LED Microsensor NT

Light Emitting Diodes
Photodiodes
Electronics

1600 – 5000 nm

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LED Microsensor NT LLC is a novel 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 Vapor 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.

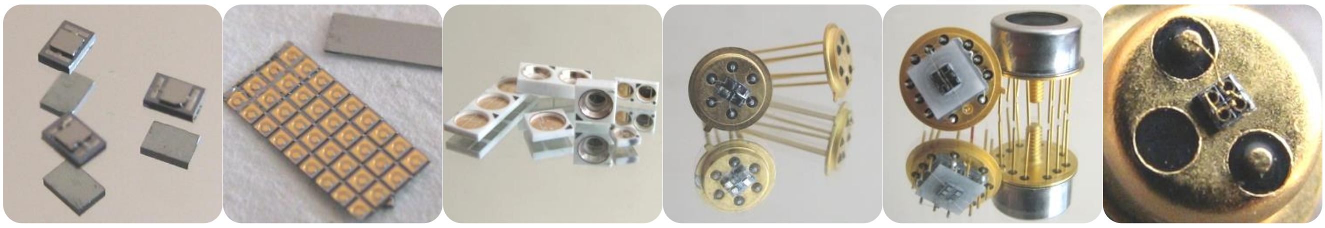
In Nov 2011, the Rusnano Corporation made an investment in LED Microsensor NT in order to expand the current optoelectronic component base of mid-infrared LEDs, LED arrays and PDs and to offer new products: optical modules and sensors.

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

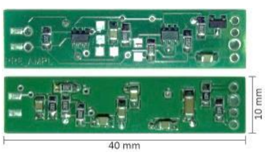
Light Emitting diodes (LEDs), Photodiodes (PDs)

LED & PD chips, LED & PD wafers, LED & PD arrays



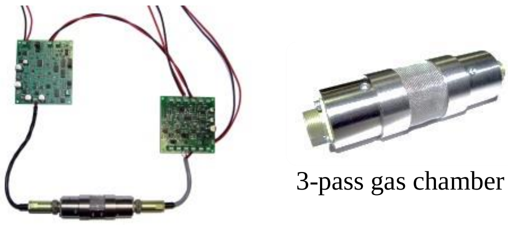
Electronic Devices (LED drivers, PD amplifiers) and Evaluation kits

LED driver



PD preamlpifier board

Synchronous detector



Evaluation system for CO_2 (or CH_4) detection

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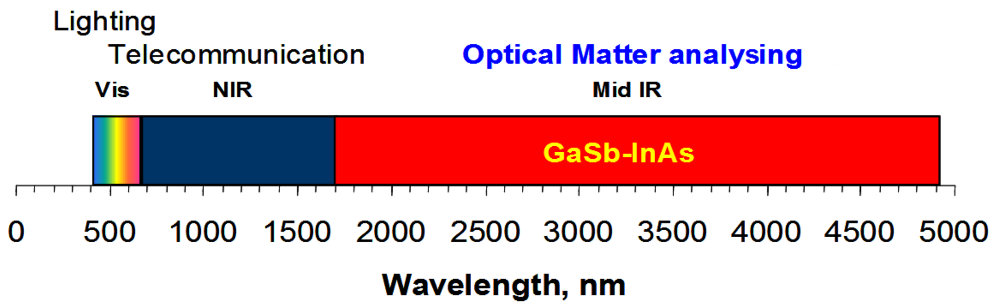
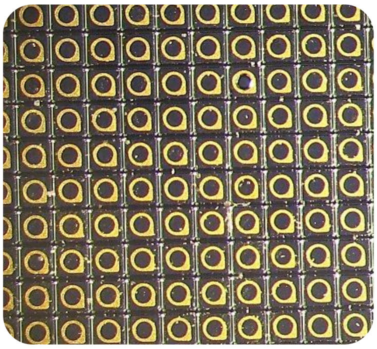
Light emitting diodes (LEDs) and Photodiodes (PDs) are semiconductor devices. The LED or PD heterostructure is formed by sequential epitaxy of semiconductor layers on the surface of a crystal substrate. LED radiation is generated in the active layer and the emission wavelength of the LED and the spectral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

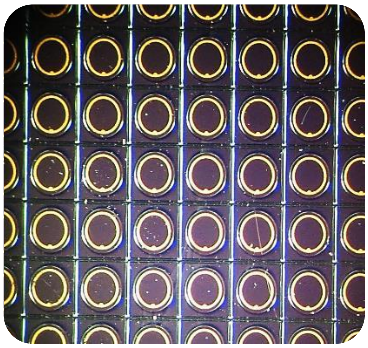
The first laser heterostructures in the world were grown at the end of the 1960s in the Ioffe Physical Technical Institute by Nobel Prize laureate Zhores Alferov.



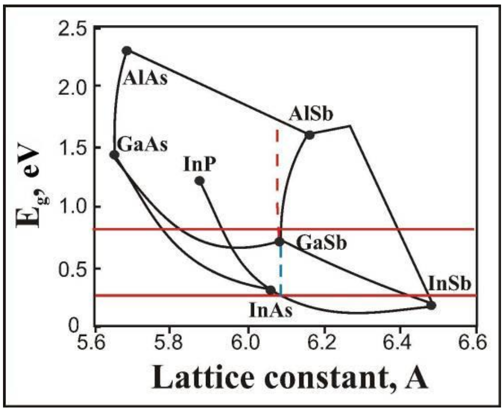
Nowadays, semiconductor optoelectronic devices for near-infrared and the visible spectral range are widely used in telecommunications and lighting. Additionally, LEDs and PDs possess great potential for use in optical analysing systems. In the middle Infrared spectral range, 1600–5000 nm, there are strong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





Semiconductor wafer (LED and PD chips with ring top contacts)



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We propose:

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

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	3.70-3.84	3.85-3.94	3.95-4.09	4.10-4.30	4.40-4.60
Lms18LED	Lms19LED	Lms20LED	Lms21LED	Lms22LED	Lms23LED	Lms34LED	Lms38LED	Lms39LED	Lms41LED	Lms43LED	Lms46LED

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

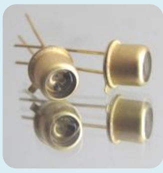
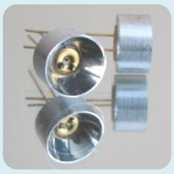
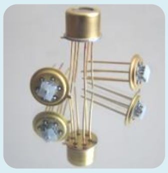
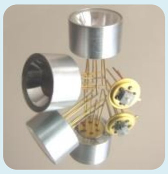
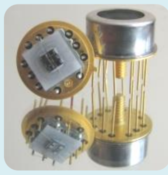
1.60-1.69	1.70-1.79	1.80-1.89	1.90-1.99	2.00-2.09	2.10-2.19	2.20-2.29	2.30-2.39
Lms16LED-FC	Lms17LED-FC	Lms18LED-FC	Lms19LED-FC	Lms20LED-FC	Lms21LED-FC	Lms22LED-FC	Lms23LED-FC

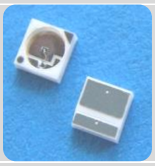
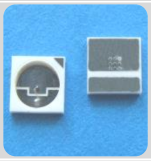
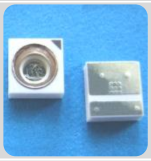
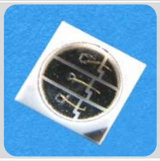
- A line of wide band PDs with sensitive area of 0.3 and 0.5 mm and cut-off at wavelengths (μm):

2.4		3.6		4.6	4.3
Lms24PD-03	Lms24PD-05	Lms36PD-03	Lms36PD-05	Lms43PD-03	PR43
Photodiodes					Photoresistor (under special request)

- Multi-element LED matrix – 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 customized packages for these devices:

	TO-18	TO-18 with PR	TO-5	TO-5 with PR	TO-8
TO Packages	with/without window		with/without thermoelectric module		
					
applied to	LED, PD		LED, PD, LED-matrix		LED-matrix

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

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

✓ LED drivers D-41, D-51 – unpackaged drivers that provide LED operation in different pulse modes;
D-51M additionally enables the LED p-n junction temperature to be obtained using current-voltage dependence.

✓ LED driver DLT-27* – provides operation and temperature stabilisation of an LED with a built-in thermocooler in QCW and pulse modes at fixed frequency and pulse duration and variable currents

✓ LED driver DLT-37* – provides operation and temperature stabilisation of an LED with a built-in thermocooler in QCW and pulse modes at several frequencies, variable pulse durations and currents;

✓ **NEW** 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(w)-PA series;

✓ PD Amplifier AMT-07* – converts the output current signal of a PD with built-in thermocooler into a voltage output with amplification; provides temperature stabilization of a PD.

✓ **NEW** 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.

***These models will be replaced with newer unpackaged device versions soon.**

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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

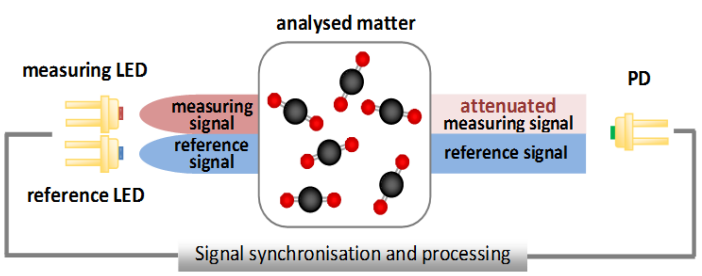
Food industry and agriculture, examples:

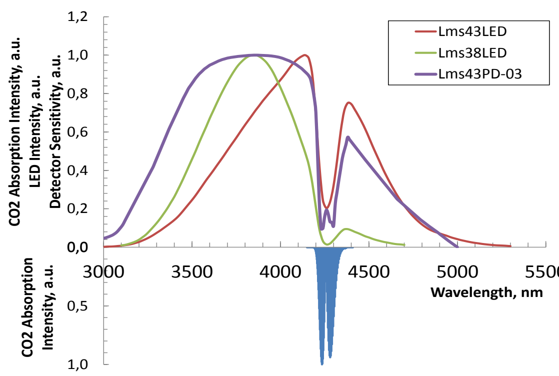
- Control of water, fibre, protein concentration in grains, humidity control of coffee beans, corn
- Control of fat and protein in milk
- Analysis of ethanol content in wine

Most commercially available instruments for this analysis employ quite sophisticated large-sized and expensive spectrometers that provide measurements solely at the laboratory. Using LED-Photodiode optopairs for the mid-infrared spectral range has allowed the development portable sensors with high reliability and adequate accuracy that can be successfully applied in different areas for matter analysis purposes.

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.

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There are strong absorption bands for many chemical agents at the mid-infrared spectral range that allows their detection with sensor devices based on LED-PD optopairs. Some of these chemical agents and their absorption bands are presented here.

