM (-R)	✓	×
LmsXXPD-XX (-R; -RW; -CG-R)-PA	×	✓

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D-41i LED driver

Application

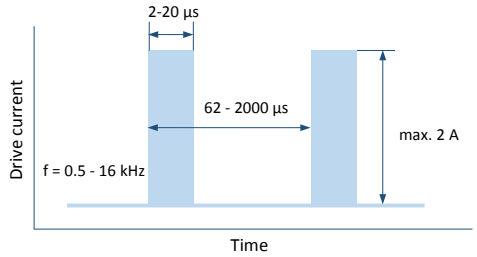
D-41i driver is designed for power supply of NIR and MIR LED models.

Features

- D-41i driver provides pulse mode of operation (the mode of maximum peak optical power of an LED).
- Possibility to choose one of five current values (0.2, 0.6, 1.0, 1.5 and 1.9 A), one of four frequencies (0.5, 1, 2 and 4 kHz) and pulse duration within five values (5, 10, 20, 50 and 150 µs)* via driver's jumpers.
- Synchronisation input terminal block allows:
  - synchronising driver with an external device (synchronous detector etc.);
  - synchronising two or more drivers simultaneously;
  - setting custom frequency of an LED signal.
- Possibility of synchronization with an external device with the help of synchronisation output terminal block.
- Ease of use and durability.

Technical characteristics

Current waveform generated by the driver



Parameters	Value
Input voltage	Stabilised +12 V
Voltage tolerance	-5 to +5 %
Power consumption	< 4 W
Board dimensions	80 × 70 × 15 mm
Synchronisation output voltage	5 V

Signal data	Pulse mode
Pulse duration*	5, 10, 20, 50 and 150 µs
Repetition rate	0.5, 1, 2 and 4 kHz
Output current amplitude	0.2, 0.6, 1.0, 1.5 and 1.9 A

*Different values of the pulse duration can be adjusted for a better performance of the LED (LED-PD optopair), follow the data pointed in the specification provided with the ordered driver.

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LED driver D-51i

Application

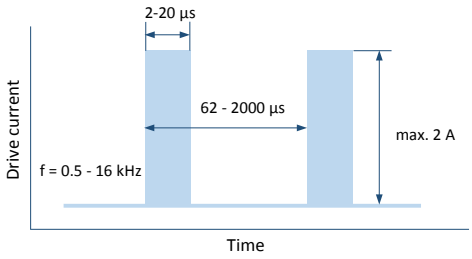
D-51i driver is designed for power supply and intrinsic temperature monitoring of MID IR LED models.

Features

- D-51i driver provides pulse mode of operation (mode of maximum peak optical power of an LED).
- Possibility to choose one of five current values (0.2, 0.6, 1.0, 1.5 and 1.9 A), one of four frequencies (0.5, 1, 2 and 4 kHz) and pulse duration within four values (5, 10, 20, 50 and 150 µs)* via driver's jumpers.
- Synchronisation input terminal block allows:
  - synchronising driver with an external device (synchronous detector etc.);
  - synchronising two or more drivers simultaneously;
  - setting custom frequency of an LED signal.
- Possibility of synchronization with an external device with the help of synchronisation output terminal block.
- Temperature control – possibility to judge about LED p-n junction temperature using current-voltage dependence. Driver generates the low current signal for plugged LED, measures and outputs the voltage. Using the obtained voltage value it is possible to calculate the intrinsic LED temperature.
- Ease of use and durability.

Technical characteristics

Current waveform generated by the driver



Parameters	Value
Input voltage	Stabilised +12 V
Voltage tolerance	-5 to +5 %
Power consumption	< 4 W
Board dimensions	80 × 70 × 15 mm
Synchronization output voltage	5 V

Signal data	Pulse mode
Pulse duration*	5, 10, 20, 50 and 150 µs
Repetition rate	0.5, 1, 2 and 4 kHz
Output current amplitude	0.2, 0.6, 1.0, 1.5 and 1.9 A

*Different values of the pulse duration can be adjusted for a better performance of the LED (LED-PD optopair), follow the data pointed in the specification provided with the ordered driver.

