

## Heat Pipe Test Report

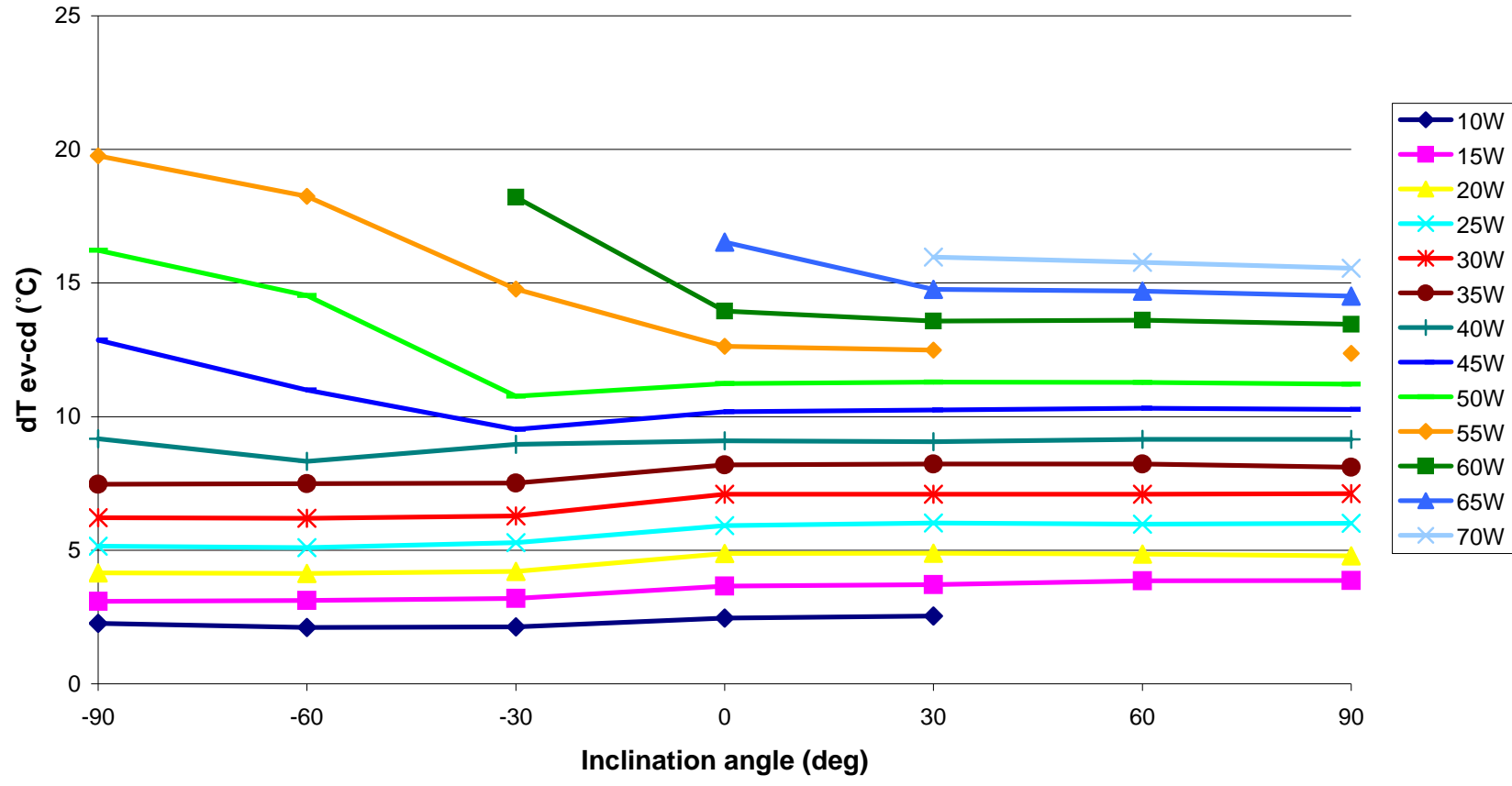
Manufacturer		Enertron				Test conditions			Test date		8/29/2011		
Wick structure/ Working fluid		Sintered Powder Metal/ Water				Effective area (m2)		2.83E-05	Note: ev- Evaporator of heat pipe cd- Condenser of heat pipe eb- Evaporator Block cb- Condenser Block				
Pipe specification		C110 Copper 0.3mm wall thickness				Coolant temp (°C)		35					
Diameter	±0.05 mm	6				Contact length of ev/cd (mm)		50					
Length	±0.10 mm	150				At 90° the evaporator is directly below the condenser; 0° is horizontal.							
Flatten thickness	±0.05 mm	n/a											
Bend angle	±1 deg	n/a											
Inclination Angle (°)	Heat Load (W)	dT ev-cd (°C)	Thermal resistance ev-cd (°C/W)	Thermal conductivity ev-cd (W/mK)	dT eb-cb (°C)	Thermal resistance eb-cb (°C/W)	Thermal Conductivity eb-cb (W/mK)	Measured Temperature T (°C)					
								ev	cd	eb1	eb2	cb1	cb2
90	15	3.87	0.26	13705	5.11	0.34	10384	41.72	37.84	42.81	42.22	37.42	37.39
	20	4.79	0.24	14777	6.65	0.33	10645	43.56	38.78	45.21	44.33	38.19	38.07
	25	6.00	0.24	14727	8.21	0.33	10776	45.62	39.62	47.55	46.49	38.88	38.76
	30	7.11	0.24	14915	9.71	0.32	10925	47.61	40.49	49.80	48.63	39.56	39.45
	35	8.11	0.23	15267	11.06	0.32	11190	49.28	41.17	51.77	50.30	40.01	39.94
	40	9.15	0.23	15455	12.64	0.32	11191	51.15	42.00	54.06	52.43	40.72	40.49
	45	10.27	0.23	15494	14.06	0.31	11322	53.14	42.87	56.29	54.52	41.40	41.30
	50	11.22	0.22	15764	15.62	0.31	11324	55.10	43.89	58.72	56.66	42.19	41.96
	55	12.37	0.22	15727	17.11	0.31	11372	57.02	44.65	61.02	58.70	42.91	42.59
	60	13.45	0.22	15774	18.49	0.31	11474	58.93	45.48	63.17	60.66	43.60	43.24
	65	14.51	0.22	15846	20.02	0.31	11485	60.83	46.33	65.45	62.72	44.29	43.85
70	15.56	0.22	15912	21.45	0.31	11543	62.71	47.15	67.69	64.76	44.96	44.60	
60	15	3.86	0.26	13755	5.08	0.34	10445	41.66	37.80	42.83	42.16	37.45	37.37
	20	4.85	0.24	14582	6.66	0.33	10629	43.68	38.83	45.31	44.44	38.27	38.16
	25	5.98	0.24	14793	8.25	0.33	10712	45.59	39.61	47.60	46.48	38.86	38.71
	30	7.10	0.24	14944	9.79	0.33	10833	47.67	40.57	49.96	48.72	39.65	39.44
	35	8.22	0.23	15056	11.27	0.32	10981	49.45	41.23	52.04	50.56	40.13	39.93
	40	9.15	0.23	15458	12.65	0.32	11183	51.19	42.04	54.13	52.46	40.74	40.54
	45	10.31	0.23	15435	14.16	0.31	11239	53.22	42.91	56.47	54.57	41.45	41.27
	50	11.29	0.23	15670	15.62	0.31	11321	55.05	43.77	58.75	56.60	42.19	41.92
	60	13.61	0.23	15595	18.76	0.31	11314	59.21	45.60	63.48	60.99	43.63	43.33
	65	14.70	0.23	15642	20.25	0.31	11351	61.21	46.51	65.86	63.03	44.33	44.06
70	15.78	0.23	15693	21.74	0.31	11386	63.05	47.28	68.13	65.07	45.01	44.69	
30	10	2.54	0.25	13941	3.45	0.34	10257	39.35	36.81	40.20	39.75	36.55	36.50
	15	3.71	0.25	14303	5.11	0.34	10392	41.56	37.85	42.85	42.15	37.43	37.35
	20	4.89	0.24	14459	6.74	0.34	10490	43.66	38.77	45.31	44.43	38.17	38.08
	25	6.02	0.24	14683	8.19	0.33	10803	45.60	39.57	47.54	46.49	38.88	38.78
	30	7.10	0.24	14946	9.79	0.33	10838	47.66	40.56	49.95	48.72	39.61	39.48
	35	8.23	0.24	15043	11.33	0.32	10930	49.47	41.25	52.13	50.63	40.13	39.98
	40	9.06	0.23	15617	12.59	0.31	11235	51.14	42.08	54.11	52.48	40.79	40.62

