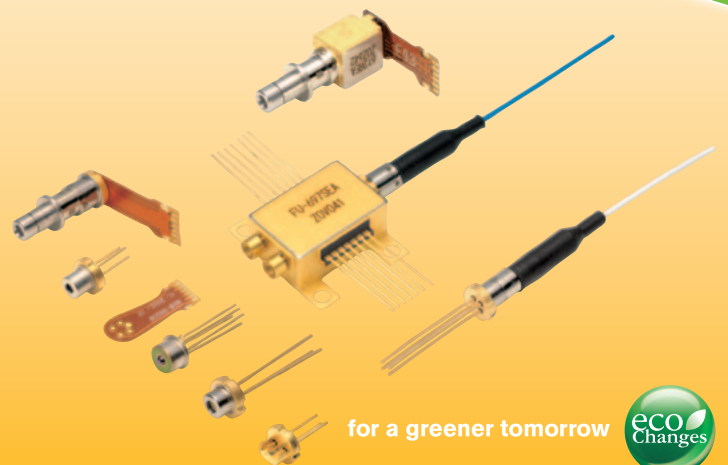




# Optical Devices

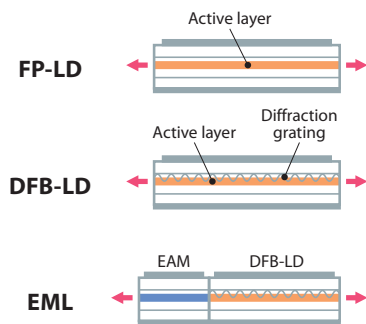


for a greener tomorrow



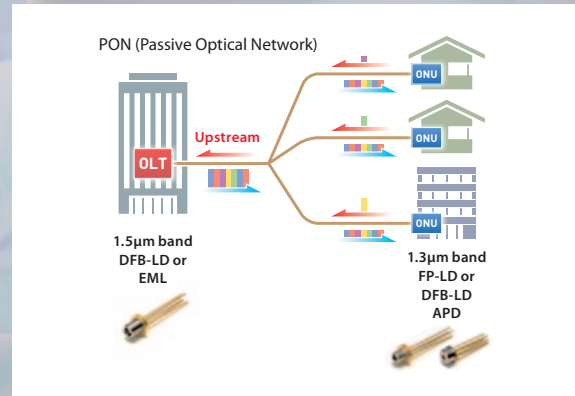
## DFB-LD: Distributed Feedback Laser Diode

DFB-LDs are semiconductor lasers that enable further and faster signal transmission than conventional FP-LDs through maintaining the oscillation spectrum in a single longitudinal mode (a single wavelength component). This is achieved by installing a minute periodic structure (diffraction grating) within the internal elements of the laser diode. EMLs are also available, featuring an electro-absorption modulator (EAM) integrated in front of the DFB-LD, for even further transmission.



## Laser Diodes and Photo Diodes for Fiber to the Home (FTTH)

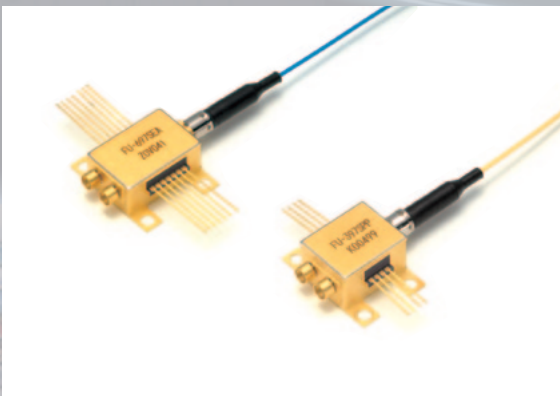
Faster PON technology has led to the development of B-PON, G-PON and GE-PON in response to demands for increased speed and capacity in optical communication systems. Backed by the leading photo diode for FTTH in the B-PON field, DFB-LDs and APDs are designed for different types of access network optical fiber grids, providing a flexible approach to changes in customer specifications and packages. These parts are used extensively in G-PON, which has rapidly become increasingly popular around the world.



