Cost-Effective 10.7 Gbit/s Cooled TOSA Employing Rectangular TO-CAN Package Operating up to 90 °C

***Norio Okada, **Toshitsugu Uesugi, *Akihiro Matsusue, *Takeshi Fujita, *Shin-ichi Takagi, *Tatsuo Hatta, **Atsushi Sugitatsu and *Hitoshi Watanabe**
**High Frequency & Optical Device Works, Mitsubishi Electric Corporation, 4-1, Mizuhara, Itami, Hyogo, Japan*
***Information Technology R&D Center, Mitsubishi Electric Corporation, 5-1-1, Ofuna, Kamakura, Kanagawa, Japan*
Okada.Norio@dc.MitsubishiElectric.co.jp

Abstract: Employing rectangular TO-CAN and optimizing coupling mode of transmission line realize both TEC power consumption of 0.6W at 90 °C and superior optical output waveform with mask margin of 24% at 10.7 Gbit/s.
©2010 Optical Society of America
OCIS codes: (230.2090) Electro-optical devices, (140.5960) Semiconductor lasers

1. Introduction

Demand for cost-effective cooled TOSA (Transmitter Optical Sub-Assembly) is rapidly increasing with growth of 10G optical market such as access, metro, or DWDM. In the past, cost of the cooled TOSA has been reduced by downscaling the package and the components, and employing FPC(Flexible Printed Circuit), however these approaches for the cost reduction have already reached a limitation. In order to reduce the cost exponentially, drastic change of the package structure from conventional ceramic-metal hybrid package[1] is necessary.

Employing TO-CAN on the package is well-known for one of the techniques for the cost reduction due to simplifying the structure and introducing automatic assembling machine. Recently several types of 10 Gbit/s uncooled EML (External Modulated Laser) assumed to be mounted in TO-CAN package have been reported[2,3], however, it is difficult for uncooled EML to meet the spec of the application such as 10G-EPON and DWDM requiring stability of wavelength and high output power, besides changing DC offset bias along with variation of the temperature. Although cooled TOSA employing TO-CAN with 2.5 Gbit/s DML (Direct Modulated Laser) has been reported[4], solutions for 10 Gbit/s EML cooled TOSA employing TO-CAN have not been found yet.

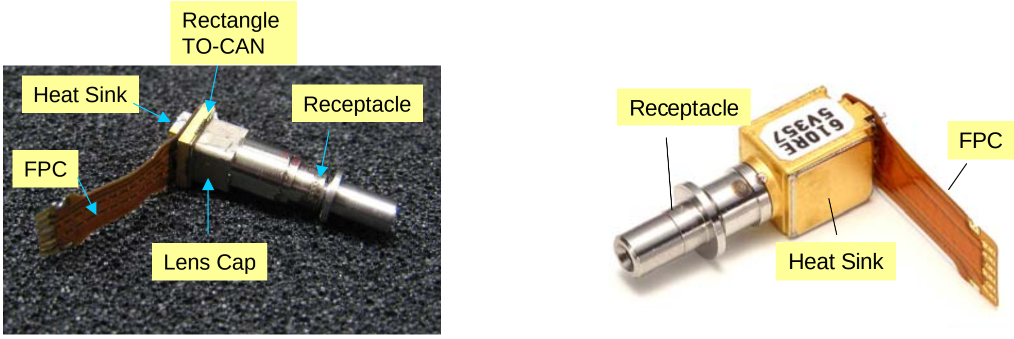
Technical issues for employing TO-CAN on EML cooled TOSA are power dissipation of TEC (Thermoelectric Cooler) in XMD-MSA[5] size and impedance matching to EML in the high frequency range. In order to solve these issues, we propose rectangular TO-CAN. Since TEC with large footprint can be mounted on the rectangular TO-CAN, operation with high optical output power is achieved at the case temperature of 90 °C. In order to match the impedance up to 10 GHz, lead pin of TO-CAN with high impedance compensates for the impedance mismatching of signal through the glass, and converting the coupling mode to coplanar waveguide at the lead pin provides stable signal and AC-GND with EML on TEC.

In this paper, we describe the module structure and both theoretical and experimental results for high frequency performance. This work is the first demonstration of 10.7 Gbit/s EML cooled TOSA employing TO-CAN package to date.

