BW10-1060-T-PxFA-yy
BW10-1060-T-TO
Application Notes

BANDWIDTH10, LTD.

7 Pin ASP lens cap package with TEC and 7 Pin pigtailed TOSA package with TEC, optical isolator, and FC/APC connector

This application note describes handling precautions and power up procedure for 1060nm tunable lasers sources.

Table of Contents

1. ESD handling and precautions

Electrostatic discharge (ESD) can damage the devices permanently, and the device does not have any integrated ESD protection circuits. Therefore, it is very important to ensure proper ESD protection. Place the packed device on an ESD protected workstation 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 website for further ESD information is https://www.esda.org/about-esd/

CAUTION: Device is very sensitive to electrostatic discharge.

2. Transient pulse suppression and other precautions

Transient pulses can damage the devices in a system environment. Please ensure proper voltage and current filtering and especially transient pulse suppression of the signals fed into the devices when developing driving circuits.

The laser and tuning circuits should both be driven with floating sources 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. In a laboratory environment we do recommend precise programmable power supplies, for example Keithley 2200 series for wavelength tuning and Keithley 2400 series as laser current sources.

Please ensure power sequencing procedure when turning the laser on or off (see section 5).

3. Operation conditions

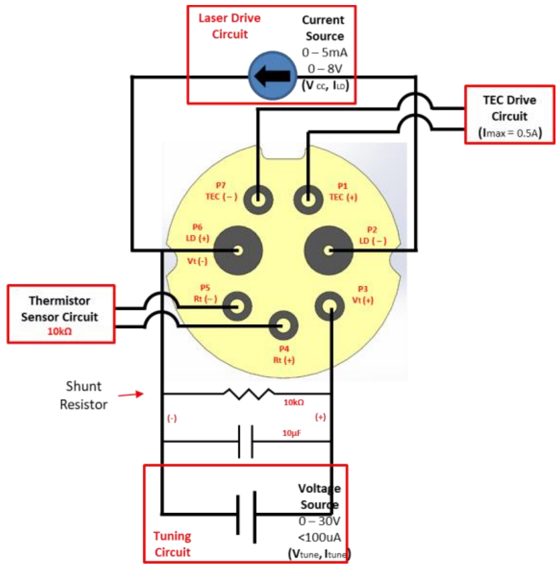
Exceeding the operating conditions can result in a permanent damage of the device. Please do not exceed the maximum operation conditions given in the datasheet of the device. Especially do not exceed the maximum tuning voltage or the maximum operating current which can result in a permanent damage to the device.

4. Optical coupling

The pigtailed TO has a 0.75m fiber pigtail with FC/APC connector. For the TO device, we recommend a triplet collimator with a convex lens for coupling the light to the fiber. For example, Thorlabs TC25FC-1064 and LB1901-ML can be used for collimator and the convex lens, respectively. The aperture of this single-mode VCSEL operation is about 10um. For some applications it works to exposing directly the TO to the optical fiber by bringing it as close as possible without any optics in between.

5. Recommended equipment and connection to the device (DC-tuning response)

Please ensure the first-time power on sequence in section 5.5 when you power up the device.



-

Figure 1: Electrical connection of the sweeping devices.

In Figure 1 the connection of the device is illustrated. In a laboratory environment we do recommend Keithley 2400 devices as current and voltage sources.

5.1. Best Performance Recommendations

- Place the TO/ Pigtail TO on a 7PIN TO-Can mount or good thermal heat sink
- Ensure a good thermal contact
- The mount/heat sink should be fixed at or near typical room temperature
- We recommend using test box BW10-420D
- Please ensure that the VT pins 3 and 6 are shorted to GND when inserting a device into the fixture.

5.2. Driving the laser

IMPORTANT: Please ensure power sequencing procedure when turning the laser on or off

- **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)
- **NOTE:** Typical commercial laser driver current sources DO NOT work well with VCSELs. (They are typically designed for low impedance edge emitters and the VCSEL differential resistance often trips the driver's protection circuitry.)

