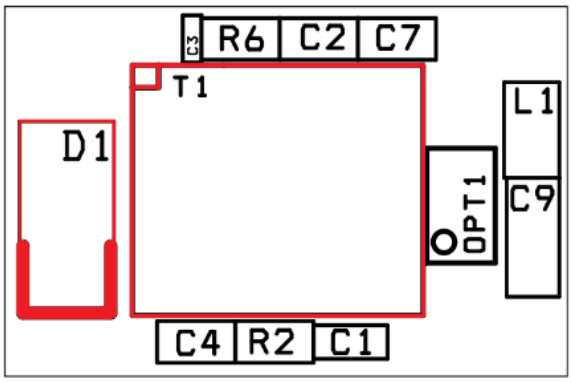
Block termination

Thermal considerations

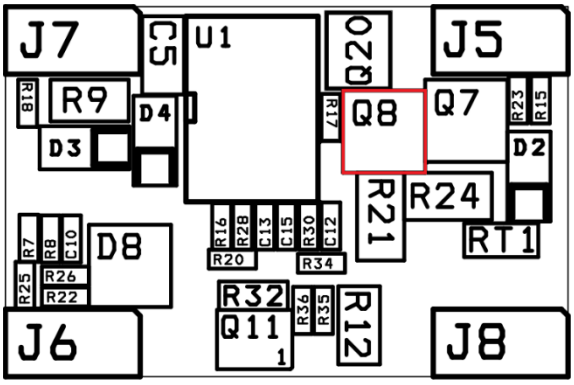
The following document explores differences in thermal performance of Silvertel module variants with pin terminations to those with block terminations. In addition, the benefit of adding a thermal gap filler between the module and the host PCB to further aid in thermal performance of the module will be measured. For this demonstration the Ag9912MT and Ag9912MTB was used.

The amount of heat generated by the module will depend on the load it is required to drive and the input voltage supplied by the source. To obtain maximum power it is important that any enclosure used has sufficient ventilation or forced airflow over the module. Even in sealed enclosures, it is recommended to stir the air to avoid the formation of heated pockets of air surrounding the power dissipating components, significantly raising their effective ambient temperature.

On the Ag9912MT and Ag9912MTB the hottest components are detailed below.



The hottest component on the topside of the board is D1, followed by the transformer



The hottest component on the underside of the board is Q8.

Depending on the model, the temperature difference between these components will vary. On the Ag9912M/MT/MTB the hottest component will be Q8.

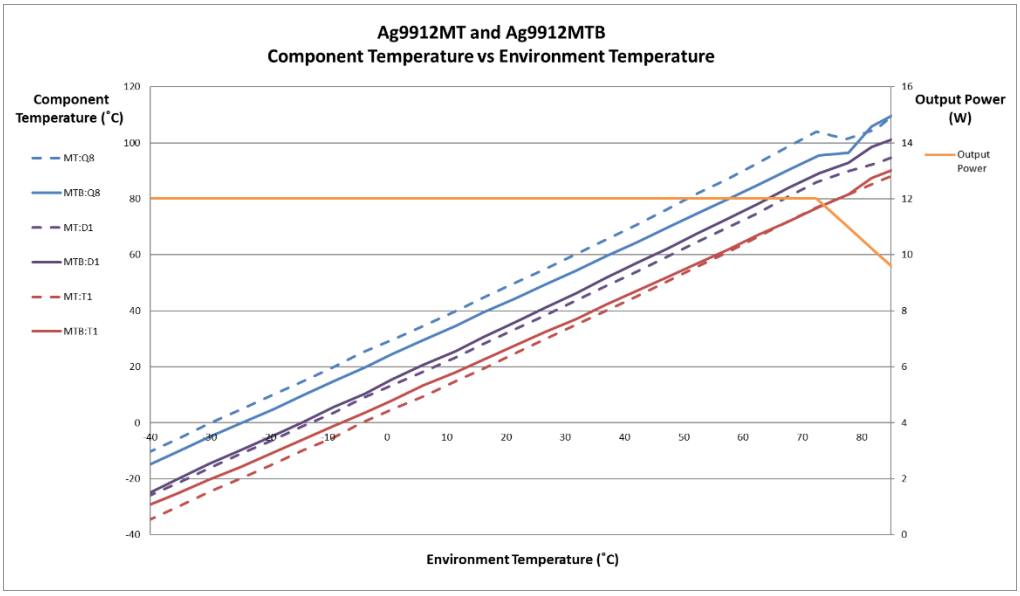
With the lower output voltage variants, the higher current on the output will result in the output diode, D2 on the Ag9900, will be dissipating a higher amount of heat, elevating its temperature.

