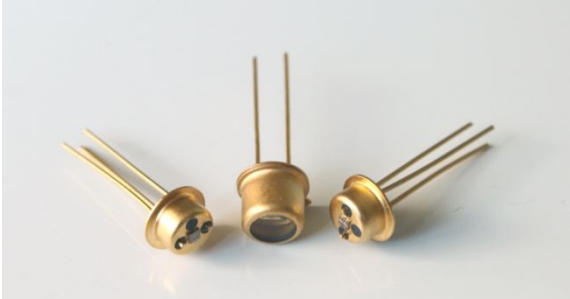
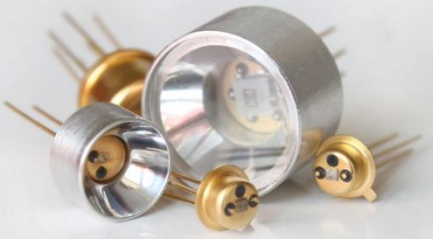
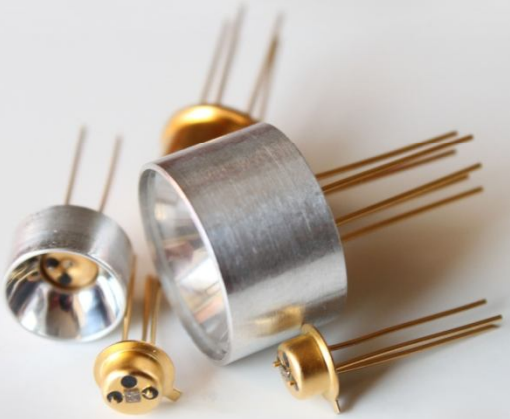
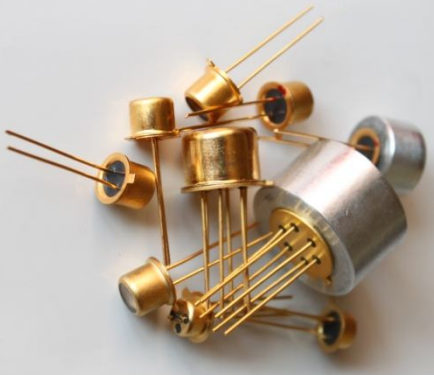
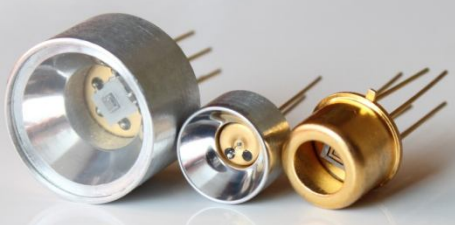
LED
Microsensor NT

Light Emitting Diodes
Photodiodes
Electronics

1600 – 5000 nm



CONTENTS

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

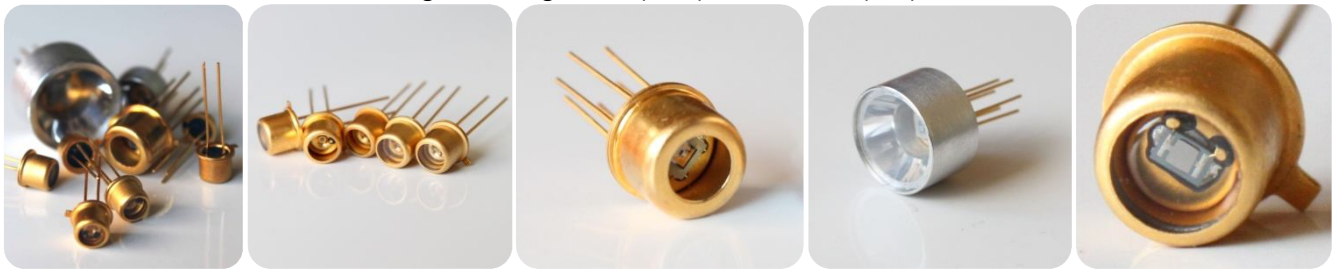
The company has a professional team of leading Russian scientists with more than 15 years experience in research and development of heterostructures for mid-infrared spectral range, design of optoelectronic devices, customers guide and support.

In Nov 2011 Rusnano Corporation has 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, surfaces can all be examined with a proper choice of sampling technique. Using LED-PD optopairs for mid-infrared spectral range allows developing 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

D-31M

DLT-27M

DLT-37M

PD Amplifiers

AM-07M

AMT-07M

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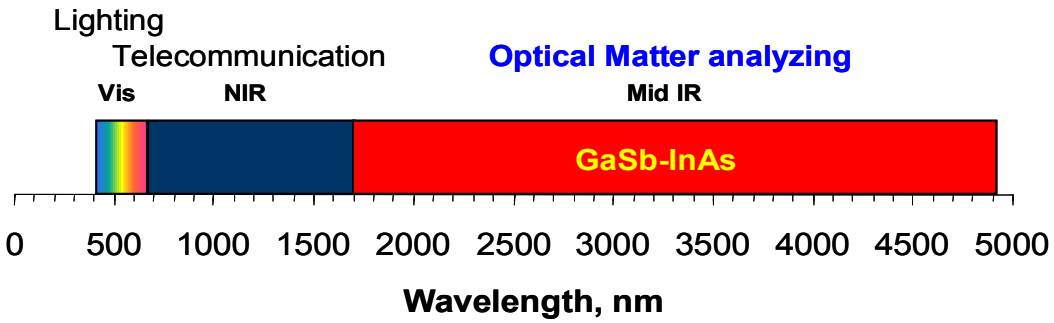
Light emitting diodes (LEDs) and Photodiodes (PDs) are the semiconductor devices. LED or PD heterostructure is formed by sequential epitaxy of semiconductor layers on the surface of a crystal substrate. LED radiation is generated in the active layer and the emission wavelength of the LED as well as the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

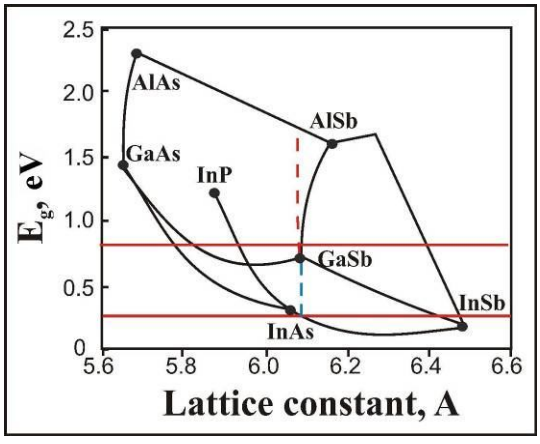
The first laser heterostructures in the world were grown at the end of 1960th in the Ioffe Physical Technical Institute by Nobel prize laureate Zhores Alferov.



Nowadays, semiconductor optoelectronic devices for near-infrared and visible spectral range are widely used in telecommunications and lighting. Besides, LEDs and PDs possess great potential of using in optical analyzing systems. In the Middle Infrared spectral range 1600-5000 nm there are strong absorption bands of 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, OCS, HCl, HOCl, HBr, H_2S, HCN, NH_3, NO_2, SO_2 , glucose and many others.

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

Semiconductor wafer
(LED 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):

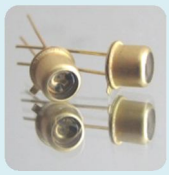
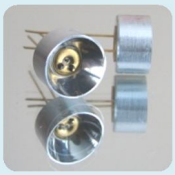
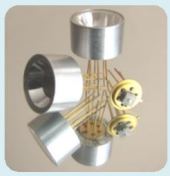
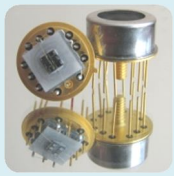
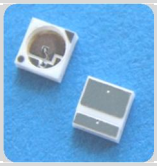
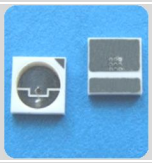
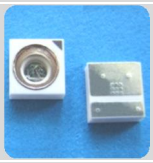
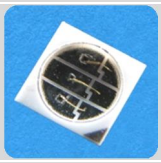
1.60-1.69	1.70-1.79	1.80-1.89	1.90-1.99	2.00-2.09	2.10-2.19	2.20-2.29	2.30-2.39
Lms16LED-FC	Lms17LED-FC	Lms18LED-FC	Lms19LED-FC	Lms20LED-FC	Lms21LED-FC	Lms22LED-FC	Lms23LED-FC

- A line of wide band PDs with cut-off at wavelengths (μm):

2.4	3.6	4.3
Lms24PD-03	Lms36PD-03	PR43
Photodiodes		Photoresistor

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

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

✓ LED driver D-31M – provides LED operation in QCW and pulse modes at several frequencies and variable pulse durations and currents;

✓ LED driver DLT-27 – provides operation and temperature stabilization 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 stabilization of an LED with a built-in thermocooler in QCW and pulse modes at several frequencies, variable pulse durations and currents;

✓ PD Amplifier AM-07 – converts the output current signal of a PD into a voltage output with amplification;

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

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We propose our optoelectronic devices for 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, fibers, 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 alike chemically 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 carbone dioxide, carbone oxide, exhaust gases in the atmosphere
- Control of methane, propane leakage
- Control of hydrocarbons in water

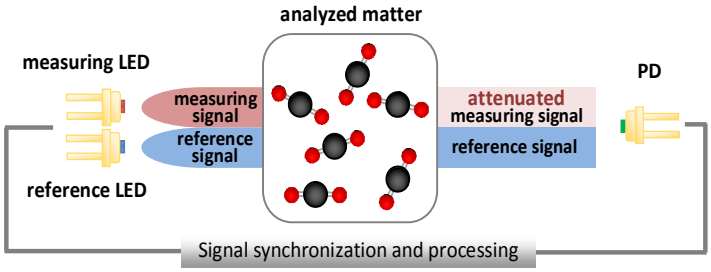
Food industry and agriculture, examples:

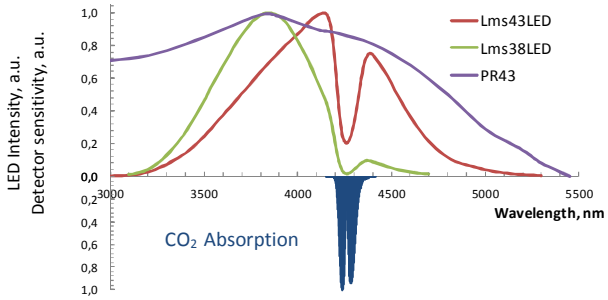
- Control of water, fiber, protein concentration in grains, humidity control of coffe beans, corn
- Control of fat and protein in milk
- Analysis of ethanol content in wine

Most of 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 mid-infrared spectral range allow developing 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 analyzed.





