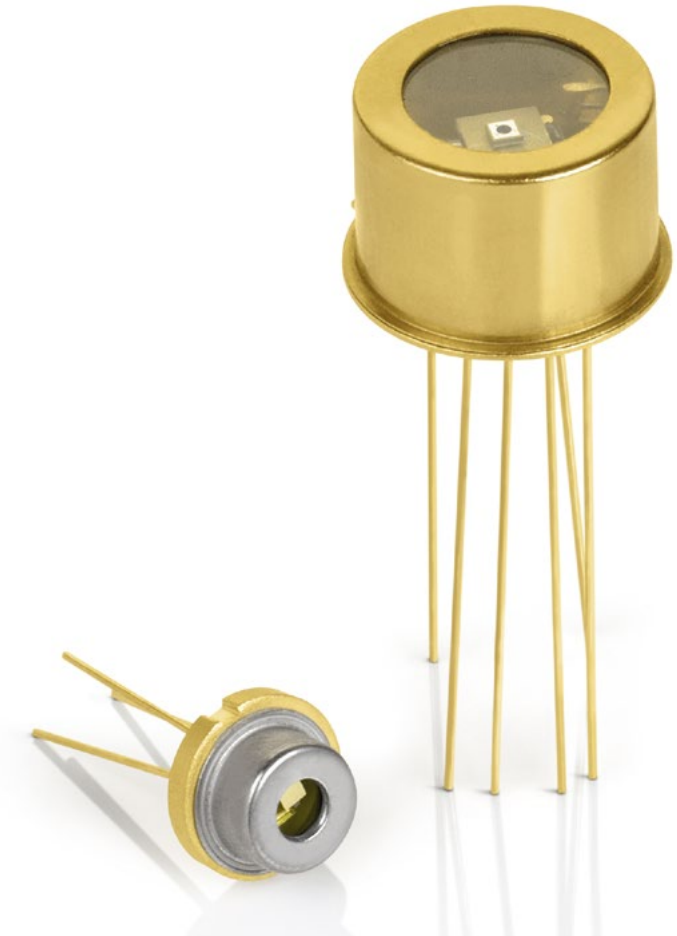
DETECTORS

LASERS

Pulsed Laser Diodes
Avalanche Photodiodes



small components
MASSIVE IMPACT

Patrick Paul

Dear Reader,

Welcome to the 6th edition of our catalog "Pulsed Laser Diodes and Avalanche Photodiodes". Much has happened since the original catalog was published: We have significantly expanded our production facilities and capabilities in recent years and the products contained in this edition have had a profound positive influence on LASER COMPONENTS' success.

We are pleased to present the ever-increasing range of products manufactured at our factories in Germany, Canada and the USA. LASER COMPONENTS is both manufacturer and distributor and understands the business from both sides, providing competent advice as a technology leader in the fields of pulsed laser diodes and avalanche photodiodes.

Since the beginning we have placed particular emphasis on the support of tailor-made OEM solutions, which are developed in close collaboration with our customers. With this catalog, we hope to provide insight into how our components are used in a wide variety of applications. These range from LiDAR and rangefinding, through sensor technology, to medical and automotive projects, as well as scientific fields such as quantum cryptography.

If you can't find what you are looking for in the catalog, please don't hesitate to contact our technical staff, who will be pleased to assist you. Custom products are often much more economical to develop than you might expect. We look forward to working together with you.

Yours

Patrick Paul
CEO

CONTENT

In-House Manufacturing


© Florian Holzherr

Pulsed laser diodes, avalanche photodiodes, CUBEs, COUNT® modules and much more: LASER COMPONENTS makes them in-house – in Germany, Canada and the USA.

The interplay between the three factories enables the production of systems based on the various components made by the LASER COMPONENTS group. Out of this synergy evolved the COUNT® modules and CUBE series, to name just two examples. We offer standard products but also custom designs – whatever the quantity.

Custom Products

We specialize in custom design and development to your exact requirements, offering competent advice and support from the initial idea through to the finished product. Our engineering team is ready to assist when needed, ensuring you get exactly the product you need.

PRODUCTION

Pulsed Laser Diodes

Jeff Britton, CEO

LASER COMPONENTS Canada, Inc. produces pulsed laser diodes in Canada. From a business that started in 2002 in a dark empty warehouse with only a plan and plenty of enthusiasm LASER COMPONENTS Canada is now a respected manufacturer and innovator of high power pulsed laser diodes serving a wide range of global applications.

Many factors have contributed to this success, but foremost has been the remarkable effectiveness of the focused and determined team in Canada, working in conjunction with the equally motivated LASER COMPONENTS distribution groups and the German head office.

LASER COMPONENTS Canada is an ISO 9001 certified fab-less operation; all the assembly, test, verification and product development is based in the facility, but our partners are responsible for growing our material to our own recipe. These products are based on innovative semiconductor material designed by LASER COMPONENTS for state-of-the-art performance.

Custom Solutions – Cost-effective, Even When Produced in Small Amounts

Close cooperation between the customer and the manufacturer has been our greatest success factor in manufacturing optimally customized products. Our customers are often pleasantly surprised by how reasonable our prices are for customized products.

LASER COMPONENTS Canada develops your pulsed laser diodes (PLDs) suited to your field of application. Almost all product parameters can be adjusted (e.g., wavelength, output power, and housing). It is also possible to develop completely new products.

Uncompromising Quality

Quality is an absolute imperative. The consistent application of quality management methods has resulted in the continuous advancement of products. New products and increasing efficiency are in constant demand.

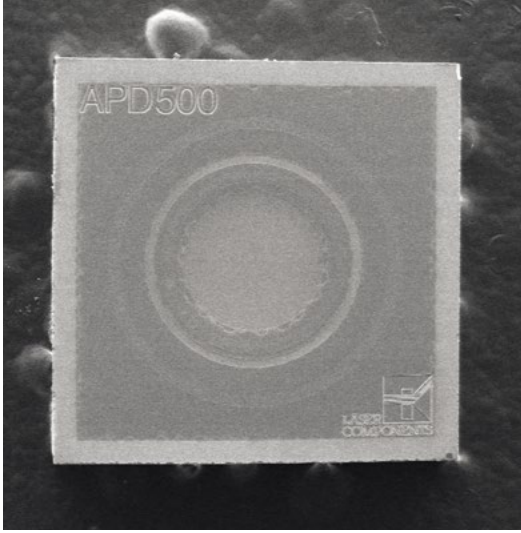
As part of quality control, a life test rack was developed to simulate very different applications. The pulsed laser diodes being tested on the life rack are frequency pushed well beyond their approved limits.

SAI GLOBAL
INFORM. INSPIRE. IMPROVE.

PRODUCTION Avalanche Photodiodes

Dragan Grubisic, CEO

LASER COMPONENTS Detector Group, Inc. has produced avalanche photodiodes in Phoenix, Arizona since 2004. In the USA the complete production chain is in our hands. The detectors are based on a specifically developed semiconductor structure. The standard program comprises silicon epitaxy and reach-through APDs with active area diameters from 230 µm to 3.0 mm. The silicon APDs from our in-house production are well suited for the detection of even the smallest amount of light, right down to single photons.



Sophisticated Products using State-of-the-Art Technology

The Detector Group is a specialist for orders with individual configurations.
Their product range extends from low-cost APDs for commercial applications to high-end components used in military applications: The heart of our photon counting modules originated from this facility: it's the VLoK series of APDs used in the detection of the smallest amount of light. Complete receivers are also produced by the Detector Group. They feature high sensitivity and have a wide wavelength range and large frequency width.

Since 2017 our new APD arrays complete the portfolio. Those components are ideally suited for LiDAR applications.

Extending Production Options with the Help of Comprehensive Equipment

We rely on the latest technologies in the production of avalanche photodiodes to implement complicated designs.

We manufacture

- Si APDs
- InGaAs APDs
- APD arrays
- APDs for single photon counting modules
- APD receivers
- IR detectors

PRODUCTION

Opto-Electronic Systems

Stand-alone products, such as our photodiode modules, are manufactured in the electronics department. This department works particularly closely with our other R&D departments to create user-friendly products.

Dr. Lars Mechold, CTO

Electronics

In-house Product Developments

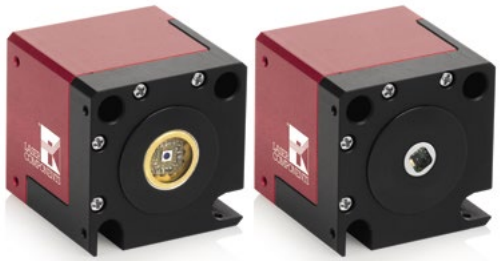
We pay close attention to the requests made by our customers. Many developments were made in accordance with concrete customer specifications; in fact, this has led to the development of different drivers for diodes.

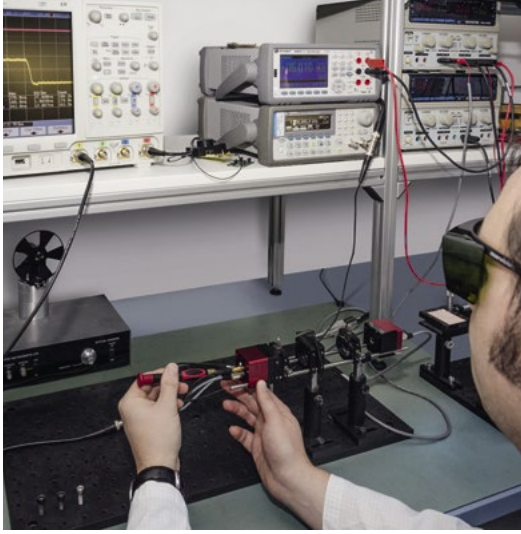
Prototype Design

Thanks to extensive laboratory equipment, developments can be made very quickly. Prototypes can be built in a matter of days. With the help of software, our R&D team initially designed a printed circuit board to be manufactured using a computer-controlled circuit board milling machine followed by the manual assembly of the prototype.

Quality Assurance and Series Production

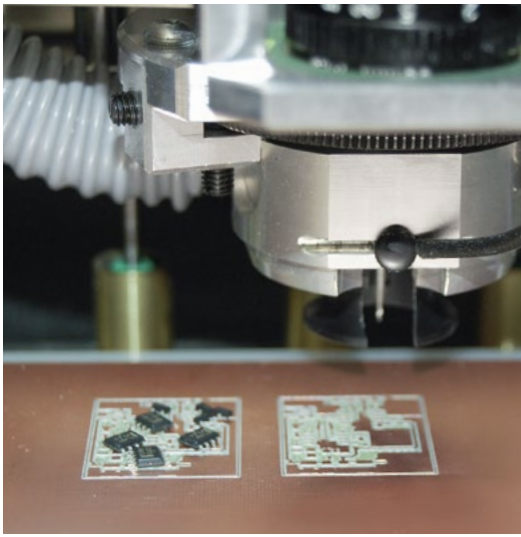
Each prototype is subjected to comprehensive testing and measurements at our measurement stations. If it meets all the criteria, the prototype is approved for series production.





Systems

As well as components, we develop sub-systems and modules to enable our customers to use our components effectively. Such products include PLD drivers, APD modules and photon counter modules.



Photon Counters from One Source

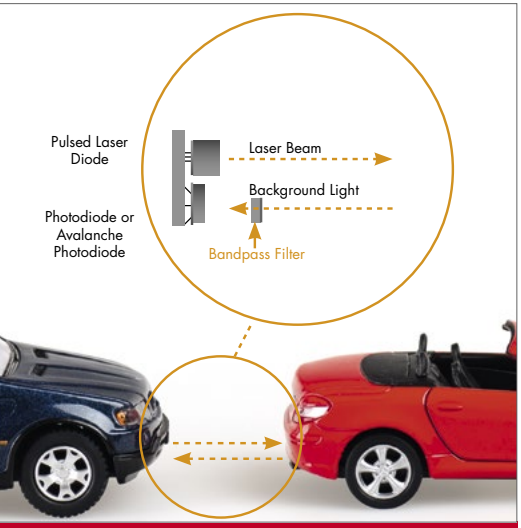
Motivated by numerous customer requests, LASER COMPONENTS GmbH ventured the development of photon counters in house in 2010, relying on the know-how of affiliated production facilities in the individual disciplines, avalanche photodiodes and electronics. The exclusive broadband coating of the integrated optics as well as the fiber connector is also manufactured by LASER COMPONENTS.