Although the spectra are characteristic 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*	***CO_2 (carbon dioxide)*** *2.00; 2.65 μm;* *4.2÷4.3 μm*	***H_2O (water)*** *2.65÷2.85 μm;* *1.86÷1.94 μm*	***N_2 (nitrogen)*** *2.2÷2.5 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*	***NO+ (nitrogen oxide cation)*** *4.08÷4.44 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*	***HO_2 (hydroperoxy radical)*** *2.73÷3.1 μm*	***SO_2 (sulfur dioxide)*** *3.96-4.06 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*	***C_3H_8 (propane)*** *3.28÷3.57 μm*	***$C_6H_{12}O_6$ (glucose)*** *2.12; 2.27; 2.32 μm*

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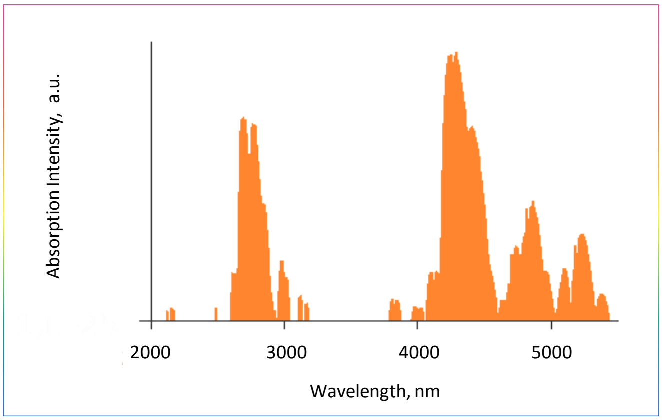
Carbon Dioxide Absorption Spectrum



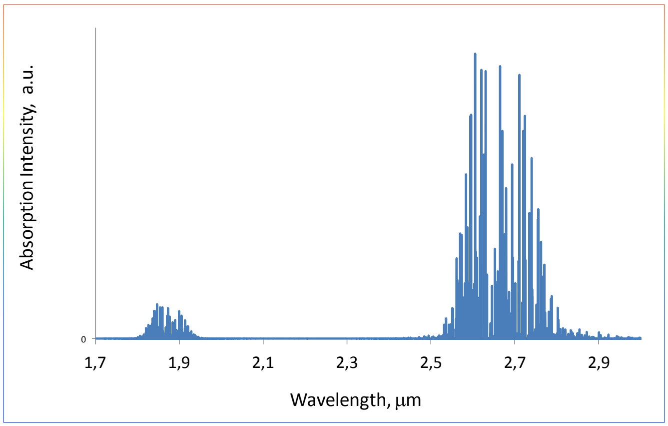
Carbon Dioxide has a strong absorption band at 4200–4320 nm spectral range and weaker bands around 2700 nm and 2000 nm (the data are taken from HITRAN Catalogue).

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.

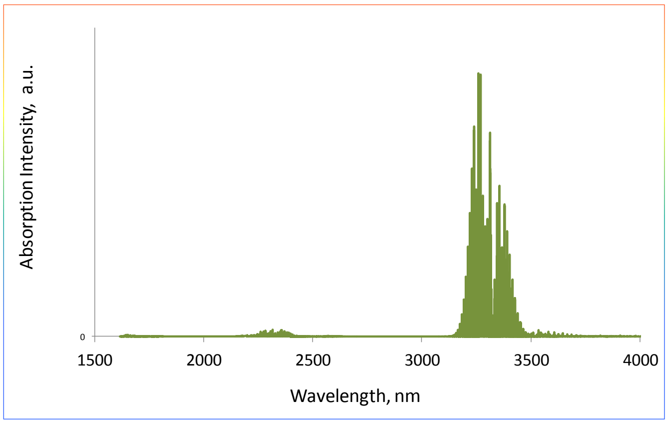
Water Absorption Spectrum



Water has strong absorption bands at spectral ranges 2550–2750 nm and 1830–1900 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 1830–1900nm.

Methane Absorption Spectrum



Methane has the main absorption band at 3200-3400 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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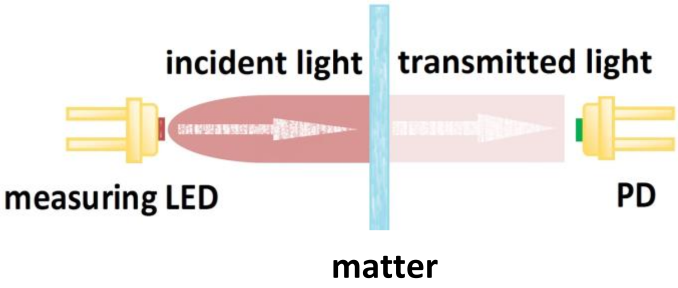
PRINCIPLE OF THICKNESS MEASUREMENT BASED ON LED – PD OPTOPAIR



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 numerous benefits that LEDs and PDs offer, our devices should be seriously considered as the new element base for thickness analysis as well.

Range of applications within plastics:

- ✓ PE films
- ✓ Containers (bottles, jars, pots, cans, glasses etc.)
- ✓ Canalisation, drainage pipes
- ✓ PE electrical insulation
- ✓ Cases for devices

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

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

- ✓ 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:

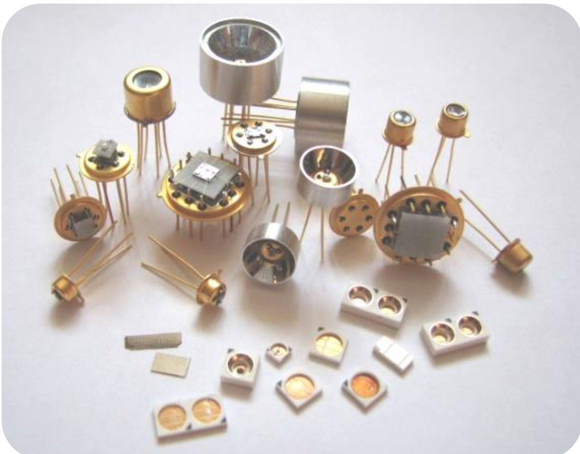
- broad-band light sources – filament black body emitters, planar filaments in thin technology – used together with crude and simple optics such as light pipes followed by filters, provide low modulation range (~8 Hz), less suitable for miniaturised sensing devices, low-cost;

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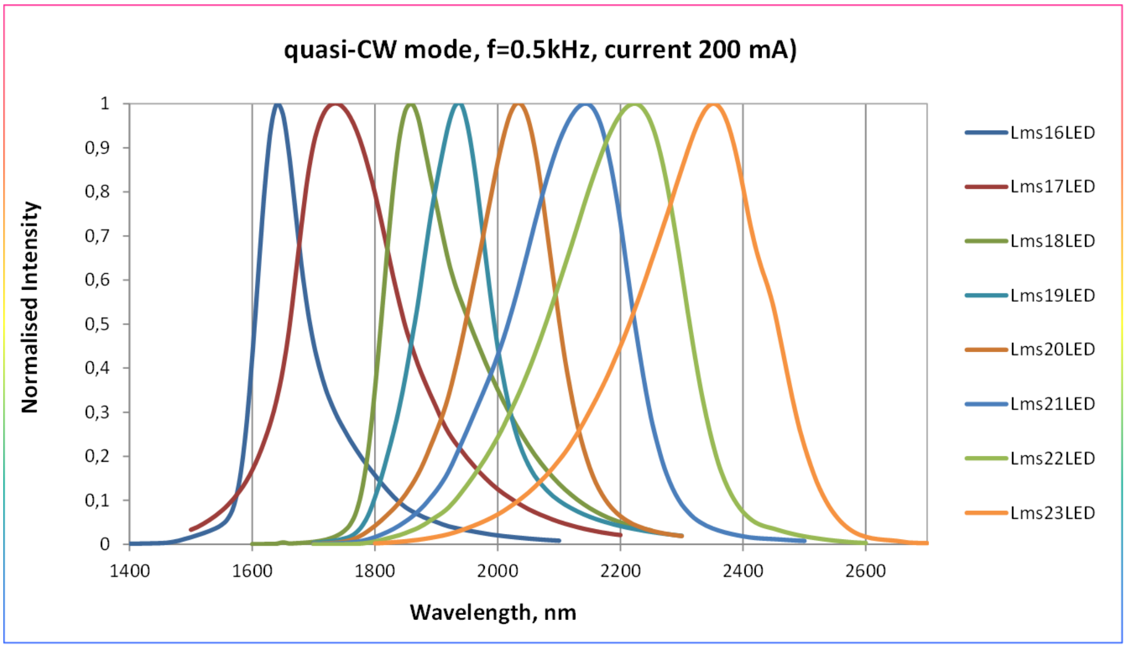
The main techniques that we use for heterostructure growth are Metal-Organic Chemical Vapour Deposition (MOCVD) and liquid-phase epitaxy (LPE). LEDs for the 1.6–2.4 µm spectral range were fabricated from a narrow-band gap GaInAsSb/AlGaAsSb-based heterostructure lattice matched to a GaSb substrate.

Light Emitting Diodes for 1.6–2.4 µm spectral range



Model	Peak emission wavelength, nm		FWHM of the emission band, nm		Power, mW QCW mode*		Power, mW Pulse mode**		Voltage*, V	Maximum operating current, mA QCW mode	Maximum operating current, mA Pulse mode	Switching time, ns	Operating temperature range, °C
	min	max	min	max	min	max	min	max					
Standard LED models (LED chip with circular or ring top contact) – Lms MIR LED (1.8 – 2.3 µm)													
Lms18LED	1.80	1.89	100	200	0.7	1.1	15	25	0.5-1.5	250	2000	10-30	-200 to +50
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	0.7	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)													
Lms16LED-FC	1.60	1.69	70	150	0.8	2.0	20	35	0.8-4.8	150-200	1000	10-30	-200 to +50
Lms17LED-FC	1.70	1.79	100	160	0.8	2.0	20	35	0.8-4.8				
Lms18LED-FC	1.80	1.89	100	180	0.7	1.4	20	30	0.6-2.0	200			
Lms19LED-FC	1.90	1.99	100	180	0.8	1.6	20	35	0.6-2.4				
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				

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

** Repetition rate: 1 kHz, pulse duration: 1 µs, duty circle: 0.1%, current: 1 A

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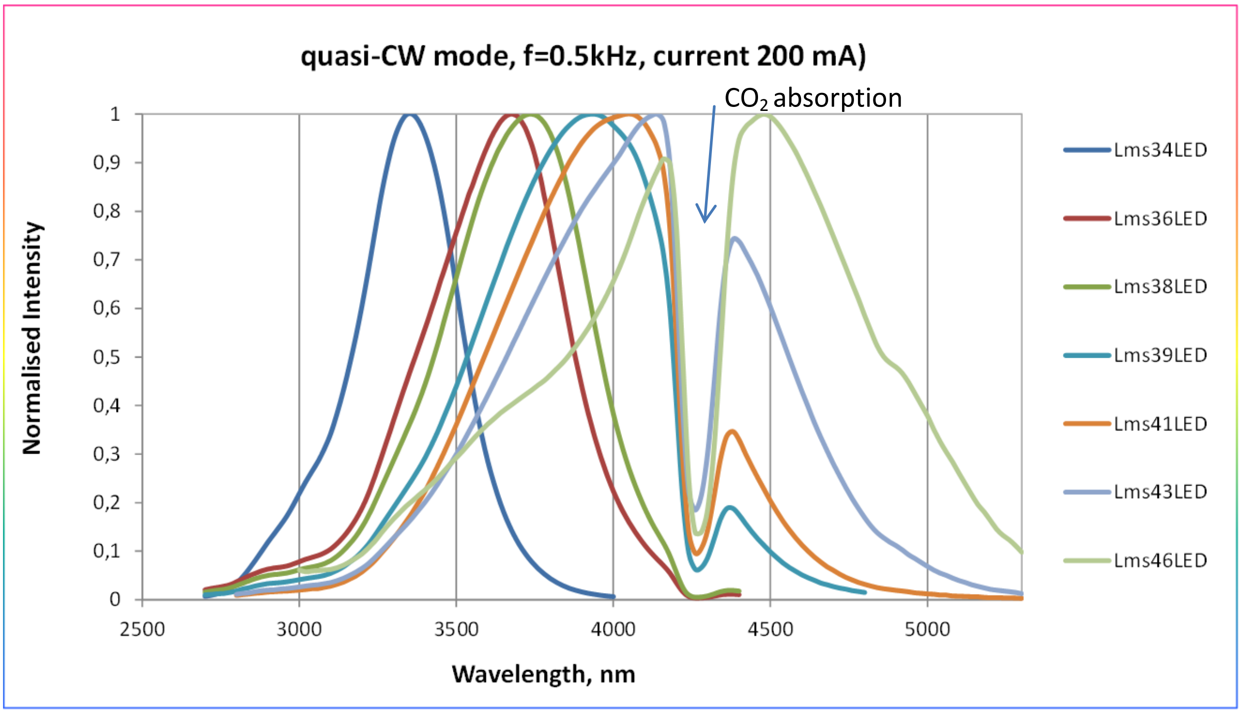
Narrow band-gap InAsSb/InAsSbP-based heterostructures lattice matched to InAs substrate were used to create LEDs for 3.3-4.6 μm spectral range.