Principle scheme for chemical agents sensing based on LED-PD optopair is quite simple. Measuring LED emits radiation at wavelength corresponding to the maximum absorption of the analyte. Reference LED emits at wavelength that is not absorbed by the analyte. 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 of many chemical agents at mid-infrared spectral range that allow 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, so that different path lengths should be provided to obtain adequate absorption in the required sensitivity range. Small measuring cell can be an advantage, notably when rapid response is needed (such as in medical applications).

CH_4 1.65;2.30 μm; 3.2÷3.45 μm	CO_2 2.00; 2.65 μm; 4.2÷4.3 μm	H_2O 2.65÷2.85 μm; 1.86÷1.94 μm	N_2 4.0÷4.54 μm
C_2H_2 2.99÷3.09 μm	$HOCl$ 2.6÷2.9 μm	HCl 3.33÷3.7 μm	NH_3 2.27; 2.94 μm
C_2H_4 3.1÷3.4 μm	HBr 3.7÷4.0 μm	OH 2.38÷2.63 μm	$NO+$ 4.08÷4.44 μm
C_2H_6 3.3 μm	HI 2.27÷2.3 μm	H_2CO 3.38÷3.7 μm	HNO_3 5.74÷5.98 μm
CH_3Cl 3.22÷3.38 μm	H_2S 3.7÷4.4 μm; 2.5÷2.8 μm	CO 2.24 μm; 4.4÷4.8 μm	NO_2 3.4 μm
OCS 3.45; 4.87 μm	HCN 2.94÷3.1 μm	HO_2 2.73÷3.1 μm	SO_2 4.0 μm
C_6H_6 2.44÷2.47 μm; 3.17÷3.33 μm	$CHBr_3$ 2.39 μm; 3.29 μm	$C_2H_4Cl_2$ 3.23÷3.51 μm	$C_2H_2Cl_2$ 2.50÷2.86 μm
C_2HCl_3 3.22÷3.25 μm; 4.20÷4.35 μm	H_2O_2 3.70÷3.85 μm; 4.17÷4.35 μm	HF 2.33÷2.78 μm; 4.17÷4.43 μm	C_3H_8 3.28÷3.57 μm

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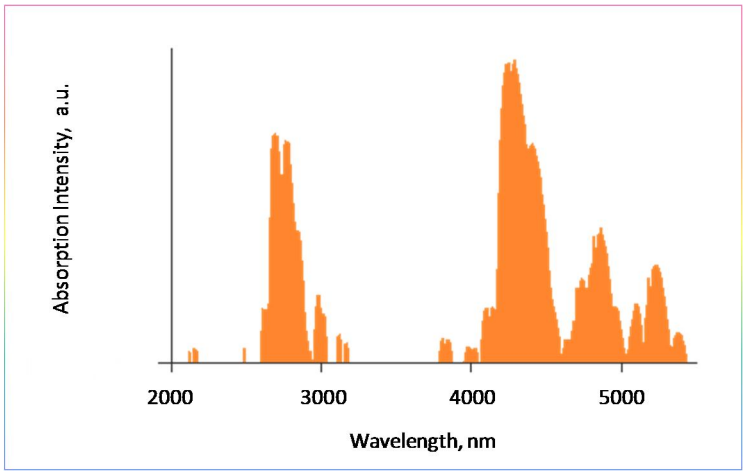
Carbon Dioxide Absorption Spectrum



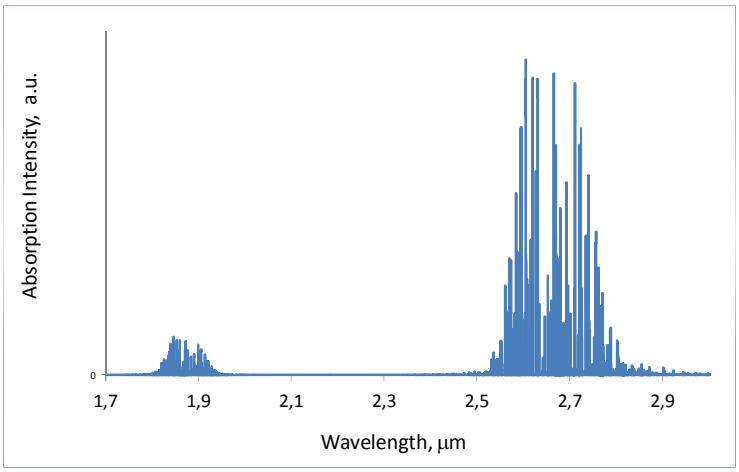
Carbon Dioxide has strong absorption band at 4200-4320 nm spectral range and weaker bands around 2700 nm and 2000 nm (the data are taken from HITRAN Catalog).

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

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

Detection around 2700 nm is complicated due to strong water absorption at the same range.

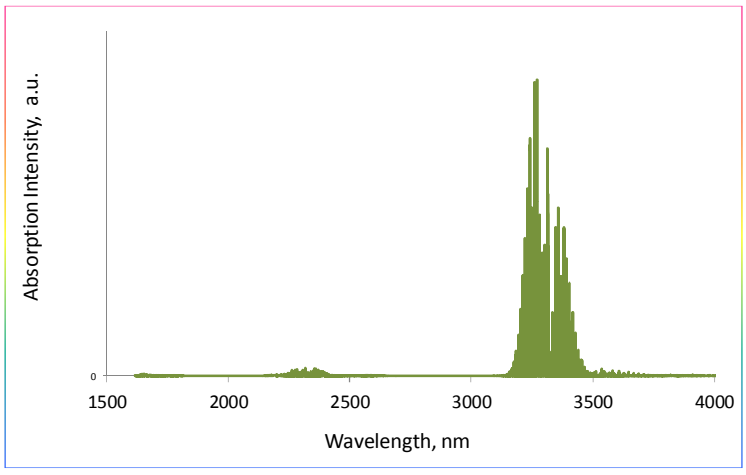
Water Absorption Spectrum



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 and Lms16LED-FC as a reference to detect water in the range 1830-1900 nm.

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 Catalog).

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

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

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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 present infrared offerings but have disadvantages in selectivity, fail-to safety, etc. There is a growing trend towards infrared technology.

Present infrared absorption technology utilizes several types of emission sources:

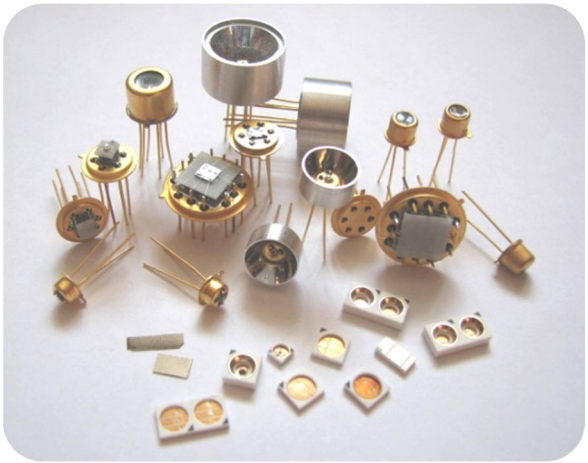
- broad-band light sources – filament black body emitters, planar filaments in thin technology – used together with crude and simple optics such as light pipes followed by filters, provide low modulation range (~8 Hz), less suitable for miniaturized sensing devices, low-cost;

- narrow-band sources – laser sources – lead-salt lasers (PbSnSe. PbSSe material systems) with wavelengths up to 14 μm and peak power in the Watt range in continuous wave (CW) mode, require 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 enable detection with very high resolution, distinguishing different absorption lines, but require accurate frequent tuning of the laser wavelength and precise temperature stabilization, have high cost.

For many applications there is no need to distinguish each absorption line and group of lines (bands) can be used. Detection of the 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 open completely new possibilities for portable sensors creation. Using Mid-infrared LED-PD optopairs allows developing an instrument that is smaller, less expensive, and versatile in functionality.

New mid-infrared LEDs possess certain competitive advantages:

- Compact size of the LED chip – 0.35x0.35 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 80 000 hours



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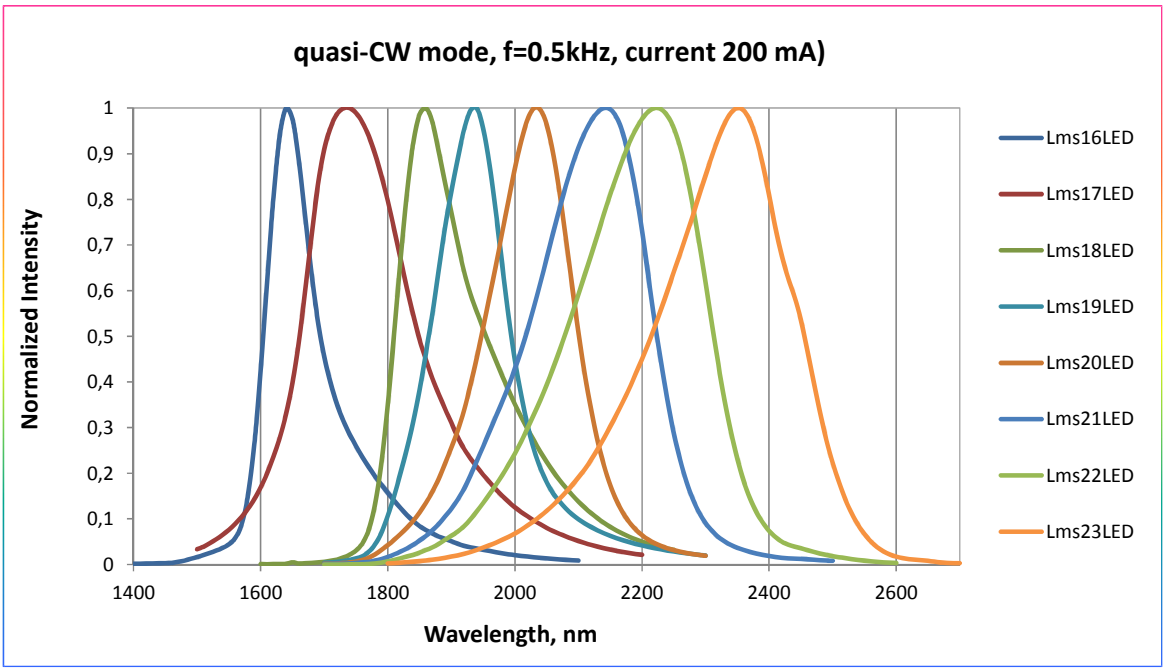
The main techniques that we use for heterostructure growth are Metal-Organic Chemical Vapor Deposition (MOCVD) and liquid-phase epitaxy (LPE). LEDs for 1.6-2.4 μm spectral range were fabricated from narrow band-gap GaInAsSb/AlGaAsSb-based heterostructures lattice matched to GaSb substrate.

