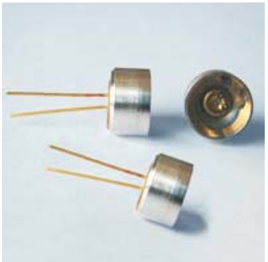
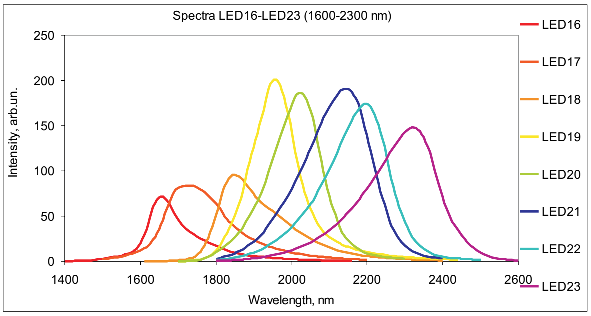
IBSG

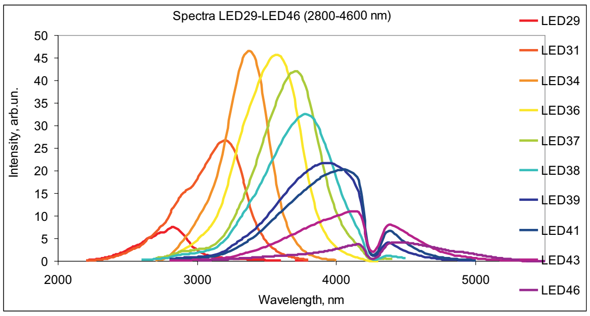
1600-5000 nm

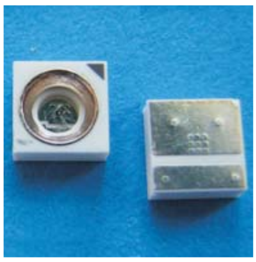
- Light Emitting Diodes
- Photodiodes
- Electronic Devices

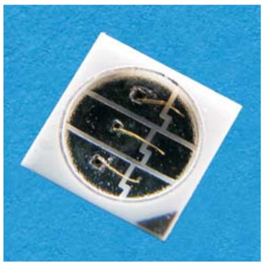
NEW MID INFRARED PRODUCTS

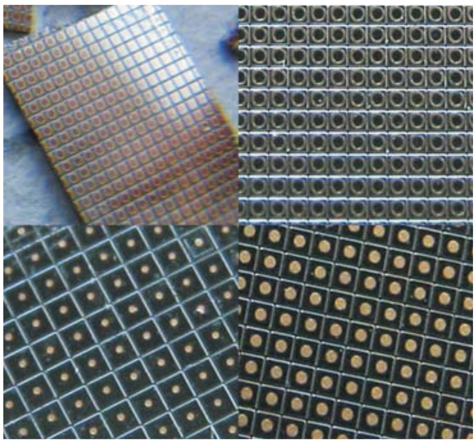


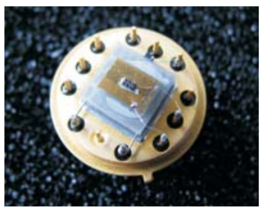












KEYSTONE

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INTRODUCTION

About the Company

IBSG Co. Ltd. was founded by several leading researchers of the Ioffe Physico-Technical Institute in 1991 and specialized in developing and manufacturing of optoelectronic devices for mid-infrared spectral range.

Now we provide the complete technological cycle including heterostructure growth using liquid phase epitaxy (LPE) and metalorganic chemical vapor deposition (MOCVD), photolithography, assembling, characteristics testing and producing of related electronic devices.

At present IBSG is the only company in the world that produces the full line of light emitting diodes, laser diodes and photodiodes for mid-infrared spectral range 1600-5000 nm.

In addition to a wide range of standard products we offer custom designed solutions for different purposes.

You can find application of IBSG products in detection systems for ecological monitoring, on-line technological process control, medical diagnostic and many other branches.

PRODUCTION LINE

Equipment for MOCVD

Photolithography room

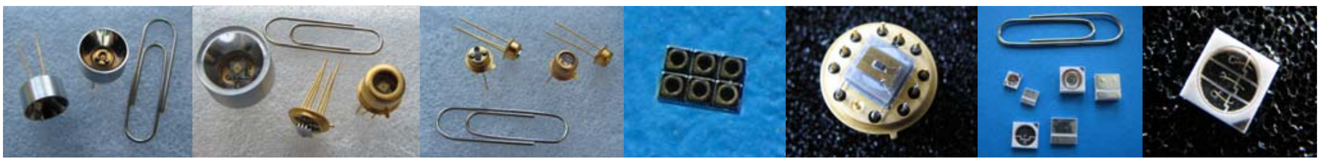
Equipment for deposition of metal layers

Equipment for structure quality control

Equipment for ball bonding of the LED and PD dies

Equipment for spectral measurements

PRODUCT LINE

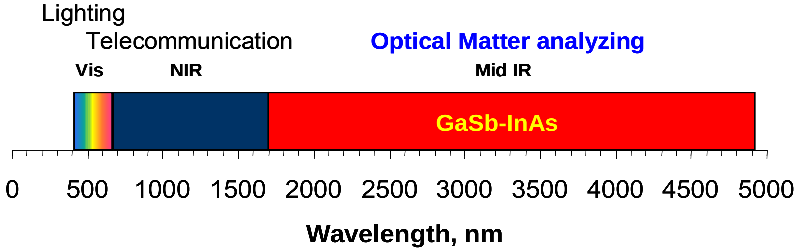


Light Emitting Diodes, Photodiodes, LED-matrix

Electronic Devices

About Semiconductor Heterostructures

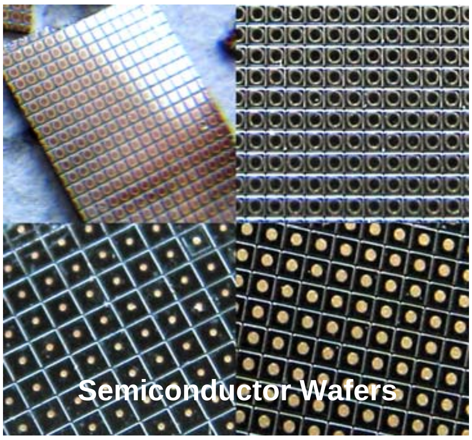
Light emitting diodes (LEDs) and Photodiodes (PDs) are semiconductor devices. LED or PD heterostructure is formed by sequential epitaxy of semiconductor layers on the surface of a crystal substrate. LED radiation is generated in the active layer and the emission wavelength of LED as well as spectral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

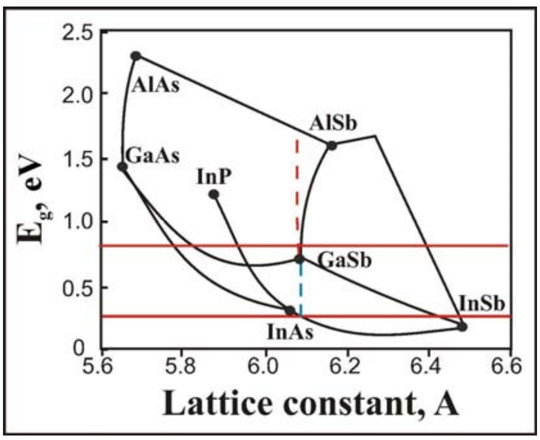


The first in the world laser heterostructures were grown at the end of 1960th in the Ioffe Institute by Nobel prize laureate Zhores Alferov.

At the moment semiconductor optoelectronic devices for near-infrared and visible spectral range are widely used in telecommunications and lighting. In addition to these applications LEDs and PDs posses great potential for 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.

More than 20 years scientists from Infrared optoelectronics Laboratory of the Ioffe Institute in collaboration with IBSG Co.Ltd work under creation of high efficiency emitters and detectors based on narrow band-gap III-V semiconductors. Qualitative technological break-through in heterostructure growing based on GaInAsSb solid solution was achieved in last decade. This material system allows developing of LEDs, Laser Diodes and Photodiodes that cover wide spectral range from 1600 nm to 5000 nm.





Using GaInAsSb/AlGaAsSb heterostructures lattice matched to GaSb substrate allowed us to create LEDs and PDs for 1.6-2.4 μm spectral range, InAsSb/InAsSbP 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 incompatibility region for GaInAsSb based solid solutions that depends on the epitaxy temperature and the compound composition.

WE PROPOSE:

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

1.85	1.88	1.95	2.05	2.15	2.18	2.20	2.27	2.31	2.35	2.84	3.40	3.55	3.65	3.75	3.90	4.05	4.15	4.45
LED18		LED19	LED20	LED21		LED22		LED23		LED29	LED34	LED35	LED36	LED38	LED39	LED41	LED43	LED46

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

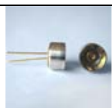
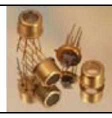
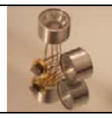
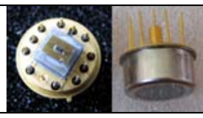
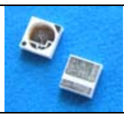
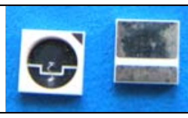
1.65	1.75	1.85	2.05	2.15	2.25	2.35	3.40	3.65	3.70	3.75
LED16FC	LED17FC	LED18FC	LED20FC	LED21FC	LED22FC	LED23FC	LED34FC	LED36FC	LED37FC	

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

2.4	2.5	3.6	4.3
PD24	PD25	PD36	PD43

- 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 package for these devices:

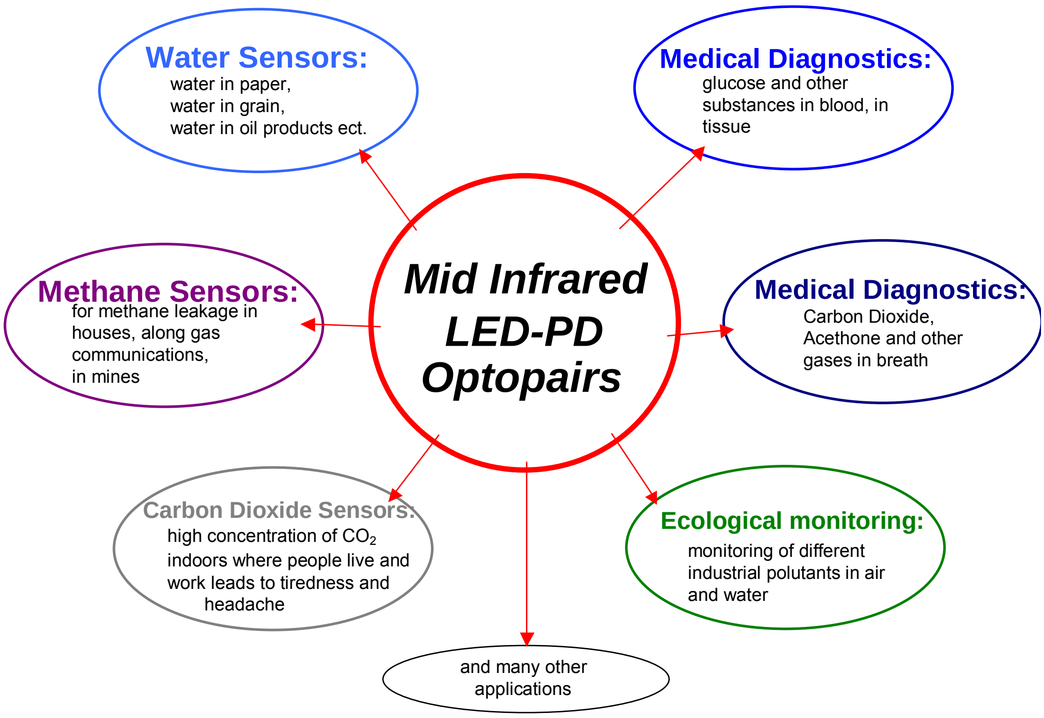
<table>
<tr><td rowspan="3">TO Packages</td><td>TO-18</td><td>TO-18 with PR</td><td>TO-5</td><td>TO-5 with PR</td><td>TO-8</td></tr>
<tr><td colspan="2">with/without window</td><td colspan="3">with/without thermoelectric module</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>applied to</td><td colspan="2">LED, PD</td><td colspan="2">LED, PD, LED-matrix</td><td>LED-matrix</td></tr>
<tr><td rowspan="2">SMD Packages</td><td>3×3 mm</td><td>5×5 mm</td><td>5×5 mm
with microreflector</td><td>5×5 mm
for 3-element matrix</td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td>applied to</td><td colspan="3">LED</td><td>LED-matrix</td></tr>
</table>

- Electronics oriented for operating with IBSG LEDs, LED-matrix and PDs:
  - ✓ LED mini-driver mD-1c–provides LED operation in QCW mode at fixed current and frequency;
  - ✓ LED mini-driver mD-1p – provides LED operation in pulse mode at fixed current, frequency and pulse duration;
  - ✓ LED driver D-31 – 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 LED with 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 LED with 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.

Range of Applications

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.

Most of commercially available instruments for this analysis employ quite sophisticated large-sized and expensive spectrometers that provide measurements solely at the laboratory. Using IBSG 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.



Examples of portable sensors (test models) based on LED-PD optopairs developed at IBSG

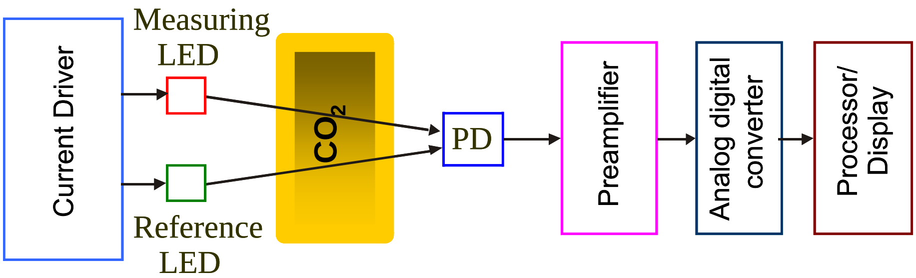
Carbon Dioxide Sensor

Water in Cut-Oil Sensor

Principle of Infrared Optical Absorption Analysis

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 maximum absorption of the analyte. Reference LED emits at wavelength that corresponds to the absence of absorption of the analyte. Signal difference between measuring LED that is partially absorbed in optical cell and the reference LED is proportional to the concentration of the analyte.