Mitsubishi Electric Optical Devices:  
The Key to Connecting Information Networks in the Future.

## 43Gbps Modulator-integrated Laser Diode and Photo Diode Modules

Compliant with industry standards (XLMD-MSA), both the laser diode module with built-in driver modulator and the large, dynamic range PD-TIA module deliver exceptional performance using Mitsubishi Electric's own optical elements (EMLs, PDs) and an original high-frequency circuit design. As transponders over VSR (short communications up to 2 km), they provide faster optical communications between routers, SONET/SDH devices and DWDM devices, and contribute to more compact devices that use less power and less cost.



## 638nm High-output Laser Diode for Industry and Displays

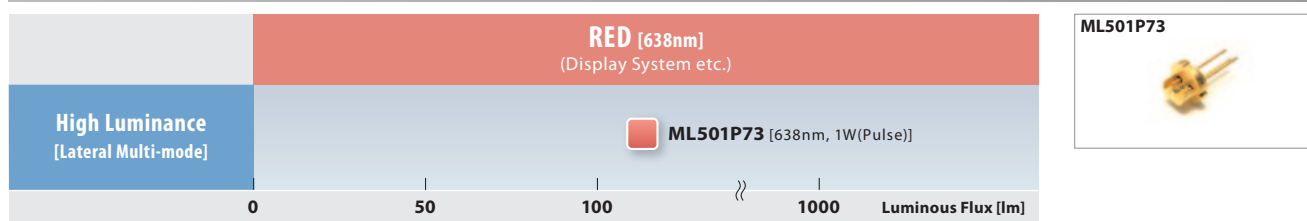
Compared to LEDs, semiconductor lasers have lower power consumption, higher output and can be used with optical systems having a higher maximum aperture. These considerable advantages mean that they can be used for projectors that do not require focal adjustment. Mitsubishi Electric has a range of lasers available, including a multi-mode semiconductor laser with a 638nm wavelength and 1W output (when pulse-driven) that provides highly visible, vibrant red colors for color projectors.

The figure is a color space diagram, likely a CIE 1931 chromaticity diagram, showing the gamut of a laser display. The diagram is a triangle with vertices labeled with wavelengths: 470, 480, 490, 500, 520, 540, 560, 580, 600, 620, 638, 650, 670, 680, 700. The diagram is labeled "Laser Display" and "sRGB". The diagram also shows the "D65" white point and the "CMY" color space.

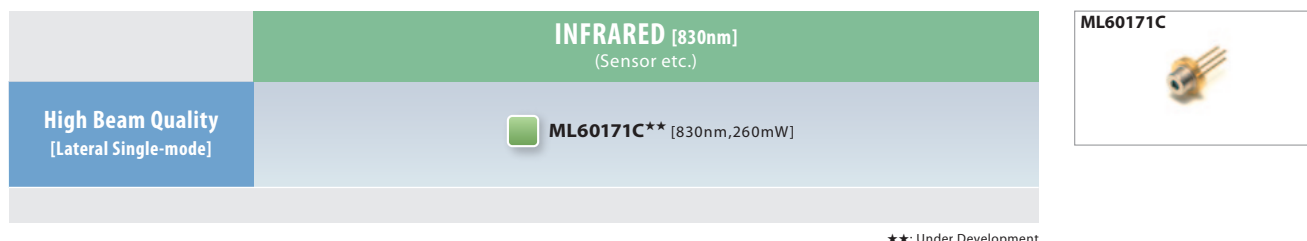
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# LASER DIODES FOR INDUSTRY & DISPLAY

## Selection map of Red Laser Diodes



## Selection map of High Power Short Wavelength Laser Diodes (Except Red LD)



## Line-up of Laser Diodes

Type Number	Application	Wavelength [nm]	Output Power@CW [mW]	Output Power @Pulse [mW]	Case Temperature [°C]	Package
ML501P73	Display	638	500	1000	40	φ5.6mm Capless
ML60171C**	Sensor, Printing	830	260	-	60	φ5.6mm TO-CAN