Inclination Angle (°)	Heat Load (W)	dT ev-cd (°C)	Thermal resistance ev-cd (°C/W)	Thermal conductivity ev-cd (W/mK)	dT eb-cb (°C)	Thermal resistance eb-cb (°C/W)	Thermal Conductivity eb-cb (W/mK)	Measured Temperature T (°C)					
								ev	cd	eb1	eb2	cb1	cb2
30	45	10.25	0.23	15532	14.23	0.32	11188	53.18	42.93	56.55	54.63	41.45	41.27
	50	11.29	0.23	15659	15.69	0.31	11269	55.06	43.77	58.81	56.69	42.20	41.91
	55	12.49	0.23	15577	17.36	0.32	11205	57.26	44.77	61.35	59.07	43.00	42.69
	60	13.57	0.23	15633	18.83	0.31	11271	59.19	45.61	63.66	61.08	43.67	43.41
	65	14.77	0.23	15567	20.41	0.31	11265	61.25	46.48	65.96	63.16	44.29	44.02
	70	15.97	0.23	15501	22.10	0.32	11204	63.25	47.28	68.42	65.42	44.95	44.70
0	10	2.46	0.25	14389	3.51	0.35	10079	39.31	36.85	40.26	39.79	36.51	36.52
	15	3.66	0.24	14511	5.09	0.34	10433	41.50	37.85	42.78	42.15	37.38	37.39
	20	4.87	0.24	14516	6.75	0.34	10476	43.64	38.76	45.30	44.45	38.20	38.05
	25	5.93	0.24	14923	8.19	0.33	10803	45.54	39.61	47.56	46.48	38.92	38.76
	30	7.10	0.24	14946	9.79	0.33	10838	47.59	40.49	49.92	48.71	39.57	39.48
	35	8.20	0.23	15100	11.32	0.32	10935	49.45	41.26	52.10	50.58	40.09	39.95
	40	9.10	0.23	15553	12.65	0.32	11186	51.09	42.00	54.17	52.47	40.76	40.58
	45	10.18	0.23	15629	14.26	0.32	11160	53.16	42.98	56.60	54.70	41.49	41.28
	50	11.23	0.22	15741	15.72	0.31	11250	55.06	43.83	58.85	56.76	42.18	41.99
	55	12.63	0.23	15402	17.57	0.32	11073	57.38	44.75	61.57	59.21	42.94	42.71
60	13.95	0.23	15213	19.18	0.32	11063	59.40	45.45	63.98	61.34	43.53	43.42	
65	16.53	0.25	13905	21.46	0.33	10712	62.49	45.95	66.82	64.27	44.01	44.16	
-30	10	2.13	0.21	16597	3.46	0.35	10234	38.99	36.86	40.19	39.80	36.58	36.50
	15	3.20	0.21	16605	5.09	0.34	10421	41.05	37.86	42.80	42.13	37.44	37.32
	20	4.21	0.21	16818	6.69	0.33	10567	42.94	38.73	45.26	44.42	38.21	38.08
	25	5.28	0.21	16749	8.18	0.33	10807	44.86	39.58	47.52	46.47	38.92	38.71
	30	6.28	0.21	16890	9.79	0.33	10839	46.79	40.51	49.94	48.66	39.59	39.43
	35	7.52	0.21	16472	11.36	0.32	10900	48.68	41.16	52.10	50.68	40.09	39.97
	40	8.96	0.22	15782	12.68	0.32	11157	50.94	41.98	54.14	52.50	40.68	40.61
	45	9.52	0.21	16721	14.36	0.32	11086	52.36	42.84	56.70	54.72	41.41	41.31
	50	10.77	0.22	16423	15.89	0.32	11131	54.31	43.55	59.01	56.84	42.07	42.00
	55	14.78	0.27	13166	19.11	0.35	10179	58.95	44.18	62.69	60.86	42.55	42.78
60	18.22	0.30	11650	22.45	0.37	9454	62.87	44.65	66.35	65.05	42.96	43.54	
-60	10	2.10	0.21	16810	3.45	0.35	10243	38.95	36.84	40.18	39.73	36.51	36.50
	15	3.12	0.21	16993	5.11	0.34	10378	40.96	37.84	42.83	42.15	37.40	37.36
	20	4.13	0.21	17115	6.76	0.34	10461	42.88	38.75	45.32	44.42	38.17	38.04
	25	5.10	0.20	17344	8.13	0.33	10872	44.76	39.67	47.46	46.49	38.91	38.77
	30	6.19	0.21	17133	9.78	0.33	10851	46.54	40.35	49.77	48.49	39.41	39.29
	35	7.49	0.21	16523	11.47	0.33	10792	48.72	41.23	52.25	50.69	40.05	39.95
	40	8.33	0.21	16987	12.80	0.32	11053	50.29	41.96	54.29	52.55	40.70	40.54
	45	10.99	0.24	14477	15.09	0.34	10549	53.60	42.61	57.23	55.49	41.22	41.33
	50	14.54	0.29	12166	18.27	0.37	9679	57.63	43.09	60.72	59.47	41.66	42.00

Inclination Angle (°)	Heat Load (W)	dT ev-cd (°C)	Thermal resistance ev-cd (°C/W)	Thermal conductivity ev-cd (W/mK)	dT eb-cb (°C)	Thermal resistance eb-cb (°C/W)	Thermal Conductivity eb-cb (W/mK)	Measured Temperature T (°C)					
								ev	cd	eb1	eb2	cb1	cb2
-60	55	18.24	0.33	10663	22.23	0.40	8752	61.99	43.75	65.15	64.34	42.19	42.84
-90	10	2.26	0.23	15629	3.58	0.36	9885	39.10	36.84	40.42	39.91	36.65	36.52
	15	3.09	0.21	17191	5.13	0.34	10341	40.98	37.90	42.86	42.19	37.42	37.38
	20	4.15	0.21	17028	6.74	0.34	10500	42.92	38.76	45.35	44.40	38.23	38.05
	25	5.15	0.21	17169	8.22	0.33	10763	44.80	39.65	47.58	46.54	38.89	38.81
	30	6.22	0.21	17064	9.78	0.33	10853	46.62	40.41	49.88	48.59	39.52	39.39
	35	7.47	0.21	16562	11.43	0.33	10826	48.79	41.32	52.30	50.80	40.12	40.12
	40	9.17	0.23	15424	13.26	0.33	10673	51.13	41.96	54.83	53.18	40.70	40.80
	45	12.86	0.29	12373	16.26	0.36	9789	55.33	42.47	58.31	56.95	41.24	41.50
	50	16.23	0.32	10898	19.91	0.40	8881	59.37	43.14	62.35	61.48	41.72	42.29
55	19.76	0.36	9843	24.07	0.44	8083	63.63	43.86	66.84	66.44	42.14	43.01	

### Heat pipe performance (dT vs Inclination angles at various heat loads)

Heat pipe tested:  $\phi 6\text{mm} \times 150\text{mm}$  sintered powder metal/ water



