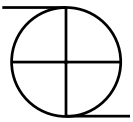
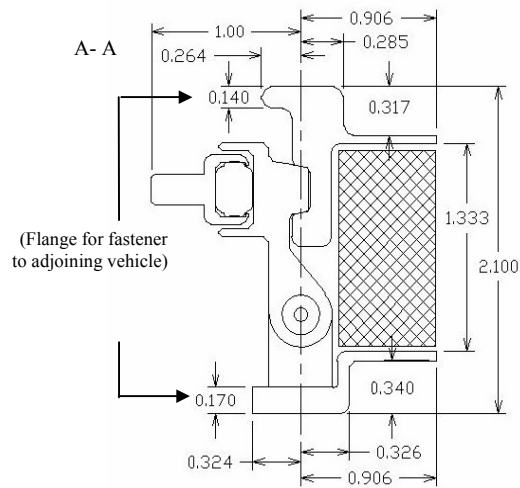


Lightband Thermal Resistance Test

- What is the thermal resistance of Motorized Lightbands?
- Test Item is MLB15.000-24 (15 inch diameter Motorized Lightband)
 - Described in 2000523C Lightband Brochure on web page
- Walter Holemans, PSC

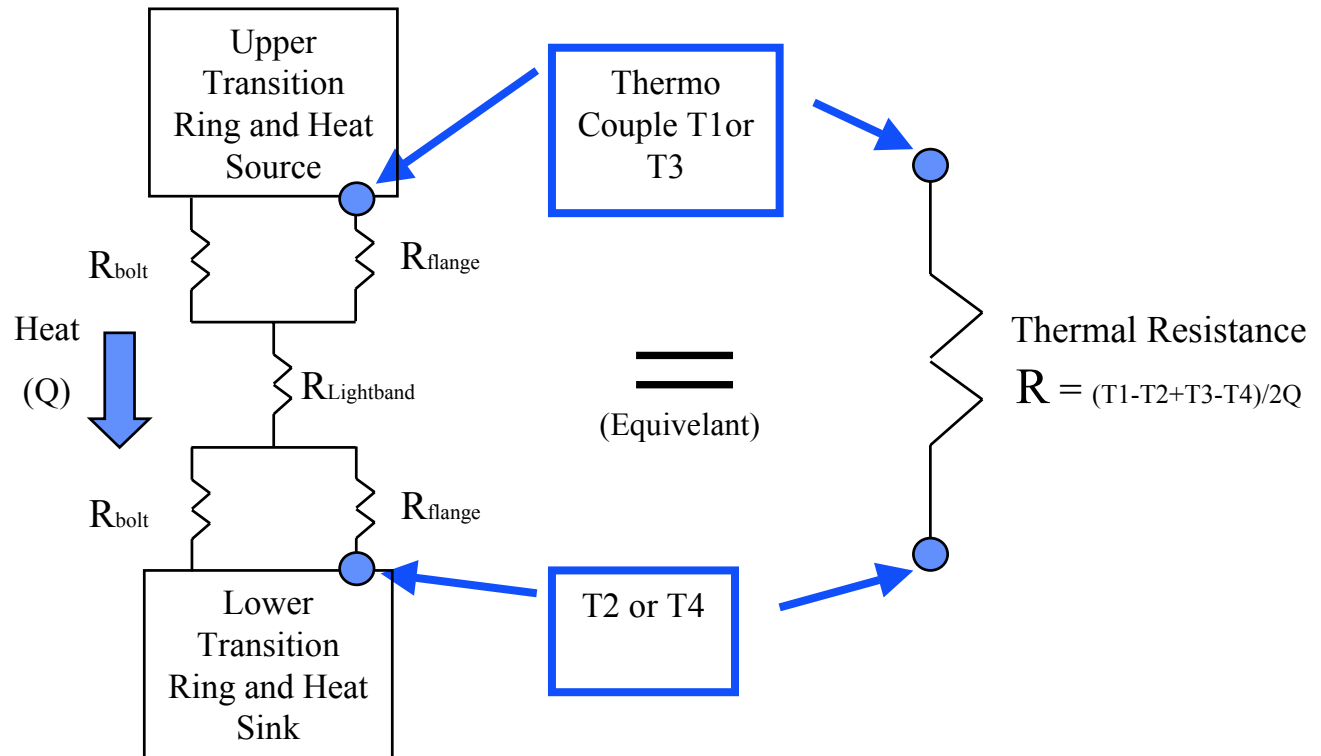


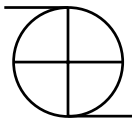
- The thermal resistance will include the bolts and the bolted flanges
 - No practical way to do this test otherwise
 - Besides, this helps the customer by including the resistance of flange and bolt that they must model anyway



