BW10-1550-T-T7 / TO Application Notes

7 Pin TOSA Package
7 Pin TO Package

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1. ESD handling and precautions

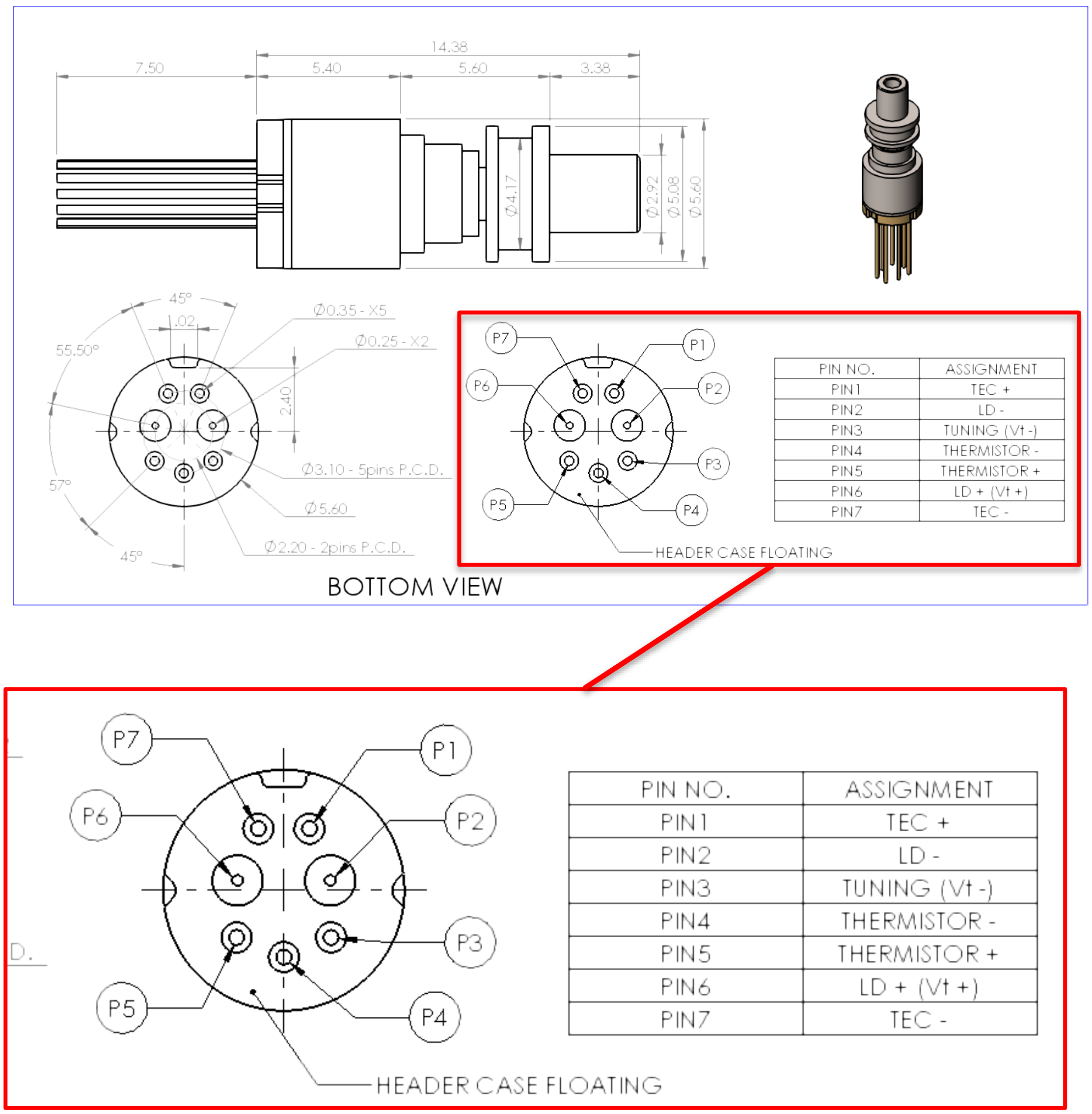
Electrostatic discharge (ESD) can damage the devices permanently and the device does not any ESD protection circuits. Therefore, it is very important to ensure proper ESD protection. Place the packed device on an ESD protected workstation i.e. before removing the ESD protection bag. You must wear a wrist strap and appropriate smocks made from dissipative material. Note that the smocks must be closed to ensure proper ESD protection. A good side for further ESD information is https://www.esda.org/about-esd/

CAUTION: Device is very sensitive to electrostatic discharge.

2. Electrical Pin Out

The electrical pin out for the TO and Tosa package is given below.

Figure 1



PIN NO.	ASSIGNMENT
PIN1	TEC +
PIN2	LD -
PIN3	TUNING (Vt -)
PIN4	THERMISTOR -
PIN5	THERMISTOR +
PIN6	LD + (Vt +)
PIN7	TEC -

Bottom View and Pin Assignments

3. Low Speed Testing Setup and Electrical Diagram

Please ensure the first-time power on sequence in section 3.5 when you power up the device.