From quality components to the complete system, everything comes from one source. This is the secret of LASER COMPONENTS' success with its COUNT® modules.

You Profit from Manufacturing Options

At the semi-automatic measuring station, quantum efficiency, dark count rates, dead time, and after-pulsing can be measured – with or without fiber coupling. We simulate different scenarios, testing efficiency in your application field. Ask us!

APPLICATIONS



Distance and relative speed measurement.

Pulsed laser diodes and avalanche photodiodes are frequently used together in the same application. We provide both components so that you can choose the ideal combination for your needs. Time-of-flight distance measurement is one of the best-known applications: read on for more details.

The Optimum Performance for Your Application

Optoelectronic measurement technology relies on precisely matched components for optimum system performance. It is therefore essential to choose components carefully from the initial development phase onwards, in order to ensure the best possible performance in the application.

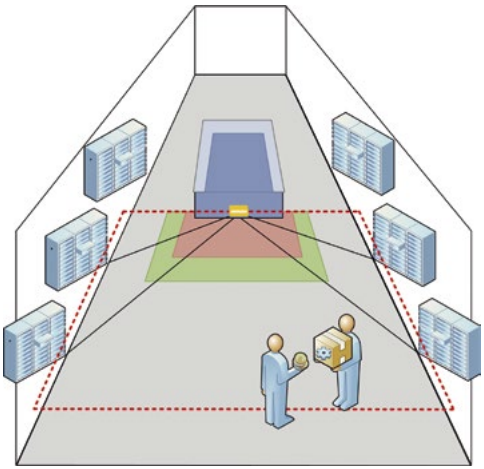
Whereas military applications may require components to perform within extremely stringent limits without the requirement for long device life, many other applications in industrial or auto-motive fields demand extremely long lifetime and reliability.

TOF – Measurement Principle

Time-of-Flight (TOF) measurement is the underlying principle for a wide variety of optical measurement applications. This non-contact measurement tool enables wide ranges of distances and speeds to be determined quickly and accurately.

The TOF measurement utilises short pulses of light transmitted through highly accurate beam-shaping optics. The time-of-flight Δt is calculated from the time of arrival of the light pulse reflected, and is used to calculate the distance l based on the known speed of light c (the distance must then be divided by two since the light pulse travels the distance between sensor and object twice). The refractive index n of the medium through which the light is propagated must also be taken into account (usually n = 1 as most measurements are made in air).

$$\lambda = \frac{c * \Delta t}{2 * n}$$



Laser safety scanner.

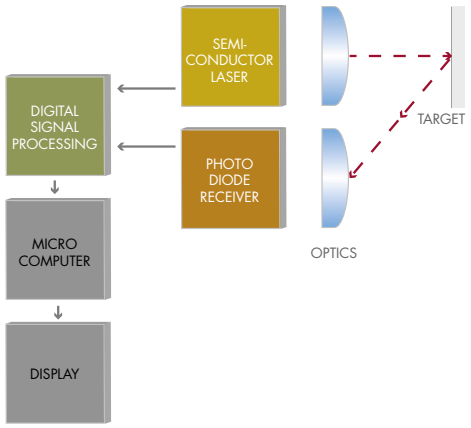
Direct TOF measurement is however not the best method for measuring very short distances due to the extremely high time resolution required, therefore an alternative method known as phase correlation is often used to provide a relative measurement. Here, the laser signal is modulated and the transmitted and reflected beam compared with one another. The distance measured can be calculated from the phase difference between the two signals.

Areas of Application

Pulsed laser diodes are found in a wide variety of applications including traffic monitoring, speed measurement and commercial rangefinders for sports applications, as well as in high-end, eye-safe military rangefinders. Further areas of application include medical therapy, industrial laser scanners, robotics and aviation (e.g. cloud base altitude measurement).

More recently, there has been considerable interest in the use of these devices in automotive applications such as automatic cruise control, obstacle avoidance and blind spot detection.

APDs are also commonly used for distance and speed measurement. Additional areas of application include medical technology (e. g. in retinal diagnostics) and telecommunications.



Schematic diagram of TOF principle.

PULSED LASER DIODES

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What Do We Offer?

LASER COMPONENTS manufactures pulsed laser diodes primarily at 850 nm, 905 nm and 1550 nm, with other wavelengths available upon request. As well as single and stacked emitters, we specialize in multi-junction laser diodes with several emitters in one chip.

Pulsed laser diodes with integrated fast axis lenses (FAC) or fiber optic pigtails offer added flexibility to the user. A world novelty is our QuickSwitch® PLD with integrated high speed driver. Read more over the next few pages.

Custom Products

LASER COMPONENTS Canada has made a name for itself as a supplier of bespoke products, having specialized in custom projects since day one. Talk to us about your requirements - custom products are often less expensive than you might expect.

Naturally we also offer a wide range of off-the-shelf technology which may well meet your exact needs – call us for more details.

Nomenclature

Our product nomenclature allows you to see at a glance what's what – details are given below.

λ	Tol	Type	Width	Package

Wavelength

850	850 nm
905	905 nm
155	1550 nm
HI155	1550 nm High intensity

Wavelength Tolerance

D	± 10 nm
G	± 30 nm
H	± 40 nm

Device Type

1S	Single chip
XS	Stacked devices with x chips
1SXJ	Multi-junction elements
XSXJ	Multi-junction devices

Contact Stripe Width

03	75 µm
06	150 µm
09	225 µm
12	300 µm
16	400 µm
	etc. 01 ≙ 25 µm

Package

C	8-32 coax
R	9 mm
S	TO-18
U	5.6 mm
UA	5.6 mm low cost
Y	Ceramic
FP	Fiber-coupled

BASICS

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Pulsed laser diodes have their roots in military applications. They are ideally suited to range-finding thanks to their short pulse widths and high output powers. Improvements in technology and cost-efficiency have opened up new areas of application in automotive, industrial safety scanner, metrology and medicine.

Principle of Operation

Most laser diodes are designed to emit in continuous wave (cw) mode with powers from a few milliwatts to a few watts. Such diodes are not designed to be overdriven; if the specified maximum power is exceeded, even for a short time, the laser resonator may be damaged, after which laser output will cease.

Pulsed laser diodes, however, are designed to be overdriven for short periods. To achieve the high peak powers demanded by the application, the duty cycle must be kept very low, typically 0.1 %. For example, a 100 ns pulse is followed by a pause of 100 µs, which means that very short pulses can be used with repetition rates in the kHz range. The maximum pulse lengths that can be achieved are therefore typically in the 200 ns range. Laser currents on the order of several tens of amperes are used to create these light pulses, which require fast switching transistors and appropriate circuit with all electrical connections as short as possible to diminish inductive losses.

Characteristics

The emission wavelength of a laser diode depends primarily upon the materials used in the active and passive layers of the semiconductor.
Typical wavelengths for commercially available pulsed laser diodes are 850–870 nm, 905 nm, and 1550 nm. The AlGaAs structure of the 905 nm devices is well known for its reliability, beam characteristics and temperature stability. The high efficiency allows powers of up to 34 W to be reached with single emitters, and of up to 130 W for stacked devices, for typical pulse lengths of 150 ns. Multi-junction pulsed laser diodes are similar to nanostack technology with multiple epitaxically stacked emitters. Single chips allows power up to 80 W, stacks up to 650 W. Available packages include hermetic metal cans (e.g. TO-18, 5.6 mm, 9 mm or coaxial) and pigtailed versions.

The 1550 nm devices available in the mid-IR can be operated at higher peak power than the 905 nm and still be regarded as eye safe since the laser radiation is not focused directly on the retina. These diodes are based on InP with additional InGaAsP layers, and can be manufactured either by molecular beam epitaxy (MBE) or metal-organic chemical vapor deposition (MOCVD). Peak output powers of up to 50 W can be reached thanks to the efficiency of 0.5 W/A.

Reliability

As with other light sources the life time of a pulsed laser diode is highly dependent on operating conditions. Without damage, the devices can be subjected to significant overdrive for short periods of time or when the pulse energy is reduced by employing pulse durations as short as 2 ns. The user should choose the appropriate device and drive conditions to suit the application and the operating lifetime required. Whereas lifetimes of less than an hour are enough for certain military applications such as thyristor ignition, industrial safety scanners in three-shift environments need to run reliably for tens of thousands of hours.
The following formula has been derived from many years of experience with 905 nm pulsed laser diodes and gives an indication of mean time to failure (MTTF) as a function of a range of parameters:

$$MTTF = 3.9 \cdot 10^{20} \cdot \{P_o/L\}^{-6} \cdot t_w^{-2} \cdot F^{-1} \cdot f(T)$$

(Estimation for triple junction laser: $MTTF = 1.11 \cdot 10^{21} \cdot \{P_o/L\}^{-6} \cdot t_w^{-2} \cdot F^{-1} \cdot f(T)$)

where

MTTF	[hours]	= Mean time to failure
P_o	[mW]	= Optical peak power
L	[µm]	= Emitter length
t_w	[ns]	= Pulse length
F	[kHz]	= Repetition rate
f(T)		= Temperaturedependant multiplying factor (= 1 at 25°C)

Example:
At room temperature the typical MTTF for a 4 W pulsed laser diode with 75 µm emitter, 100 ns pulse length and 10 kHz repetition rate would be approx. 170,000 hours. If the power is increased to 6 W with all other parameters unchanged the lifetime is reduced to 15,000 hours. Emitter length is equally important – if the power is halved, or the emitter length doubled, the lifetime is increased by a factor of sixty-four.

850 nm
Pulsed Laser Diodes

Our 850 nm PLDs are available as single chip with 13 W in a range of packages including TO-18, 5.6 mm, 9 mm, 8-32 coax and chip-on-ceramic.

Generic Specifications at 21°C

	Min.	Typ.	Max.
Wavelength [nm]	835	850	860
Spectral bandwidth [nm]		5.5	
Temperature coefficient [nm/°C]		0.21	
Beam spread (FWHM)			
Parallel to junction plane [degrees]		10.5	
Perpendicular		20	
Reverse voltage [V]			6
Pulse duration [ns]			150
Duty factor [%]			0.1
Temperature			
Storage [°C]	-55		100
Operating [°C]	-45		85

850 nm Series

The 850 series can be characterized as absolutely reliable; it features a low divergence of 10.5° x 20° and high temperature stability up to +85 °C. The focus of 850 nm pulsed laser diodes includes applications such as rangefinding, speed monitoring, laser radar, security scanners, or laser light curtains. These PLDs are also used in test and measurement systems.

Single Devices

Part Number	Wave-length [nm]	Min Power [W]	Package	Emitting Area [µm x µm]	I_{op} [A]	I_{th} [mA]
850D1S06X	850	10.5	U, S	150 x 1	12	700

! Information Specifications @ 21°C, 150 ns, 6.66 kHz • Option: C, R, Y package

905 nm
Pulsed Laser Diodes

Our 905 nm PLDs are available as single chip, stacked or multi-junction devices.

Generic Specifications at 21°C

	Min.	Typ.	Max.
Wavelength [nm]	895	905	915
Spectral bandwidth [nm]		5 (8*)	
Temperature coefficient [nm/°C]		0.27	
Beam spread (FWHM)			
Parallel to junction plane [degrees]		12	
Perpendicular			
Single elements [degrees]		25 (20*)	
Stacks [degrees]		30 (20*)	
Reverse voltage [V]			6
Pulse duration			
Single element [µs]			1 (0.15*)
Stacks [ns]			200
Duty factor [%]			0.1
Temperature			
Storage [°C]	-55		100
Operating [°C]	-45		85

* For multi-junction devices

Single and Stacked Devices

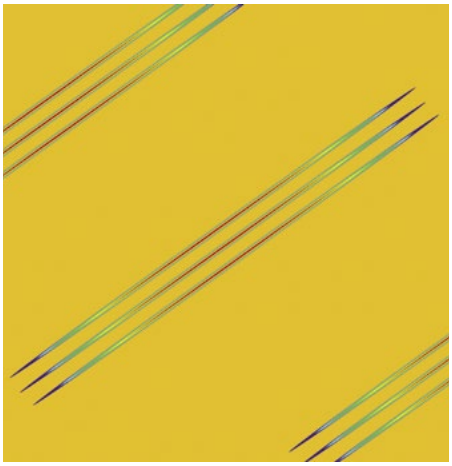
The proven AlGaAs-based design of the 905 series features unrivalled reliability, beam parameters and temperature stability, with output powers of up to 34 W (single chip) or 130 W (stack) with 150 ns pulses at 0.1 % duty cycle, thanks to the high efficiency of the design (1 W/A).