Light Emitting Diodes for 1.6-2.4 μm spectral range



Model	Peak emission wavelength, nm		FWHM of the emission band, nm		Power, mW				Voltage*, V	Maximum operating current, mA		Switching time, ns	Operating temperature range, °C
					QCW mode*		Pulse mode**						
	min	max	min	max	min	max	min	max		QCW mode	Pulse mode		
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…+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	30	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	0.5-2.5				
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		10-30	-200…+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	1000		
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	0.6-2.8				
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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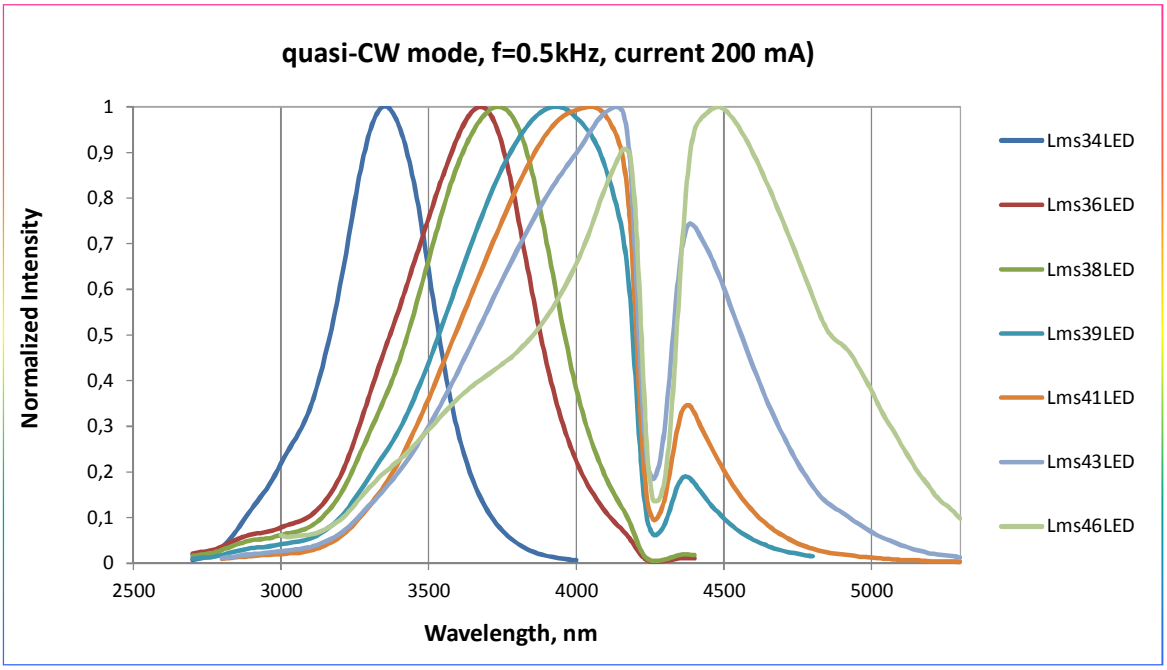
Narrow band-gap InAsSb/InAsSbP-based heterostructures lattice matched to InAs substrate were used to create LEDs for 3.3-4.6 μm spectral range.

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**						
	min	max	min	max	min	max	min	max		QCW mode	Pulse mode		
Lms34LED	3.30	3.49	400	600	25	45	320	480	0.2-0.5	250	2000	10-30	-200…+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	800	1100	4	8	120	160	1.6-2.6				

* 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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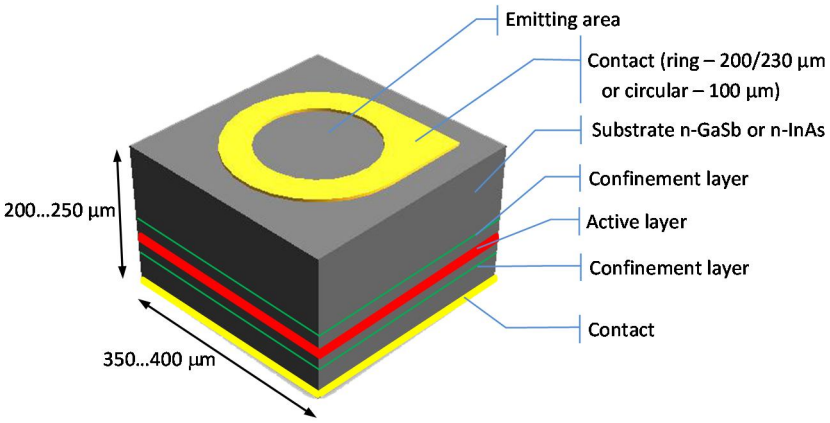
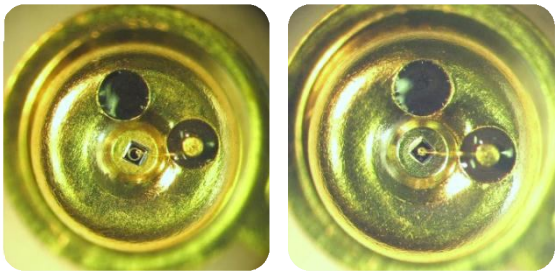
Standard Mid Infrared LED chip



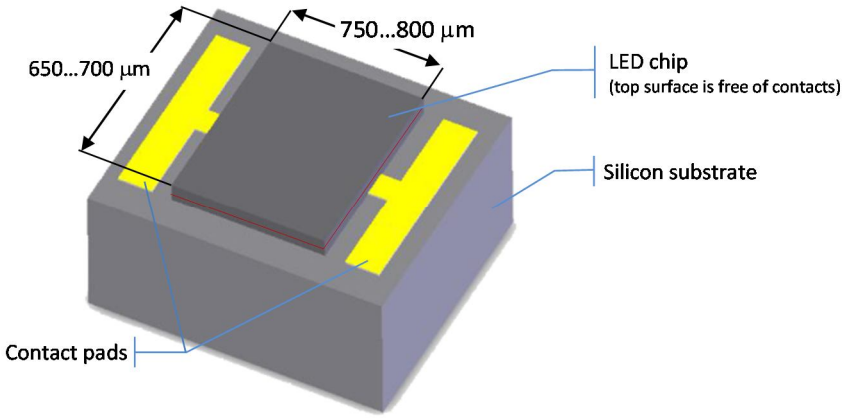


This shape of the LED chip is typical for most of LED Microsensor NT standard LED models (Lms XX LED series).

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 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 are not hindering the 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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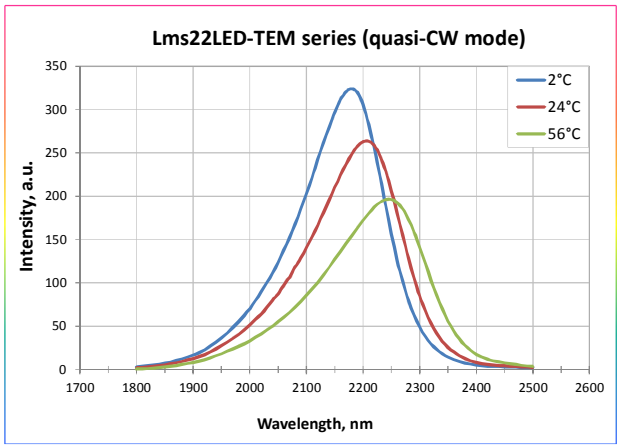
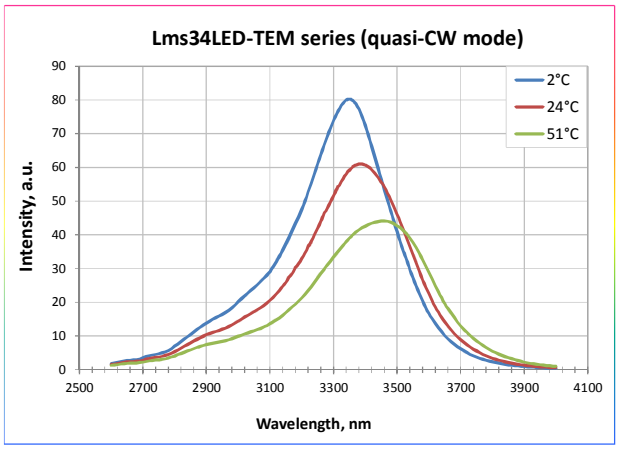
Temperature Dependences of Optical Characteristics

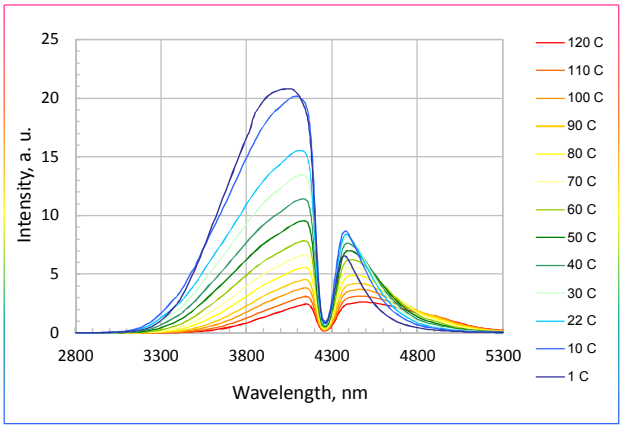
It is typical for all semiconductor radiation sources to have intensity decreasing with temperature increase. This decrease of the emission intensity is related with several temperature-dependent factors, including non-radiative recombination via deep levels, surface recombination, and carrier loss over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

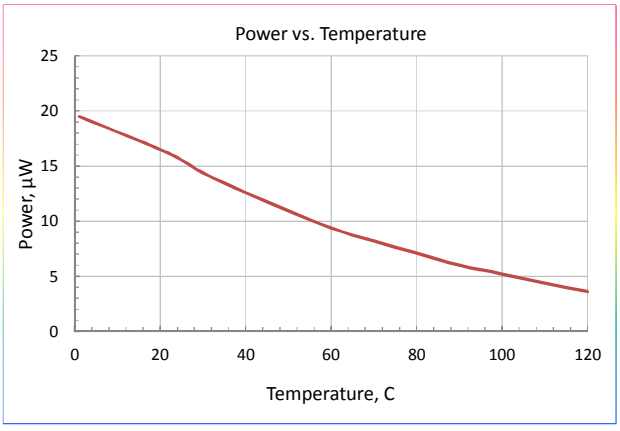
Mounting of an LED chip into a package with a thermoelectric module (Peltier element) enables stabilization the temperature of an LED chip, providing wavelength tuning in a certain wavelength range.





