

## End-to-end “Platform Agnostic” Laser and Broadband Light Source Solutions

### Sensing Products & Applications



Powering Your Future Through Light



**DenseLight** specializes in providing end-to-end integrated photonics solutions for the global Photonics & Data Centre markets. Our solutions include design and simulation, epitaxial growth, wafer fabrication, chip production, in-line optical coating, sub-mounting, photonic measurements and product tests and screening.

This is accomplished in DenseLight with our state-of-the-art Indium Phosphide (InP) and Gallium Arsenide (GaAs) wafer epitaxial growth and fabrication cleanroom, together with high precision photonics assembly and test facilities.

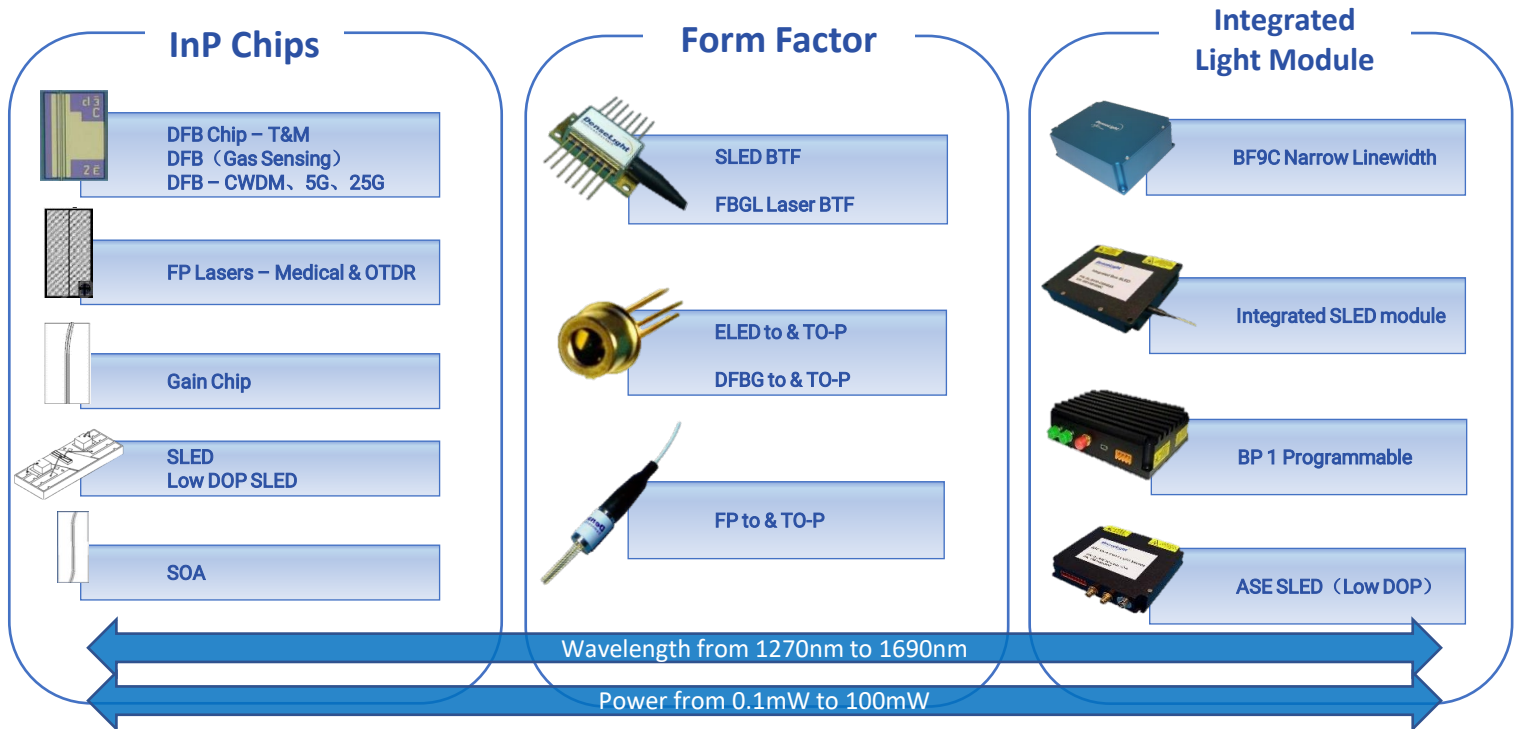
# Sensing Products & Applications

## Table of contents

.....

Product Range	<u>4</u>
SLED	<u>5</u>
Low DOP SLED	<u>7</u>
SLED sets	<u>8</u>
BZ 1, BX 9 & BX 10 (ILM)	<u>10</u>
ASE Broadband Light Source	<u>13</u>
Semiconductor Optical Amplifier (SOA)	<u>15</u>
BF9 & BF10 (ILM)	<u>16</u>
BF9C (ILM)	<u>17</u>
Ultra Narrow Linewidth Laser (NLW)	<u>19</u>
Distributed Feedback Laser (DFB)	<u>20</u>
Uncooled edge emitting LEDs (ELED)	<u>21</u>
Applications - Summary	<u>22</u>

# DenseLight Semiconductors Product Range

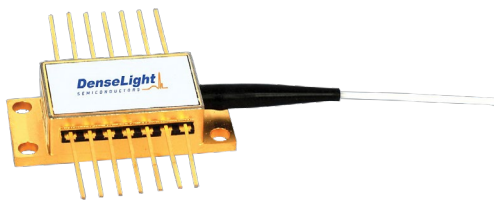


## Superluminescent light-emitting diode SLED

A superluminescent light-emitting diode (SLED or SLD) is a superluminescence-based edge-emitting semiconductor light source that combines the high power and brightness of a laser diode with the low coherence of conventional light-emitting diodes.

DenseLight has been designing and manufacturing SLEDs in our own fab, with the highest power and widest bandwidth devices in the industry in the 1200nm to 1700nm wavelength range.