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mD-1c and mD-1p minidrivers

Application

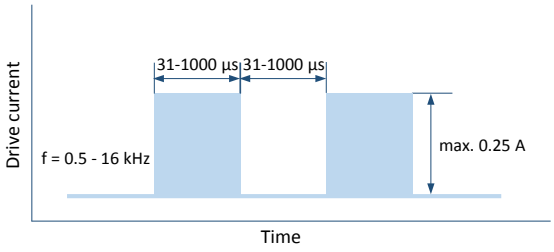
mD-1c and mD-1p minidrivers are designed for power supply of NIR and MIR LED models.

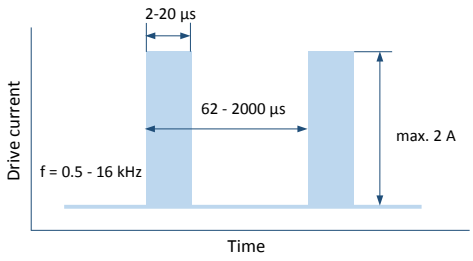
Features

- mD-1c minidriver provides a qCW mode of operation with fixed signal data parameters (amplitude, repetition rate and pulse duration).
- mD-1p minidriver provides a pulse mode of operation with fixed signal data parameters (amplitude, repetition rate and pulse duration).
- Possibility of synchronization with an external device (such as LMSNT SDM synchronous detector) with the help of synchronization output contacts.
- Ease of use and durability.

Technical characteristics

Parameters	Value
Input voltage	Stabilised +12 V
Voltage tolerance	-5 to +5 %
Power consumption	< 4 W
Board dimensions	24 × 12 mm
Synchronization output voltage	5 V





mD-1c (qCW)

Signal data	qCW
Pulse duration	500 µs
Repetition rate	1 kHz
Output current amplitude	150 mA

mD-1p (pulse)

Signal data	Pulse mode
Pulse duration	5 µs
Repetition rate	2 kHz
Output current amplitude	2 A

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MCD multichannel driver

Application

MCD driver is a utility board that unites several functions:

- power supply of LED matrices comprising of up to 8 LEDs;
- synchronisation of LED signals with a one photodiode;
- photodiode signal processing.

Features

- LED driving at pulse mode (mode that provides maximum peak optical power).
- Built-in 8-channel synchronous detector, which provides synchronisation with a one photodiode.
- Two MCD configurations are available:
  - with a built-in preamplifier circuitry;
  - without preamplifier circuitry for operation with an external photodiode preamplifier.
- Parameters adjusted by manufacturer for every MCD for most optimal performance:
  - current amplitudes;
  - for modification with a built-in preamplifier circuitry - preamplifier is adjusted for the exact photodiode model.

Compatibility table

MCD driver is oriented for operation with multielement LED matrices comprised of up to 8 independently powered LED chips or with up to 8 standard one-element LEDs. Compatibility with different LED matrices (or set of standard one-element LEDs) used in a pair with LMSNT photodiodes can be defined using the following table.

LED\Photodiode	Lms24PD-03 Lms25PD-05 Lms25PD-10	Lms24PD-03-R(W)-PA Lms25PD-05-R(W)-PA Lms25PD-10-R(W)-PA	Lms36PD-03 Lms36PD-05 Lms36PD-03-CG Lms36PD-05-CG	Lms36PD-03-R(W)-PA Lms36PD-05-R(W)-PA Lms36PD-03-CG-R-PA Lms36PD-05-CG-R-PA
Lms10LED, ... Lms23LED	✓ (MCD with a built-in preadjusted preamp.)	✓ (MCD without preamp.)	×	×
Lms27LED, ... Lms34LED Lms27LED-CG, ... Lms34LED-CG	×	×	✓ (MCD with a built-in preadjusted preamp.)	✓ (MCD without preamp.)

Photodiode series Lms40PD/ Lms41PD, Lms43PD, Lms49PD are not compatible with MCD board because of the inability to detect emission with 20 µs pulse duration properly.

Question of compatibility of custom matrices and photodiodes with the MCD board should be discussed with the manufacturer in advance.