These results have been recorded in a Temperature Applied Sciences ECO MT135 Environmental chamber (with circulating air) with forced airflow across the module at a rate of approximately 0.5m/s. The modules were fitted to EvalAg9900 rev.4 evaluation boards.

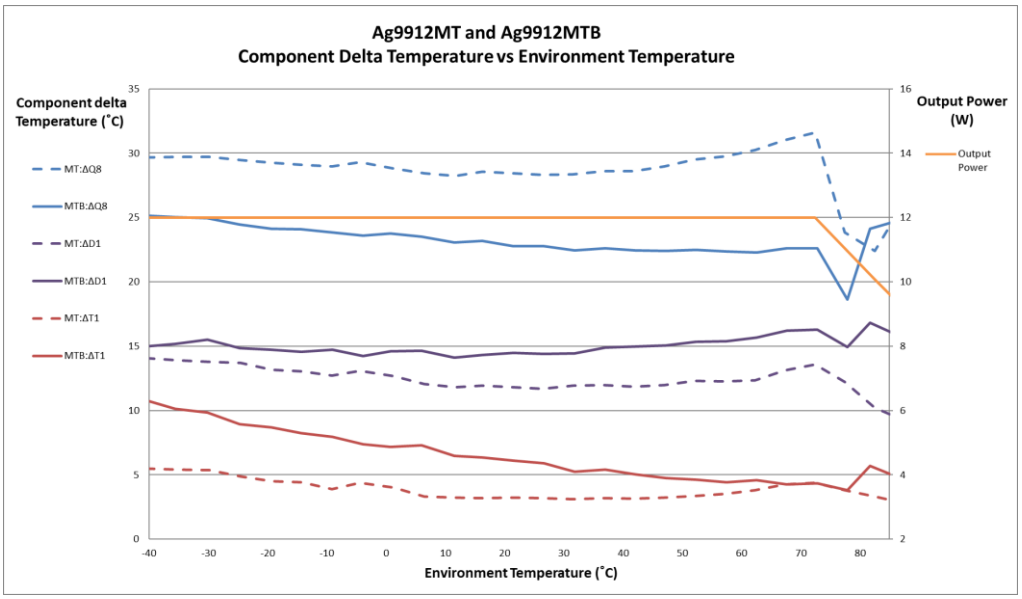
The graph plots below show the measured temperature of the components, followed by the difference in component to the airflow temperature passing across the module. The linear derating specified in te datasheet was applied during the collecting of these results, and the modules output power vs Environment temperature is plotted along the second vertical axis.

As can be seen in the results below, the components fitted to the underside of the module, have a lower operating temperature with the block terminations, this is due to the reduced thermal resistance that the block termination provides between the underside layer of the PCB and the application PCB due to the wider conduction path.

The components on the topside of the PCB do operate at a slightly elevated temperature due to the increased thermal resistance between the PCB layers resulting from the large through hole no longer being present. On an SMT or DIL package, such as the Ag9900, Silvertel will always design the highest power dissipating components fitted to the underside to allow for a thermal interface material to be used in the thermal management solution.