3.1. Best Performance Recommendations:

- Place the TOSA on a TO-Can mount or good thermal heat sink
- Clamp the TOSA down for best thermal contact
- The mount/heat sink fixed at or near typical room temperature
- We recommend using Bandwidth10's fixture BW10-420B
- If the device is used on a customer PCB, we recommend using Bandwidth10's socket p/n 2020-006

3.2. Driving the laser:

- **IMPORTANT:** The laser and tuning circuits should both be driven with floating sources.
- **DO NOT USE SOURCES WITH EARTH GROUND if possible!**
- If sources with earth ground cannot be avoided, please ensure that only one of the sources has earth ground or else that the earth ground of both devices is connected to pin 6. Failure to do so will cause a ground loop that may result in possible catastrophic damage to the device.
- Should be a precision current source for best stability (ideally with <10 µA noise). We recommend Keithley 2200 power supply.
- **NOTE:** Typical commercial laser driver current sources Do Not work well with VCSELs. (They are typically designed for Edge Emitters and the VCSEL differential resistance often trips the driver's protection circuitry.
- We recommend using a standard current source that is NOT DESIGNED FOR LASERS. We recommend Keithley 2400 source meters.

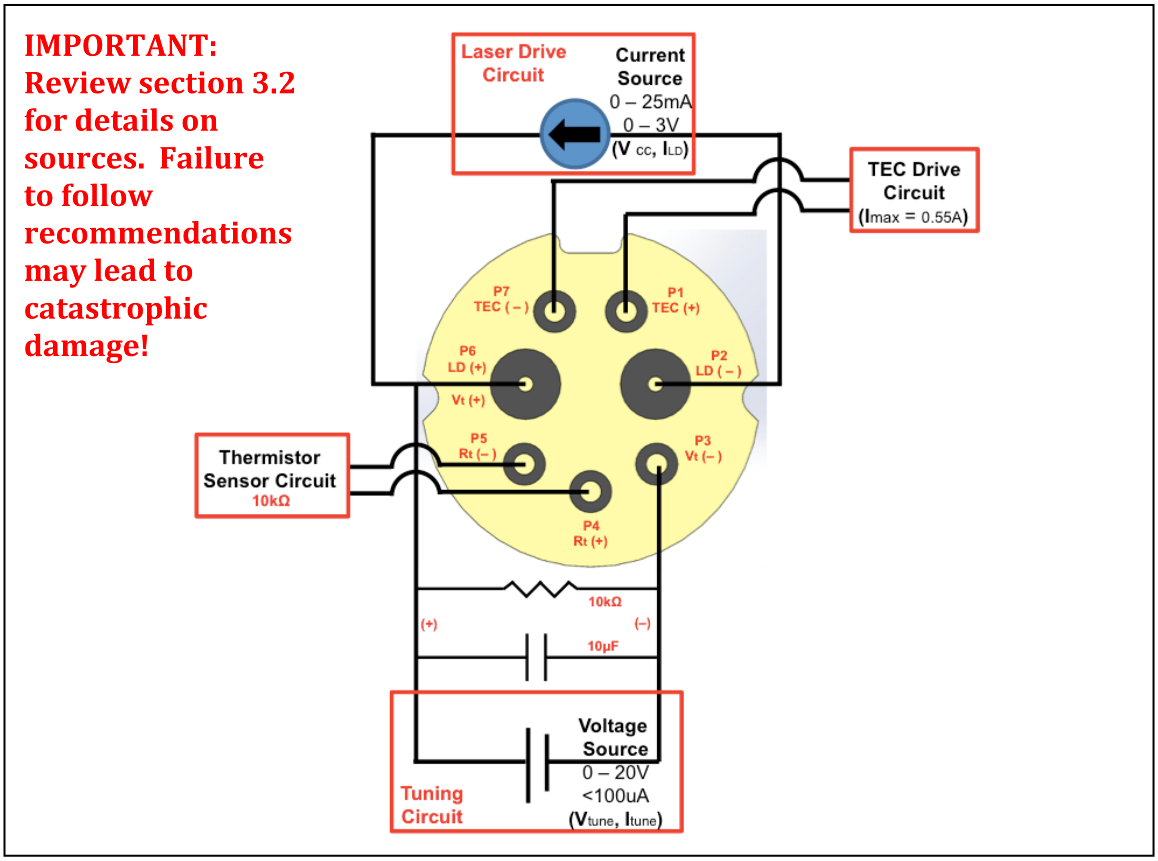
3.3. Tuning the Laser:

- As noted on previous page and shown on diagram below, the tuning bias voltage should be applied between the tuning pin (Vt-) and the laser drive pin (LD+).
- Typical current-voltage response is shown in section 5.1
- The voltage source should not exceed 16V (unless otherwise noted in the test sheet)
- The compliance current should not exceed 100 µA
- Notice that the wavelength tuning is approximately quadratic with voltage, so we recommend a 10 µF capacitor and 10 kΩ resistor in parallel with the tuning voltage source to reduce noise and guard against any transients. (see diagram below)

3.4. The TEC and Thermistor:

- The TEC has an Imax of 0.55A
- The Thermistor is 10 kΩ sensor
- The leads can connect to a standard TEC controller, verify that the controller's connection assignments match with the TOSA pinout
- Review the TEC setup section below for all TEC and Thermistor Parameter settings and limits

Figure 2



3.5. First Time Setup Sequence

1. Following steps in order, "Do Not" proceed to a next step without completing a previous step
2. Hook up all testing equipment, laser power source, tuning source, and the TEC controller
   Lots of supplies have transient pulse from the supply when first turn-on. We highly recommend to short the supply before opening to the diode.
3. Power up the equipment. Ensure that all outputs are disabled. Do Not power up the source output power for any testing equipment.
4. Connect all cables to the testing equipment
5. Using ESD protection load the TOSA to mount or heat sink and clamp it down if possible
6. Connect each testing equipment to the TOSA, starting with the Laser source, then the Tuning source, and finally the TEC/Thermistor controller