5.3. Tuning the Laser wavelength

- As noted on the previous page and shown on the diagram in Figure 1, the tuning bias voltage should be applied between the tuning pin (P3 / Vt+) and the laser drive pin (P6 / LD+).
- The voltage source should not exceed 25V (unless otherwise noted in the test sheet)
- The compliance current should not exceed 10 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 Figure 1). However, the capacitor might limit the sweep rate for the application.
- Please short pin 3 to GND before enabling the laser current

5.4. The TEC and Thermistor

- The TEC has an Imax of 0.5A
- P1 and P7 can connect to a standard TEC driving current source.
- P4 and P5 is connected to the thermistor, which is a 10 kΩ sensor, also compatible with standard TEC drivers.

5.5. First Time Setup Sequence with lab equipment and BW10-420D fixture

Follow these steps in exact order, to avoid damage!

1. Hook up all equipment. Do short all supply outputs before use (to reduce the risk of surges when first switched on).
2. Power up the equipment. Ensure all supply outputs are disabled. Set supply compliance limits (if applicable).
3. Connect all cables to testing equipment, the fixture BW10-420D is recommended.
4. If possible, connect TO pin 2, 3 and 6 to GND, i.e. short the laser driver output and tuning voltage source output to GND.
5. Observing ESD protection, load the TO into mount or heatsink (clamp it down if applicable).
6. Check TEC controller reading (room temperature).
7. If OK, set TEC controller to 25°C and turn it on, and wait for stable 25°C reading. If the temperature is oscillating adjust the gain or PID settings of the controller.
8. Turn on Tuning voltage, with setting to 0V.
9. Remove the GND connecting from point 4.
10. Turn on Laser driver (low bias <0.5mA). Slowly increase bias to 3.5mA (or the current specified in test report for specific part). TEC controller

shall indicate a TO temperature jump, followed by stabilization back to set point.

11. Check the Laser driver readouts to verify that voltage is within expected range (as per datasheet).
12. Connect optical output to Power meter and/or Optical spectrum analyzer respective Spectrometer (using fiber splitter if applicable)
13. Double check TEC controller for stable reading at set point.
14. Slowly increase Tuning voltage to the tuning voltage for WLstart given in the test report. You should be able to measure an optical power larger than the value P_O given in the datasheet. If you measure the spectrum you will notice that the laser will laser at the start wavelength given in the test report.
15. Apply various tuning voltages (observing max. ratings as of testsheet), for detailed check of tuning function. If you AC sweep the tuning voltage ensure that you never have a negative tuning voltage, i.e. apply a DC bias first and slowly increase the AC voltage

System and laser are now ready for standard testing procedure.

5.6. Shutdown Procedure with lab equipment and BW10-420D fixture

Follow these steps in exact order, to avoid damage!

1. Lower the tuning voltage to 0V.
2. Lower the laser current to 0 mA.
3. Short the Laser current source outputs to GND.
4. Short the DC voltage source outputs to GND.
5. Disable the TEC.

You can now safely disconnect the laser. Please place the laser in the ESD safe container used for shipment.

5.7. Power sequencing when driving the laser with your own circuit.

Follow these steps in exact order, to avoid damage!

Enabling the laser:

1. We recommend adding SPDT electrical switches which short pin 2,3 and 6 to GND if the laser is not in use.
2. Tune on your circuity.
3. Turn on the TEC control.
4. Toggle SPDT switches to connect pin 2, 3 and 6 with your circuit. Verify applied laser diode current is 0 mA and tuning voltage is 0 V before toggling!
5. Next increase the laser current to the value given in the test sheet.
6. Apply the DC portion of the tuning voltage.
7. Apply the AC portion of the tuning voltage.
8. Once a tuning voltage is applied do not change the laser current.

Disabling the laser

1. Decrease the AC portion of the tuning voltage to ~0 Vpp.
2. Decrease the DC portion of the tuning voltage to 0 V.
3. Decrease the laser current to 0 mA.
4. Toggle the SPDT switches and short pin 2,3 and 6 to GND.
5. Turn off the TEC circuit.

Do not hesitate to contact BW10 for further support!

6. Optical spectrum as a function of voltage tuning

Once the devices are property setup, you should be able to measure the optical output signal with a standard optical power meter operating around the lasing frequency of 10x0 nm. Please set the laser current and TEC temperature given by the test datasheet – Typically it is 3.5mA and 25°C TEC temperature. By applying a voltage of up to the maximum tuning voltage indicated in the test report, you can see the wavelength sweeping on an optical spectrum analyzer. The emitted mode of the device depends on the sweeping voltage.