2. Module structure and simulation

Fig.1(a) and (b) show photographs of the TO-CAN TOSA and the conventional box-type cooled TOSA, respectively. Size of rectangular TO-CAN is 5.6 mm x 5.6 mm x 1.0 mm, distance between receptacle and edge of heat sink is 15.8 mm, which complies with XMD-MSA. Since shape of TO-CAN is rectangular and highly compatible with conventional box-type cooled TOSA, this cooled TOSA can be employed to optical transceiver without revision of its mechanical design. Fig.2 shows a schematic drawing of heat dissipation. Generated heat of TEC is dissipated to a case of optical transceiver through TO-CAN and a heat sink, which is the same as the conventional box-type cooled TOSA. Temperatures of cold and hot side are 40 °C and 90 °C, respectively. Since total amount of thermal power by EML, matching resistor and influence through bonding wires is about 0.3W at 90 °C, TEC with large footprint should be employed to 10.7 Gbit/s EML cooled TOSA. Fig.3 shows a comparison of mounting area for TEC between on (a) rectangular and (b) conventional TO-CAN. Mounting area for TEC excluding 7 control pins and area for projection weld is limited. This figure indicates that this rectangular TO-CAN package is the only solution for realizing both complying with XMD-MSA size and operating at 90 °C due to much larger TEC area.

Fig.4 shows a schematic drawing of impedance matching design. In order to match the signal line to 50 Ω, the lead pins of inside and outside of TO-CAN with high impedance compensates low impedance of lead through the glass. Since EML cooled TOSA driven by single mode requires to be connected both signal and stable AC-GND with EML on TEC, the coupling mode is converted to the coplanar on the transmission line. AC-GND and signal are connected to EML and resistor on TEC with bonding wires, so that superior high frequency performance and reducing the influence of power to TEC are realized. Fig.5 shows a simulated E/O frequency response. 3D simulation model includes transmission line, bonding wires, rectangular TO-CAN, parasitic capacitance and resistor of EML. 3dB bandwidth of 12GHz is obtained without unwanted ripple.



(a) (b)

Fig.1(a) a photographs of (a) TO-CAN TOSA and (b) conventional box-type cooled TOSA

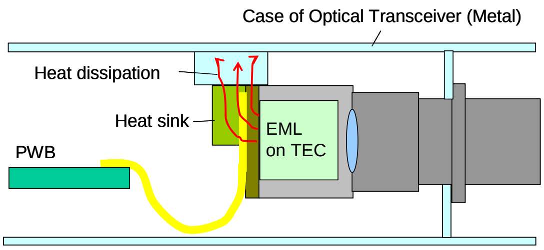
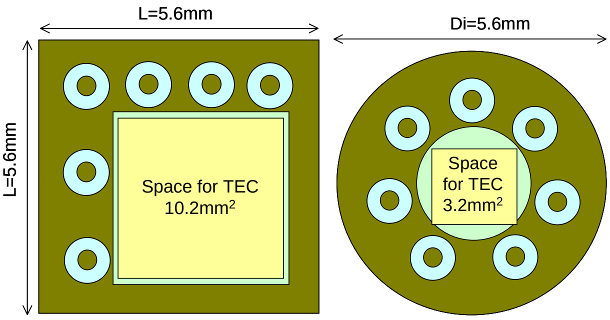


Fig.2 a schematic drawing of heat dissipation



(a) (b)

