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Rev. 310315

HEAD OFFICE **LED Microsensor NT, LLC** and R&D CENTRE **Microsensor Technology, LLC**
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About the company

INTRODUCTION

LED Microsensor NT LLC is a company focused on developing and manufacturing optoelectronic devices for the mid-infrared spectral range. The company offers a wide range of Light Emitting Diodes (LEDs), LED arrays and spectral matched Photodiodes (PD) that cover the spectral range from 1600 to 5000 nm, together with other related electronic devices (LED drivers and PD amplifiers).

Our key technology is the epitaxial growth (Liquid Phase Epitaxy and Metalorganic Chemical Vapour Deposition) 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 the research and development of heterostructures for the mid-infrared spectral range, the design of optoelectronic devices, customer guide and support.

In Nov 2011, the Rusnano Corporation made an investment in LED Microsensor NT in order to expand the production of mid-infrared LEDs and PDs. In 2012 a spin-off R&D company Microsensor Technology LLC was arranged, focusing within itself the intellectual capacity and the necessary basis for research and development of new products – LED arrays, optical cells and modules. The company has become a resident of the Skolkovo Innovation Centre and carry out a number of challenging projects by the moment.

RUSNANO
Russian Corporation of Nanotechnologies

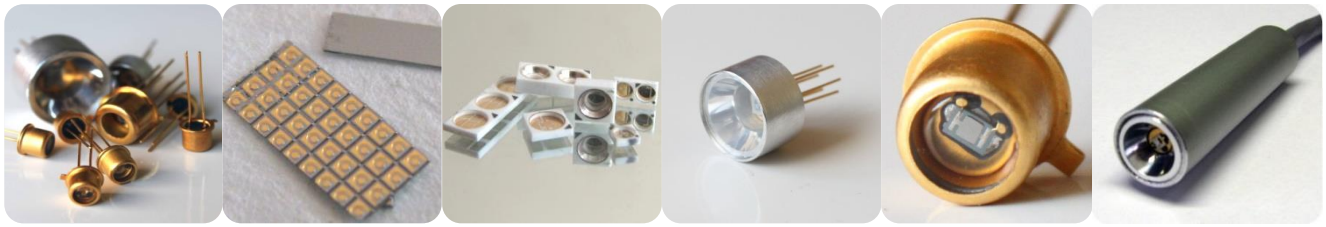
Sk Resident

Sk Nuclear

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 mid-infrared spectral range has allowed the development of portable sensors with high reliability and adequate accuracy that can be successfully applied in different areas for matter analysis purposes.

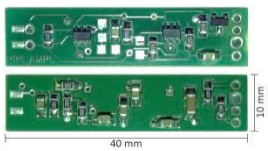
Standard products

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



Electronic devices (LED drivers, PD amplifiers) and Evaluation kits

LED driver



PD preamplifier board

Synchronous detector

Evaluation systems for CH_4 (or CO_2) detection

3-pass gas chamber for CDS/MDS-3

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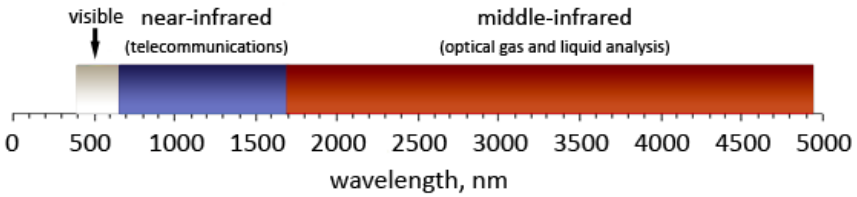
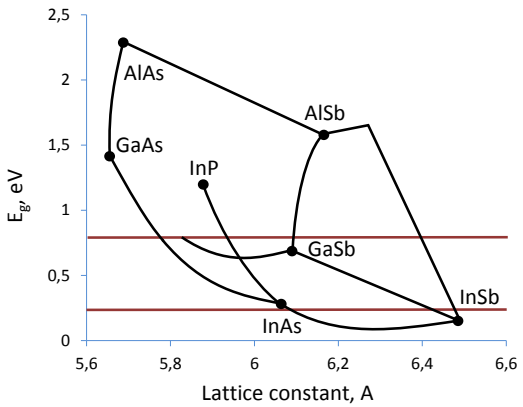
Light emitting diodes (LEDs) and Photodiodes (PDs) are semiconductor devices. The LED or PD heterostructure is formed by sequential epitaxy of semiconductor layers on the surface of a crystal substrate. LED radiation is generated in the active layer and the emission wavelength of the LED and the spectral response of the PD are determined by the energy gap of the material in the active layer.

The first laser heterostructures in the world were grown at the end of the 1960s in the Ioffe Physical Technical Institute by Nobel Prize laureate Zhores Alferov.

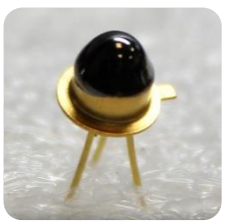




Nowadays, semiconductor optoelectronic devices for near-infrared and the visible spectral range are widely used in telecommunications and lighting. Additionally, LEDs and PDs possess great potential for use in optical analysing systems. In the middle Infrared spectral range, 1600–5000 nm, there are strong absorption bands for the most important gases and liquids, such as: 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.

Using a GaInAsSb/AlGaAsSb-based heterostructure lattice matched to a GaSb substrate allowed us to create LEDs and PDs for the 1.6–2.4 μm spectral range and by using an InAsSb/InAsSbP-based lattice matched to an InAs substrate we created LEDs and PDs for the 2.8–5.0 μm spectral range. There is a gap from about 2.4 to 2.8 μm due to the existence of a region of immiscibility for GaInAsSb based solid solutions which depends on the epitaxy temperature and the compound composition.

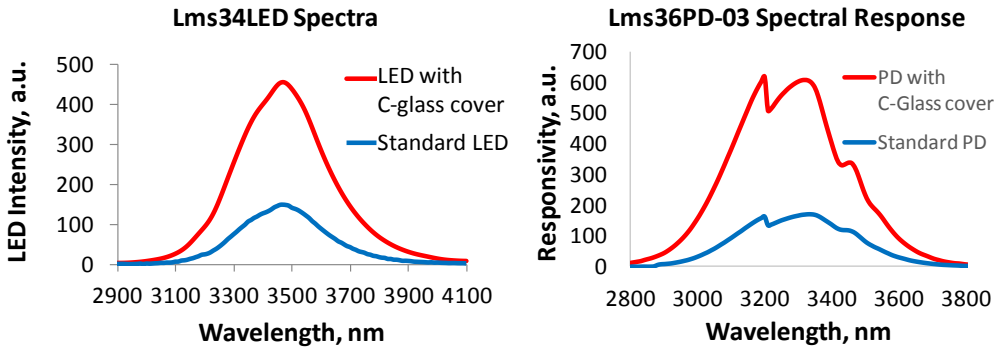
NEW LEDs and Photodiodes with a glass covering



Direct covering of LEDs and Photodiodes with a special glass enabled increasing of the diode external quantum efficiency. LED optical power and PD responsivity was **increased in ~3-5 times**. Narrowing of the beam divergence pattern for the LEDs and directing of the incident radiation on the sensitive area of the photodiode was also achieved.

Stability tests of the new LEDs and PDs are in progress, serial production of these types is scheduled in 2015.

Spectra examples of the standard LED and Photodiode and the new diodes with a glass covering



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We propose:

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

1.61-1.69	1.71-1.76	1.80-1.89	1.90-1.99	2.00-2.09	2.10-2.19	2.20-2.29	2.30-2.39	3.30-3.49	3.70-3.94	3.95-4.09	4.10-4.30	4.40-4.60
Lms16LED	Lms17LED	Lms18LED	Lms19LED	Lms20LED	Lms21LED	Lms22LED	Lms23LED	Lms34LED	Lms38LED	Lms41LED	Lms43LED	Lms46LED

- A line of flip-chip bonded LEDs (LED chip top surface is free of contacts) with peak wavelengths (μm):

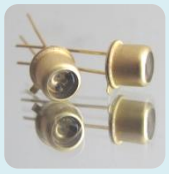
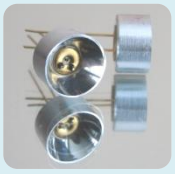
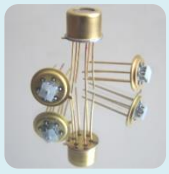
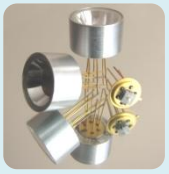
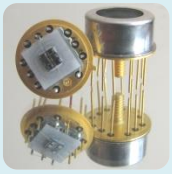
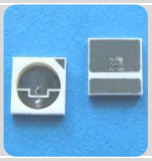
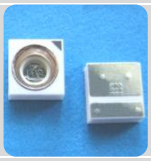
1.90-1.99	2.00-2.09	2.10-2.19	2.20-2.29	2.30-2.39
Lms19LED-FC	Lms20LED-FC	Lms21LED-FC	Lms22LED-FC	Lms23LED-FC

- A line of wide band Photodiodes with sensitive area of 0.3, 0.5 and 1.0 mm and cut-off at wavelengths (μm):

2.4			3.6		4.6	
Lms24PD-03	Lms24PD-05	Lms24PD-10	Lms36PD-03	Lms36PD-05	Lms43PD-03	Lms43PD-05

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

We offer a range of standard and customised packages for these devices:

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, PD, LED-matrix		LED-matrix
SMD Packages	5×5 mm		5×5 mm with microreflector		5×5 mm for 3-element matrix
					
applied to	LED				LED-matrix

- **NEW** line of LEDs and PDs **with a glass covering** (Lms XX LED-CG and Lms XX PD-XX-CG series) is coming very soon.

- Electronics oriented for operating with LEDs, LED-matrix and PDs:

✓ LED drivers D-41, D-51; minidrivers mD-1c, mD-1p – unpackaged drivers that provide LED power supply in different pulse modes; D-51M additionally enables monitoring of the LED p-n junction temperature judging by current-voltage dependence.

✓ PD preamplifier PAb – converts the output current signal of a photodiode into a voltage pulse output signal with amplification, is available together with a PD in a metal tube – LmsXXPD-XX-R-PA series and LmsXXPD-XX-RW-PA series;

✓ SDM synchronous detector – measures the voltage signal from the output of photodiode preamplifier and converts it to the DC voltage signal proportional to amplitude of voltage from input, designed for operation with LmsXXPD-XX-R-PA series and LmsXXPD-XX-RW-PA series photodiodes and LEDs driven by D-41, D-51 drivers;

✓ Thermocontroller TCM - designed for control and adjustment of temperature of LMSNT light-emitting diode and photodiode models with built-in thermoelectric modules

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We propose our optoelectronic devices for the mid-infrared spectral range as a new powerful base for optical absorption analysis. One of the great advantages of this method is that virtually any sample in virtually any state may be studied; liquids, solutions, pastes, powders, films, fibres, gases and surfaces can all be examined with a proper choice of sampling technique. This approach may be used for the analysis of one component in a mixture, especially when the compounds in the mixture are chemically alike, or have very similar physical properties.

Range of applications

Control of technological processes, examples:

- Paper industry (water in paper control, paper thickness control)
- Oil and petroleum industry (detection of water concentration in oil and oil products)
- Thickness testing (thickness of plastic, glass bottles)
- Pharmaceutical industry

Medical diagnostics, examples:

- Out-breath control (measurement of carbone dioxide, acetone concentration)
- Non-invasive control of glucose in blood

Ecological monitoring, examples:

- Control of carbon dioxide, carbon monoxide, exhaust gases in the atmosphere
- Control of methane, propane leakage
- Control of hydrocarbons in water
- Water turbidity measurement

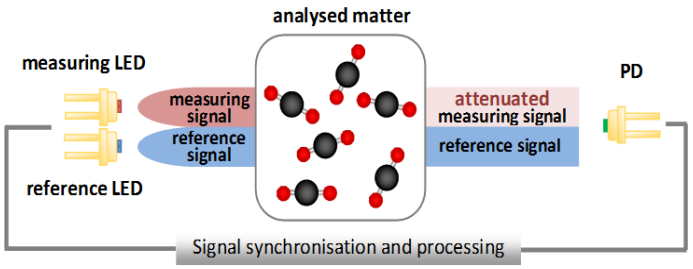
Food industry and agriculture, examples:

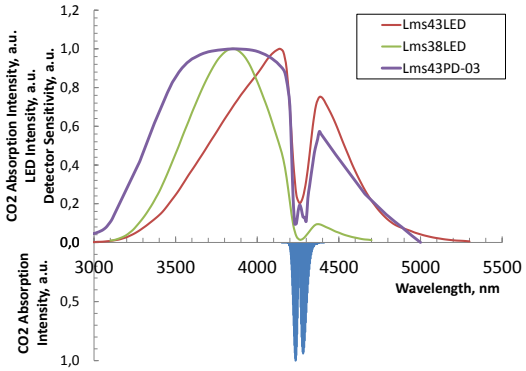
- Control of water, fibre, protein concentration in grains, humidity control of coffee beans, corn
- Control of fat and protein in milk
- Analysis of ethanol content in wine

Most commercially available instruments for this analysis employ quite sophisticated large-sized and expensive spectrometers that provide measurements solely at the laboratory. Mid-infrared LEDs and photodiodes enable development of very compact, cost-effective, durable optical sensors with very low power consumption and fast response time.

Principle of optical spectroscopy based on LED – PD optopair

Infrared optical analysis is based on the vibrations of the atoms of a molecule. 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.





The principle scheme for sensing chemical agents, based on LED-PD optopairs, is quite simple. The measuring LED emits radiation at a wavelength corresponding to the maximum absorption of the analyte. The reference LED emits radiation at a wavelength that is not absorbed by the analyte. The signal difference between the measuring LED that is partially absorbed in the optical cell and the reference LED is proportional to the concentration of the analyte.

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

Although the spectra are characteristics of the molecules, in a number of cases they overlap. The frequency of the fundamental vibrations varies with the atomic weight of the constituents. Further spectra exist due to overtones. These are in general much weaker, but there are still possibilities for these to be used for measurement purposes. The absorption strengths also vary with different molecules and therefore, different path lengths should be provided in order to obtain adequate absorption in the required sensitivity range. Small measuring cells can be advantageous, notably when a rapid response is needed (such as in medical applications).

CH_4 (methane) 1.65;2.30 μm; 3.2÷3.45 μm	**C_3H_8 (propane)** 3.28÷3.57 μm	**CO_2 (carbon dioxide)** 2.00; 2.70 μm; 4.20÷4.32 μm	**H_2O (water)** 2.55÷2.80 μm; 1.83÷1.94 μm
C_2H_2 (acetylene) 2.99÷3.09 μm	**HOCl (hypochlorous acid)** 2.6÷2.9 μm	**HCl (hydrogen chloride)** 3.33÷3.7 μm	**NH_3 (ammonia)** 2.27; 2.94 μm
C_2H_4 (ethylene) 3.1÷3.4 μm	**HBr (hydrogen bromide)** 3.7÷4.0 μm	**OH (hydroxyl radical)** 2.7÷3.0 μm	**$C_6H_{12}O_6$ (glucose)** 2.12; 2.27; 2.32 μm
C_2H_6 (ethane) 3.35 μm	**HI (hydrogen iodide)** 2.22÷2.35μm; 4.2÷4.5μm	**H_2CO (formaldehyde)** 3.38÷3.7 μm	**HNO_3 (nitric acid)** 2.80÷2.84 μm
CH_3Cl (methyl chloride) 3.22÷3.38 μm	**H_2S (hydrogen sulfide)** 4.2÷4.4 μm; 3.6÷3.8 μm; 2.5÷2.75 μm	**CO (carbon monoxide)** 4.5÷4.85 μm; 2.3-2.4 μm	**HF (hydrogen fluoride)** 2.33÷2.78 μm
OCS (carbonyl sulfide) 4.80-4.92 μm; 3.40-3.47μm	**HCN (hydrogen cyanide)** 2.94÷3.1 μm	**N_2O (nitrous oxide)** 2.85-3.01 μm; 3.85-4.10 μm; 4.23-4.57 μm	**NO_2 (nitrogen dioxide)** 3.4-3.5 μm

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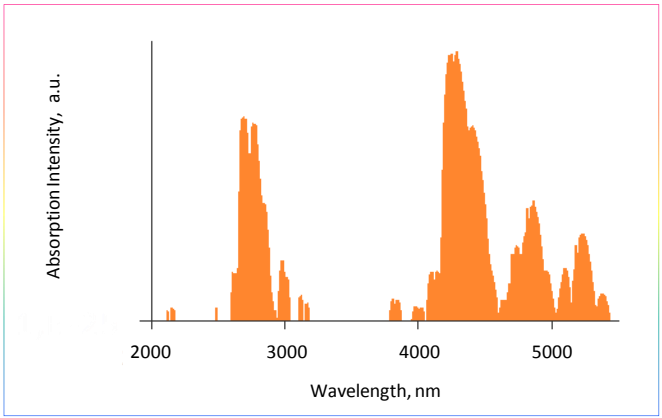
Carbon dioxide absorption spectrum



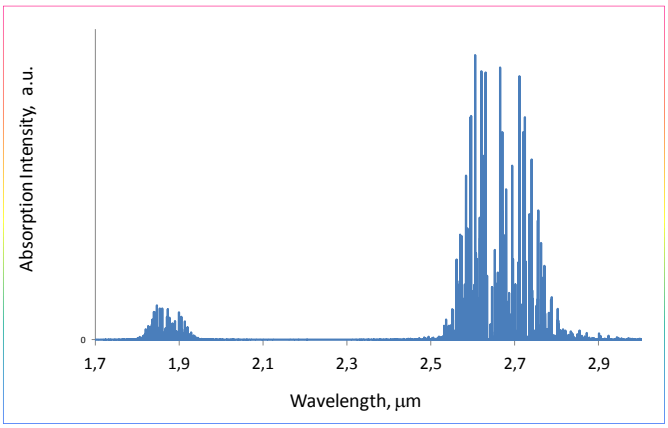
Carbon Dioxide has a strong absorption band at 4200–4320 nm spectral range and weaker bands around 2700 nm and 2000 nm (the data are taken from HITRAN Catalogue).