Light Emitting Diodes for 2.8–4.6 μm spectral range



Standard LED models (LED chip with circular or ring top contact) – Lms MIR LED (3.3 – 4.6 nm)													
Model	Peak emission wavelength, nm		FWHM of the emission band, nm		Power, μW				Voltage*, V	Maximum operating current, mA		Switching time, ns	Operating temperature range, °C
					QCW mode*		Pulse mode**			QCW mode	Pulse mode		
	min	max	min	max	min	max	min	max					
Lms34LED	3.30	3.49	400	600	25	45	320	480	0.2-0.5	250	2000	10-30	-200 to +50
Lms34LED high power	3.30	3.49	400	500	45	80	480	720	0.2-0.5				
Lms38LED	3.70	3.84	500	700	20	40	180	220	0.5-0.8				
Lms39LED	3.85	3.94	550	750	15	30	180	220	0.5-0.8				
Lms41LED	3.95	4.09	700	1000	15	30	180	220	0.5-0.7				
Lms43LED	4.10	4.30	700	1000	8	12	180	220	0.2-0.8				
Lms46LED	4.40	4.60	700	1100	2	4	100	140	1.5-3.0				

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

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

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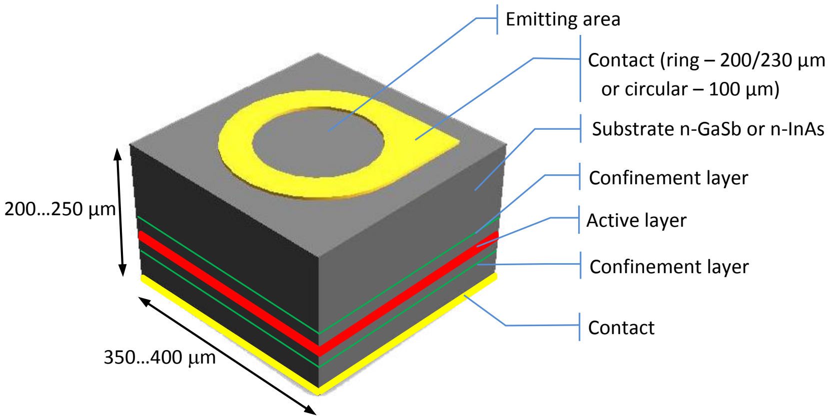
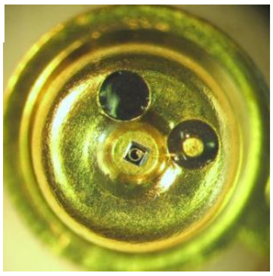
Standard Mid Infrared LED chip



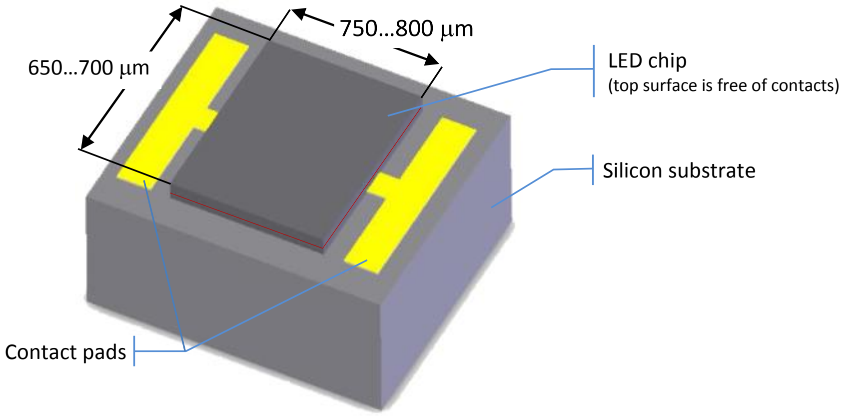


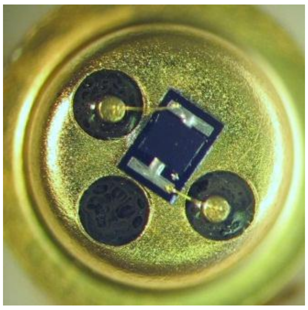
This shape of LED chip is typical for most of the LED Microsensor NT standard LED models (Lms XX LED series).

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 will hinder the extraction of light. This fundamental 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.

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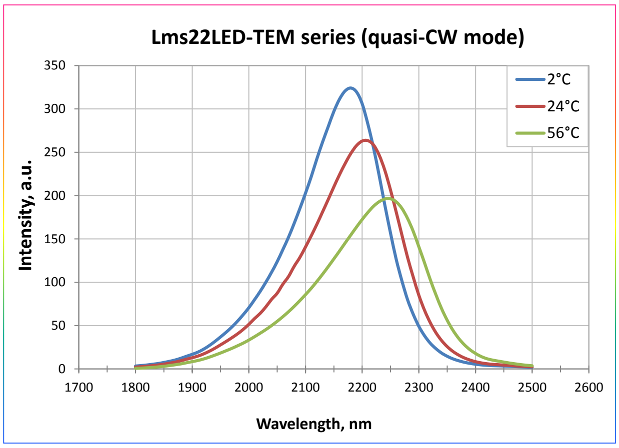
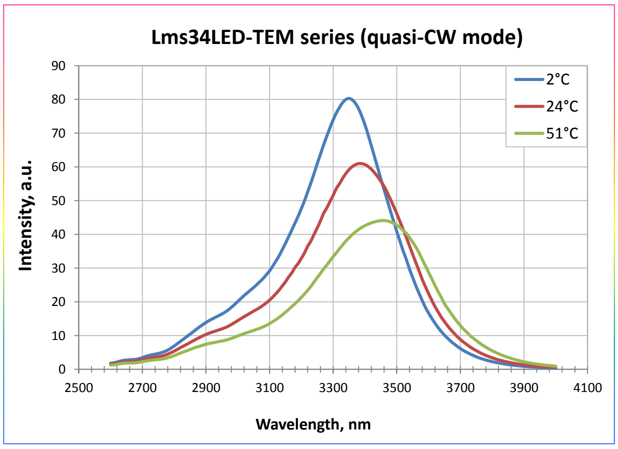
Temperature Dependences of Optical Characteristics

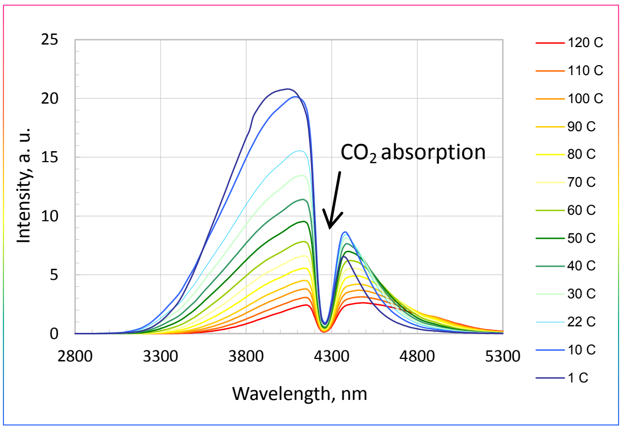
It is typical for all semiconductor radiation sources to have intensity decreasing with temperature increase. This decrease of the emission intensity is related to several temperature-dependent factors, including non-radiative recombination via deep levels, surface recombination and carrier loss over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

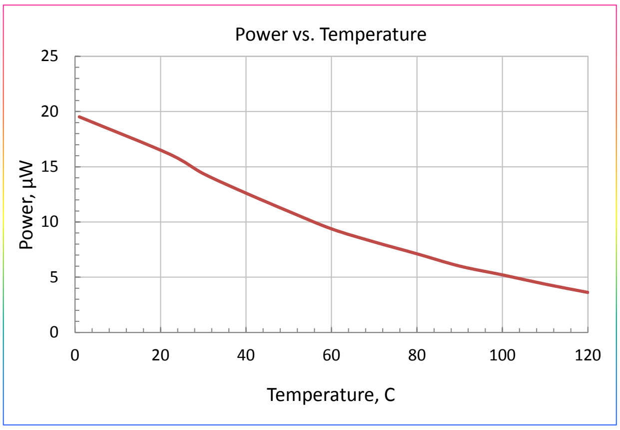
Mounting of an LED chip into a package with a thermoelectric module (Peltier element) enables stabilization of the temperature of an LED chip, providing wavelength tuning in a certain wavelength range.





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.





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 ms).

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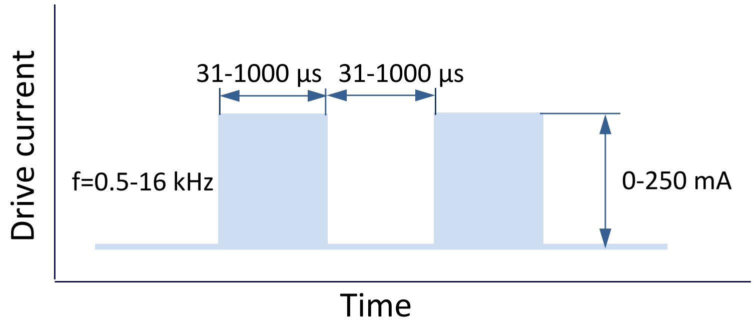
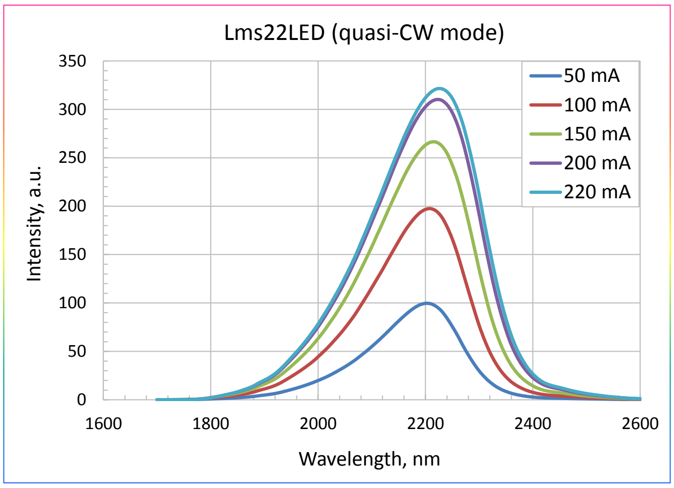
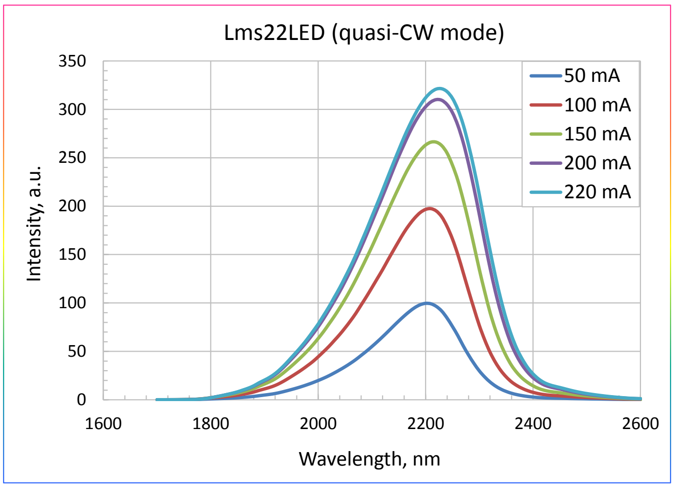
QUASI-CONTINUOUS WAVE (QUASI-CW) MODE:

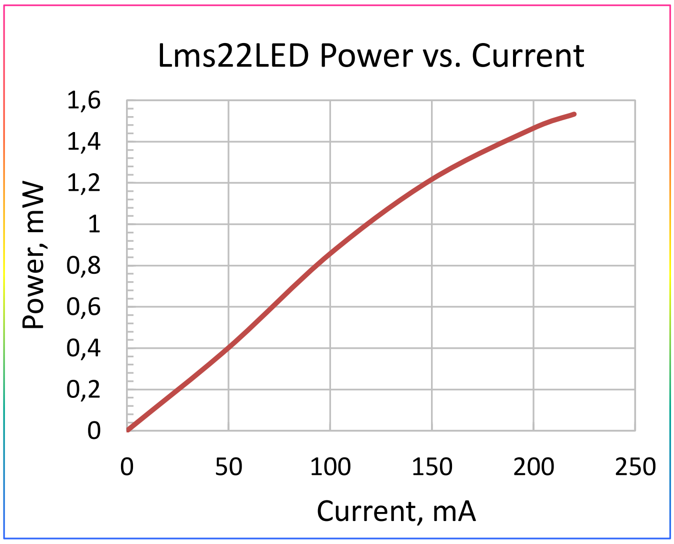


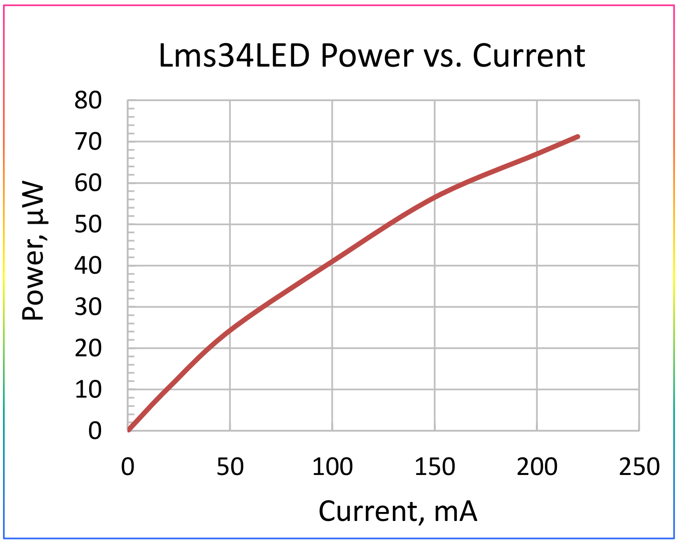
Spectra at different currents in the quasi-CW mode (frequency 0.5 kHz, duty cycle 50%):





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





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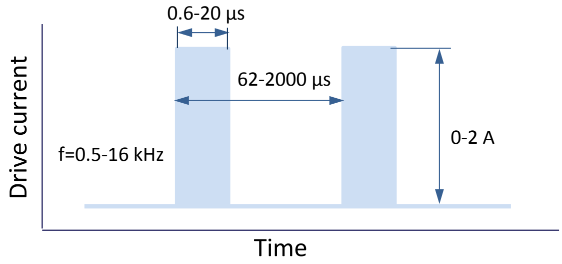
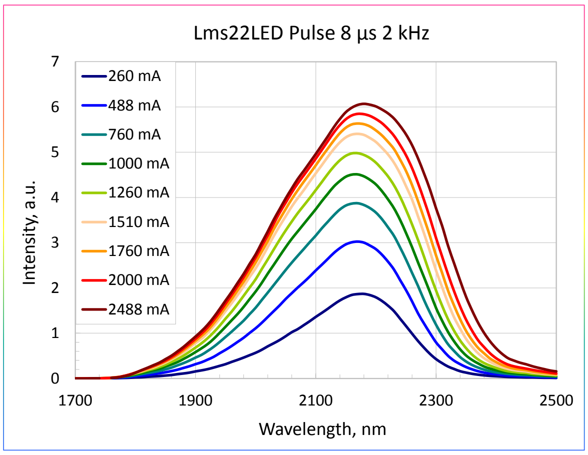
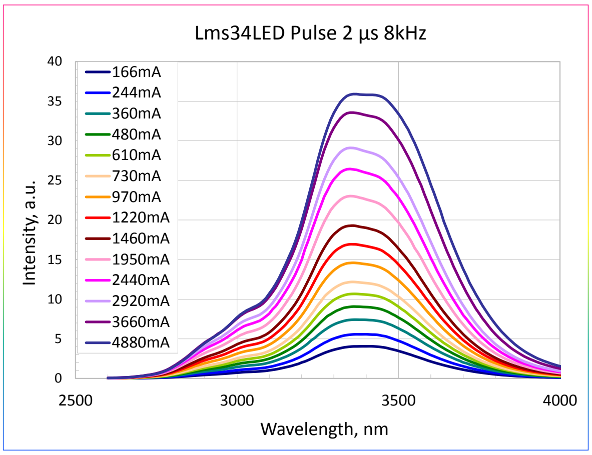
PULSE MODE:

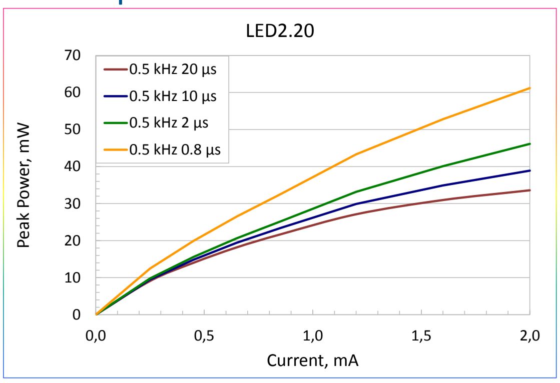


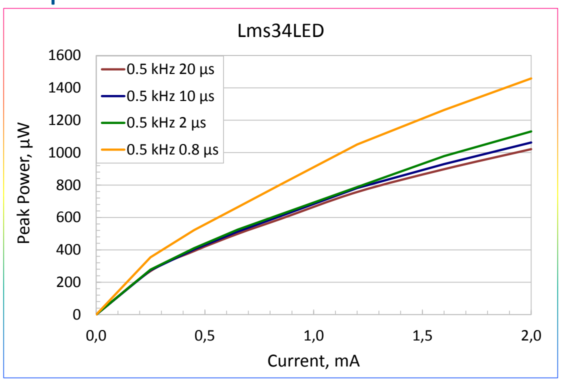
Spectra at different currents in the pulse mode:



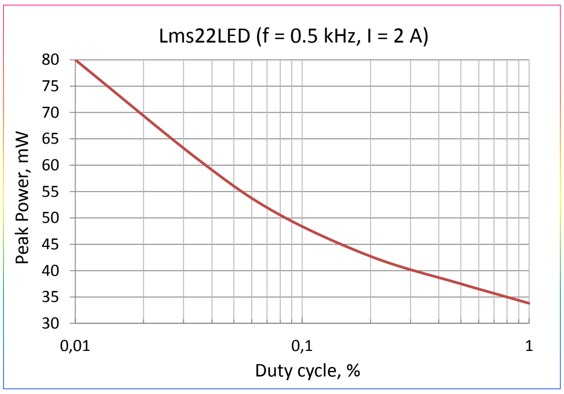


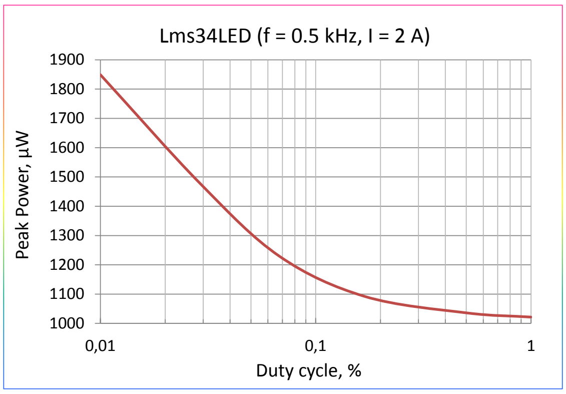
Power dependence on the drive current in the pulse mode:





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





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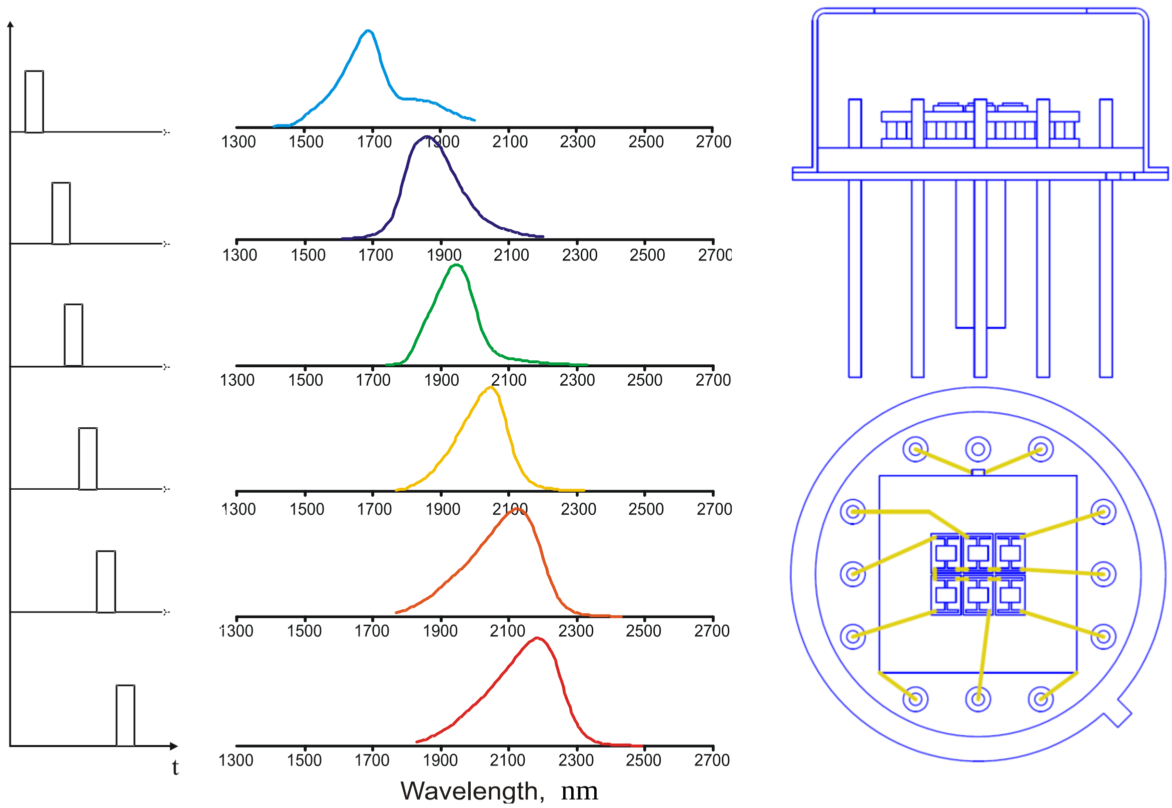
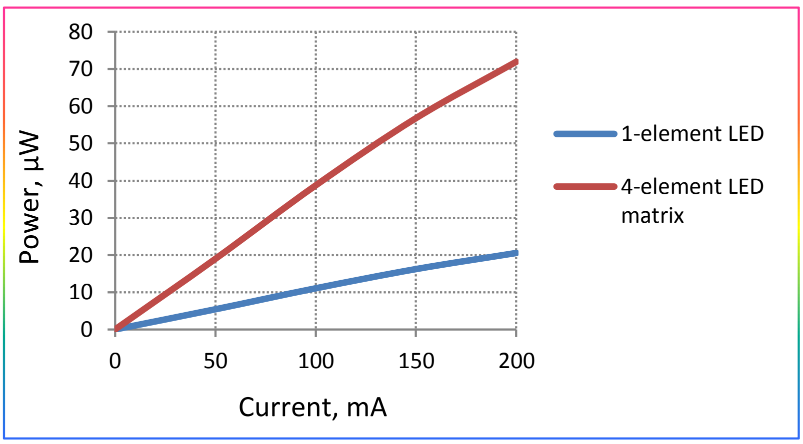
The tiny size of an LED chip (0.35 × 0.35 mm), narrow-band emission spectrum, short response time and low thermal flux enables the creation of very compact multi-element LED arrays and LED matrices emitting at one or different wavelengths.