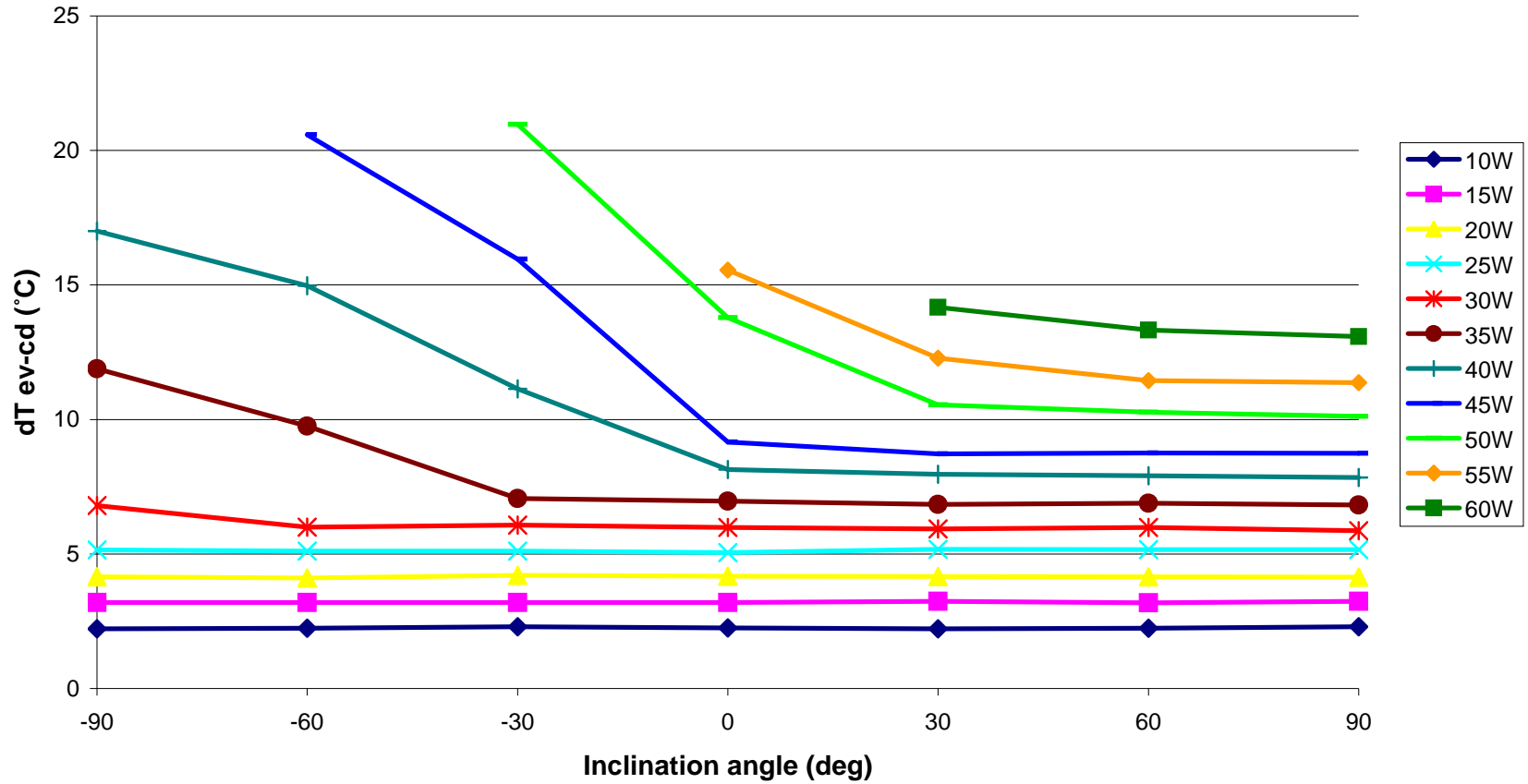
## Heat Pipe Test Report

Manufacturer		Enertron				Test conditions				Test date	8/30/2011						
Wick structure/ Working fluid		Sintered Powder Metal/ Water				Effective area (m2)		2.83E-05		Note: ev- Evaporator of heat pipe cd- Condenser of heat pipe eb- Evaporator Block cb- Condenser Block							
Pipe specification		C110 Copper 0.3mm wall thickness				Coolant temp (°C)		35									
Diameter	±0.05 mm	6				Contact length of ev/cd (mm)		50									
Length	±0.10 mm	175				At 90° the evaporator is directly below the condenser; 0° is horizontal.											
Flatten thickness	±0.05 mm	n/a															
Bend angle	±1 deg	n/a															
Inclination Angle (°)	Heat Load (W)	dT ev-cd (°C)	Thermal resistance ev-cd (°C/W)	Thermal conductivity ev-cd (W/mK)	dT eb-cb (°C)	Thermal resistance eb-cb (°C/W)	Thermal Conductivity eb-cb (W/mK)	Measured Temperature T (°C)									
								ev	cd	eb1	eb2	cb1	cb2				
90	10	2.30	0.23	19247	4.40	0.44	10052	39.38	37.08	41.30	40.57	36.63	36.44				
	15	3.24	0.22	20455	6.25	0.42	10607	41.37	38.13	44.02	43.04	37.40	37.16				
	20	4.15	0.21	21326	8.17	0.41	10829	43.30	39.15	46.73	45.42	38.07	37.76				
	25	5.16	0.21	21415	10.02	0.40	11030	45.18	40.02	49.47	47.86	38.82	38.46				
	30	5.86	0.20	22629	11.64	0.39	11393	46.61	40.75	51.66	49.77	39.29	38.86				
	35	6.82	0.19	22682	13.60	0.39	11381	48.49	41.67	54.46	52.19	40.02	39.43				
	40	7.84	0.20	22544	15.59	0.39	11347	50.37	42.53	57.21	54.75	40.73	40.05				
	45	8.75	0.19	22747	17.43	0.39	11411	52.20	43.45	60.02	57.08	41.48	40.76				
	50	10.11	0.20	21856	19.58	0.39	11291	54.62	44.51	63.04	59.83	42.27	41.44				
	55	11.37	0.21	21386	21.46	0.39	11332	56.52	45.15	65.54	62.04	42.74	41.92				
60	13.08	0.22	20277	23.84	0.40	11127	59.36	46.28	68.73	65.00	43.50	42.55					
60	10	2.24	0.22	19710	4.39	0.44	10077	39.41	37.17	41.21	40.53	36.56	36.41				
	15	3.18	0.21	20854	6.21	0.41	10680	41.33	38.15	44.02	43.00	37.44	37.16				
	20	4.16	0.21	21270	8.11	0.41	10901	43.29	39.13	46.72	45.44	38.13	37.81				
	25	5.17	0.21	21386	9.89	0.40	11181	45.08	39.91	49.29	47.71	38.85	38.38				
	30	5.99	0.20	22142	11.77	0.39	11271	46.77	40.78	51.89	49.92	39.37	38.90				
	35	6.88	0.20	22484	13.63	0.39	11352	48.58	41.70	54.55	52.33	40.11	39.51				
	40	7.91	0.20	22354	15.68	0.39	11277	50.53	42.62	57.51	54.90	40.84	40.21				
	45	8.75	0.19	22729	17.39	0.39	11442	52.21	43.46	59.97	57.13	41.52	40.81				
	50	10.27	0.21	21528	19.68	0.39	11230	54.79	44.53	63.18	59.96	42.27	41.51				
	55	11.44	0.21	21247	21.45	0.39	11338	56.59	45.15	65.48	62.04	42.78	41.85				
60	13.33	0.22	19904	24.04	0.40	11036	59.67	46.34	68.97	65.23	43.53	42.61					
30	10	2.22	0.22	19887	4.22	0.42	10469	39.39	37.16	41.17	40.46	36.66	36.53				
	15	3.24	0.22	20499	6.21	0.41	10677	41.37	38.13	44.05	43.02	37.46	37.19				
	20	4.16	0.21	21265	8.09	0.40	10925	43.29	39.14	46.70	45.46	38.14	37.84				
	25	5.18	0.21	21353	9.95	0.40	11108	45.14	39.97	49.37	47.75	38.81	38.41				
	30	5.93	0.20	22354	11.77	0.39	11266	46.78	40.85	51.86	49.95	39.38	38.89				
	35	6.84	0.20	22622	13.65	0.39	11337	48.61	41.77	54.62	52.36	40.14	39.55				
	40	7.97	0.20	22194	15.69	0.39	11270	50.58	42.61	57.50	54.94	40.89	40.17				
	45	8.72	0.19	22820	17.42	0.39	11420	52.28	43.57	60.07	57.27	41.64	40.85				