We recommend using Lms43LED (measuring), Lms38LED (reference) and Lms43PD (detector) for small measuring cells and/or for detection of small CO_2 concentrations.

Lms20LED (measuring), Lms23LED (reference) and Lms24PD (detector) can be used in long-path measuring cells and/or for high CO_2 concentration detection.

Detection around 2700 nm can be difficult due to the strong absorption by water at the same range.

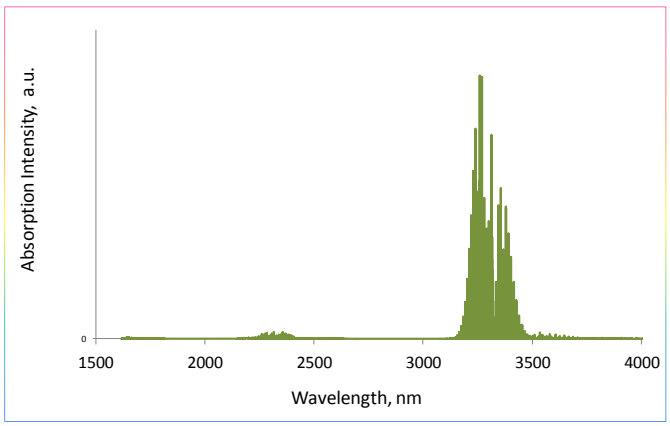
Water absorption spectrum



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

We recommend using Lms18LED or Lms19LED as a measuring signal, Lms16LED-FC as a reference and photodiode series Lms24PD to detect water in the range 1830–1940nm.

Methane absorption spectrum



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

We recommend using Lms34LED (measuring), Lms38LED (reference) and photodiode series Lms36PD for small measuring cells and/or for detection of small CH_4 concentrations.

Lms23LED (measuring) and Lms20LED (reference) and Lms24PD (detector) can be used in long-path measuring cells and/or for high CH_4 concentration detection.

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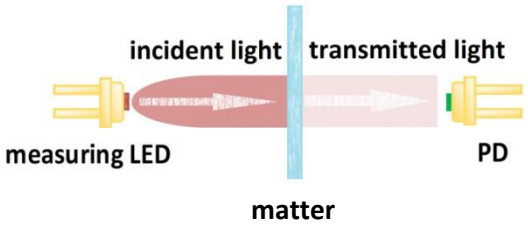
Principle of thickness measurement based on LED – PD optopair



Thickness measurement is based on the Beer's law which states that intensity of transmitted light exponentially depends on thickness of material:

$$I(l) = I_0 e^{-k_\lambda l},$$

Where I_0 and I are the intensity of the incident light and the transmitted light, respectively; k_λ – the absorption coefficient, l – the material thickness.

When the incident light comes through the matter, its intensity reduces and degree of the reduction is proportional to the thickness of the investigated object. This principle is applicable to thickness measurement of plastic, paper etc. Thanks to the fast response time, low power consumption, relatively narrow spectral width and other numerous benefits that LEDs and PDs offer, our devices have already found the successful application for plastic thickness control and can be considered as the competitive elements for other optical thickness analysers.

Range of applications within plastics:

01 PET
- ✓ PE films
- ✓ Containers (bottles, jars, pots, cans, glasses etc.)

02 PE-HD
- ✓ Canalisation, drainage pipes
- ✓ PE electrical insulation

04 PE-LD
- ✓ Cases for devices

03 PVC
- ✓ PVC fibers
- ✓ PVC electrical insulation
- ✓ Doors and windows

05 PP
- ✓ Details for automotive production
- ✓ Packaging
- ✓ Water supply system pipes

06 PS
- ✓ PS Heat insulation
- ✓ Containers and films for food industry

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

Present infrared absorption technology utilises several types of emission sources:

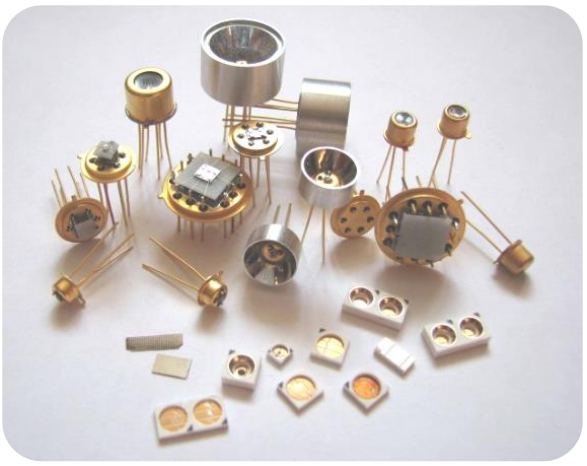
- broad-band light sources – filament black body emitters, planar filaments in thin technology – used together with crude and simple optics such as light pipes followed by filters, provide low modulation range (~8 Hz), less suitable for miniaturised sensing devices, low-cost;

- 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 elaborate cooling, 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 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. Detection of band absorption is more tolerant to the frequency stability of the spectral elements of the measuring device, leading to lower unit cost. New optoelectronic devices for the middle Infrared spectral range provide completely new possibilities for the creation of portable sensors creation. Using mid-infrared LED-PD optopairs has allowed the development of an instrument that is smaller, less expensive, and more versatile in functionality.

New mid-infrared LEDs possess certain competitive advantages:

- Compact size of the LED chip – 0.35 × 0.35 mm
- Possibility to arrange multi-element arrays enables obtaining multi-wavelength emitters in single compact packages
- LEDs emission band widths are comparable with absorption band widths of many chemical agents
- Capability to provide sufficient selectivity and accuracy for different sensing applications
- Low power consumption (<1 mW)
- Short response time (10–50 ns)
- Modulation ranges of up to 100 MHz can be achieved
- Operation temperatures up to +150°C
- Lifetime of 80 000 hours



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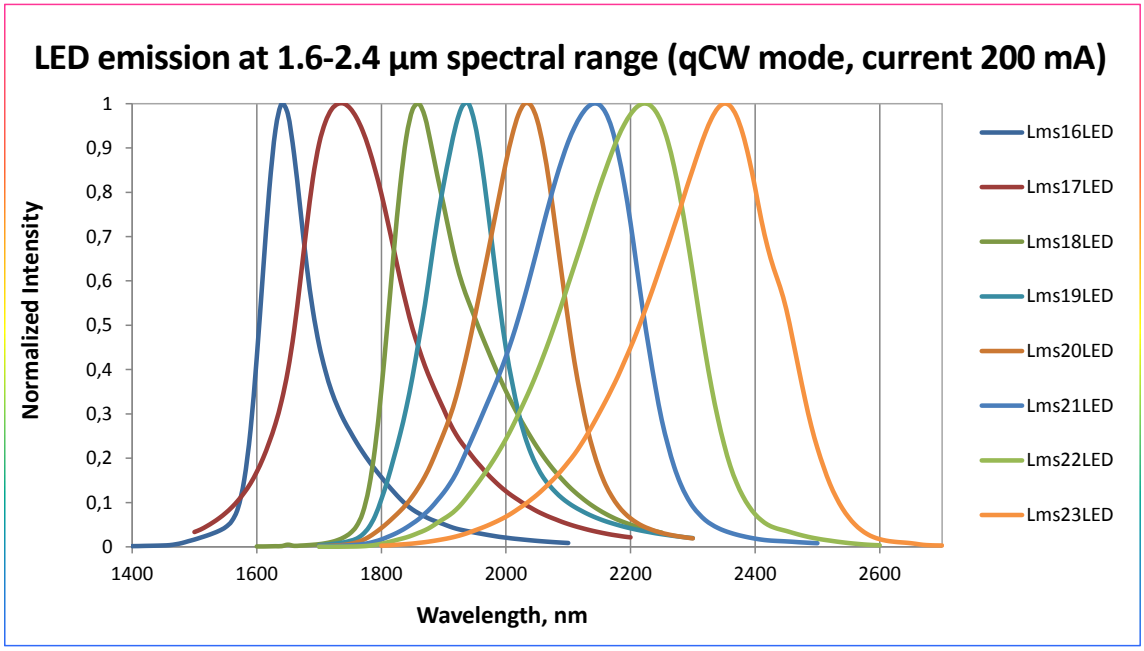
The main techniques that we use for heterostructure growth are Metal-Organic Chemical Vapour Deposition (MOCVD) and liquid-phase epitaxy (LPE). LEDs for the 1.6–2.4 μm spectral range were fabricated from a narrow-band gap GaInAsSb/AlGaAsSb-based heterostructure lattice matched to a GaSb substrate.

Light Emitting Diodes for 1.6 - 2.4 μm spectral range



Model	Peak emission wavelength, μm		FWHM of the emission band, nm		Power, mW				Voltage, V	Maximum operating current, mA		Operating temperature range, °C
					QCW mode*1		Pulse mode*2					
	min	max	min	max	min	max	min	max		QCW mode	Pulse mode	
Standard LED models (LED chip with circular, ring or grid top contact) – Lms MIR LED (1.8 – 2.3 μm)												
Lms16LED	1.61	1.69	150	250	4.0*3	8.0*3			0.8-1.1	200	N/A	-50 to +80
Lms17LED	1.71	1.76	150	250	5.5*3	7.5*3			0.5-1.0			
Lms18LED	1.80	1.89	100	200	0.7	1.1	15	25	0.5-1.5	250	2000	
Lms19LED	1.90	1.99	100	200	0.8	1.2	20	30	0.5-1.5			
Lms20LED	2.00	2.09	150	250	0.8	1.2	20	30	0.5-1.5			
Lms21LED	2.10	2.19	150	250	0.8	1.2	15	25	0.5-1.0			
Lms22LED	2.20	2.29	150	250	0.8	1.2	15	25	0.5-1.0			
Lms23LED	2.30	2.39	170	270	0.6	1.0	12	20	0.5-1.0			
LED Flip-Chip models (top surface of a LED chip is free of contacts) – Lms MIR LED-FC (1.6 – 2.3 μm)												
Lms19LED-FC	1.90	1.99	100	180	0.8	1.6	20	35	0.6-2.4	200	1000	-50 to +80
Lms20LED-FC	2.00	2.09	140	220	0.8	2.0	20	35	0.5-1.0			
Lms21LED-FC	2.10	2.19	200	300	0.8	2.5	20	40	1.6-2.8			
Lms22LED-FC	2.20	2.29	200	300	0.8	2.5	20	40	0.6-2.8			
Lms23LED-FC	2.30	2.37	200	340	0.8	1.4	20	30	1.2-2.8			

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

*2 Repetition rate: 1 kHz, pulse duration: 1 μs, duty cycle: 0.1%, current: 1 A.

*3 Repetition rate: 0.5 kHz, pulse duration: 1 ms, duty cycle: 50%, current: 100 mA.

Production of flip-chip LED models: **Lms16LED-FC, Lms17LED-FC, Lms18LED-FC** was **discontinued**

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

Standard LED models (LED chip with circular or ring top contact) – Lms MIR LED (1.8 – 2.3 µm)

Model	Peak emission wavelength, µm		Power, mW QCW mode*		Category	Price Discount
	min	max	min	max		
Lms18LED	1.80	1.89	0.7	1.1	A	standard
			0.5	0.69	B	-40%
			0.3	0.49	C	-70%
Lms19LED	1.90	1.99	0.8	1.2	A	standard
			0.6	0.79	B	-40%
			0.3	0.59	C	-70%
Lms20LED	2.00	2.09	0.8	1.2	A	standard
			0.6	0.79	B	-40%
			0.3	0.59	C	-70%
Lms21LED	2.10	2.19	0.8	1.2	A	standard
			0.6	0.79	B	-40%
			0.3	0.59	C	-70%
Lms22LED	2.20	2.29	0.8	1.2	A	standard
			0.6	0.79	B	-40%
			0.3	0.59	C	-70%
Lms23LED	2.30	2.39	0.6	1.0	A	standard
			0.45	0.59	B	-40%
			0.3	0.44	C	-70%

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

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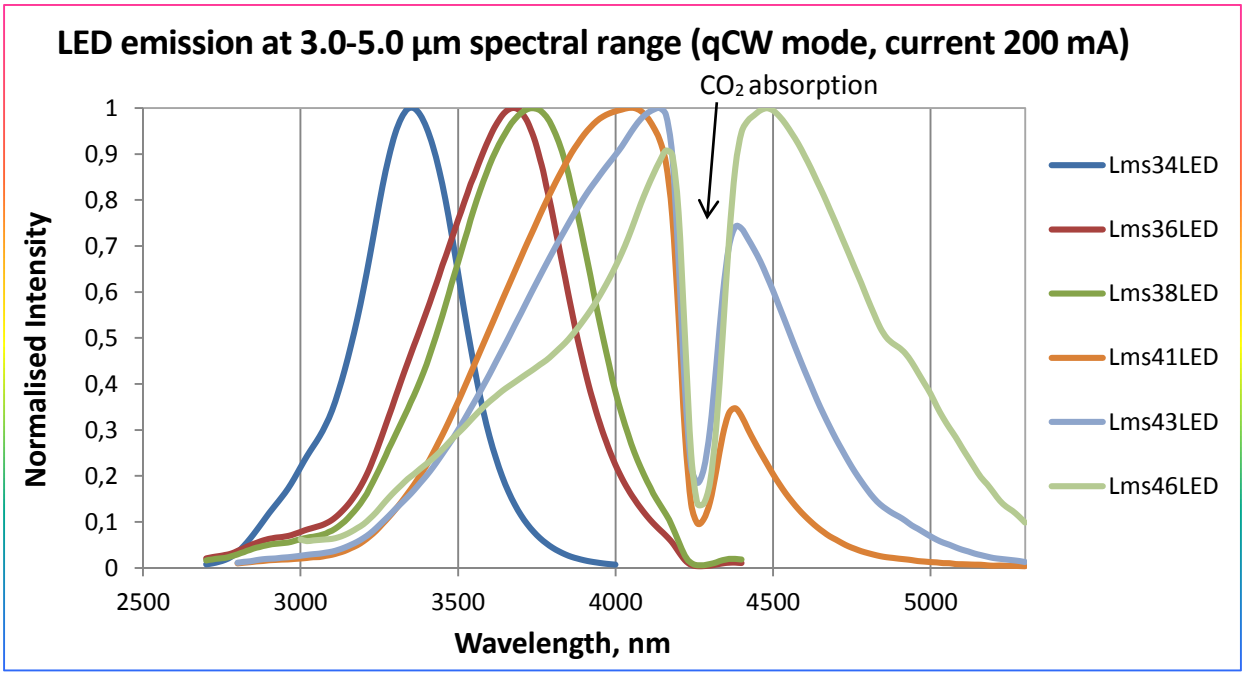
Narrow band-gap InAsSb/InAsSbP-based heterostructures lattice matched to InAs substrate were used to create LEDs for 3.0-5.0 μm spectral range.