Technical characteristics

Parameters	Value
Input voltage	Stabilised +12 V
Voltage tolerance	-5 to +5 %
Input current	max. 0.25 A
Board dimensions	105 × 70 × 15 mm
Signal output voltage amplitude	11 V (-4 V for inverted constant signal)

Parameters	Value
Pulse duration	20 µs
Repetition rate (per channel)	0.5 kHz
Repetition rate (8 channels)	4 kHz
Output current amplitude	adjusted by manufacturer*
Output signal gain (adjustable)	1x - 10x

*Current values are to be preadjusted by manufacturer depending on the LED matrix (set of LEDs) and photodiode that are to be used with MCD.

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Application

PAb preamplifier is oriented for amplification and conversion of the pulse current signal generated by photodiodes (PDs). The resulted voltage signal has the same form as the photocurrent, i.e. if the photocurrent from photodiode is a meander, the converted signal will be a meander too with the same frequency and pulse duration. Current into voltage conversion coefficient is constant and depends on given photodiode.

Features

- Enables PD operation at a photovoltaic mode (with no reverse bias).
- Provides conversion of the photodiode photocurrent to a voltage signal with amplification.
- Process modulated signals (can't work with CW signals).
- Adjustment for the exact photodiode type is required for the proper operation.

Compatibility table

Photodiode models	
LmsXXPD-XX	✓
LmsXXPD-XX-R	✓
LmsXXPD-XX-RW	✓
LmsXXPD-XX-CG	✓
LmsXXPD-XX-R-PA	×
LmsXXPD-XX-RW-PA	×
LmsXXPD-XX-CG-R-PA	×

Technical characteristics

Parameters	Value
Input voltage	Stabilised +5 V
Voltage tolerance	-5 to +5 %
Board dimensions	10 × 26 mm

PAb preamplifier is also available along with a photodiode in a single metal-tube packing: LmsXXPD-XX-R-PA/LmsXXPD-XX-RW-PA and LmsXXPD-XX-CG-R-PA models.

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Application

SDM synchronous detector measures the voltage signal from the output of a photodiode preamplifier and converts it to the DC voltage signal proportional to amplitude of the voltage from input.

Features

- Three independent channels for detection. One can connect three systems with drivers and preamplifiers and run them through the synchronous detector simultaneously.
- Built-in power supply for preamplifiers.
- Possibility of input polarity inversion using the appropriate jumper. In case of wrong polarity connection from photodiode preamplifier one can simply switch the input polarity inversion jumper.

Technical characteristics

Parameters	Value
Input voltage	Stabilised +12 V
Voltage tolerance	-5 to +5 %
Power supply current, max	< 0.1 A
Board dimensions	70 × 70 × 19 mm
Synchronization output voltage	5 V
Output constant voltage signal, max	10 V (-3 V for inverted constant signal)

Parameters	Value
Averaging time	100, 200 and 300 ms
Voltage tolerance	1x, 5x and 10x

Parameters	Value
Pulse duration	2 - 20 µs
Repetition rate	0.5 - 16 kHz
Input voltage signal from preamplifier, max	±3 V

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Mid-infrared light-emitting diodes and photodiodes manufactured by LED Microsensor NT, LLC have already found their usefulness in a vast area of applications. For the first-time users we announce sample systems and kits that enable fast preliminary experiments with infrared LED-PD optopairs for different detection purposes.

Evaluation kits for methane (MDK and MDK-c) and carbon dioxide (CDK and CDK-c) detection

Evaluation kit for CH_4 detection (MDK) includes:

- Lms34LED-RW;
- Lms36PD-05-RW-PA;
- acryl glass optical chamber (optional, under request);
- LED Driver (D-41i / D-51i / mD-1p);
- synchronous detector SDM;
- AC/DC Adaptor, connection wires.

Evaluation kit for CO_2 detection (CDK) includes:

- Lms43LED-RW;
- Lms43PD-03-RW-PA;
- acryl glass optical chamber (optional, under request);
- LED Driver (D-41i / D-51i / mD-1c);
- synchronous detector SDM;
- AC/DC Adaptor, connection wires.