Inclination Angle (°)	Heat Load (W)	dT ev-cd (°C)	Thermal resistance ev-cd (°C/W)	Thermal conductivity ev-cd (W/mK)	dT eb-cb (°C)	Thermal resistance eb-cb (°C/W)	Thermal Conductivity eb-cb (W/mK)	Measured Temperature T (°C)					
								ev	cd	eb1	eb2	cb1	cb2
30	50	10.54	0.21	20970	19.88	0.40	11119	55.18	44.64	63.37	60.17	42.28	41.51
	55	12.28	0.22	19794	22.17	0.40	10966	57.76	45.48	66.30	62.88	42.78	42.06
	60	14.17	0.24	18716	24.69	0.41	10743	60.82	46.64	69.61	65.92	43.53	42.63
0	10	2.25	0.23	19649	4.23	0.42	10456	39.38	37.13	41.17	40.48	36.67	36.53
	15	3.19	0.21	20769	6.20	0.41	10694	41.30	38.11	43.94	42.95	37.35	37.13
	20	4.17	0.21	21194	8.10	0.41	10913	43.31	39.14	46.73	45.37	38.10	37.80
	25	5.05	0.20	21886	9.95	0.40	11112	45.06	40.01	49.31	47.72	38.80	38.34
	30	5.98	0.20	22168	11.79	0.39	11247	46.73	40.75	51.87	49.94	39.39	38.85
	35	6.97	0.20	22203	13.71	0.39	11285	48.58	41.61	54.61	52.35	40.04	39.50
	40	8.14	0.20	21735	15.78	0.39	11210	50.65	42.51	57.56	55.02	40.83	40.19
	45	9.16	0.20	21723	17.60	0.39	11303	52.48	43.32	60.23	57.40	41.57	40.85
	50	13.79	0.28	16034	20.95	0.42	10553	57.93	44.15	64.14	61.24	42.06	41.43
	55	15.55	0.28	15637	23.72	0.43	10251	60.92	45.37	67.70	64.59	42.76	42.09
-30	10	2.30	0.23	19213	4.26	0.43	10380	39.43	37.12	41.24	40.49	36.66	36.55
	15	3.20	0.21	20730	6.19	0.41	10706	41.31	38.11	43.98	42.94	37.36	37.17
	20	4.21	0.21	21017	8.03	0.40	11010	43.25	39.04	46.62	45.36	38.14	37.78
	25	5.10	0.20	21654	9.93	0.40	11129	45.05	39.94	49.33	47.69	38.80	38.36
	30	6.08	0.20	21828	11.75	0.39	11284	46.73	40.66	51.84	49.94	39.37	38.90
	35	7.07	0.20	21901	13.74	0.39	11258	48.65	41.58	54.63	52.42	40.08	39.49
	40	11.14	0.28	15874	16.79	0.42	10532	53.59	42.45	58.38	56.13	40.72	40.21
	45	15.96	0.35	12467	21.42	0.48	9289	59.06	43.10	63.42	61.46	41.21	40.84
	50	20.97	0.42	10540	27.12	0.54	8152	64.61	43.63	69.43	67.65	41.51	41.34
-60	10	2.24	0.22	19745	4.29	0.43	10303	39.41	37.17	41.20	40.50	36.62	36.50
	15	3.20	0.21	20756	6.15	0.41	10788	41.32	38.13	43.97	42.91	37.43	37.16
	20	4.11	0.21	21539	8.06	0.40	10970	43.16	39.06	46.64	45.35	38.12	37.75
	25	5.11	0.20	21616	10.03	0.40	11024	45.09	39.98	49.38	47.79	38.75	38.37
	30	6.00	0.20	22109	11.83	0.39	11213	46.73	40.73	51.90	49.96	39.35	38.86
	35	9.75	0.28	15870	14.74	0.42	10500	51.26	41.51	55.50	53.42	39.93	39.51
	40	14.97	0.37	11814	19.89	0.50	8890	57.17	42.21	61.07	59.39	40.48	40.19
	45	20.59	0.46	9664	26.34	0.59	7552	63.46	42.87	67.97	66.48	40.88	40.89
-90	10	2.22	0.22	19941	4.23	0.42	10464	39.41	37.19	41.21	40.51	36.70	36.56
	15	3.20	0.21	20756	6.21	0.41	10682	41.36	38.16	43.96	42.96	37.39	37.12
	20	4.15	0.21	21301	8.12	0.41	10893	43.26	39.11	46.74	45.43	38.12	37.82
	25	5.15	0.21	21453	9.99	0.40	11065	45.20	40.04	49.46	47.86	38.88	38.46
	30	6.80	0.23	19510	12.07	0.40	10993	47.67	40.88	52.12	50.26	39.31	38.95
	35	11.89	0.34	13016	16.30	0.47	9495	53.32	41.43	56.88	55.21	39.88	39.62
	40	17.00	0.43	10400	22.05	0.55	8019	59.33	42.32	63.19	61.74	40.48	40.34

**Heat pipe performance (dT vs Inclination angles at various heat loads)**

Heat pipe tested:  $\phi 6\text{mm} \times 175\text{mm}$  sintered powder metal/ water