Light Emitting Diodes for 3.0 - 5.0 μm spectral range



Standard LED models (LED chip with circular or ring top contact) – Lms MIR LED (3.4 – 4.6 μm)												
Model	Peak emission wavelength, μm		FWHM of the emission band, nm		Power, μW				Voltage, V	Maximum operating current, mA		Operating temperature range, °C
					QCW mode*1		Pulse mode*2					
	min	max	min	max	min	max	min	max		QCW mode	Pulse mode	
Lms34LED	3.30	3.49	300	600	25	45	320	480	0.2-0.5	250	2000	-50 to +80
Lms34LED high power	3.30	3.49	300	500	45	80	480	720	0.2-0.5			
Lms38LED	3.70	3.94	500	700	20	40	180	220	0.2-0.8			
Lms41LED	3.95	4.09	700	1000	15	30	180	220	0.5-0.7			
Lms43LED	4.10	4.30	700	1200	8	12	180	220	0.2-0.8			
Lms46LED	4.40	4.60	700	1200	2	4	100	140	1.5-3.0			

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

*2 Repetition rate: 2 kHz, pulse duration: 0.5 μs, duty cycle: 0.1%, current: 1 A

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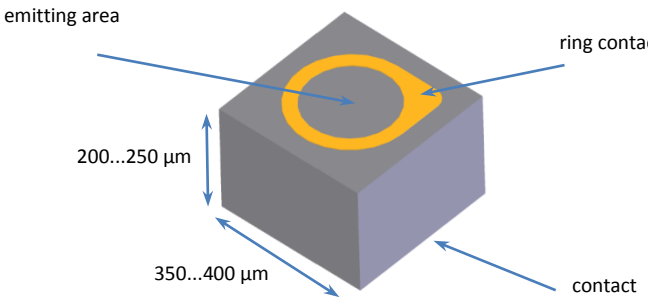
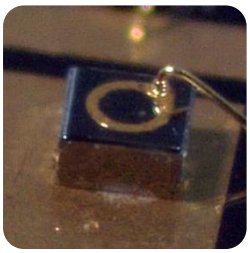
Standard Mid Infrared LED chip



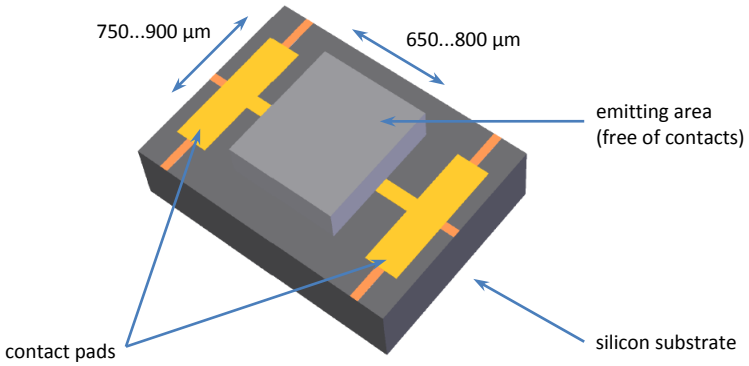


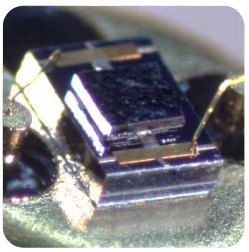
This shape of LED chip is typical for most of the LED Microsensor NT standard LED models (Lms XX LED series).

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)

Mid Infrared flip-chip LED





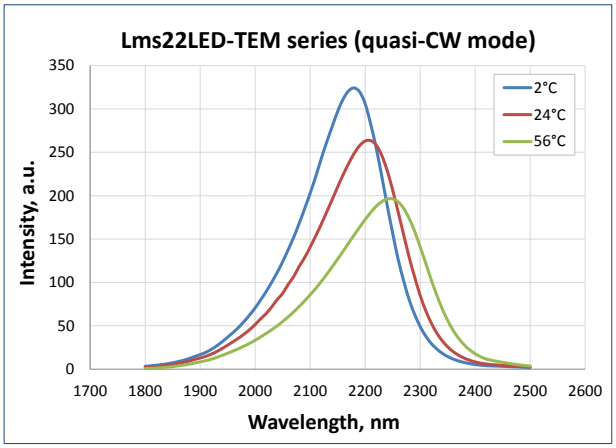
In the case of standard chip design top contact hinders the extraction of light. This trade-off can be avoided by flip-chip packaging – LmsXXLED-FC models.

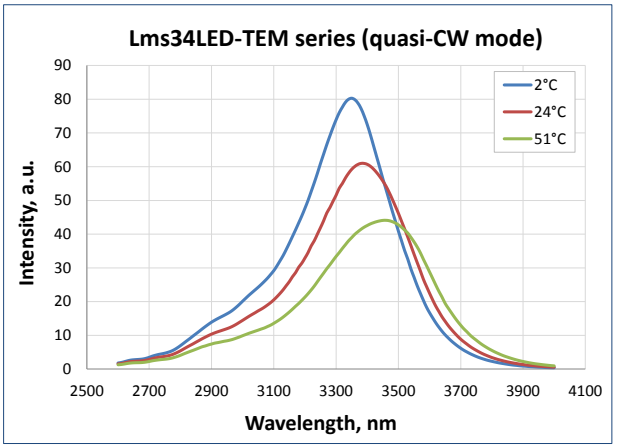
Main features of flip-chip packaging are:

- ✓ Larger size of the LED chip
- ✓ Contact metal pads do not hinder emission from the active region
- ✓ Flip-chip packaging is more expensive compared with standard packaging due to larger size of the chip and more complicated fabrication process.

Temperature dependences of optical characteristics

It is typical for all semiconductor radiation sources to have intensity decreasing with temperature increase. 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 rises.





We can offer several ways to control LED temperature:

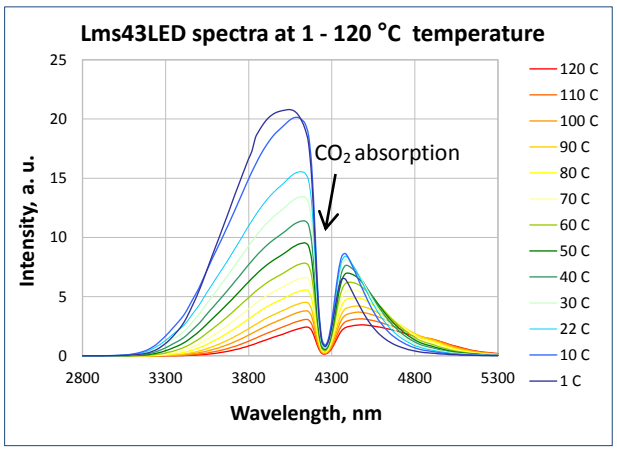
✓ Mounting of an LED chip into a package with a thermoelectric module (Peltier element) enables stabilization of the temperature of an LED chip, providing wavelength tuning in a certain wavelength range.

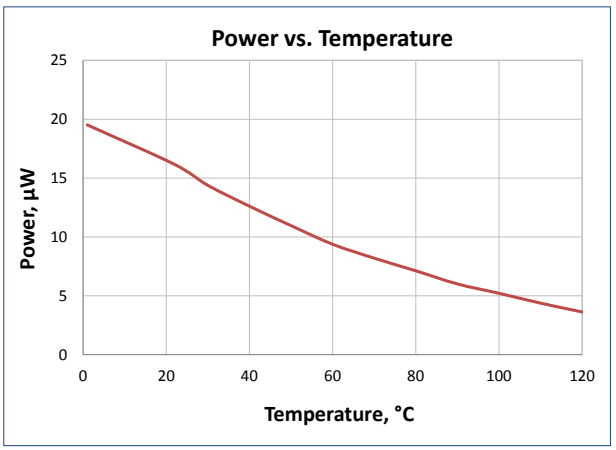
✓ Monitoring the intrinsic LED temperature judging by the LED current-voltage dependence:

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-51 LED driver produced by LMS NT (see section Electronics of the Catalogue and/or manual for D-51 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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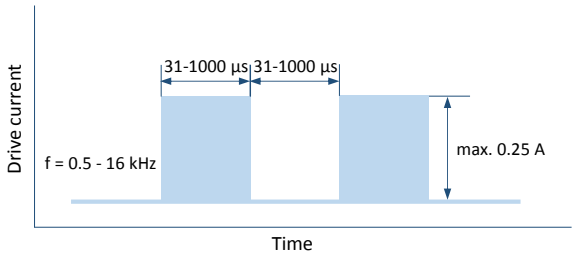
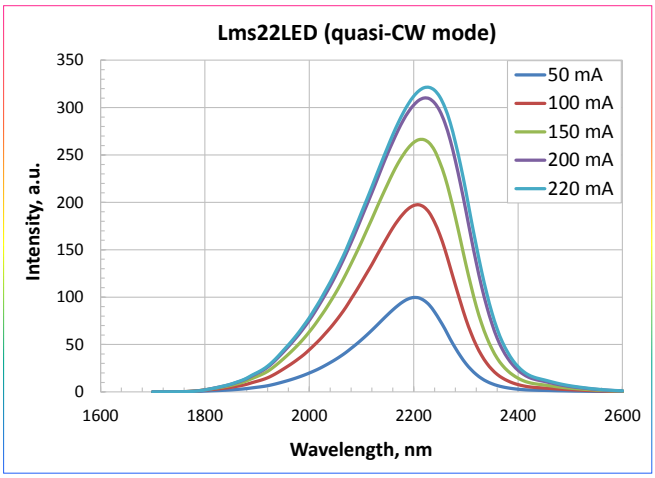
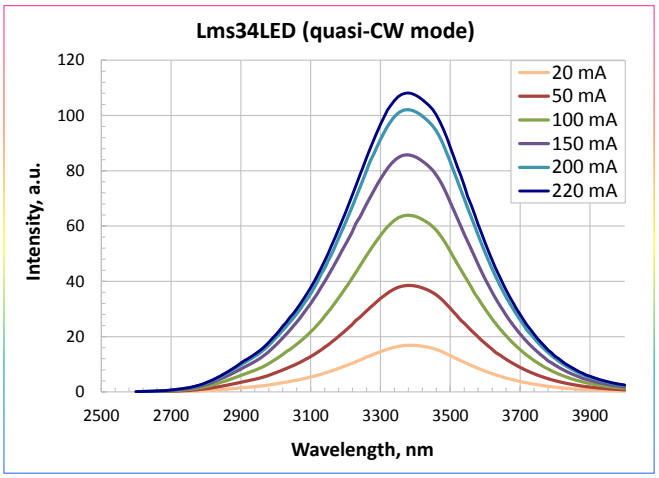
LEDs offer numerous benefits due to the possibility for different operational modes. The optical parameters of LED strongly depend on the operational regime that you choose. We recommend using pulse modes with duty cycle 50% (quasi-continuous wave mode) or 25% to receive maximum average power. These modes provide signal modulation at a certain frequency and allow higher output intensity to be obtained than is the case when using hard CW (continuous wave) mode; therefore, hard CW mode is not recommended. To obtain the maximum peak power we recommend using short pulse modes (less than 50 μs).

Quasi-continuous wave (quasi-CW) mode:

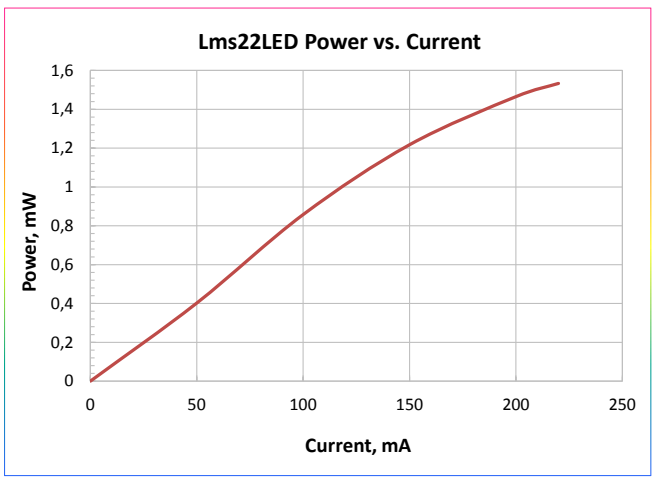


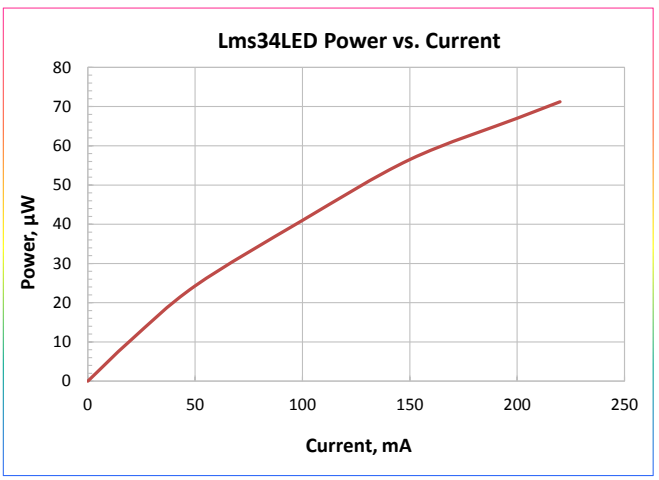
Spectra at different currents in the quasi-CW mode (frequency 0.5 kHz, duty cycle 50%):





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





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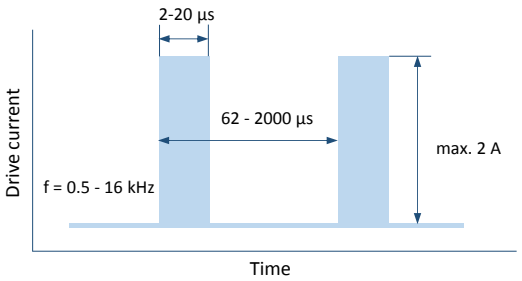
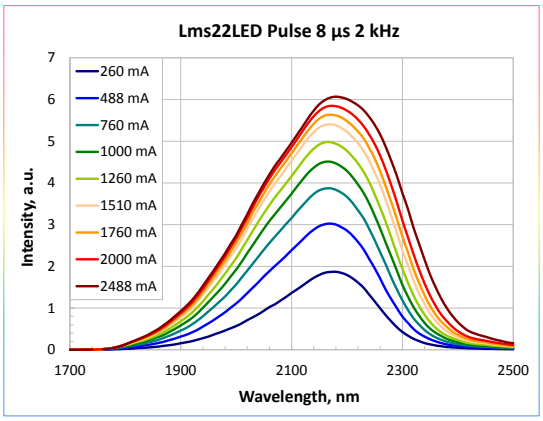
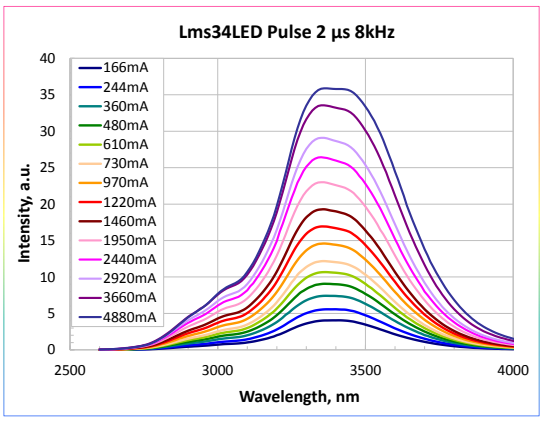
Pulse mode:

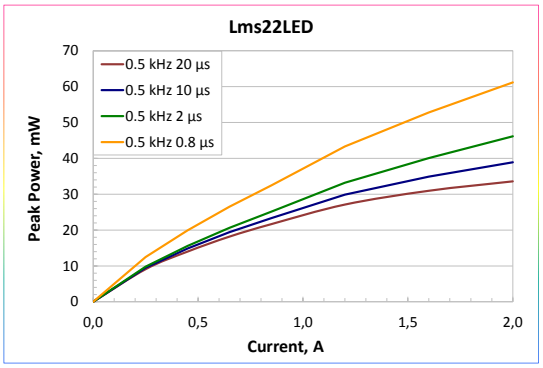


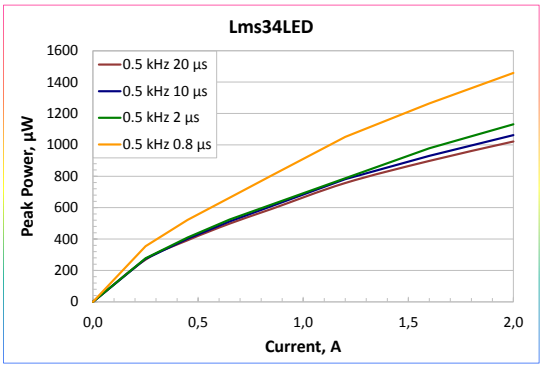
Spectra at different currents in the pulse mode:



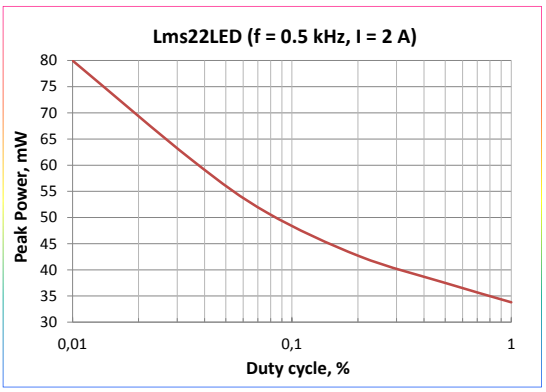


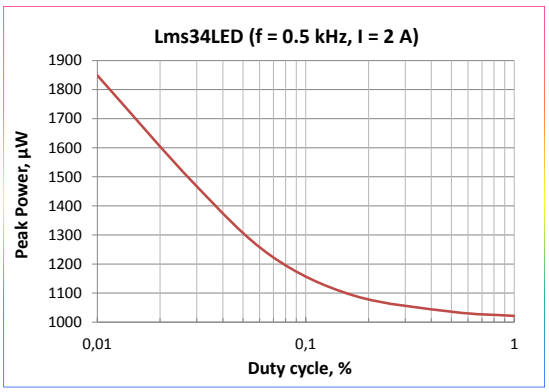
Power dependence on the drive current in the pulse mode:





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





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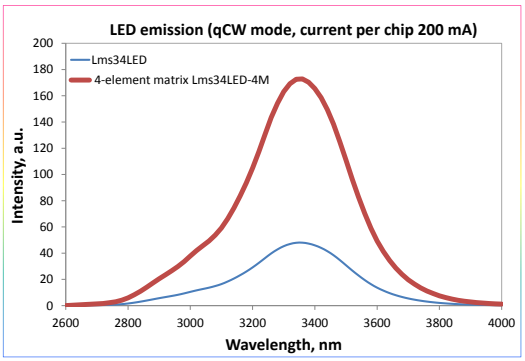
The tiny size of an LED chip (0.35 × 0.35 mm), narrow-band emission spectrum, short response time and low thermal flux enables the creation of very compact multi-element LED arrays and LED matrices emitting at one or different wavelengths.

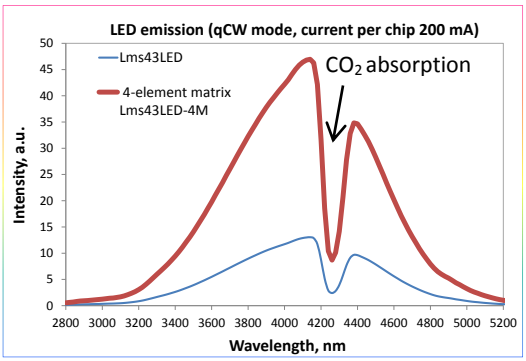
The LED matrix is a kind of arrangement of similar or different LED-chips mounted in a single compact package and driven together or independently. This kind of emitter is a powerful radiation source for portable optical analysing systems.

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

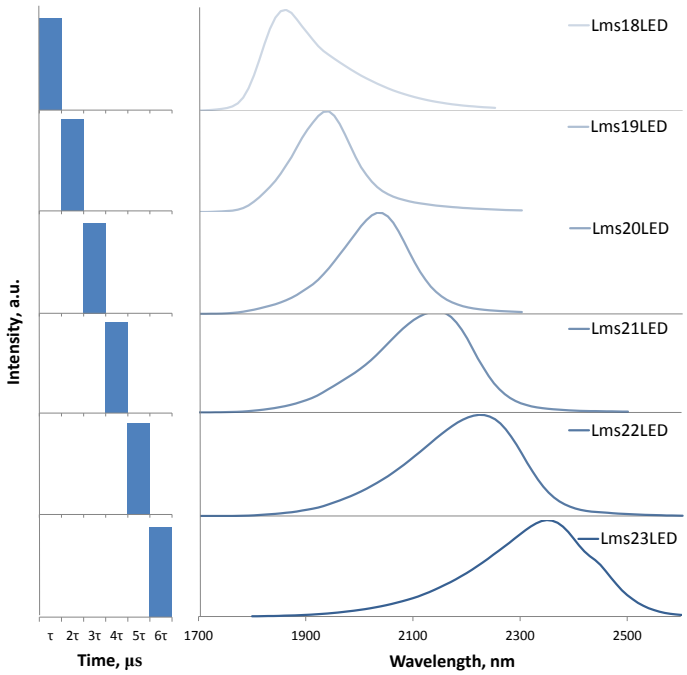
Currently we offer two **standard LED matrix** types - with a one peak wavelength and increased optical power and multi-wavelength array:

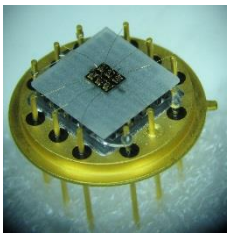
✓ 4-element LED matrix with a one peak wavelength at 3.4 µm or 4.3 µm in TO18 package with a cap/reflector and with a sapphire window or in TO5 package with a built-in thermoelectric module with a cap/reflector and with a sapphire window.

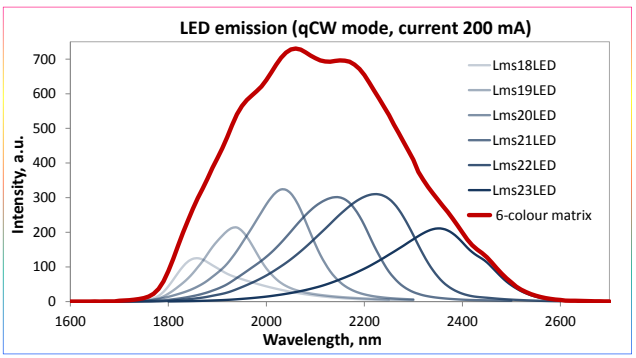




✓ 6-element multi-wavelength LED matrix with peak wavelengths at 1.8, 1.9, 2.0, 2.1, 2.2 and 2.3 µm in TO5 or in TO8 package with a built-in thermoelectric module and a parabolic reflector with a quartz window.







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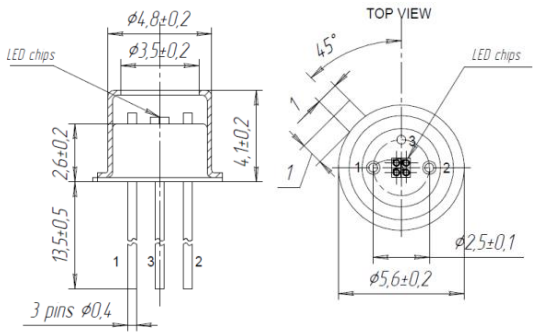
Standard one-wavelength LED matrix models											
Model	Peak emission wavelength, µm		FWHM of the emission band, nm		Power, µW				Voltage, V	Maximum operating current, mA		Operating temperature range, °C
					QCW mode*		Pulse mode**				
	min	max	min	max	min	max	min	max		QCW mode	Pulse mode	
Lms34LED-4M	3.30	3.49	400	600	90	160	1000	1700	0.2-0.5	1000	8000	-60 to +80
Lms43LED-4M	4.10	4.30	700	1000	25	45	650	800	0.2-0.8			

* Repetition rate: 0.5 kHz, pulse duration: 1 ms, duty cycle: 50%, current: 800 mA

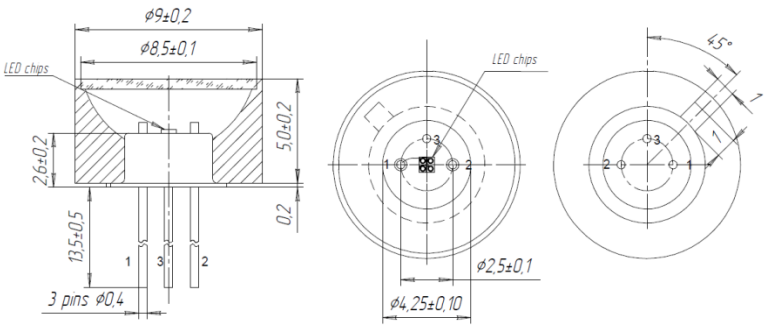
** Repetition rate: 2 kHz, pulse duration: 0.5 µs, duty cycle: 0.1%, current: 4 A

Standard matrix packages:

TO-18 package with a cap



TO-18 package with a reflector



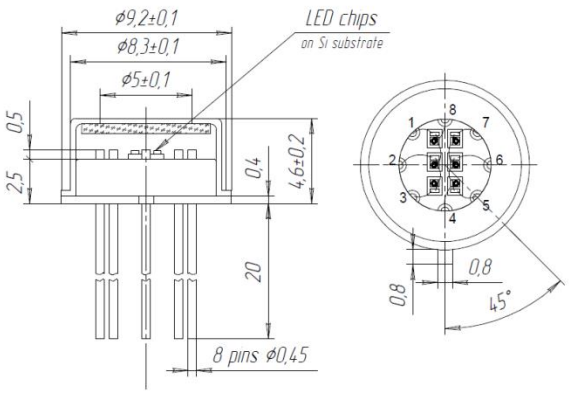
Standard multi-wavelength LED matrix **Lms18-19-20-21-22-23LED-6M**											
LED chip #	Peak emission wavelength, µm		FWHM of the emission band, nm		Power, mW				Voltage, V		Operating temperature range, °C
					QCW mode*		Pulse mode**				
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	
Lms18LED	1.80	1.89	100	200	0.5	1.1	8	25	0.5	1.5	-60 to +80
Lms19LED	1.90	1.99	100	200	0.6	1.2	15	30	0.5	1.5	
Lms20LED	2.00	2.09	150	250	0.6	1.2	15	30	0.5	1.5	
Lms21LED	2.10	2.19	150	250	0.6	1.2	10	25	0.5	1.0	
Lms22LED	2.20	2.29	150	250	0.6	1.2	10	25	0.5	1.0	
Lms23LED	2.30	2.39	170	270	0.5	1.0	8	20	0.5	1.0	

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

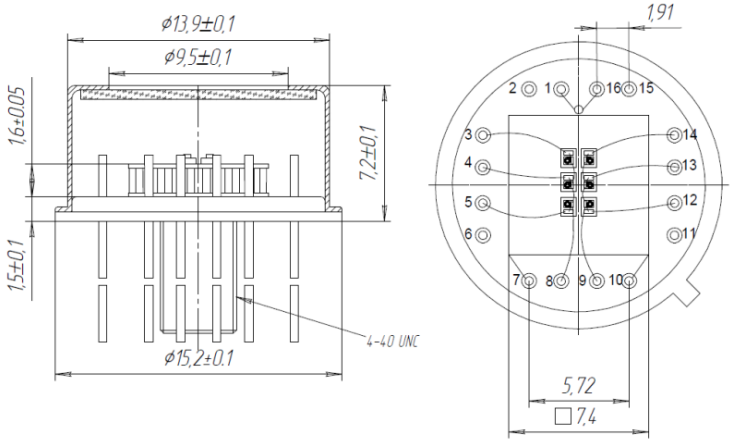
** Repetition rate: 2 kHz, pulse duration: 0.5 µs, duty cycle: 0.1%, current: 1 A

Standard matrix packages:

TO-5 package with a cap



TO-8 package with a thermoelectric module with a cap



These standard matrix types are the basic versions that were designed mainly to give an idea about the possible array arrangement and evaluate its' performance. We are always open to consider a special solution for the exact customers' needs.

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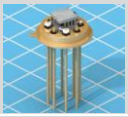
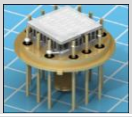
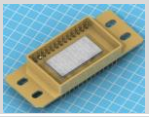
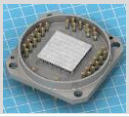
For the **custom arrays and matrices** the number elements included depends on the application and the chosen package type. Standard TO-type packages offered by RMT Ltd. can be used. Packages with built-in thermoelectric modules (Peltier elements) provide temperature stabilisation of LED chip parameters. Use of these packages allows creation of different variations of LED arrays and matrices arrangements, some of which are presented below.

LED matrix type	Package type					
	TO-18 	TO-5 	TO-5 TEM 	TO-8 TEM 	PS-28 TEM 	MS-32 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)				✔		
Lms X1÷X20 LED-20M-TEM					✔	✔

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Generally, LEDs are mounted in the package that provides two electrical leads, a transparent optical window for the emission and heat-sinking. An LED chip is soldered/ glued to the package surface that is connected to the one of the lead wires. The 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-type packages:

TO18 – appropriate for mounting one-element LEDs, single-wavelength matrices, 2-wavelength matrices

TO5 (TO39) – appropriate for mounting one element LEDs or LED-matrices

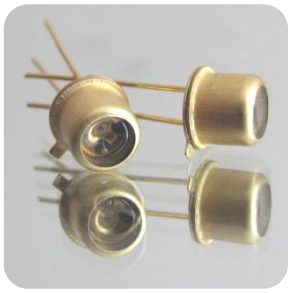
TO8 – appropriate for mounting multi-element LED-matrices

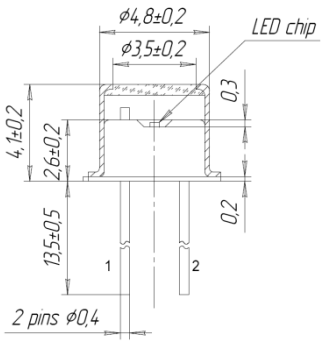
✓ SMD type packages:

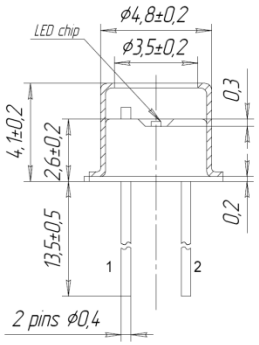
CS5 (SMD 5 × 5 mm), CS5R (SMD 5 × 5 mm with microreflector) – appropriate for mounting one-element LEDs or single-wavelength matrices

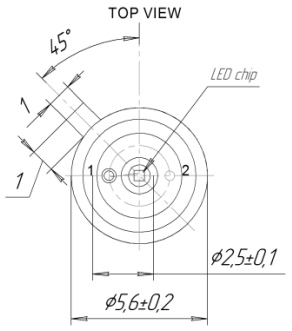
CS5R-3M (SMD 5 × 5 mm) – appropriate for mounting three-element LED-matrices

TO18

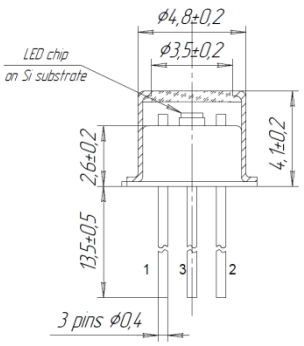


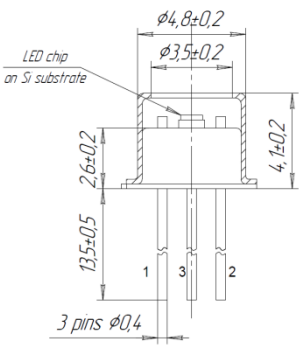


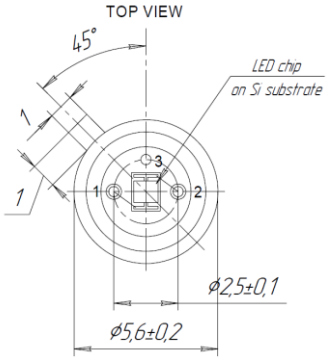




TO18
(3-pin for flip-chip models)