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. 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.



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.



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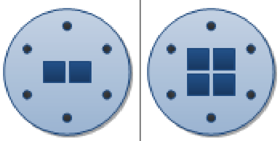
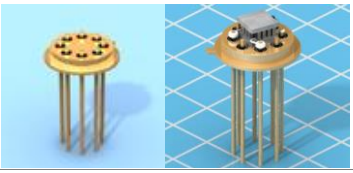
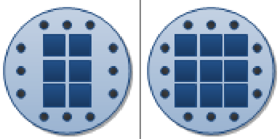
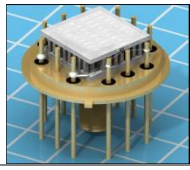
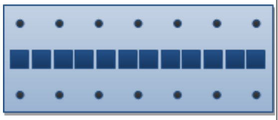
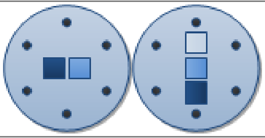
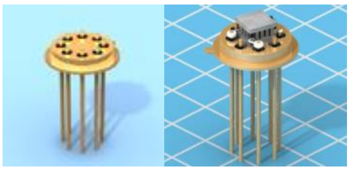
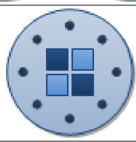
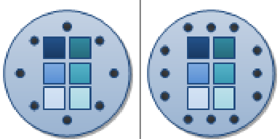
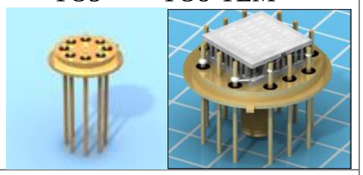
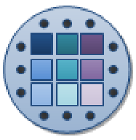
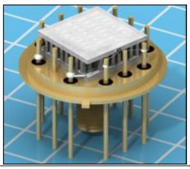
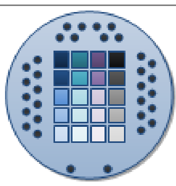
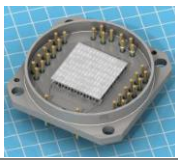
The number of array or matrix elements depends on the application and the chosen package type. Standard TO-type packages offered by RMT Ltd. can be used. Packages with built-in thermoelectric modules (Peltier elements) provide temperature stabilisation of LED chip parameters. Use of these packages allows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

LED array/LED matrix Model	Element Arrangement	Package
✓ LmsXXLED-2M(-TEM), LmsXXLED-4M(-TEM): 2 or 4 LED elements on ceramic substrate emitting at one wavelength mounted on a single 9 mm package with/without a thermoelectric module		TO5 TO5-TEM 
✓ LmsXXLED-6M-TEM, LmsXXLED-9M-TEM: 6 or 9 LED elements on ceramic substrate emitting at one wavelength mounted on a single 15 mm package with a thermoelectric module		TO8-TEM 
✓ LmsXXLED-12A-TEM: 12 LED elements on ceramic substrate emitting at one wavelength mounted on a single PS28 package with a thermoelectric module. This solution is appropriate for the spatial distribution analysis of the analyte		PS28-TEM 
✓ LmsXX&YY&ZZLED-2M(-TEM), LmsXX&YY&ZZLED-3M(-TEM) 2 or 3 LED elements on ceramic substrate emitting at 2 or 3 different wavelengths mounted on a single 9 mm package with/without a thermoelectric module		TO5 TO5-TEM 
✓ LmsXX&YYLED-4M(-TEM) 4 LED elements on ceramic substrate mounted on a single 9 mm package with/without a thermoelectric module, 2 elements emit at one wavelength and 2 other elements – at another		
✓ LmsXX÷YYLED-6M(-TEM) 6 LED elements on ceramic substrate emitting at 6 different wavelengths mounted on a single 9 mm package without a thermoelectric module or on a single 15 mm package with a thermoelectric module		TO5 TO8-TEM 
✓ LmsXX÷YYLED-9M-TEM 9 LED elements on ceramic substrate emitting at 9 different wavelengths mounted on a single 15 mm package (16 pins) with a thermoelectric module		TO8 
✓ LmsXX÷YYLED-20M-TEM 20 LED elements on ceramic substrate emitting at 20 different wavelengths mounted on a single 36 mm package with a thermoelectric module		MS32-TEM 

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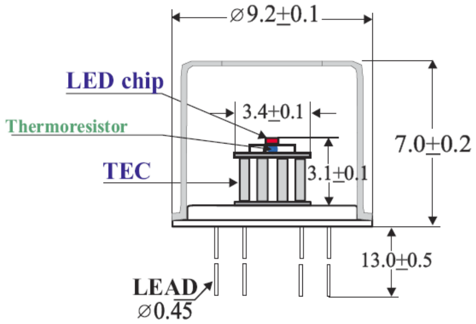
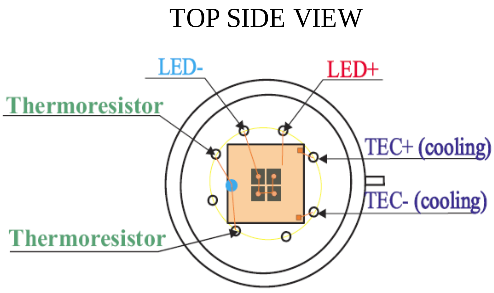
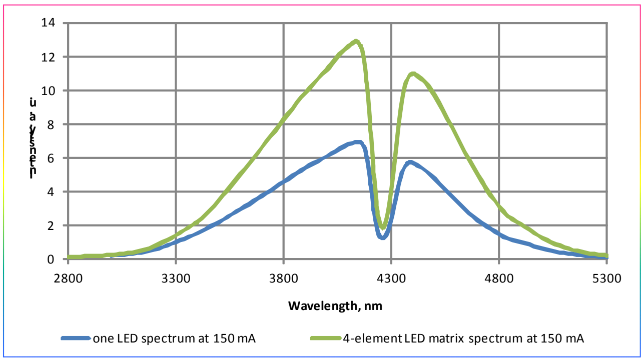
Two possible matrix arrangements are presented below in detail:

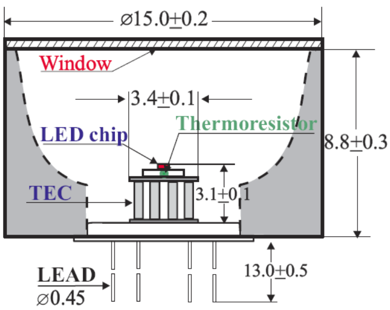
✓ 4-element LmsLED matrix with one peak wavelength at 4.14 µm in 9 mm TO5 package with a built-in thermoelectric module and a cap with a sapphire window

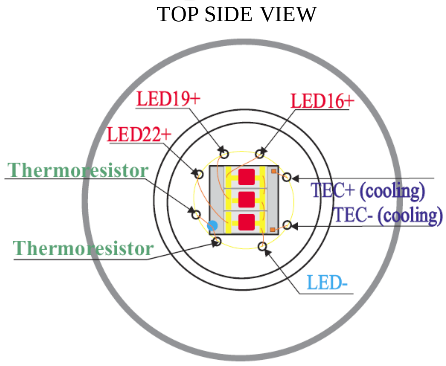


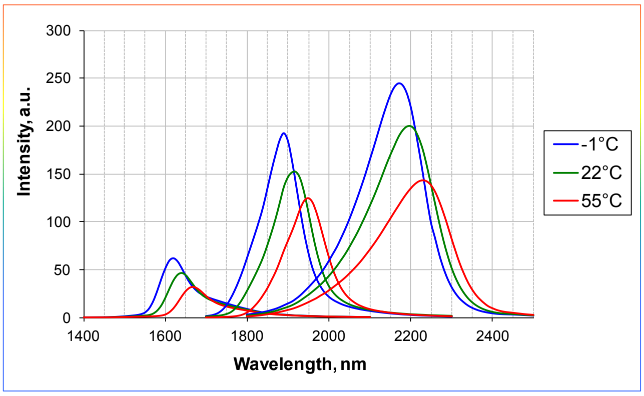




✓ 3-element LED matrix with peak wavelengths at 1.6, 1.9 and 2.2 µm in 9 mm TO5 package with a built-in thermoelectric module and a parabolic reflector with a quartz window







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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

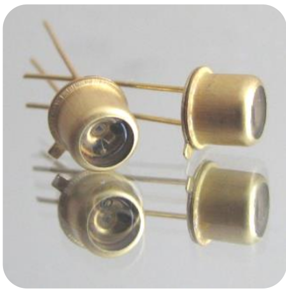
TO8 – appropriate for mounting multi-element LED-matrices

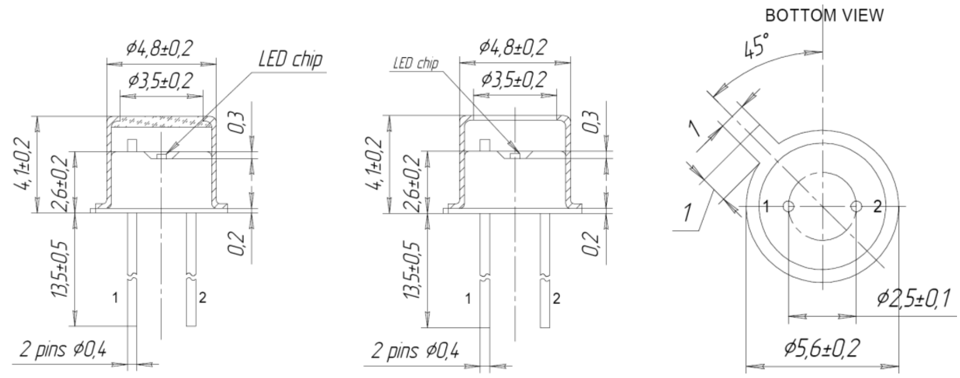
✓ SMD type packages:

CS3 (SMD 3 × 3 mm), CS5 (SMD 5 × 5 mm), CS5R (SMD 5 × 5 mm with microreflector) – appropriate for mounting one-element LEDs or single-wavelength matrices

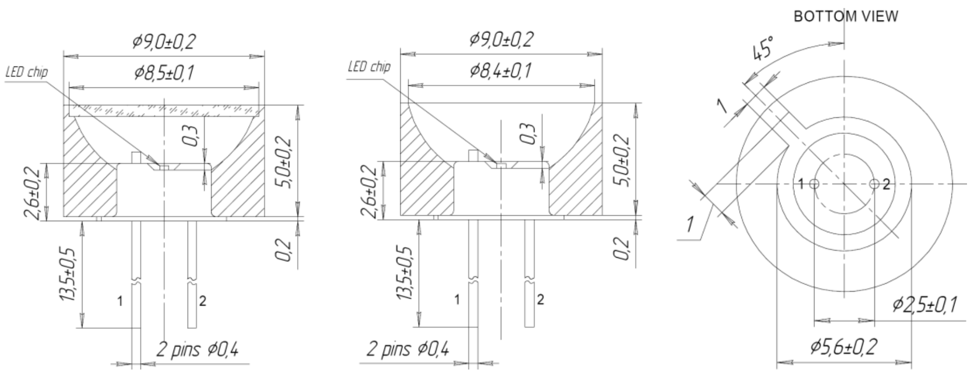
CS5R-3M (SMD 5 × 5 mm) – appropriate for mounting three-element LED-matrices

TO18





TO18-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 protects LED device from damage

Parabolic reflector with a glass window (RW) or without a window (R) protects LED device from damage and provides at reduction of the radiation divergence.

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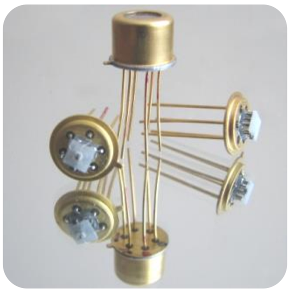
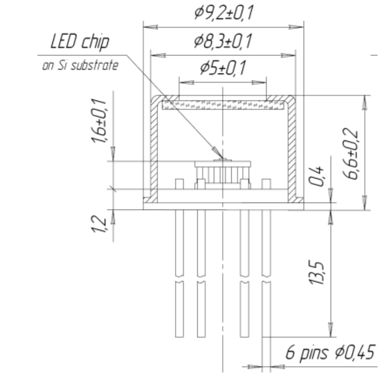
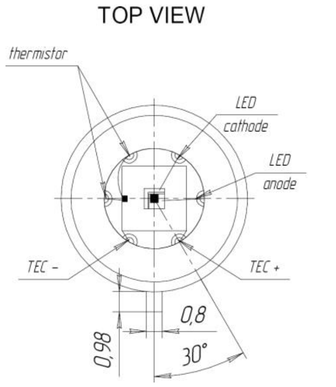
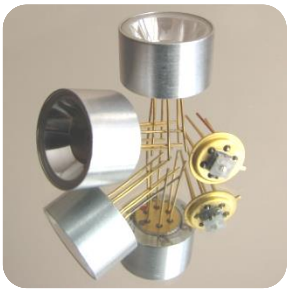
TO5-TEM

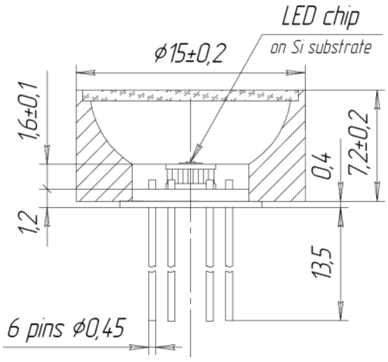


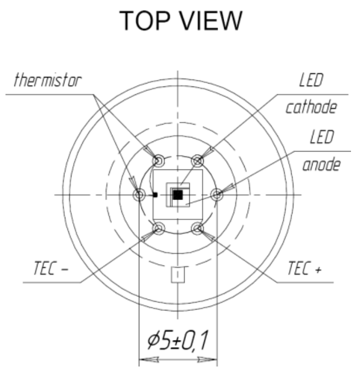




TO5-TEM-R





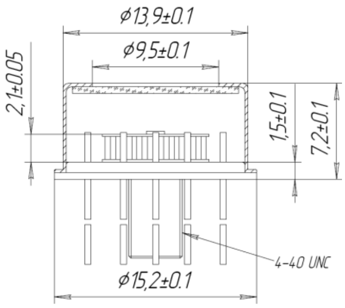


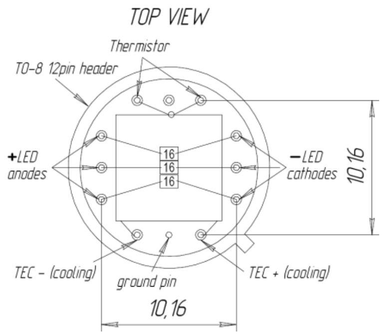
- Small packages with 3.2 × 3.2 mm^2 thermocooler surface open for mounting
- Header material – kovar, finish – gold/plating; thermocooler ceramics – Al_2O_3
- The number of lead pins is 6 or 9
- Built-in thermoelectric module (TEM) – thermocooler and thermoresistor – provides LED chip temperature adjustment 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 at reduction of the radiation divergence

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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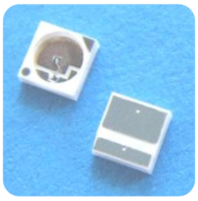
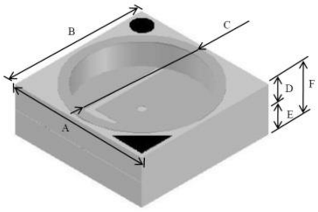
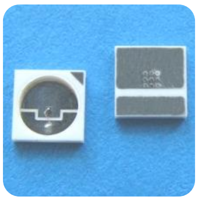
CS3
3×3 mm

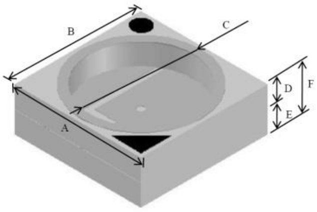




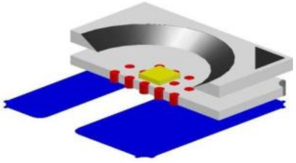
ITEM	Symbol	Rule
Basic Outline	A	3.0± 0.1mm
Basic Outline	B	3.0± 0.1mm
Cavity size	C	Max 2.4Φ
Top layer	D	Min 0.4mm
Bottom layer	E	Min 0.4mm
Thickness	F	Max 2mm

CS5
5×5 mm

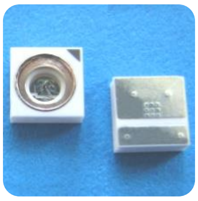


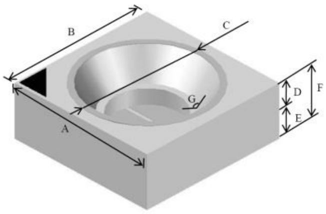


ITEM	Symbol	Rule
Basic Outline	A	5.0± 0.1mm
Basic Outline	B	5.0± 0.1mm
Cavity size	C	Max 4.2Φ
Top layer	D	Min 0.4mm
Bottom layer	E	Min 0.4mm
Thickness	F	Max 2mm



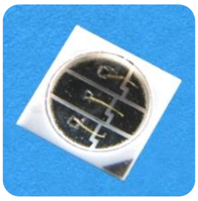
CS5R
5×5 mm

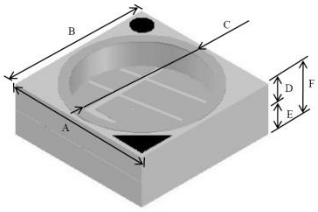




ITEM	Symbol	Rule
Basic Outline	A	5.0± 0.1mm
Basic Outline	B	5.0± 0.1mm
Cavity size	C	Max 4.2Φ
Top layer	D	Min 0.4mm
Bottom layer	E	Min 0.4mm
Thickness	F	Max 2mm
Angle	G	Customize

CS5-3M
5×5 mm





ITEM	Symbol	Rule
Basic Outline	A	5.0± 0.1mm
Basic Outline	B	5.0± 0.1mm
Cavity size	C	Max 4.2Φ
Top layer	D	Min 0.4mm
Bottom layer	E	Min 0.4mm
Thickness	F	Max 2mm

- 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.

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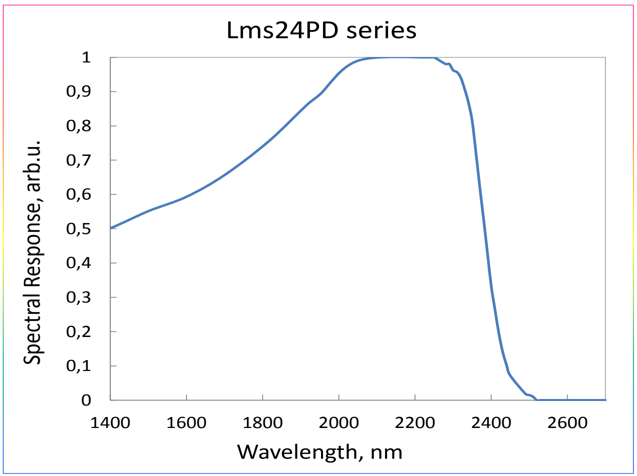
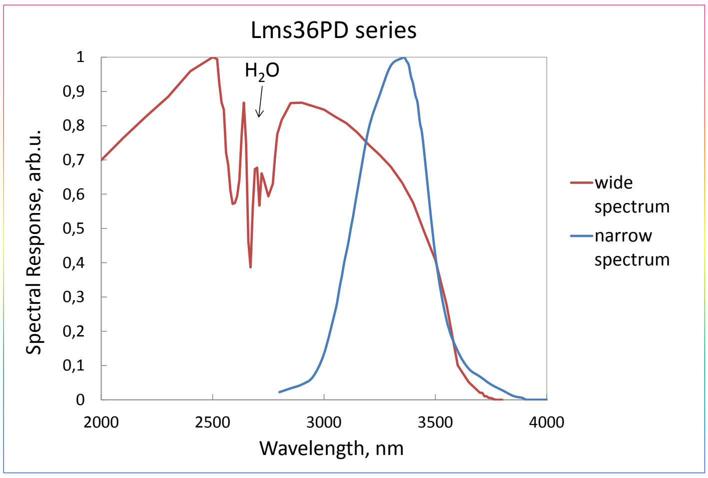
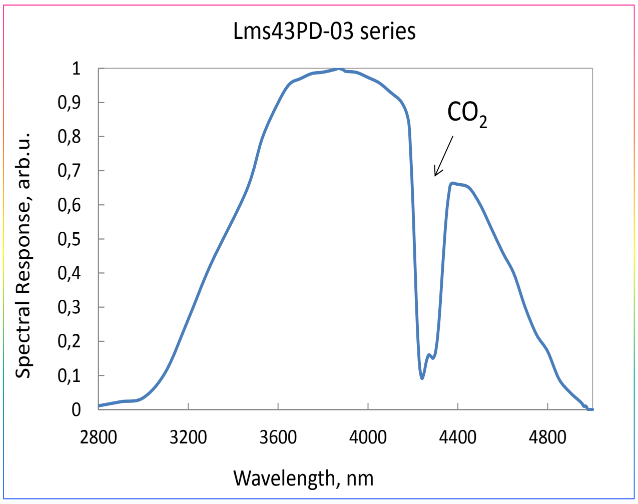
Currently, we offer the following photodiodes with cut-off wavelength at about 2.4, 3.6 and 4.6 µm:

Model	Sensitive area, mm	Peak sensitivity wavelength, nm	Cut-off wave length, µm	Dark current, mA		Resistance, kOhm (10 mV)		Capaci-tance, pF	Photo-sensitivity, A/W	Specific Detectivity, cm*Hz$^{1/2}$/W
				max	**typ**	min	**typ**	**typ**		
Lms24PD-03	0.3	1.85-2.30	2.40	0.1 (-1V)	**0.025 (-1V)**	3	**7**	**20**	0.7-1.0	(1-4)*10^{10}
Lms24PD-05	0.5	1.40-2.20	2.40	0.1 (-1V)	**0.04 (-1V)**	4	**5**	**340**	0.7-1.0	(2-5)*10^{10}
Lms36PD-03	0.3	2.40-3.40	3.60	0.75 (-0.1V)	**0.5 (-0.1V)**	0.1	**0.2**	**500**	0.8-1.0	(2-5)*10^{9}
Lms36PD-05	0.5	2.40-3.30	3.60	2 (-0.1V)	**1 (-0.1V)**	0.1	**0.16**	**800-900**	0.8-1.0	(3-6)*10^{9}
Lms43PD-03	0.3	3.60-4.10	4.60	10 (-0.1V)	**7 (-0.1V)**	0.01	**0.11**	**2000**	0.7-0.9	(5-8)*10^{8}

Typical Spectral Response







There are also the following photodiodes under development, which will be released soon:

Model	Sensitive area, mm	Spectral sensitivity range, nm
Line of standard photodiodes		
Lms43PD-05	0.5	3.50–4.30
Lms24PD-10	1.0	1.50–2.40
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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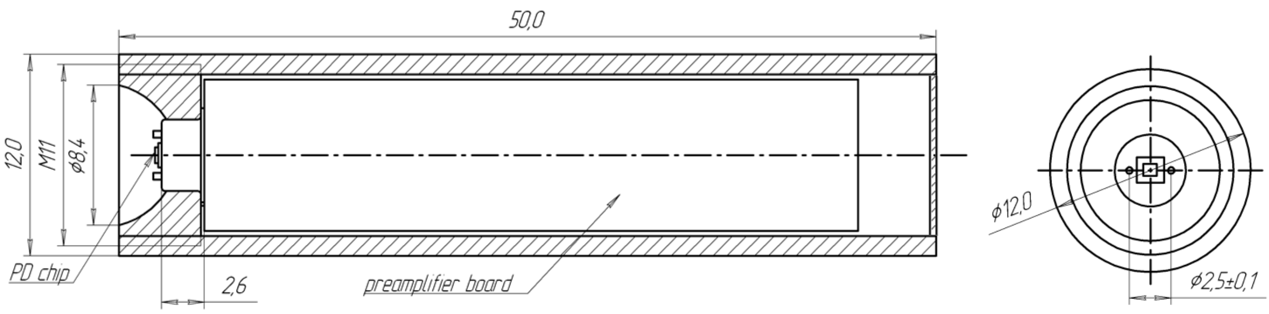
All the above mentioned PD models are available coupled with preamplifier (LmsXXPD-XX-PA):

Model
Lms24PD-03-PA
Lms24PD-05-PA
Lms36PD-03-PA
Lms36PD-05-PA
Lms43PD-03-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.



Photodiode models with LMSNT preamplifier (PAb type) are equipped with parabolic reflector without/with a glass window and packaged in an aluminum tube for protection and screening. Parabolic reflector protects PD device from damage and increases that part of the radiation that reaches 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-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. 32.

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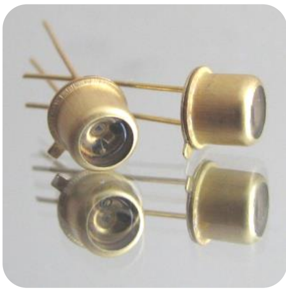
We offer a range of standard packages for PDs as follows:

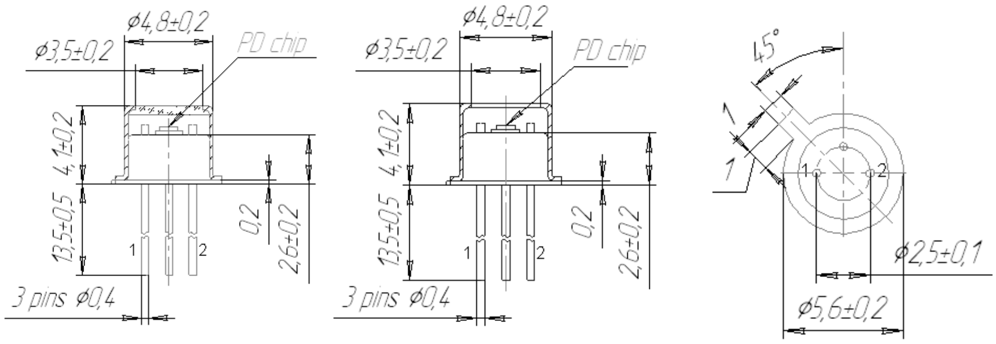
✓ TO-type packages:

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

TO18

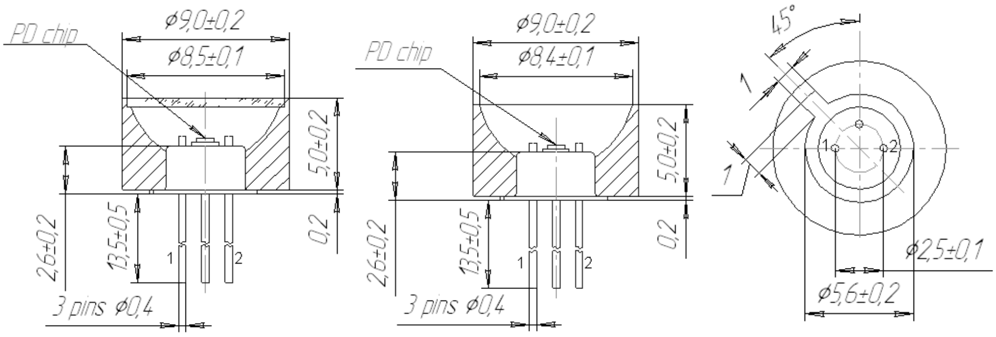


BOTTOM VIEW



TO18-R
TO18-RW

BOTTOM VIEW



- 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 increases that part of the radiation that reaches the sensitive area of the photodiode.

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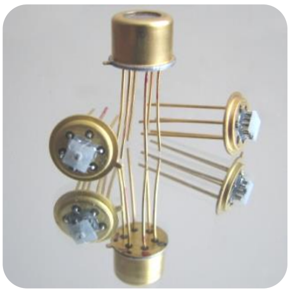
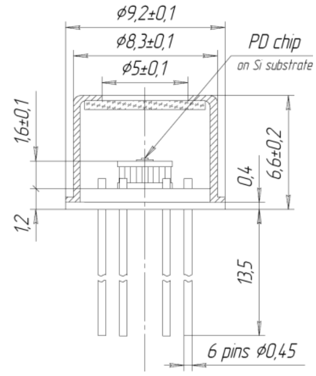
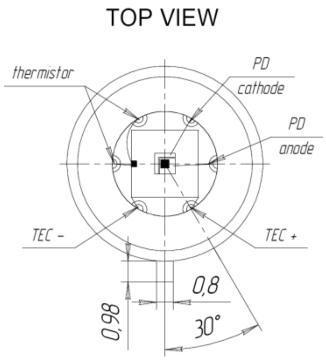
TO5 (TO39) – appropriate for mounting photodiode arrays, 1-element photodiodes and arrays with thermocooler.

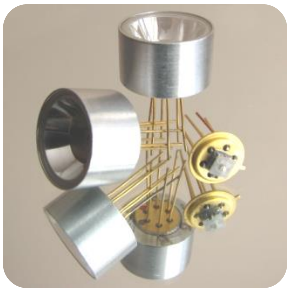
TO5-TEM

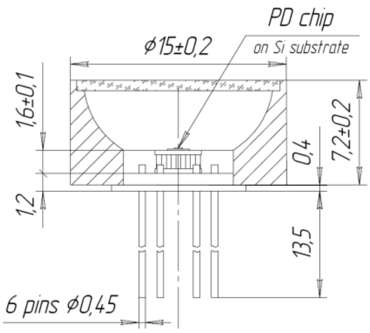


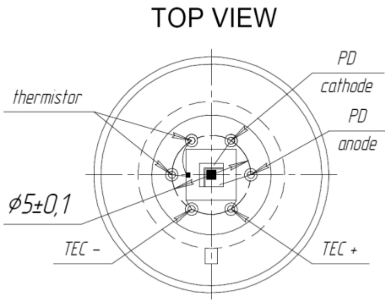




TO5-TEM-R





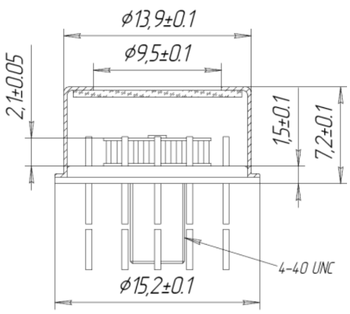


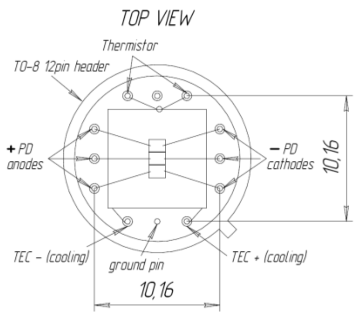
- Small packages with 3.2 × 3.2 mm^2 thermocooler surface open for mounting
- Header material – kovar, finish – gold/plating, thermocooler ceramic – Al_2O_3
- The number of lead pins is 6 or 9
- Built-in thermoelectric module (TEM) – thermocooler and thermoresistor – provides PD chip temperature adjusting 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 increases that part of the radiation that reaches the sensitive area of the photodiode.

TO8-TEM





- Compact packages with 8×8 mm^2 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.

You can select the appropriate driver and amplifier for your experiments using the following tables:

LED Drivers, LED Drivers with Temperature Controllers

LED \ Driver	D-41M	D-51M	DLT-27M*	DLT-37M*
Lms XX LED (-R; -RW)	D-41M	D-51M		
Lms XX LED-TEM (-R)			DLT-27M*	DLT-37M*

PD Preamplifiers, PD Amplifiers with Temperature Controllers

PD \ (Pre)Amplifier	Preamplifier PAb	Preamplifier PAb and SDM synchronous detector	AMT-07M*
Lms XX PD-XX-R (-RW)	Lms XX PD-XX(w)-PA (provides pulse voltage output signal)	Lms XX PD-XX(w)-PA and SDM (provide DC voltage output signal)	
Lms XX PD-XX-TEM (-R)			AMT-07M*

For more information regarding PDs with built-in preamplifiers Lms XX PD-XX(w)-PA series please refer to the Photodiodes section, p. 22.