All versions are available in a range of packages including TO-18, 5.6 mm, 9 mm, 8-32 coax and chip-on-ceramic.

Single and Stacked Devices

Part Number	Min Power [W]	Package	Emitting Area [µm x µm]	I_{op} [A]	I_{th} [mA]
905D1S1.5X	3	U,S	37.5 x 1	3.5	100
905D1S03X	6	U,S	75 x 1	7	200
905D1S06X	13	U,S	150 x 1	15	400
905D1S09X	19	U,S	230 x 1	22	600
905D1S12X	26	U,S	300 x 1	30	800
905D1S16X	34	U,S	400 x 1	40	1200
905D2S06X	25	U,S	150 x 125	15	400
905D3S09X	55	U,S	230 x 225	22	600
905D3S12X	70	U,S	300 x 225	30	800
905D4S12X	90	U,S	300 x 340	30	800
905D4S16X	130	U,S	400 x 340	40	1200

! Information Specifications @ 21°C, 150 ns, 6.66 kHz • Option: C, R, Y package



Multi-junction PLDs

Multi-junction pulsed laser diodes are similar to nanostack technology.
LASER COMPONENTS' PLDs exhibit a peak power of up to 650 W at a pulse length of 150 ns from a small, compact TO-18 package.

Multi-junction Devices

Part Number	Min Power [W]	Package	Emitting Area [µm x µm]	I_{op} [A]	I_{th} [mA]
905D1S3J03X	25	U,S	85 x 10	11	300
905D1S3J06X	50	U,S	160 x 10	22	500
905D1S3J09X	75	U,S	235 x 10	35	800
905D2S3J09X	135	U,S	235 x 200	35	800
905D3S3J09X	200	S	235 x 400	35	800
905D1S3J08X	65	U,S	200 x 10	30	750
905D2S3J08X	130	U,S	200 x 110	30	750
905D3S3J08X	195	U,S	200 x 220	30	750
905D4S3J08X	260	S	200 x 330	30	750
905D5S3J08X	325	S	200 x 440	30	750
905D4S2L3J08X	520	S	800 x 330	60	1500
905D5S2L3J08X	650	S	800 x 440	60	1500

! Information Specifications @ 21°C, 150 ns, 6.66 kHz • Option: C, R, Y package

Low Cost Series

The high-volume/low-cost series consists of pulsed laser diodes in a metal housing that are best suited for consumer products such as laser rangefinders.

The 905DxxUA series features a center wavelength of 905 nm. The devices offered include single chip devices with powers ranging from 6 W to 19 W as well as multi-junction versions from 25 W to 75 W (150 ns, 0.1% duty cycle).

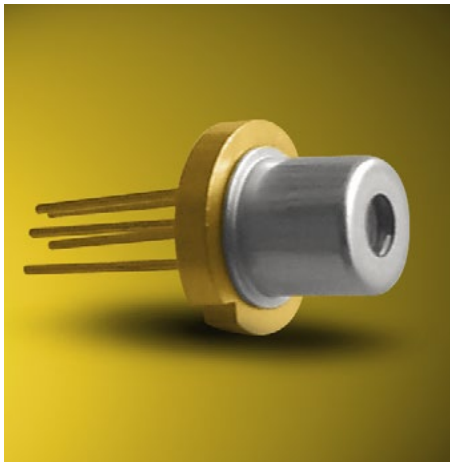
The high production volume of these devices enables LASER COMPONENTS to offer these high-quality PLDs in hermetic metal packages, at prices competitive to those offered in plastic housings.

The hermetic 5.6 mm package allows the user to benefit from the many technical advantages of the 905DxxUA series, including excellent reliability, unrivalled overdrive capability, optimum heat handling and a precise chip-to-package alignment.

Low Cost PLDs

Part Number	Wavelength [nm]	Min Power [W]	Package	Emitting Area [µm x µm]	I_{op} [A]	I_{th} [mA]
905D1S03UA	905	6	UA	75 x 1	7	200
905D1S09UA	905	19	UA	230 x 1	22	600
905D1S3J03UA	905	25	UA	85 x 10	11	300
905D1S3J06UA*	905	50	UA	160 x 10	22	500
905D1S3J09UA	905	75	UA	235 x 10	35	800
905D1S3J12UA*	905	110	UA	310 x 10	45	1000

For generic specifications please refer to the table on page 22. * available on request

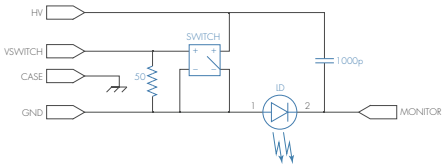


Fastest Hybrid Pulsed Laser Diode Worldwide with 2.5 ns pulse width

QuickSwitch® QS-905 Series

Ultra compact module containing a high current switch, charge storage capacitor and pulsed laser diode inside a small package. The high current loop is all internal to the package which provides EMI shielding when the switch is active. The package has an independent ground pin from the signal and supply returns.

Electronic Schematic QS-905

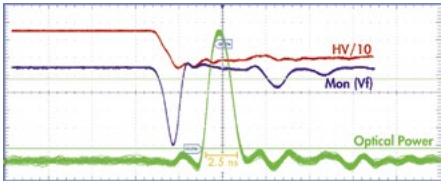


! Evaluation Board available

Generic Characteristics at t_{RT}= 21°C, I_{FM}

	Min	Typ	Max
Wavelength of peak radiant intensity λ m [nm]	895	905	915
Spectral bandwidth Δλ at 50% intensity points [nm]		8	
Wavelength temperature coefficient [nm/°C]		0.27	
Beam spread (50% peak intensity)			
Parallel to junction plane ∥ [°]		12	
Perpendicular to junction plane ⊥ [°]		20	

Performance Plot QS-905



Typical Product Characteristics

	P_o at HV (Typ.) [W]	Pulse width (Typ.) [ns]	Emitting area [µm x µm]
QS905D1S3J03U	36	2.5	75 x 10
QS905D1S3J09U	87	2.5	230 x 10

Conditions are t_{RT} = 21 °C, p_w (trig) = 40 ns, P_{rr} = 10 kHz

QuickSwitch® Evaluation Board

This is the evaluation board for the QS-905 pulsed laser diode. The board has an internal short pulse generator, allowing direct drive from a squarewave generator. The board has a socket for easy QS-905 installation.

Specifications for QS01-Eval

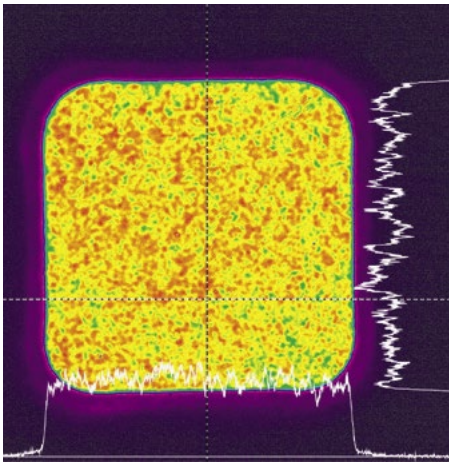
I_{HV} HV = 50 V quietscent (Vswitch = 0) [µA]	<3
I_{HV} HV=50 V, V_{TRIG}= 200 KHz square wave [mA]	13
V+ [V]	5.7 +/- 0.2
I_{V+} Quiescent [mA]	4
I_{V+} 200 kHz [mA]	5
$V_{TrigLOW}$ [V]	<0.8
$V_{TrigHIGH}$ [V]	2.0<V<3.3
R_{Trig} Internal Termination [Ohms]	50
$FWHM_{VMON}$ JP1(Horz. shorts), 50 Ω, Neg. pulse [ns]	3
$FWHM_{VMON}$ JP1(Vert. shorts), 50 Ω, Neg. pulse [ns]	700
T_D turn on delay (Trig to laser pulse) [ns]	15 typ
P_D Quiescent [W]	0.04
P_D 200 kHz [W]	0.6

SQF Series

Pulsed Laser Diodes with Homogenized Beam

Pulsed laser diodes are becoming more efficient and powerful. This makes them a real alternative to expensive and large laser systems. One advantage of the solid state laser is the very good beam profile. Here semiconductor lasers require external beam shaping elements or homogenizers. Optional diffusing discs, diffractive elements or long light waveguides, with all variants losing power or the mechanical effort is very high.

We have combined the powerful, multi-junction PLDs with a special fiber structure. Already after 15 mm a clearly homogeneous beam profile can be seen (see opposite figure). The design is compact and robust with simultaneously low losses and thus high peak power. The standard version 905D1S3J06SQF-14-15 provides a homogeneous beam from a 140 x 140 µm emitter area with a peak power of min. 25 W. Customized variants are available upon request. Of course this option can also be offered with our proven 1550 nm PLDs.



Typ. near field emission after 15 mm (2D view)

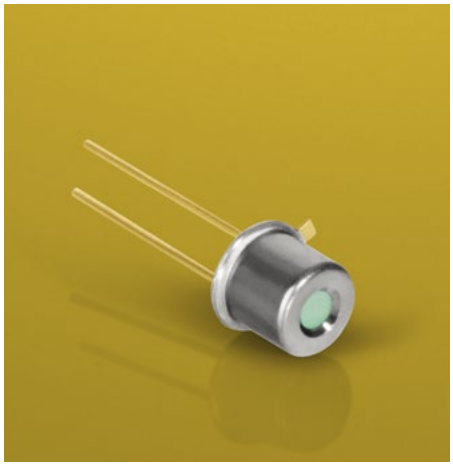
Generic Characteristics at t_{RT}= 21°C, I_{FM}

	Min	Typ	Max
Wavelength of peak radiant intensity λ m [nm]	895	905	915
Spectral bandwidth Δλ at 50% intensity points [nm]		8	
Wavelength temperature coefficient [nm]/°C		0.27	

Multi Junction Chip

	Integrated Pulsed Laser Diode	P_o ex Fiber @ i_{FM} (typ.) [W]	Emitting Area [µm x µm]	Divergence NA	Max Peak Forward Current i_{FM} [A]	I_{th} typ [mA]	Forward Voltage @ I max [V]
905D1S3J06-SQF-14-15	905D1S3J06R	25	140 x 140	0.22	22	500	11

Single chip characteristics at t_{RT} = 21°C, t_w = 150 ns, P_{rr} = 6.66 kHz



FAC Series

905 nm High Power Pulsed Laser Diodes with Fast Axis Collimators

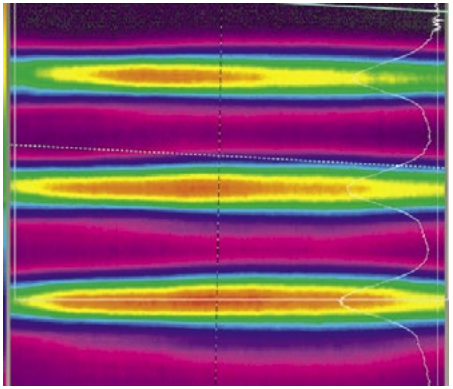
We have combined our multi-junction PLD with a fast axis collimator lens (FAC lens) mounted directly in front of the laser diode chip inside the hermetic TO-18 can.

A divergence of 36 mrad can be achieved by a triple junction laser with peak power of up to 65 W. The compact design can save engineering costs and allow for more compact laser range finder design. The design can withstand high acceleration rates of over 1500 g/ms and high temperature of up to +80 °C.

Typical Product Characteristics

	P_o @ I_{FM} (min.) [W]	Emitting Area [µm x µm]	Max. Current I_{FM} [A]	Threshold, I_{TH} [mA]	Forward Voltage @ I_{FM} [V]
905D1S3J03X	23	85 x 10	11	300	12
905D1S3J06X	45	160 x 10	22	500	11
905D1S3J09X	65	235 x 10	30	800	11

Conditions are t_{RT}= 21°C, t_w= 150 ns, P_{rr}= 3.33 kHz



Near field

Optical Characteristics at t_{RT}= 21°C, I_{FM}

	Min	Typ	Max
Wavelength of peak radiant intensity λ m [nm]	895	905	915
Spectral bandwidth Δλ at 50% intensity points at i_{FM} [nm]		8	
Wavelength temperature coefficient [nm/°C]		0.27	
Divergence, w.r.t. junction plane			
Parallel, ∥ [°]		12	
Perpendicular, ⊥ with 590µm EFL lens [mrad]			36

Absolute Maximum Ratings

	Maximun Ratings
Peak forward current (I_{FM}) [A]	50
Peak reverse voltage [V]	6
Pulse duration [ns]	150
Duty factor [%]	0.10
Temperature [°C]	
Storage	-55 to + 100
Operating	-45 to + 85
Lead soldering [°C]	
5 seconds max @	200

1550 nm
Pulsed Laser Diodes

1550 pulsed laser diodes are classified as eye-safe and are available as single or stacked devices.