Our Light Source family covers all the bands needed for broadband and high-power requirements, our SLED-based light sources will cover all the main bands used in telecom applications, and communications and test applications. It provides a broader spectral range and high spectral density. Our product family is ideal for broadband applications, and passive component testing, as well as fiber-optic sensing and spectroscopy.



14-pin BTF

### Applications

- Test and Measurement: Fiber Optic Networks
- Medical Imaging, Patient Monitoring & Detection (OCT, Glucose Monitoring)
- Navigation: FOG Fiber Optic Gyroscope
- Structural Health Monitoring: FBG Sensor Interrogation

Product Description	Features & Performance
<ul style="list-style-type: none"> <li>• Broad product range</li> <li>• Wavelength options from 1260nm to 1700nm</li> <li>• Bandwidth options from typical 25nm to 100nm</li> <li>• SLEDs cover the spectrum between 1250nm and 1700nm</li> <li>• FP/APC connector ports with SMF and PMF fiber pigtail options</li> <li>• Integrated light modules (DL-ASE series) available with low polarization SLED options</li> </ul>	<ul style="list-style-type: none"> <li>• Highest energy/ output efficiency in the market</li> <li>• Comprehensive range to suit your needs</li> <li>• Superior power and spectral coverage</li> <li>• Telcordia and ISO9001:2008 certification</li> <li>• RoHS Compliance</li> <li>• High TE/TM ratio (&gt;20dB possible)</li> <li>• Direct Modulation up to 622 MHz available on request</li> <li>• Low Coherence Noise</li> <li>• Low Spectra Ripple</li> <li>• (&lt; 0.1db Low Power, &lt; 0.3db Medium power, &lt; 0.5db High Power)</li> <li>• Relative Intensity Noise: Typ. -140dB/Hz to -125dB/Hz</li> </ul>

## Superluminescent light-emitting diode SLED

### Product Specifications

Center Wavelength (nm)	Product Code	Minimum Power (mW)	Typical Bandwidth FWHM(nm)	Typical Spectral Ripple (dB)	Form Factor	Typical Iop (mA)	PD Options	Applications
1275	DL-CS2079A*	7	75	0.15	14 pin BTF	400	Yes	T & M - CT
	DL-CS2089A	8	75	0.2	14 pin BTF	400	Yes	T & M - CT
	DL-CS2184A	18	40	0.15	14 pin BTF	350	Yes	T & M - CT
Premium	DL-CS3089A	8	75	0.2	14 pin BTF	400	Yes	T&M - Metrology
	DL-CS3158A*	15	60	0.3	14 pin BTF	500	Yes	T & M
	DL-CS3159A*	15	83	0.25	14 pin BTF	500	Yes	T & M, Medical
	DL-CS3184A	18	42	0.15	14 pin BTF	350	Yes	T & M
	DL-CS3202A	20	30	0.2	14 pin BTF	350	Yes	T & M
	DL-CS3207A*	20	56	0.15	14 pin BTF	500	Yes	T & M
	DL-CS3452A	40	32	0.35	14 pin BTF	700	Yes	T & M
	DL-CS43H4A*	15	45	0.2	14 pin BTF	350	Yes	T&M – Optical Networks
1430	DL-CS44H4A*	15	45	0.2	14 pin BTF	350	Yes	T&M – Optical Networks
1480	DL-CS48H5A	15	50	0.2	14 pin BTF	350	Yes	T&M – Optical Networks
1550	DL-CS5037A*	3	60	0.15	14 pin BTF	250	Yes	T & M
	DL-CS5077A*	5	60	0.2	14 pin BTF	250	Yes	T & M - CT
	DL-CS5107A	8	60	0.2	14 pin BTF	300	Yes	T&M – Navigation
	DL-CS5103A*	10	40	0.15	14 pin BTF	300	Yes	导航
Premium	DL-CS51010A-T30	10	100	0.25	14-Pin BTF	600	Yes	T&M – Structural Health Monitoring
	DL-CS5153A*	15	40	0.2	14 pin BTF	350	Yes	T&M – Structural Health Monitoring
Premium	DL-CS5169A/-T20*	16	80	0.3	14 pin BTF	500	Yes	T&M – Structural Health Monitoring
	DL-CS5203A*	20	40	0.25	14 pin BTF	450	Yes	T&M – Structural Health Monitoring
	DL-CS5254A*	25	40	0.25	14 pin BTF	450	Yes	T&M – Structural Health Monitoring
	DL-CS5403A*	35	40	0.35	14 pin BTF	650	Yes	T & M - CT
1580	DL-CS58M7A	5	58	0.15	14 pin BTF	250	Yes	T & M
1600	DL-CS6055A	5	55	0.15	14 pin BTF	200	Yes	T & M
	DL-CS6107A*	8	60	0.15	14 pin BTF	300	Yes	T & M
1620	DL-CS62M7A*	8	60	0.15	14 pin BTF	300	Yes	T & M – Fiber Sensing
1650	DL-CS65M5A*	10	50	0.2	14 pin BTF	350	Yes	T & M – Fiber Sensing
1680	DL-CS68M5A*	15	50	0.3	14 pin BTF	500	Yes	T & M – Fiber Sensing
1690	DL-CS69M5A	10	50	0.15	14 pin BTF	400	Yes	T & M – Fiber Sensing

\* PMF version available, Please contact your local sales or write to sales@denselight.com for information

#### Premium SLED

1310nm Premium Model CS 3159A,

1550nm Premium Model CS 5169A,

CS 51010A-T30

Features: Bandwidth 83nm (Typical value) , Power 16mW (Typical value)

Features: Bandwidth 80nm (Typical value) , Power 16mW (Typical value)

Features: Bandwidth 100nm (Typical value) , Power 10mW (Typical value)

Product Series: 1600/1620/1680: High power & high bandwidth available (>30nm)

## Low DOP SLED

Recognizing the need for SLEDs with Low Degree of Polarization for the FOG and FBGL sensing markets, DenseLight has now developed a range of devices to meet the demanding specifications of these markets.

Low DOP SLED have a center wavelength of 1310nm or 1550nm and we also offer customized low DOP SLED products.