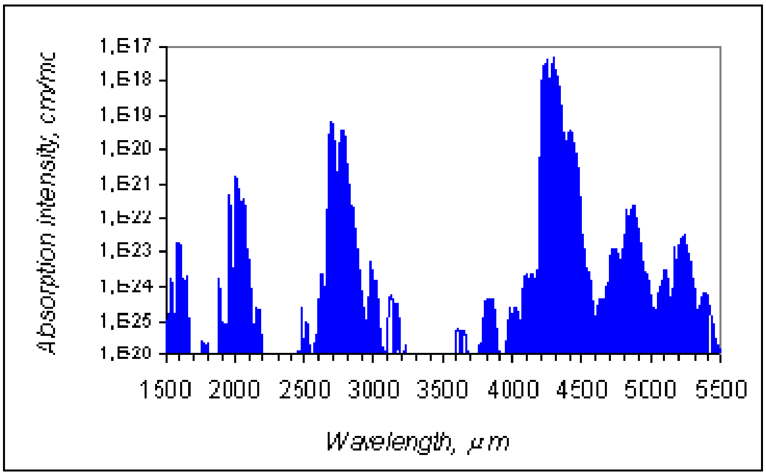


There are strong absorption bands of many chemical agents at mid-infrared spectral range that allow their detection with sensor devices based on LED-PD optopairs. Some of these chemical agents and their absorption bands are presented here:

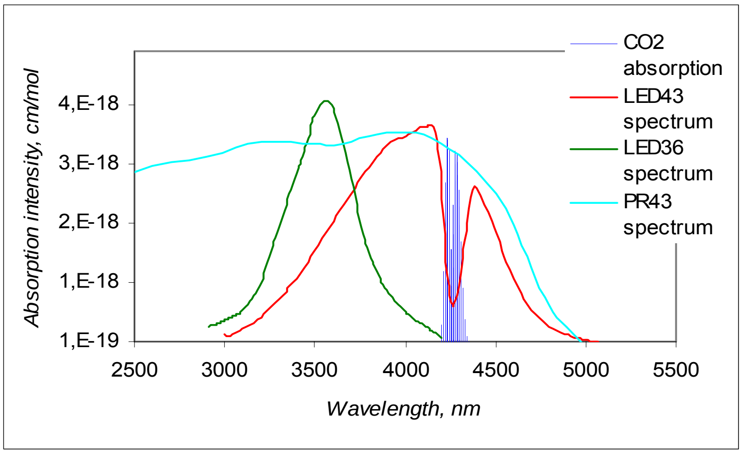
CH_4 *1.65;2.30 μm; 3.2÷3.45 μm*	***CO_2*** *2.00; 2.65 μm; 4.2÷4.3 μm*	***H_2O*** *2.65÷2.85 μm; 1.86÷1.94 μm*	***N_2*** *4.0÷4.54 μm*
C_2H_2 *2.99÷3.09 μm*	***HOCl*** *2.6÷2.9 μm*	***HCl*** *3.33÷3.7 μm*	***NH_3*** *2.27; 2.94 μm*
C_2H_4 *3.1÷3.4 μm*	***HBr*** *3.7÷4.0 μm*	***OH*** *2.38÷2.63 μm*	***NO+*** *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*

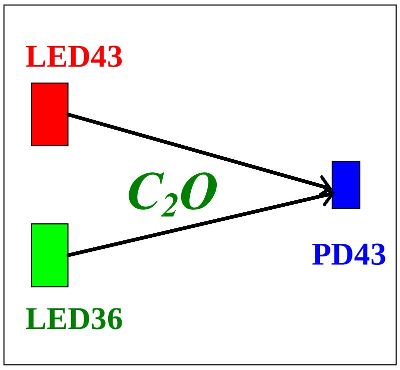
Range of Applications. Examples

Carbon Dioxide Detection



Carbon Dioxide has very strong absorption band at 4200-4320 nm. Other not so strong absorption bands that can be used for detection are located around 2700 nm and 2000 nm. (the data are taken from HITRAN Catalog).





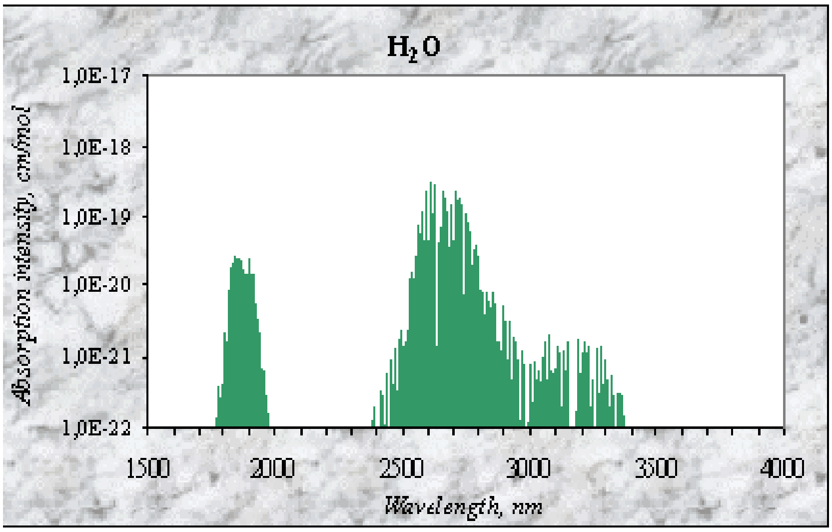
The strongest absorption band of carbon dioxide is located around 4.27 μm. Maximum of LED43 spectrum is close to this absorption band, so LED43 can be applied as a radiation source for the measuring channel. LED36 can be used as a reference signal since CO_2 absorption practically doesn't influence this emitter radiation. Photodiode PD43 or photoresistor PR43 can be used for signals detection. Difference between signals from these two LEDs will be proportional to the carbon dioxide concentration.

Using the second absorption band of CO_2 is not appropriate for its detection since there is very strong absorption of water at the same spectral interval.

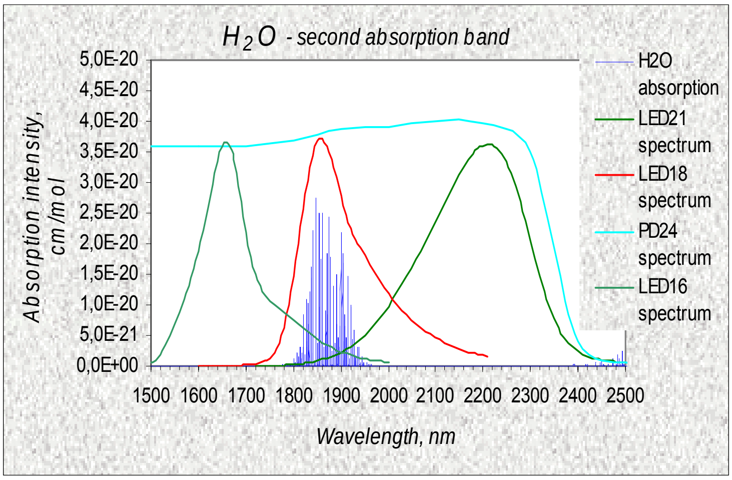
Third absorption band around 2.30 μm is by three orders weaker than the main absorption at 4.27 μm. But LED23 optical power is about 100 times higher than LED43 power. PD24 detectivity is also much better than PD43 or PR43 detectivity. So, for some applications using LED23 with maximum intensity at 2.3 μm as a measuring signal can be reasonable.

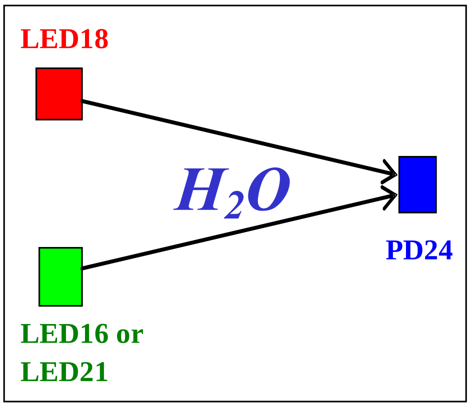
Range of Applications. Examples

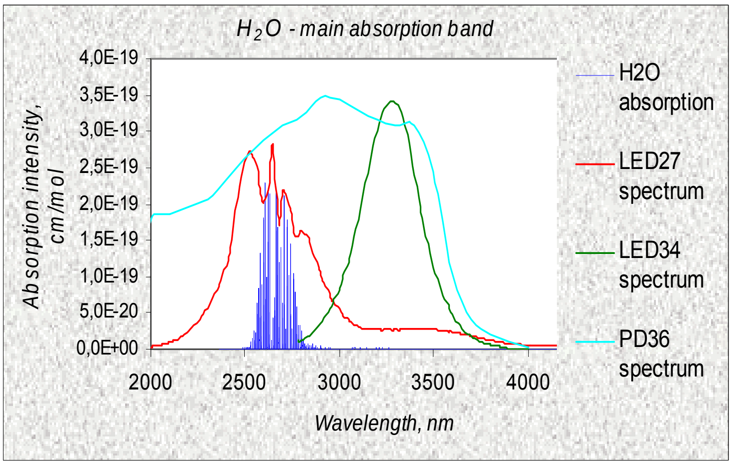
Water Detection

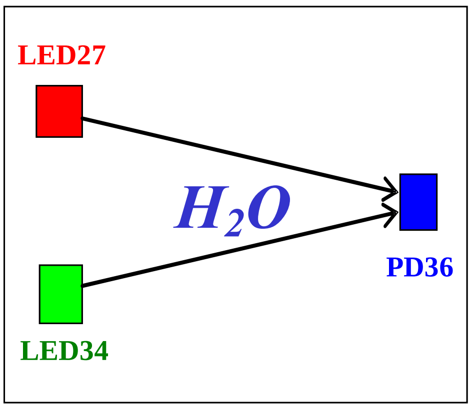


Water has very strong absorption band at 2550-2750 nm and 1830-1900 nm. When applying IBSG LEDs and PDs it is more preferable to use the second absorption band at 1830-1900 nm since emitters and detectors for this spectral range provide much better efficiency (the data are taken from HITRAN Catalog).





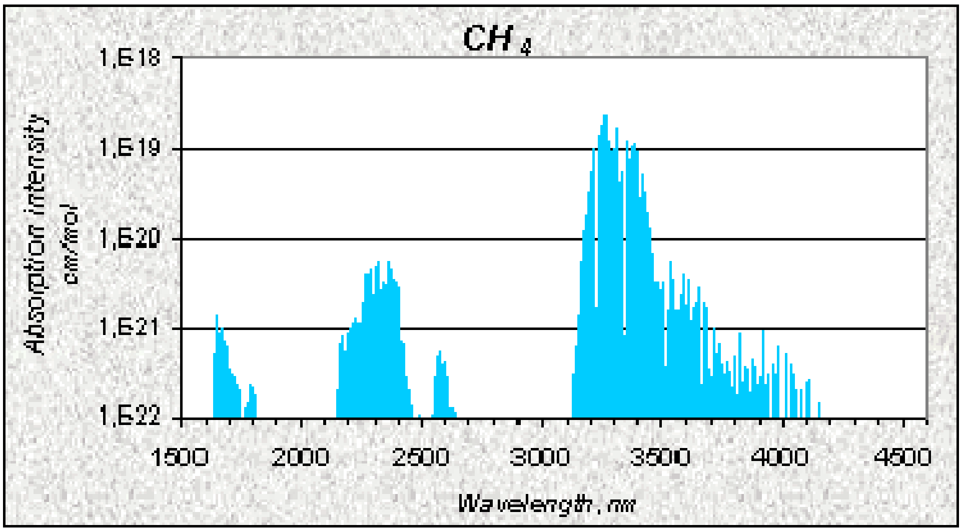




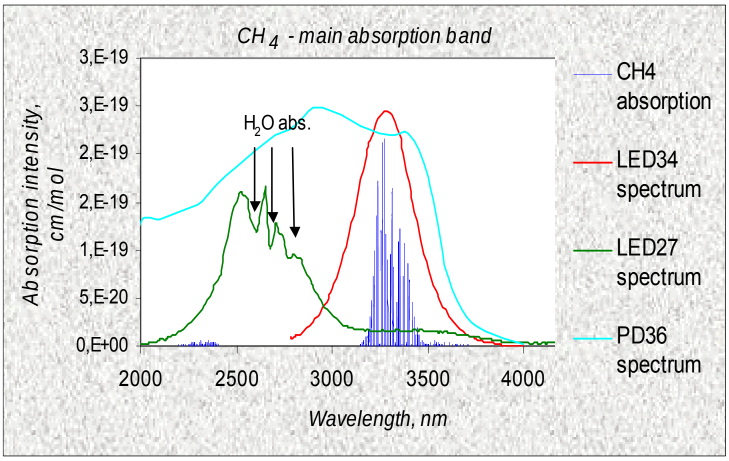
INTRODUCTION

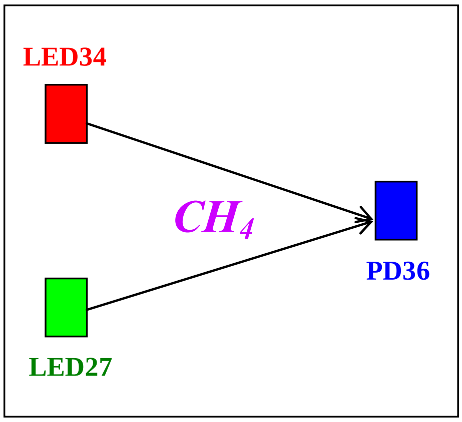
Range of Applications. Examples

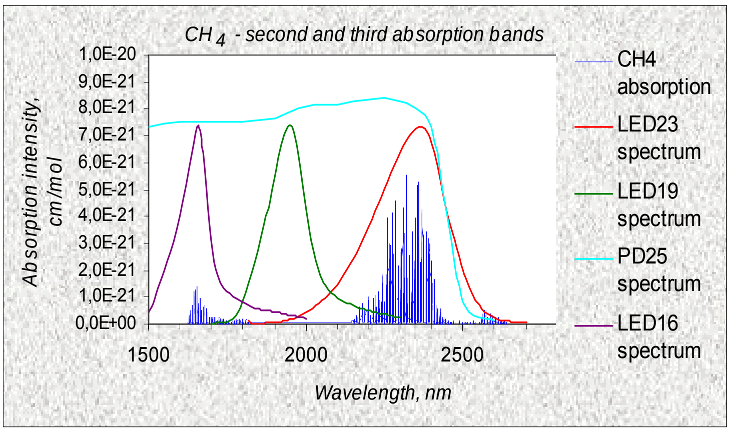
Methane Detection

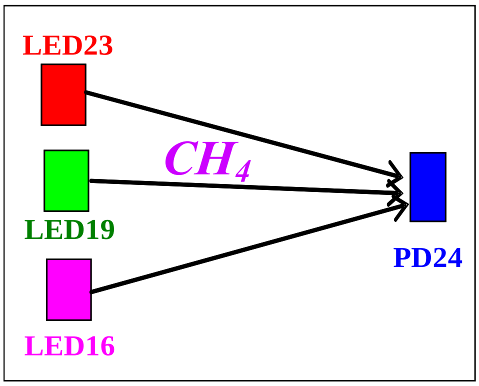


Methane has the main absorption band at 3200-3400 nm. Other not so strong absorption bands that can be used for detection are located around 2300 nm and 1650 nm (the data are taken from HITRAN Catalog).