Generic Specifications at 21°C • Single and Stacked Devices

	Min.	Typ.	Max.
Wavelength [nm]	1520	1550	1580
Spectral bandwidth [nm]		20	
Temperature coefficient [nm/°C]		0.5	
Beam spread (FWHM)			
Parallel to junction plane [degrees]		12	
Perpendicular			
Single element [degrees]		30	
Stacks [degrees]		30	
Reverse voltage [V]			2
Pulse duration			
Single element [ns]			200
Stacks [ns]			150
Duty factor [%]			0.1
Temperature [°C]			
Storage	-55		100
Operating	-45		85

Single and Stacked Devices

The innovative InGaAsP-based design of the 1550 series features unrivalled reliability, beam parameters and temperature stability. 0.35 W/A efficiency translates to output powers of up to 12 W (single chip) or 40 W (stack) with 150 ns pulses at 0.1 % duty cycle.

Single and Stacked Devices

Part Number	Wavelength [nm]	Min Power [W]	Package	Emitting Area [µm x µm]	I_{op} [A]	I_{th} [mA]
155G1S06X*	1550	5	S	150 x 1	20	0.8
155G1S14X	1550	12	S	350 x 1	40	1.9
155G2S06X*	1550	10	S	150 x 150	20	0.8
155G4S14X	1550	40	S	350 x 340	40	1.9

! Information Specifications @ 21°C, 150 ns, 6.66 kHz • Option: C, R, U, Y package

* Products are available on request.

HI Series

Our high intensity PLDs feature an efficiency of 0.5 W/A with a divergence of only 25 x 12 degrees and are offered as single chip devices with power up to 30 W. Packages offered include TO-18, 5.6 mm, 9 mm, and chip-on ceramic.

High Intensity Devices

Part Number	Wavelength [nm]	Min Power [W]	Package	Emitting Area [µm x µm]	I_{op} [A]	I_{th} [mA]
HI155G1S02X	1550	8	S	50 x 1	16	0.3
HI155G1S04X	1550	16	S	100 x 1	26	0.6
HI155G1S07X	1550	20	S	180 x 1	35	0.9
HI155G1S14X*	1550	30	S	350 x 1	70	2

! Information Specifications @ 21°C, 150 ns, 3.33 kHz • Option: C, R, U, Y package

* Product available on request.

Generic Specifications at 21°C • High Intensity Devices

	Min.	Typ.	Max.
Wavelength [nm]	1540	1555	1580
Spectral bandwidth [nm]		25	
Temperature coefficient [nm/°C]		0.6	
Beam spread (FWHM) [deegrees]			
Parallel to junction plane		12	
Perpendicular		25	
Reverse voltage [V]			6
Pulse duration [ns]			150
Duty factor [%]			0.1
Temperature [°C]			
Storage	-55		100
Operating	-45		85

HI-FAC Series

We have combined the high performance HI series with a fast axis collimator lens (FAC lens) mounted directly in front of the laser diode chip inside the hermetic TO-18 can.

Divergences of 5 mrad can be achieved depending on the lens used resulting in 12 degree x 5 mrad divergence which can save engineering costs and allow for more compact range finder design. Other options are 9.5 mrad or 15 mrad.

The design can withstand high acceleration rates of over 1500 g/ms and high temperatures of up to + 80 °C.

High Intensity Devices

Part Number	Wavelength [nm]	Min Power [W]	Package	Emitting Area [µm x µm]	I_{op} [A]	I_{th} [mA]
HI155G1S04SCX*	1550	10	S + FAC	100 x 1	26	0.6
HI155G1S07SCX	1550	17	S + FAC	180 x 1	35	0.9
HI155G1S14SCX**	1550	33	S + FAC	350 x 1	70	2

* Various lens options are available on request.

** Product available on request.

Generic Specifications at 21°C • High Intensity Devices

	Min.	Typ.	Max.
Wavelength of peak radiant intensity λ [nm]	1520	1550	1580
Spectral width Δλ at 50% intensity points at i_{FM} [nm]		19.5	
Wavelength temperature coefficient [nm/°C]		0.5	
Divergence, w.r.t. junction plane			
Parallel [degrees]		12	
Perpendicular, ⊥ with 150 µm EFL lens [mrad]		15	
Perpendicular, ⊥ with 275 µm EFL lens [mrad]		9.5	
Perpendicular, ⊥ with 590 µm EFL lens [mrad]		5	
Perpendicular, ⊥ with 750 µm EFL lens [mrad]		3.8	
Reverse voltage [V]			6
Pulse duration [ns]			150
Duty factor [%]			0.1
Temperature [°C]			
Storage			100
Operating			85

Fiber Pigtailed
Pulsed Laser Diodes

Fiber Pigtailed 905 nm PLDs

A near homogeneous beam distribution can be achieved by mixing the modes in an optical fiber. These PLDs have an optical output power of up to 65 W. They are, therefore, ideally suited for medical applications, laser rangefinder or illumination in which a high amount of peak power must be delivered to a point as efficiently as possible.

Multi-junction Chips and Stacked Arrays

Parameter	Integrated Pulsed Laser Diode	Po ex Fiber at I_{FM} (min.) [W]	Fiber Core / Cladding Diameter [µm / µm]	Fiber NA	Max. Peak Forward Current I_{FM} [A]	I_{th} (typ) [mA]
905D1S3J03FP-10/22-F-0-01	905D1S3J03R	12	105/125	0.22	11	300
905D1S3J09FP-40/22-F-0-01	905D1S3J09R	35	400/440	0.22	35	800
905D2S3J09FP-40/22-F-0-01	905D2S3J09R	65	400/440	0.22	35	800

! Information: Single chip characteristics @ t_{RT}= 21°C, t_W= 150 ns, P_{rr}= 6.66 kHz

Fiber Pigtailed 1550 nm PLDs

An almost homogeneous beam distribution in laser diodes can be achieved by mixing the modes in an optical fiber. Therefore LASER COMPONENTS has developed pulsed laser diodes with a fiber pigtail.

The fiber pigtailed 1550 nm PLDs have an optical output power of up to 7 W ex 105 µm fiber. These PLDs are ideally suited for laser rangefinding applications or DTS (distributed temperature sensing) in which a high amount of peak power must be delivered to a point as efficiently as possible.

Fiber-pigtailed Devices

Parameter	Integrated Pulsed Laser Diode	Po ex Fiber @ I_{FM} (min.) [W]	Fiber Core / Cladding Diameter [µm / µm]	Fiber NA	Max. Peak Forward Current I_{FM} [A]	I_{th} (typ) [mA]
HI155G1S02FP-62/27-F-0-01	HI155G1S02R	4	62.5/125	0.27	20	300
HI155G1S04FP-10/22-L-0-01	HI155G1S04R	7	105/125	0.22	30	600
HI155G1S04FP-10/22-F-0-01	HI155G1S04R	5	105/125	0.22	30	600

! Information: Additional products are available on request.

Package Drawings

1

2

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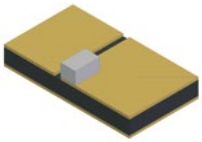

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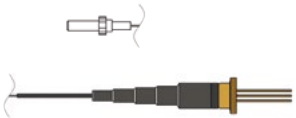

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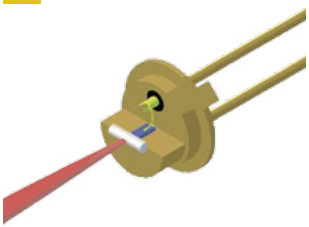

Package shown without cap

9

AVALANCHE PHOTODIODES

info@lasercomponents.com

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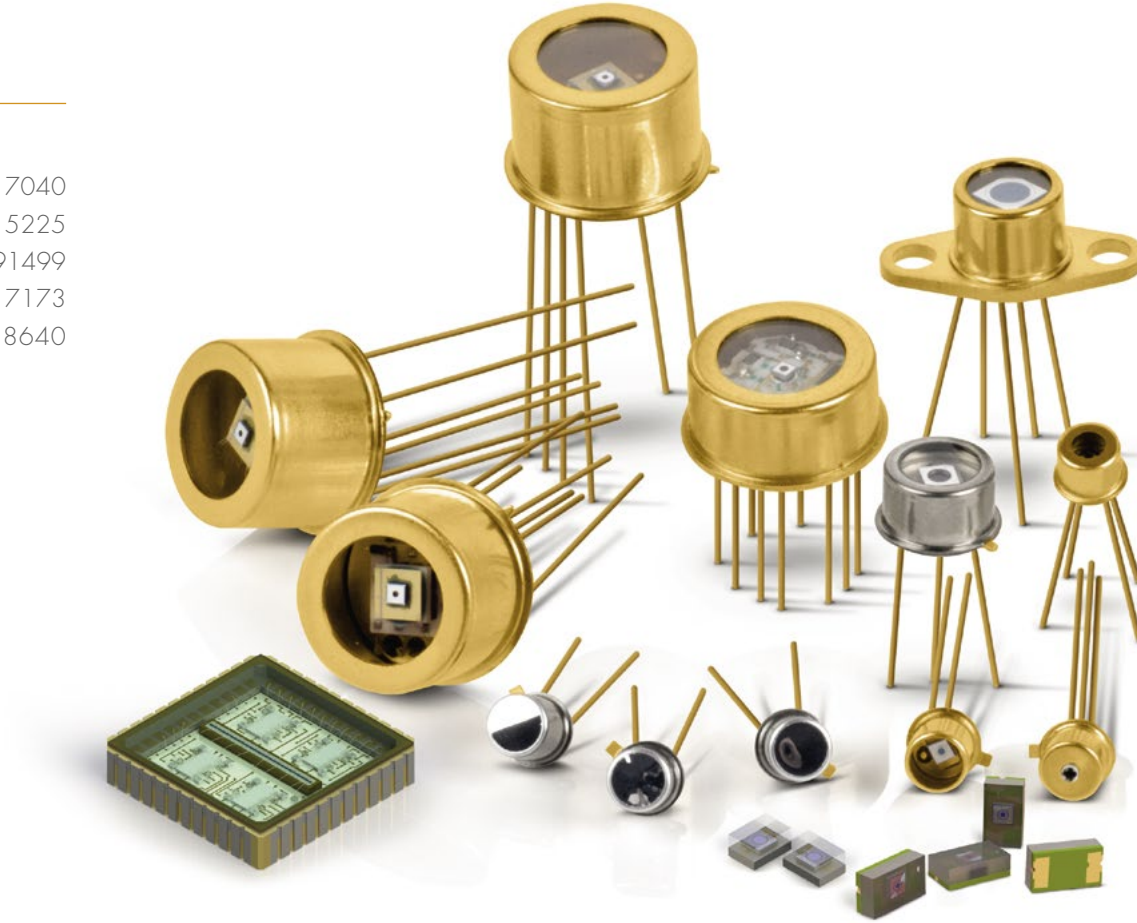

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Sophisticated Si and InGaAs APDs

Avalanche photodiodes are manufactured from different semiconductor materials. Depending on the spectral sensitivity, silicon or InGaAs is used.

Silicon avalanche photodiodes detect radiation in the range from 255 nm to 1100 nm. Different versions are optimized for each of their own wavelength ranges; thus, there are series available for the UV range, the visible range, and the NIR.

For detection in the infrared spectral range, InGaAs is used. The products have three features: an extremely high damage threshold, a very low capacitance, and a low dark current.

Custom APD Products

Our team in Arizona offers not only standard avalanche photodiodes but also receivers and photon counting detectors, to name just two examples. Custom projects are always welcome – ask us for details!

Nomenclature

Our product nomenclature allows you to see at a glance what's what – details are given below.