★★: Under Development

## Terminology

<b>APC</b> ..... Angled Physical Contact	<b>OLT</b> ..... Optical Line Terminal
<b>APD</b> ..... Avalanche Photo Diode	<b>ONU</b> ..... Optical Network Unit
<b>APD TIA</b> ..... Avalanche Photo Diode Trans Impedance Amplifier	<b>OTDR</b> ..... Optical Time Domain Reflectometer
<b>B-PON</b> ..... Broadband Passive Optical Network	<b>P2P</b> ..... Peer to Peer
<b>CPRI</b> ..... Common Public Radio Interface	<b>PC</b> ..... Physical Contact
<b>CWDM</b> ..... Coarse Wavelength Division Multiplexing	<b>PD-TIA</b> ..... Photo Diode with Trans-Impedance Amplifier
<b>DFB-LD</b> ..... Distributed FeedBack Laser Diode	<b>RoF</b> ..... Radio over Fiber
<b>DWDM</b> ..... Dense Wavelength Division Multiplexing	<b>ROSA</b> ..... Receiver Optical Sub-Assembly
<b>EAM</b> ..... Electro Absorption Modulator	<b>SC</b> ..... Single fiber Connector
<b>EML</b> ..... Electro absorption Modulator integrated Laser diode	<b>SDH</b> ..... Synchronous Digital Hierarchy
<b>ER</b> ..... Extended Reach	<b>SONET</b> ..... Synchronous Optical NETWORK
<b>FP-LD</b> ..... Fabry-Perot Laser Diode	<b>TOSA</b> ..... Transmitter Optical Sub-Assembly
<b>FR</b> ..... Fiber Reach	<b>VSR</b> ..... Very Short Reach
<b>FTTH</b> ..... Fiber To The Home	<b>X2</b> ..... 2nd Generation XENPAK
<b>G-PON</b> ..... Gigabit Passive Optical Network	<b>XENPAK</b> ..... 10 Gigabit Ethernet Transceiver Package
<b>GE-PON</b> ..... Gigabit Ethernet-Passive Optical Network	<b>XFP</b> ..... 10 Gigabit small Form-factor Pluggable
<b>LC</b> ..... Lucent Connector	<b>XG-PON</b> ..... 10 Gigabit Passive Optical Network
<b>LED</b> ..... Light Emitting Diode	<b>XLMD-MSA</b> ..... 40 Gbps Miniature Device Multi Source Agreement
<b>LR</b> ..... Long Reach	<b>XMD-MSA</b> ..... 10 Gbps Miniature Device Multi Source Agreement
<b>LRM</b> ..... Long Reach Multimode	

## SAFETY CAUTIONS FOR USE OR DISPOSAL OF LISTED PRODUCTS

The warnings below apply to all products listed in this pamphlet.

	<b>WARNING</b>
Laser Beam	While the laser diode is on, it gives a laser beam. Even if we can't see a laser beam by its wavelength, penetration into the eye by a laser beam or its reflected light may cause eye injury. Prevent the irradiating part or its reflected light from entering the eyes.
Injury	Fiber fragments may cause injury. In cases of fiber bending or breakage, never touch the fragment.
GaAs	Gallium arsenide (GaAs) is used in these products. To avoid danger, strictly observe the following cautions. <ul style="list-style-type: none"> <li>• Never place the products in your mouth.</li> <li>• Never burn or break the products, or use any type of chemical treatment to reduce them to gas or powder.</li> <li>• When disposing of the products, always follow the laws which apply, as well as your own company's internal waste treatment regulations.</li> </ul>
Disposal of Flame-Retarded Fiber Core Wire	Flame retardant resin must be disposed of according to law of industrial waste in disposal place. This product is a bromine type flame-retarded resin, containing bromine compounds and antimony trioxide. All disposal operations should be conducted with full consideration of this content.