MDK-c and CDK-c are advanced evaluation kits for CH_4 and CO_2 detection with glass-covered LED and photodiode, which includes all the needed components for quick and simple start.

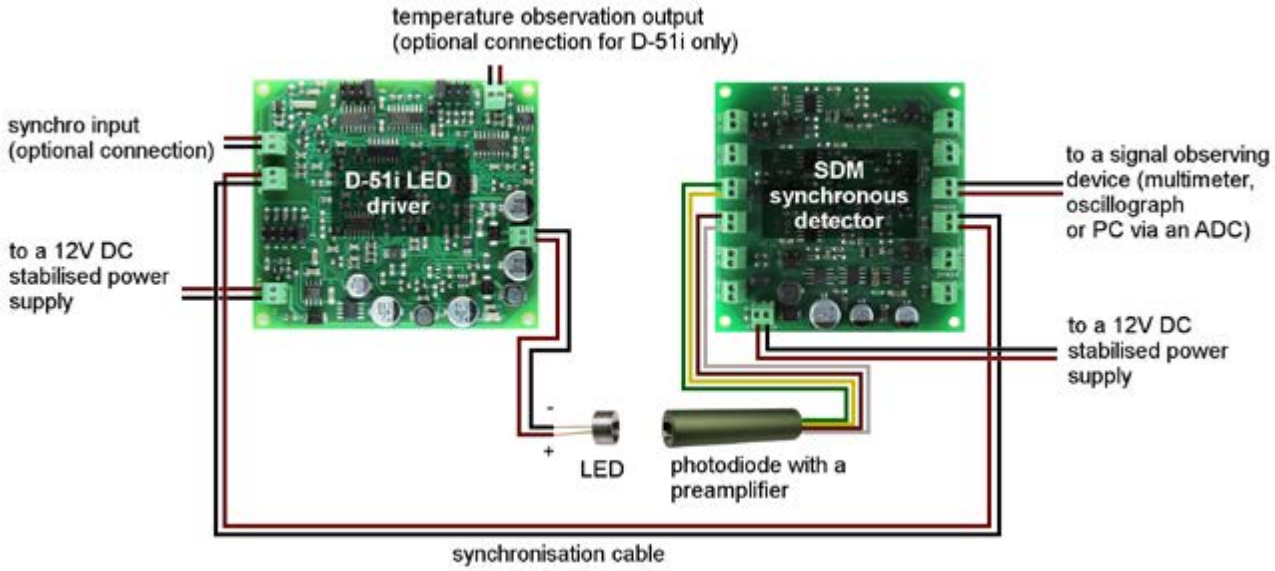
Evaluation kit for CH_4 detection (MDK-c) includes:

- Lms34LED-CG-R;
- Lms36PD-05-CG-R-PA;
- LED Driver (D-41i / D-51i / mD-1p);
- synchronous detector SDM;
- AC/DC Adaptor, connection wires.

Evaluation kit for CO_2 detection (CDK-c) includes:

- Lms43LED-CG-R;
- Lms43PD-03-CG-R-PA;
- LED Driver (D-41i / D-51i / mD-1c);
- synchronous detector SDM;
- AC/DC Adaptor, connection wires.

Connection setup



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Evaluation systems for methane (MDS-5) and carbon dioxide (CDS-5) detection