APD-Type		
SAE	=	SAE Series
SAR	=	SAR Series
SAP	=	SAP Series
SARP	=	SARP Series
SARF	=	SARF Series
SAT	=	SAT Series
IAG	=	IAG Series
SUR	=	SUR Series
SAH	=	SAH Series

Active Area		
080	=	80 µm
200	=	200 µm
230	=	230 µm
350	=	350 µm
500	=	500 µm
800	=	800 µm
1500	=	1500 µm
3000	=	3000 µm

Package	
E1	TO-8
F2	TO-46 2-pin with filter
F3	TO-46 3-pin with filter
FP	fiber-coupled
G1	TO-5
Hx	Receiver
LCC44	SMD
M1	SMD
M2	SMD
M6	SMD
M8	SMD
S2	TO-46 2-pin (Si)
S3	TO-46 3-pin (Si)
S5	TO-46 2-pin (InGaAs)
S6	TO-46 3-pin (InGaAs)
S7	TO-46 low profile
T6	TO-37 with 1-stage TEC
T8	TO-37 with 2-stage TEC
Y(Y1)	Ceramic
S14	14-PIN-DIL

BASICS

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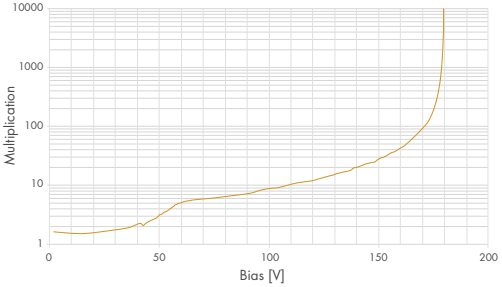


Typical gain vs. operating voltage for a Si APD when D = 500 µm

What Is An APD?

APDs differ from "normal" PIN photodiodes in that incoming photons internally trigger a charge avalanche. The prerequisite for this is the application of reverse bias voltage to the APD to broaden the absorption layer "A".

In conventional photodiodes, incoming photons create electron-hole pairs, also called charge carriers, which supply a measurable photocurrent. The power of the incoming photons has been transformed into electrical energy. Here, APDs have taken a significant step forward. The bias potential is much higher than in normal photodiodes. In the APD, the charge carriers set free by the light are accelerated in the electrical field in such a manner that they produce further electron-hole pairs through impact ionization. If the reverse bias voltage is less than the breakdown voltage, the avalanche will die down again due to friction losses. To this point a single photon has generated hundreds or even thousands of electrons. Above the breakdown voltage, the acceleration of the charge carriers is high enough to keep the avalanche alive. A single photon can be sufficient to generate a constant current which can be measured by external electronic equipment.

The current generated is calculated as follows:

$$I = R_0 \cdot M \cdot P_S$$

whereby R_0 (A/W) is the spectral responsivity of the APD, M is the internal gain and P_S (Watt) the incident optical power.

The gain of the APD thereby depends on the reverse bias voltage applied (see opposite diagram).

Choosing The Correct APD

APDs are generally recommended for very high bandwidth applications or where internal gain is needed to overcome secondary amplifier noise. The following items must be considered when making a selection:

Spectral Operating Range

APDs are available in the range from 260 nm to 1700 nm. Silicon APDs are, depending on their structure, suitable between 260 nm and 1100 nm, germanium between 800 nm and 1600 nm, and InGaAs from 900 nm to 1700 nm.

Silicon offers the most extensive APD product range. Depending on the manufacturing process, various parameters which offer advantages for the individual applications can be achieved. Compared to germanium APDs, InGaAs APDs have significantly lower noise characteristics, a higher bandwidth relative to the active area and advantages due to the extended spectral response to 1700 nm. A disadvantage is that InGaAs APDs are more expensive than Ge APDs. Germanium is therefore primarily recommended for cost-sensitive applications or in systems exposed to electromagnetic interference and in which the secondary amplifier noise is significantly higher.

Detector Area

It is obvious that small-area APDs are more economical than larger detectors since more chips can be manufactured per wafer. Therefore, the minimum active surface size required to realize the optical structure should first be determined. Sometimes it may be advantageous to use a somewhat larger APD, since special optics for focusing on a small spot may be more expensive than the additional charge for a larger APD.

Bandwidth and Noise

To compare the efficiency of an APD with a PIN diode, it is not sufficient to merely compare the noise of the detectors. The signal-to-noise ratio of the entire system is crucial. For PIN diodes, the respective preamplifier must also always be considered. Its noise characteristics are, among other things, frequency dependent. An APD is superior to a PIN diode whenever the APD can substantially boost the signal level without significantly increasing the overall system noise. Thus APDs are preferred wherever low light intensities at middle or high frequencies have to be detected. The optimum internal gain is selected when the detector noise is approximately equal to the input noise of the secondary amplifier (or load resistance), so that the APD does not affect the system noise. Noise increases with the bandwidth of the system for PIN diodes as well as APDs. Therefore it is important to reduce the bandwidth as far as is practicable.

Silicon APDs

Silicon avalanche photodiodes detect radiation from 260 nm to 1100 nm. Different versions are optimized for each of their own wavelength ranges.

Generic Specifications for all Si APDs • Absolute Maximum Ratings

	Min	Max
Storage temperature [°C]	-55	100
Operating temperature [°C]	-40	85
Reverse current (cw) [µA]		200
Reverse current (1 sec) [mA]		1
Forward current (cw) [mA]		5
Forward current (1 sec) [mA]		50
Max. power dissipation [mW]		60
Soldering (for 5 sec) [°C]		260

SAE Series

The SAE series is based on a planar epitaxial structure and is offered as either red-enhanced or NIR-enhanced to best match the requirements of the application. These APDs feature a choice of active area size (230 µm or 500 µm diameter) and feature high gain and a wide dynamic range.

Si Epi APDs • SAE Series

Part Number	Diameter [µm]	Wavelength Range [nm]	Peak Sensitivity [nm]	Responsivity @ λ Peak [A/W]	Packages*	V_{br} [V]	Vbr TC [V/°C]	Id [nA]	Noise [pA/sqrt. Hz]	Capacitance [pF]	Rise Time [ps]
SAE230Nx	230	550 – 1050	850	50	S2, S3, M8, F3, L3	150 – 300	0.6	0.5	0.2	1	500
SAE500Nx	500	550 – 1050	850	50	S2, S3, M8, L3, F3	150 – 300	0.6	1.0	0.2	2	500
SAE230Vx	230	400 – 1000	650	38	S2, S3, L3, M8	150 – 300	0.2	5	0.6	4	450
SAE500Vx	500	400 – 1000	650	38	S2, S3, L3, M8	150 – 300	0.2	5	0.6	4	450

! Information Specifications @ M=100, peak sensitivity

*Other packages are available on request.

SAR Series

The SAR series is based on a reach-through structure for high sensitivity across the range 400 – 1100 nm and features very fast response as well as extremely low noise and dark current levels. Active area sizes from 500 µm to 3 mm are offered. A specially selected low noise version (SARP series) is also available.

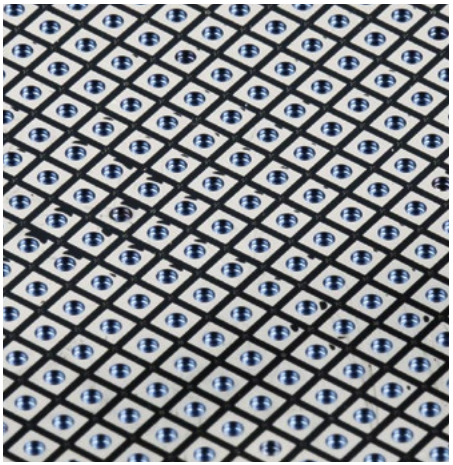
Si Reach-Through APDs • SAR Series

Part Number	Diameter [µm]	Wavelength Range [nm]	Peak Sensitivity [nm]	Responsivity @ λ Peak [A/W]	Package	V_{br} [V]	V_{br} TC [V/°C]	I_d [nA]	Noise [pA/ sqrt. Hz]	Capacitance [pF]	Rise Time [ps]
SAR500x	500	400 – 1100	890	60	S2, S3, F3	150 – 400	1	1.5	< 1	1.5	450
SARP500x	500	400 – 1100	890	60	S2, S3	150 – 400	1	0.5	< 0.2	1.5	450
SAR1500x	1500	400 – 1100	890	55	G1, T6	typ. 270	1	1	typ. 2.5	4	500
SAR3000x	3000	400 – 1100	890	55	E1, G1, T6	typ. 270	1	3	typ. 5	7	500

* With integrated bandpass filter.

SUR Series

The SUR series is based on a silicon reach-through structure with high sensitivity in the DUV/UV wavelength range. Many applications particulary in the medical and biomedical fields require highly sensitive detectors at short wavelengths for fluorescence measurements, analytical equipment or scintillation.



Electrical Characteristics • SUR Series

	Min	Typ.	Max
Wavelength range [nm]	260		1000
Active area diameter [nm]		0.5	
Breakdown voltage @ I_d=10 µA [V]	100	200	300
Responsivity @ M=100 [A/W]			
260 nm		21	
300 nm		22	
350 nm		25	
400 nm		28	
650 nm		44	
NEP @ M=100 [W/sqrt (Hz)]			
280 nm		22	
300 nm		20	
350 nm		18	
400 nm		16	
Temperature coefficient @ M=100 [V/K]		0.9	
Dark Current, I_d @ M=100 [pA]		200	
Noise current @ M=100 [pA/sqrt (Hz)]		2	
Capacitance @ M=100 [pF]		1.4	
Rise Time @ M=100 & 400 nm & RL=50 Ohms [nsec]		2	
Cut-off frequency @ M=100 [MHz]		150	

Characteristics

The benefit of the SUR series is an extremely high sensitivity and low noise performance operating in the blue to UV wavelength range. They are superior to any similar detector commercially available in the wavelength range from 260 nm to 1000 nm.

The diameter of the active area is 0.5 mm. The SUR series is delivered in a hermetically sealed TO-46 package optimized for the UV wavelength range.

SARF Series Si APDs with 905 nm Filter

The SARF500F2 features a reach-through structure with excellent quantum efficiency and fast response. The modified TO-46 package contains a 500 µm APD chip with peak sensitivity optimized for 905 nm as well as a bandpass filter centered at that wavelength.

For 905 nm Rangefinding

The detector is the device of choice for 905 nm rangefinding applications where low gains are used due to high background light, or where temperature compensation is not possible.

The advantages are obvious: cost saving, as no external filter or filter mount is required, compact design and optimized performance at 905 nm.

Si APD with 905 nm Filter

Part Number	Diameter [µm]	Wave-length Range [µm]	Peak Sensitivity [nm]	Responsivity @ λ Peak [A/W]	Package	V_{op} [Volt]	V_{br} TC [V/°C]	I_d [nA]	Noise [pA/ sqrt. Hz]	Capacitance [pf]	Rise Time [ps]
SARF500	500	880 – 930	905	10	F2, F3, M8F	typ. 160	1	1	0.05	1	3000

! Information Specifications @ M = 18, 905 nm

SAH Series (NIR-Enhanced)
Low-Cost Silicon Avalanche Photodiode

The SAH230MX and SAH500MX are low-cost, general purpose silicon APDs in a miniature SMD package. Responsivity is optimised for 850 nm and 905 nm rangefinders. Optional the SAH series is also available with 905 nm bandpass filter.

SAH Series (NIR-Enhanced)

		Diameter [µm]	Wavelength Range [nm]	Peak Sensitivity [nm]	V_{br} [V]	Responsivity @ 905 nm [A/W]	V_{br} TC [V/°C]	Dark current I_d [nA]	Noise I_d [pA/ sqrt. Hz]	Capacitance [pF]	Rise time @ M=100 [psec]	Package
SAH230X	Min		400									M1 (F) M2 (F)
	Typ	230		800	150	40		0.5	0.06	1.0	250	
	Max		1000		200		0.5	1.0				
SAH500X	Min		400									M1 (F) M2 (F)
	Typ	500		800	150	40		1.0	0.09	2.0	300	
	Max		1000		200		0.5	3.0				

Electrical Characteristics, Ta = 25°C, M = 100

SAP Series
Avalanche Photodiodes for Photon Counting

The SAP series silicon avalanche photodiodes are primarily used in photon counting. This series features highest efficiency and lowest dark count rates.

This specially developed APD is designed for operation in Geiger mode ($V_{op} > V_{br}$), where a single photon may cause an avalanche of up to 10^8 charge carriers. This device is especially suitable for Photon Counting, spectroscopy, fluorescence detection, medical applications and high-end LIDAR.