Our LEDs can operate in a wide temperature range, so that 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 possibility for different operation modes. Optical parameters of light emitting diodes strongly depend on the operation 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 certain frequency and allow obtaining higher output intensity than in case of using hard CW (continuous wave) mode. Therefore hard CW is not recommended. To obtain the maximum peak power we recommend using short pulse modes (less than 50 ms)

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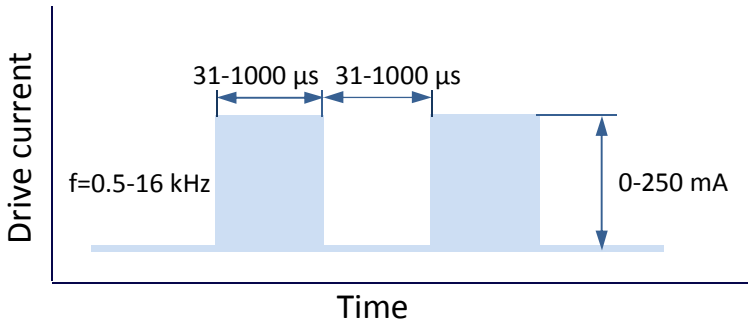
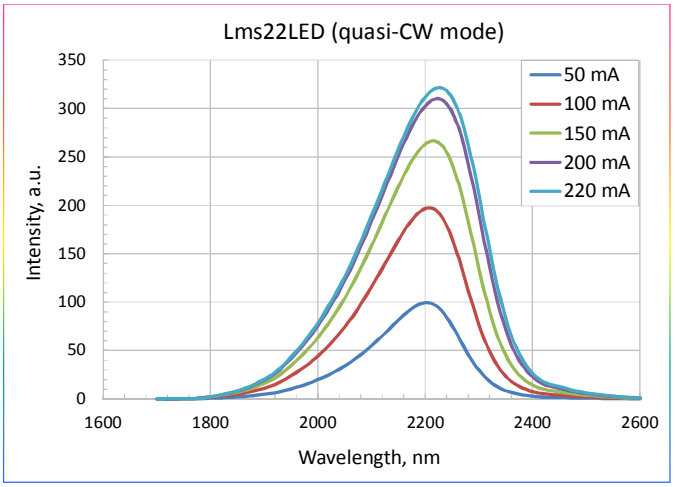
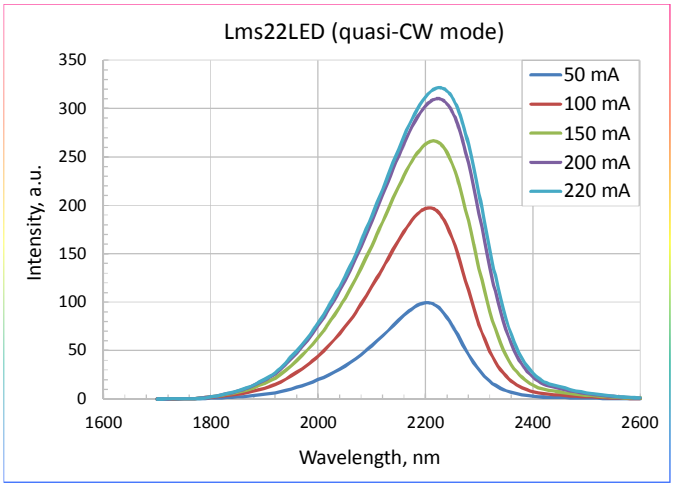
QUASI-CONTINUOUS WAVE (QUASI-CW) MODE:

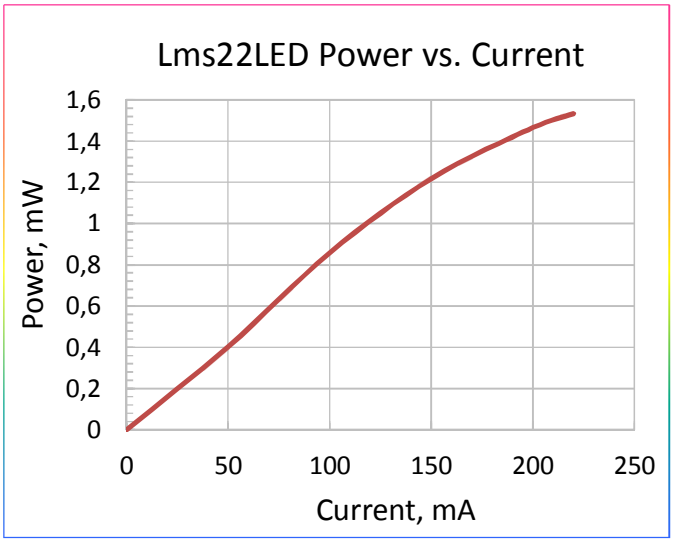


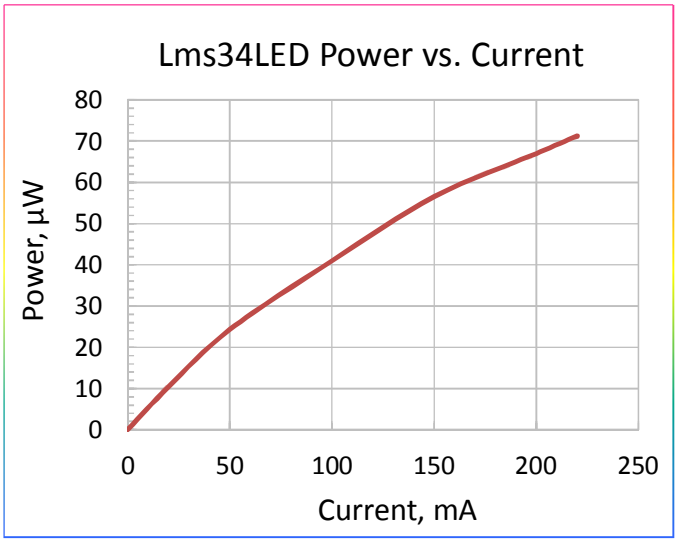
Spectra at different currents in the quasi-CW mode (frequency 0.5 kHz, duty cycle 50%):





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





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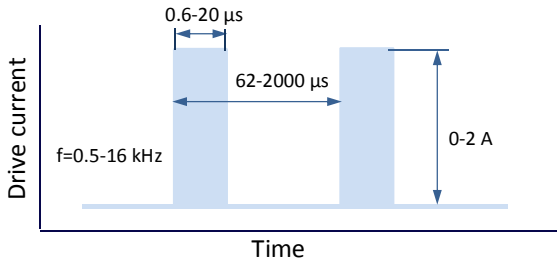
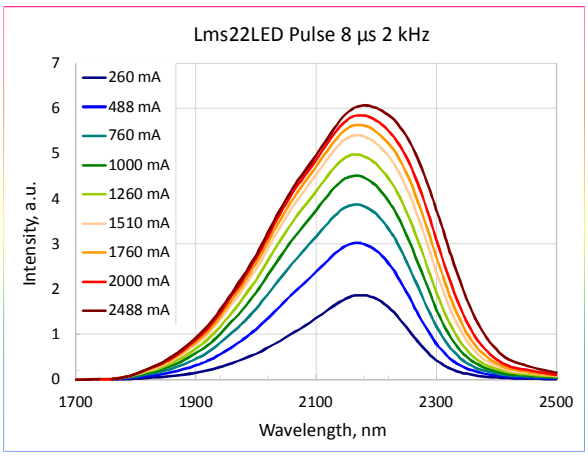
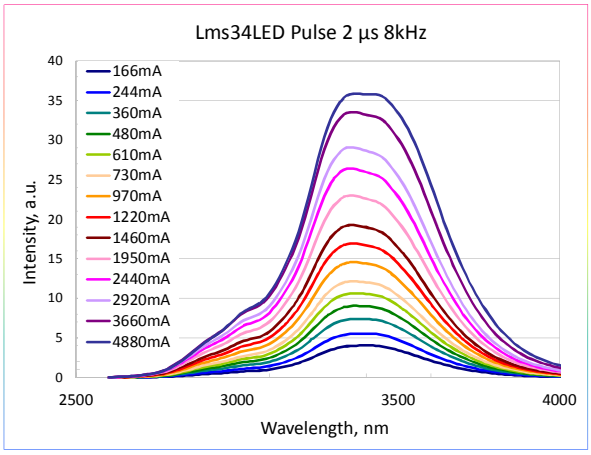
PULSE MODE:

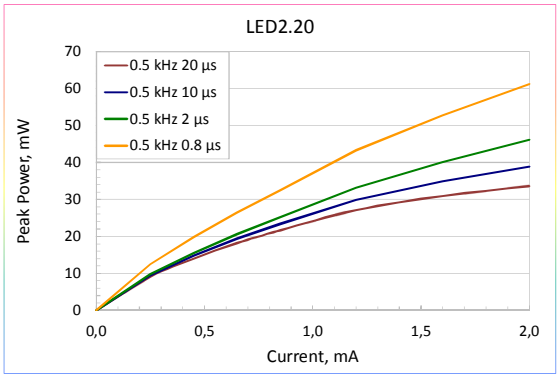


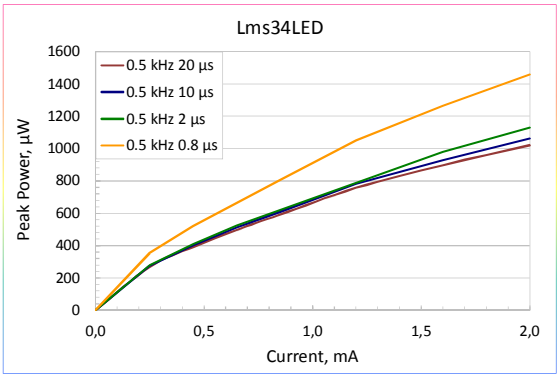
Spectra at different currents in the pulse mode:



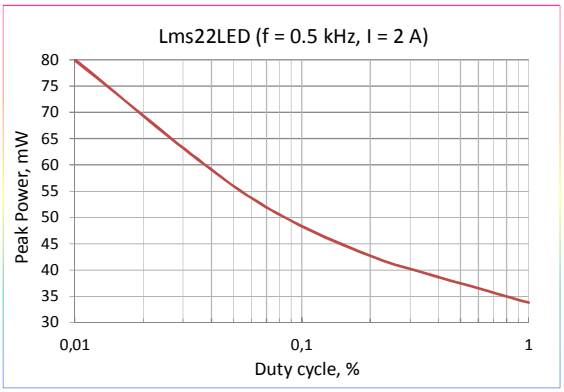


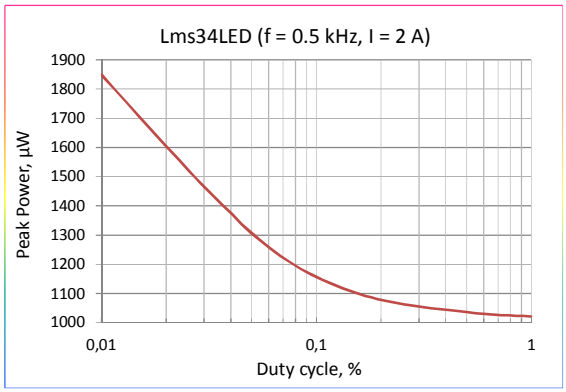
Power dependence on the drive current in the pulse mode:





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





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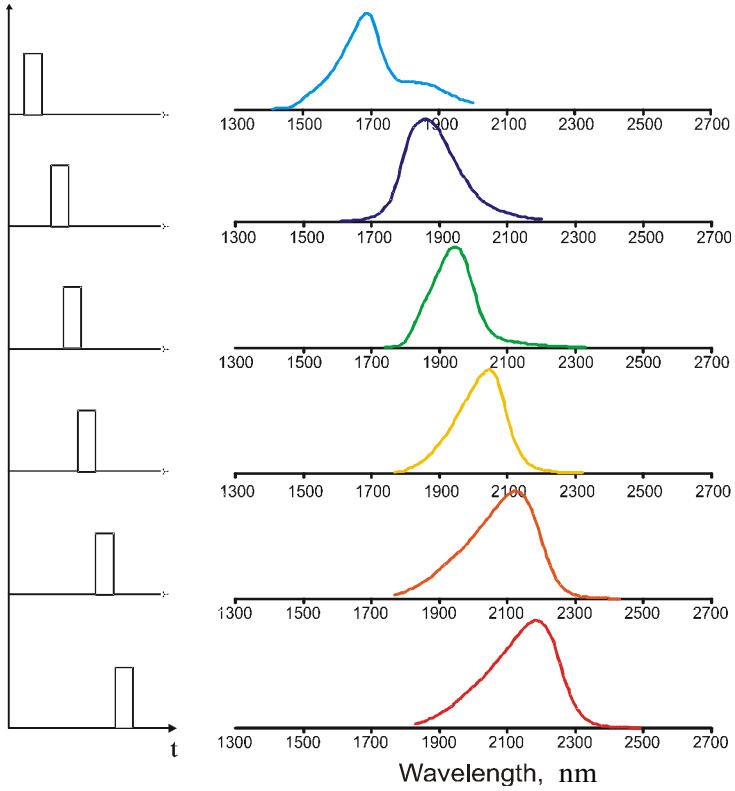
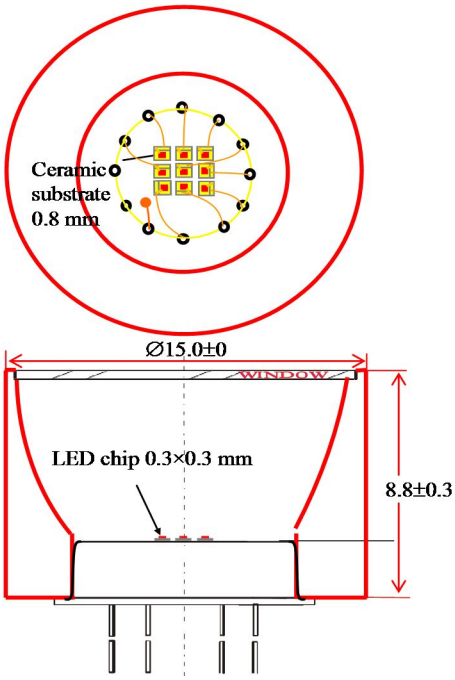
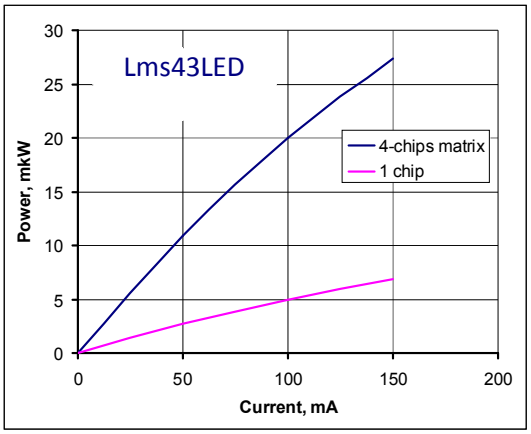
Tiny size of an LED chip (0.35×0.35 mm), narrow-band emission spectrum, short response time and low thermal flux enables creating very compact multielement LED arrays and LED matrices emitting at one or different wavelengths.

LED matrix is a kind of arrangement of similar or different LED-chips mounted in a single compact package and driven together or independently. Such kind of emitter is a powerful radiation source for portable optical analyzing systems. Connecting LED chips emitting 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 emitting at the same wavelength and driving them together can provide significant increase of total optical power.



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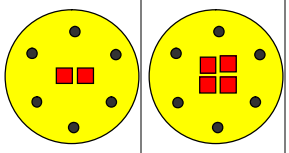
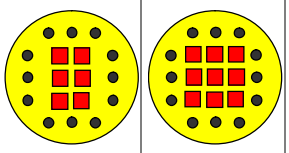
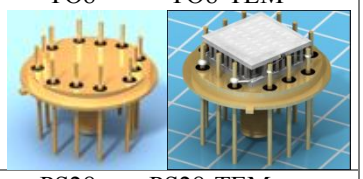
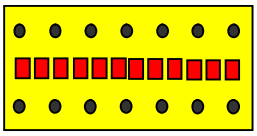
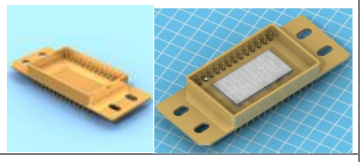
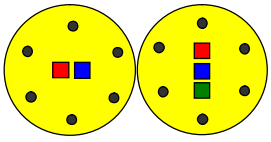
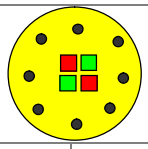
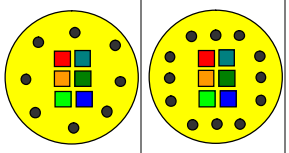
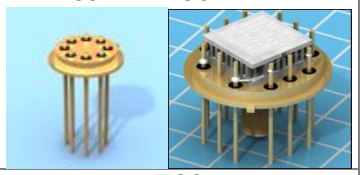
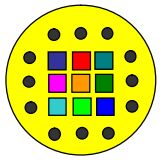
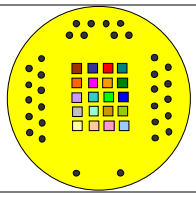
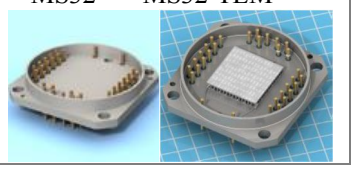
The number of array or matrix elements depends on the application and the chosen package type being chosen. Standard TO-type packages offered by RMT Ltd. can be used. Packages with built-in thermoelectric modules (Peltier elements) provide temperature stabilization of LED-chip parameters. Use of these packages allows creating different variations of LED arrays and matrices arrangements. Some of them 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 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/without thermoelectric module		TO8 TO8-TEM 
✓ LmsXXLED-12A(-TEM): 12 LED elements on ceramic substrate emitting at one wavelength mounted on a single PS28 package with/without thermoelectric module. This solution is appropriate for the spatial distribution analysis of the analyte		PS28 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 thermoelectric module		TO5 TO5-TEM 
✓ LmsXX&YYLED-4M(-TEM) 4 LED elements on ceramic substrate mounted on a single 9 mm package with/without 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 thermoelectric module or on a single 15 mm package with thermoelectric module		TO5 TO8-TEM 
✓ LmsXX÷YYLED-9M 9 LED elements on ceramic substrate emitting at 9 different wavelengths mounted on a single 15 mm package without 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/without thermoelectric module		MS32 MS32-TEM 

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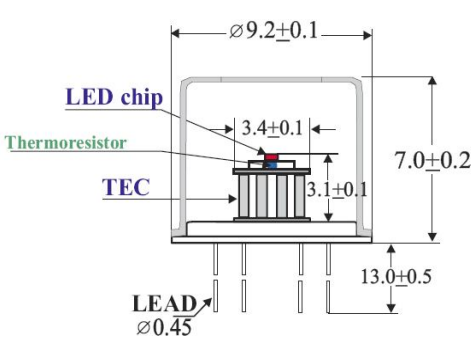
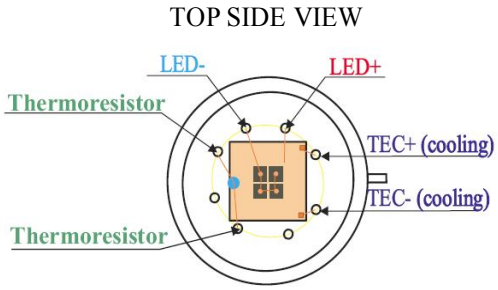
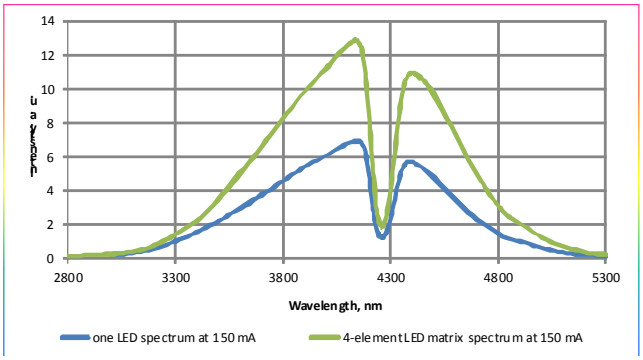
Two possible matrix arrangements are presented below in detail:

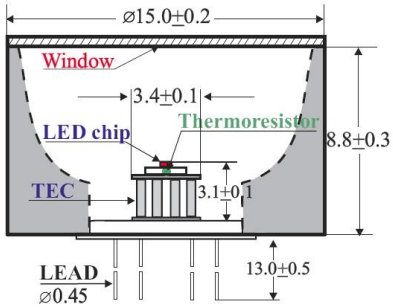
✓ 4-element LmsLED matrix with one peak wavelength at 4.14 µm in 9 mm TO5 package with a built-in thermoelectric module and a cap with a sapphire window