## Selection map of LD/PD Modules

		Bit Rate			
		10Gbps	28Gbps	43Gbps	
DFB-LD	1.3μm	FU-456RDF			FU-456RDF 
	1.55μm		FU-412REA* for 100GBASE-LR4, ER4, OTU4	FU-497SEA*	FU-412REA/FU-612REA  FU-613REA  FU-697SEA 
EML	1.3μm				
	1.55μm	FU-612REA for 40,80km TDM 40km DWDM FU-613REA* for 40km TDM		FU-697SEA for VSR2000 FU-695REA** for FR	FU-397SPP 
pin PD				FU-397SPP for VSR2000 FU-395RPP** for FR	FU-357RPA 
APD		FU-357RPA FU-357SPA			FU-470SHL/ FU-670SHL 
For OTDR		For Analog		FU-450SDF/ FU-650SDF 	
FU-470SHL / FU-670SHL 1.3μm FP-LD / 1.55μm FP-LD		FU-450SDF / FU-650SDF 1.3μm DFB-LD / 1.55μm DFB-LD			

★: New Product ★★: Under Development

## ■ Line up of LD Modules

	Type Number	Chip Type	Package	Wavelength [nm]	Output Power	Features
43G	FU-497SEA★	EML	LC/SC Pigtail	1310	1.5dBm	43Gbps 10km, XLMD-MSA Compliant
	FU-697SEA	EML	LC/SC Pigtail	1550	1.5dBm	43Gbps, VSR2000, XLMD-MSA Compliant
	FU-695REA★★	EML	TOSA, LC Receptacle	1550	1.5dBm	43Gbps, FR, XLMD2-MSA Compliant
28G	FU-412REA★	EML	TOSA, LC Receptacle	LAN-WDM	2.0dBm	28Gbps x 4ch
10G	FU-612REA	EML	TOSA, LC Receptacle	1550	1.0dBm	XFP 40,80km, 40km DWDM, XMD-MSA Compliant
	FU-613REA★	EML	TOSA, LC Receptacle	1550	1.0dBm	SFP+ 40km, XMD-MSA Compliant
	FU-456RDF	DFB-LD	TOSA, LC Receptacle	1310	-2.0dBm	XFP 2km, XMD-MSA Compliant
OTDR	FU-470SHL	FP-LD	Coaxial Pigtail	1310	~120mW(Pulse)	Pulse width=10μs, Duty=1%
	FU-670SHL	FP-LD	Coaxial Pigtail	1550	~90mW(Pulse)	Pulse width=10μs, Duty=1%
Analog	FU-450SDF	DFB-LD	Coaxial Pigtail	1310	4mW	CATV Return Path, RoF
	FU-650SDF	DFB-LD	Coaxial Pigtail	1470, 1490, 1510, 1530, 1550, 1570, 1590, 1610	4mW	CATV Return Path, RoF

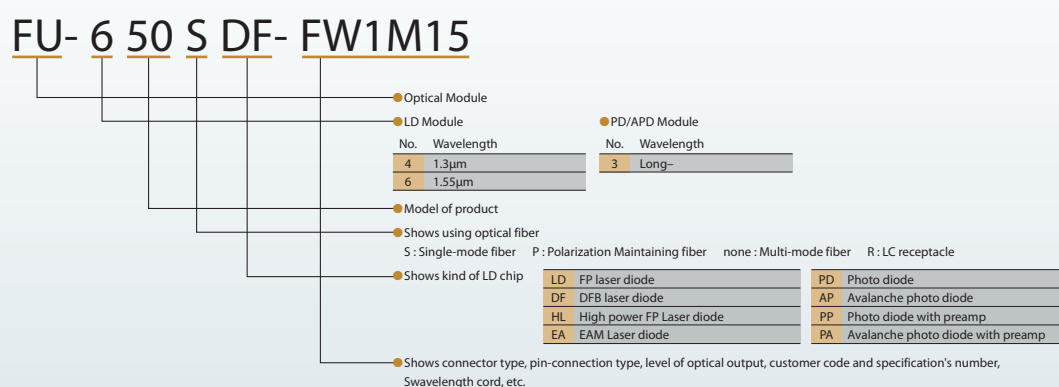
★: New Product   ★★: Under Development

## ■ Line up of PD Modules

	Type Number	Chip Type	Package	Wavelength [nm]	Application	Features
43G	FU-397SPP	pin PD	LC/SC Pigtail	-	VSR2000	XLMD-MSA Compliant
	FU-395RPP**	pin PD	ROSA, LC Receptacle	-	FR	XLMD2-MSA Compliant
10G	FU-357RPA	APD	ROSA, LC Receptacle	-	XFP 80km	APD TIA, XMD-MSA Compliant
	FU-357SPA	APD	ROSA, LC Receptacle	-	300pin 80km	APD, TIA