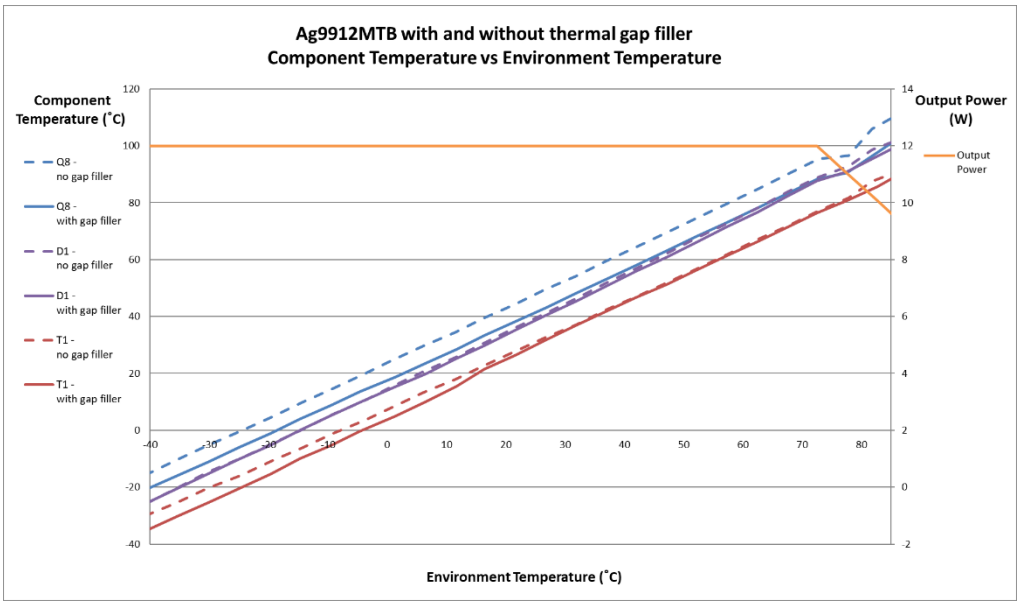
Ag9912MT Vs Ag9912MTB:
Absolute Component Temperature



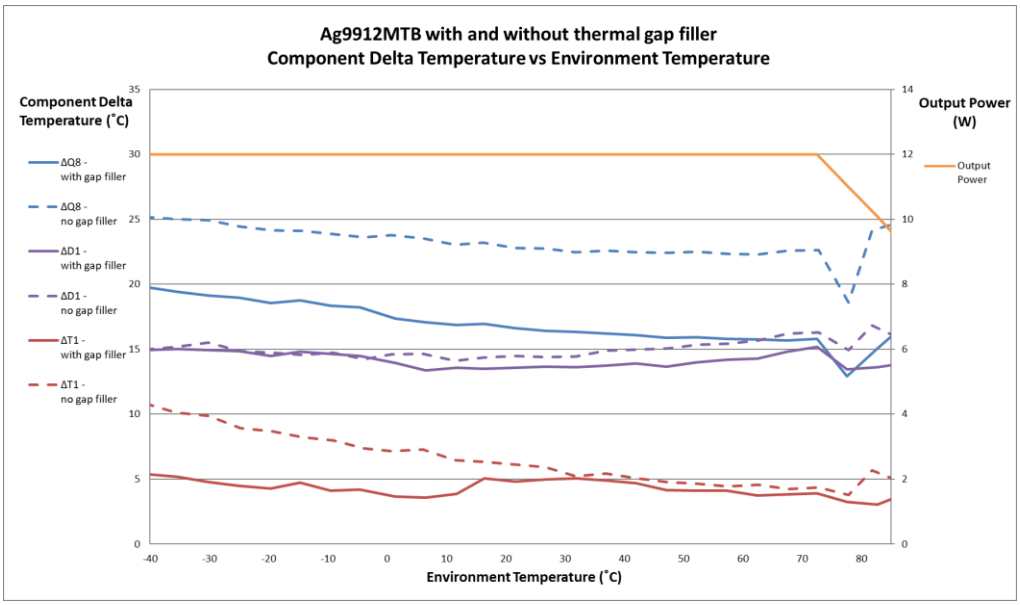
Ag9912MT Vs Ag9912MTB:
Difference In Component Temperature To Airflow Temperature

Block termination
Thermal considerations

Silvertel recommends the use of a thermal gap filler under the module to assist in the thermal management of the module, this is not required for operation, but is advantageous in applications with limited airflow. For this demonstration, Parker Chomerics THERM-A-GAP GEL 37 was injected under the module after mounting, covering approximately one third of the module in the region detailed in the datasheet for the Ag9900.
As can be seen in the graph below, the components on the underside of the module benefit significantly from the addition of the gap filler, with the thermal energy being drawn away from both the package and surrounding PCB into the application PCB where it can be dissipated over a larger surface area.
The components on the topside of the module do still benefit from the application of a gap filler material between the module and the application board, however the reduction in temperatures will be less significant, as the thermal transfer is limited by the thermal resistance of the energy being transferred through the PCB material and thermal relief vias.