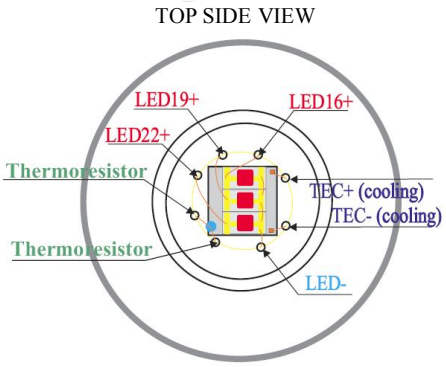


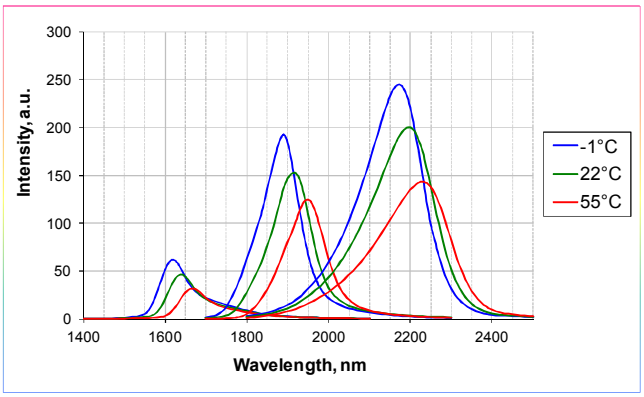




✓ 3-element LED matrix with peak wavelengths at 1.6, 1.9, 2.2 µm in 9 mm TO5 package with a built-in thermoelectric module and a parabolic reflector with a quartz window







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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. 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

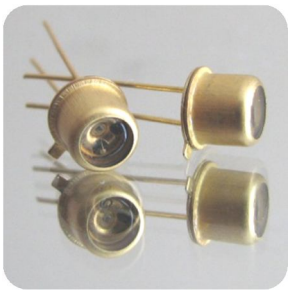
TO8 – appropriate for mounting multi-element LED-matrices

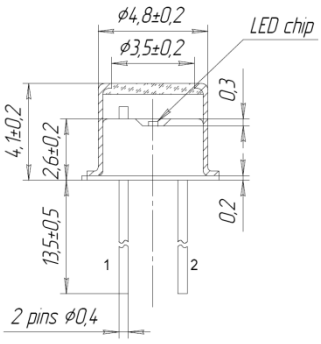
✓ SMD type packages:

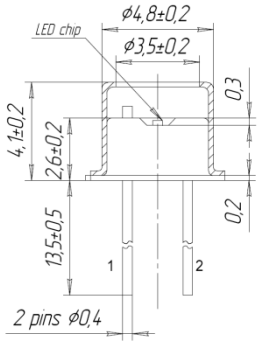
CS3 (SMD 3×3 mm), CS5 (SMD 5×5 mm), CS5R (SMD 5×5 mm with microreflector) – appropriate for mounting one-element LEDs or single-wavelength matrices

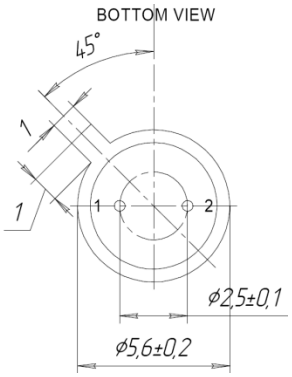
CS5R-3M (SMD 5×5 mm) – appropriate for mounting three-element LED-matrices

TO18

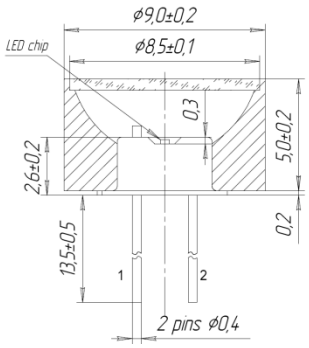


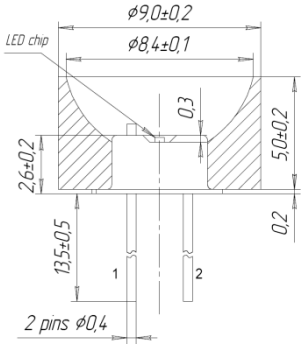


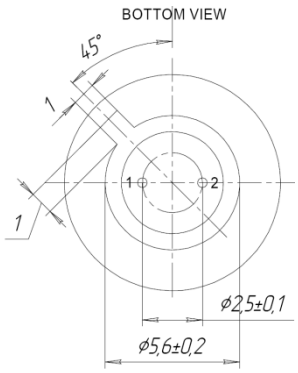




TO18-R
TO18-RW







- 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 the reduction of the radiation divergence.

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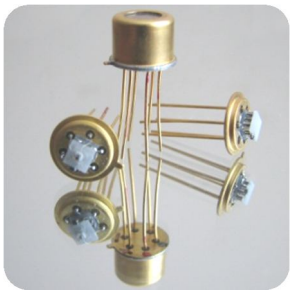
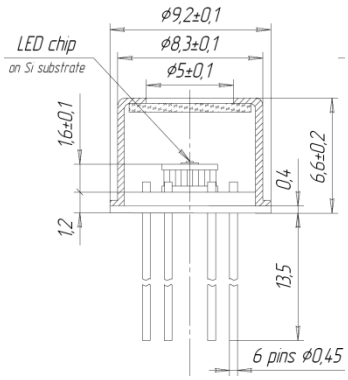
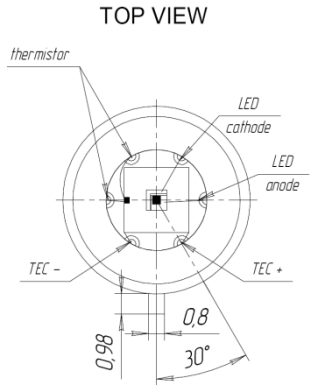
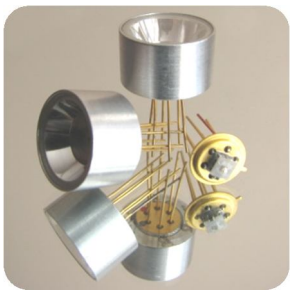
TO5-TEM

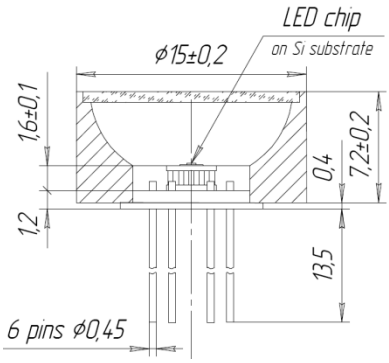


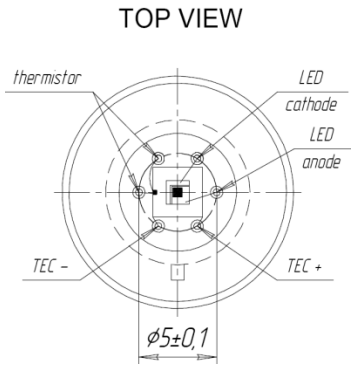




TO5-TEM-R





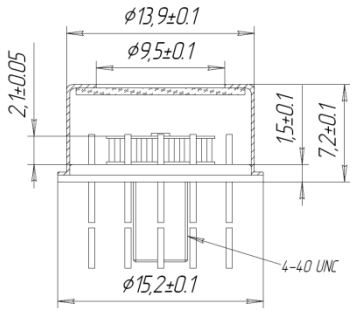


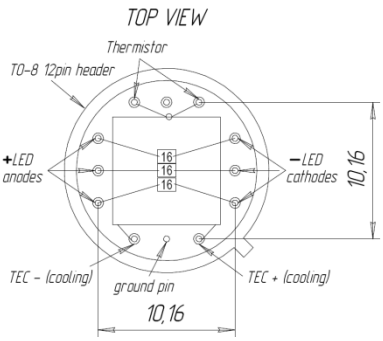
- Small packages with 3.2×3.2 mm^2 thermocooler surface open for mounting
- Header material – kovar, finish – gold/plating; thermocooler ceramics – Al_2O_3
- The number of lead pins is 6 or 9
- Built-in thermoelectric module (TEM) – thermocooler and thermoresistor – provides LED chip temperature adjusting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

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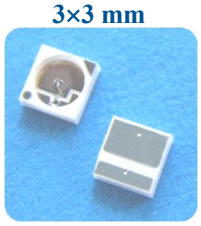
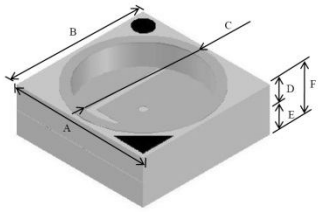
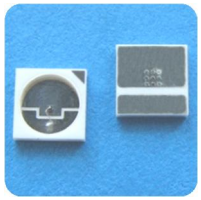
CS3
3×3 mm

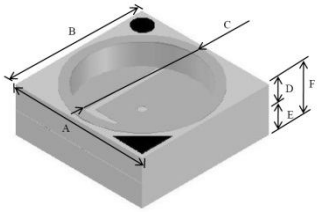




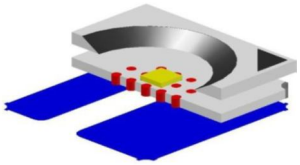
ITEM	Symbol	Rule
Basic Outline	A	3.0± 0.1mm
Basic Outline	B	3.0± 0.1mm
Cavity size	C	Max 2.4Φ
Top layer	D	Min 0.4mm
Bottom layer	E	Min 0.4mm
Thickness	F	Max 2mm

CS5
5×5 mm

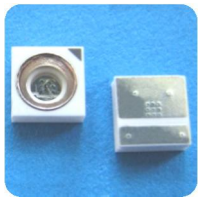


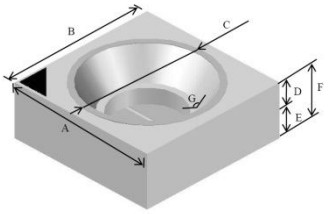


ITEM	Symbol	Rule
Basic Outline	A	5.0± 0.1mm
Basic Outline	B	5.0± 0.1mm
Cavity size	C	Max 4.2Φ
Top layer	D	Min 0.4mm
Bottom layer	E	Min 0.4mm
Thickness	F	Max 2mm



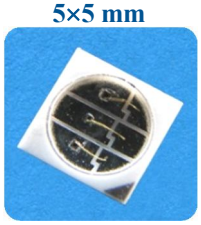
CS5R
5×5 mm

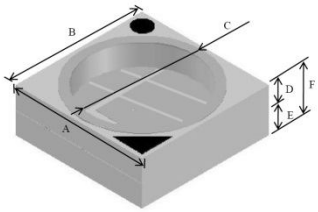




ITEM	Symbol	Rule
Basic Outline	A	5.0± 0.1mm
Basic Outline	B	5.0± 0.1mm
Cavity size	C	Max 4.2Φ
Top layer	D	Min 0.4mm
Bottom layer	E	Min 0.4mm
Thickness	F	Max 2mm
Angle	G	Customize