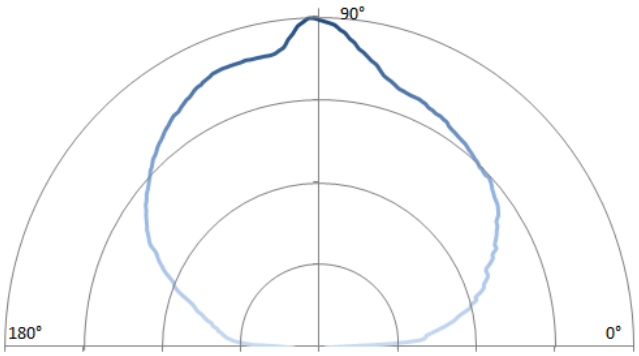




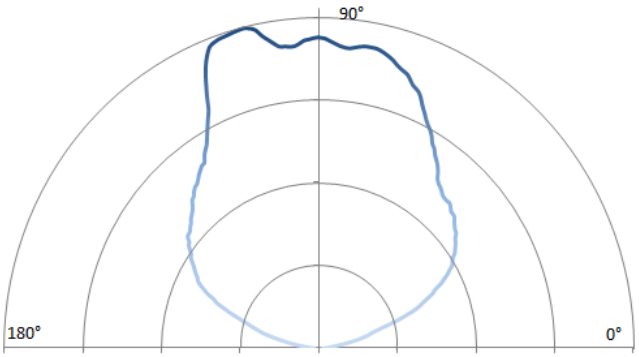


Beam divergence for LED models in TO-18 package:

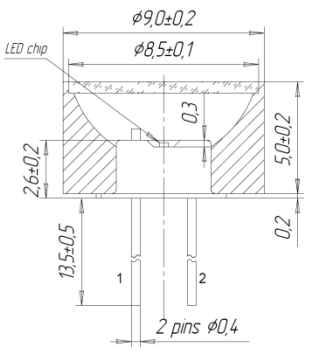
flat package (flip-chips)

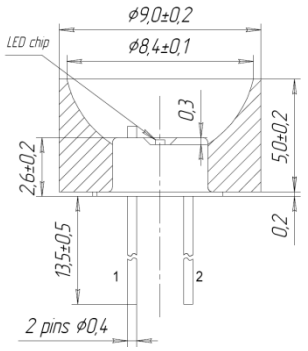


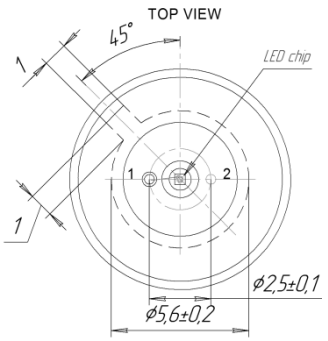
package with a cavity (standard chips)



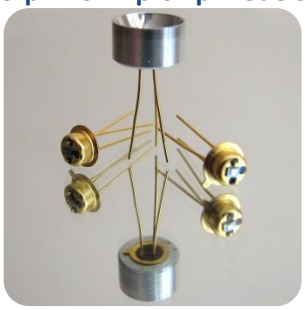
TO18-R
TO18-RW

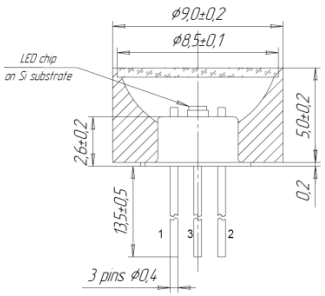


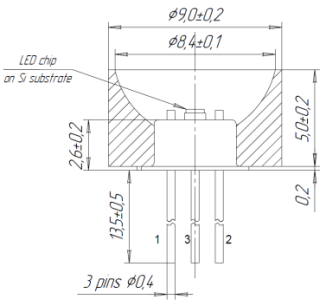


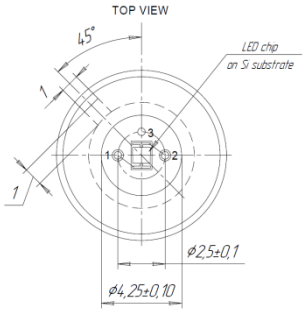


TO18-R
TO18-RW
(3-pin for flip-chip models)



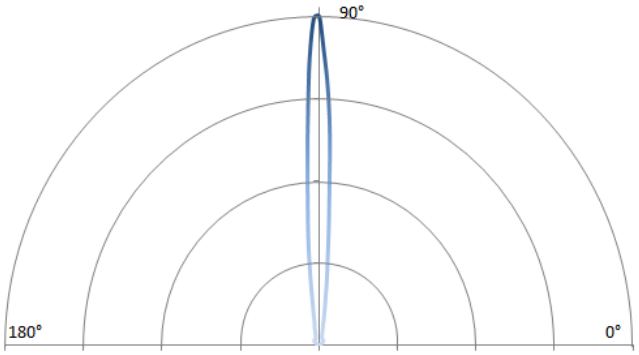




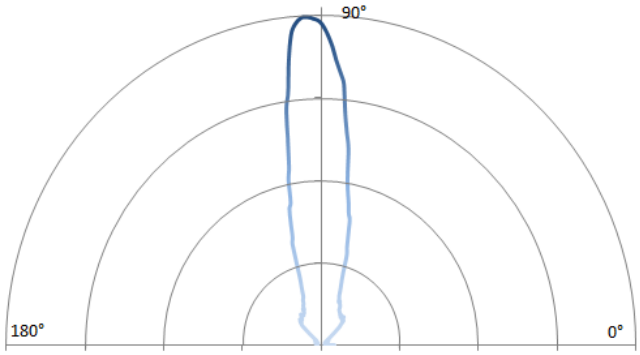


Beam divergence for LED models in TO-18 package with a parabolic reflector:

flat package (flip-chips)



package with cavity (standard chips)



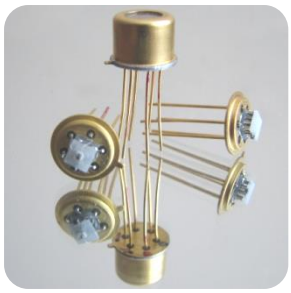
TO-18 packages features:

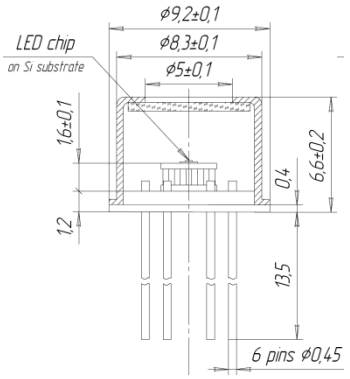
- Very miniature packages with limited area for mounting
- Material – kovar, finish – gold/plating
- The number of lead pins is 2 or 3
- Equipped with a cap (with/without a glass window) or a parabolic reflector (with/without a glass window)

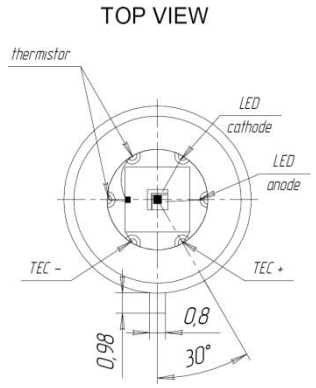
Cap protects LED device from damage

Parabolic reflector with a glass window (RW) or without a window (R) protects LED device from damage and provides narrowing of the beam divergence pattern.

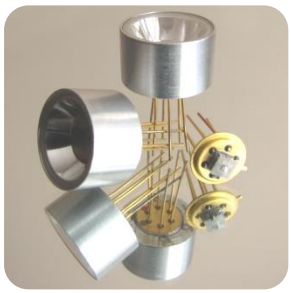
TO5-TEM

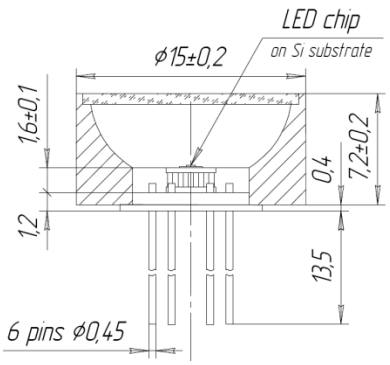


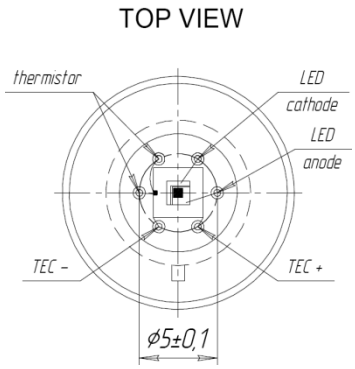




TO5-TEM-R

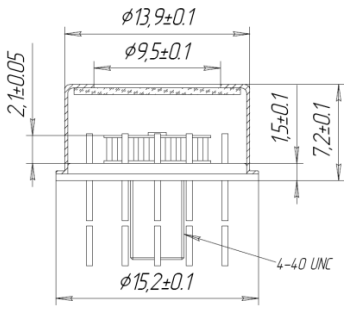


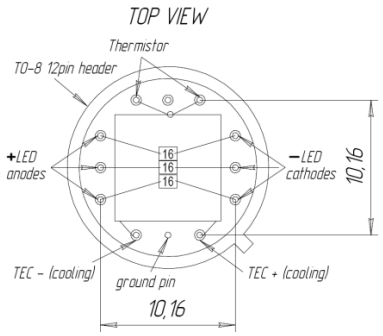




- Small packages with 3.2 × 3.2 mm^2 thermocooler surface open for mounting
- Header material – kovar, finish – gold/plating; thermocooler ceramics – Al_2O_3
- The number of lead pins is 6 or 9
- Built-in thermoelectric module (TEM) – thermocooler and thermoresistor – provides LED chip temperature adjustment and stabilisation in the range -5 to +65 °C
- Equipped with a cap (with a glass window) or a parabolic reflector (with a glass window)
  Cap protects LED device from damage
  Parabolic reflector protects LED device from damage and provides narrowing of the beam divergence pattern

TO8-TEM





- Compact packages with 8 × 8 mm^2 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 stabilisation in the range -5 to +65 °C
- Equipped with a cap with a glass window that protects LED device from damage

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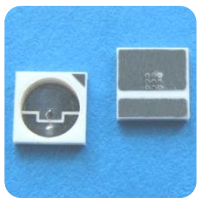
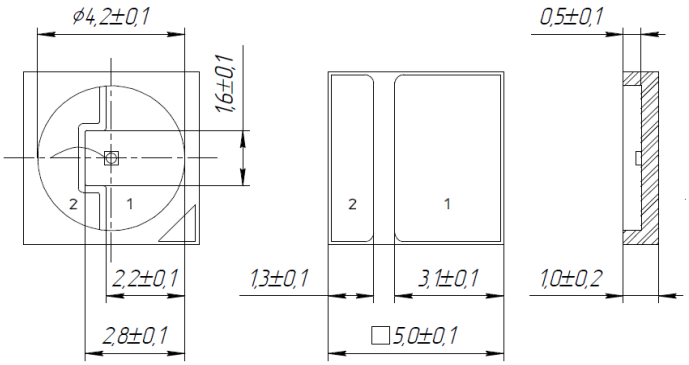
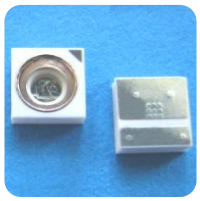
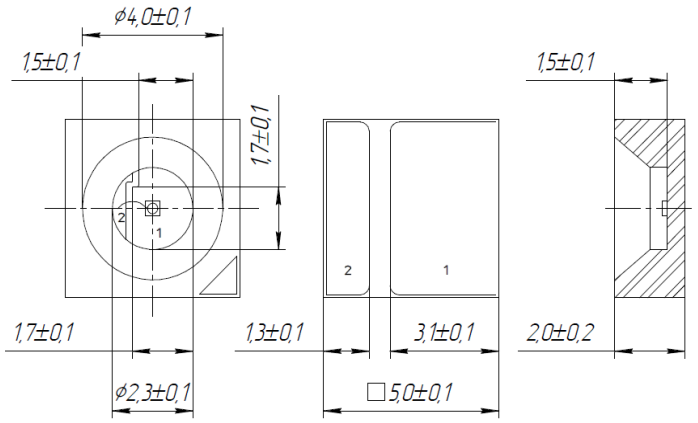
SMD* CS5
5×5 mm



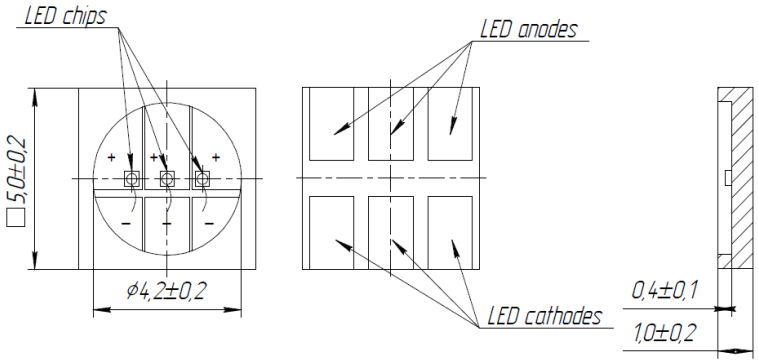


SMD* CS5R
5×5 mm





SMD* CS5-3M
5×5 mm



***All SMD packages can be substituted by other ones.**

- Tiny packages for surface mounting
- Anode and cathode are led to the metalised areas on the back side of the ceramic surface
- Material – Low Temperature Co-fired Ceramic (LTCC):
  - thermal conductivity 25 W/mK
  - thermoresistance 8 °C/W
- Microreflector (for model SMD5R) provides at reduction of radiation divergence

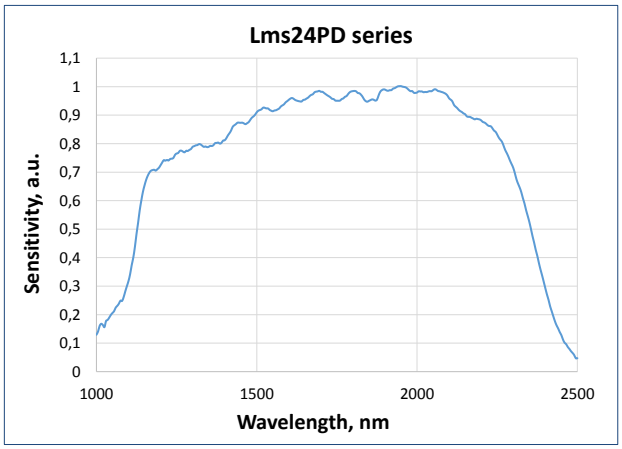
In addition to our standard packages, we are ready to offer specifically designed solutions according to our customers' needs.