The APD is hermetically sealed in a modified TO-46 package. Cooled versions with either a one-stage or two-stage TEC in TO-37 or TO-8 packages offer significant reduction of noise for even higher performance.

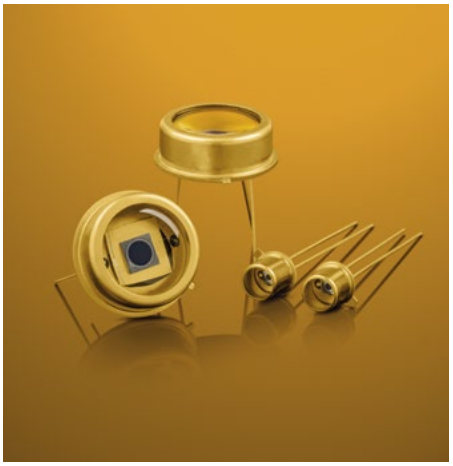
SAP Series

Part Number	Diameter [µm]	Wavelength Range [nm]	Peak Sensitivity [nm]	Responsivity @ 830 nm [A/W]	Package	V_{br} [Volt]	V_{br} TC [V/°C]	I_d* [pA]	Noise* [pA/ sqrt. Hz]	Capacitance* [pf]	Dark count rate** [cps]
SAP500S2	500	400 – 1100	700	110	S2	125	0.35	1000	90	3.3	10,000
SAP500T6	500	400 – 1100	700	110	T6	125	0.35	200	40	3.3	5,000
SAP500T8	500	400 – 1100	700	110	T8	125	0.35	70	20	3.3	2,000

* Specifications @ M = 250, 830 nm

** Geiger mode

SAT Series
Si APDs for 1064 nm



LiDAR applications typically require efficient detectors for 1064 nm.

The SAT series is a Reach-Through-APD with sensitivity optimised for the near IR and a significantly higher QE at 1064 nm than standard silicon APDs. These devices are ideally suited to rangefinding with Nd:YAG lasers.

A choice of active area sizes (800 µm and 3 mm) is offered. TO-5, TO-8 and cooled TO-37 packages are available.

! Only available in the U.S.

The SAT series is only available in the U.S. For all other countries an end-user statement is required!

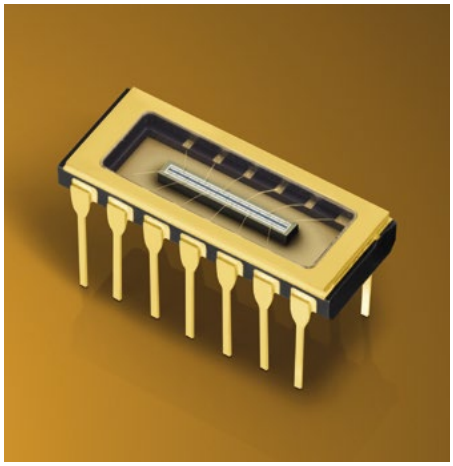
ITAR COMPLIANT
International Traffic in Arms Regulations Compliant

LASER COMPONENTS USA, Inc.

Si APD for 1064 nm • SAT Series

Part Number	Diameter [µm]	Wavelength Range [nm]	Peak Sensitivity [nm]	Responsivity @ λ 1064 nm [A/W]	Package	V_{br} [Volt]	V_{br} TC [V/°C]	I_d [nA]	Noise [pA/ sqrt. Hz]	Capacitance [pF]	Rise Time [ns]
SAT800x	800	700 – 1100	980	25	E1, G1, T6	400	2.5	1	0.5	2	1
SAT3000x	3000	700 – 1100	980	34	E1, G1, T6	400	2.5	5	1	10	3

! Information Specifications @ M = 100, peak sensitivity



Si-APD Arrays

The SAH1LX series is a linear Si-APD array with 8, 12 or 16 elements in a 14-pin-DIL or LCC44 package with protective window. Responsivity is optimised for 850 nm. The LCC44 package version is optional available with integrated TIA.

The array offers uniform gain and small crosstalk between each element. Custom designs are available on request.

Si APD Array

Parameter	Condition	Min	Typ	Max
# of elements		8 / 12 / 16		
Active area [µm] / element		620 x 190		
Gap [µm]		40		
Dark current I_d [nA]	M=100, λ=905 nm, per element		4	10
Capacitance, C [pF]	M=100, per element		3	
Responsivity, R_I	M=100, λ=905 nm	40	50	
Rise time, t_r [psec]	M=100, λ=905 nm, R_L=50 Ohms		1000	
Temperature coefficient [V/K]	I_R=10 µA		0.5	
Crosstalk [dB]	λ=905 nm		50	
Dark current uniformity [%]	M=100		±5	±20
Photo current uniformity [%]	M=100, λ=905 nm		±5	±20
Package		S14 / LCC44		

Electrical Characteristics, Ta = 25°C

InGaAs APDs

InGaAs detectors have been created for the wavelength range 1000 – 1650 nm. These devices offer superior performance to germanium APDs, e.g. much lower noise, higher bandwidth and ensitivity at longer wavelengths.

Generic Specifications for all InGaAs APDs • Absolute Maximum Ratings

	Min	Max
Storage temperature [°C]	-60	125
Operating temperature [°C]	-40	85
Reverse current [mA]		1
Forward current [mA]		10
Soldering (for 5 sec) [°C]		260

IAG Series

The IAG series offers best dark current, noise performance and damage threshold and is offered in three active area sizes, 80 µm, 200 µm and 350 µm, the largest InGaAs-APD currently available on the market.

Both device types are offered in a hermetic TO-46 package. Options include chip-on ceramic as well as a cooled version in a TO-37 package.

InGaAs APDs • IAG Series

Part Number	Diameter [µm]	Wavelength Range [nm]	Peak Sensitivity [nm]	Responsivity @ λ Peak [A/W]	Package	V_{br} [V]	V_{br} TC [V/°C]	I_d [nA]	Noise [pA/ sqrt. Hz]	Capacitance [pF]	Rise Time [ps]
IAG080x	80	1000 – 1630	1550	9	S5, S6, S7, Y, T6, T8	40–80	0.06	typ. 1	< 0.4	0.35	140
IAG200x	200	1000 – 1630	1550	9	S5, S6, S7, Y, T6, T8	50–83	0.075	typ. 8	< 0.9	1.5	235
IAG350x	350	1000 – 1630	1550	9.4	S5, S6, S7, Y, T6, T8	35–70	0.075	typ. 190	typ. 1 4.	4.1	585

Fiber pigtailed Si and InGaAs APDs

Extremely accurate micro-positioners allow the fiber to be adjusted to within a few microns, enabling coupling efficiencies close to 100% to be achieved. The versatile construction approach allows almost any combination of APD and fiber to be built – any of our TO-46 packaged APDs can be pigtailed with monomode or multimode fibers of up to 105 µm core diameter.

Pigtailed APDs offer advantages in many different situations – medical or analytical application often require the detector to be positioned remote from the measurement; photon counting applications benefit from an opaque fiber buffer ensuring that only the photons of interest reach the detector, and data can be easily transmitted over long distances in industrial applications.

APD Type and Size	FP	Fiber	Connector	Length
SAE500N	FP = fiber pigtail	1/15 = 9 µm core, NA 0.15	0 = none	1 to 100 in meters
SAE230N		5/20 = 50 µm core, NA 0.20	SM = SMA	
SAE500V		6/27 = 62.5 µm core, NA 0.27	FC = FC/PC	
SAE230V		10/22 = 105 µm core, NA 0.22	FA = FC/APC	
SAR500				
SARP500				
SAP500				
IAG080				
IAG200				

Note: other fibers and connectors are available on request.

APD Receivers

APD receivers come equipped with an integrated preamplifier – for optimal performance.

The performance of an APD in a specific application is often limited by the electronics, therefore the pre-amplifier needs to be chosen and implemented with great care in order to achieve the best possible signal-to-noise ratio.

Our H series receivers offer the user an APD with matched, integrated pre-amplifier in a compact, hermetic package.

All the receivers listed below are available with silicon* or InGaAs**-APDs and are therefore suitable for the wavelength ranges 400 – 1100 nm and 1000 – 1650 nm respectively.

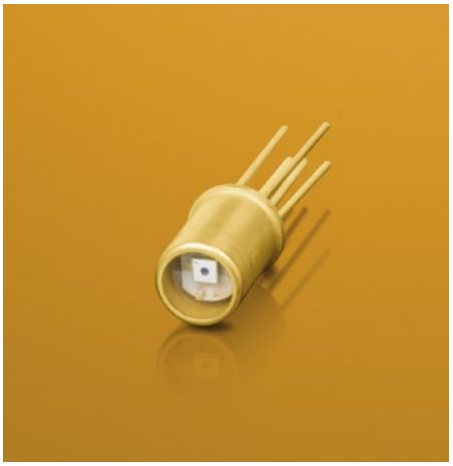
* (SAE, SAR, SAT Series)

** (IAG Series)

H0 Series

The H0 series includes a silicon or InGaAs APD with an optimized low noise hybrid pre-amplifier for the use in laser range finding, LiDAR, medical and analytical applications.

Housed in a modified 5 pin TO-46 package they offer bandwidths up to 80 MHz and a single ended output. Higher bandwidths can be achieved by further lowering the feedback resistor values.



Electrical Characteristics • H0 Series

Part Number	IAG080H0	IAG200H0	SAR500H0	SAR1500H0	SAT800H0
InGaAs-APD[1] | Si-APD[2]	IAG080[1]	IAG200[1]	SAR500[2]	SAR1500[2]	SAT800[3]
Diameter [µm]	80	200	500	1500	800
Wavelength Range [nm]	900 – 1700	900 – 1700	400 – 1000	400 – 1000	700–1100
Peak Sensitivity [nm]	1550	1550	890	890	980
Bandwidth [MHz]	DC - 80	DC - 80	DC - 20	DC - 20	DC - 20
Responsivity [MV/W]					
1550 nm	0.1	0.1			
540 nm			1.35	1.35	1.35
650 nm			2.00	2.00	2.00
905 nm			2.50	2.50	2.50
NEP [pW/rtHz]					
1550 nm	0.3	0.4			
540 nm			0.10	0.10	0.10
650 nm			0.06	0.06	0.06
905 nm			0.05	0.05	0.05
Output Noise Density [nV/rtHz]	30	40	100	100	100
Input Refered Noise Density [pA/rtHz]	3	4	2	2	2
Output Voltage Swing (1 MΩ) [V]			3	3	3
Output Voltage Swing (50Ω) [V]			1.5	1.5	1.5
Output Offset Voltage [mV]			25	50	25

1 ! Information Specifications @ M = 10, 25°C, RF = 50 kΩ (typ), (InGaAs)

2 ! Information Specifications @ M = 100, 25°C, RF = 50 kΩ (typ), (Silicon)

3 An export license is required by customers outside the USA.

H1 Series

The H1 series includes a silicon or InGaAs avalanche photodiode with an optimized low noise hybrid preamplifier for the use in laser range finding, LiDAR, medical and analytical applications. Housed in a 12 pin TO-8 package they offer bandwidths up to 25 MHz, an onboard temperature sensor and a single ended output.

The Si-APDs used in these devices are SAR500, SAR1500, SAR3000 and for YAG enhanced application SAT800, providing excellent responsivity between 400 nm and 1100 nm and very fast rise and fall times at all wavelengths. For the wavelength range between 900 nm and 1700 nm our InGaAs-APD IAG series is used.
All APD receivers are available with various gain/bandwidth configurations.

Custom versions with all other APD chips from our product range are available on request.

Electrical Characteristics • H1 Series

H1 Hybrid Series Type	H1A	H1B	H1C	H1D
Bandwidth	DC – 25 MHz	DC – 10 MHz	DC – 3 MHz	DC – 1 MHz
Responsivity [MV/W]				
540 nm	0.27	2.7	27	270
650 nm	0.4	4	40	400
905 nm	0.5	5	50	500
1550 nm (IAG series, M = 10)	0.094	0.94	9.4	94
NEP [fW/#Hz]				
540 nm	150	55	11	11
650 nm	100	37.5	7.5	7.5
905 nm	80	30	6	6
1550 nm (IAG series, M = 10)	425	160	64	32
Output noise density [nV/sqrt. Hz]	40	150	300	3000
Input referred noise density [pA/sqrt. Hz]	4	1.5	0.3	0.3

! Information: All data shown is for SAR series APD, M = 100 unless otherwise noted. Bandwidth specifications refers to SAR500. Noise measured at 100 kHz.