Fig.3 Mounting area for TEC of (a) rectangular and (b) conventional TO-CAN

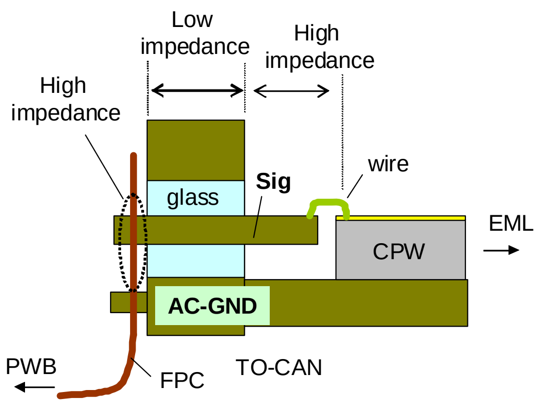


Fig.4 Schematic drawing of impedance matching design

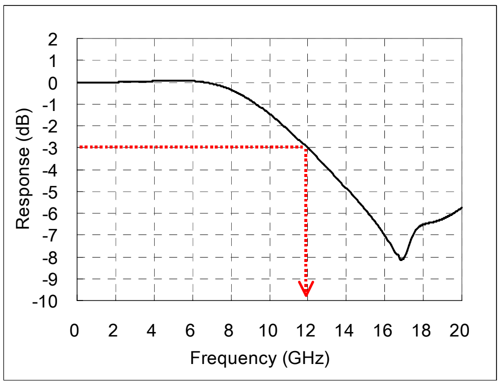


Fig.5 Simulated E/O frequency response

3. Experimental results

Fig.6 shows 10.7 Gbit/s optical output waveform of PRBS 2^{31}-1 through 4th–order Bessel filter at case temperature of 25 °C. TEC temperature and LD current are set at 40 °C and 100 mA, respectively. Clear eye-opening of optical output waveform with mask margin of 24% was achieved. Extinction ratio was 9.7dB. Fig.7 shows measured E/O frequency response. Superior high frequency performance with 3dB bandwidth of 12GHz was achieved, which well agreed with the simulation. Fig.8 shows TEC power consumption. Effective heat dissipation through rectangular TO-CAN and employing TEC with high absorbing power realized the operation at 90 °C, so that TEC power consumption of 0.6 W was achieved. Fig.9 is temperature dependence of wavelength. Optical wavelength was stable in the wide temperature range, less than 0.2 pm/°C. This result indicates that this cooled TOSA can be employed to DWDM or 10G-EPON[6].

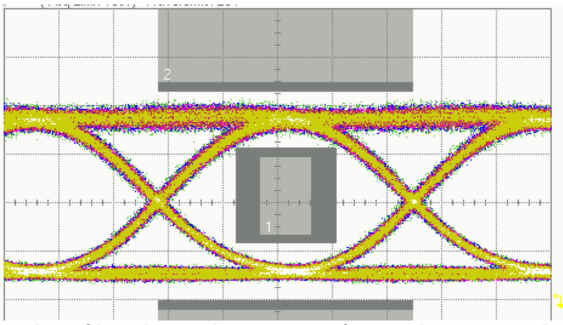


Fig.6 10.7 Gbit/s filtered optical output waveform with ITU-T mask

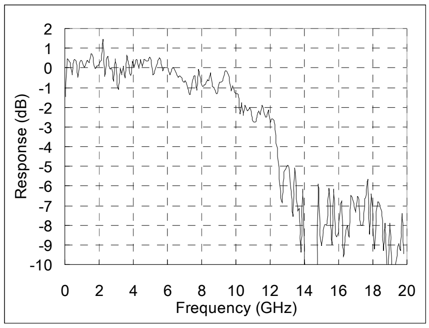


Fig.7 Measured E/O frequency response

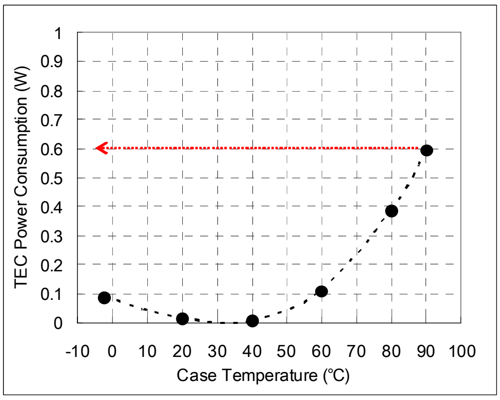


Fig.8 TEC power consumption

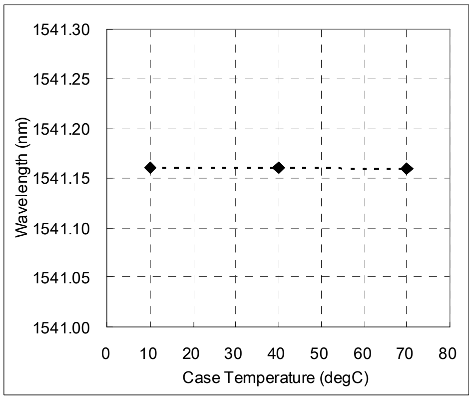


Fig.9 Temperature dependence of wavelength

4. Conclusions

Cost-effective 10.7 Gbit/s cooled TOSA employing TO-CAN with low power consumption and superior high frequency performance has been successfully achieved. Design schemes of rectangular TO-CAN and converting the coupling mode of the transmission line were employed. As a result, low jitter optical output waveform with mask margin of 24% and TEC power consumption of 0.6W at the case temperature of 90 °C have been experimentally confirmed. The temperature dependence of optical wavelength was less than 0.2 pm/°C. We believe that this cooled TOSA is the most cost-effective solution for metro, 10G-EPON and DWDM.

5. References

[1] N.Okada *et al*., *ECOC2006*, Cannes, France, **We3.P.66** (2006).
[2] S. Makino *et al*., in *Proc. OFC/NFOEC 2009*, San Diego, CA, **OThT5** (2009).
[3] C.Coriasso *et al*., *ECOC2006*, Cannes, France, **We1.6.7** (2006).
[4] A. Miki *et al*., *ECOC2004*, Stockholm, Sweden, **Th2.4.4** (2004).
[5] 10 Gbit/s Miniature Device Multi Source Agreement, http://www.xmdmsa.org/.
[6] IEEE 802.3av, http://www.ieee802.org/3/av/