## Heat Pipe Test Report

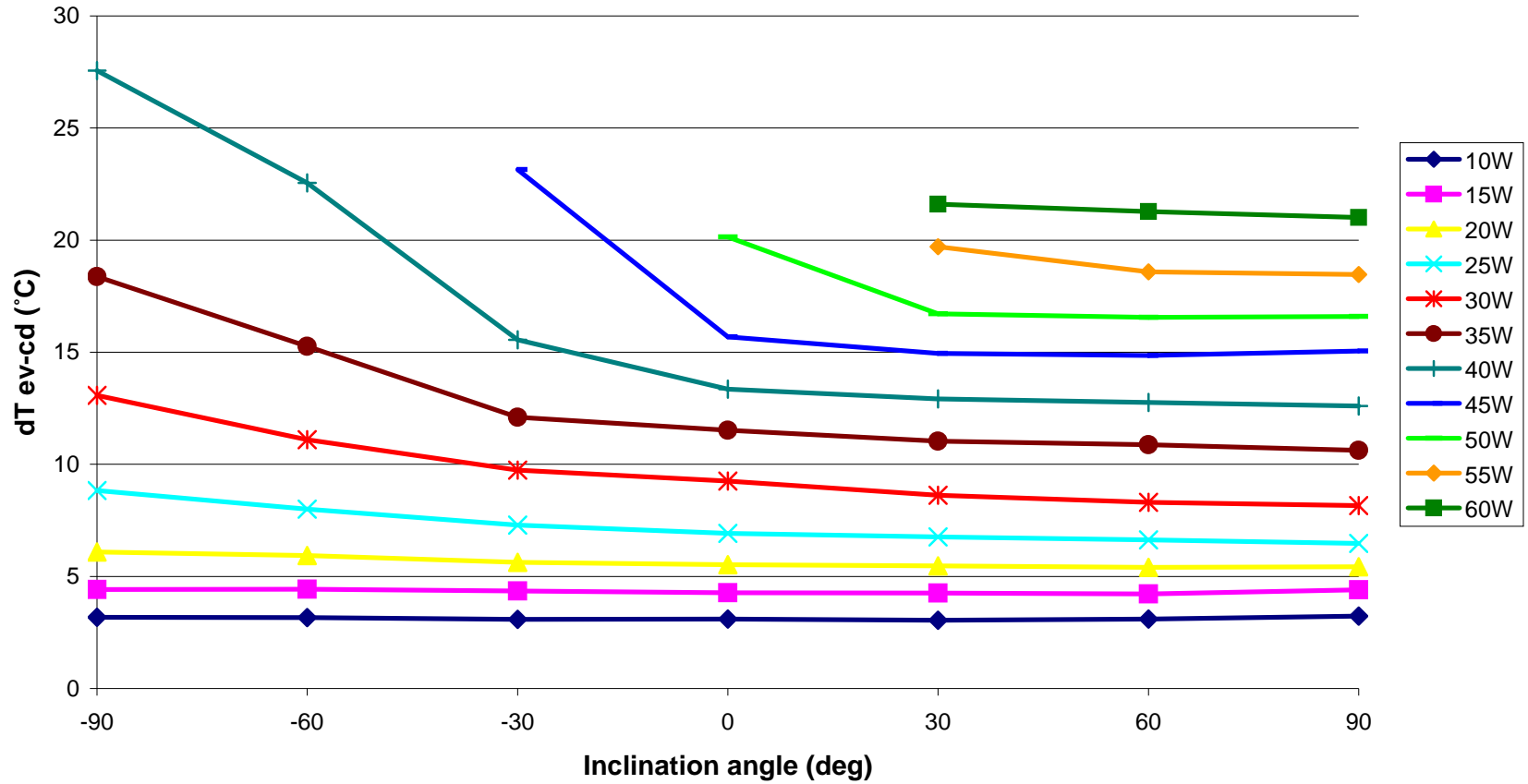
Manufacturer		Enertron				Test conditions				Test date	9/1/2011						
Wick structure/ Working fluid		Sintered Powder Metal/ Water				Effective area (m2)		2.83E-05		Note: ev- Evaporator of heat pipe cd- Condenser of heat pipe eb- Evaporator Block cb- Condenser Block							
Pipe specification		C110 Copper 0.3mm wall thickness				Coolant temp (°C)		35									
Diameter	±0.05 mm	6				Contact length of ev/cd (mm)		50									
Length	±0.10 mm	200				At 90° the evaporator is directly below the condenser; 0° is horizontal.											
Flatten thickness	±0.05 mm	n/a															
Bend angle	±1 deg	n/a															
Inclination Angle (°)	Heat Load (W)	dT ev-cd (°C)	Thermal resistance ev-cd (°C/W)	Thermal conductivity ev-cd (W/mK)	dT eb-cb (°C)	Thermal resistance eb-cb (°C/W)	Thermal Conductivity eb-cb (W/mK)	Measured Temperature T (°C)									
								ev	cd	eb1	eb2	cb1	cb2				
90	10	3.23	0.32	16435	3.58	0.36	14815	39.62	36.39	40.19	39.79	36.35	36.48				
	15	4.40	0.29	18090	4.84	0.32	16459	41.37	36.97	42.25	41.63	37.04	37.17				
	20	5.43	0.27	19558	6.13	0.31	17303	43.13	37.70	44.34	43.50	37.74	37.83				
	25	6.47	0.26	20505	7.46	0.30	17779	44.95	38.48	46.43	45.41	38.42	38.50				
	30	8.16	0.27	19495	9.43	0.31	16878	47.38	39.22	49.06	48.06	39.15	39.10				
	35	10.63	0.30	17474	11.80	0.34	15737	50.75	40.12	52.05	51.25	39.87	39.83				
	40	12.60	0.31	16847	13.85	0.35	15320	53.65	41.05	54.83	54.10	40.72	40.51				
	45	15.05	0.33	15859	16.63	0.37	14360	57.20	42.14	58.19	57.73	41.53	41.14				
	50	16.59	0.33	15985	18.41	0.37	14412	59.59	43.00	60.58	60.21	42.24	41.73				
	55	18.46	0.34	15804	20.63	0.38	14146	62.34	43.87	63.49	63.09	43.00	42.33				
60	21.02	0.35	15147	22.89	0.38	13908	65.04	44.03	66.10	65.92	43.40	42.84					
60	10	3.09	0.31	17152	3.48	0.35	15253	39.51	36.42	40.08	39.70	36.32	36.51				
	15	4.22	0.28	18880	4.85	0.32	16411	41.28	37.06	42.20	41.58	37.02	37.07				
	20	5.41	0.27	19620	6.16	0.31	17222	43.11	37.71	44.32	43.50	37.75	37.75				
	25	6.64	0.27	19986	7.56	0.30	17541	45.12	38.49	46.61	45.57	38.53	38.52				
	30	8.31	0.28	19161	9.57	0.32	16632	47.62	39.31	49.30	48.33	39.29	39.20				
	35	10.88	0.31	17073	11.99	0.34	15484	51.01	40.14	52.35	51.53	40.03	39.86				
	40	12.76	0.32	16631	14.15	0.35	14998	54.01	41.25	55.13	54.44	40.77	40.51				
	45	14.86	0.33	16068	16.50	0.37	14471	56.97	42.11	58.00	57.58	41.48	41.10				
	50	16.56	0.33	16023	18.45	0.37	14377	59.60	43.04	60.66	60.28	42.31	41.73				
	55	18.58	0.34	15703	20.71	0.38	14088	62.36	43.78	63.54	63.11	42.94	42.29				
60	21.27	0.35	14966	23.35	0.39	13630	65.54	44.27	66.74	66.46	43.58	42.91					
30	10	3.04	0.30	17445	3.49	0.35	15214	39.42	36.38	40.11	39.67	36.30	36.50				
	15	4.26	0.28	18671	4.80	0.32	16592	41.30	37.03	42.21	41.61	37.06	37.17				
	20	5.48	0.27	19376	6.18	0.31	17163	43.20	37.73	44.36	43.55	37.79	37.77				
	25	6.76	0.27	19614	7.74	0.31	17129	45.25	38.48	46.73	45.75	38.51	38.47				
	30	8.62	0.29	18457	9.83	0.33	16199	47.90	39.27	49.50	48.60	39.27	39.17				
	35	11.04	0.32	16823	12.18	0.35	15251	51.27	40.23	52.53	51.69	40.00	39.86				
	40	12.92	0.32	16431	14.27	0.36	14871	54.15	41.23	55.26	54.64	40.81	40.56				
	45	14.95	0.33	15974	16.61	0.37	14375	57.08	42.14	58.08	57.63	41.42	41.08				