### Features

- Center Wavelength :1290-1330nm
- Spectral ripple/modulation  $\leq 0.2\text{dB}$
- Polarization extinction ratio  $\leq 1.2\text{dB}$
- Bandwidth  $\geq 35\text{nm}$
- Chip optical power  $\geq 1.5\text{mW}$  or  $3\text{mW}$



### Applications

- FOG Fiber Optic Gyroscope
- Medical Imaging, Patient Monitoring & Detection (OCT, Glucose Monitoring)
- Optical Test & Measurement
- Optical Fiber Communication

Wavelength	Product Code	Form Factor	Remarks
1310nm Low DOP	DL-CS31033A-LDP-J0	COS (3mW)	
	DL-CS31013A-LDP-J0	COS (1.5mW)	
	DL-CS31033D-LDP	Die (3mW)	
	DL-CS31013D-LDP	Die (1.5mW)	
	DL-CS31033A-LDP-RA-J15	COS (3mW)	Adaptable to smaller sizes
	DL-CS31013A-LDP-RA-J15	COS (1.5mW)	Adaptable to smaller sizes
	DL-CS31033D-LDP-RA	Die (3mW)	Adaptable to smaller sizes
	DL-CS31013D-LDP-RA	Die (1.5mW)	Adaptable to smaller sizes
1550nm Low DOP	DL-CS5083A-LDP-FP*	14pin BTF	

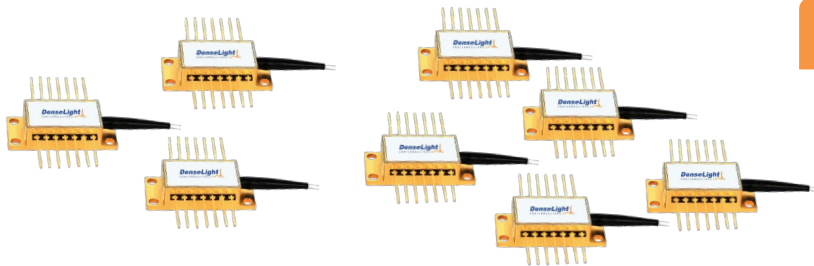
\*Note: Available in 8-pin or 14-pin butterfly package

## SLED Sets

Denselight offers proprietary matching of our SLEDs, to produce a multi-product combination, which combines a single spatial mode, across a broad spectrum for both sensing or telecom applications that require a broadband spectrum

With a total output power up to 50 mW, that covers a range of from 1250 nm to 1700 nm, the Denselight SLED offering provides unparalleled flexibility, value and versatility, for those customers who need quick agile alternatives for drop in IR Light sources, to fulfill spectrum needs.

The Denselight Light Source family, provides the required spectral stability, and total output power stability required for both application specific, and specific spectral regions of interest. Our Light Source Family of SLED's also provides the necessary Spectral Power Density as a key attribute, required for sensing applications and telecom uses which may or may not have polarization dependencies.



### Application

- Broadband Fiber-Coupled Light Sources for Spectroscopy,
- Telecommunication,
- Test & measurements,
- Component testing.

### Product Description

**Multiple Light Source Matching in One Broad Band Source** – For multiple wavelength testing, our Dual (2) to Six (6) SLED combinations cover all the major network bands, which enables accurate characterization of fiber links and their passive components, with a very cost-effective test set up. Use our 1300nm/1500nm source for most major passive components; Isolators, Couplers

**SLED Light Sources Choice Selection for Component testing** – Denselight's diverse SLED line of products offers enough variety of choice in power selection along with spectral symmetry. You can efficiently qualify your components during your systems & components development and perform Pass/Fail testing during production.

**High Spectral Density Stability** – High spectral density stability is essential to ensure that the test setup provide accurate measurements. The more stable the spectrum, the less often a reference trace has to be acquired

### Features & Performance

- **Single SLED:** 1275nm, 1310nm, 1440nm, 1530nm, 1550nm, 1600nm, 1620nm, 1650nm
- **Dual SLED Combinations:** 1230nm - 1400nm 1450nm - 1670nm

(Other wavelengths available upon request)



## SLED Sets

### Product Selection

Telecom bands	Wavelengths (nm)	Minimum Spectral Density (dBm/1n m)*	Mad. Spectral Flatness (dB)	SLEDs combination quantity
O-E	1230-1400	-30	3	2
O-L	1250-1600	-30	14	3
O-U	1250-1650	-25	10	4
	1250-1650	-22	8.5	5
	1250-1700	-25	2	6
S-U	1450-1670	-30	2	2

\* Excludes passive insertion loss due to optical components

## Integrated Light Module

The Denselight BX, BZ-series of Integrated Infrared Light Module (ILM) products are based on the proven performance DL-CS series of 14-PIN Butterfly SLED.

It is an ideal balance of cost-performance-value solution, for general purpose applications that require convenient usage, low wavelength sensitivity to environment, and lifetime reliability. The BX-series and BZ-series incorporate a compact form factor with precise controllers for high output level and excellent power stability.

**DL-BX series** is focused on providing a Precisely Power Tuned light source, with the functional feature of plugging-in-and providing infrared light, where absolute accuracy, stability, lifetime reliability and high resolution are vital. The DL-BZ line of I2LM series provides option to directly intensity modulate the SLED.



