High Output Power Full Band Tunable Laser

1. INTRODUCTION

With the increase of transmission capacity in long haul and metropolitan area due to fiber to the home (FTTH) growth, data transmission rate per wavelength for wavelength division multiplexing (WDM) is migrating from 10 Gbps to 40 Gbps. With the implementation of 40 Gbps transmission, new modulation formats using phase modulation such as differential phase shift keying (DPSK) and differential quadrature phase shift keying (DQPSK) are becoming major. For further improvement in transmission characteristics, signal return to zero (RZ) type RZ-DPSK and RZ-DQPSK are applied. In modulation methods identified above, a multistage modulator is required. As a consequence, modulator insertion loss increases. In order to compensate for the loss, high output power full band tunable laser is demanded than ever before.

Furukawa Electric has produced the full band tunable laser diode module (FBT-LDM) with an optical output of 13 dBm. Moreover, Furukawa Electric commercializes FBT-LDM with an optical output of 15 dBm, as shown in Figure 1 below. Table 1 shows the performance specification of the product. This commercialized FBT-LDM is more suitable for modern 40 Gbps transmission.

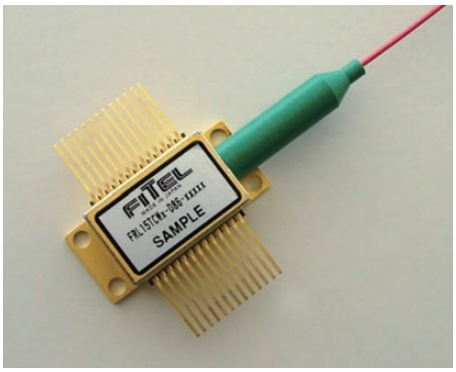

Figure 1 High output power full band tunable laser module.

2. FEATURE

Our FBT laser structure is shown in Figure 2. One semiconductor device contains an array of distributed feedback laser diodes (DFB-LD), where each DFB-LD has different oscillation wavelength, bent waveguide, optical coupler and semiconductor optical amplifier (SOA). This structure performance is superior in wavelength stability and controllability because it is based on DFB laser technology which is already proven in optical communication field. Also, because of a robust structure without mechanically moving part, it has excellent long term reliability.

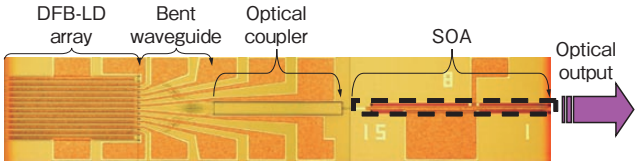

Figure 2 Structure of FBT-LD.

In this device, the required optical output is obtained by amplifying output light from DFB-LD at SOA. Therefore, in order to have high output at the FBT laser, it is significant to increase the SOA gain. In general, SOA gain is limited due to thermal roll-over and blue shift of gain-peak wavelength which are caused by injected carrier into active layer, and the gain saturation caused by the increase of photon density in the active layer. The commercialized high output FBT-LDM suppresses the blue shift by the optimizing of the active layer structure. Also, by optimizing the waveguiding structure, the photon density is reduced and gain saturation is suppressed, which allows us to attain high power output.

Figure 3 shows an example of FBT-LDM's current-optical output-power characteristics. At the maximum 50°C, more than 32 mW (15 dBm) of fiber facet output is attained even when any of DFB1 ~ 12 (from the shortest wavelength to the longest wavelength) is driven.

3. IN CONCLUSION

As an optical source for 40 Gbps transmission, Furukawa Electric succeeded in the development of a High Output Power Full Band Tunable Laser with an optical output of 15 dBm. This laser module is a product which can fulfill very well clients' demands in the current growth of the 40 Gbps transmission system.