Inclination Angle (°)	Heat Load (W)	dT ev-cd (°C)	Thermal resistance ev-cd (°C/W)	Thermal conductivity ev-cd (W/mK)	dT eb-cb (°C)	Thermal resistance eb-cb (°C/W)	Thermal Conductivity eb-cb (W/mK)	Measured Temperature T (°C)					
								ev	cd	eb1	eb2	cb1	cb2
30	50	16.71	0.33	15870	18.64	0.37	14230	59.78	43.07	60.84	60.44	42.26	41.74
	55	19.71	0.36	14808	21.50	0.39	13569	63.08	43.37	64.22	63.89	42.76	42.34
	60	21.60	0.36	14735	23.90	0.40	13321	66.24	44.64	67.27	67.10	43.60	42.97
0	10	3.10	0.31	17097	3.45	0.35	15377	39.47	36.37	40.07	39.66	36.35	36.48
	15	4.27	0.28	18628	4.83	0.32	16462	41.34	37.07	42.23	41.61	37.04	37.13
	20	5.53	0.28	19190	6.19	0.31	17138	43.23	37.70	44.39	43.61	37.78	37.83
	25	6.92	0.28	19172	7.97	0.32	16639	45.35	38.43	46.87	45.99	38.45	38.46
	30	9.25	0.31	17210	10.15	0.34	15676	48.48	39.23	49.76	48.98	39.26	39.18
	35	11.51	0.33	16127	12.44	0.36	14932	51.63	40.11	52.68	52.01	39.94	39.88
	40	13.35	0.33	15892	14.55	0.36	14587	54.48	41.12	55.46	54.95	40.79	40.53
	45	15.68	0.35	15226	17.15	0.38	13921	57.66	41.98	58.59	58.23	41.42	41.10
	50	20.14	0.40	13169	21.21	0.42	12507	62.26	42.12	62.98	63.20	41.98	41.78
	-30	10	3.08	0.31	17230	3.53	0.35	15020	39.43	36.35	40.11	39.70	36.27
15		4.35	0.29	18285	4.86	0.32	16371	41.37	37.02	42.21	41.69	37.03	37.15
20		5.62	0.28	18866	6.39	0.32	16594	43.34	37.72	44.53	43.81	37.75	37.80
25		7.29	0.29	18193	8.20	0.33	16180	45.79	38.50	47.07	46.37	38.50	38.54
30		9.74	0.32	16340	10.49	0.35	15175	49.00	39.26	50.05	49.34	39.27	39.14
35		12.10	0.35	15346	12.97	0.37	14319	52.18	40.08	53.08	52.61	39.90	39.86
40		15.56	0.39	13638	16.53	0.41	12835	56.34	40.78	57.03	57.02	40.52	40.47
45		23.15	0.51	10313	24.29	0.54	9827	64.40	41.26	65.01	65.70	40.96	41.16
-60	10	3.17	0.32	16762	3.52	0.35	15059	39.48	36.32	40.12	39.66	36.29	36.45
	15	4.42	0.29	17988	4.93	0.33	16138	41.40	36.98	42.31	41.68	37.01	37.12
	20	5.94	0.30	17872	6.65	0.33	15953	43.68	37.74	44.81	44.13	37.80	37.84
	25	8.00	0.32	16570	8.60	0.34	15431	46.42	38.41	47.31	46.75	38.44	38.43
	30	11.10	0.37	14337	11.66	0.39	13646	50.26	39.16	50.90	50.68	39.09	39.17
	35	15.26	0.44	12168	16.00	0.46	11607	55.06	39.80	55.59	55.86	39.67	39.79
	40	22.55	0.56	9409	23.61	0.59	8990	62.96	40.41	63.53	64.27	40.08	40.51
-90	10	3.17	0.32	16725	3.48	0.35	15258	39.50	36.33	40.08	39.67	36.30	36.49
	15	4.42	0.29	17996	4.97	0.33	16005	41.40	36.98	42.32	41.72	37.01	37.08
	20	6.09	0.30	17414	6.81	0.34	15571	43.85	37.76	44.93	44.26	37.76	37.79
	25	8.83	0.35	15019	9.25	0.37	14337	47.18	38.35	47.80	47.47	38.37	38.40
	30	13.08	0.44	12169	13.64	0.45	11671	52.13	39.05	52.64	52.81	38.98	39.20
	35	18.38	0.53	10105	19.10	0.55	9719	58.13	39.75	58.57	59.07	39.52	39.91
	40	27.56	0.69	7701	28.68	0.72	7400	67.92	40.36	68.61	69.29	39.98	40.56

**Heat pipe performance (dT vs Inclination angles at various heat loads)**

Heat pipe tested:  $\phi 6\text{mm} \times 200\text{mm}$  sintered powder metal/ water