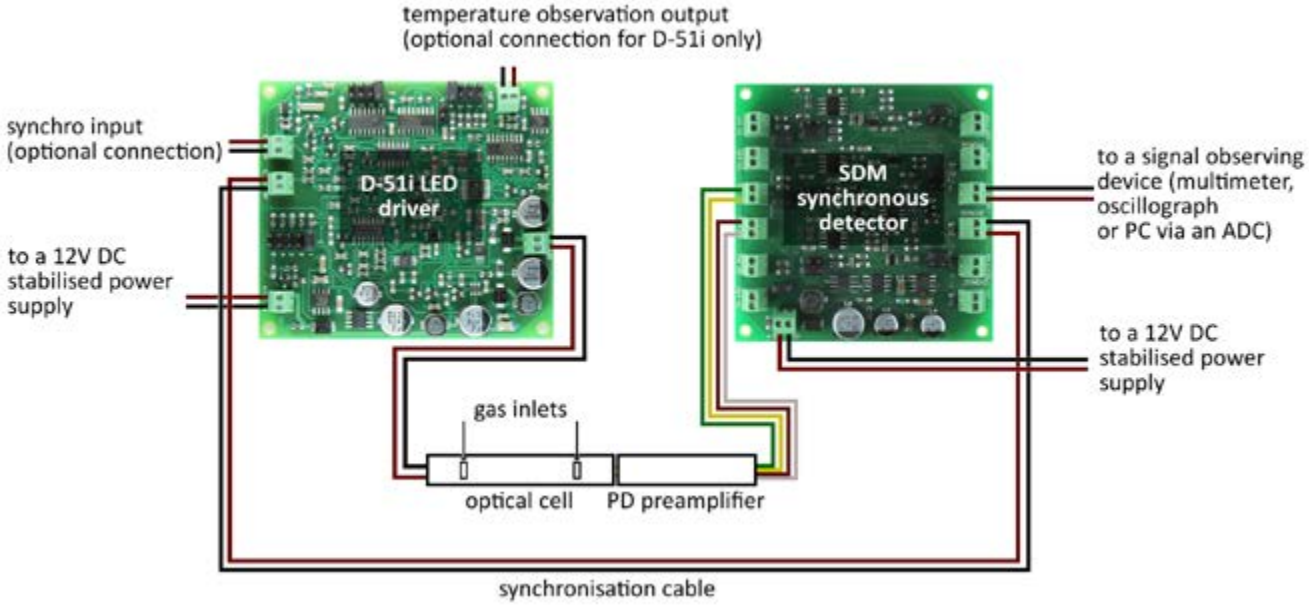
Evaluation system for CH_4 detection (MDS-5) includes:

- optical cell with:
  - Lms34LED-CG;
  - Lms36PD-05-CG;
- PD preamplifier;
- LED Driver (D-41i /D-51i/mD-1p);
- synchronous detector SDM;
- AC/DC Adaptor, connection wires.

Evaluation system for CO_2 detection (CDS-5) includes:

- optical cell with:
  - Lms43LED-CG;
  - Lms43PD-03-CG;
- PD preamplifier;
- LED Driver (D-41i /D-51i/mD-1p);
- synchronous detector SDM;
- AC/DC Adaptor, connection wires.

Connection setup



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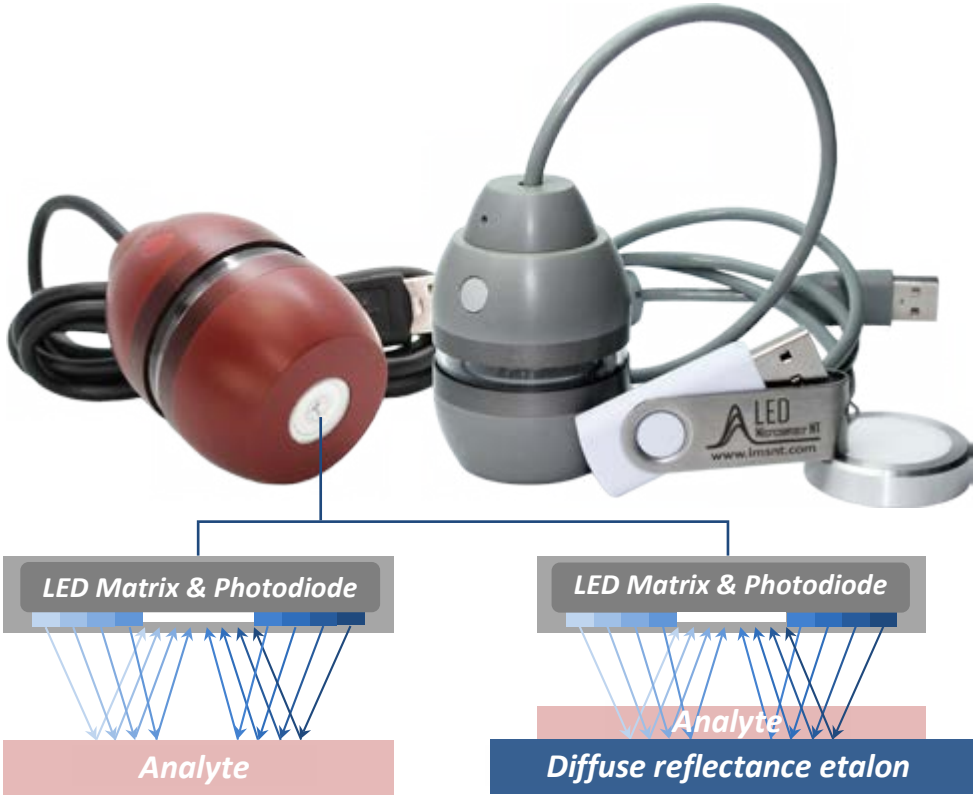
LMS-R LED Minispectrometer is our vey new ultra compact, lightweight instrument **for spectral analysis in the near-infrared range 1.3 – 2.4 µm**. It enables very fast and simple measurement procedure of various samples – solids, liquids, powders.