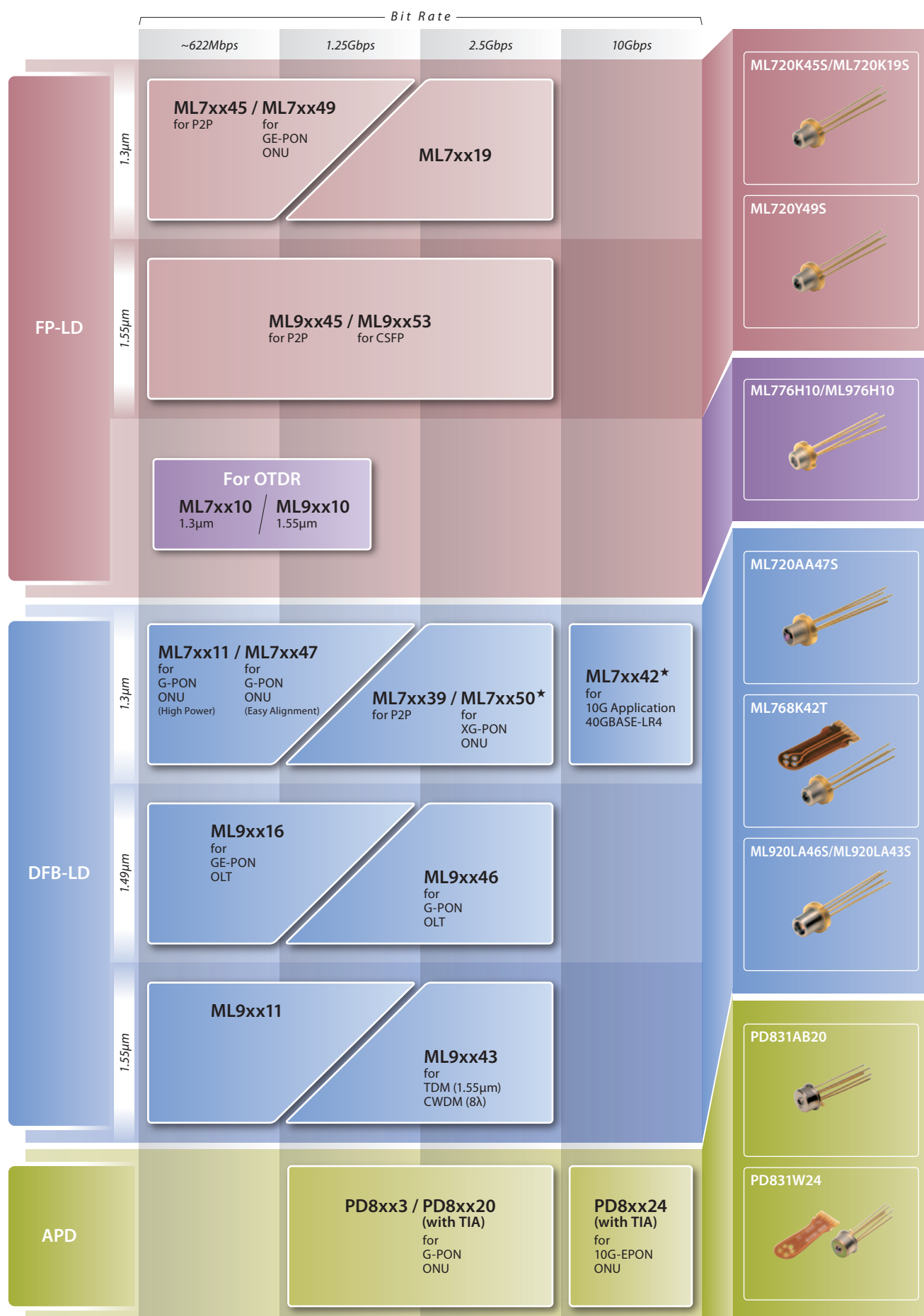
★★: Under Development

## Type Name Definition of Optical Devices for Optical Communication System





## Selection map of LD/PD



★: New Product

## Line up of LD

	Type Number	Wavelength [nm]	Output Power@CW [mW]	Case Temp. [°C]	Features
FP-LD	ML7xx45	1310	5	-40~+85	155M, 622M, 1.25Gbps
	ML7xx49	1310	11	-40~+85	GE-PON ONU, 1.25Gbps, High Coupling Efficiency
	ML7xx19	1310	5	-40~+85	2.5Gbps
	ML9xx53	1530	5	-40~+85	155M, 622M, 1.25Gbps
	ML9xx45	1530	5	-40~+85	155M, 622M, 1.25Gbps
FP-LD for OTDR	ML7xx10	1310	300(Pulse)	-40~+85	OTDR
	ML9xx10	1550	200(Pulse)	-40~+85	OTDR
DFB-LD	ML7xx11	1310	5	-40~+85	155M, 622M, 1.25Gbps, High Coupling Efficiency
	ML7xx47	1310	5	-40~+85	G-PON ONU, 1.25Gbps, Easy Alignment
	ML7xx39	1310	5	-40~+95	1.25G, 2.5Gbps
	ML7xx50*	1270	8	-40~+95	XG-PON ONU, 2.5Gbps
	ML7xx42*				
	ML768T42T*	1270	10	-5~+75	10GE-PON ONU, 10Gbps
	ML768K42T	1310	5	-40~+95	10GBASE-LR, SONET/SDH, 10Gbps
	ML768LA42T*	1270, 1330	6	-40~+95	CPRI, 10Gbps x 2λ
	ML768AA42T*	1270, 1290, 1310, 1330	10	-5~+80	40GBASE-LR4, 10Gbps x 4λ
	ML768J42T*				
	ML9xx11	1550	5	-40~+85	155M, 622M, 1.25Gbps
	ML9xx16	1490	10	-40~+85	GE-PON OLT, 1.25Gbps
	ML9xx46	1490	15	-40~+85	G-PON OLT, 2.5Gbps
		1550	5	-20~+95	2.5Gbps
	ML9xx43	1470, 1490, 1510, 1530, 1550, 1570, 1590, 1610	5	-10~+85	1.25Gbps, 2.5Gbps, 8λ for CWDM

★: New Product

## Line up of PD

	Type Number	Wavelength [nm]	Active Diameter [nm]	Case Temp. [°C]	Features