Ag9912MTB with and without thermal gap filler:
Absolute Component Temperature



Ag9912MTB with and without thermal gap filler:
Difference In Component Temperature To Airflow Temperature

Ag9912MT - no gap filler under module							
Chamber temperature (C)	D1 temperature (C)	Q8 temperature (C)	T1 temperature (C)	Supply Voltage (V)	Supply Current (A)	Output Voltage (V)	Output Load (A)
-40.13	-26.43	-10.82	-35.03	56.99	0.24	11.907	1.00
-35.01	-21.39	-5.58	-29.89	57.00	0.24	11.917	1.00
-29.75	-16.03	-0.10	-24.45	57.01	0.24	11.928	1.00
-25.10	-10.88	4.90	-19.71	56.99	0.24	11.937	1.00
-20.08	-6.17	9.92	-14.84	56.99	0.24	11.946	1.00
-14.95	-1.16	14.87	-9.81	57.00	0.24	11.954	1.00
-10.40	3.59	19.85	-5.22	57.01	0.24	11.961	1.00
-5.08	8.70	24.91	-0.03	57.01	0.24	11.969	1.00
0.05	13.97	30.13	5.30	56.99	0.24	11.977	1.00
4.93	18.51	34.88	9.77	57.00	0.24	11.984	1.00
9.94	23.54	39.95	14.95	57.01	0.24	11.991	1.00
14.69	28.17	44.79	19.43	56.99	0.24	11.997	1.00
19.86	33.22	49.82	24.61	57.00	0.24	12.002	1.00
24.80	38.11	54.73	29.62	57.01	0.24	12.008	1.00
29.98	43.48	59.91	34.68	57.00	0.24	12.013	1.00
34.86	48.70	65.30	39.92	57.01	0.24	12.017	1.00
39.96	53.70	70.43	45.00	57.01	0.24	12.021	1.00
44.92	58.94	75.93	50.20	56.99	0.24	12.026	1.00
49.88	64.32	81.54	55.38	57.00	0.24	12.029	1.00
54.94	69.46	86.94	60.70	57.01	0.24	12.033	1.00
59.91	74.66	92.56	66.09	57.01	0.24	12.036	1.00
64.82	80.48	98.38	71.60	57.00	0.24	12.04	1.00
69.95	85.99	104.04	76.82	57.01	0.24	12.042	1.00
74.99	89.66	101.28	81.24	57.00	0.22	12.044	0.92
80.01	92.76	104.93	85.86	57.00	0.20	12.045	0.84
84.87	96.86	114.01	90.47	57.01	0.19	12.044	0.76