BZ1



BX9



BX10

Product Description	Features & Performance
<p><b>Extra Features in BX-9 Series</b></p> <ul style="list-style-type: none"> <li>• Tunable optical power</li> <li>• Over temperature protection</li> <li>• Smallest size in I2LM family</li> </ul>	<ul style="list-style-type: none"> <li>• Excellent stable CW operation ( &lt;0.01dB)</li> <li>• Optical power range up to 50mW</li> <li>• Wide 3dB spectral bandwidth of 25nm up to 100nm</li> <li>• Integrated optical isolator</li> <li>• Standard operating temperature: 0°C to 70°C</li> <li>• Optical output: SMF or PMF fiber options with pigtail (BX) or with receptacle (BZ) options, with FC/APC connector</li> <li>• Wavelength from 1200nm to 1700nm</li> <li>• Customized design and features (Return Sensing Signal Port, Monitoring Optical Coupler or Application Specific Passive Components)</li> <li>• Linearly voltage controlled tunable optical power</li> <li>• Built-in current driver and temperature controller</li> <li>• High wall-plug efficiency</li> <li>• Telcordia qualified, RoHS Compliance</li> </ul>
<p><b>Extra Features in BX-10 Series</b></p> <ul style="list-style-type: none"> <li>• Over temperature protection and internal PCB temperature monitor</li> <li>• Active-Low optical power enabled function</li> <li>• Operating temperature up to 70 °C</li> </ul>	
<p><b>Extra Features in BZ-1 Series</b></p> <ul style="list-style-type: none"> <li>• Over temperature protection and internal PCB temperature monitor</li> <li>• Pre-bias optical power</li> <li>• Analog intensity modulation up to 20MHz</li> <li>• Pulse or digital modulation up to 200MHz</li> </ul>	

## Integrated Light Module

### Application

Structure Health Monitoring	<ul style="list-style-type: none"> <li>sensing in gas &amp; oil production, telemetry in electricity distribution (FOS)</li> <li>physical (temp, pressure, strain, vibrations), structural and civil engineering, smart structures, intelligent distributed sensing (DTS &amp; DTSS)</li> </ul>
Test & Measurement	<ul style="list-style-type: none"> <li>in-line production process monitoring, 3D metrology and surface metrology, semiconductor fabrication (solar cells)</li> </ul>
Medical Technology	<ul style="list-style-type: none"> <li>OCT (biopsies-less medical cell imaging, diagnostic imaging), point of use/ handhelds/ noninvasive diagnosis (blood analysis)</li> </ul>
Navigation	<ul style="list-style-type: none"> <li>navigation and guidance - inertia sensing (Gyroscope)</li> </ul>

### Specifications

BX9 Dimension:	L100mm x W80mm x H16 mm
BX10 Dimension:	L100mm x W80mm x H20 mm
BZ1 Dimension:	L100mm x W80mm x H22.5 mm
Enclosure:	Metal Case
Cooling:	Air-Cooled
Optical Output:	Receptacle
Connector Type:	FC/APC
Power Supply:	5V DC

# Integrated Light Module

## Product Selection

Wavelength Range (nm)	Model selection DL-BX9-CSxxxxA, DL-BX10-CSxxxxA, DL-BZ1-CSxxxxA	Typ Module Power (mW)	Typ Module FWHM (nm)	Typ Module Ripple (dB)
1260 - 1290	2079A	7	75	0.15
	2184A	18	40	0.15
1290 - 1330	3089A	8	75	0.2
	3159A	15	83	0.25
<u>Premium</u>	3184A	18	42	0.15
	3202A	20	30	0.2
	3207A	20	56	0.15
	3452A	40	32	0.35
1380 - 1420	40H2A	15	35	0.2
1415 - 1445	43H4A	15	45	0.2
1430 - 1470	44H4A	15	45	0.2
1460 - 1500	48H5A	15	50	0.2
	5037A	3	60	0.15
1530 - 1570	5077A	5	60	0.2
	5107A	8	60	0.2
	5103A	10	40	0.15
	51010A	10	100	0.25
	<u>Premium</u>	5153A	15	40
	5169A	16	80	0.3
	5203A	20	40	0.25
	5254A	25	40	0.25
	5403A	35	40	0.35
1560 - 1600	58M7A	5	58	0.15
1580 - 1620	6055A	5	55	0.15
	6107A	8	60	0.15
1600 - 1630	62M7A	8	60	0.15
1635 - 1690	65M5A	10	50	0.2
	69M5A	10	50	0.2

- Due to insertion loss of integrated optical isolator, optical power and bandwidth in ILM form can be up to 10% lower than corresponding DL-CS module
- All current model selections are available in Premium-, A- and B-Grade performance models which offer variety in Center Wavelength, Bandwidth, Power Ranges and Spectral Modulation Ranges

## All-Semiconductor ASE Broadband Light Source

DenseLight DL ASE is a series of all semiconductor low DOP ASE optical sources with a wide selection of wavelengths, covering the entire telecom spectral bands (from O to U). The CW output standard model comes with excellent stability in output power and spectrum. As it operates on direct light generation from super luminescent principle (SLED) it can be directly intensity modulated, Modulation models are available upon request, as well as custom models to meet your specific needs

- Low DOP capability < 5%
- High optical power up to 19dBm
- Consistent spectral power density across wide bandwidth (up to 120nm)
- Excellent power stability <0.01dB
- Analog modulation (3dB~20 MHz)
- Digital modulation (tr<1ns)

### Application

- OCT, non invasive analysis
- SHM sensing in gas & oil
- FOS
- T&M
- Communications
- Defense & Security



ASE (IM)



ASE (CW)

Product Description	Features & Performance
<p><b>DL-ASE-CW Series</b></p> <ul style="list-style-type: none"> <li>• Over temperature protection and internal PCB temperature monitor</li> <li>• Active Low optical power enabled function</li> <li>• Extendable Operating temperature up to 70°C</li> <li>• Optical Output SMF Fiber Pigtail Output</li> </ul> <p><b>DL-ASE-IM Series</b></p> <ul style="list-style-type: none"> <li>• Over temperature protection and internal PCB temperature monitor</li> <li>• Pre bias optical power</li> <li>• Analog intensity modulation up to 20MHz</li> <li>• Pulse or digital modulation up to 200MHz</li> <li>• Optical Output FC Receptacle</li> </ul>	<ul style="list-style-type: none"> <li>• Wide spectral coverage, 1200nm 1700nm</li> <li>• Customized ASE design and spectrum combination (e.g. return sensing signal port, monitoring optical coupler, etc)</li> <li>• <b>CW operation (DL ASE CW Series) or Direct modulation operation (DL ASE IM Series)</b></li> <li>• Fiber pigtail or FC receptacle output</li> <li>• Improved reliability by integrated optical isolator</li> <li>• Remote optical power enabled function by active low logic</li> <li>• Standard operating temperature: 00°C to 6565°C. Extended range 2020°C to 7070°C</li> <li>• Telcordia certification, RoHS Compliance</li> </ul>