7. If properly connected, the TEC controller should have a readout of the TEC's current temperature, which should be at the room temperature
8. If TEC's required parameters are properly set and the controller is showing a room temperature readout, then set the controller to 20C and turn it on
9. Plug in the fiber to the TOSA's LC connector, which should be hooked up to a PD or an OSA or both using a fiber splitter.
10. Once the TEC Controller shows the TOSA is stable at 20C, it is ok to remove the laser source short and apply a 15mA bias current to the laser. At which time, the TEC controller will show a jump in the TOSA temperature, this is normal and allow it to stabilize back to the 20C set point.
11. Check the Laser source meter readouts to verify that,
    a. the voltage is within the expected range as noted on the Data Sheet
    b. the output power is at the expected power level for 15mA @20C
    c. if there is a spectrometer connected, turn it on to see the wavelength of the TOSA at these set conditions
12. Double check the TEC controller is still holding the temperature at the set point.
13. Finally, turn on the tuning circuit source meter, starting at 0V, then slowly increase the voltage to +10V to verify the device is properly connected and tuning.
14. Double check the TEC controller is still holding the temperature at the setpoint.
15. Now, apply various tuning voltages, not to exceed the limits found on the data sheet, to test out the changes in wavelength to get a good understanding of what the TOSA will tune to, (keeping a 100 µA compliance)
16. Now you have completed the initial setup sequence and the testing system and TOSA are ready for standard testing procedures as you need.
17. If one or more of these steps fail and several attempts to start over from the beginning continue to result in failure of a working and tunable laser or controlled temperature, then notify you BW10 contact for further support.
18. If you have more than one TOSA to test and you feel the setup is properly setup, then starting with "Step 5", repeat the steps on a different TOSA to see it fails as well.
19. If the second TOSA fails one of the steps, then it is most likely that your setup or a piece equipment is not properly setup for the VCSELs needs.
20. Contact your BW10 support for further help

4. High Speed Setup

4.1. Requirements for High Speed Modulation:

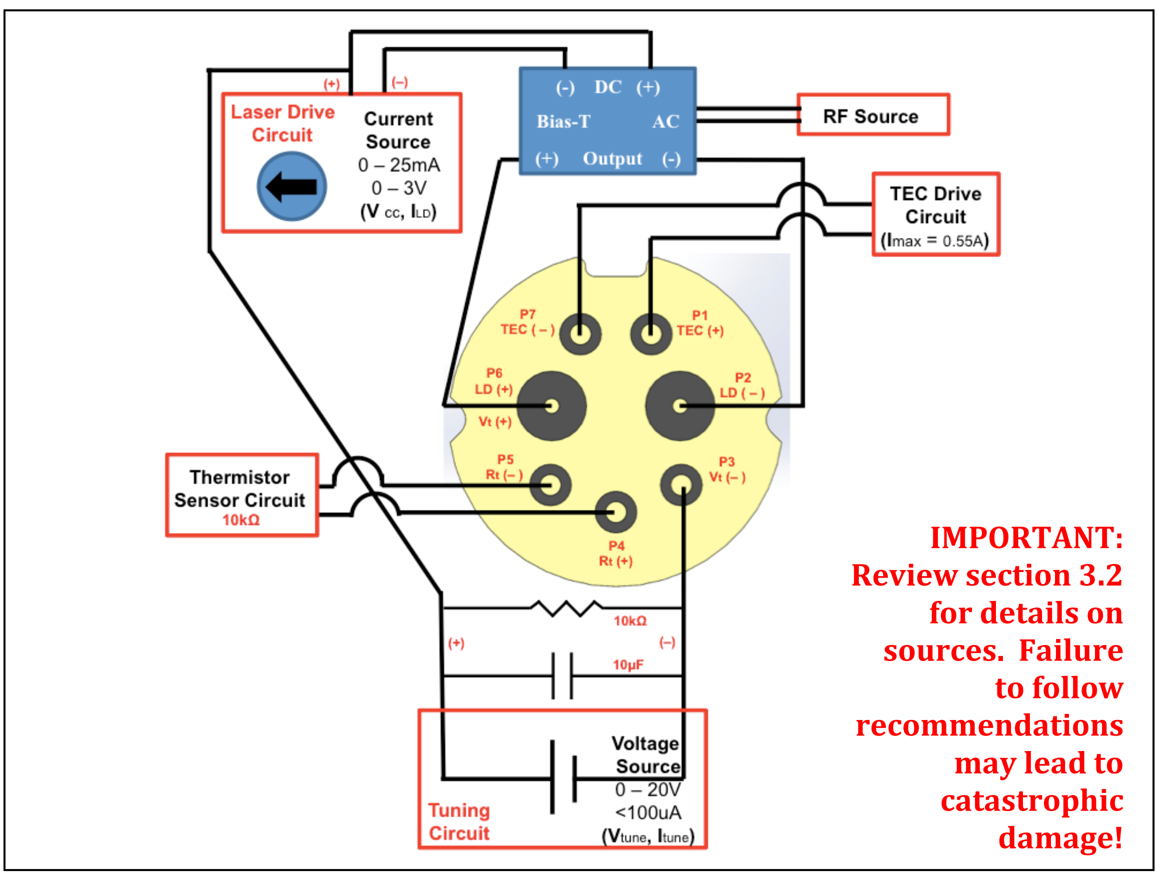
- The TOSA must be connected to a high-speed modulation board, either directly soldered or via a high-speed flex board.
- **Please Note:** That for the initial evaluation of the high-speed setup, the TEC does not need to be connected but for higher output power and wavelength stability it should be used. If the choice is not to use the TEC for initial testing, then it is required that you short the TEC+ to the TEC- on the board.