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 metalized 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 the reduction of radiation divergence

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

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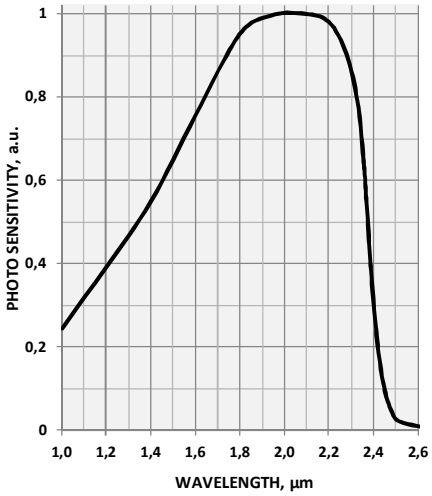
Currently we offer Photodiodes with cut-off at 2.4 and 3.6 μm with sensitive area o.5 mm

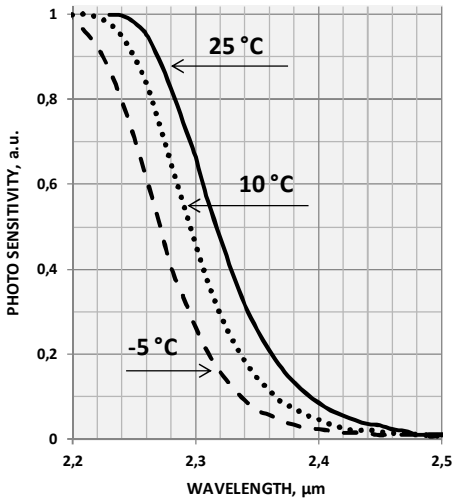
- Photodiodes with cut-off at 2.4μm Lms24PD-03 Series

Absolute maximum ratings (T = 25 °C unless otherwise specified)

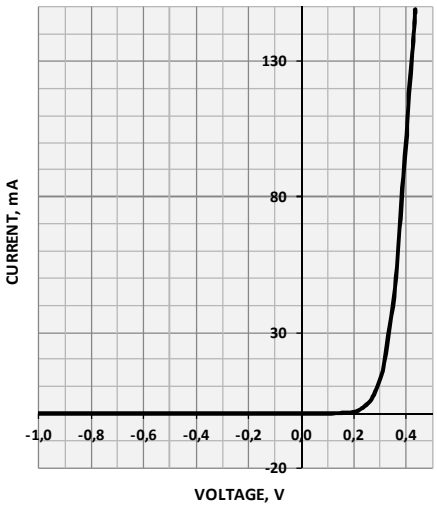
Parameter	Symbol	Value	Units
TOTAL DEVICE			
Sensitive area diameter	d	0.3	mm
Storage Temperature	T_{stg}	-200.. +70	°C
Operating Temperature	T_{opr}	-200.. +60	°C
PHOTODIODE			
Reverse bias voltage	V_r	-5.0	V
Cut-off wavelength	λ_{cut}	2.45	μm
Maximum sensitivity wavelength (> 90%)	λ_p	1.75 - 2.3	μm
Dark current (V_r = -1 V)	I_d	20 ÷ 50	μA
Shunt resistance (V_r = -10 mV)	R_{sh}	> 10	kOhm
Terminal capacitance (Vr = -1 V, f = 64 kHz)	C	40 ÷ 150	pF
Detectivity ($\lambda=\lambda_p$)	D	2-5 10^{10}	cm $Hz^{1/2}$ W^{-1}

Typical Spectral response





Typical Current-Voltage characteristic



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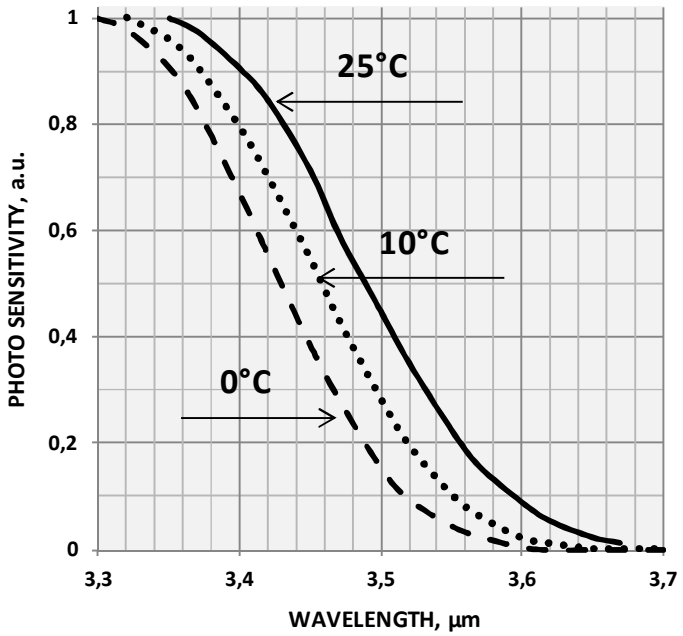
Photodiodes with cut-off at 3.6µm Lms36PD-03 Series

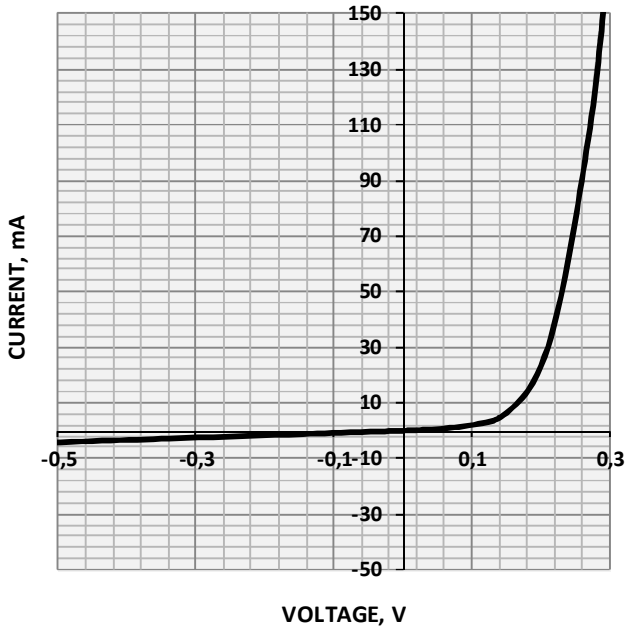
Absolute maximum ratings (T = 25 °C unless otherwise specified)

Parameter	Symbol	Value	Units
TOTAL DEVICE			
Sensitive area diameter	d	0.3	mm
Storage Temperature	T_{stg}	-200.. +70	°C
Operating Temperature	T_{opr}	-200.. +60	°C
PHOTODIODE			
Maximum reverse bias voltage	V_r	-1.0	V
Cut-off wavelength	λ_{cut}	3.65	µm
Peak sensitivity wavelength	λ_p	3.35	µm
Dark current (V_r = -0.1 V)	I_d	75 ÷ 750	µA
Shunt resistance (V_r = -10 mV)	R_{sh}	100 ÷ 600	Ohm
Detectivity ($\lambda=\lambda_p$)	D	3-5 10^9	cm $Hz^{1/2}$ W^{-1}

Typical Spectral response



Typical Current-Voltage characteristic



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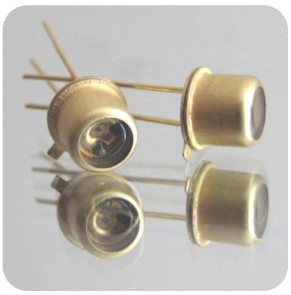
We offer a range of standard packages for PDs as follows:

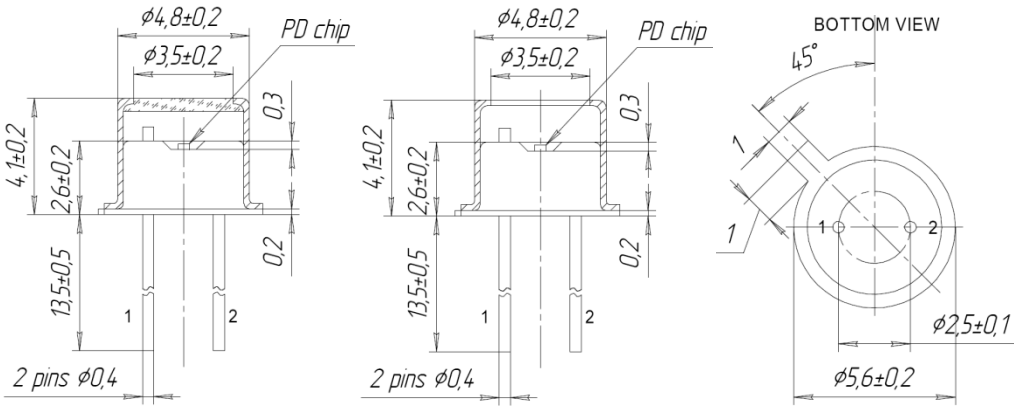
✓ TO-type packages:

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

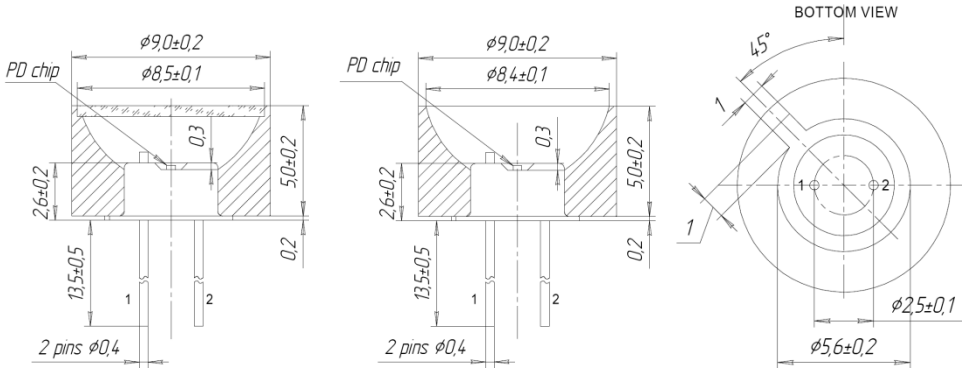
TO5 (TO39) – appropriate for mounting photodiode arrays, 1-element photodiodes and arrays with thermocooler.