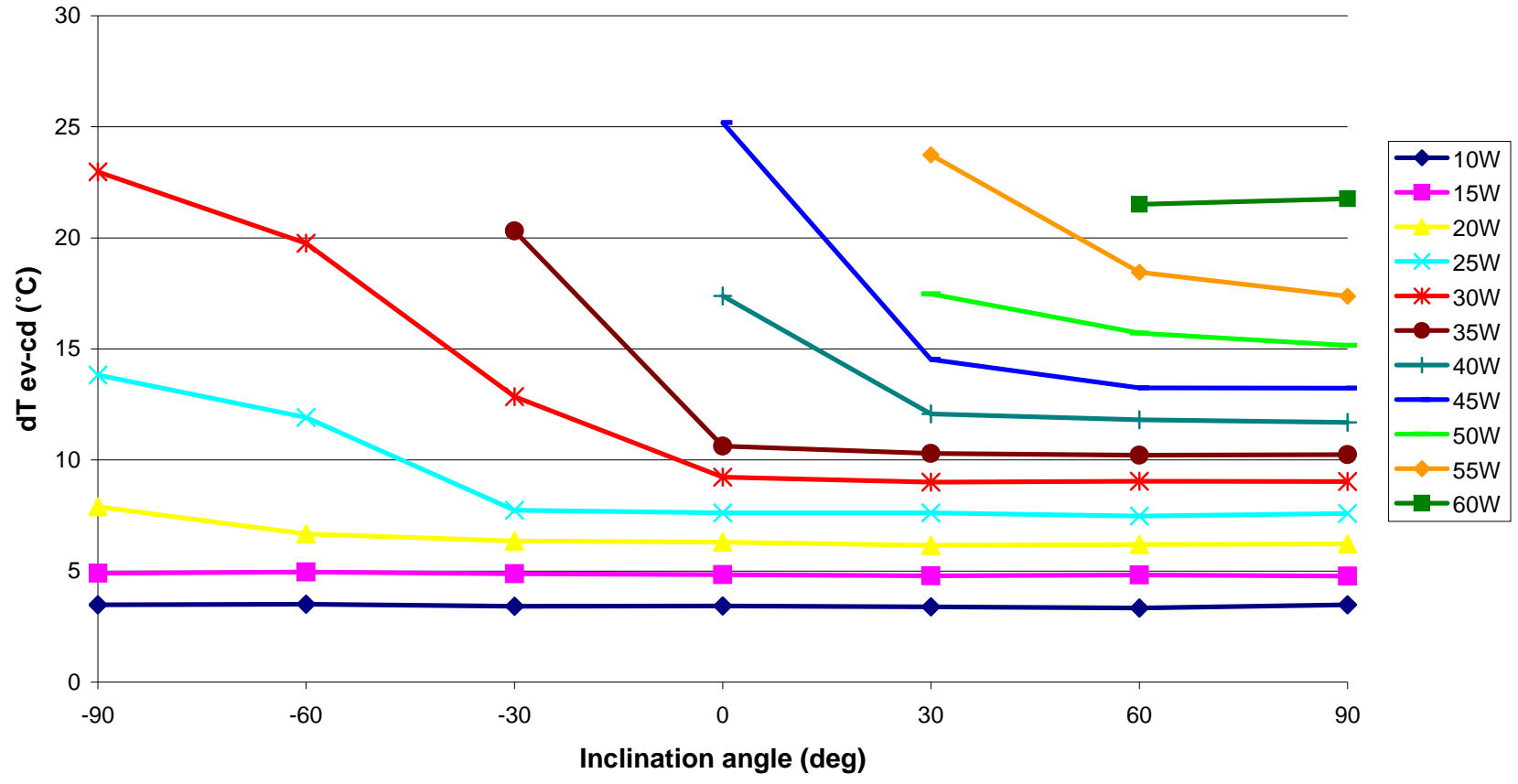
## Heat Pipe Test Report

Manufacturer		Enertron				Test conditions				Test date	9/2/2011		
Wick structure/ Working fluid		Sintered Powder Metal/ Water				Effective area (m2)		2.83E-05		Note: ev- Evaporator of heat pipe cd- Condenser of heat pipe eb- Evaporator Block cb- Condenser Block			
Pipe specification		C110 Copper 0.3mm wall thickness				Coolant temp (°C)		35					
Diameter	±0.05 mm	6				Contact length of ev/cd (mm)		50					
Length	±0.10 mm	225				At 90° the evaporator is directly below the condenser; 0° is horizontal.							
Flatten thickness	±0.05 mm	n/a											
Bend angle	±1 deg	n/a											
Inclination Angle (°)	Heat Load (W)	dT ev-cd (°C)	Thermal resistance ev-cd (°C/W)	Thermal conductivity ev-cd (W/mK)	dT eb-cb (°C)	Thermal resistance eb-cb (°C/W)	Thermal Conductivity eb-cb (W/mK)	Measured Temperature T (°C)					
								ev	cd	eb1	eb2	cb1	cb2
90	10	3.48	0.35	17775	4.06	0.41	15248	39.98	36.50	40.61	40.16	36.32	36.32
	15	4.77	0.32	19455	5.58	0.37	16653	42.34	37.57	43.15	42.49	37.29	37.19
	20	6.23	0.31	19885	7.32	0.37	16922	44.61	38.38	45.77	44.86	38.05	37.95
	25	7.60	0.30	20365	8.89	0.36	17415	46.94	39.35	48.11	47.16	38.90	38.60
	30	9.03	0.30	20563	10.59	0.35	17539	49.24	40.21	50.76	49.52	39.75	39.35
	35	10.24	0.29	21153	12.16	0.35	17821	50.75	40.51	52.64	51.19	40.00	39.53
	40	11.69	0.29	21171	13.86	0.35	17863	52.86	41.17	54.95	53.37	40.61	39.98
	45	13.23	0.29	21052	15.78	0.35	17651	55.42	42.19	57.83	56.01	41.49	40.79
	50	15.16	0.30	20417	18.08	0.36	17117	58.32	43.17	61.01	59.09	42.36	41.58
	55	17.37	0.32	19602	20.71	0.38	16439	61.30	43.93	64.20	62.09	42.84	42.04
60	21.76	0.36	17065	24.99	0.42	14859	66.34	44.58	69.18	67.10	43.91	42.39	
60	10	3.34	0.33	18542	3.98	0.40	15563	40.02	36.68	40.62	40.15	36.39	36.43
	15	4.83	0.32	19222	5.57	0.37	16665	42.38	37.55	43.17	42.50	37.29	37.24
	20	6.20	0.31	19966	7.26	0.36	17041	44.64	38.44	45.66	44.80	38.01	37.92
	25	7.48	0.30	20700	8.86	0.35	17466	46.88	39.41	48.16	47.11	38.91	38.64
	30	9.04	0.30	20544	10.59	0.35	17537	49.26	40.22	50.70	49.47	39.73	39.27
	35	10.21	0.29	21211	12.06	0.34	17960	50.71	40.50	52.52	51.16	39.99	39.57
	40	11.81	0.30	20960	14.05	0.35	17626	53.10	41.29	55.25	53.64	40.67	40.12
	45	13.25	0.29	21019	15.84	0.35	17587	55.54	42.28	57.95	56.14	41.57	40.84
	50	15.71	0.31	19703	18.71	0.37	16540	58.95	43.25	61.65	59.70	42.38	41.55
	55	18.45	0.34	18452	21.61	0.39	15752	62.26	43.81	65.21	63.09	43.20	41.88
60	21.51	0.36	17267	24.64	0.41	15070	66.11	44.60	68.80	66.83	43.92	42.43	
30	10	3.38	0.34	18290	3.95	0.39	15681	40.11	36.73	40.70	40.25	36.51	36.55
	15	4.79	0.32	19386	5.62	0.37	16528	42.36	37.57	43.21	42.53	37.28	37.23
	20	6.15	0.31	20128	7.35	0.37	16844	44.65	38.50	45.80	44.91	38.08	37.93
	25	7.61	0.30	20322	8.86	0.35	17470	46.93	39.32	48.15	47.12	38.90	38.65
	30	9.01	0.30	20620	10.60	0.35	17512	49.25	40.24	50.80	49.51	39.76	39.35
	35	10.30	0.29	21032	12.14	0.35	17847	50.79	40.49	52.60	51.19	39.99	39.53
	40	12.08	0.30	20500	14.42	0.36	17174	53.48	41.40	55.63	53.97	40.67	40.10
	45	14.52	0.32	19181	17.10	0.38	16285	56.90	42.38	59.25	57.42	41.52	40.93

Inclination Angle (°)	Heat Load (W)	dT ev-cd (°C)	Thermal resistance ev-cd (°C/W)	Thermal conductivity ev-cd (W/mK)	dT eb-cb (°C)	Thermal resistance eb-cb (°C/W)	Thermal Conductivity eb-cb (W/mK)	Measured Temperature T (°C)					
								ev	cd	eb1	eb2	cb1	cb2
30	50	17.47	0.35	17711	20.15	0.40	15360	60.45	42.97	63.06	61.14	42.59	41.32
	55	23.74	0.43	14337	25.86	0.47	13165	67.19	43.45	69.00	67.47	42.89	41.87
0	10	3.43	0.34	18045	4.00	0.40	15470	40.13	36.70	40.77	40.24	36.47	36.53
	15	4.84	0.32	19190	5.61	0.37	16561	42.38	37.54	43.22	42.59	37.34	37.27
	20	6.29	0.31	19667	7.38	0.37	16771	44.76	38.46	45.83	44.95	38.12	37.90
	25	7.62	0.30	20312	8.93	0.36	17335	46.99	39.37	48.19	47.18	38.88	38.64
	30	9.23	0.31	20119	10.70	0.36	17358	49.44	40.21	50.90	49.58	39.75	39.33
	35	10.62	0.30	20400	12.55	0.36	17256	51.13	40.52	52.96	51.53	39.88	39.49
	40	17.39	0.43	14237	18.81	0.47	13160	58.45	41.06	59.33	58.65	40.03	40.33
	45	25.18	0.56	11060	26.83	0.60	10379	67.10	41.92	67.72	67.68	40.46	41.28
-30	10	3.41	0.34	18151	3.99	0.40	15512	40.15	36.74	40.82	40.25	36.49	36.59
	15	4.88	0.33	19025	5.65	0.38	16432	42.49	37.61	43.33	42.61	37.35	37.29
	20	6.35	0.32	19503	7.35	0.37	16837	44.76	38.41	45.81	44.93	38.12	37.92
	25	7.74	0.31	19991	9.15	0.37	16920	47.11	39.37	48.39	47.37	38.86	38.61
	30	12.85	0.43	14445	14.06	0.47	13203	52.97	40.12	53.66	53.10	39.21	39.43
	35	20.31	0.58	10668	21.80	0.62	9935	60.63	40.32	61.17	61.19	39.05	39.70
-60	10	3.51	0.35	17654	4.02	0.40	15416	40.18	36.67	40.75	40.34	36.51	36.56
	15	4.95	0.33	18748	5.68	0.38	16357	42.53	37.57	43.26	42.66	37.32	37.25
	20	6.67	0.33	18553	7.71	0.39	16049	45.07	38.40	46.15	45.28	38.03	37.97
	25	11.92	0.48	12980	12.95	0.52	11951	51.26	39.34	51.78	51.47	38.56	38.79
	30	19.75	0.66	9400	21.35	0.71	8697	60.04	40.28	60.53	60.63	38.90	39.56
-90	10	3.48	0.35	17796	4.05	0.40	15286	40.19	36.71	40.81	40.32	36.49	36.54
	15	4.91	0.33	18924	5.72	0.38	16237	42.54	37.64	43.37	42.69	37.35	37.27
	20	7.89	0.39	15691	8.79	0.44	14086	46.32	38.43	47.06	46.38	37.85	38.01
	25	13.83	0.55	11187	14.72	0.59	10515	53.04	39.21	53.46	53.36	38.49	38.90
	30	22.97	0.77	8084	24.62	0.82	7542	63.04	40.07	63.57	63.63	38.56	39.40

**Heat pipe performance (dT vs Inclination angles at various heat loads)**

Heat pipe tested:  $\phi 6\text{mm} \times 225\text{mm}$  sintered powder metal/ water