What Are the Benefits of Using LEDs?

New optoelectronic devices for the Middle Infrared spectral range open completely new possibilities for portable sensors creation. Using Mid-infrared LED-PD optopairs allow developing an instrument that is smaller, less expensive, and versatile in functionality.

It is worthwhile to focus on some features of gas sensor market since gases are the most significant type of analytes. Today a number of companies produce Mid Infrared optical gas sensors based on dispersive emission sources. These sensors have become popular and often replace chemical and adsorption ones. The main features of different types of gas sensors for on-line monitoring are presented here:

Gas Sensors

Adsorption and other chemical Gas Sensors	Optical Gas Sensors based on heating IR sources
How it works: There are many different types. For example MOSFET with a sensitive paladium or tin oxide gate: Adsorption of measured gas on the surface of the gate changes current through the metal- oxide-silicon field effect transistor.	**How it works:** Charactreistic absorption bands of the most important gases lie in the middle IR spectral range. In dispersive emission source a wire is heated up by a current flow and emits in a very wide range according to Planck`s law. The required spectral range is cut off by special optical filters.
Advantages: Low cost; Acceptable sensitivity; Small size of the chip	**Advantages:** High selectivity; High reliability; Simple for using
Disadvantages: **Low selectivity:** Sensitive to high humidity, to presence of such reagents as ammonia, chlorine, fluorine, sulfur, phosphorus, nitrogen and carbon oxides in the environment. **Short lifetime:** Often calibration or replacement of a sensitive element is necessary	**Disadvantages:** **Restricted possibilities for miniaturization** due to additional filters and high heat dissipation. **High electric power consumption:** We use only a small part of radiation cut by filter. **Low response speed**. **High cost**

But at present market is strongly restricted due to substantial disadvantages of proposed sensors. Either they have poor selectivity, so that quite complicated and frequent calibrations are required, or they are very expensive. The best way to eliminate disadvantages of the present optical sensors is to apply high-powered fast light emitting diodes for Mid-infrared spectral range.

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What Are the Benefits of Using LEDs?

LEDs and other sources of infrared radiation

In thermal (heating) emission source of infrared radiation a wire is heated up by a current flow and emits in a very wide range according to Planck`s law. The required spectral range is obtained by using special optical filters. Sensors employing this type of radiation source have some certain drawbacks:

- High electrical power consumption and low efficiency. Filter cuts only small part of wide emitted spectral range.
- Low speed of response.
- Heating infrared source practically can not be modulated by current.
- Short lifetime. Frequent catastrophic degradation takes place.
- Restricted possibilities for miniaturization due to high heat dissipation and necessity for using filters.

LEDs and Photodiodes that cover 1600-5000nm spectral range were developed and their production was started at IBSG.

New Mid-Infrared LEDs posses certain advantages comparing to heating infrared radiation sources:

- ❑ compactness (size of the standard LED chip is 0.3x0.3 mm)
- ❑ low electrical power consumption (down to 1 mW in pulse mode)
- ❑ high speed response (tens per nanoseconds)
- ❑ long lifetime (up to 100 000 hours)
- ❑ low cost in mass production

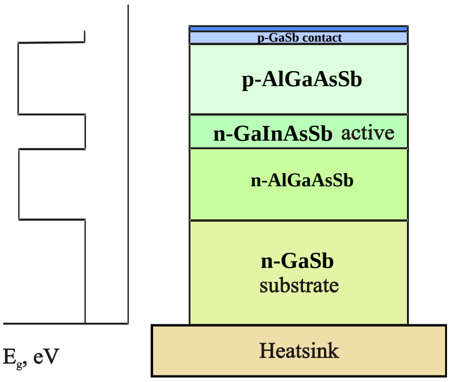
Creation of Mid-infrared optoelectronic devices became possible due to qualitative technological break-through in growing of latticed-matched heterostructures based on narrow band-gap substrates GaSb and InAs that was achieved last decade in IBSG Co., Ltd in collaboration with Ioffe Institute, Russian Academy of Sciences.

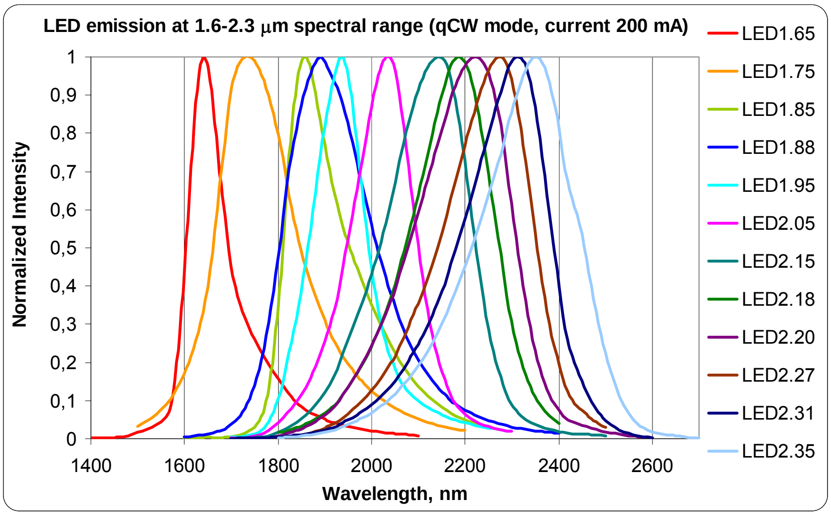
LIGHT EMITTING DIODES

Main Parameters

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 heterostructures lattice matched to GaSb substrate.

Light Emitting Diodes for 1.6-2.4 µm spectral range





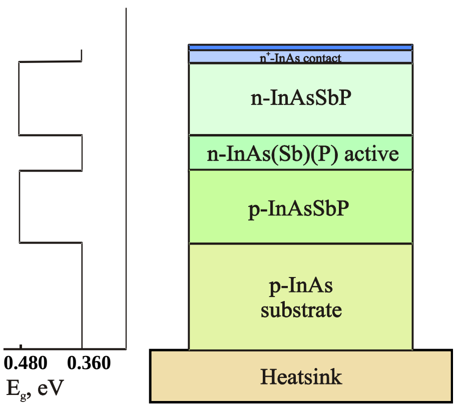
Model		Peak emission wavelength, nm		FWHM of the emission band, nm		Power, mW				Voltage*, V	Maximum operating current, mA		Switching time, ns	Operating temperature range, °C
						QCW mode*		Pulse mode**						
		min	max	min	max	min	max	min	max		QCW mode	Pulse mode		
Standard LED models (LED chip with circular or ring top contact) – LEDXX														
LED18	1.85	1.83	1.87	100	200	0.7	1.1	15	25	0.5-1.5				
	1.88	1.87	1.90	100	200	0.7	1.1	15	25	0.5-1.5				
LED19	1.95	1.92	1.97	100	200	0.8	1.2	20	30	0.5-1.5				
LED20	2.05	2.02	2.07	150	250	0.8	1.2	20	30	0.5-1.5				
LED21	2.15	2.13	2.16	150	250	0.8	1.2	20	30	0.5-1.0				
	2.18	2.17	2.19	150	250	0.8	1.2	15	25	0.5-1.0	250	2000	10-30	-240…+50
LED22	2.20	2.19	2.22	150	250	0.8	1.2	15	25	0.5-1.0				
	2.27	2.25	2.29	150	250	0.7	1.1	15	25	0.5-1.0				
LED23	2.31	2.30	2.33	170	270	0.6	1.0	12	20	0.8-2.5				
	2.35	2.33	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) – LEDXXFC														
LED16FC	1.65	1.60	1.69	70	150	1.0	3.0	20	45	0.8-4.2				
LED17FC	1.75	1.70	1.79	100	160	1.0	3.0	20	45	0.8-3.6				
LED18FC	1.85	1.80	1.89	100	180	0.8	2.0	20	35	0.6-2.0				
LED20FC	2.05	2.00	2.09	140	220	0.8	2.5	20	40	0.5-1.0	250	2000	10-30	-240…+50
LED21FC	2.15	2.10	2.19	200	300	0.8	2.5	20	40	1.6-2.8				
LED22FC	2.25	2.20	2.29	200	300	0.8	3.0	20	45	0.6-2.8				
LED23FC	2.35	2.30	2.37	200	340	0.8	2.0	20	35	1.2-2.8				

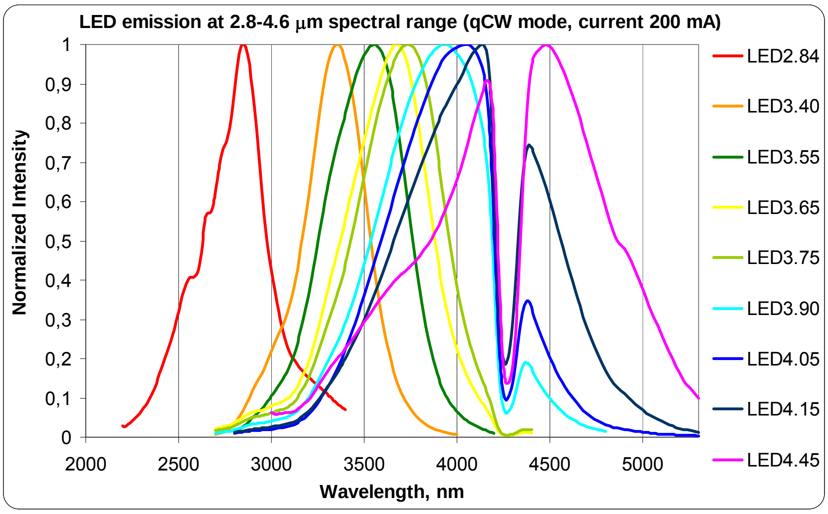
* Repetition rate: 0.5 kHz, pulse duration: 1 ms, duty circle: 50%, current: 200 mA

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

Narrow band-gap InAsSb/InAsSbP lattice matched to InAs substrate were used to create LEDs for 2.8-4.6 µm spectral range.

Light Emitting Diodes for 2.8-4.6 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) – LEDXX														
LED29	2.84	2.80	2.90	300	500	5	10	120	170	1.0-1.4				
LED34	3.40	3.32	3.46	400	600	25	45	320	480	0.3-0.5				
LED35	3.55	3.50	3.65	400	600	20	40	180	220	0.2-0.4				
LED36	3.65	3.60	3.70	400	600	20	40	180	220	0.2-0.4				
LED38	3.75	3.70	3.85	500	700	20	40	180	220	0.5-0.8	250	2000	10-30	-240…+50
LED39	3.90	3.85	3.95	550	750	15	30	180	220	0.5-0.8				
LED41	4.05	3.95	4.10	700	1000	15	30	180	220	0.5-0.7				
LED43	4.15	4.10	4.30	700	1000	8	12	180	220	0.2-0.8				
LED46	4.45	4.40	4.60	800	1100	4	8	120	160	1.6-2.6				
LED Flip-Chip models (top surface of a LED chip is free of contacts) – LEDXXFC														
LED34FC	3.40	3.35	3.45	320	400	30	45	340	480	0.2-0.4				
LED36FC	3.65	3.60	3.70	520	600	35	45	360	480	0.2-0.4				
LED37FC	3.70	3.66	3.72	420	500	12	24	180	200	0.2-0.4	250	2000	10-30	-240…+50
	3.75	3.73	3.78	520	600	20	45	300	480	0.2-0.4				

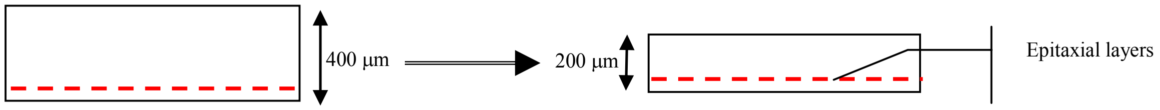
* Repetition rate: 0.5 kHz, pulse duration: 1 ms, duty circle: 50%, current: 200 mA

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

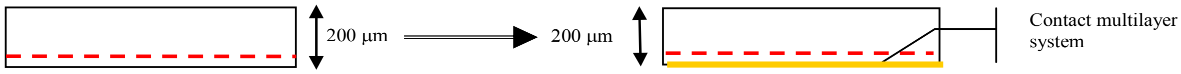
LED Chip Design

Main post-grown technological processes that forms Mid IR LED chips are presented below:

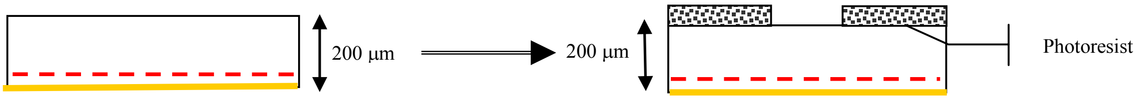
1) Decreasing the wafer thickness to 200 µm



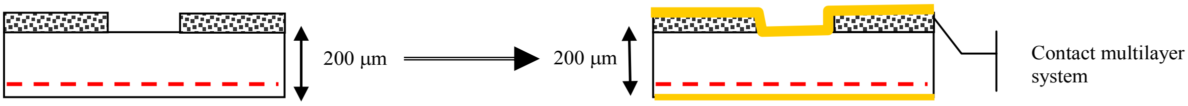
2) Deposition of the full area contact multilayer system Cr/(Au+Te)/Ni/Au to n-type semiconductor



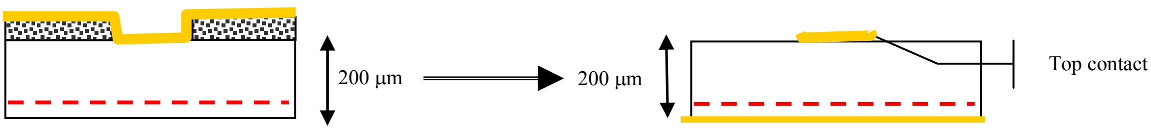
3) Photolithography for the circular or ring top contacts



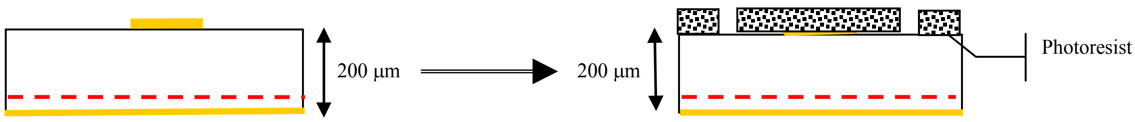
4) Deposition of the top contact multilayer system Cr/(Au+Zn)/Ni/Au to p-type semiconductor