Motorized Lightband Cross Section (Transition rings not shown)

This cross section does not vary. Consequently other diameters of Lightbands should be more conductive in direct proportion to their diameters.





Test Set-up

- Used PSC's Thermal Vacuum Chamber 2000506, Silver Spring MD



Heat source:
1.00 ohm, 10 W
resistor, 24x
bonded to 15
inch diameter
aluminum
transition ring

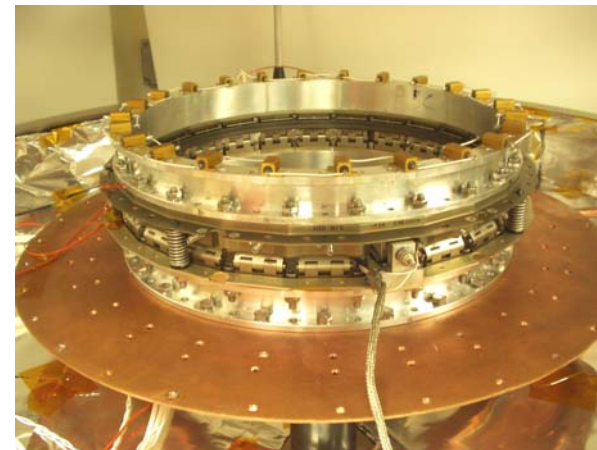


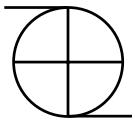
2000466-
Transition
ring, 2x

MLB15.000-24



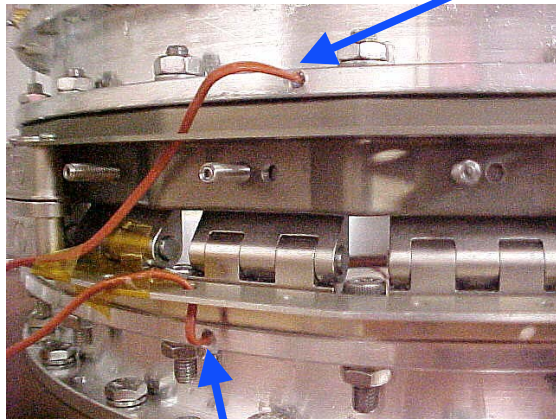
Heat sink:
Coolant
loop inside
Thermal
vacuum
chamber
(Tbath)





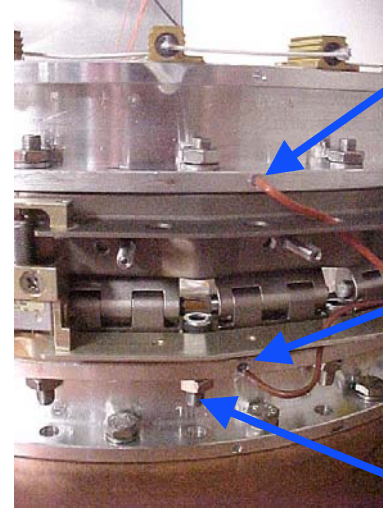
Test Set-up

- Four Thermo couples



Thermo Couple T1 and epoxy

T2



T3

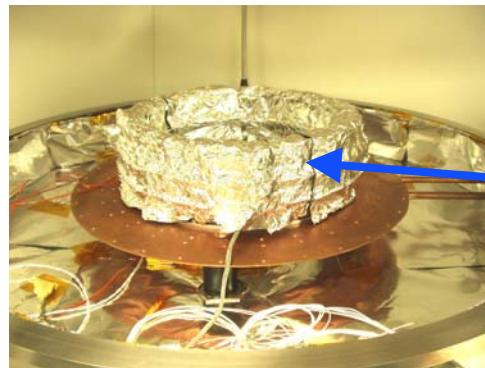
T4

1/4-28 bolt, 100 in lbf torque, 24 x at each of three bolted joints

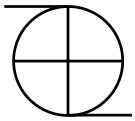
Insulation

The pressure of 5e-6 torr, the aluminum insulation and the closeness to chamber wall temperature will maximize radiative and convective resistance. The aluminum foil and wires (four thermocouples and one 8 wire cable) is assumed to have minor conductance due to its thinness and poor junction to adjoining structures and length.