H2/H3/H4/H5 Series

The H2/H3/H4/H5 series includes a Silicon or InGaAs Avalanche Photodiode with an optimized low noise hybrid preamplifier for the use in high speed, low light detection, in laser range finding, LiDAR, medical and analytical applications. Housed in a 5 pin TO-46 or 6 pin TO-5 package they offer bandwidths up to 700 MHz and a differential ended output. The Si-APDs used in these devices are SAR500, SAR1500 and for YAG enhanced application SAT800, providing very good response between 400 nm and 1100 nm and very fast rise and fall times at all wavelengths. For the wavelength range between 900 nm and 1700 nm our InGaAs-APD IAG series is used.
All APD Receivers are available with various gain/bandwidth configurations.

Custom versions with all other APD chips from our product range are available on request.

Electrical Characteristics • H2/H3/H4/H5 Series

Hybrid Series	H2	H3	H4	H5
Supply voltage – Vcc [Volts]	3.3	5.0	3.3 or 5.0	3.3
Supply current [mA]	25	30	30	25
Bandwidth	10 kHz – 100 MHz	10 kHz – 240 MHz	20 kHz – 470 MHz	20 kHz – 700 MHz
Responsivity [MV/W]				
540 nm	1.50	0.54	0.22	0.12
650 nm	2.20	0.80	0.32	0.18
905 nm	2.70	1.00	0.40	0.22
1550 nm (IAG series, M = 10)	0.50	0.19	0.075	0.042
NEP [fW/#Hz]				
540 nm	70	75	230	420
650 nm	45	50	160	290
905 nm	40	40	125	230
1550 nm (IAG series, M = 10)	250	300	700	1200
Output noise density [nV/sqrt. Hz]	100	50	50	50
Input referred noise density [pA/sqrt. Hz]	2	3	7	12

! Information: All data shown is for SAR series APD, M = 100 unless otherwise noted. Bandwidth specifications refer to SAR500. Noise measured at 100 kHz.

Package Drawings

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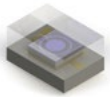

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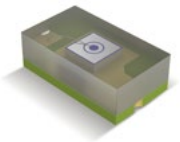

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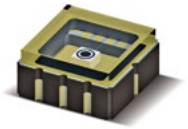

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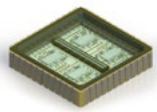

SYSTEMS & ELECTRONICS

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LASER COMPONENTS
EVA-CW

Pulsed Laser Diode Modules

Complete pulsed laser diode modules for simple plug & play operation.

Our PLD modules are easy to handle and require only a +12 VDC supply and a trigger signal.

A range of housing types is offered, including closed metal housings and low-cost versions. The metal versions are fully nickel-plated, in order to reduce EMI emissions from the module, and to protect the module from any external EMI.

Customized Products

Custom designed modules are available on request!

Typical Specifications

- Wavelength: 850 nm, 905 nm, 1550 nm
- Optical peak power: 3 W – 220 W
- Short rise and fall times
- Optional: adjustable pulse power
  adjustable pulse length
- Excellent temperature stability
- Complete unit in compact housing: no additional equipment needed
- Straightforward interfacing: standard drive voltages, TTL & CMOS trigger

Part Number	Wavelength [nm]	Peak Power [Watt]	Pulse Length [ns]
LS8-10-150-S10-00	850	10	150
LS8-1/10-30/150-S10-11	850	1 – 10*	30 – 150*
LS9-25-4-S10-00	905	25	4
LS9-220-8-S10-00	905	220	8
LS9-40/220-30/100-S10-11	905	40 – 220*	30 – 100*
LS5-5-4-S10-00	1550	5	4
LS5-40-8-S10-00	1550	40	8
LS5-10/50-30/150-S10-11	1550	10 – 50*	30 –150*

* User-defined via voltage input.

** Factory pre-set to customer specified value within given range.

CUBE Series

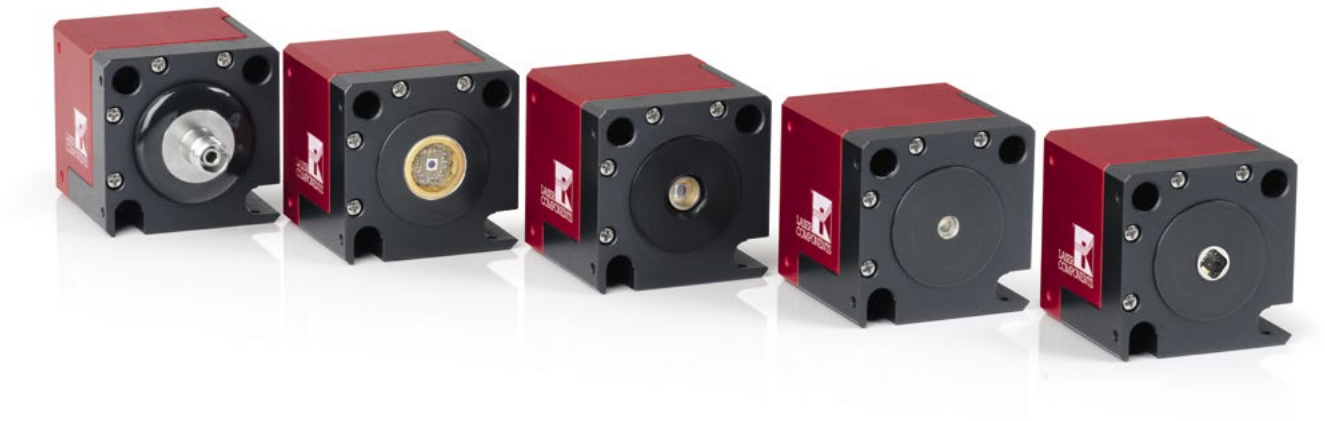
The CUBE series has been designed to provide plug & play pulsed laser diodes, PIN diodes and avalanche photodiodes for easy integration onto your optical bench.

These products make your job easier, for example by including an APD high voltage supply into the same compact housing as the active components, with easy mechanical mounting to an optical table.

! Customized Products

Custom designed modules and OEM versions are available on request!

! Also Available for IR Components



A-CUBE

Fast, straightforward detection of low light levels is enabled by our APD modules A-CUBE.

The heart of our APD modules is a low-noise Si or InGaAs avalanche photodiode that is equipped with a preamplifier and an integrated high voltage supply. The module offers everything needed to operate APDs easily and conveniently.

In-built temperature compensation circuitry allows the APD to be operated at constant gain even if the ambient temperature changes. A 12 VDC supply is all that is needed to operate the module, which is supplied in a compact, electrically shielded metal package (approx. 40 x 40 x 40 mm^3).

Specifications APD Modules A-CUBE

Part Number	Detector Type	Wavelength Range [nm]	Active Area Dia. [mm]	Bandwidth [MHz]	NEP* [fW/#Hz]
A-CUBE-S500-01	SAR500	400 – 1100	0.5	DC-1	6
A-CUBE-S500-03	SAR500	400 – 1100	0.5	DC-3	6
A-CUBE-S500-10	SAR500	400 – 1100	0.5	DC-10	30
A-CUBE-S500-25	SAR500	400 – 1100	0.5	DC-25	80
A-CUBE-S500-100	SAR500	400 – 1000	0.5	0.01 – 100	40
A-CUBE-S500-240	SAR500	400 – 1000	0.5	0.01 – 240	40
A-CUBE-S1500-01	SAR1500	400 – 1100	1.5	DC-1	6
A-CUBE-S1500-03	SAR1500	400 – 1100	1.5	DC-3	20
A-CUBE-S1500-10	SAR1500	400 – 1100	1.5	DC-10	30
A-CUBE-S1500-25	SAR1500	400 – 1100	1.5	DC-25	80
A-CUBE-S3000-01	SAR3000	400 – 1100	3.0	DC-1	9
A-CUBE-S3000-03	SAR3000	400 – 1100	3.0	DC-3	20
A-CUBE-S3000-10	SAR3000	400 – 1100	3.0	DC-10	30
A-CUBE-S3000-25	SAR3000	400 – 1100	3.0	DC-25	120
A-CUBE-I200-01	IAG200	1000 – 1650	0.2	DC-1	32**
A-CUBE-I200-03	IAG200	1000 – 1650	0.2	DC-3	64**
A-CUBE-I200-10	IAG200	1000 – 1650	0.2	DC-10	160**
A-CUBE-I200-25	IAG200	1000 – 1650	0.2	DC-25	425**
A-CUBE-I200-100	IAG200	900 – 1700	0.2	0.01 – 100	200**
A-CUBE-I200-240	IAG200	900 – 1700	0.2	0.01 – 240	300**

* Specification @ 905 nm ** Specification @1550 nm

L-CUBE

The L-CUBEs are pulsed laser diode modules offer all of the features needed to safely drive pulsed lasers of different powers, in a compact housing. The modules are easy to handle and require only a +12 VDC supply and a trigger signal. External devices, such as trigger interfaces, are not necessary. These modules make the operation of pulsed lasers as straightforward as their cw counterparts.

For most applications it is only necessary to drive the laser with constant power and pulse length. However the following additional options are also offered:

- adjustable pulse power (via control voltage)
- adjustable pulse length (via control voltage)

These options offer the user greater flexibility and allow parameters to be changed while the laser is operating. Such flexibility can mean real cost savings in product development.

Specifications PLD Modules L-CUBE

Part Number	Wavelength [nm]	Optical Peak Power (NA>0.5) [W]	Pulse Length [ns]
L-CUBE-8-1/10-30/150	850	1 – 10	30 – 150
L-CUBE-9-40/200-30/100	905	40 – 200	30 – 100
L-CUBE-5-10/40-30/150	1550	10 – 40	30 – 150

Note: Power variation in the tolerance of +0%/-10%

P-CUBE

The P-CUBE series manufactured by LASER COMPONENTS has been designed for customers interested in experimenting with low noise silicon or InGaAs pin detectors.

Integrated in a small package the P-CUBE series can be assembled in to an optical set up very easily.

The optional FC connector provides a convenient method for connecting the detector to the sample using an optical fiber.

Custom designed modules and OEM versions are available on request.

Specifications P-CUBEs

Part Number	Integrated Photodiode	Wavelength Range [nm]	Active Area [mm²]	Dark Current [nA]
P-CUBE-10	GaP	190 – 570	10.9	0.02
P-CUBE-20	Si	200 – 1050	5	0.1
P-CUBE-40	InGaAs	800 – 2200	0.05	0.7

Single Photon Counting Modules

Photon counters are used for measurements of extremely low light levels. One of the most important measurement parameters in terms of product quality is quantum efficiency at specific wavelengths.

Depending on the application, different COUNT® modules are available. The Si SPAD COUNT® module is optimized for wavelengths in the range from 500 nm to 700 nm. For shorter wavelengths, the COUNT® blue is available, which also features high detection efficiency in the blue-green spectral range. The COUNT® NIR module delivers the best performance in the near infrared range. For timing applications the COUNT® T is the right choice. The COUNT® S features an active area of 500 µm.

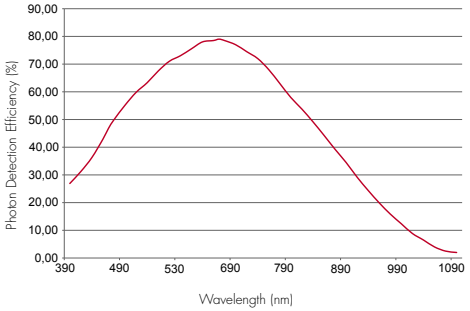
! Optional

The optional FC connector provides a convenient method for connecting the module to the sample using a singlemode or multimode optical fiber.

COUNT®

The allrounder: With high detection efficiencies in the red wavelength range and very low dark count rates the COUNT® module is used in applications including spectroscopy, quantum optics, LiDAR and particle sizing.