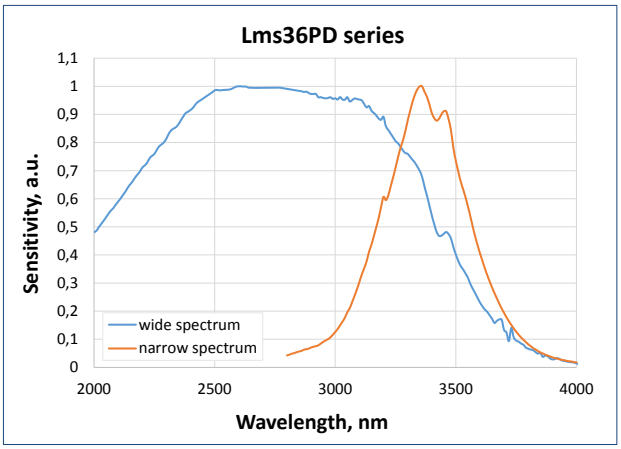
Currently, we offer the following photodiodes with cut-off wavelength at about 2.4, 3.6 and 4.3 µm:

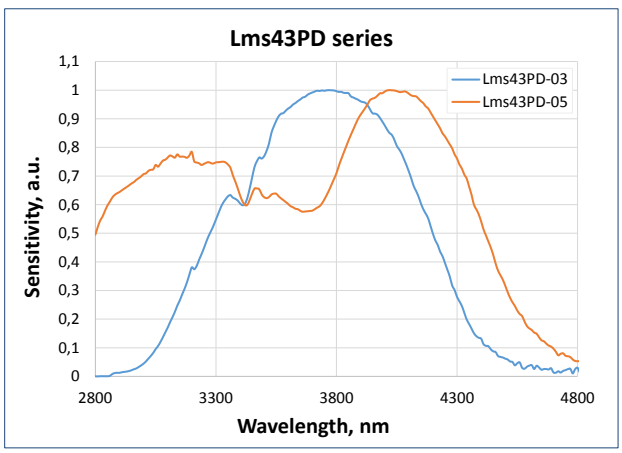
Model	Sensitive area, mm	Max. sensitivity range, µm	Cut-off wave length, µm	Dark current, µA	Resistance, kOhm (10 mV)	Capaci-tance, pF	Photo-sensitivity, A/W	Noise equivalent power, $W/Hz^{1/2}$	Specific Detectivity, $cm*Hz^{1/2}/W$
Lms24PD-03	0.3	1.85-2.30	2.42-2.43	10-60 (-1V)	5-20	50-200	0.7-1.0	$(0.9\text{-}2.5)*10^{-12}$	$(1\text{-}3.5)*10^{10}$
Lms24PD-05	0.5	1.1-2.3	2.40-2.46	10-100 (-1V)	4-18	200-600	0.9-1.1	$(0.9\text{-}2)*10^{-12}$	$(2\text{-}5)*10^{10}$
Lms24PD-10	1.0	1.4-2.2	2.40-2.46	100-300 (-1V)	1-3	1000-1500	0.8-0.9	$(2.5\text{-}5)*10^{-12}$	$(2\text{-}3.5)*10^{10}$
Lms36PD-03	0.3	3.2-3.4	3.55-3.7	200-600 (-0.1V)	0.2-0.8	150-350	0.75-1.1	$(4\text{-}12)*10^{-12}$	$(2.5\text{-}7.5)*10^{9}$
Lms36PD-03ws*	0.3	2.4-3.1	3.7-3.8	50-600 (-0.1V)	0.2-0.6	200-300	0.7-0.8	$(6\text{-}13)*10^{-12}$	$(2\text{-}4)*10^{9}$
Lms36PD-05	0.5	2.2-3.4	3.6-3.7	50-1000 (-0.1V)	0.2-0.8	600-1400	1.0-1.5	$(3\text{-}9)*10^{-12}$	$(4.5\text{-}14)*10^{9}$
Lms43PD-03	0.3	3.6-4.1	4.4-4.8	1000-4000 (-0.1V)	$(10\text{-}50)*10^{-3}$	1300-2600	0.8-1.2	$(1.5\text{-}5)*10^{-11}$	$(0.6\text{-}2)*10^{9}$
Lms43PD-05	0.5	3.5-4.2	4.5-4.8	8000-25000 (-0.1V)	$(4\text{-}6)*10^{-3}$	-	1.0-1.6	$(3\text{-}6)*10^{-11}$	$(0.6\text{-}1)*10^{9}$

* ws – wide spectrum

Typical spectral response







There are also the following photodiodes under development:

Model	Sensitive area, mm	Spectral sensitivity range, µm
Line of standard photodiodes		
Lms36PD-10	1.0	2.40 - 3.60
Line of photodiode matrices		
Lms24PD-03-4M	4 PDs × 0.3	1.50 - 2.40
Lms24PD-05-4M	4 PDs × 0.5	1.50 - 2.40
Lms36PD-05-4M	4 PDs × 0.5	2.40 - 3.60
Lms43PD-03-4M	4 PDs × 0.3	3.50 - 4.30

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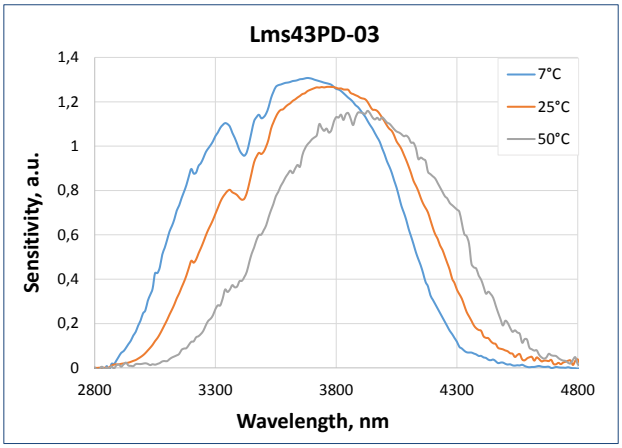
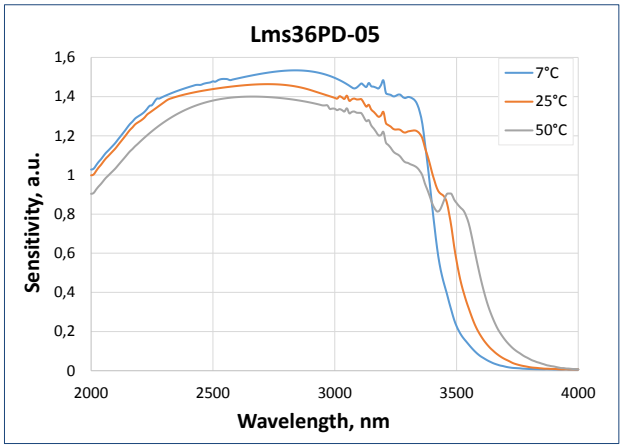
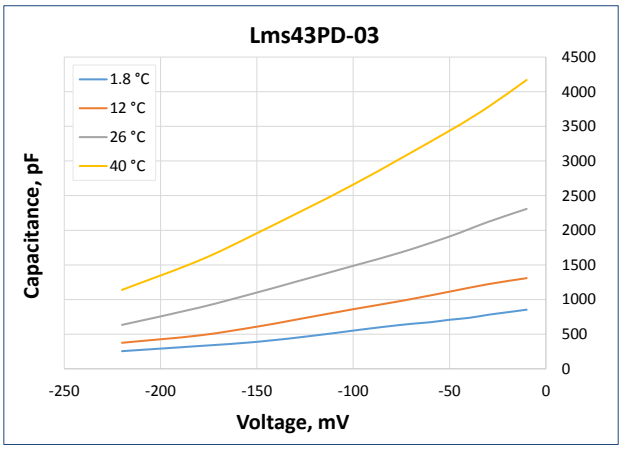
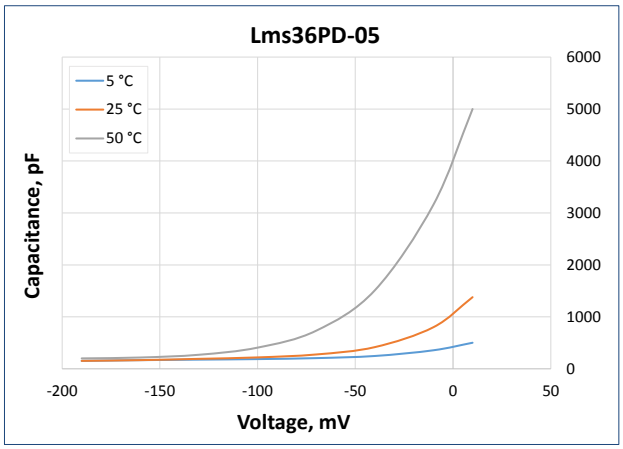
Temperature shift of spectral response



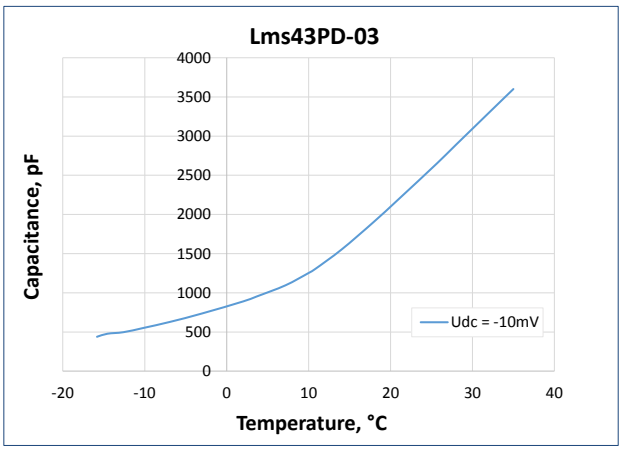


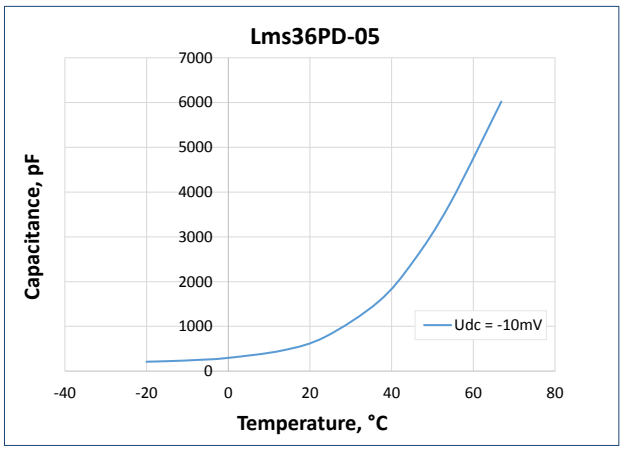
Capacitance vs. voltage





Capacitance vs. temperature





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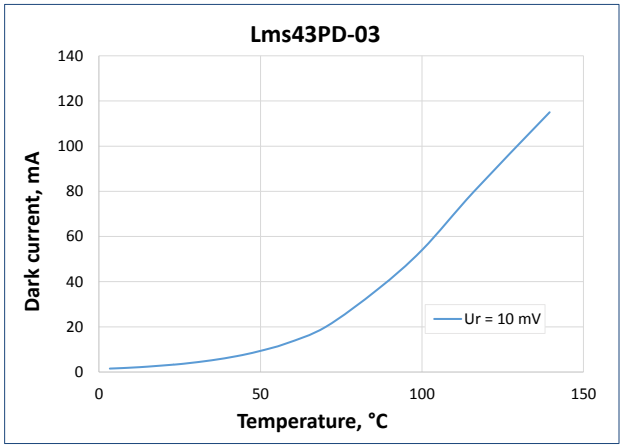
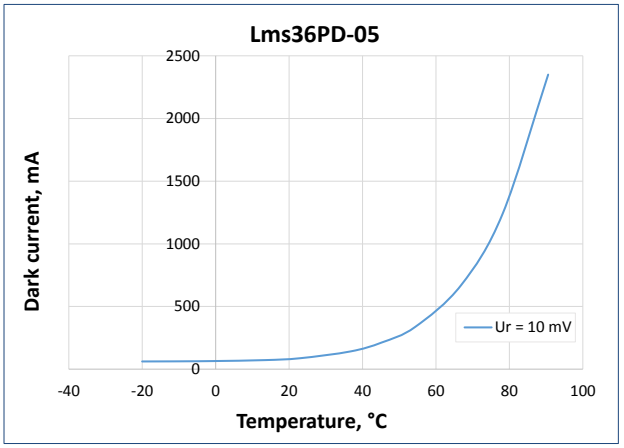
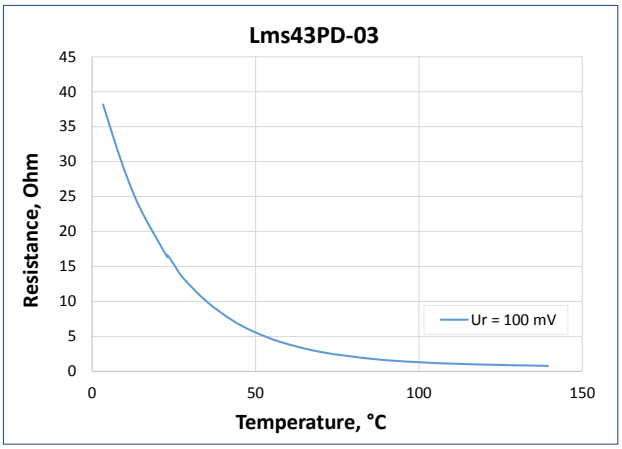
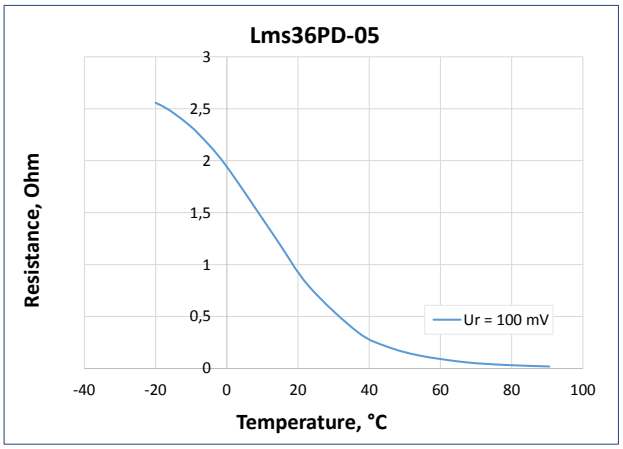
Dark current vs. temperature



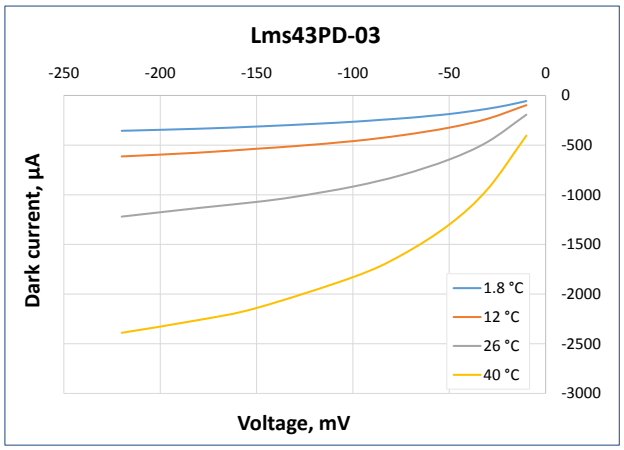


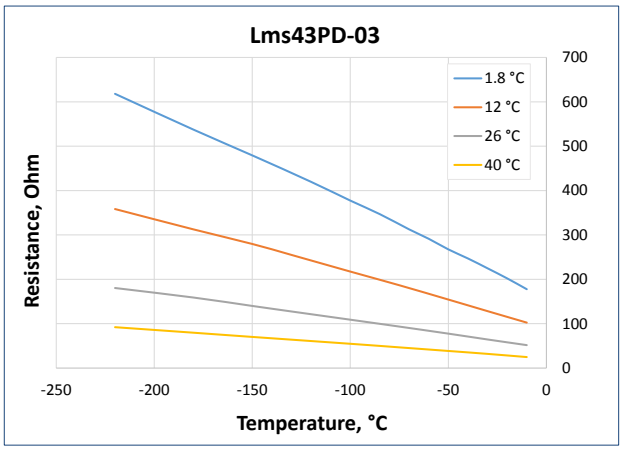
Shunt resistance vs. temperature





Temperature dependences of dark current and shunt resistance of Lms43PD-03





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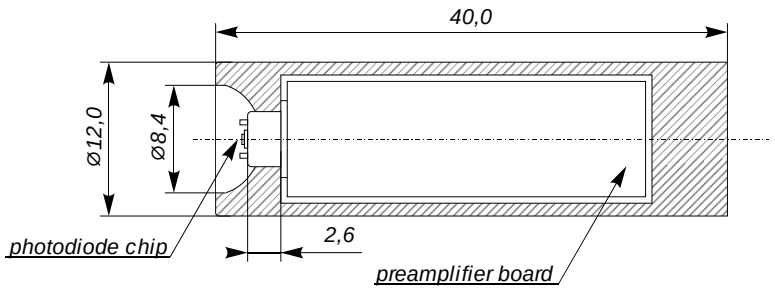
All the above mentioned PD models are available coupled with a preamplifier (LmsXXPD-XX-R-PA and LmsXXPD-XX-RW-PA):

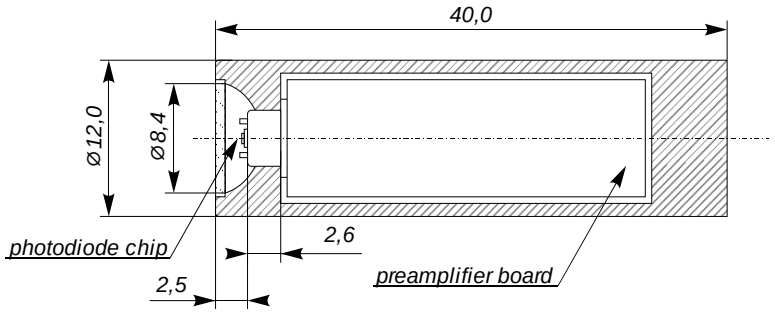
Model without a glass window	Model with a glass window	Models with a built-in thermoelectric module (with a cap/reflector with a glass window) are available under request
Lms24PD-03-R-PA	Lms24PD-03-RW-PA	Lms24PD-03-TEM(-R)-PA
Lms24PD-05-R-PA	Lms24PD-05-RW-PA	Lms24PD-05-TEM(-R)-PA
Lms24PD-10-R-PA	Lms24PD-10-RW-PA	Lms24PD-10-TEM(-R)-PA
Lms36PD-03-R-PA	Lms36PD-03-RW-PA	Lms36PD-03-TEM(-R)-PA
Lms36PD-05-R-PA	Lms36PD-05-RW-PA	Lms36PD-05-TEM(-R)-PA
Lms43PD-03-R-PA	Lms43PD-03-RW-PA	Lms43PD-03-TEM(-R)-PA

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

Technical drawing of the LmsXXPD-XX-R-PA model without a glass window



Technical drawing of the LmsXXPD-XX-RW-PA model with a glass window



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

For further signal conversion and synchronous detection of the signals from photodiodes with preamplifiers, we have developed the SDM synchronous detector. SDM synchronous detectors are tuned for optimal operation with LmsXXPD-XX-R-PA and LmsXXPD-XX-RW-PA models and make the photodiodes with preamplifier signal measurement easy and convenient. For more information regarding SDM synchronous detector please refer to the Electronics section, p. 34.