## All-Semiconductor ASE Broadband Light Source

### Product Selection

Telecom Band	Product Code	SLED Type	Wavelength Range	CWL	Bandwidth	Power	Power Density	Usage Method	Spectral Symmetry
			(nm)	(+/- 20 nm)	3dB	dBm	dBm/nm		Gaussian
<b>O Band</b> (1260 - 1360 nm)	DL-ASE-CW-CSO 193A	DL-CS-3452A-FP	1285 - 1335	1310	32	19	-6.5	CW	Yes
	DL-ASE-CW-CSO 157A	DL-CS-3207A-FP	1265 - 1365	1310	50	15	-12.5	CW	Yes
	DL-ASE-CW-CSO 139A	DL-CS-3159A-FP	1250 - 1350	1310	75	13.5	-7.5	CW	Yes
	DL-ASE-CW-CSO 119A	DL-CS-3159A-FP	1250-1350	1310	75	11	-12.5	CW	Yes
	DL-ASE-CW-CSOE 109A	DL-CS-2079A-FP	1235-1380	1310	120	10	-15	CW	No
<b>E Band</b> (1360 - 1460 nm)	DL-ASE-CW-CSE 145A	DL-CS-44H5A-FP	1420 - 1460	1450	50	14	-7.5	CW	Yes
<b>S Band</b> (1460 - 1530 nm)	DL-ASE-CW-CSS 145A	DL-CS-48H5A-FP	1470-1506	1480	50	13.5	-9	CW	Yes
<b>S-C Band</b> (1460 - 1565 nm)	DL-ASE-CW-CSSC 129A	DL-CS-53109A	1470-1565	1530	80	12	-10	CW	Yes
<b>C Band</b> (1530 - 1565 nm)	DL-ASE-CW-CSC 183A	DL-DL-CS5403A-FP	1525 - 1565	1550	35	18	-3.5	CW	Yes
	DL-ASE-CW-CSC 164A	DL-CS-5254A-FP	1525 - 1565	1550	40	16	-5	CW	Yes
	DL-ASE-CW-CSC 147A	DL-CS-5107A-FP	1510- 1590	1550	60	15	-7.5	CW	Yes
	DL-ASE-CW-CSC 119A	DL-CS-5169A-FP	1510- 1590	1550	80	11.5	-9	CW	Yes
	DL-ASE-CW-CSC 117A	DL-CS-5107A-FP	1525 - 1565	1550	60	11	-10	CW	Yes
	DL-ASE-CW-CSC 107A	DL-CS-5107A-FP	1526 - 1565	1550	60	10	-11	IM	Yes
	DL-ASE-CW-CSC 143A	DL-CS-5254A-FP	1525 - 1565	1550	40	14	-8	CW	Yes
<b>C-L Band</b> (1525 - 1625 nm)	DL-ASE-CW-CSC 117A	DL-CS 58M7A-FP	1527 - 1610	1580	58	11	-15	CW	Yes
	DL-ASE-IM-CSCL 107A	DL-CS 58M7A-FP	1526 - 1625	1580	58	10	-16	IM	Yes
<b>L- Band</b> (1565 - 1625 nm)	DL-ASE-CW-CSL 165A	DL-CS60H5A-FP	1525-1610	1600	50	16	-6	CW	Yes
<b>U Band</b> (1625 - 1675 nm)	DL-ASE-CW-CSU 125A	DL-CS65M5A-FP	1651-1691	1650	50	11.5	-13	CW	Yes
	DL-ASE-CW-CSU 125A	DL-CS65M5A-FP	1625-1675	1650	50	11.5	-9	CW	Yes
	DL-ASE-CW-CSU 135A	DL-CS69M5A-FP	1645-1710	1690	50	13	-10	CW	Yes

## Semiconductor Optical Amplifier (SOA)

DenseLight has developed 1310nm and 1550nm SOA for the optical communications and sensing market. We are also able to provide high power SOA for auto LiDAR and road LiDAR field.

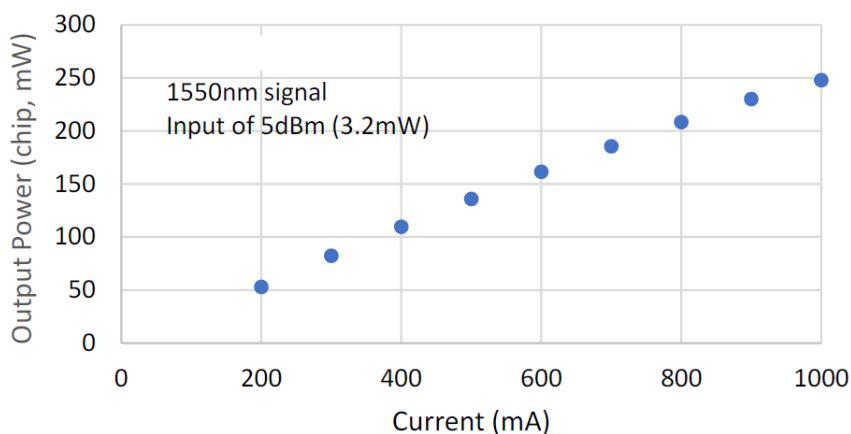
Our SOA also has a switch function and is available in 14pin butterfly packaging.

Many of today's applications require these SOAs to be mounted onto an optical engine platforms, and these SOAs can be customized to be flip-chip bonded and the modes be matched to waveguides on these platforms for efficient coupling. Customization of multiple-element SOAs is also possible.