4.2. High Speed Electrical Diagram

4.2.1. Diagram Explained

- Diagram below is laid out for high speed testing of the TOSA
- There is a RF source required
- The TEC controller, Tuning source, and the laser DC power source are all the same as described in the Low Speed Setup, (All sequential setup steps should be followed for the high speed setup as well to ensure proper testing of the TOSA)
- As in diagram 1, there is a 10μF capacitor and 10kΩ resistor, parallel to the tuning circuit

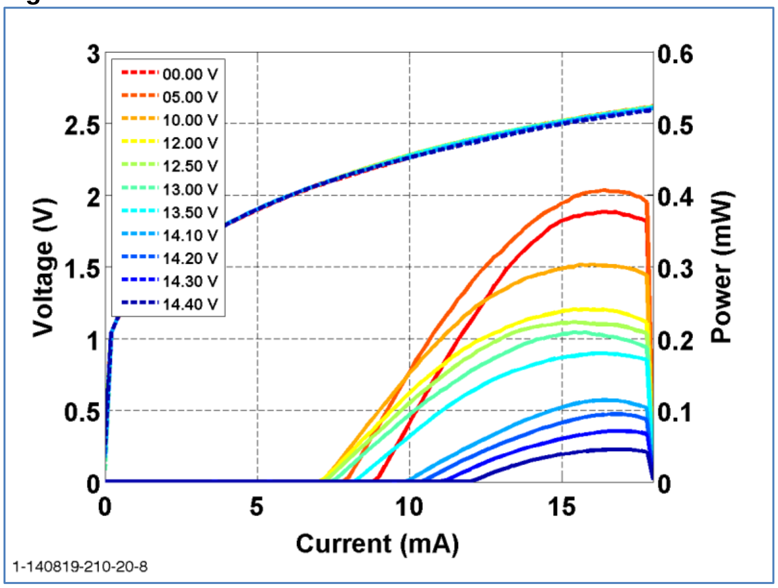
Figure 3



5. Laser Electrical and Optical Characteristics

5.1. Light-Current Voltage Response at 20ºC (As a function of Tuning Voltage)

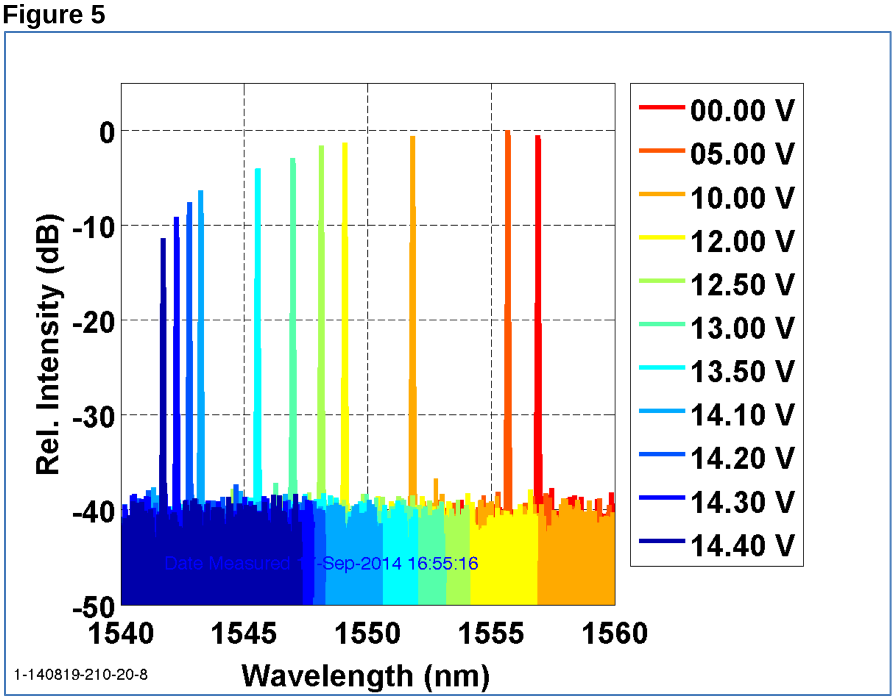
Figure 4



5.2. Optical Spectrum at 15mA at 20ºC

(As a function of Tuning Voltage)

Figure 5



Typical Device shows:

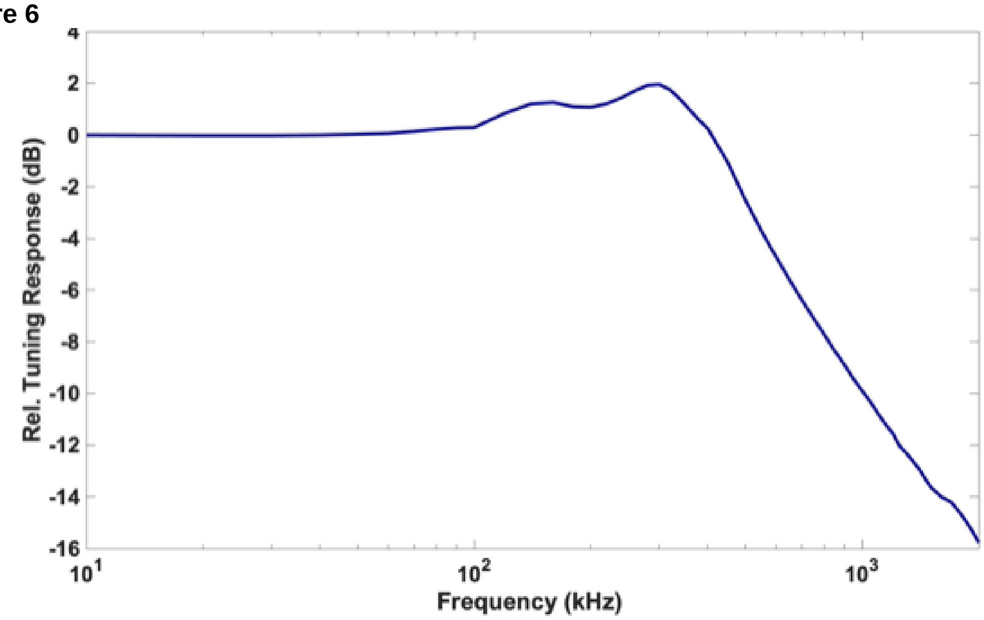
- Typical Tuning Curve (Note that start and stop wavelengths may differ)
- It is >10 nm, continuous, mode-hop-free tuning range