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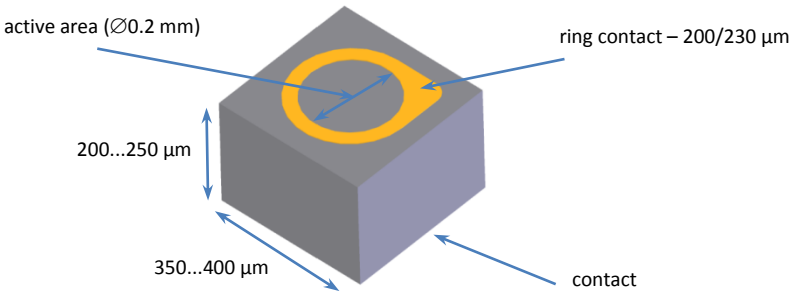
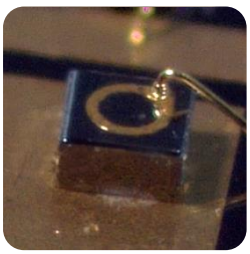
Standard Mid Infrared 0.3 mm photodiode chip

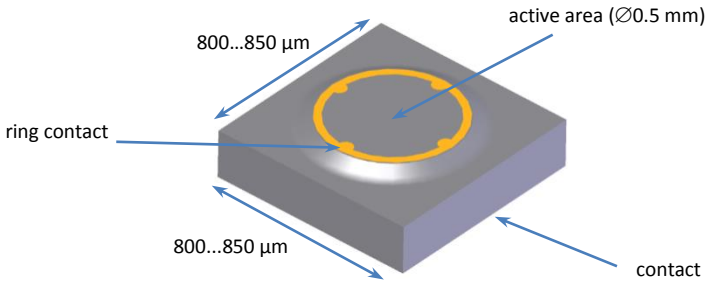


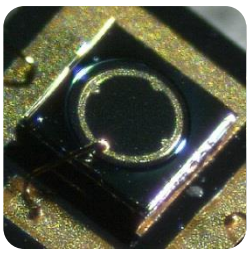


This shape of PD chip is one of the types of LED Microsensor NT standard photodiode models (Lms XX PD-03 series).
Main features are:

- ✓ Small size of the PD chip
- ✓ Cost effective (due to small size)

Mid Infrared 0.5 mm photodiode chip

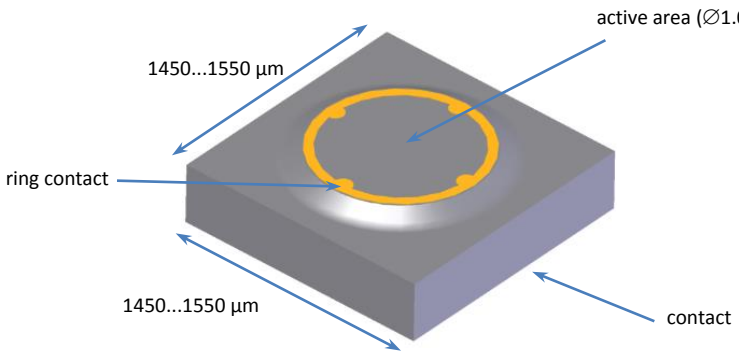


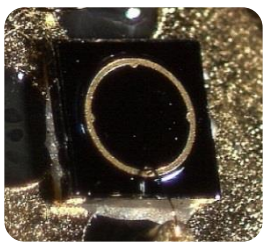


This shape of PD chip is one of the types of LED Microsensor NT standard photodiode models (Lms XX PD-05 series).
Main features are:

- ✓ Larger size of the PD active area and, consequently, higher sensitivity
- ✓ Mesa shaped structure

Mid Infrared 1.0 mm photodiode chip





This shape of PD chip is one of the types of LED Microsensor NT standard photodiode models (Lms XX PD-10 series).
Main features are:

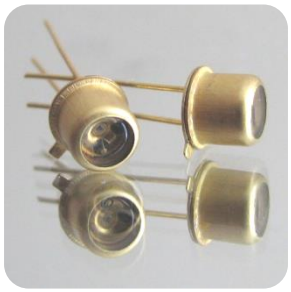
- ✓ Larger size of the PD active area and, consequently, higher sensitivity
- ✓ Mesa shaped structure

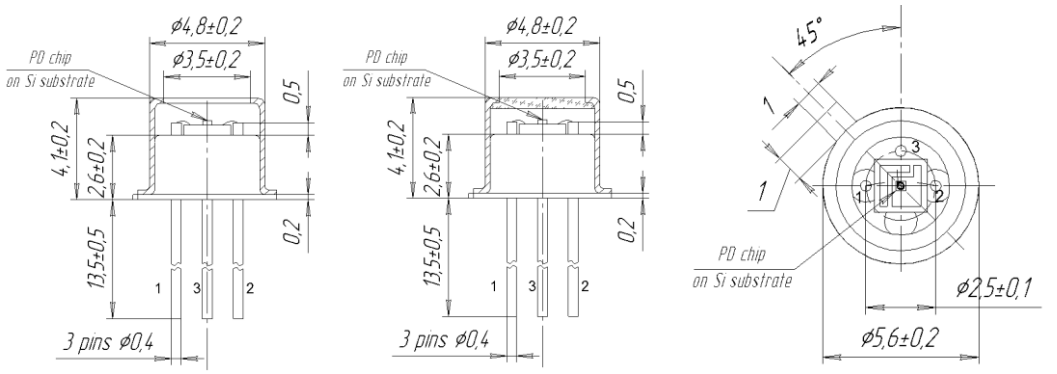
We offer a range of standard packages for PDs as follows:

✓ TO-type packages:

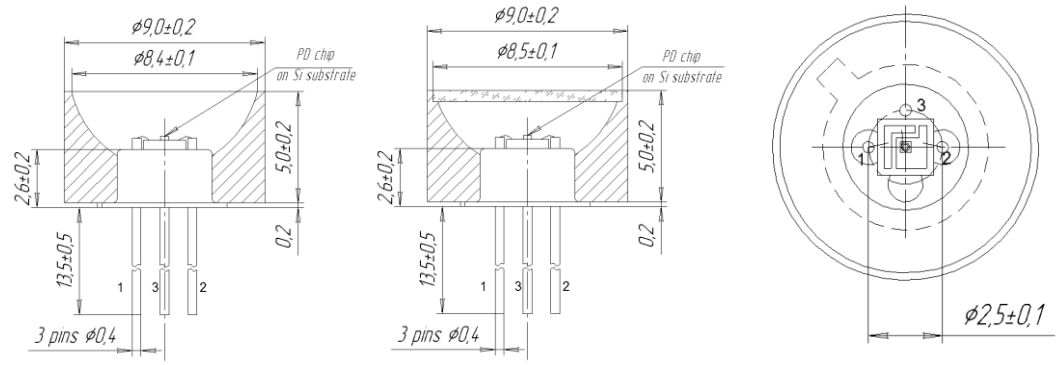
TO18 – appropriate for mounting photodiodes and photodiodes arrays and matrices without thermocooler.

TO18





TO18-R
TO18-RW



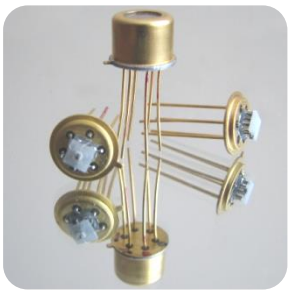
- Very miniature packages with limited area for mounting
- Material – kovar, finish – gold/plating
- The number of lead pins is 2 or 3
- Equipped with a cap (with/without a glass window) or a parabolic reflector (with/without a glass window)

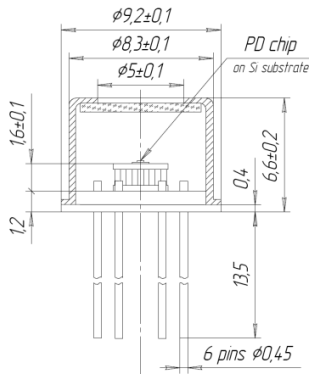
Cap with a window (typically for models Lms24PD) or without a window (for model Lms36PD) protects PD device from damage.

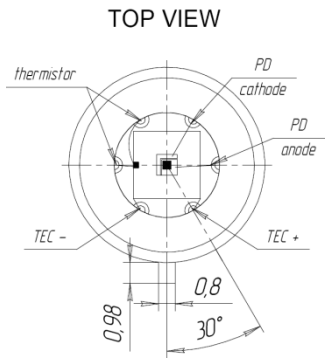
Parabolic reflector protects PD device from damage and directs incident radiation on the sensitive area of the photodiode.

TO5 (TO39) – appropriate for mounting photodiode arrays, 1-element photodiodes and arrays with thermocooler.

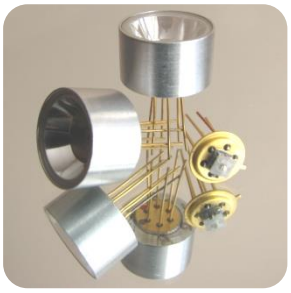
TO5-TEM

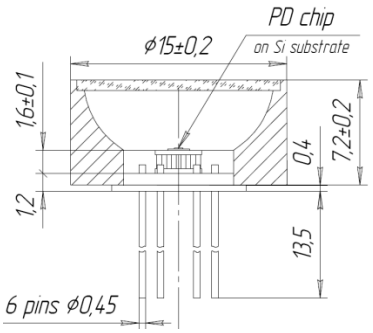


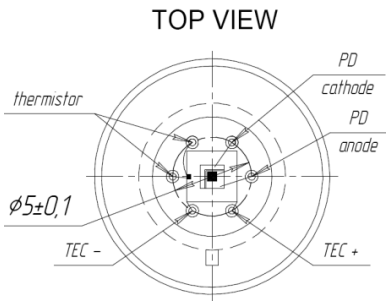




TO5-TEM-R

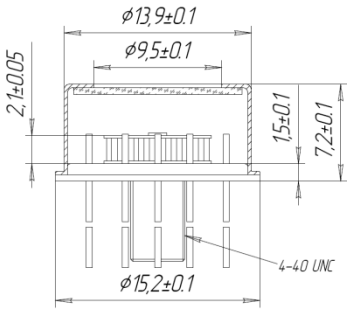


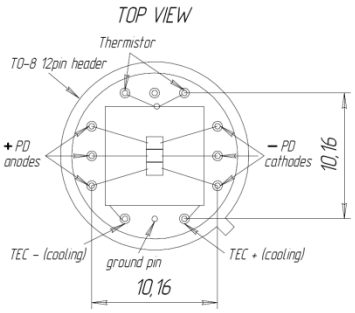




- Small packages with 3.2 × 3.2 mm² thermocooler surface open for mounting.
- Header material – kovar, finish – gold/plating, thermocooler ceramic – Al_2O_3.
- The number of lead pins is 6 or 9.
- Built-in thermoelectric module (TEM) – thermocooler and thermoresistor – provides PD chip temperature adjusting and stabilising in the range -5 to +65 °C.
- Equipped with a cap (with a glass window) or a parabolic reflector (with a glass window).
  Cap protects PD device from damage.
  Parabolic reflector protects PD device from damage and directs incident radiation on the sensitive area of the photodiode

TO8-TEM





- Compact packages with 8×8 mm² thermocooler surface open for mounting.
- Header material – kovar, finish – gold/plating, thermocooler ceramic – Al_2O_3.
- The number of lead pins is 12 or 16.
- Built-in thermoelectric module (TEM) – thermocooler and thermoresistor – provides PD chip temperature adjusting and stabilising in the range -5 to +65 °C .
- Equipped with a cap with a glass window that protects PD device from damage.

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In response to customers' requests we have developed different models of electronic units oriented for optimal operation with mid-Infrared 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 mid-infrared spectral range. The available operational regimes can be selected to attain the maximum benefits of using the new narrow-band-gap mid-IR LEDs and PDs.

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

LED driver D-41 – provides Pulse mode operation.

LED driver D-51 – provides Pulse mode operation; has an additional temperature control (monitoring) feature.

Minidriver mD-1c – provides qCW mode of operation with fixed signal data parameters.

Minidriver mD-1p – provides Pulse mode of operation with fixed signal data parameters.

For Photodiode signal processing we offer several solutions:

PAb preamplifier board – is incorporated in PD models: LmsXXPD-XX-R(-RW)-PA and LmsXXPD-XX-TEM(-R)-PA – converts the output current of a photodiode into a pulse voltage signal with amplification.

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.

For LED/Photodiode temperature control and adjustment we offer:

TCM thermocontroller – enables control and adjustment of temperature of LED and PD models with built-in thermoelectric modules: LmsXXLED-TEM(-R); LmsXXPD-XX-TEM(-R); LmsXXPD-XX-TEM(-R)-PA.

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

LED models compatibility with drivers and temperature controller (TCM)

LED \ Electronic device	D-41	D-51	Minidriver mD-1c	Minidriver mD-1p	TCM
Lms XX LED (-R; -RW)	✔	✔	✔	✔	✘
Lms XX LED-TEM (-R)	✔	✔	✔	✔	✔

PD models compatibility with synchronous detector (SDM) and temperature controller (TCM)

PD \ Electronic device	SDM	TCM
Lms XX PD-XX (-R; -RW)	✘	✘
Lms XX PD-XX-TEM (-R)	✘	✔
Lms XX PD-XX-R(-RW)-PA	✔	✘
Lms XX PD-XX-TEM(-R)-PA	✔	✔

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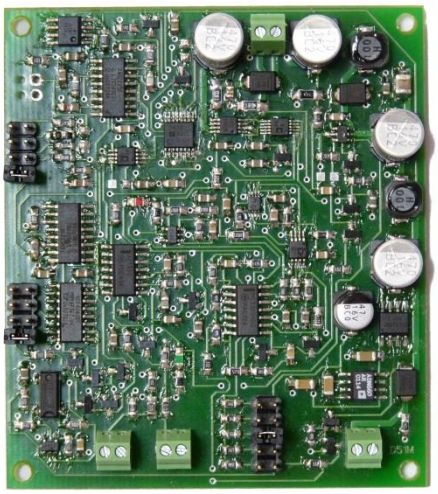
Application

D-41 driver is designed for power supply of all Lms MIR LED models.



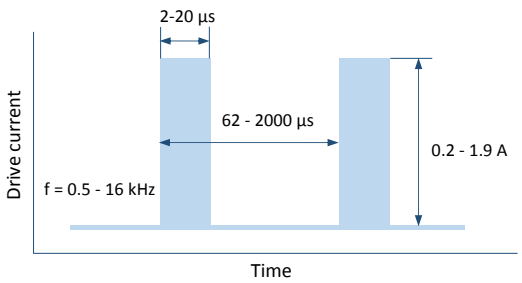
- Ease of use and durability.