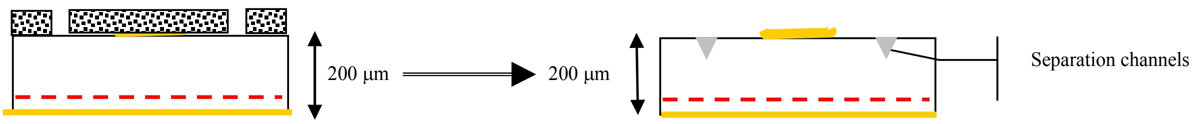
5) Lift-off removing of the photoresist



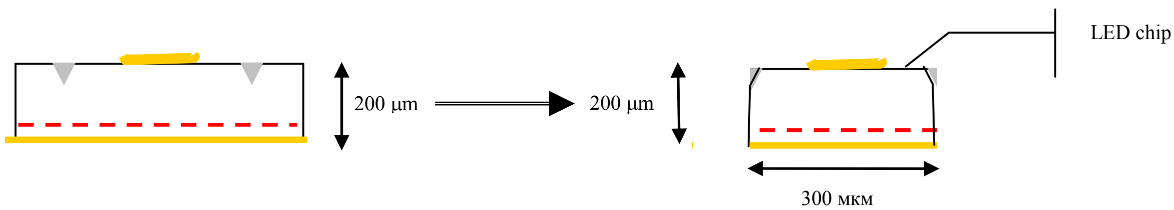
6) Photolithography for LED chip forming



7) Etching of separation channels



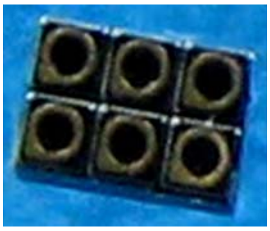
8) Cutting LED chips

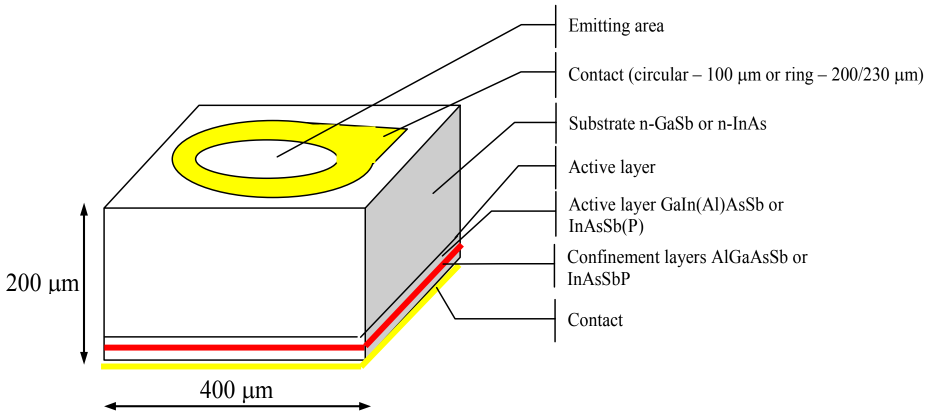


LIGHT EMITTING DIODES

LED Chip Design

Standard Mid Infrared LED chip





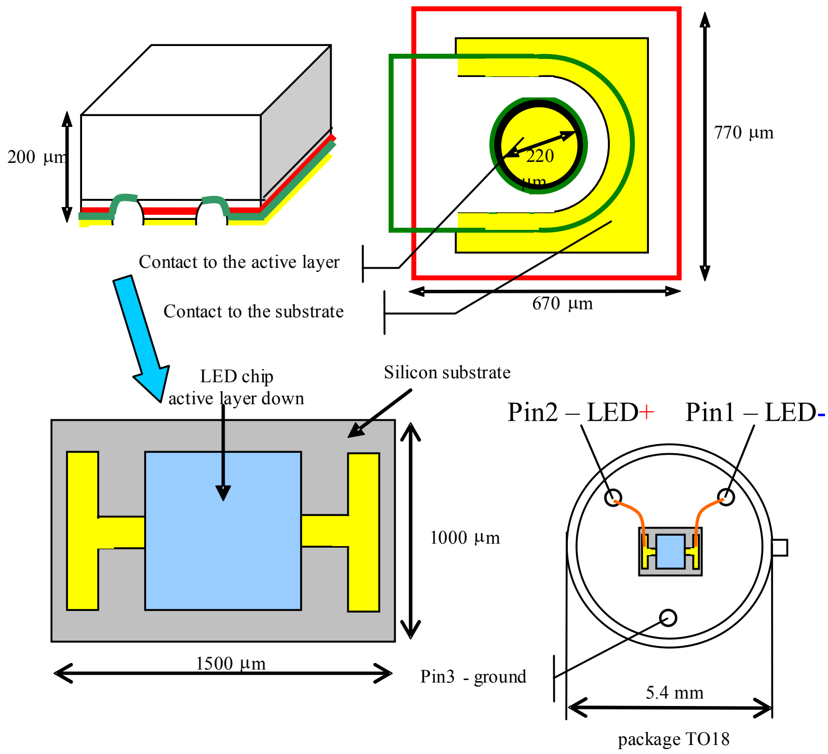
This shape of the LED chip is typical for most of IBSG standard Mid IR LEDs models.

Main advantages are:

- ✓ Small size of the LED chip (close to point source)
- ✓ High heat loading from the active layer
- ✓ Homogeneous current flow
- ✓ Cost effective (due to small size)

As a result we have very good quantum efficiency in a wide current range.

Mid Infrared LED Flip-chip



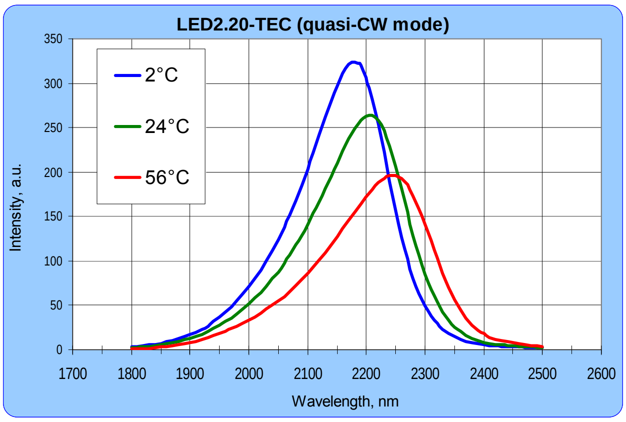
The other available LED chip design is Mid IR Flip-chip (LEDXXFC models). Main advantage of this design is free top surface. Larger area gives higher total optical power.

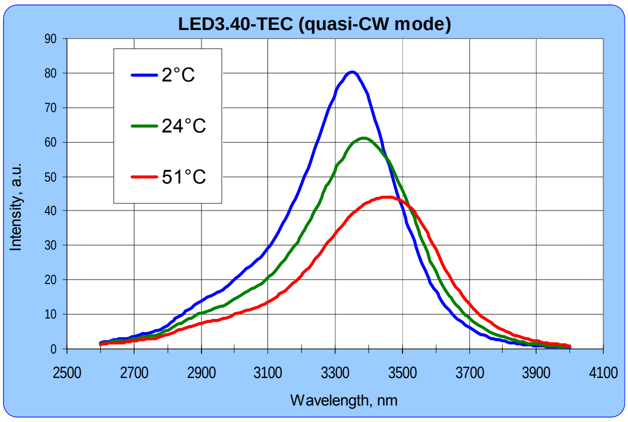
Cost of LEDs with flip-chips design is higher due to larger size.

Temperature Dependences of Optical Characteristics

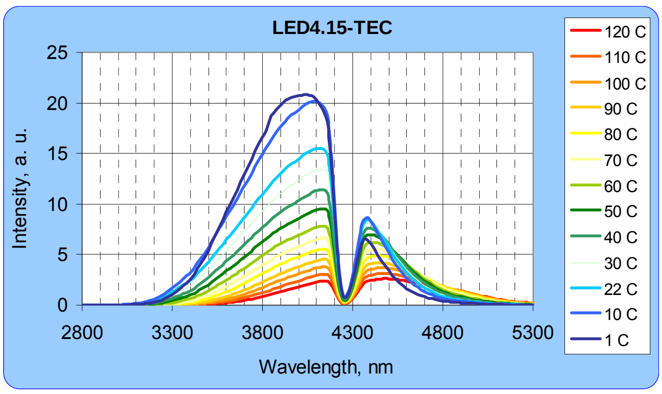
It is typical for all semiconductor radiation sources to have intensity decreasing with increasing temperature. This decrease of the emission intensity is due to several temperature-dependent factors including non-radiative recombination via deep levels, surface recombination, and carrier loss over heterostructure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

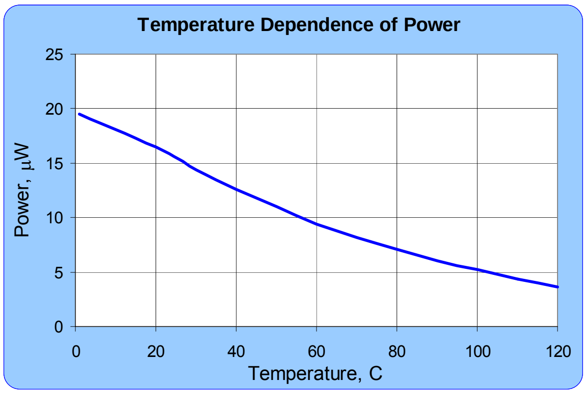
Housing LED chip into a package with a thermoelectric module (Peltier element) enables to obtain fixed temperature of a LED chip in a wide range and thereby to provide wavelength tuning and stabile operating at the desired wavelength.





IBSG LEDs can operate in a wide temperature range, so that certainly broadens their field of application. As an example LED4.15 spectra at 1-120°C temperature range are presented here.



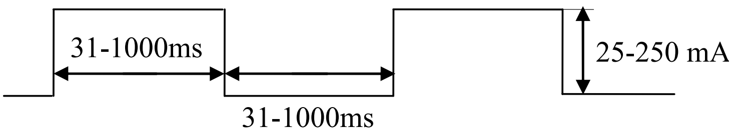


LED Parameters at Different Operation Modes

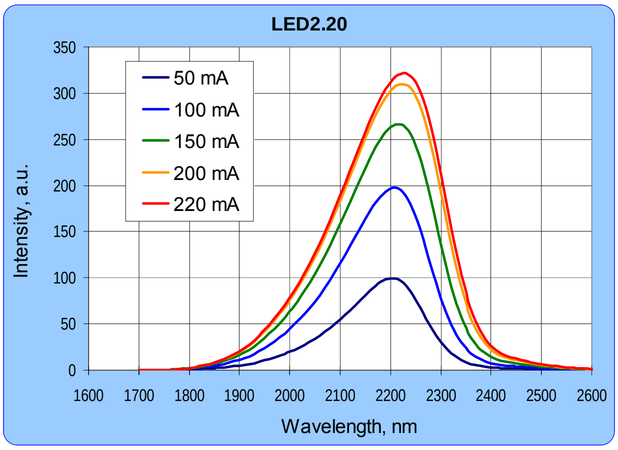
LEDs offer numerous benefits due to possibility for different operation modes. Optical parameters of light emitting diodes strongly depend on the regime of operation that you choose. To receive maximum average power we recommend using pulse modes with duty cycle 50% (quasi-continuous wave mode) or 25%. This mode provides signal modulation at certain frequency and allows obtaining higher output intensity than in case of using hard CW (continuous wave) mode. Due to these facts hard CW is not recommended. To obtain maximum peak power we recommend using short pulse modes (less then 50 ms).

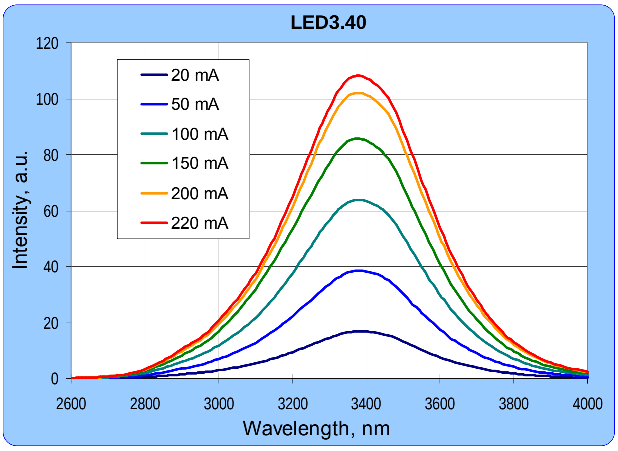
QUASI-CONTINUOUS WAVE (QUASI-CW) MODE:

f=0.5-16 kHz

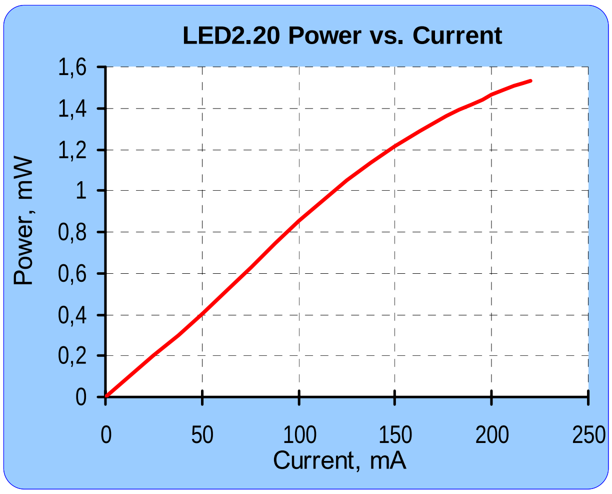


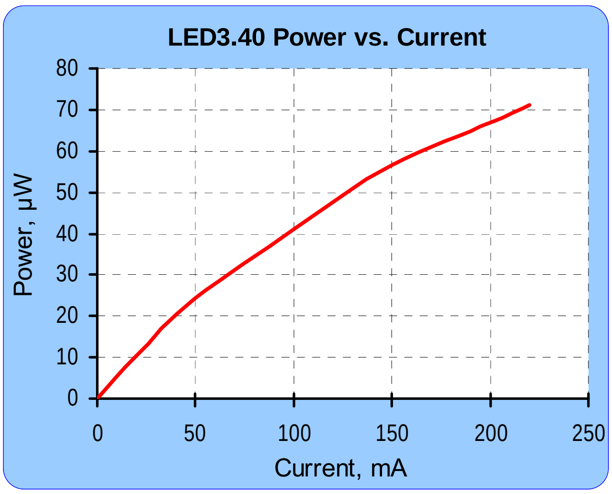
Spectra at different currents in the quasi-CW mode (frequency 0.5 kHz, duty circle 50%):





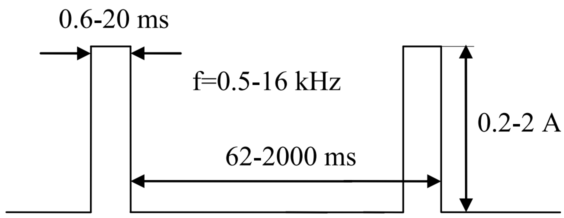
Power dependence on current in the quasi-CW mode (frequency 0.5 kHz, duty circle 50%):