Typically, the devices are emitting the X-1 mode, and the mode jumps around 6V to 10V. This behavior is illustrated in Figure 2.

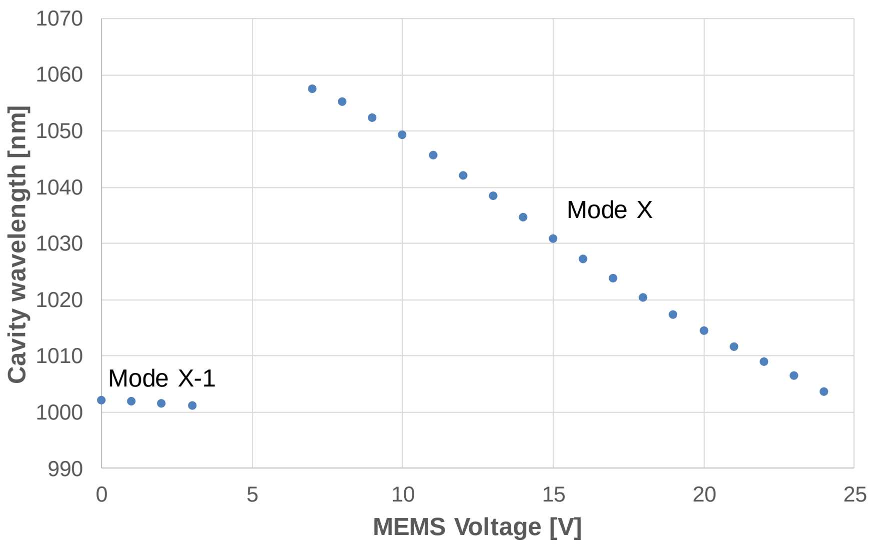


Figure 2: Wavelength vs. tuning voltage

Figure 3 shows the X-mode characteristics of a typical device. Sweeping is achieved from 7 to 25V on the mems port and that device has a running range of approximately 53nm.

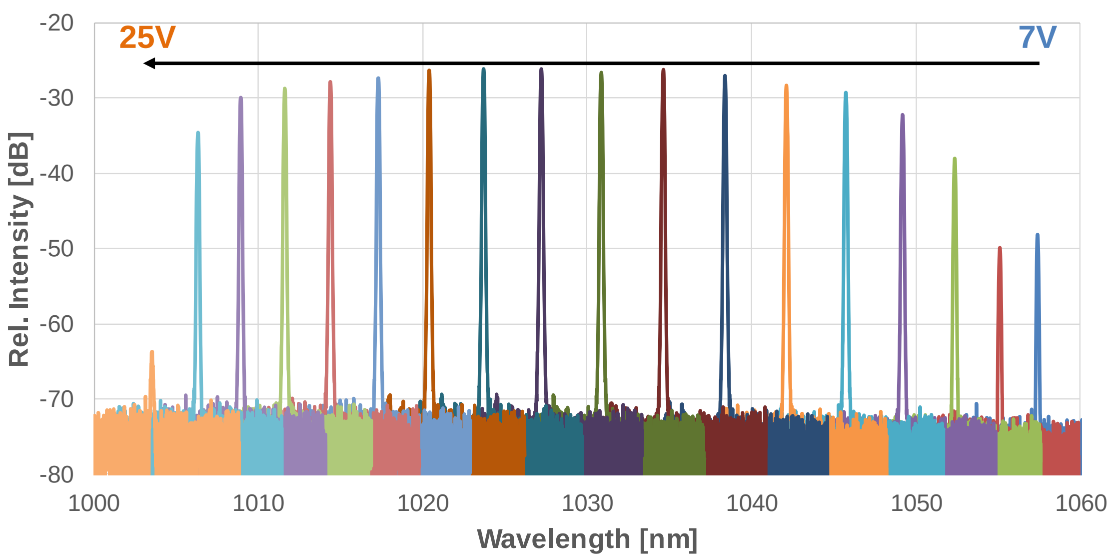


Figure 3: Optical Spectrum of the X-mode as a function of tuning voltage

7. Recommended equipment and connection to the device (AC-tuning response)

The electrical AC tuning setup of the sweeping device **using floating sources**, i.e. laboratory equipment is shown in Figure 4. As an AC tuning source, we recommend Tektronix AFG 3011C. If you are preparing your PCB and you cannot use floating sources we recommend that you develop a circuit which ensured that ground is only on pin 6.