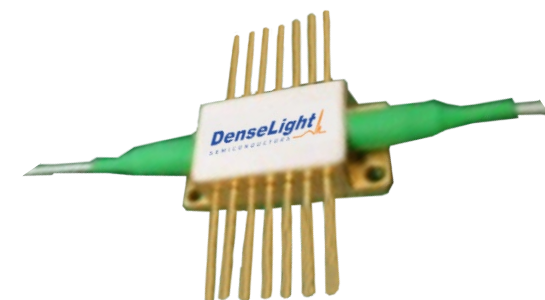
### Product Performance

- ASE bandwidth  $\geq 45\text{nm}$
- ASE spectral ripple  $\leq 0.3\text{dB}$
- High saturation output power  $\geq 20\text{dBm}^*$
- NF figure  $\leq 8\text{dB}$
- Gain value  $\geq 20\text{dB}$

\* Higher saturated optical power version available, please consult factory for more information.



Current and Saturation Out Power@45 °C Chip Operating Temperature



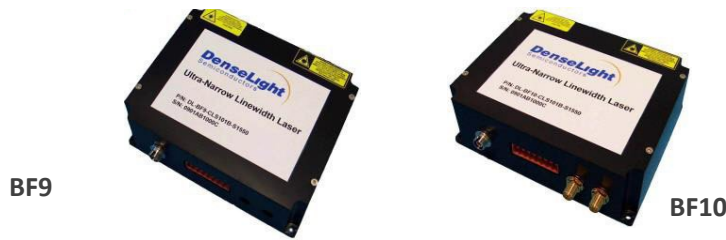
### Applications

- Wind LiDAR
- Auto LiDAR
- Road LiDAR
- Fiber optic sensing
- Coherent Optical Fiber Communications (ITLA)

Product	Product Code	Packaging
SOA for LiDAR	DL-SOA55020C-320-HDP-45-2	COS
	DL-SOA55014A-HDP-45	14pin BTF

## Ultra-Narrow Linewidth Laser Single Frequency Lasers

The DL-BF9/BF10 series of integrated modules are designed for applications in optical metrology & instrumentation and optical gas & chemical sensing, requiring narrow spectral linewidth, excellent SMSR, power stability, and a very highly wavelength stable laser output. is complete with a DenseLight 14-pin BTF package laser, integrated laser driver & temperature controller. They are available over a wide wavelength range across the O, E, S, C and L bands which can be customized with various options to meet your specific needs.



### Product Model

	Direct Modulation
<b>BF9</b>	No
<b>BF10</b>	Yes

### Application

- Distributed temperature sensing (DTS)
- Out-of-band OTDR
- Optical metrology
- Gas/chemical sensing
- Fiber laser seeding
- LiDAR

### Product Description

#### BF9 & BF10 Series

The DenseLight DL-BF9/BF10-CLSxxxB-Syyyy is a series of ultra narrow linewidth lasers. The DL-BF10 series comes with 2 direct modulation inputs (analog input: BW 20MHz & digital input: BW 200MHz).

### Features & Performance

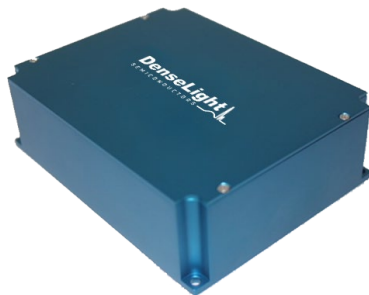
- Typical ultra-narrow linewidth < 10KHz
- Wavelength available from 1260nm ~ 1670nm
- High power: CW up to 10mW
- Excellent RIN < -140dB / Hz (for power >10mW)
- Excellent minimum SMSR >45dB
- Wavelength stability: +/-1pm @ 25°C
- Integrated laser driver and temperature controller
- Integrated optical isolator
- Dimensions: L120mm x W93mm x H36.5 mm
- Telcordia qualified(GR-468-CORE)



## [BF9C] Constellation Series

The DL-BF9C Constellation product series uses DenseLight's proprietary 14-pin butterfly package manufacturing process, enabling improved performance of the external cavity laser to give high PER performance, high stability line width, low RIN < -155 dB/Hz & low phase noise performance

This series features a narrow linewidth of <50Khz, & <200 KHz. option & a minimum output power of 10 mW. The Constellation ILM is suitable for embedded designs or stand alone uses in a wide range of communication and sensing application. When using the Constellation series, the fiber optic systems will operate at a premium performance level



### Application

- DAS
- Interferometric Sensing Metrology
- Defense & Security
- Coherent Communications
- Oil & Gas
- Wind LiDAR

Technical Specifications		Features & Performance
Dimensions	L120mm x W93mm x H36.5 mm	<ul style="list-style-type: none"> <li>• Ultra-Narrow Linewidth &lt; 50Khz &amp; &lt; 200Khz options.</li> <li>• Excellent RIN &lt; -155 dB/Hz</li> <li>• High Frequency stability within <math>\pm 1</math>pm after 15 minutes warm-up</li> <li>• Excellent Typical SMSR</li> <li>• Typical PER &gt; 15dB (PMF)</li> <li>• CW &gt; 10mW</li> <li>• Mode-Hop-Free over 0°C to 50°C</li> <li>• Integrated optical isolator, Proprietary Laser Driver and temperature controller</li> <li>• Over-temperature protection and internal PCB temperature monitor</li> </ul>
Enclosure:	Metal Casing	
Cooling:	Air-Cooled	
Optical Output:	Receptacle	
Connector Type:	FC/APC	
Electronic Interface:	8-pin terminal block	
Power Supply:	5V DC	

## [BF9C] Constellation Series

### Product Offering

Output Fiber Type	Linewidth (kHz)	Product Code
PM	< 50	DL-BF9C-CLS101B-FP-S1550-LW050
	< 200	DL-BF9C-CLS101B-FP-S1550-LW200

### Product Performance

Optical Parameters	Min	Max	Units
Output Power	10	-	mW
Centre Wavelength	1548	1552	nm
PER (PMF)	15		dB
Power Stability (8 hours)	-0.05	+0.05	dB
Operating Temperature Range	0	50	°C
Optical Isolation	45		dB

Noise Performance	Frequency Range		Typical Performance
RIN (Relative Intensity Noise)	0 MHz	0.5 MHz	-145 dB/Hz
	0.5 MHz	10 MHz	-150 dB/Hz
	10 MHz	50 MHz	-160 dB/Hz
Phase Noise	10 Hz		190 uRad/sqrt-Hz
	200 Hz		22 uRad/sqr-Hz

## Ultra Narrow Linewidth Laser(NLW)

DenseLight DL-CLS series is a cooled narrow linewidth laser in 14-pin BTF package with a single frequency emission. The DL-CLS laser family is based on proprietary external cavity laser design utilizing a built-in fiber Bragg grating, offering very stable performance of lasing wavelength, narrow spectral linewidth and excellent SMSR.