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

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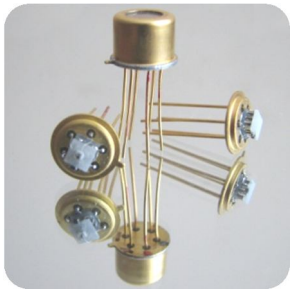
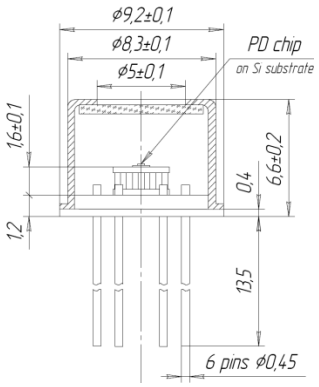
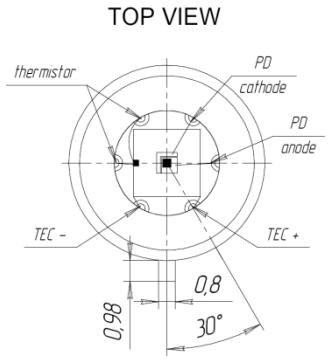
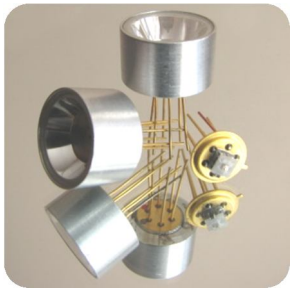
TO5-TEM

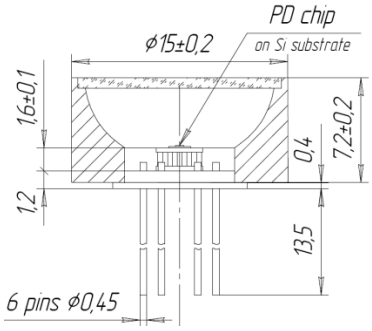


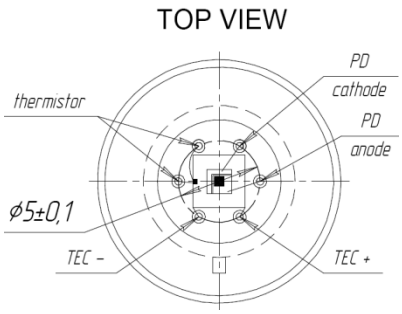




TO5-TEM-R





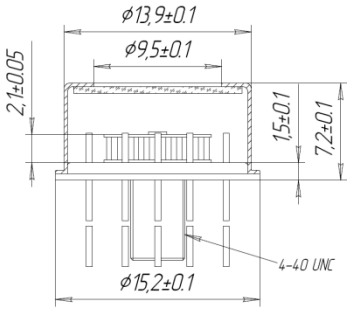


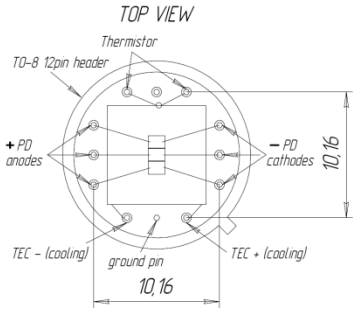
- Small packages with 3.2×3.2 mm^2 thermocooler surface open for mounting
- Header material – kovar, finish – gold/plating, thermocooler ceramic – Al_2O_3
- The number of lead pins is 6 or 9
- Built-in thermoelectric module (TEM) – thermocooler and thermoresistor – provides PD chip temperature adjusting and stabilizing in the range -5…+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 part of radiation that reaches 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 stabilizing in the range -5…+65°C
- Equipped with a cap with a glass window that protects PD device from damage

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According to the Customers' requests we developed different models of electronic units oriented for optimal operation with Mid Infrared LEDs and Photodiodes. Drivers and Amplifiers allow arranging a very flexible and easy-to-use set-up to carry out first experiments concerning optical measurements of gases, liquids and solid materials absorption in the middle infrared spectral range. The available operation regimes can be selected to take maximum benefits of using 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-31M	DLT-27M	DLT-37M
Lms MIR LED	D-31M		
Lms MIR LED–R	D-31M		
Lms MIR LED–RW	D-31M		
Lms MIR LED–TEM		DLT-27M	DLT-37M
Lms MIR LED–TEM–R		DLT-27M	DLT-37M

PD Amplifiers, PD Amplifiers with Temperature Controllers

PD \ Amplifer	AM-07 for Lms24PD	AM-07 for Lms36PD	AM-07 for PR43	AMT-07 for Lms24PD–TEM(–R)	AMT-07 for Lms36PD–TEM(–R)
Lms24PD	AM-07 for Lms24PD				
Lms36PD		AM-07 for Lms36PD			
PR43			AM-07 for PR43		
Lms24PD–TEM(–R)				AMT-07 for Lms24PD–TEM(–PR)	
Lms36PD–TEM(–R)					AMT-07 for Lms36PD–TEM(–PR)

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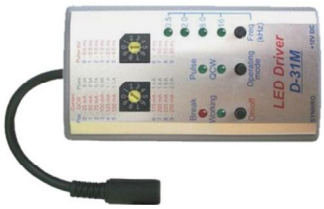
LED Drivers are produced in 3 variants:

LED driver D-31M 	Driver D-31M provides two modes of operation: ✓ **Quasi Continuous Wave (qCW) (quasi steady-state) mode.** Current in this mode can be adjusted in the range 25-250 mA. One of four frequencies (0.5 kHz, 2 kHz, 8 kHz and 16 kHz) can be selected. ✓ **Pulse mode:** In this mode in addition to frequency changing, pulse duration can be also selected in the range 0.6-20 µs. Peak current in pulse mode can be adjusted in the range 0-2 A.
LED Driver with 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. Current in this mode can be changed in the range 20-250 mA. Frequency modulation 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 that is built in DLT-27M provides selecting and stabilizing the LED chip temperature in a wide range.
LED Driver with 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. Current in this mode can be changed in the range 20-250 mA. One of four frequencies (2 kHz, 4 kHz, 8 kHz and 16 kHz) can be selected. ✓ Pulse mode. In addition to frequency changing pulse duration can be also 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 that is built in DLT-37M provides selecting and stabilizing the LED chip temperature in a wide range.

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PD Amplifiers are produced in 2 variants:

Amplifier for a Photodiode AM-07M 	Amplifier AM-07 converts the output current of a signal source (such as Mid-Infrared photodiode) into a voltage output with amplification for subsequent use with various electronic systems, such as lock-in-amplifiers, oscilloscopes or A/D converters. Synchro detector is included in the same package and gives direct current proportional to the signal at selected frequency. Customer can see the signal on LC Display.
Amplifier for a Photodiode 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 output with amplification for subsequent use with various electronic systems, such as lock-in amplifiers, oscilloscopes or A/D converters. Synchro detector is included in the same package and gives direct current proportional to the signal at selected frequency. Customer can see the signal on LC Display. Amplifier AMT-07M is oriented for operation with photodiodes with built-in thermocooler and thermistor (Models LmsXXPD-TEM(-R)). Customer can select and set the PD operation temperature. Circuit with feedback will set the appropriate thermocooler current for maintaining the selected temperature.

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APPLICATION

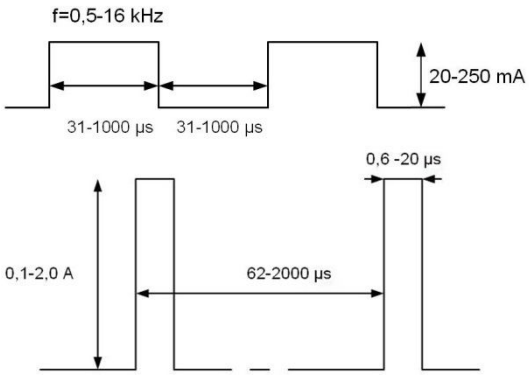
The driver D-31M is designed for power supply of Lms MIR LEDs

FEATURES

- The driver D-31M provides two modes of operation: Quasi Continuous Wave mode (the mode of *maximum average optical power* from the LED) and pulse mode (the mode of *maximum peak optical power* from the LED).
- The possibility of tuning the LED current amplitude, repetition rate and pulse duration to select the optimal mode of the LED.
- The synchronization capability with a selective amplifier or with some other device.
- Easy and durable.

TECHNICAL CHARACTERISTICS

CURRENT WAVEFORM GENERATED BY THE DRIVER IN QCW AND PULSE MODES



Parameters	Value
Input voltage	Stabilized +12 V
Voltage tolerance	-5..+5 %
Power consumption	< 4 W
Board dimensions	105×58×20 mm
Weight	90 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 driver DLT-37M is designed for power supply of all models Lms MIR LEDs with built-in cooler.

FEATURES

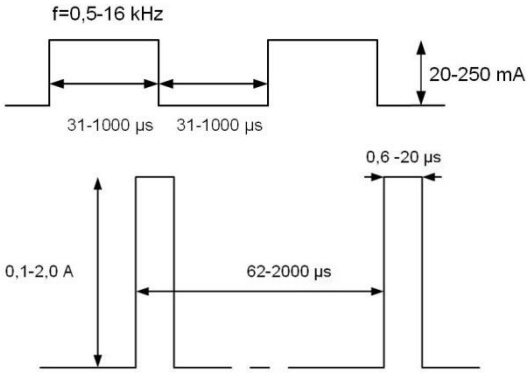
- The driver DLT-37M provides two modes of operation:

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

- Temperature controller that is built in DLT-37 provides selecting and stabilizing of temperature on the LED's chip in wide range. That gives possibility of stabilizing and tuning the wavelength or optical power of the LED.
- The possibility to tune the LED current amplitude, repetition rate and pulse duration to select the optimal mode of the LED.
- The synchronization capability with a selective amplifier or with some other device.
- Easy and durable.

TECHNICAL CHARACTERISTICS

CURRENT WAVEFORM GENERATED BY THE DRIVER IN QCW AND PULSE MODES



Parameters	Value
Input voltage	Stabilized +12 V
Voltage tolerance	-5..+5 %
Power consumption	< 4 W
Adjustment temperature range	-10 °C…+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

- The possibility of discrete changing of current amplification to raise the measurement accuracy.
- The presence of analog output for external device connection and LCD-display for signal level indication.
- The intrinsic function for background level compensation.
- Temperature controller that is built in AMT-07M provides to select and stabilize the temperature of the LED's chip in wide range. That gives possibility of tuning and stabilizing the photodiode spectral characteristics.

TECHNICAL CHARACTERISTIC

Parameters	Value
Input voltage	Stabilized +12 V
Voltage tolerance	-5..+5 %
Power consumption	< 3 W
Adjustment temperature range	-15 °C…+15°C
Board dimensions	148×78×30 mm
Maximal amplification	$6{,}4\times10^{6}$ 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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