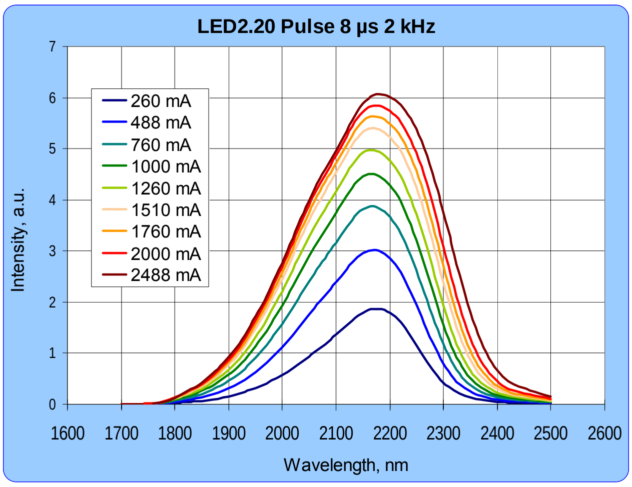


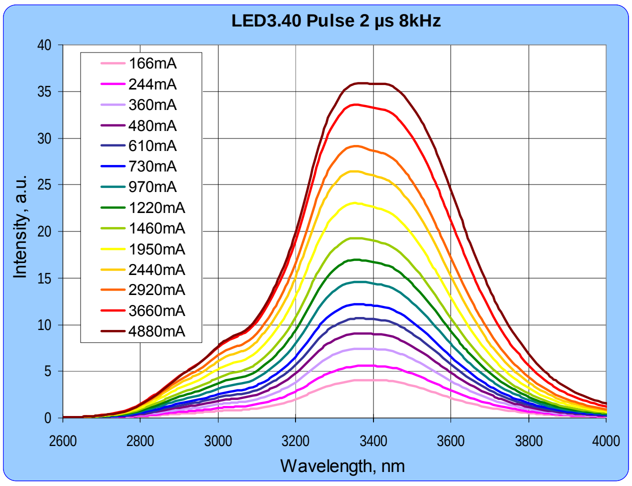
LED Parameters at Different Operation Modes

PULSE MODE:

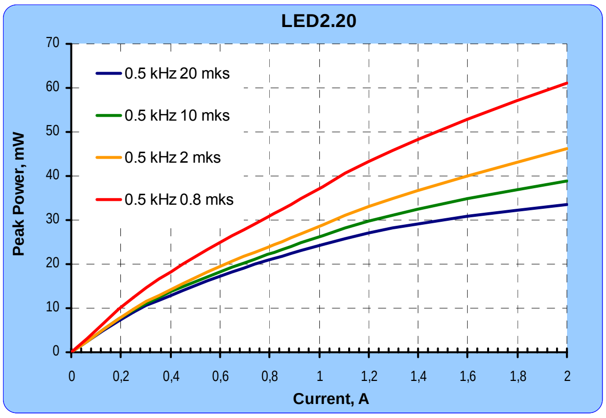


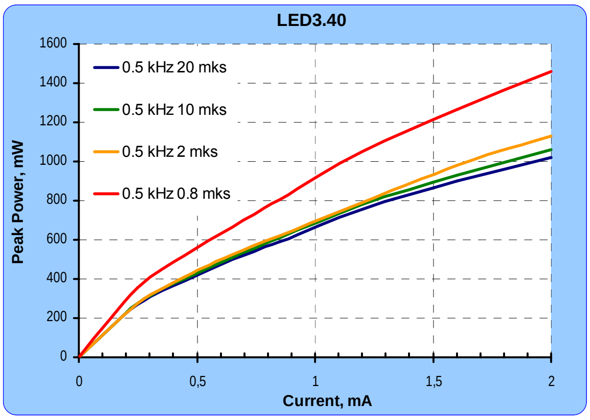
Spectra at different currents in the pulse mode:



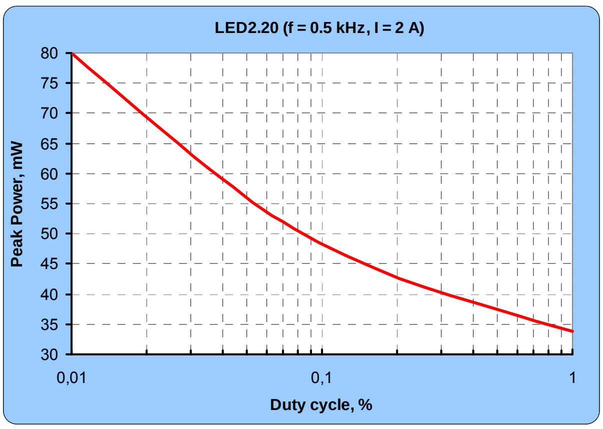


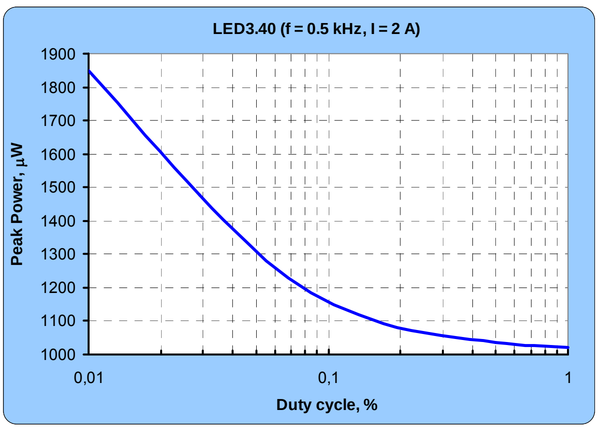
Power dependence on current in the pulse mode:





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





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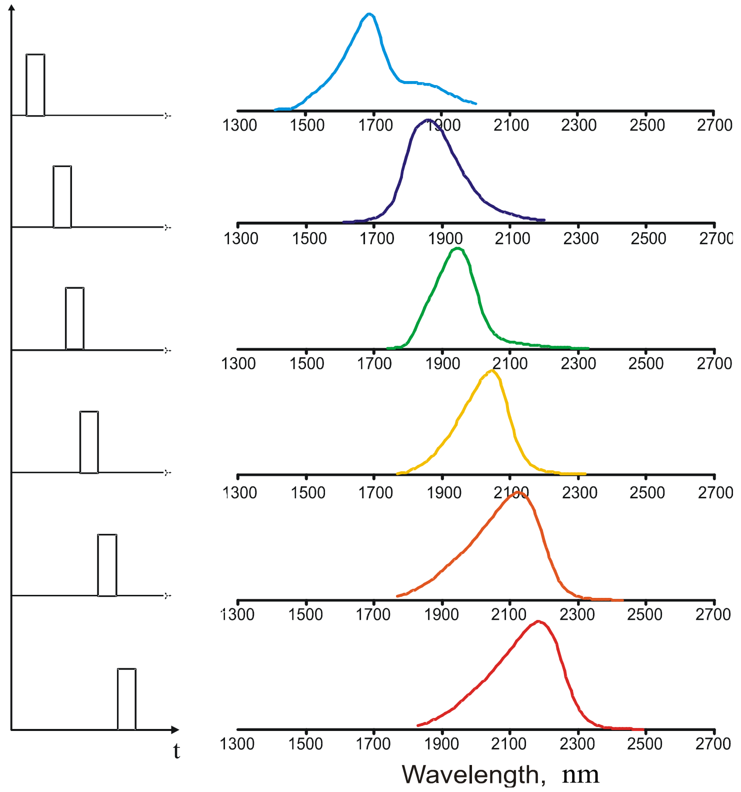
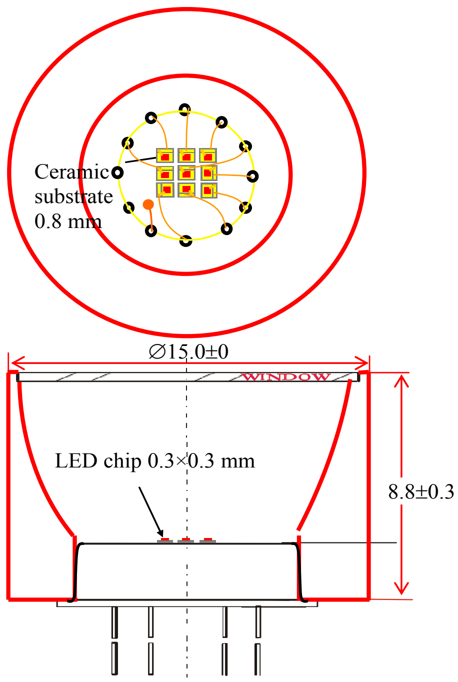
LED Arrays and Matrix

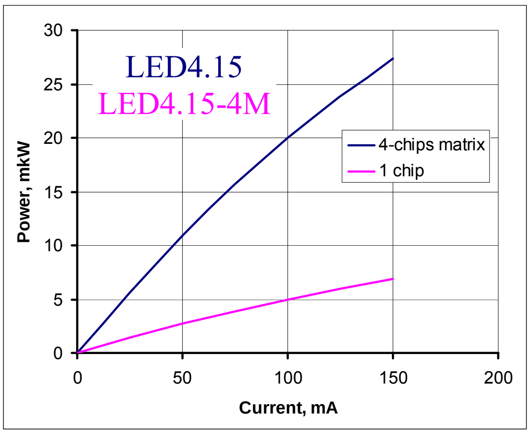
Tiny size of LED chip (0.35×0.35 mm), narrow-band emission spectrum, short response time and low thermal flux enables creating very compact multielement LED arrays and LED matrices emitting at one or different wavelengths.

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 certain spectral range with the help of very compact radiation source.



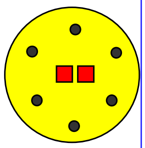
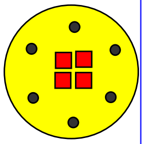
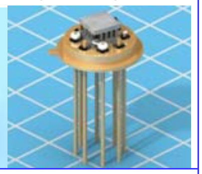
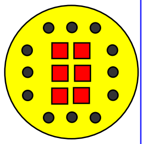
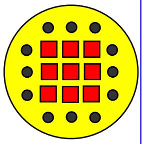
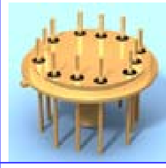
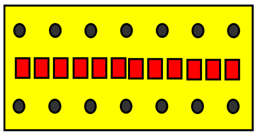
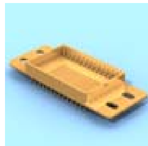
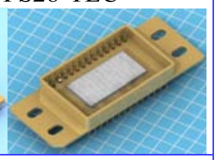
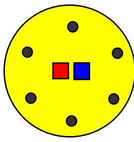
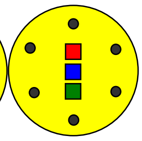
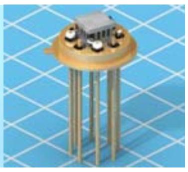
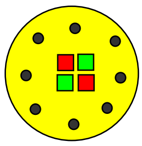
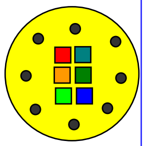
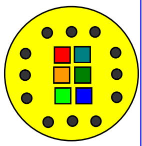
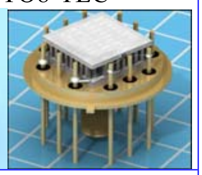
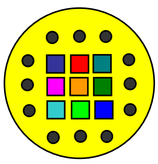
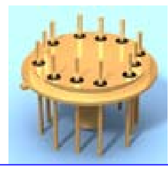
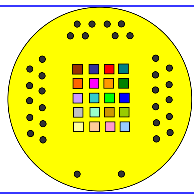


Parallel connection of several LED chips emitting at the same wavelength and driving them together provides significant increasing in total optical power.



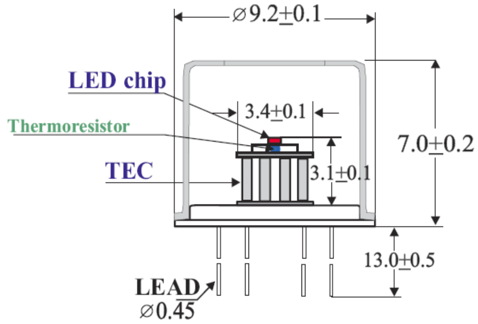
LED Arrays and Matrix

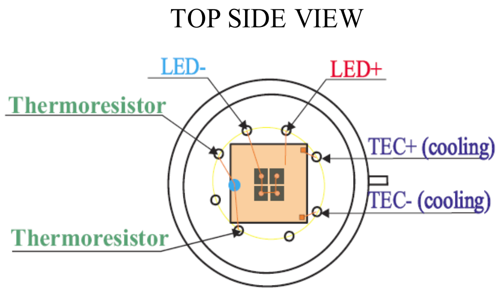
The number of array or matrix elements depends on the application and the package type being chosen. Standard TO-type packages offered by RMT Ltd. can be used. Thermoelectric modules built into these packages provide temperature stabilization of LED-chip parameters. Using these packages allows creating different variations of LED arrays and matrices arrangements. Some of them are presented below.