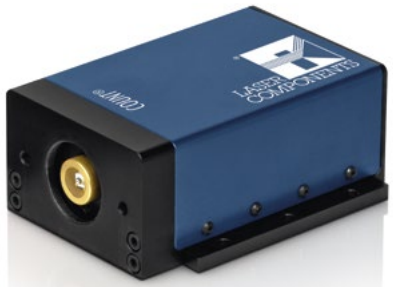
COUNT®



Typical photon detection efficiency

Specifications COUNT®

Parameter	Min	Typ	Max
Spectral range [nm]	400		1000
Dark count rate [Counts/s]			
COUNT-10C			10
COUNT-20C			20
COUNT-50C			50
COUNT-100C			100
COUNT-250C			250
COUNT-500C			500
Photon detection efficiency Pd at: [%]			
405 nm	5	15	
670 nm	60	70	
810 nm	40	50	
Dead time [ns]	42	45	
Operating voltage [V]	11.5	12.0	12.5
Max. count rate [M Counts/s]			20



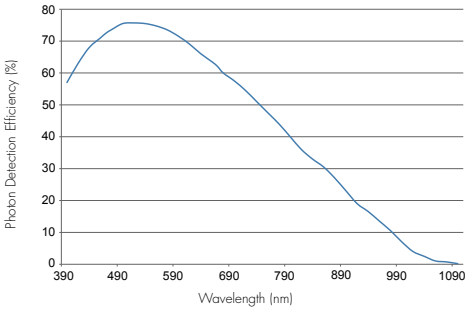
COUNT® BLUE

FLIM, STED, FCS or even quantum information experiments – the COUNT® BLUE offers high detection efficiencies and very low dark count rates in the blue and green range.

Specifications COUNT® BLUE

Parameter	Min	Typ	Max
Spectral range [nm]	350		1000
Dark count rate [Counts/s]			
COUNT-10B			10
COUNT-20B			20
COUNT-50B			50
COUNT-100B			100
COUNT-250B			250
Photon detection efficiency Pd at: [%]			
405 nm	50	55	
532 nm	60	70	
670 nm	50	55	
Dead time [ns]	42	45	
Operating voltage [V]	11.5	12.0	12.5
Max. count rate [M Counts/s]			20

COUNT® BLUE



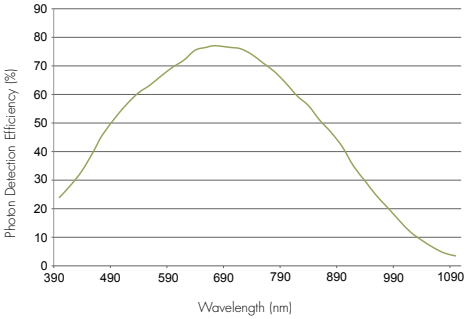
Typical photon detection efficiency

COUNT® NIR

The COUNT® NIR features an APD with enhanced detection efficiency > 50% around 810nm. This wavelength plays an important role in quantum cryptography applications.

The optional fiber connector allows straightforward fiber coupling.

COUNT® NIR



Typical photon detection efficiency

Specifications COUNT® NIR

Parameter	Min	Typ	Max
Spectral range [nm]	400		1100
Dark count rate [Counts/s]			
COUNT-50N			50
COUNT-100N			100
COUNT-250N			250
COUNT-500N			500
Photon detection efficiency Pd at: [%]			
670nm	60	70	
810nm	50	60	
Dead time [ns]	42	45	
Operating voltage [V]	11.5	12.0	12.5
Max. count rate [M Counts/s]			20

COUNT® T

LASER COMPONENTS' COUNT® T series of Single Photon Counting Modules has been developed to offer a unique combination of optimized high detection efficiency, wide dynamic range and ease of use for single molecule applications like time correlated single photon counting (TCSPC), fluorescence correlation spectroscopy (FCS) or fluorescence lifetime imaging (FLIM).

Specifications COUNT® T

Parameter	Min	Typ	Max
Spectral range [nm]	400		1000
Dark count rate [Counts/s]			
COUNT-T-100			100
COUNT-T-250			250
Photon detection efficiency Pd[1] at: [%]			
405 nm	20	40	
670 nm	60	75	
810 nm	40	60	
Timing resolution [ps]		350	
Dead time [ns]	42	45	
Operating voltage [V]	11.5	12.0	12.5
Max. count rate [M Counts/s]			20

1 Specifications valid for modules without FC-connector

COUNT® S

To further simplify detection of small light quantities the new passively quenched COUNT® S series features an active area of 500 µm. High detection efficiencies of over 60% at 670 nm and dark count rates in the range of 1000–5000 cps make the COUNT® S an ideal candidate for applications with counting rates up to 800 K Counts/s.

Specifications COUNT® S

Parameter	Min	Typ	Max
Spectral range [nm]	400		1000
Dark count rate [Counts/s]			
COUNT-1000S			1000
COUNT-2000S			2000
COUNT-5000S			5000
Photon detection efficiency Pd at: [%]			
405 nm		60	
670 nm		65	
810 nm		45	
Dead time [ns]	300	700	1500
Operating voltage [V]	11.5	12.0	12.5
Max. count rate [K Counts/s]		500	

Electronics

We offer drivers for pulsed laser diode as well as APD controllers.

Our plug & play driver modules for PLDs couldn't be easier to operate, particularly with the optional evaluation board.

High voltage supplies (up to 1000 V) enable straightforward operation of APDs or photo-mulipliers, with the optional digital interface (depending on version) adding extra flexibility.

PLD Driver Electronics

The LSP-40 is an inexpensive, easy to use driver allowing straightforward operation of any LASER COMPONENTS pulse laser diode.

Simply add two appropriate resistors to the circuit to set the pulse length and power of the laser, and apply 12V and a TTL trigger signal.

Unlike complete PLD modules with integrated lasers, the LSP-40 is flexible, allowing the user to simply operate any chosen laser diode via straightforward soldered connections.

The optional evaluation board makes operation even easier by adding trim pots for power and pulse length adjustment, as well as an SMB trigger input.

Specifications LSP-40

Drive current [A]	0 – 40
Pulse length (@ 40 A) [ns]	30 – 150
Pulse length (@ 12 A) [ns]	30 – 1000
Trigger input [-]	TTL ↑
Max. rep. rate [kHz]	10
Package dimensions [mm]	40 x 40 x 10
Operating voltage [VDC]	+12

High-Voltage Modules dBC Series

The dBC series (dBC = digital bias controller) of miniature high voltage modules has been specially designed for avalanche photodiode (APD) operation. 3 versions are offered: The dBC-120-3x delivers a precisely controlled voltage in the range 1–120V from a 3V input voltage. This version is designed for use with InGaAs-APDs as well as very fast Si-PIN-photodiodes. The dBC-220-3x provides an output voltage range of 1–220V, also from a 3V supply, and is the ideal choice for most silicon APDs. Larger area APDs requiring higher voltages benefit from the dBC-380-5x which supplies up to 380V from a 5V input voltage. All three versions share a compact housing design with dimensions 21 mm x 21 mm x 8.3 mm.

The modules have integrated temperature compensation circuitry allowing both discrete APDs as well as APD modules with built-in temperature sensors to be controlled. An integrated current limiter ensures that the APD is protected against overexposure.

Specifications dBC Series

Part Number	Operating voltage [V]	Output voltage [V]	Output adjust [VDC]	TK adjust [VDC]	Temperature sensor (default)	Output current [mA]	Operating temperature [°C]	Dimensions [mm]	Weight [g]
dBC-120-3x	2.8 ... 12.5	1 ... 120	0 .. + 2.2	0 .. + 2.2	Si diode	max. 0.45	-10 ... +50	21 x 21 x 8.3	10
dBC-220-3x	2.8 ... 12.5	1 ... 220	0 .. + 2.2	0 .. + 2.2	Si diode	max. 0.45	-10 ... +50	21 x 21 x 8.3	10
dBC-380-5x	4.8 ... 12.5	1 ... 380	0 .. + 2.2	0 .. + 2.2	Si diode	0.3 @ 380 V max. 0.9 @ short-circuit	-10 ... +50	21 x 21 x 8.3	10

High-Voltage Modules ABC550 Series

The ABC series of DC/DC converters has been designed for optimum avalanche photo-diode (APD) performance. The output voltage is precisely adjustable and highly stable and the temperature coefficient of the output voltage can be exactly adapted to the properties of the APD. Discrete APDs as well as APD modules with integrated temperature sensors can be controlled using the ABC series. The output current is limited to a safe level so that the APD is protected against overload. A precise reference voltage source is built in. The output voltage can be adjusted either with a simple potential divider or with an external control voltage.

Specifications ABC Series

Part Number	Operating voltage [VDC]	Setting of amplifier [VDC]	Control voltage [VDC]	Reference voltage [VDC]	Temperature Sensor	Output voltage [VDC]	Output current [mA]	Dimensions [mm]	Weight [g]
550-04	+10 .. +18	0 .. + 5.0	0 .. + 5.0	+ 5.050	Temperature dependent resistor	+10 .. + 500	max. 0.2	40 x 40 x10	35
550-05	+10 .. +18	0 .. + 5.0	0 .. + 5.0	+ 5.050	Si-PIN-Diode	+10 .. + 500	max. 0.2	40 x 40 x10	35
550-06	+10 .. +18	0 .. + 5.0	0 .. + 5.0	+ 5.050	Temperature dependent resistor	-10 .. - 500	max. 0.2	40 x 40 x10	35

Mini High-Voltage Modules HV1000 Series

The HV series of DC/DC converters has been designed for optimum photomultiplier (PMT) performance. It is also suitable for avalanche photodiodes (APD), solid state detectors, piezo devices and other applications requiring precision, low noise, high voltage in a compact shielding housing. The output voltage is precisely adjustable and highly stable. The output current is limited to a safe level so that the detector is protected against overload.

Improvements in stability and ripple, along with an on board precision reference, a voltage monitor and increased protection, enable these modules to replace much larger, more expensive power supplies in many applications. The output voltage can be adjusted either with a simple potential divider or with an external control voltage.

Typical Specifications

- Negative output voltage up to 1025 V
- High accuracy < 0.2%
- High stability < 0.01%
- Short-circuit proof
- Low ripple
- Compact shielded housing

Specifications HV1000 Series

Operating voltage [VDC]	+11 ... +15
Setting of amplifier [VDC]	0 ... +5.0
Control voltage [VDC]	0 ... +5.0
Reference voltage [VDC]	+5.050
Output voltage [V]	-10 ... -1025
Output current [mA]	max. 1.8
Dimensions [mm]	40 x 40 x 13
Weight [g]	48

Product Changes

LASER COMPONENTS reserves the right to make changes to the product(s) or information contained herein without notice. No liability is assumed as a result of their use or application.

Ordering Information

Products can be ordered directly from LASER COMPONENTS or its representatives. For a complete listing of representatives, visit our website at www.lasercomponents.com

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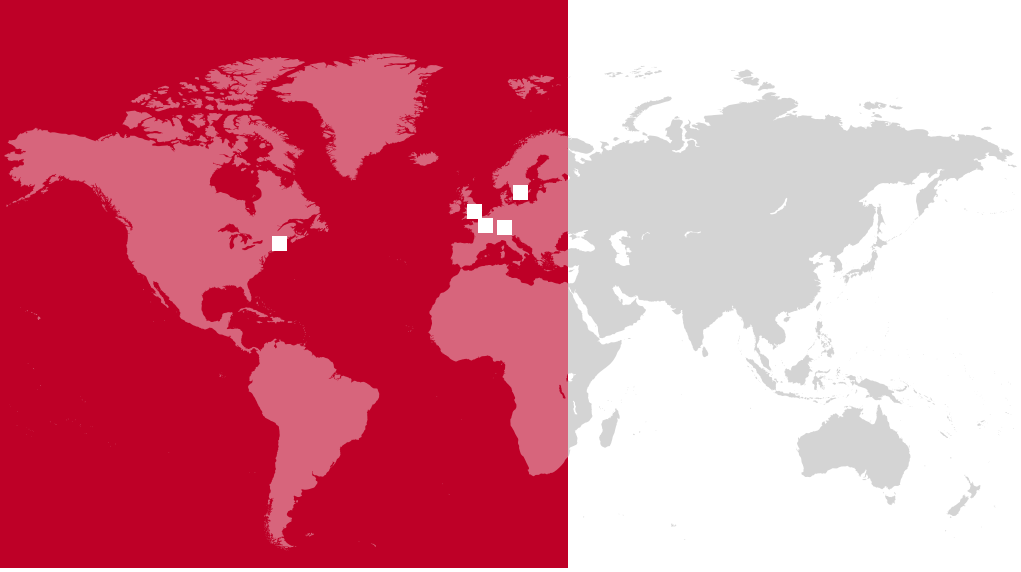
Version 9 - 03/18 - 3030898



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