For more information, please contact
Global Business Solutions, Telecommunications Company
Tel: +81-3-3286-3253 Fax: +81-3-3286-3978

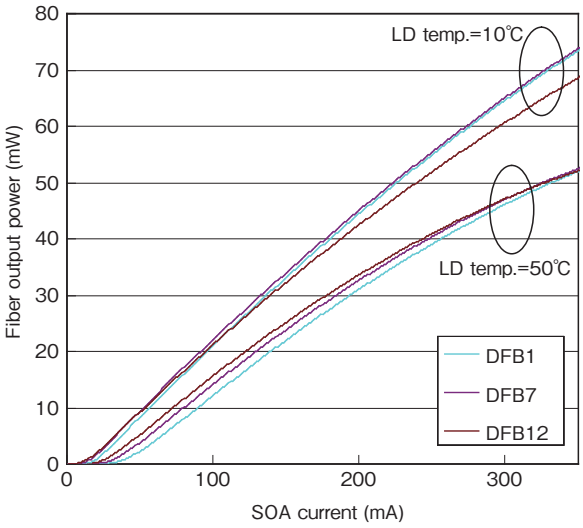

Figure 3 Light-SOA current characteristics of high power FBT-LDM. (with DFB current = 150 mA)

Table 2 Characteristics.

(Tc=25°C, BOL, unless otherwise specified)

Parameters	Sym.	Min.	Typ.	Max.	Unit	Conditions
Optical output power FRL15TCWC	Pf		32		mW	CW
LD operating temperature	T_{LD}	10	–	50	°C	Rated power, CW
LD forward current	If_{LD}	–	100, 150	–	mA	CW, dependent on channel
LD forward voltage	Vf_{LD}	–	–	2.2	V	CW
SOA forward current	If_{SOA}	–	–	525	mA	Rated power, CW
SOA forward voltage	Vf_{SOA}	–	–	3.0	V	Rated power, CW
Wavelength	λp	1528.773	–	1563.863	nm	Rated power, CW
Spectral linewidth	Δv	–	–	10	MHz	Rated power, CW
Side mode suppression ratio	SMSR	40	–	–	dB	Rated power, CW
Optical isolation	I_{SO}	25	–	–	dB	Rated power, CW
Relative intensity noise	RIN	–	–	−135	dB/Hz	Rated power, CW OpRL<25 dB 100 MHz<f<10 GHz
Frequency stability to ITU grid	Δfs	−2.5	–	2.5	GHz	Rated power, CW
Filter operating temperature	Tf	35	–	50	°C	
Free spectral range	FSR	–	50	–	GHz	
Capture range (negative side)	−CR	14	–	22.5	GHz	
Capture range (positive side)	+CR	27.5	–	36	GHz	
Power monitor current	Im	40	–	1100	μA	Vr_{PD}=5V, Rated power, CW
Power monitor dark current	Id	–	–	100	nA	Vr_{PD}=5V
Wavelength monitor current	Imλ	40	–	1100	μA	Vr_{PD}=5V, Rated power, CW
Wavelength monitor dark current	Idλ	–	–	100	nA	Vr_{PD}=5V
Wavelength monitor current slope	Slope	2	–	100	μA/GHz	Vr_{PD}=5V, See note 1
Tracking error	TE	−0.5	–	0.5	dB	Im=const., Tc=−5°C/35°C/75°C
TEC1 current (LD)	Itec1	–	–	1.4	A	Tc=75°C, Rated power, CW
TEC1 voltage (LD)	Vtec1	–	–	2.4	V	Tc=75°C, Rated power, CW
TEC2 current (Filter)	Itec2	–	–	1.9	A	Tc=75°C, Rated power, CW
TEC2 voltage (Filter)	Vtec2	–	–	3.0	V	Tc=75°C, Rated power, CW
Total power consumption (R_{LD}+R_{SOA}+R_{TEC1}+R_{TEC2})	Ptotal	–	4.0	4.5	W	Tc=75°C, Rated power, CW
Thermistor B constant	Bth	–	3900	–	K	
Thermistor resisitance	Rth	9.5	10	10.5	kΩ	T_{LD}=25°C
Polarization extinction ratio	Er	20	–	–	dB	Rated power, CW

BOL (beginning of life), OpRL (optical return loss)