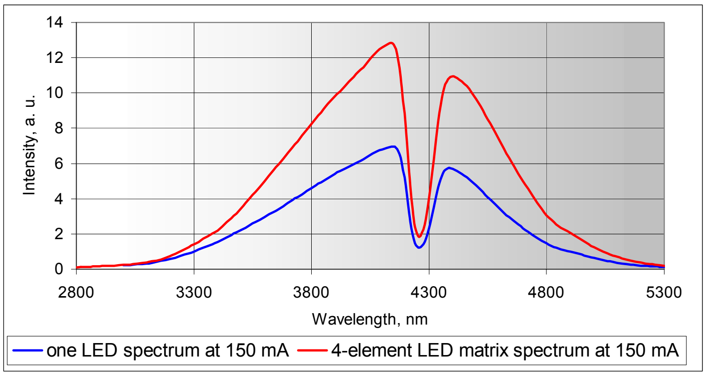
LED array/LED matrix Model	Element Arrangement	Package
✓ LEDXX-2M(-TEC), LEDXX-4M(-TEC): 2 or 4 LED elements on ceramic substrate emitting at one wavelength mounted on a single 9 mm package with/without thermoelectric module	 	TO5 TO5-TEC  
✓ LEDXX-6M(-TEC), LEDXX-9M(-TEC): 6 or 9 LED elements on ceramic substrate emitting at one wavelength mounted on a single 15 mm package with/without thermoelectric module	 	TO8 TO8-TEC  
✓ LEDXX-12A(-TEC): 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-TEC  
✓ LEDXX&YY&ZZ-2M(-TEC), LEDXX&YY&ZZ-3M(-TEC) 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-TEC  
✓ LEDXX&YY-4M(-TEC) 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		
✓ LEDXX÷YY-6M(-TEC) 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-TEC  
✓ LEDXX÷YY-9M 9 LED elements on ceramic substrate emitting at 9 different wavelengths mounted on a single 15 mm package without thermoelectric module		TO8 
✓ LEDXX÷YY-20M(-TEC) 20 LED elements on ceramic substrate emitting at 6 different wavelengths mounted on a single 36 mm package with/without thermoelectric module		MS32 MS32-TEC  

Two possible matrix arrangements are presented below in detail:

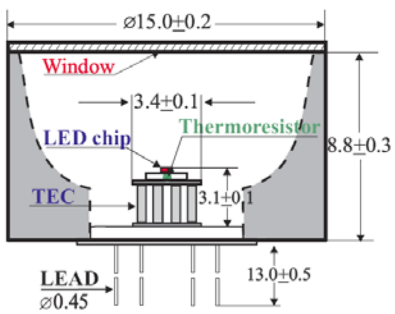
✓ 4-element LED matrix with one peak wavelength at 4.14 μm in 9 mm TO5 package with built-in thermoelectric module and a cap with sapphire window

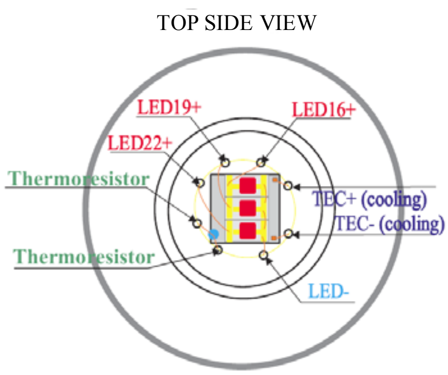


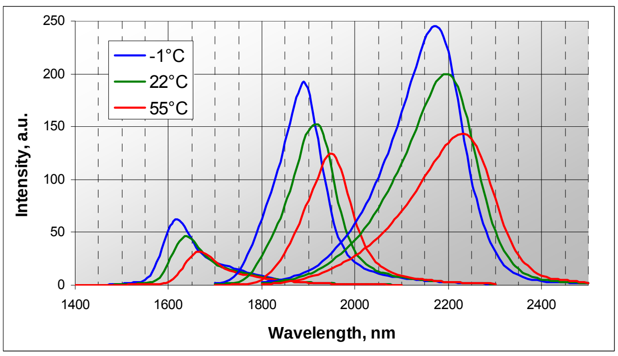




✓ 3-element LED matrix with peak wavelengths at 1.6, 1.9, 2.2 μm in 9 mm TO5 package with built-in thermoelectric module and a parabolic reflector with quartz window







Generally LEDs are mounted in a package that provides two electrical leads, a transparent optical window for the light to escape, and heat-sinking. LED chip is soldered to the package surface that is connected to one of the lead wires. Top contact of the chip is connected to the other lead with a bond 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

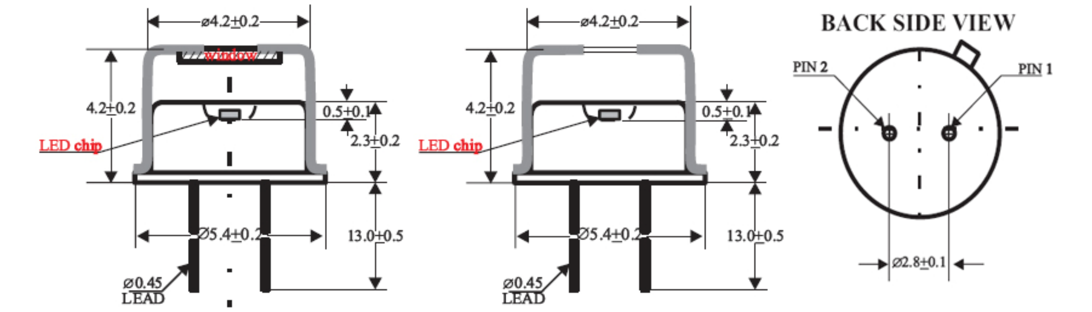
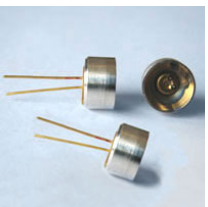
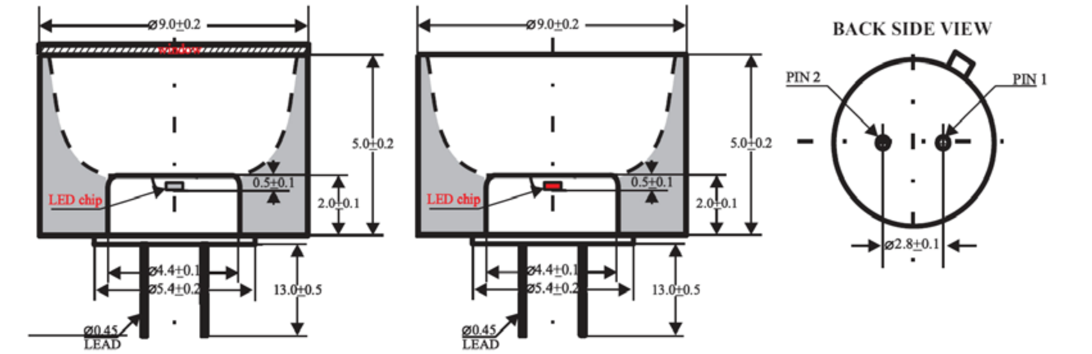
TO5 (TO39) – appropriate for mounting one element LEDs or LED-matrices

TO8 – appropriate for mounting multi-element LED-matrices

✓ SMD type packages:

SMD3 (3×3 mm), SMD5 (5×5 mm), SMD5R (5×5 mm with microreflector) – appropriate for mounting one-element LEDs

SMD5R-3M (5×5 mm) – appropriate for mounting three-element LED-matrices

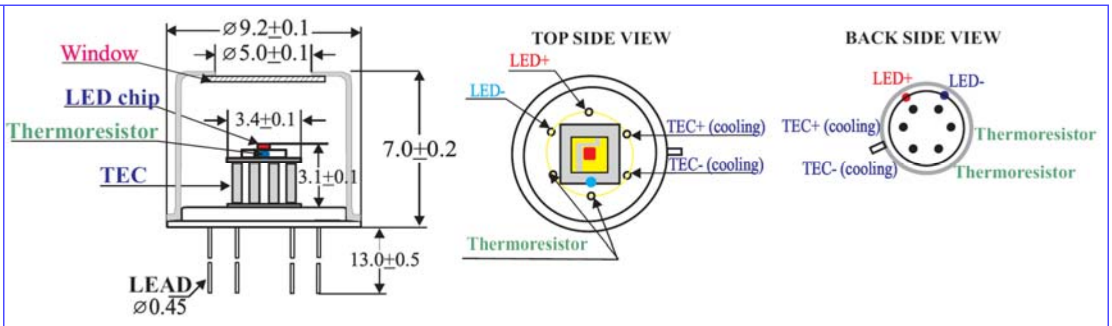
TO18 	
TO18-PR TO18-PRwin 	

- 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 window) or a parabolic reflector (with/without a window)

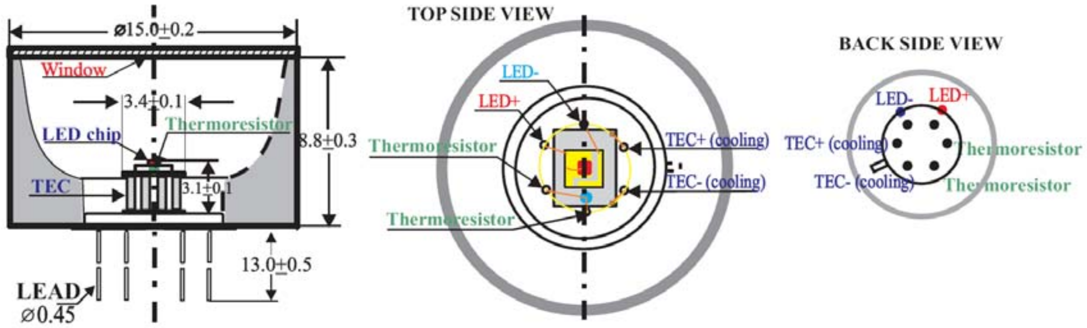
Cap with a window (typically for models LED1.58-LED2.15) or without a window (for model LED2.20-LED4.45) protects LED device from damage

Parabolic reflector with a quartz (for models LED1.58-LED3.65) or sapphire (for models LED3.75-LED4.45) window (PRwin) or without a window (PR) protects LED device from damage, provides the reduction of radiation divergence to 12° and improves the heat-sinking

TO5



TO5-PR

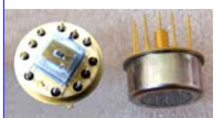


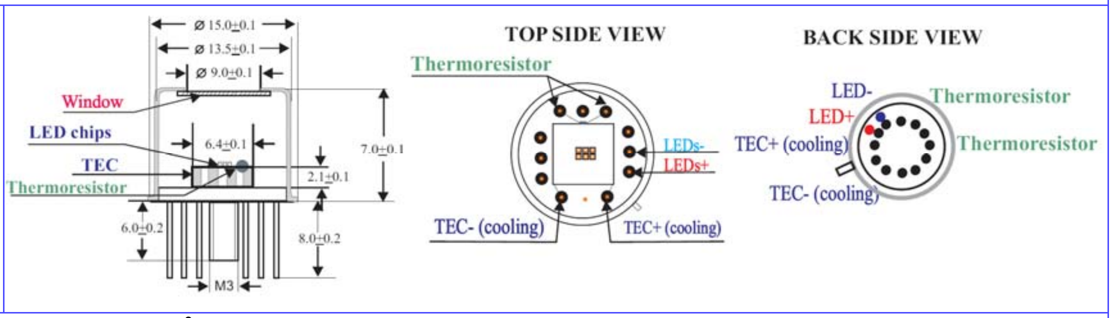
- Small packages with 3.2×3.2 mm^2 header surface open for mounting
- Material – kovar, finish – gold/plating
- The number of lead pins is 6 or 9
- Built-in thermoelectric module – thermocooler (TEC) and thermoresistor – provides LED chip temperature adjusting and stabilizing in the range -5…+65°C
- Equipped with a cap (with a window) or a parabolic reflector (with a window)

Cap with a quartz (for models LED1.58-LED3.65) or sapphire (for models LED3.75-LED4.45) window protects LED device from damage

Parabolic reflector with a quartz (for models LED1.58-LED3.65) or sapphire (for models LED3.75-LED4.45) window (PRwin) protects LED device from damage and provides the reduction of radiation divergence

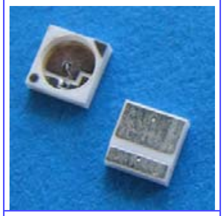
TO8

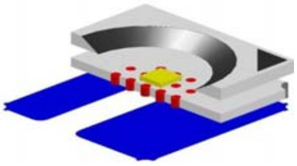


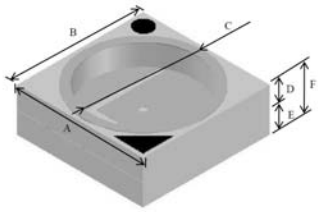


- Small packages with 8×8 mm^2 header surface open for mounting
- Material – kovar, finish – gold/plating
- The number of lead pins is 12
- Built-in thermoelectric module – thermocooler (TEC) and thermoresistor – provides LED chip temperature adjusting and stabilizing in the range -5…+65°C
- Equipped with a cap with a quartz (for models LED1.58-LED3.65) or sapphire (for models LED3.75-LED4.45) window that protects LED device from damage

SMD3
3×3 mm

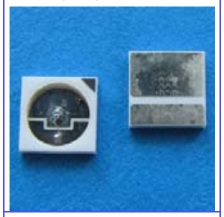


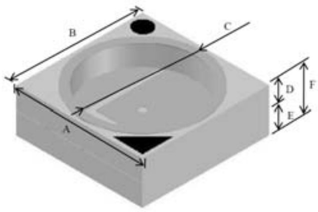




ITEM	Symbol	Rule
Basic Outline	A	3.0± 0.1mm
Basic Outline	B	3.0± 0.1mm
Cavity size	C	Max 2.4Φ
Top layer	D	Min 0.4mm
Bottom layer	E	Min 0.4mm
Thickness	F	Max 2mm

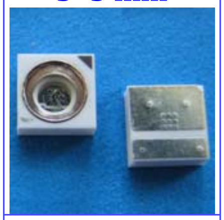
SMD5
5×5 mm

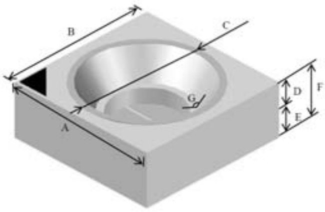




ITEM	Symbol	Rule
Basic Outline	A	5.0± 0.1mm
Basic Outline	B	5.0± 0.1mm
Cavity size	C	Max 4.2Φ
Top layer	D	Min 0.4mm
Bottom layer	E	Min 0.4mm
Thickness	F	Max 2mm

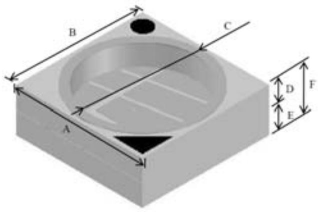
SMD5R
5×5 mm





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

SMD5R-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

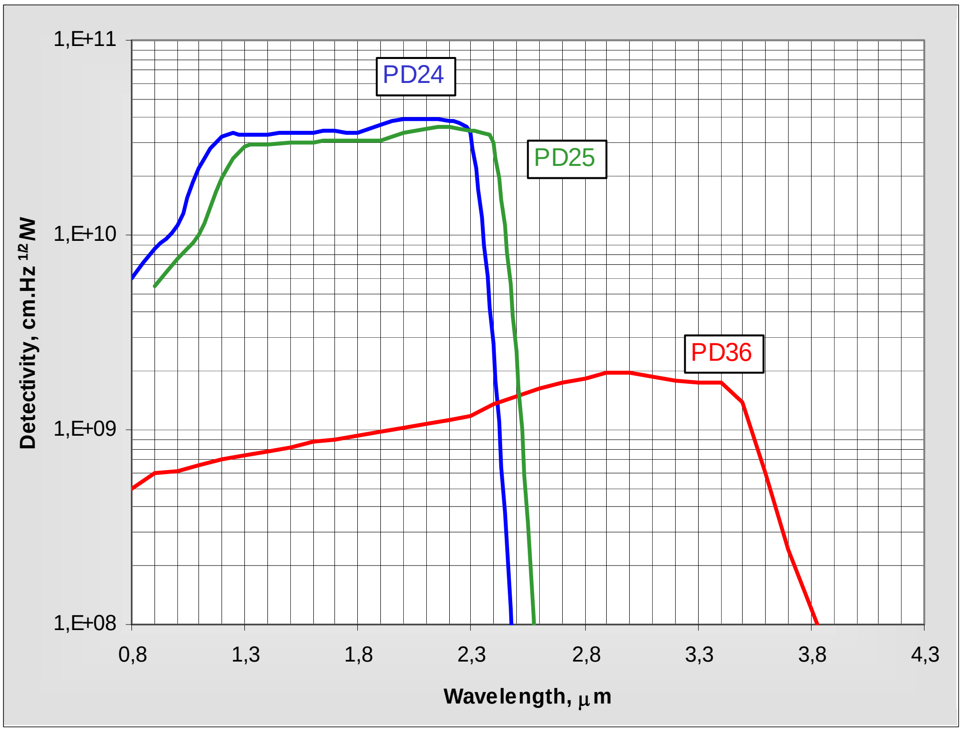
- Tiny packages for surface mounting
- Anode and cathode are led to the metalized areas on the back side of the ceramic surface
- Material – Low Temperature Co-fired Ceramic (LTCC):
  - thermal conductivity 25 W/mK
  - thermoresistance 8°C/W
- Microreflector (for model SMD5R) provides the reduction of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

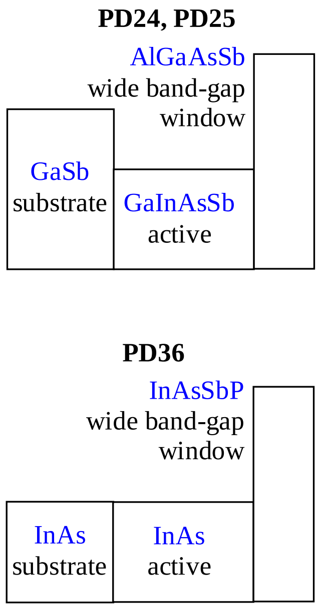
In addition to our standard packages we are ready to offer specially designed solutions according to customers needs.