- Δλ is ~ quadratic with respect to tuning voltage
- Maximum output power is relatively constant across the range
- ~5-13V (maximum power decreases beyond that voltage)
- Tuning voltage is the voltage between the laser drive pin (LD+) and tuning pin (Vt -), (The LD+ pin being the positive side)

5.3. Mechanical Wavelength Tuning Response

Typical devices show mechanical tuning responses to input frequencies up to ~1 MHz on the tuning contact with a -3dB point of ~400 kHz.

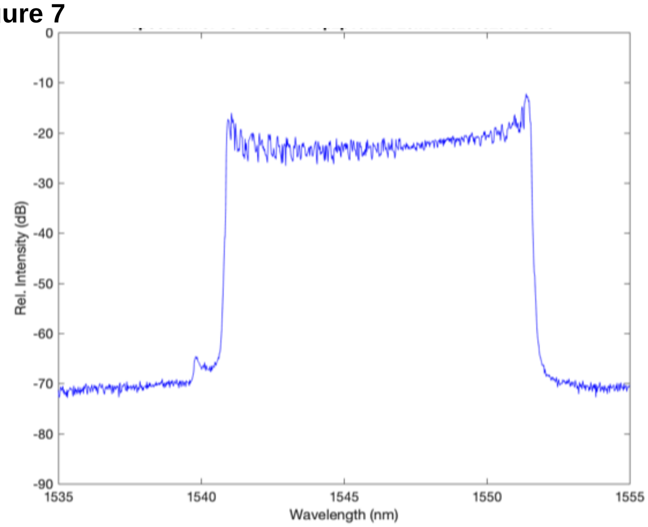
Figure 6



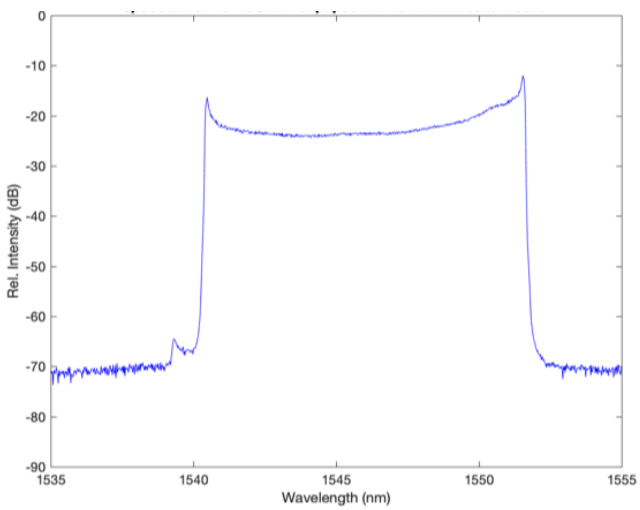
6. Swept source operation

The device can be used as a swept source. As a function generator we recommend using Tektronix AFG3011C. The response of a typical device is shown for 10kHz, 80kHz and 300 kHz in Fig. 7. For the 300kHz response the MEMS is exceeding the laser's tuning range on the right side of the spectrum due to reaching a MEMS resonance at 300 kHz. The laser was biased at 20 mA drive current with a tuning voltage of 12 V DC and 16 Vpp AC (i.e. 12 V DC ±8V AC). The AC signal is a sine wave.