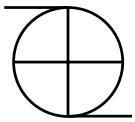
Bottom Line: Assume 85% of the heat goes through the Lightband



Two layers of aluminum foil provide substantial radiative insulation



- Prior to test Verified accuracy, traceable to NIST of:
 - Resistor network
 - Current transducer
 - Thermocouples
 - Pressure gage



• Data

- Heater power is reduced by 15% to account for losses in the calculation of thermal resistance
- Bold outlines at 174, 246 and 324 minutes are assumed to be steady state. Those three values are averaged to yield one number for thermal resistance

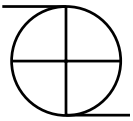
Time [mm/dd/yyyy Hr:Min]	Minutes Since Start [min]	Tbath [C]	T1 [C]	T2 [C]	T3 [C]	T4 [C]	Heater Current [A]	Heater Power [W]	T1-T2 [C]	T3-T4 [C]	Average [C]	Thermal Resistance (n=85%) [C/W]
	8/2/2004 11:59	120.1	0.0	6.6	2.7	6.8	2.7	1.00	24.0	3.9	4.0	4.0
8/2/2004 12:05	126.1	0.0	6.8	2.7	6.8	3.5	1.00	24.0	4.1	3.4	3.7	0.182
8/2/2004 12:11	132.1	0.0	6.8	3.0	7.8	4.0	1.00	24.0	3.8	3.9	3.9	0.189
8/2/2004 12:18	138.1	0.0	6.8	3.5	8.0	4.1	1.00	24.0	3.4	4.0	3.7	0.180
8/2/2004 12:23	144.1	0.0	7.3	3.5	8.1	4.1	1.00	24.0	3.8	4.1	3.9	0.192
8/2/2004 12:29	150.1	0.0	7.2	3.6	8.1	4.1	1.00	24.0	3.6	4.1	3.8	0.188
8/2/2004 12:35	156.1	0.0	7.7	3.8	8.1	4.1	1.00	24.0	3.9	4.1	4.0	0.196
8/2/2004 12:41	162.0	0.0	7.6	3.7	8.1	4.1	1.00	24.0	3.9	4.1	4.0	0.194
8/2/2004 12:47	168.1	0.0	7.7	3.8	8.1	4.0	1.00	24.0	3.9	4.1	4.0	0.195
8/2/2004 12:53	174.0	0.0	7.7	3.8	8.1	4.1	1.00	24.0	3.9	4.1	4.0	0.195
8/2/2004 12:59	180.1	0.0	7.8	3.8	8.1	4.1	1.00	24.0	4.0	4.1	4.0	0.198
8/2/2004 13:05	186.1	0.0	8.1	3.8	8.2	4.0	1.46	51.2	4.3	4.2	4.2	0.098
8/2/2004 13:11	192.1	0.0	10.8	4.1	11.9	4.8	1.46	51.2	6.8	7.1	6.9	0.160