APD	PD8xx3	1260~1620	35	-40~+85	1.25G, 2.5Gbps
	PD8xx20	1490	50	-40~+85	G-PON ONU, 2.5Gbps, Built-in TIA
	PD8xx24	1577	40	-5~+75	10G-EPON, 10Gbps, Built-in TIA

## Type Name Definition of Laser and Photo Diodes

**ML 7 20K 45 S**

● Device Type [ML: Laser Diode PD: Photo Diode]

● Wavelength

● Package\*

● Chip Series

● Pin Assignment (Available for Monitor PD Contained Package)

Categories

Device Type	Wavelength	Wavelength Range (nm)
ML	5	500<λ≤700
	6	700<λ≤1000
	7	1250<λ≤1400
	9	1400<λ
PD	7	1000<λ≤1600
	8	

Type	N	C	R	F	E	S	T
LD	Anode Common	Cathode Common	Cathode Common	Anode Common	Cathode Common	Floating	Floating
PD	Cathode Common	Cathode Common	Anode Common	Floating	Floating	Floating	Anode Common

\*Please contact our sales office about the selection packages.

Please visit our website for further details.

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#### Keep safety first in your circuit designs!

- Mitsubishi Electric Corporation puts the maximum effort into making semiconductor products better and more reliable, but there is always the possibility that trouble may occur with them. Trouble with semiconductors may lead to personal injury, fire or property damage. Remember to give due consideration to safety when making your circuit designs, with appropriate measures such as (i) placement of substitutive, auxiliary circuits, (ii) use of non-flammable material or (iii) prevention against any malfunction or mishap.

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