The nomenclature of IBSG production includes:

MID INFRARED POTODIODES WITH CUT-OFF λ=2.4; 2.5; 3.8; 4.3 μm

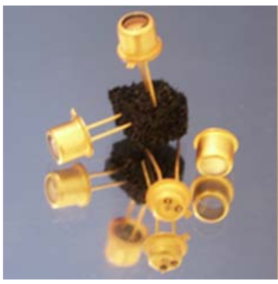
Curves of detectivity vs. wavelength at room temperature are presented here. With decreasing temperature (using thermo-electric cooler) detectivity increases and cut-off wavelength shifts to shorter wavelengths.



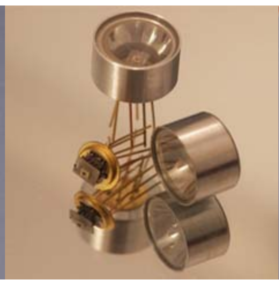


IBSG photodiodes are based on heterostructures with wide band-gap window. PD24 and PD25 models are based on GaInAsSb/GaAlAsSb structure, PD36 is based on InAs/InAsSbP structure. Fast response time makes them suitable for detection of high-frequency modulated IR laser radiation. Photodiodes with cut-off 4.3 μm PD43 are based on PbSe material.

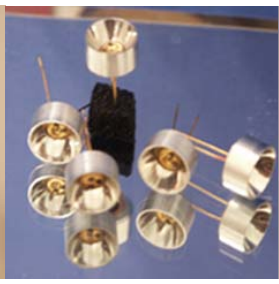
The device is mounted on the TO-18 package or TO-5 package with built-in thermoelectric module (TEC) inside and can be equipped with a parabolic reflector (PR).



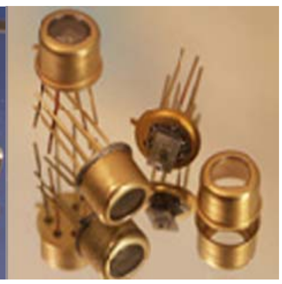
TO-18



TO-5-TEC-PR

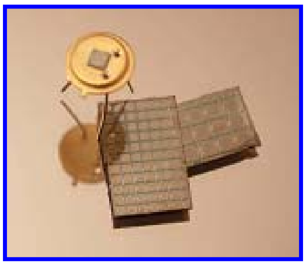


TO-18-PR



TO-5-TEC

Discrete photodiodes are produced in 5 variants:



Series PDXX

♦ PDs are mounted on a standard 5.4 mm package TO-18 with a cap.

Series PDXX-PR

♦ PDs are mounted on the same package TO-18 with a parabolic reflector.

Series PDXX-PRW

♦ PDs are mounted on TO-18 with parabolic reflector. Quartz or sapphire window is added to the reflector.

Series PDXX-TEC

♦ PDs are mounted on a 9 mm package TO-5 with built-in micro TE cooler and thermistor. Cap with quartz or sapphire window is hermetically welded.

Series PDXX-TEC-PR

♦ PDs are mounted on a 9 mm package TO-5 with built-in micro TE cooler and thermistor. Parabolic reflector with quartz or sapphire window is hermetically welded.

Standard types of photodiodes are produced using PD chips with ring top contact and different sizes of the sensitive area.

Series PD24 (PD24-02; PD24-05; PD24-10; PD24-20)

♦ PD24 are produced with the sizes of the sensitive area as follows: 0.2 mm (PD24-02), 0.5 mm (PD24-05), 1.0 mm (PD24-10) and 2.0 mm (PD24-20). Model PD24-20 is mounted on a 9 mm package TO-5. Model PD24-20 (without TEC) is not available with parabolic reflector. All other models PD24 are available in 5 standard variants described above.

Series PD25 (PD25-02; PD25-05; PD25-10; PD25-20)

♦ PD25 are produced with the sizes of the sensitive area as follows: 0.2 mm (PD25-02), 0.5 mm (PD25-05), 1.0 mm (PD25-10) and 2.0 mm (PD25-20). Model PD25-20 is mounted on a 9 mm package TO-5. Model PD25-20 (without TEC) is not available with parabolic reflector. All other models PD25 are available in 5 standard variants described above.

Series PD36 (PD36-02; PD36-03; PD36-05)

♦ PD36 are produced with next sizes of the sensitive area: 0.2 mm (PD36-02), 0.3 mm (PD36-03), and 0.5 mm (PD36-05).

Photodiode PD43

♦ PD43 is produced with size of the sensitive area 2x2 mm. It is mounted in 9mm package TO-5 with cap and silicon window.

Photoresistor PR43

♦ PR43 is produced with size of the sensitive area 2x2 mm. It is mounted in 9mm package TO-5 with cap and silicon window.

Optionally photodiodes with other sizes of sensitive area can be produced. Designing and producing of multi-element photodiodes is also available.

PHOTODIODES

Main Parameters

PD24-03÷05 for 1.6-2.4 μm spectral range

Parameters	Units	Condition	PD 24-03	PD 24-05
Sensitive Area Diameter	mm		0.3	0.5
Cut-off Wave-length	μm	at 10 %	2.4	2.4
Peak Wavelength	μm	>90%	2.0-2.2	2.0-2.2
Responsivity	A/W	at λ_p	0.9-1.1	0.9-1.1
Dark Current	μA	V_R=-0.2 V =-0.5 V =-1.0 V	0.7-3.0 1.5-6.0 2.0-10	3-10 6-15 8-20
Impedance	kOhm	V_R=10 mV	30-100	8-20
Capacitance	pF	V_R=0 V f=1 MHz	10-50	80-400
Rise and Fall Time	ns	(0V;50 Ohm)	2-10	15-80
Detectivity	cm.Hz$^{1/2}$/W	(λ_p,1000,1)	(1-3) $*10^{10}$	(3-5) $*10^{10}$
Package PD24-XX PD24-XX-PR, PD24-XX-PRW PD XX-TEC PD XX-TEC-PR			TO-18 TO-18+PR TO-5 TO-5+PR	TO-18 TO-18+PR TO-5 TO-5+PR

PD24-10÷20 for 1.6-2.4 μm spectral range

Parameters	Units	Condition	PD 24-10	PD 24-20
Sensitive Area Diameter	mm		1.0	2.0
Cut-off Wave-length	μm	at 10 %	2.4	2.4
Peak Wavelength	μm	>90%	2.0-2.0	2.0-2.2
Responsivity	A/W	at λ_p	0.9-1.1	0.9-1.1
Dark Current	μA	V_R=-0.2 V =-0.5 V =-1.0 V	30-60 50-150 70-200	50-100 100-200 150-300
Impedance	kOhm	V_R=10 mV	0.7-4.0	0.3-1.5
Capacitance	nF	V_R=0 V f=1 MHz	0.5-1.5	1.2-3.0
Rise and Fall Time	ns	(0V; 50 Ohm)	100-200	120-400
Detectivity	cm.Hz$^{1/2}$/W	(λ_p,1000,1)	(3-5) $*10^{10}$	(5-8) $*10^{10}$
Package PD24-XX PD24-XX-PR, PD24-XX-PRW PD XX-TEC PD XX-TEC-PR			TO-18 TO-18+PR TO-5 TO-5+PR	TO-5 TO-5+PR TO-5 TO-5+PR

PD36-02÷03 for 2.4-3.8 µm spectral range

Parameters	Units	Condition	PD 36-02	PD 36-03
Sensitive Area Diameter	mm		0.2	0.3
Cut-off Wave-length	µm	at 10 %	3.8	3.8
Peak Wavelength	µm	>90%	2.8-3.4	2.8-3.4
Responsivity	A/W	at λ_p	1.0-1.2	1.0-1.2
Dark Current	µA	V_R=-0.2 V	200-300	300-500
Impedance	Ohm	V_R=10 mV	130-200	100-150
Capacitance	pF	V_R=0 V V_R=-0.5 V (f=1 MHz)	1300-2000 100-300	1500-2200 150-400
Rise and Fall Time	ns	(0 V; 50 Ohm) (0.5V; 50 Ohm)	150-200 20-50	180-220 30-60
Detectivity	cm.Hz$^{1/2}$ /W	(λ_p,1000,1)	(1-3) *10^9	(1-3) *10^9
Package PD36-XX PD36-XX-PR, PD36-XX-PRW PD XX-TEC PD XX-TEC-PR			TO-18 TO-18+PR TO-5 TO-5+PR	TO-18 TO-18+PR TO-5 TO-5+PR

PD25-05 for 2.4-3.8 mm spectral range

Parameters	Units	Condition	PD 36-05
Sensitive Area Diameter	mm		0.5
Cut-off Wave-length	µm	at 10 %	3.8
Peak Wavelength	µm	>90%	2.8-3.4
Responsivity	A/W	at λ_p	1.0-1.2
Dark Current	µA	V_R=-0.2 V	500-800
Impedance	kOhm	V_R=10 mV	50-120
Capacitance	nF	V_R=0 V V_R=-0.5 V (f=1 MHz)	2000-3000 400-900
Rise and Fall Time	ns	(0 V; 50 Ohm) (0.5V; 50 Ohm)	250-350 80-150
Detectivity	cm.Hz$^{1/2}$ /W	(λ_p,1000,1)	(2-4) *10^9
Package PD36-XX PD36-XX-PR, PD36-XX-PRW PD XX-TEC PD XX-TEC-PR			TO-18 TO-18+PR TO-5 TO-5+PR

Generally Photodiodes are mounted in a package that provides two electrical leads, a transparent optical window for the light to escape, and heat-sinking. PD chip is soldered to the package surface that is connected to one of the lead wires. Top contact of the chip is connected to the other lead with a bond wire.

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

✓ TO-type packages:

TO18 – appropriate for mounting small area (0.2mm, 0.3mm, 0.5mm and 1.0mm) photodiodes without thermocooler.

TO5 (TO39) – appropriate for mounting bigger area photodiodes (1.0mm and 2.0mm) as well as photodiodes with thermocooler.

<table>
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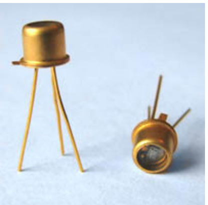
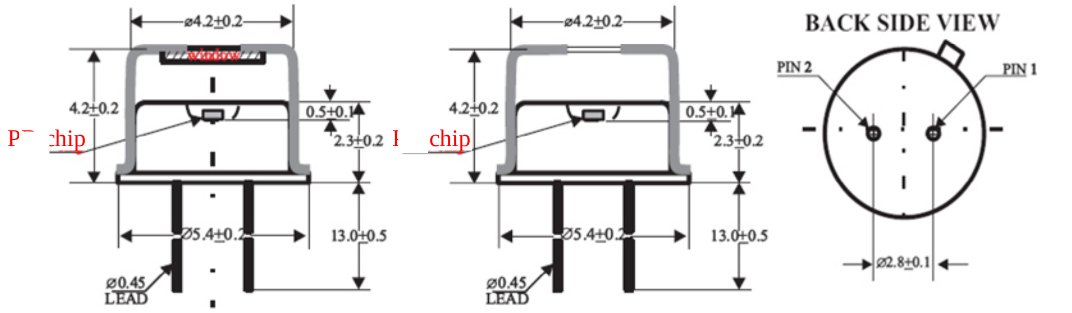
</td><td>
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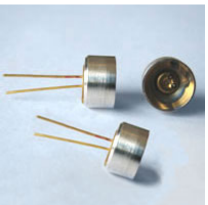
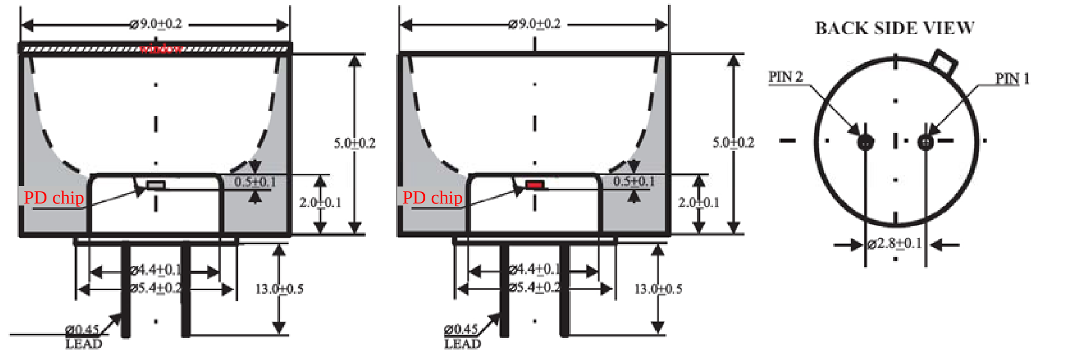
<tr><td>TO18-PR
TO18-PRwin
</td><td>
</td></tr>
</table>

- 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 window) or a parabolic reflector (with/without a window)

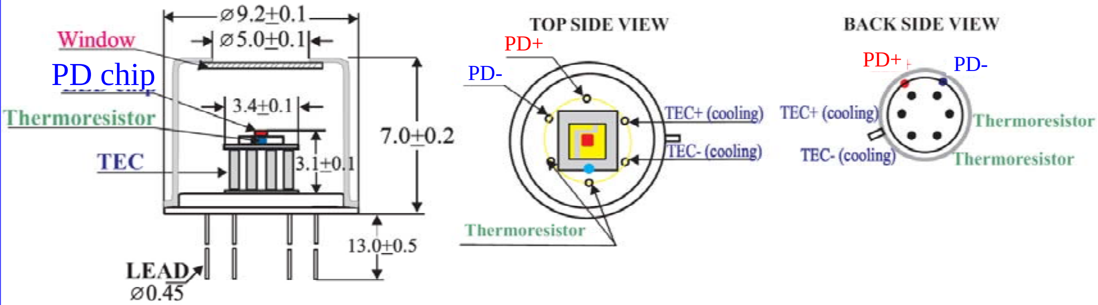
Cap with a window (typically for models PD24 and PD25) or without a window (for model PD36) protects PD device from damage

Parabolic reflector with a quartz (for models PD24, PD25 and PD36) or sapphire (for models PR43, PD43) window (PRwin) or without a window (PR) protects PD device from damage, increases part of radiation that reaches sensitive area of the photodiode.