8/2/2004 13:17	198.1	0.0	12.8	5.4	13.5	5.4	1.46	51.2	7.4	8.1	7.7	0.178
8/2/2004 13:23	204.0	0.0	13.7	5.4	14.9	6.4	1.46	51.2	8.2	8.5	8.4	0.193
8/2/2004 13:30	210.1	0.0	14.9	6.3	15.0	6.8	1.46	51.2	8.6	8.2	8.4	0.193
8/2/2004 13:35	216.1	0.0	14.9	6.8	16.0	6.8	1.46	51.2	8.1	9.3	8.7	0.200
8/2/2004 13:41	222.1	0.0	15.3	6.8	16.3	6.8	1.46	51.2	8.5	9.5	9.0	0.207
8/2/2004 13:47	228.1	0.0	16.1	6.8	16.3	6.8	1.46	51.2	9.3	9.5	9.4	0.216
8/2/2004 13:53	234.0	0.0	16.3	6.8	16.3	6.8	1.46	51.2	9.5	9.5	9.5	0.218
8/2/2004 13:59	240.1	0.0	16.3	6.8	16.3	7.0	1.46	51.2	9.5	9.3	9.4	0.216
8/2/2004 14:05	246.0	0.0	16.3	6.8	16.3	7.0	1.46	51.2	9.5	9.3	9.4	0.216
8/2/2004 14:11	252.1	0.0	16.3	6.8	16.3	7.1	1.46	51.2	9.5	9.2	9.3	0.215
8/2/2004 14:17	258.1	0.0	16.3	6.8	16.3	7.1	1.46	51.2	9.5	9.2	9.3	0.215
8/2/2004 14:23	264.1	0.0	16.3	6.8	16.3	7.2	1.46	51.2	9.5	9.1	9.3	0.213
8/2/2004 14:30	270.2	9.1	16.3	8.9	16.5	9.5	1.46	51.2	7.3	7.0	7.2	0.165
8/2/2004 14:36	276.2	10.0	19.0	12.2	19.0	12.9	1.46	51.2	6.8	6.1	6.4	0.148
8/2/2004 14:42	282.2	10.0	21.0	13.6	21.7	14.4	1.46	51.2	7.5	7.3	7.4	0.170
8/2/2004 14:47	288.1	10.0	22.8	14.9	23.1	14.9	1.46	51.2	7.9	8.1	8.0	0.185
8/2/2004 14:53	294.1	10.0	23.2	14.9	24.4	15.9	1.46	51.2	8.2	8.4	8.3	0.192
8/2/2004 14:59	300.1	10.0	24.4	15.7	24.4	16.3	1.46	51.2	8.7	8.1	8.4	0.194
8/2/2004 15:05	306.0	10.0	24.4	16.2	25.3	16.3	1.46	51.2	8.2	9.0	8.6	0.198
8/2/2004 15:11	312.1	10.0	24.6	16.3	25.8	16.3	1.46	51.2	8.3	9.5	8.9	0.205
8/2/2004 15:17	318.1	10.0	25.2	16.3	25.8	16.3	1.46	51.2	8.9	9.5	9.2	0.211
8/2/2004 15:23	324.1	10.0	25.6	16.3	25.8	16.3	1.46	51.2	9.3	9.5	9.4	0.216
8/2/2004 15:29	330.1	1.5	25.5	14.9	25.8	15.3	1.46	51.2	10.6	10.5	10.5	0.242