***These models will be replaced with newer unpackaged device versions soon.**

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

LED driver D-41 	D-41 Driver provides **Pulse mode** operation. Using this mode it is possible to choose one of five current values (0.2, 0.6, 1.0, 1.5 and 1.9 A), select one of four frequencies (0.5, 2, 8 and 16 kHz) and choose pulse duration within four values (2, 5, 10 and 20 µs).
LED driver D-51 	D-51 Driver has the same characteristics as D-41 but also has another important feature: ✓ **Temperature control** – possibility to observe 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.
LED Driver with a temperature controller DLT-27M* 	Driver DLT-27M* is oriented for operating with all Lms MIR LED models with built-in thermocoolers. Driver provides two operation modes: ✓ **Quasi Continuous Wave mode.** Using this mode it is possible to adjust the current in the range 25-250 mA. Modulation frequency is 16 kHz. ✓ **Pulse mode.** Peak current in pulse mode can be changed in the range 0-2 A. Pulse duration is 1 µs. Temperature controller built into the DLT-27M* provides the selection and stabilization of the LED chip temperature over a wide range.
LED Driver with a temperature controller DLT-37M* 	Driver DLT-37M* is oriented for operating with all Lms MIR LED models with built-in thermocoolers. Driver provides two operation modes: ✓ **Quasi Continuous Wave mode.** Using this mode it is possible to change the current in the range 20-250 mA. One of four frequencies (2, 4, 8 and 16 kHz) can be selected. ✓ **Pulse mode.** In addition to frequency adjustment, pulse duration can be selected in the range 0.6-20 µs. Peak current in pulse mode can be changed in the range 0-2 A. Pulse duration is 1 µs. Temperature controller built into the DLT-37M provides the selection and stabilsation of the LED chip temperature over a wide range.

***These models will be replaced with newer unpackaged device versions soon.**

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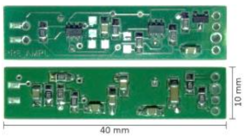
For photodiode signal processing we offer several solutions:

Photodiode with built-in preamplifier (PAb) – NEW Lms XX PD-XX(w)-PA series



PAb preamplifier board

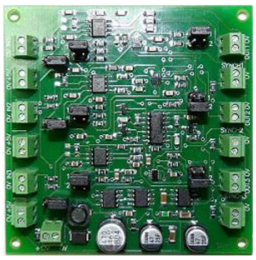

Photodiode with a built-in preamplifier

Preamplifier converts the output current of a photodiode into a pulse voltage signal with amplification.

The signal converted by preamplifier has the same form, frequency and pulse duration as the photocurrent signal from photodiode. For more information regarding PDs with built-in preamplifiers Lms XX PD-XX(w)-PA series please refer to the Photodiodes section, p. 22.

For further conversion of a signal from PD preamplifier and obtaining DC voltage signal we have developed the SDM synchronous detector.

NEW SDM Synchronous Detector



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.

Amplifier for Photodiodes with built-in thermocooler AMT-07M*

Amplifier AMT-07M* converts the output current of a signal source (such as mid-Infrared photodiode) into a voltage with amplification for subsequent use with various electronic systems, such as lock-in amplifiers, oscilloscopes or A/D converters. Synchronous detector is built into the same package and gives direct current proportional to signal at selected frequency. Signal value is viewed on LCD Display.

Amplifier AMT-07M* is oriented for operation with photodiodes with built-in thermocooler and thermistor (LmsXXPD-TEM(-R) models). Customers can select and set PD operation temperature. Circuit with feedback will set the appropriate thermocooler current for maintaining the selected temperature.

***This model will be replaced with newer unpackaged device versions soon.**

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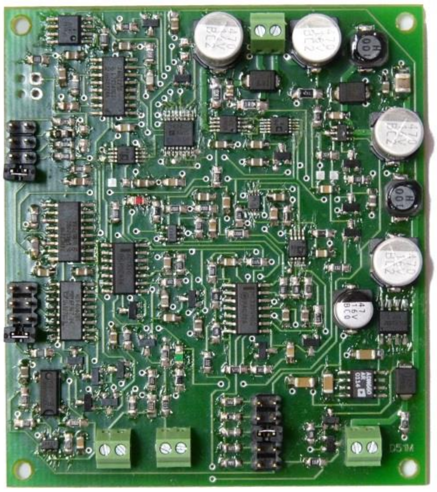
APPLICATION

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

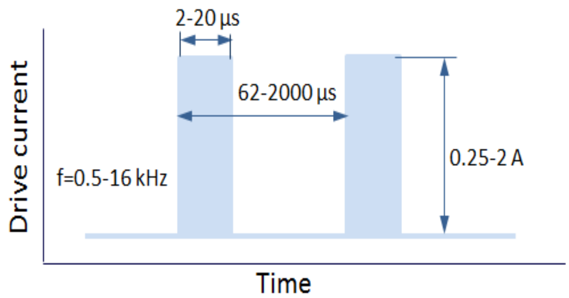


FEATURES

- 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.
- 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

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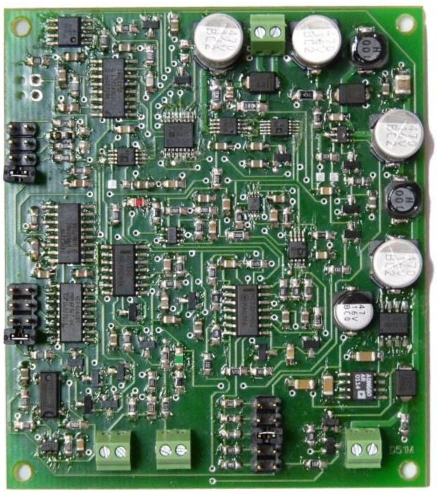
APPLICATION

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

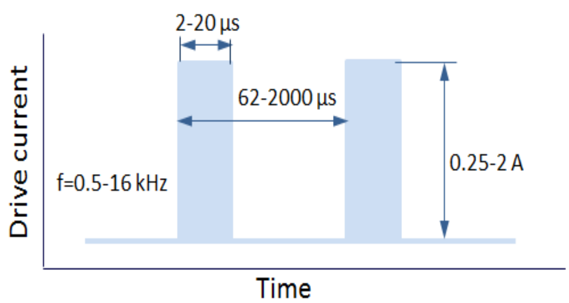
FEATURES



- 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 observe 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

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APPLICATION

DLT-37M driver is designed for power supply of all Lms MIR LED models with built-in cooler.

FEATURES

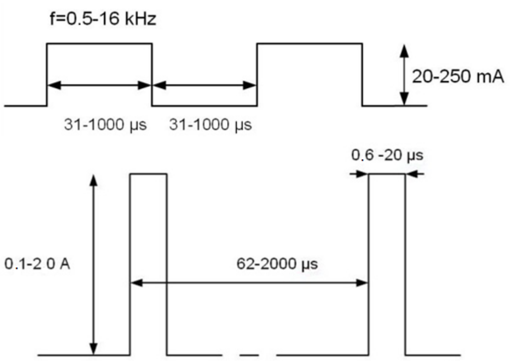
- DLT-37M driver provides two modes of operation:

Quasi Continuous Wave mode (the mode of *maximum average optical power* of an LED) and pulse mode (the mode of *maximum peak optical power* of an LED).

- Temperature controller that is built into the DLT-37 provides selection and stabilisation of temperature on the LED's chip over a wide range. This gives the possibility of stabilising and tuning the wavelength or optical power of the LED.
- Possibility to tune the LED current amplitude, repetition rate and pulse duration to select the optimal mode of the LED.
- Capability to synchronise with a selective amplifier or with any other device.
- Easy to use and durable.

TECHNICAL CHARACTERISTICS

CURRENT WAVEFORM GENERATED BY THE DRIVER IN QCW AND PULSE MODES



Parameters	Value
Input voltage	Stabilised +12 V
Voltage tolerance	-5 to +5 %
Power consumption	< 4 W
Adjustment temperature range	-10 °C to +25 °C
Board dimensions	145 × 70 × 30 mm
Weight	200 g

Signal data	QCW mode	Pulse mode
Pulse duration	31 – 1000 µs	0.6 – 20 µs
Repetition rate	0.5 – 16 kHz	0.5 – 16 kHz
Output current amplitude	20 – 250 mA	0.1- 2.0 A

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APPLICATION

The amplifier AMT-07M is designed for amplification of signal from Lms MIR Photodiode with built-in cooler.

FEATURES

- Possibility of discrete change of current amplification to raise the measurement accuracy.
- The presence of analogue output for external device connection and LCD-display for signal level indication.
- The intrinsic function for background level compensation.
- Temperature controller that is built into the AMT-07M provides selection and stabilization of the temperature of the LED's chip over a wide range. This gives the possibility of tuning and stabilising the photodiode spectral characteristics.

TECHNICAL CHARACTERISTIC

Parameters	Value
Input voltage	Stabilised +12 V
Voltage tolerance	-5 to +5 %
Power consumption	< 3 W
Adjustment temperature range	-15 °C to +15°C
Board dimensions	148 × 78 × 30 mm
Maximal amplification	6.4×10^6 V/A
Maximal amplitude of output voltage	|± 4 V|
Output resistance	50 Ohm
Transmission band with PD24	0.5 kHz – 20 kHz
Transmission band with PD25	0.5 kHz – 1 MHz

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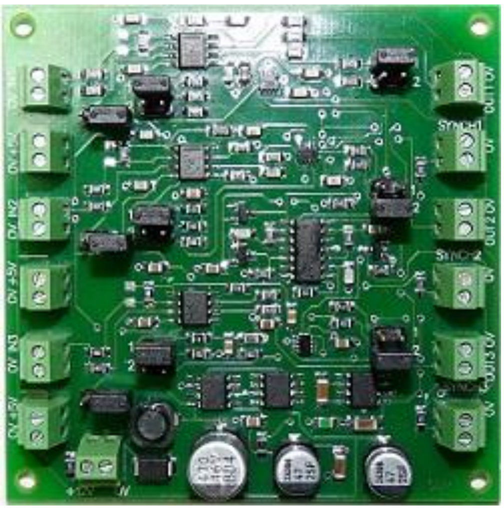
NEW SDM Synchronous Detector

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 μs
Voltage tolerance	1x, 5x and 10x

Signal data	Pulse mode
Pulse duration	2–20 μs
Repetition rate	0.5–16 kHz
Output current amplitude	0.4–2.0 A

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 new line of devices includes evaluation systems for CO_2 and CH_4 (CDS-3 and MDS-3) for precise experiments with gases, evaluation kits that offer high flexibility and miniature on-board evaluation systems for CO_2 and CH_4 (CDS-4 and MDS-4, coming soon).

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

Standard packaging arrangement:

- a light-emitting diode with a driver
- a photodiode with a preamplifier
- a synchronous detector
- an optical chamber

NEW CDS-3 CO_2 Evaluation System   Optical cell	CDS-3 is an evaluation system for CO_2 detection. It includes a mid-infrared light emitting diode Lms43LED with LED driver, photodiode Lms43PD-03 with preamplifier and synchronous detector. CDS-3 has a three-pass gas chamber. It is a turnkey device which allows detecting presence of carbon dioxide in gas flow with precision.
NEW MDS-3 CH_4 Evaluation System   Optical cell	MDS-3 is an evaluation system for CH4 detection. It includes a mid-infrared light emitting diode Lms34LED with LED driver, photodiode Lms36PD-03 with preamplifier and synchronous detector. MDS-3 has a three-pass gas chamber. It is a turnkey device which allows detecting presence of methane in gas flow with precision.
NEW Evaluation Kits	The possibility to change LED and/or PD easily in evaluation kits makes them a flexible and utility solution.
Coming Soon CDS-4/MDS-4 On-Board Evaluation Systems	This is a low-cost system with a compact "on-board" design that includes a very compact optical cell and electronics for LED power supply and PD signal amplification.

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