Note that the shunt resistor and capacitor is removed in this illustration as they will damp the AC input at high frequencies. When adding the signal generator to the tuning path, we highly recommend disabling the outputs of the equipment first. Afterwards, we recommend shorting the outputs of the voltage and laser sources to GND before removing or adding cable connections.
Note that the AC signal generator should be the last output to turn on when powering up the TO and should be turned on at the lowest possible output voltage of the tool to prevent any transients.
If we assume the device in Figure 2 and we want to sweep between 1050 nm and 1020 nm we need to read first the corresponding DC voltages. At 1050nm the DC voltage is 10V. At 1020nm, it is approximately 18V. In the AC tuning setup, the DC voltage source needs to be set to the average voltage of 14V and the AC sweep generator needs to sweep with a peak to peak amplitude of 8V. The function generator should be set to high impedance (high Z) mode. Do not exceed the AC voltage beyond the DC tuning voltage range defined for Mode X, otherwise the response will cover both modes and we will see a dip on the response. After fixing the DC and AC voltages, you can sweep the frequency up to 100kHz. A typical plot of the AC response is shown in Figure 5.

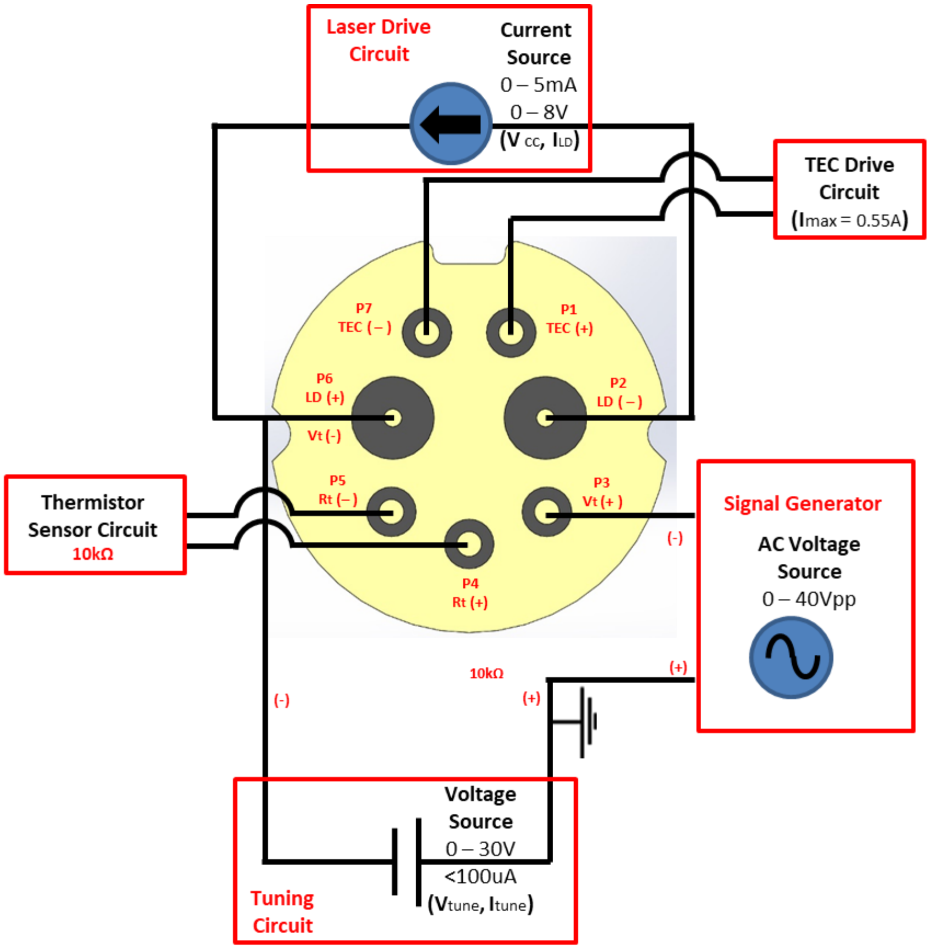


Figure 4: Electrical connection of the sweeping devices (AC tuning).