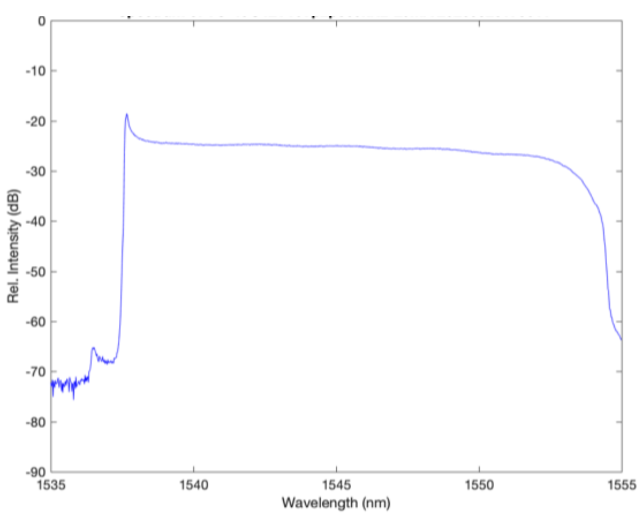
Figure 7



10 kHz



80 kHz

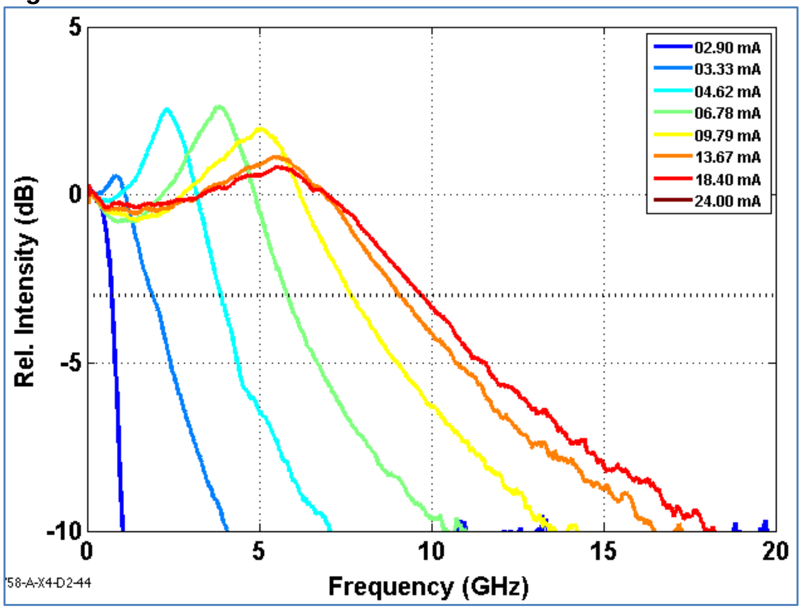


300 kHz

7. Direct Modulation Small Signal (S21) Response

Typical TOSAs show direct optical modulation responses due to electrical input responses (S21) up to 8+ GHz.
Typically, the maximum response is achieved near the roll over point of the VCSEL

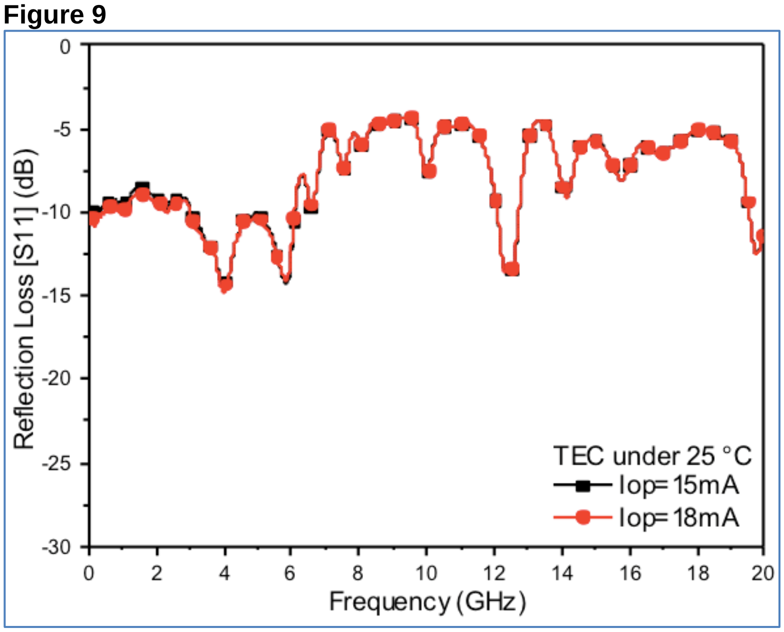
Figure 8



8. S11 Performance

A typical S11 response of a BW10-1550-T-T6B is shown below at 15 and 18 mA bias currents, with the TEC set at 25º C

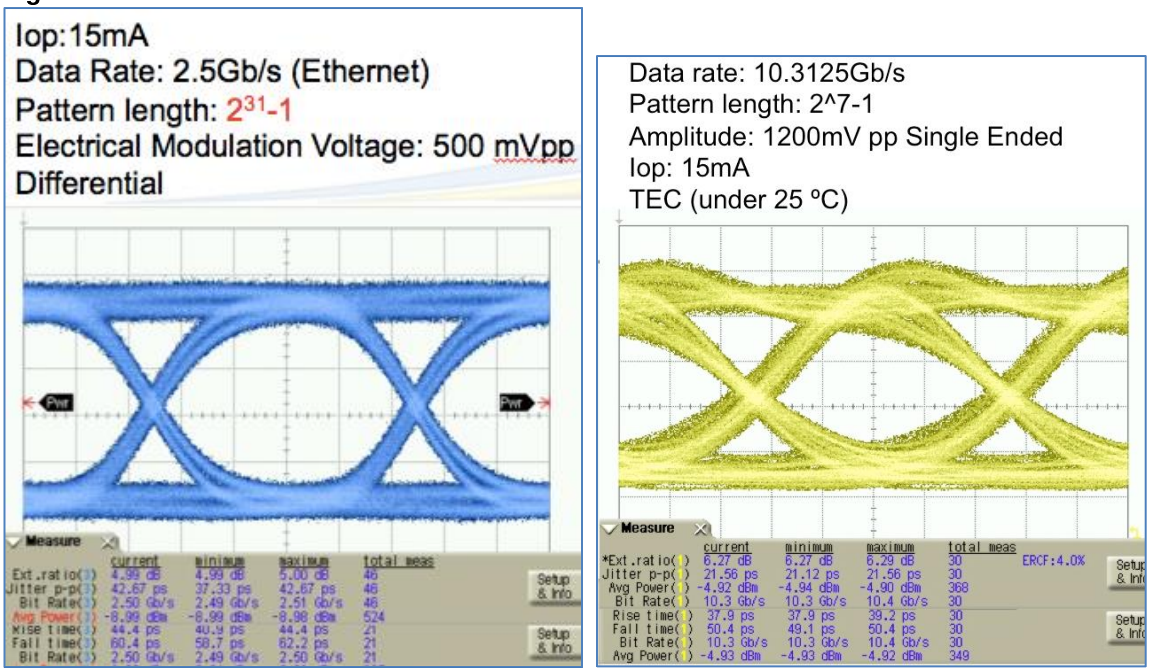
Figure 9



9. Large Signal Performance

Typical eye diagrams at 2.5G and 10G (with drive condition notes above the eye and measured results noted below the eyes), with the TEC set at 25º C are shown below:

Figure 10



Please note that 500 mV differential drive indicates the laser itself is seeing a full 1 Vpp swing.