Features

- D-41 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, 2, 8 and 16 kHz) and pulse duration within four values (2, 5, 10 and 20 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 the LED signal.
- Possibility of synchronization with an external device with the help of synchronisation output terminal block.

Technical characteristics

Current waveform generated by the driver in pulse mode



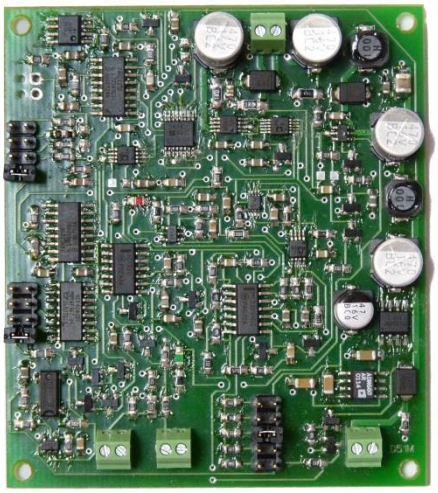
Parameters	Value
Input voltage	Stabilised +12 V
Voltage tolerance	-5 to +5 %
Power consumption	< 4 W
Board dimensions	80 × 70 × 15 mm
Synchronization output voltage	5 V

Signal data	Pulse mode
Pulse duration*	2, 5, 10 and 20 µs
Repetition rate	0.5, 2, 8 and 16 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 the better performance of the LED (LED-PD optopair), follow the data pointed in the specification provided with the ordered driver.

Application

D-51 driver is designed for power supply of all Lms MIR LED models and has a notable feature of intrinsic LED **temperature monitoring**.

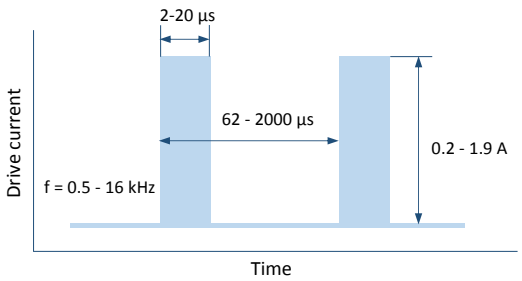


Features

- D-51 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, 2, 8 and 16 kHz) and pulse duration within four values (2, 5, 10 and 20 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 the 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 in pulse mode



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*	2, 5, 10 and 20 µs
Repetition rate	0.5, 2, 8 and 16 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 the better performance of the LED (LED-PD optopair), follow the data pointed in the specification provided with the ordered driver.

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Application

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

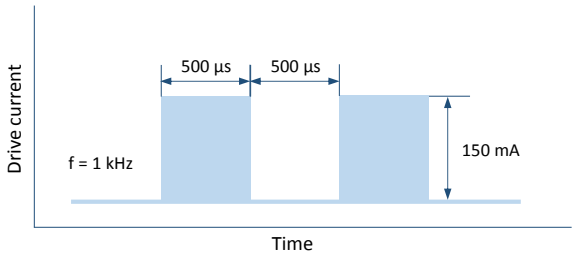
Features

- Minidriver **mD-1c** provides **qCW** mode of operation with fixed signal data parameters (amplitude, repetition rate and pulse duration).
- Minidriver **mD-1p** provides **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

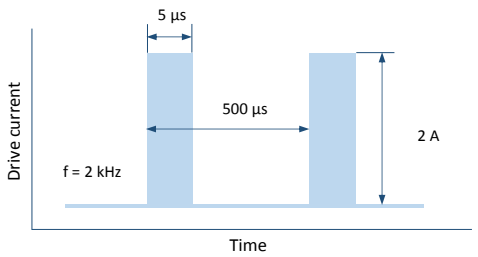
Parameters	Value
Input voltage	Stabilised +12 V
Voltage tolerance	-5 to +5 %
Power consumption	< 4 W
Board dimensions	24 × 12 mm
Synchronization output voltage	5 V

mD-1c (qCW)



Signal data	Pulse mode
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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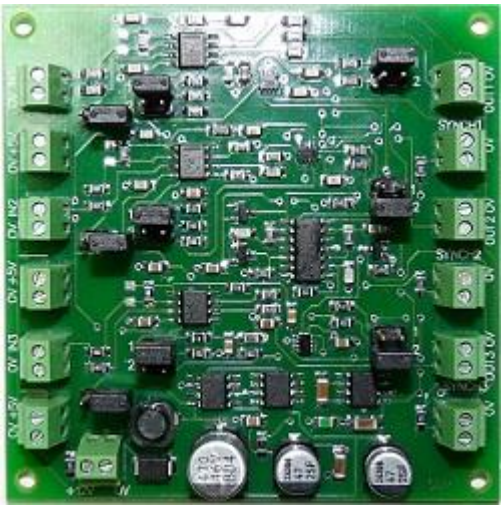
Application

SDM synchronous detector measures the voltage signal from the output of photodiode preamplifier* and converts it to the DC voltage signal proportional to amplitude of voltage from input.
(*Note that it works with preamplified signal only)



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

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

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

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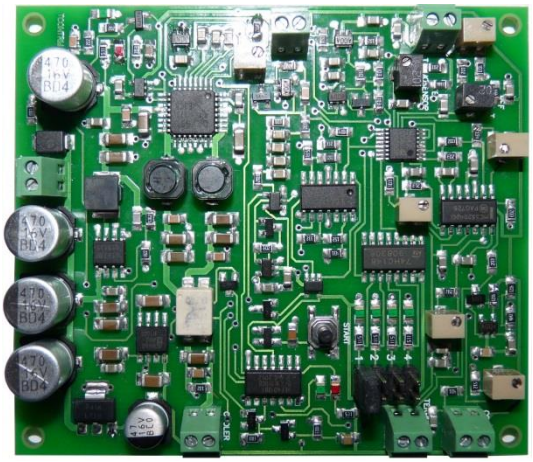
SUNSTAR传感与控制 http://www.sensor-ic.com/ TEL:0755-83376549 FAX:0755-83376182 E-MAIL:szss20@163.com

Application

Thermocontroller is designed for control and adjustment of temperature of LMSNT light-emitting diode and photodiode models with built-in thermoelectric modules (thermocoolers) – TEM models.



Features

- Two modes of temperature adjustment:
  - potentiometer adjustment;
  - adjustment from an external device via temperature voltage adjustment input;
- Two ways of temperature control:
  - with a thermoresistor built in an LED/PD package;
  - with temperature control block of D51 LED driver (LEDs only);
- Possibility of temperature voltage output to a signal observing device.

Technical characteristics

Parameters	Value
Input voltage	Stabilised +12 V
Voltage tolerance	-5 to +5 %
Input current	max. 0.3 A
Board dimensions	80 × 70 × 15 mm
Temperature adjustment input voltage	0..5 V
Thermistor output voltage	-0.15 V...+0.25 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 mid-infrared LED-PD optopairs for different detection purposes.

The line of devices includes evaluation systems for CH_4 and CO_2 (MDS-3 and CDS-3) for the initial experiments with gases, evaluation kits (CDK and MDK) that offer high flexibility. Miniature on-board evaluation systems for CH_4 and CO_2 (MDS-4 and CDS-4) are coming soon.

Every system is an out-of-the-box solution and can be launched with minimal effort.

CDK carbon dioxide and MDK methane evaluation kits

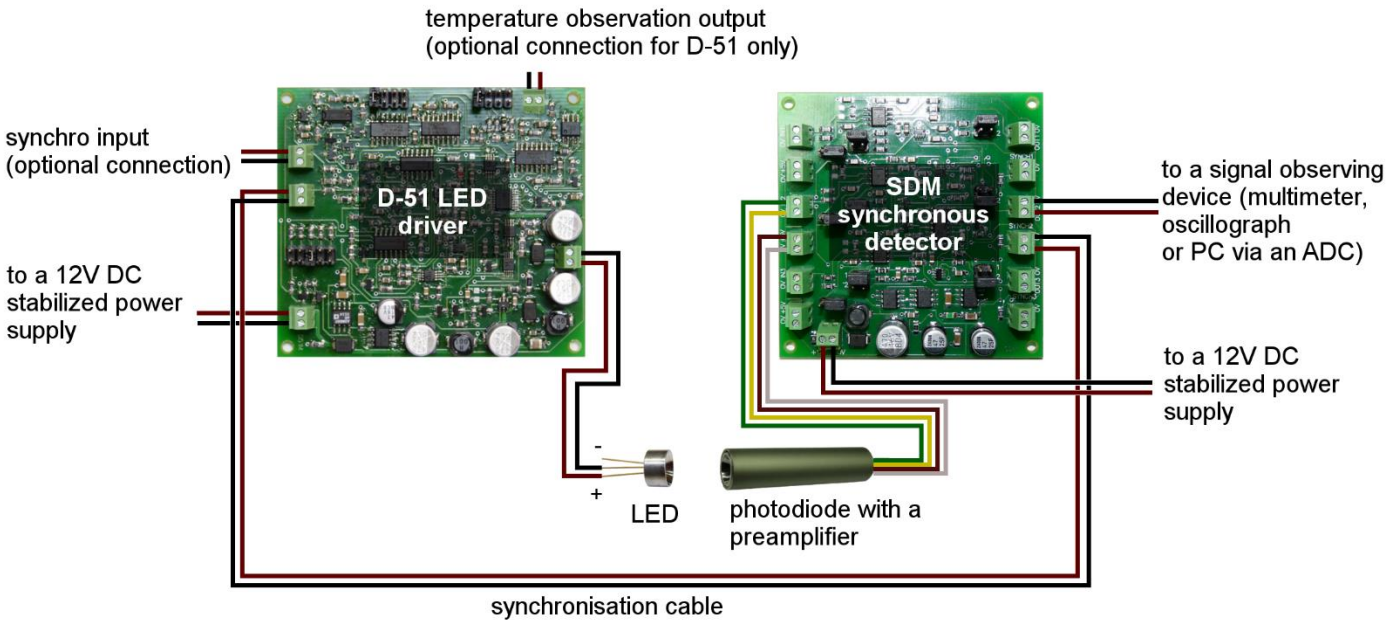
Evaluation kit for CO_2 detection (CDK-1) includes:

- Lms43LED-RW
- Lms43PD-03-RW-PA
- Org glass optical chamber (optional, under request)
- LED Driver (D-41 / D-51)
- Synchrodetector SDM
- AC/DC Adaptor, connection wires

Evaluation kit for CH_4 detection (MDK-1) includes:

- Lms34LED-RW
- Lms36PD-05-RW-PA
- Org glass optical chamber (optional, under request)
- LED Driver (D-41 / D-51)
- Synchrodetector SDM
- AC/DC Adaptor, connection wires

Connection setup



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CDS-3 carbon dioxide and MDS-3 methane evaluation systems

Evaluation system for CO_2 detection (CDS-3) includes:

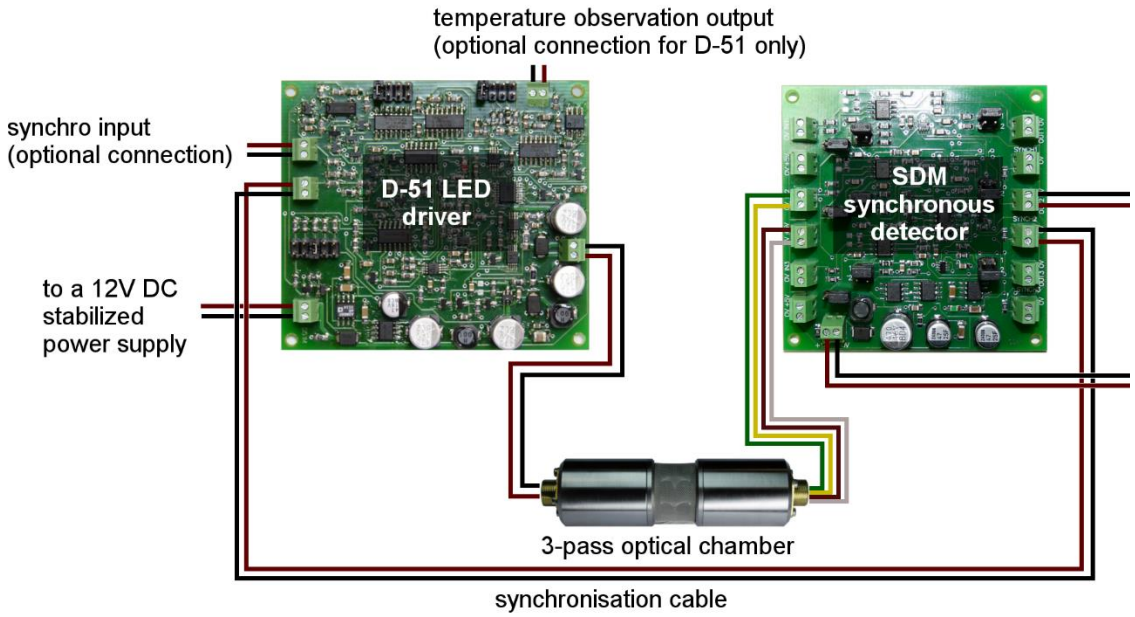
- 3-pass optical chamber* with built-in:
  - Lms43LED
  - Lms43PD-03
  - PD preamplifier
  - Built-in driver (in case this driver type is chosen for LED power supply)
- LED Driver (D-41 / D-51 in case built-in driver is not chosen)
- Synchrodetector SDM
- AC/DC adaptor, connection wires

Evaluation system for CH_4 detection (MDS-3) includes:

- 3-pass optical chamber* with built-in:
  - Lms34LED
  - Lms36PD-05
  - PD preamplifier
  - Built-in driver (in case this driver type is chosen for LED power supply)
- LED Driver (D-41 / D-51 in case built-in driver is not chosen)
- Synchrodetector SDM
- AC/DC adaptor; connection wires

*Disassembling of the optical chamber is forbidden

Connection setup



NEW MDS-4 on-board evaluation system

This is a low-cost system with “on-board” design that includes a very compact optical cell and electronics for LED power supply and PD signal amplification all-in-one.

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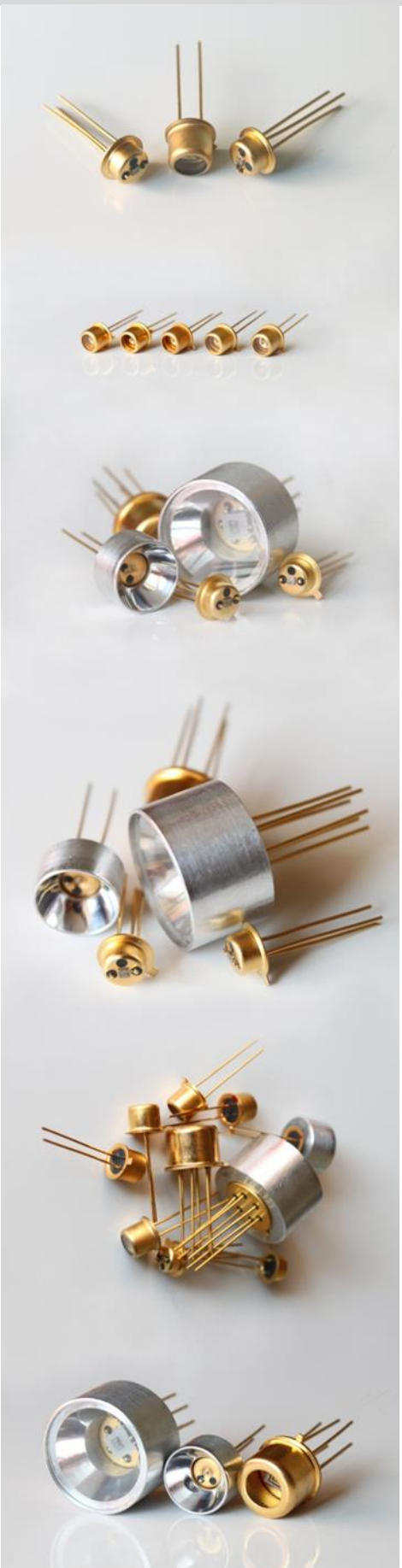

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Notes