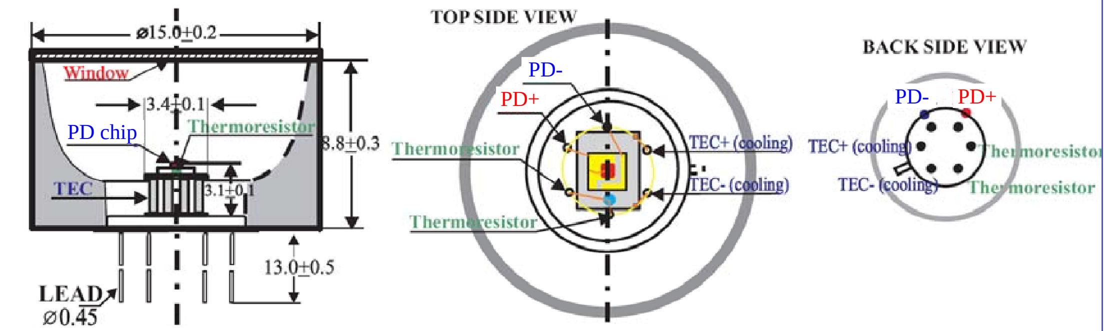
PHOTODIODES

Packages

TO5



TO5-PR

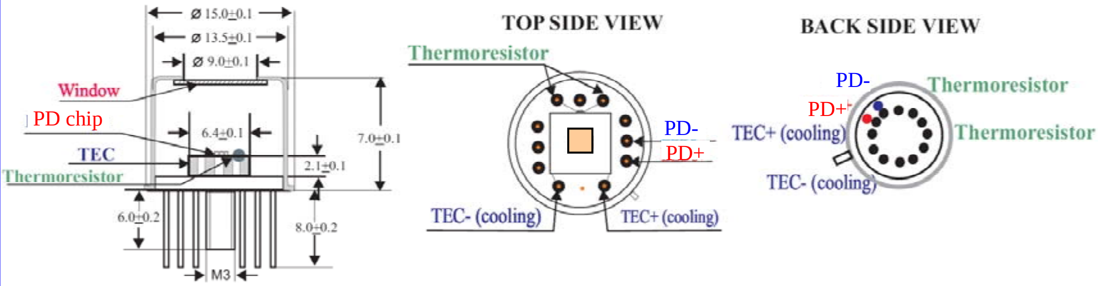


- Small packages with 3.2×3.2 mm^2 header surface open for mounting
- Material – kovar, finish – gold/plating
- The number of lead pins is 6 or 9
- Built-in thermoelectric module – thermocooler (TEC) and thermoresistor – provides PD chip temperature adjusting and stabilizing in the range -5…+65°C
- Equipped with a cap (with a window) or a parabolic reflector (with a window)

Cap with a quartz (for models PD24, PD25 and PD36) or sapphire (for models PR43 and PD43) window protects PD device from damage

Parabolic reflector with a quartz (for models PD24, PD25 and PD36) or sapphire (for models PR43, PD43) protects PD device from damage, increases part of radiation that reaches sensitive area of the photodiode.

TO8



- Small packages with 8×8 mm^2 header surface open for mounting
- Material – kovar, finish – gold/plating
- The number of lead pins is 12
- Built-in thermoelectric module – thermocooler (TEC) and thermoresistor – provides PD chip temperature adjusting and stabilizing in the range -35…+65°C
- Equipped with a cap with a quartz (for models PD24, PD25 and PD36) or sapphire ((for models PR43, PD43) window that protects LED device from damage

According to IBSG 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 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:

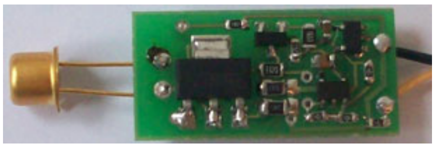
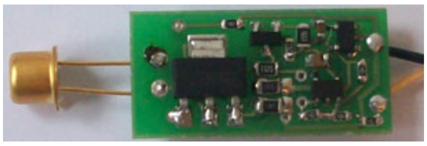
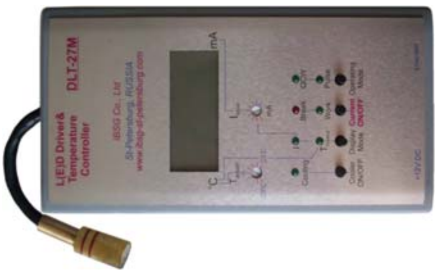
LED Drivers, LED Drivers with Temperature Controllers

LED \ Driver	mD-1c	mD-1p	D-31	DLT-27	DLT-37
LEDXX	mD-1c	mD-1p	D-31		
LEDXX–PR	mD-1c	mD-1p	D-31		
LEDXX–PRwin	mD-1c	mD-1p	D-31		
LEDXX–TEC				DLT-27	DLT-37
LEDXX–TEC–PR				DLT-27	DLT-37

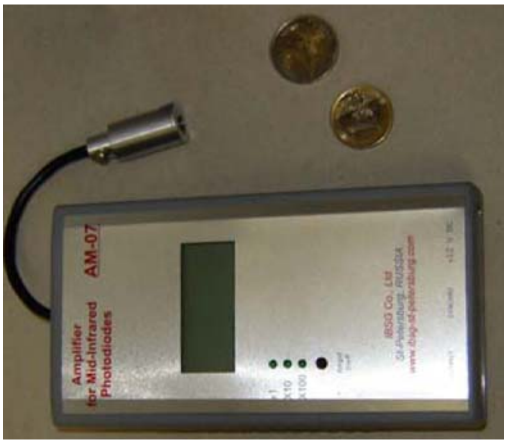
PD Amplifiers, PD Amplifiers with Temperature Controllers

PD \ Amplifer	**AM-07 for PD24**	**AM-07 for PD36**	**AM-07 for PR43**	**AMT-07 for PD24–TEC(–PR)**	**AMT-07 for PD36–TEC(–PR)**
PD24	AM-07 for PD24				
PD36		AM-07 for PD36			
PR43			AM-07 for PR43		
PD24–TEC(–PR)				AMT-07 for PD24–TEC(–PR)	
PD36–TEC(–PR)					AMT-07 for PD36–TEC(–PR)

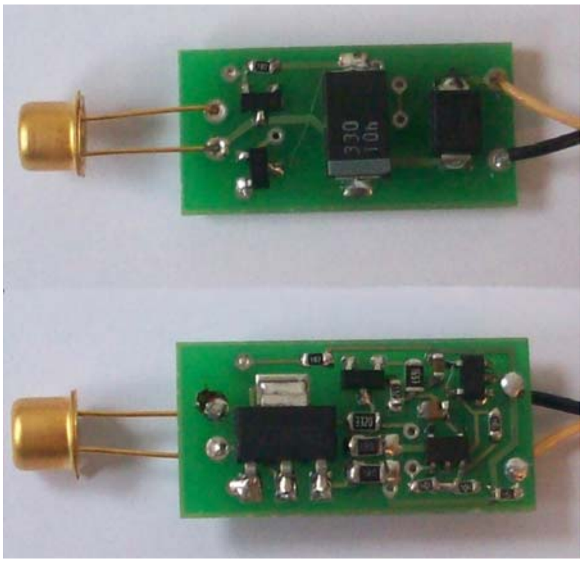
LED Drivers are produced in 5 variants:

LED mini-driver mD-1c 	LED driver mD-1c generates symmetrical unipolar meander (quasi-continuous mode). Such mode provides maximum average optical power from the LED. Signal data (such as amplitude, repetition rate and pulse duration), remains steady while the input voltage may vary from 5 to 6 voltage.
LED mini-driver mD-1p 	LED driver mD-1p generates sequence of pulses (pulse mode). Such mode provides maximum peak optical power from the LED. Signal data (such as amplitude, repetition rate and pulse duration), remains steady while the input voltage may vary from 5 to 6 voltage.
LED driver D-31 	Driver D-31 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 Mid-IR 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 Mid-IR 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.

PD Amplifiers are produced in 2 variants:

Amplifier for a Photodiode AM-07  	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. Sinchrodetector 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-inamplifiers, oscilloscopes or A/D converters. Sinchrodetector 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 termocooler and thermistor (Models PDXX-XX-TEC). Customer can select and set the PD operation temperature. Circuit with feedback will set the appropriate thermocooler current for maintaining the selected temperature.

Mini LED driver mD-1c



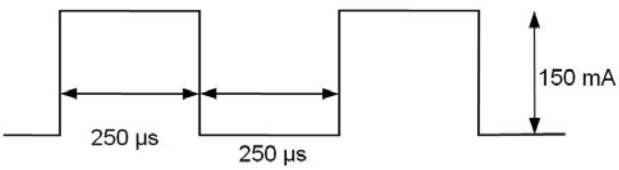
FEATURES

- The driver generates symmetrical unipolar meander (quasi-continuous mode). Such mode provides maximum average optical power from the LED.
- Signal data (such as amplitude, repetition rate and pulse duration) don't depend on the input voltage which may vary from 5 to 6 V.
- Easy and durable in use.
- Compact.
- The possibility of changing driver's settings on the customer's request.

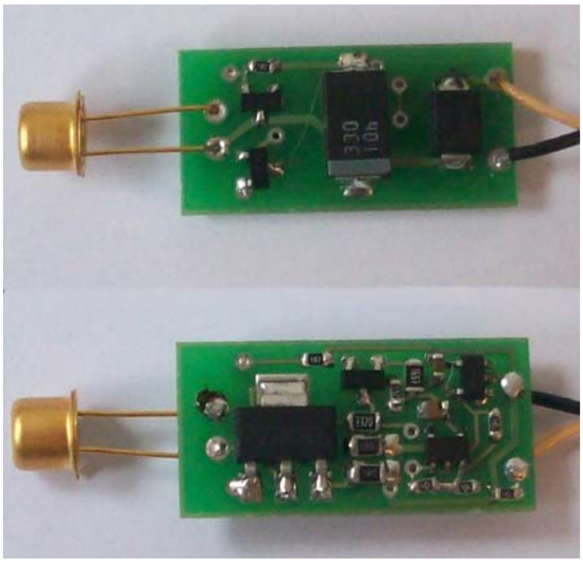
TECHNICAL CHARACTERISTICS

Parameter	Value
Input voltage range	Stabilized +5 ÷ +6 V
Power consumption	Less then 1 watt
Board dimensions (without LED), mm	24×12
Weight	5 g
Repetition rate (Frequency)	2 kHz
Pulse duration	250 μs
Output current amplitude	150 mA

CURRENT WAVEFORM GENERATED BY THE DRIVER



Mini LED driver mD-1p



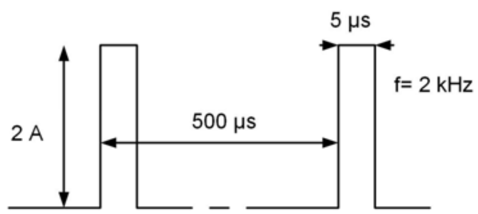
FEATURES

- The driver generates sequence of pulses (pulse mode). Such mode provides maximum peak optical power from the LED.
- Signal data (such as amplitude, repetition rate and pulse duration), don't depend on the input voltage which may vary from 5 to 6 V.
- Easy and durable in use.
- Compact.
- The possibility of changing driver's settings on the customer's request.

TECHNICAL CHARACTERISTICS

Parameter	Value
Input voltage range	Stabilized +5 ÷ +6 V
Power consumption	Less then 1 watt
Board dimensions (without LED), mm	24×12
Weight	5 g
Repetition rate (Frequency)	2 kHz
Pulse duration	5 μs
Output current amplitude	2 A

CURRENT WAVEFORM GENERATED BY THE DRIVER



APPLICATION

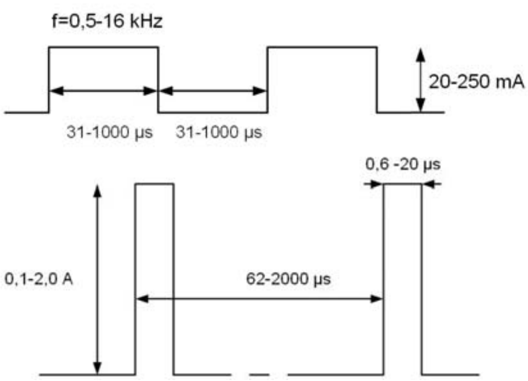
The driver D-31 is designed for power supply of Mid-IR LEDs manufactured by IBSG.

FEATURES

- The driver D-31 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 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 in use.

TECHNICAL CHARACTERISTICS

CURRENT WAVEFORM GENERATED BY THE DRIVER IN QSW 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 г

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	20 – 250 mA	0,1- 2,0 A

LED Driver DLT-37M

APPLICATION

The driver DLT-37M is designed for power supply of all models Mid-IR LEDs with built-in cooler manufactured by IBSG.

FEATURES

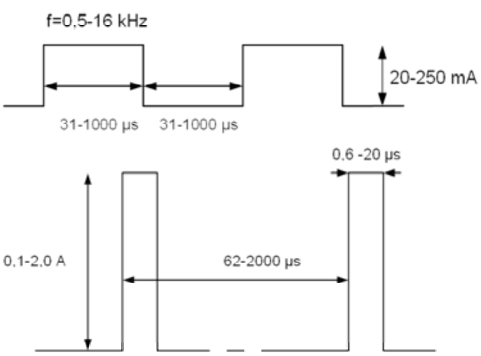
▪ The driver DLT-37M provides two modes of operation: Quasi Continuous Wave mode (the mode of *maximum average optical power* from the LED) and pulse mode (the mode of *maximum peak optical power* from the LED).

▪ 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 to stabilize and tune 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

CURRENT WAVEFORM GENERATED BY THE DRIVER IN QSW AND PULSE MODES



TECHNICAL CHARACTERISTICS

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 г

Signal data	QCW mode	Pulse mode
Pulse duration	31 – 1000 µs	0,6 – 20 µs
Repetition rate (Frequency)	0,5 – 16 kHz	0,5 – 16 kHz
Output current amplitude	20 – 250 mA	0,1- 2,0 A

PD Amplifier AMT-07M

APPLICATION

The amplifier AMT-07M is designed for amplification of signal from Mid IR 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 on the LED's chip in wide range. That gives possibility to tune and stabilize the photodiode spectral characteristics.

TECHNICAL CHARACTERISTICS

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