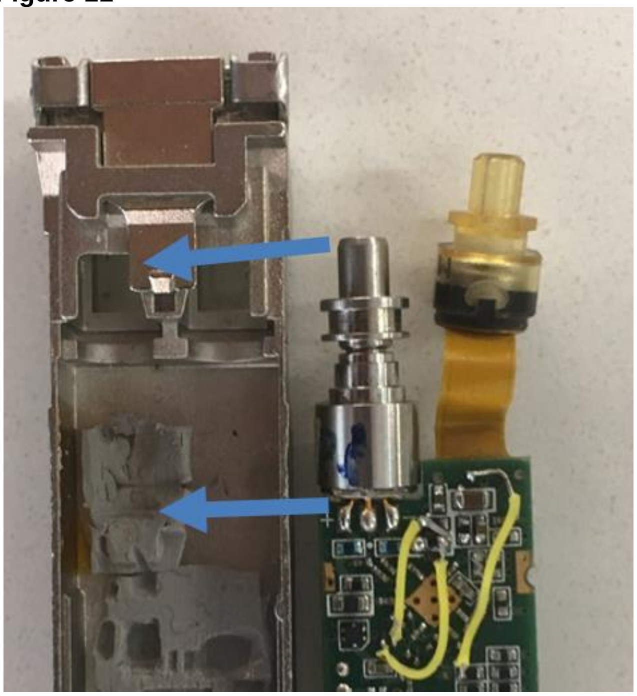
10. Heat Sinking

The TO/TOSA PKG generates heat along the header base, (golden colored area) where the pins are extending out of. The pins are isolated from header base and cannot electrically connect to the header base.

For maximal heat sinking we suggest, mounting the Header PKG to a metal heat sink plate/sub-mount, such as Aluminum or Ni Plated Copper, keeping the pins isolated from contacting the heat sink. The contact points are around the edge and the base of the header, like how our 420Test Box is designed. Ideally, a thermal conductive compound, not electrically conductive, can be used at the interface to maximize heat conduction. Whether or not a compound is used, a clamping mechanism is recommended, to hold tightly the TO/TOSA flush against the heat sink, for best heat conduction.

A non-heat sink option is, the usage of a deformable heat conducting material pad, wrapping side of the package, and if possible, the bottom side of the PKG metal areas, to bring heat out. One such pad for example is a TG-A1780 Ultra Soft Thermal Pad from t-global Technology. See an example of how this is implemented in a transceiver in the picture below, where the TOSA is pressed against the thermal pad, which is attached to a metal housing. With such a setup it is possible for the case temperature to exceed 70º C while holding the laser at ~35º C.

Figure 11



11. TEC Parameters and Response

Typical Performance under Controlled Conditions				
	ΔTmax (K)	Qmax (W)	Imax (A)	Umax (V)
@ 27C	0.71	0.30	0.55	1.0
@ 75C	0.89	0.40	0.55	1.3