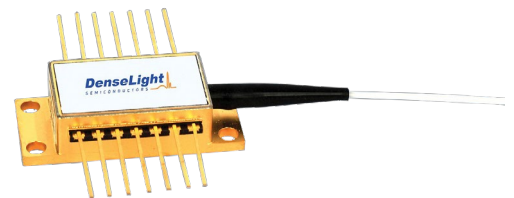
The as-built lasing wavelength can be specified precisely to 1nm. The device can directly intensity modulated up to 622MBPS. Typical output power is up to 10mW CW.

### Product features

- Narrow linewidth: < 50KHz ,100KHz , 200KHz
- Optional with built in isolator
- Wavelength 1550nm or 1560nm
- High power CW up to 10 mW
- Excellent typical SMSR: >45dB
- Wavelength stability: +/-1pm
- Typical PER: 15dB
- Direct Intensity Modulation up to 622Mbps
- Excellent RIN  $\leq$  -150dB/Hz
- SMF or PMF pigtail output
- Telcordia Qualified (GR-468-CORE)

### Applications

- Distributed temperature sensing (DTSS by B OTDR)
- Gas/chemical (e.g. methane) sensing and moisture detection
- Fiber Laser seeding for LIDAR
- Out of band Live OTDR
- Microwave generation by beat note signal
- Autopilot
- Wind LiDAR



### Product Selection

Peak Wavelength (nm)	Product Code	Fiber Type	Operating Condition	Min Power (mW)	Typical Spectrum Linewidth (kHz)	Min SMSR (dB)	Packaging Option
1550nm	DL-CLS101B-FP-S1550	PMF	CW	10	< 200	45	BTF

- For wavelengths – 1260, 1383, 1648, 1653 & 1665, please reach out to Sales Team at [sales@denselight.com](mailto:sales@denselight.com)

#### Note:

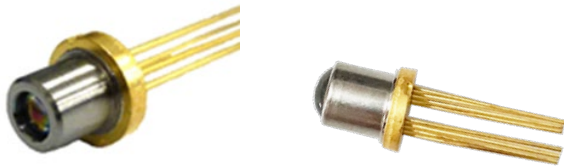
Typical linewidth can be narrowed down to **Ultra-Narrow Linewidth** < 5KHz when using Integrated InfraRed Light Module (I<sup>2</sup>LM) BF-series with high precision laser driver and temperature controller. Further precision wavelength (DOWN TO PICOMETER RANGE) CAN BE ACHIEVED THROUGH TUNING THE INTERNAL TEMPERATURE OR DRIVE CURRENT.

## Distributed Feedback Laser (DFB)

Accuracy and real-time detection of methane gas is very important, which is used in many scenarios, including natural gas pipeline leakage monitoring, household safety and coal mining safety production monitoring.

DenseLight 1653.7 nm DFB laser is widely used in applications where accurate measurement of methane is required. By adjusting the temperature and driver current of the DFB laser device, methane concentration can be detected in real time and on line, providing the advantages of extra full concentration detection range, high accuracy and good selectivity.

Our 1653.7nm DFB laser assembly allows easy integration into commercially available methane gas sensors for our customers



### Application

- OTDR
- Gas Sensing
- Biomedical Sensing
- Telecommunications

### Features & Performance

The DL-DFB1653 series is an InGaAsP-based distributed feedback laser series available in pigtailed packages with aspheric or spherical lenses.. Gas sensors with 1653.7nm wavelength of TO can and chip type are available. These devices are optimized for communications, test and measurement, and photonic sensing applications (gases).

### Methane Gas Sensing Product Selection

Wavelength (nm)	Product Code	Packaging
1653nm DFB	DL-DFB65310A	14pin BTF
	DL-DFB65404T-C-S	TO-60
	DL-DFB65407D	Die

DenseLight has capability to do other wavelengths. Please contact your local sales or write to [sales@denselight.com](mailto:sales@denselight.com) for information

## Uncooled edge emitting LEDs (ELED)

The DenseLight DL-US series are uncooled edge emitting LEDs in TO-can or coaxial pigtail package engineered for optical communication systems and test instruments. It operates over a wide temperature range from 0 to 70C without any need for a thermoelectric cooler and temperature controller.



### Application

- OTDR
- Optical test instrument
- Optical transceiver
- Fiber optic sensors
- Power line transmission monitor
- Optical metrology
- Reconfigurable Optical Add-Drop Multiplexer (ROADM)

### Features & Performance

- Uncooled ELED in TO-can, coaxial pigtail or collimation TOSA
- Center wavelength of 1310nm and 1550nm (for datacom), other wavelengths on request
- Form factor available: TO-56, TO-56 coaxial pigtail, and others on request
- High coupled power to SMF /MMF
- Narrow beam divergence upon collimation (free-space model)
- Cost effective and flexible manufacturing process
- Monitoring photo diode(Optional)