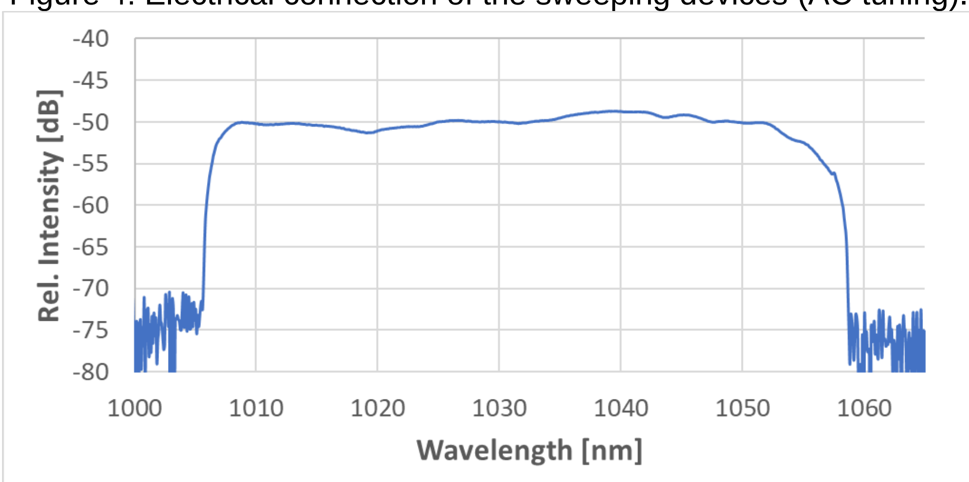


Figure 5: Typical AC response obtained with an 100kHz sweep rate.

8. Farfield information

The beam divergence of the bare chip is at 50% power (full angle) is ~10-12deg in one axis and slightly larger ~ 13-16deg on the perpendicular axis (elliptic shape).
At 95% power the divergence is larger ~ 16-18deg.

The TO with aspherical lens far field divergence (full angle) is 4° at > 50% power and 8° at 95% power.

9. 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

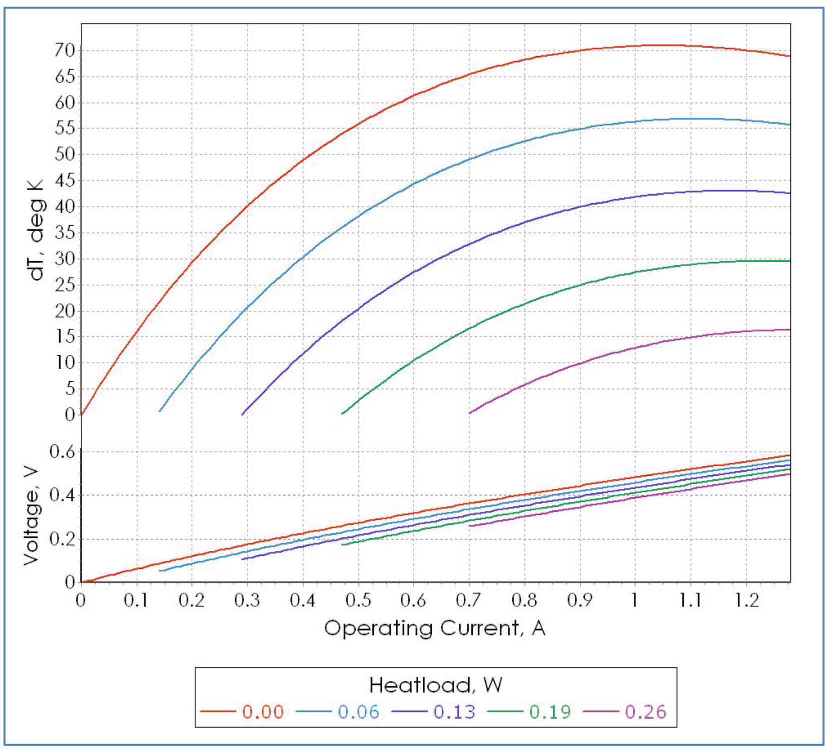


Figure 6 Typical TEC Performance under Lab Controlled Conditions, 10^-5 TORR Vacuum

10. Thermistor Performance Table

The thermistor is a standard 10kΩ thermistor. A table showing thermistor resistance over thermistor resistance at 25º C is shown in Figure 7.

°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		

Figure 7: Thermistor table