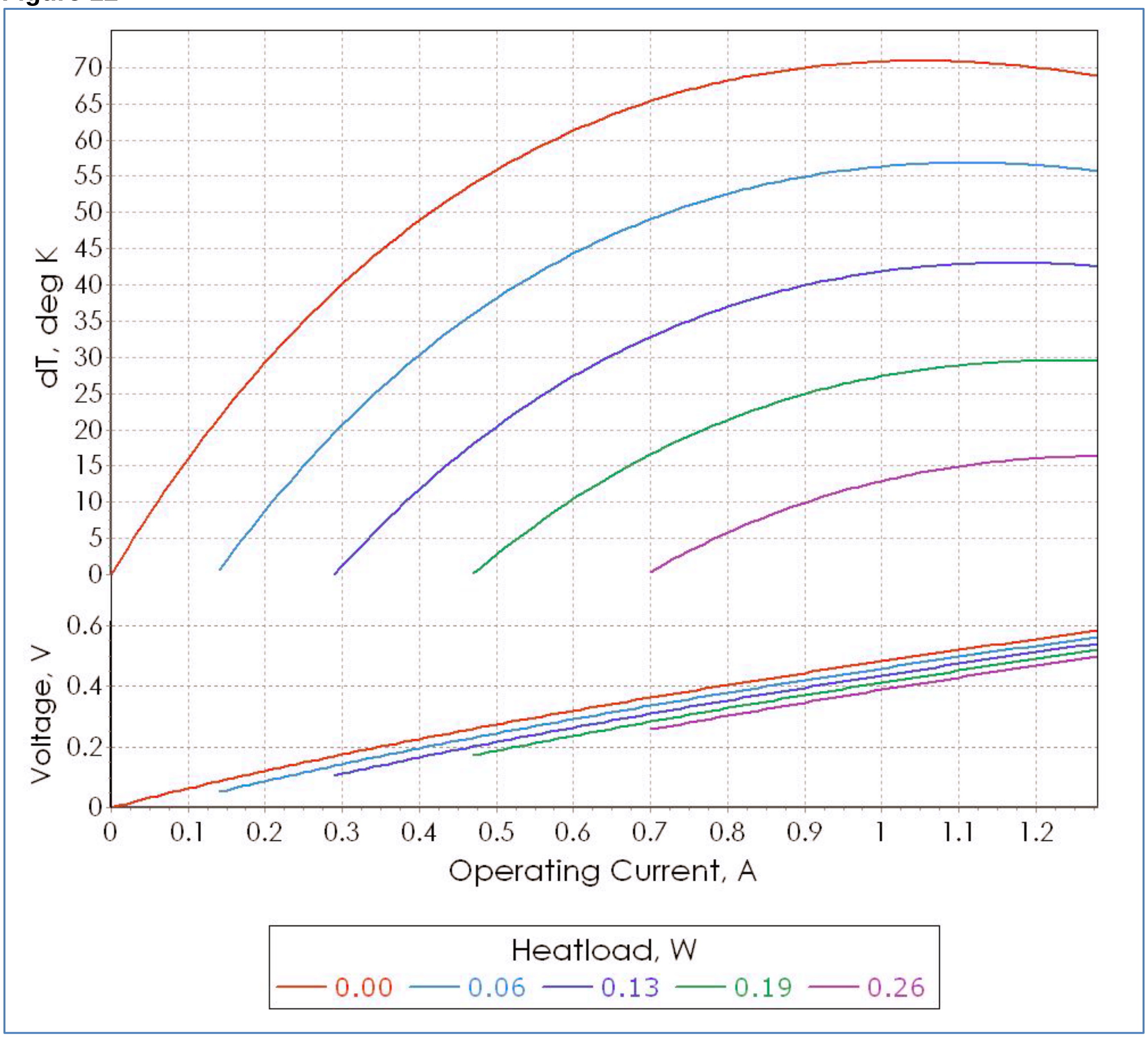
Typical Gain PID Settings

P = 0.005

I = 0.0001

D = 0.01

Figure 12



Typical TEC Performance under Lab Controlled Conditions, 10^-5 TORR Vacuum

12. Thermistor Performance Table

The thermistor is a standard 10kΩ thermistor. A table showing thermistor resistance over thermistor resistance at 25º C is shown below.

Figure 13

°C	R_t/R_{25}	°C	R_t/R_{25}	°C	R_t/R_{25}	°C	R_t/R_{25}v	°C	R_t/R_{25}
-50	67.0115	-9	5.24025	32	0.74025	73	0.15816	114	0.045755
-49	62.4122	-8	4.96529	33	0.70983	74	0.15295	115	0.044531
-48	58.1579	-7	4.70621	34	0.68082	75	0.14793	116	0.043345
-47	54.2210	-6	4.46231	35	0.65314	76	0.14311	117	0.042196
-46	50.5749	-5	4.23247	36	0.62675	77	0.13846	118	0.041083
-45	47.1985	-4	4.01573	37	0.60157	78	0.13399	119	0.040004
-44	44.0682	-3	3.81144	38	0.57752	79	0.12969	120	0.038958
-43	41.1655	-2	3.61858	39	0.55456	80	0.12554	121	0.037945
-42	38.4725	-1	3.43675	40	0.53266	81	0.12155	122	0.036962
-41	35.9716	0	3.26505	41	0.51172	82	0.11771	123	0.036009
-40	33.6499	1	3.10302	42	0.49172	83	0.11400	124	0.035086
-39	31.4920	2	2.94995	43	0.47262	84	0.11044	125	0.034190
-38	29.4867	3	2.80530	44	0.45435	85	0.10700	126	0.033321
-37	27.6208	4	2.66858	45	0.43689	86	0.10368	127	0.032478
-36	25.8853	5	2.53931	46	0.42019	87	0.100484	128	0.031660
-35	24.2694	6	2.41710	47	0.40422	88	0.097402	129	0.030867
-34	22.7642	7	2.30140	48	0.38893	89	0.094430	130	0.030096
-33	21.3619	8	2.19191	49	0.37431	90	0.091563	131	0.029349
-32	20.0546	9	2.08829	50	0.36031	91	0.088797	132	0.028623
-31	18.8354	10	1.99013	51	0.34687	92	0.086127	133	0.027919
-30	17.6977	11	1.89719	52	0.33401	93	0.083552	134	0.027234
-29	16.6360	12	1.80903	53	0.32168	94	0.081064	135	0.026570
-28	15.6440	13	1.72553	54	0.30988	95	0.078666	136	0.025925
-27	14.7176	14	1.64633	55	0.29857	96	0.076348	137	0.025299
-26	13.8515	15	1.57121	56	0.28773	97	0.074109	138	0.024690
-25	13.0418	16	1.49991	57	0.27735	98	0.071948	139	0.024099
-24	12.2842	17	1.43235	58	0.26739	99	0.069860	140	0.023524
-23	11.5754	18	1.36814	59	0.25784	100	0.067842	141	0.022966
-22	10.9116	19	1.30718	60	0.24869	101	0.065901	142	0.022423
-21	10.2899	20	1.24927	61	0.23990	102	0.064023	143	0.021895
-20	9.70741	21	1.19424	62	0.23147	103	0.062208	144	0.021383
-19	9.16150	22	1.14195	63	0.22338	104	0.060453	145	0.020884
-18	8.64951	23	1.09223	64	0.21562	105	0.058757	146	0.020399
-17	8.16902	24	1.04497	65	0.20816	106	0.057117	147	0.019928
-16	7.71837	25	1.00000	66	0.20101	107	0.055527	148	0.019470
-15	7.29500	26	0.95721	67	0.19413	108	0.053991	149	0.019024
-14	6.89749	27	0.91649	68	0.18753	109	0.052505	150	0.018590
-13	6.52404	28	0.87774	69	0.18118	110	0.051066		
-12	6.17302	29	0.84083	70	0.17508	111	0.049673		
-11	5.84286	30	0.80567	71	0.16922	112	0.048325		
-10	5.53247	31	0.77217	72	0.16358	113	0.047019		