Ag9912MT Component Temperature with no Gap Filer

Ag9912MTB - no gap filler under module							
Chamber temperature (C)	D1 temperature (C)	Q8 temperature (C)	T1 temperature (C)	Supply Voltage (V)	Supply Current (A)	Output Voltage (V)	Output Load (A)
-40.32	-25.83	-15.65	-30.01	57.01	0.24	11.944	1.00
-35.30	-20.40	-10.56	-25.45	57.01	0.24	11.956	1.00
-29.79	-14.62	-5.19	-20.28	57.01	0.24	11.967	1.00
-25.13	-9.89	-0.31	-15.83	56.99	0.24	11.977	1.00
-19.91	-4.66	4.74	-10.71	57.00	0.24	11.987	1.00
-15.21	0.25	9.79	-6.05	57.00	0.24	11.997	1.00
-10.00	5.63	14.77	-1.13	57.01	0.24	12.007	1.00
-5.11	10.39	19.76	3.51	57.01	0.24	12.015	1.00
-0.33	15.32	24.48	7.87	57.00	0.24	12.023	1.00
4.77	20.64	29.52	13.28	57.01	0.24	12.031	1.00
9.81	25.59	34.53	17.94	57.00	0.24	12.038	1.00
14.77	30.54	39.40	22.55	57.00	0.24	12.045	1.00
19.99	35.98	44.31	27.62	57.00	0.24	12.052	1.00
24.93	41.06	49.44	32.58	57.00	0.24	12.058	1.00
29.83	46.29	54.29	37.07	57.01	0.24	12.064	1.00
34.83	51.84	59.55	42.37	56.99	0.24	12.069	1.00
39.93	57.10	64.55	47.16	57.00	0.24	12.074	1.00
44.88	62.30	69.67	52.03	57.01	0.24	12.079	1.00
50.04	67.67	74.79	56.95	57.00	0.24	12.084	1.00
55.12	72.86	79.81	61.89	57.00	0.24	12.088	1.00
60.13	78.25	84.89	67.16	57.00	0.24	12.092	1.00
65.02	83.85	90.23	71.88	57.00	0.24	12.095	1.00
70.26	89.09	95.43	77.15	57.00	0.24	12.099	1.00
75.22	92.77	96.46	81.64	57.00	0.22	12.102	0.92
80.49	98.56	105.88	87.43	57.00	0.20	12.103	0.84
85.46	102.89	112.09	91.88	57.00	0.19	12.104	0.76

Ag9912MTB Component Temperature with no Gap Filer

Ag9912MTB - with gap filler under module							
Chamber temperature (C)	D1 temperature (C)	Q8 temperature (C)	T1 temperature (C)	Supply Voltage (V)	Supply Current (A)	Output Voltage (V)	Output Load (A)
-40.20	-25.73	-20.89	-35.30	57.00	0.24	11.939	1.00
-35.01	-20.35	-15.96	-30.19	57.00	0.24	11.95	1.00
-29.99	-15.13	-10.94	-25.30	57.00	0.24	11.962	1.00
-25.28	-10.09	-6.00	-20.48	56.99	0.24	11.972	1.00
-19.99	-5.16	-1.07	-15.36	56.99	0.24	11.983	1.00
-14.56	0.12	4.09	-9.94	57.00	0.24	11.993	1.00
-10.10	5.11	8.79	-5.43	57.00	0.24	12.002	1.00
-4.99	9.91	13.64	-0.39	56.98	0.24	12.011	1.00
0.16	15.30	18.70	5.00	57.01	0.24	12.019	1.00
5.01	19.84	23.54	10.04	57.01	0.24	12.027	1.00
10.05	25.25	28.52	15.54	57.00	0.24	12.034	1.00
14.83	29.85	33.30	21.44	57.00	0.24	12.041	1.00
19.97	35.20	38.21	26.41	57.01	0.24	12.048	1.00
25.16	40.43	43.20	31.79	57.00	0.24	12.054	1.00
30.14	45.47	48.17	36.92	57.00	0.24	12.06	1.00
35.24	50.65	53.12	41.83	57.00	0.24	12.066	1.00
40.09	55.90	58.06	46.69	57.01	0.24	12.071	1.00
45.06	60.81	63.01	51.30	57.01	0.24	12.075	1.00
50.07	66.11	68.06	56.24	57.01	0.24	12.079	1.00
54.99	71.43	73.04	61.36	57.01	0.24	12.084	1.00
60.09	76.69	78.14	66.16	57.00	0.24	12.087	1.00
65.04	82.27	83.14	71.28	57.02	0.24	12.091	1.00
69.98	87.69	88.31	76.42	57.01	0.24	12.093	1.00
75.09	90.95	90.44	80.78	57.01	0.22	12.097	0.92
80.31	96.27	97.70	85.67	57.00	0.2	12.101	0.84
85.51	101.54	104.58	91.49	56.99	0.19	12.104	0.76

Ag9912MTB Component Temperature with Gap Filer