### Product Selection

Center Wavelength (nm)	Product Code	Min Power (mW)	Min Bandwidth FWHM (nm)	Package Options	Typical Iop (mA)
1310	DL-US3054D-PD	0.5	35	TO-56 Aspherical Lens with PD	100
	DL-US3154D-PD	1.5	35	TO-56 Aspherical Lens with PD	100
	DL-US3044H	0.4	40	TO-56 Flat Lens	100
	DL-US3064H	0.6	40	TO-56 Flat Lens	100
	DL-US3104H	1	40	TO-56 Flat Lens	100
	DL-US31014D-FS*	0.15	40	TO-56 SMF Coaxial Pigtail	100
	DL-US31034D-FS*	0.3	40	TO-56 SMF Coaxial Pigtail	120
1550	DL-US5054D-PD	0.5	35	TO-56 Aspherical Lens with PD	120
	DL-US5154D-PD	1.5	35	TO-56 Aspherical Lens with PD	120
	DL-US5084D	0.8	40	TO-56 Aspherical Lens	120
	DL-US55016D-FS*	0.12	50	TO-56 SMF Coaxial Pigtail	125
	DL-US55036D-FS*	0.25	50	TO-56 SMF Coaxial Pigtail	125

\*TO-56 SMF Coaxial Pigtail with PD is available

## Applications - Summary

Application	Product Type	Form Factor	Technical Specs	Product Code
<b>Guidance &amp; Navigation</b> (Fiber Optic Gyroscope - FOG)	SLED	14-pin BTF	Typ. WL 1550 nm Typ. FWHM 40 nm Min. Power 10, 15, 20, 35 mW SMF/PMF	DL-CS5103A DL-CS5153A DL-CS5203A
		8-pin BTF	Typ WL 1550 nm Typ FWHM 40, 60 nm Min Power 1, 5 mW	DL-CS50L4C DL-CS55057C
	Low DOP SLED	COS	Typ WL 1310 nm Typ FWHM 40nm Min Power 1.5, 3 mW	DL-CS31033A-LDP-J0 DL-CS31013A-LDP-J0 DL-CS31033A-LDP-J15 DL-CS31013A-LDP-J15
		Die	Typ WL 1310 nm Typ FWHM 40nm Min Power 1.5, 3 mW	DL-CS31033D-LDP DL-CS31013D-LDP DL-CS31033D-LDP-RA DL-CS31013D-LDP-RA
<b>Fiber Test &amp; Measurement</b>	SLED	14-pin BTF	Typ. WL 1310 nm Typ. FWHM 75, 83 nm Min. Power 8, 15 mW	DL-CS3089A DL-CS3159A
		14-pin BTF	Typ. WL 1430 nm Typ. FWHM 45 nm Min. Power 15 mW	DL-CS43H4A
		14-pin BTF	Typ. WL 1550 nm Typ. FWHM 80, 100 nm Min. Power 16, 10 mW	DL-CS5169A
		14-pin BTF	Typ. WL 1550 nm Typ. FWHM 80, 100 nm Min. Power 16, 10 mW	DL-CS51010A
		14-pin DIL	Typ. WL 1510 nm Typ. FWHM 100 nm Min. Power 0.2 mW	DL-CS5029L
	ELED	TO-56 Aspherical Lens	Typ. WL 1550 nm Typ. FWHM 40 nm Min. Power 0.8 mW	DL-US5084D
		TO-56 Coaxial	Typ. WL 1310 nm Typ. FWHM 40 nm Min. Power 0.15 mW	DL-US31014D-FS
<b>Data Communications</b>	ELED	TO-56 Flat Lens	Typ. WL 1310 nm Typ. FWHM 40 nm Min. Power 1 mW	DL-US3104H
<b>Metering</b>	SLED	14-pin BTF	Typ. WL 1310 nm Typ. FWHM 40, 75, 83 nm Min. Power 2, 8, 15 mW	DL-CS3024A DL-CS3089A DL-CS3159A

## Applications - Summary

Application	Product Type	Form Factor	Technical Specs	Product Code
<b>Distributed Fiber Optic Sensing</b> <ul style="list-style-type: none"> <li>• DAS</li> <li>• Perimeter Security</li> </ul>	ASE Series	ILM box	WL 1510 - 1590 nm DOP < 5% Power Density > -25 dBm/0.1 nm	DL-ASE-CW-CSC5169A
	BP1 Series	ILM box	Typ. WL 1550 nm Typ. FWHM 80 nm Min. Power 12 mW (with circulator)	DL-BP1-CS5169A
	BF Series	ILM box	WL 1550 nm, Min. Power 10 mW, Linewidth <50, <200 kHz	DL-BFx-CLS101B-S1550
<b>Gas Sensing</b> <ul style="list-style-type: none"> <li>• Methane Gas Sensing</li> </ul>	DFB	TO	WL 1653.7nm, Min. Power 3.5mW, SMSR >35dB	DL-DFB65404T-C-S
		Chip	WL 1653.7nm, Min. Power 7mW, SMSR >35dB	DL-DFB65407D
<b>Sensing</b> <ul style="list-style-type: none"> <li>• LiDAR</li> <li>• Wind LiDAR</li> <li>• Current</li> <li>• Spectrometer</li> </ul>	NLW	14-pin BTF	WL 1550nm, Min. Power 10mW, Linewidth <100, <200 kHz SMSR >45dB	DL-CLS101B-FP-S1550
	BF Series	ILM box	WL 1550nm, Min. Power 10mW, Linewidth <50, <200 kHz	DL-BFx-CLS101B-S1550
<b>Structural Health Monitoring</b>	SLED	14-pin BTF	Typ. WL 1550nm Typ. FWHM: 40nm Min. Power 10, 15, 20, 35mW SMF/PMF	DL -CS5103A DL -CS5153A DL -CS5203A
		14-pin BTF	Typ. WL 1550nm Typ. FWHM: 80, 100nm Min. Power 16, 10mW	DL-CS5169A
	BF Series	ILM box	WL 1550nm, Min. Power 10mW, Linewidth <50, <200kHz	DL-BFx-CLS101B-S1550
<b>Medical</b> <ul style="list-style-type: none"> <li>• OCT</li> <li>• Glucose Monitoring</li> </ul>	SLED	14-pin BTF	Typ. WL 1680nm Typ. BW FWHM 50 nm Min. Power 15 mW Typ. Spectral Ripple 0.3 dB	DL-CS68M5A



## Mission & Vision

### MISSION

To be a global leader in providing innovative integrated photonics solutions that enable our customers to excel and win in the Sensing & Data Communications markets.

### VISION

Powering Your Future Through Light

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