The main part of the device is the optical block comprised of **12 near-infrared LEDs** with different emission peaks (~1.31, 1.45, 1.51, 1.55, 1.66, 1.76, 1.84, 1.94, 2.06, 2.16, 2.21, 2.36) and **one wideband photodiode**.

LEDs are turned on one by one and irradiate the analysed sample. Emission reflected back from the sample is captured by the photodiode, converted into electrical signals that are further processed by the electronic block.

Using IR LEDs and photodiodes enables numerous benefits: minimising device dimensions, reducing its power consumption and measurement time while essentially decreasing its price comparing to functional analogues.

Main technical parameters:

- wavelength range: 1.3-2.4 µm;
- reflectance-based spectral measurement;
- measurement speed: 1 s;
- power supply: USB-powered;
- - input voltage: max. 5.25 V;
- - input power: max. 2.5 W;
- sizes: 60x42x42 mm;
- weight: 150 g;
- provided with a software for Windows PCs.

LMS-R Minispectrometer package contents

Range of applications

- express analysis of food (for example, defining deviations from the normal parameters judged by the absorption properties of the analysed sample);
- analysis of biomaterials for medical purposes (for example, concentration of sugar in blood, urine etc.);
- moisture control (for example, moisture control of paper, wood, constructional materials etc);
- water concentration measurement in cut-oil and oil products.

We are open to a joint development of custom instruments based on multielement LED matrices for the exact analysis tasks

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Current growth of interest in autonomously operated analysers and wireless sensor networks with remote control encourage development of the new durable and reliable sensors with low power consumption and fast response time.

Compact NDIR sensor modules based on mid IR LEDs and Photodiodes are good alternative of optical sensors on conventional thermal IR emitters and pyroelectric detectors.

Main features of LED-PD based gas sensor modules

- Diffuse type optical cell;
- Low power consumption (enables arranging battery power supply);
- Short response time;
- Sompact size;
- Temperature compensation algorithm included;
- Pre-calibrated for CH_4 or CO_2 detection.

Sensor module prototype

Range of applications

Key parameters of the new sensors - low power consumption, fast response time - open **wide opportunities for their usage within autonomously operated portable analysers**, as well as **complete sensor networks**, for example:

- ✓ CH_4 concentration control in the natural gas, oil extraction fields, coal mines, biogas production plants;
- ✓ gas concentration monitoring along the pipelines, local gas networks, on the territory of petroleum oil refineries and natural gas processing plants, waste landfill sites;
- ✓ CH_4 emissions control in household and industrial applications, where natural gas is used as an energy source;
- ✓ CH_4 leakage monitoring in the gas filling stations and vehicles running on gas fuel;
- ✓ CH_4 emissions control of agricultural objects (pastures, biomass storages);
- ✓ CO_2 concentration measurement within demand control ventilation and HVAC systems in buildings;
- ✓ CO_2 control in greenhouses;
- ✓ monitoring of polluting emissions in cities.

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