Bolt Circle Diameter	MLB	MLB	MLB	MLB	MLB	MLB	MLB	MLB	MLB	MLB	MLB
	11.732	15.000	19.848	23.250	30.000	34.000	38.810	45.709	62.010	66.000	120.000
Thermal Resistance [C/W]	0.267	0.209	0.158	0.135	0.105	0.092	0.081	0.069	0.051	0.048	0.026

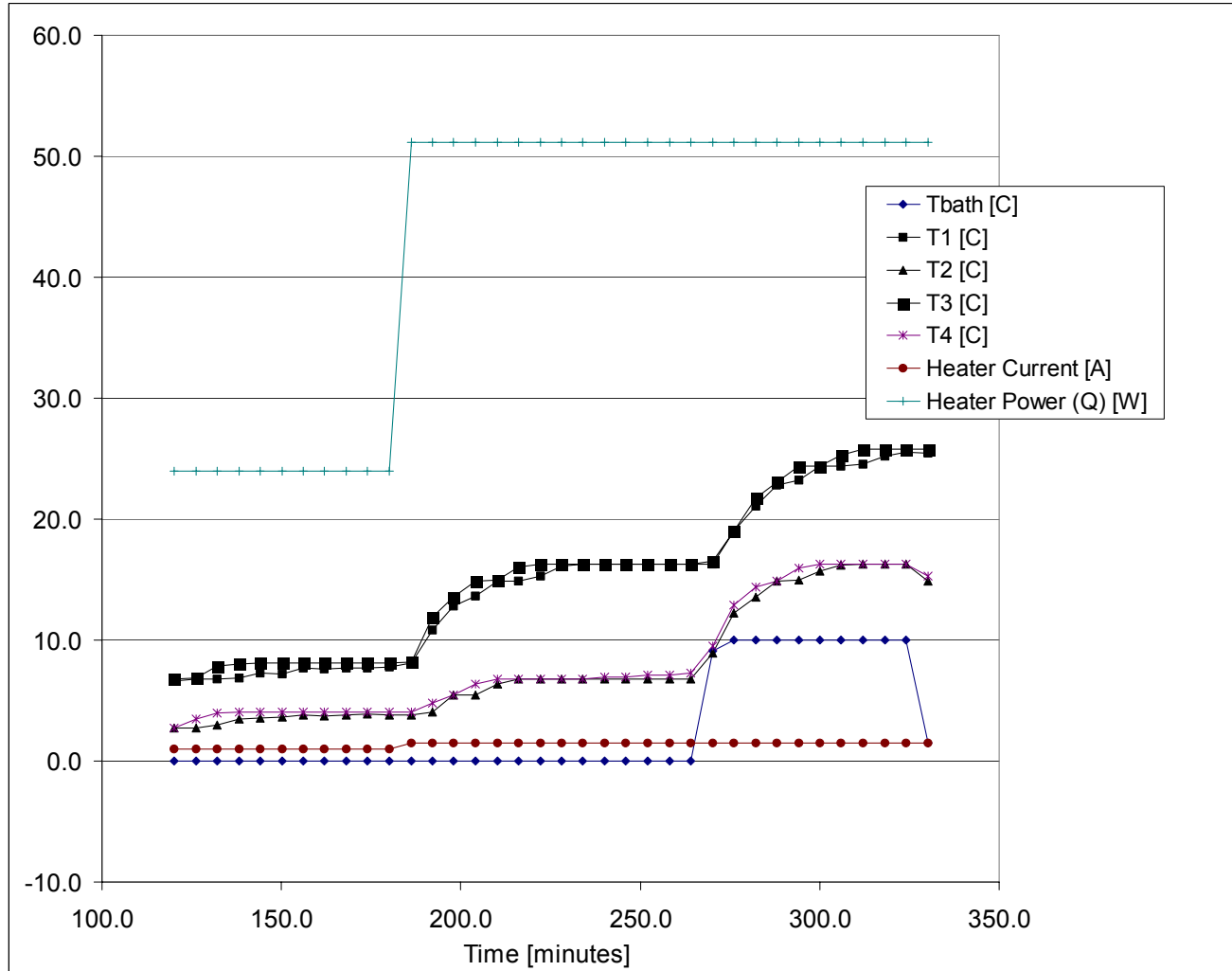
Average of all heater power levels [C/W] = 0.209

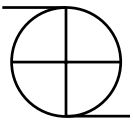
Tall 0.053 m
Thermal conductivity 182 w/mK
Area 0.00152013 m²
Thermal Resistance 0.193 C/W

Sanity Check: 15 inch aluminum ring, 0.050 inch thick wall, 2.1 inches tall

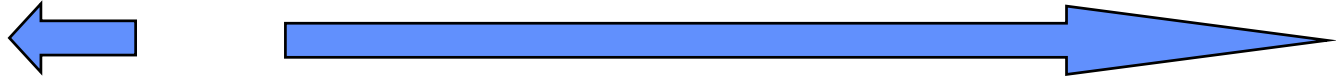


- Plot





- Thermal resistance of other Motorized Lightband diameters
 - Extrapolated from the MLB15.000 in proportion to bolt circle diameter



	MLB	MLB	MLB	MLB	MLB	MLB	MLB	MLB	MLB	MLB	MLB	MLB
Bolt Circle Diameter	11.732	15.000	19.848	23.250	30.000	34.000	38.810	45.709	62.010	66.000	120.000	
Thermal Resistance [C/W]	0.267	0.209	0.158	0.135	0.105	0.092	0.081	0.069	0.051	0.048	0.026	