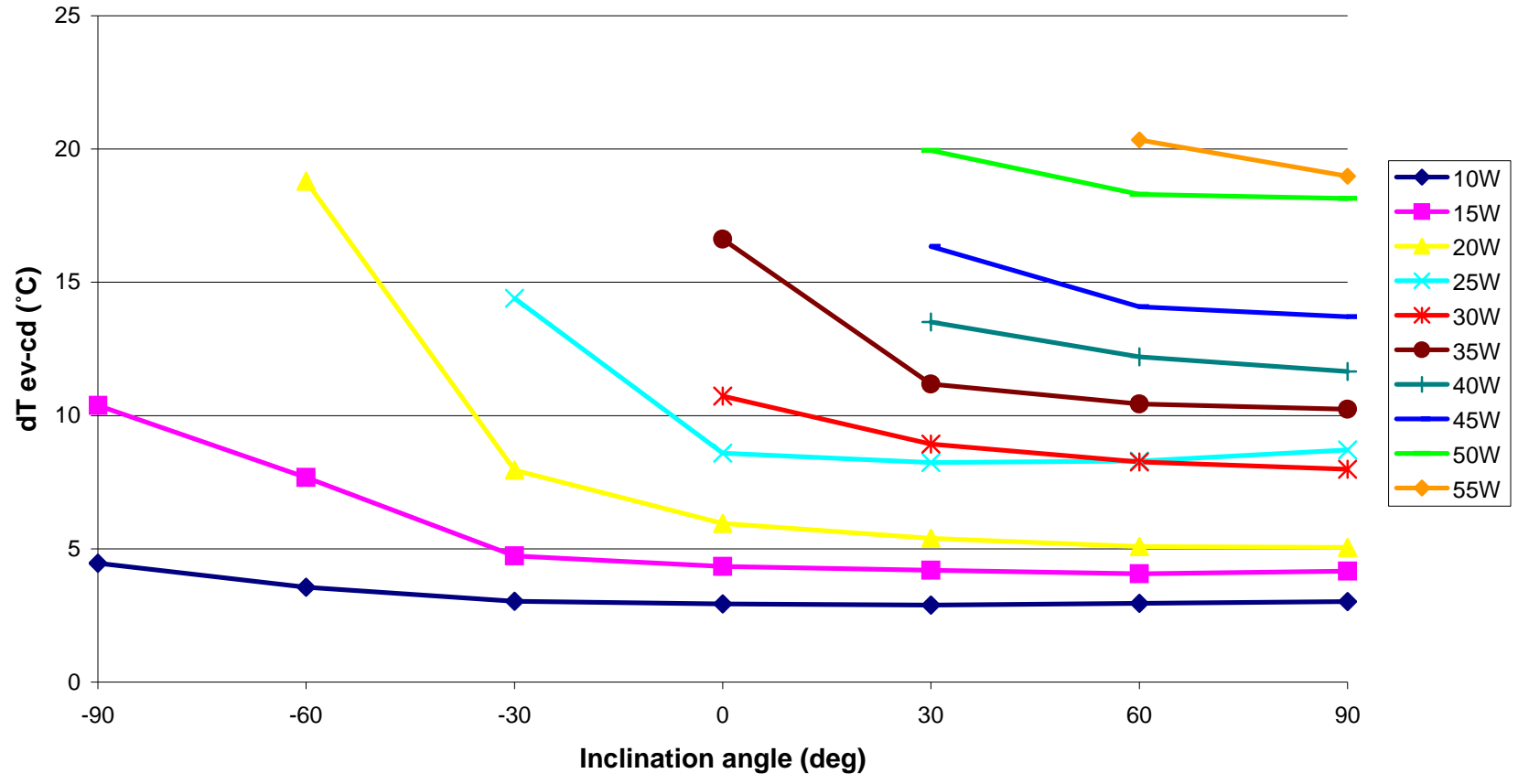
## Heat Pipe Test Report

Manufacturer		Enertron				Test conditions			Test date		9/12/2011		
Wick structure/ Working fluid		Sintered Powder Metal/ Water				Effective area (m2)		2.83E-05	Note: ev- Evaporator of heat pipe cd- Condenser of heat pipe eb- Evaporator Block cb- Condenser Block				
Pipe specification		C110 Copper 0.3mm wall thickness				Coolant temp (°C)		35					
Diameter ±0.05 mm		6				Contact length of ev/cd (mm)		50					
Length ±0.10 mm		250				At 90° the evaporator is directly below the condenser; 0° is horizontal.							
Flatten thickness ±0.05 mm		n/a											
Bend angle ±1 deg		n/a											
Inclination Angle (°)	Heat Load (W)	dT ev-cd (°C)	Thermal resistance ev-cd (°C/W)	Thermal conductivity ev-cd (W/mK)	dT eb-cb (°C)	Thermal resistance eb-cb (°C/W)	Thermal Conductivity eb-cb (W/mK)	Measured Temperature T (°C)					
								ev	cd	eb1	eb2	cb1	cb2
90	10	3.02	0.30	23446	3.54	0.35	19999	39.81	36.79	40.31	39.80	36.23	36.82
	15	4.16	0.28	25518	4.99	0.33	21250	41.73	37.58	42.55	41.87	36.86	37.58
	20	5.06	0.25	27981	5.97	0.30	23681	43.15	38.10	44.10	43.19	37.23	38.11
	25	8.72	0.35	20291	10.09	0.40	17519	48.26	39.55	49.04	48.62	38.22	39.24
	30	7.99	0.27	26562	9.55	0.32	22223	48.20	40.21	49.39	48.32	38.72	39.89
	35	10.24	0.29	24172	12.10	0.35	20469	51.30	41.05	52.45	51.58	39.27	40.58
	40	11.66	0.29	24270	14.02	0.35	20181	53.67	42.01	54.99	54.12	39.80	41.26
	45	13.71	0.30	23214	16.41	0.36	19400	56.63	42.91	57.97	57.25	40.44	41.96
	50	18.15	0.36	19490	21.28	0.43	16621	61.84	43.69	63.14	63.07	41.03	42.62
60	10	2.95	0.30	23962	3.42	0.34	20659	39.67	36.72	40.21	39.69	36.26	36.79
	15	4.06	0.27	26115	4.92	0.33	21566	41.76	37.69	42.49	41.81	36.89	37.58
	20	5.08	0.25	27832	6.04	0.30	23418	43.26	38.17	44.20	43.30	37.29	38.12
	25	8.29	0.33	21334	9.54	0.38	18542	47.64	39.36	48.35	47.87	38.06	39.09
	30	8.26	0.28	25688	9.93	0.33	21364	48.54	40.28	49.61	48.64	38.58	39.80
	35	10.44	0.30	23721	12.39	0.35	19975	51.57	41.13	52.70	51.86	39.23	40.54
	40	12.20	0.31	23186	14.57	0.36	19422	54.29	42.08	55.52	54.77	39.86	41.30
	45	14.08	0.31	22604	16.69	0.37	19074	56.91	42.82	58.11	57.55	40.37	41.92
	50	18.30	0.37	19323	21.47	0.43	16477	62.02	43.72	63.38	63.28	41.05	42.68
30	10	2.89	0.29	24484	3.46	0.35	20420	39.62	36.73	40.17	39.68	36.20	36.73
	15	4.19	0.28	25299	4.95	0.33	21431	41.81	37.62	42.46	41.88	36.85	37.59
	20	5.40	0.27	26213	6.50	0.33	21765	43.62	38.23	44.64	43.72	37.26	38.09
	25	8.24	0.33	21453	9.54	0.38	18539	47.57	39.33	48.32	47.87	38.05	39.05
	30	8.93	0.30	23777	10.60	0.35	20019	49.23	40.31	50.19	49.47	38.65	39.81
	35	11.19	0.32	22133	13.09	0.37	18913	52.29	41.11	53.24	52.76	39.25	40.58
	40	13.51	0.34	20937	15.90	0.40	17801	55.55	42.04	56.62	56.27	39.82	41.28
	45	16.35	0.36	19473	19.25	0.43	16535	59.25	42.91	60.47	60.27	40.30	41.93
	50	19.95	0.40	17729	23.35	0.47	15149	63.97	44.02	65.18	65.25	40.98	42.75
0	10	2.93	0.29	24109	3.53	0.35	20061	39.72	36.79	40.24	39.78	36.23	36.74

Inclination Angle (°)	Heat Load (W)	dT ev-cd (°C)	Thermal resistance ev-cd (°C/W)	Thermal conductivity ev-cd (W/mK)	dT eb-cb (°C)	Thermal resistance eb-cb (°C/W)	Thermal Conductivity eb-cb (W/mK)	Measured Temperature T (°C)					
								ev	cd	eb1	eb2	cb1	cb2
0	15	4.34	0.29	24453	5.20	0.35	20408	41.96	37.62	42.70	42.08	36.81	37.57
	20	5.95	0.30	23761	6.94	0.35	20385	44.18	38.23	44.98	44.22	37.22	38.09
	25	8.59	0.34	20599	9.90	0.40	17872	47.89	39.30	48.55	48.25	38.05	38.96
	30	10.73	0.36	19782	12.34	0.41	17195	50.86	40.13	51.60	51.37	38.54	39.74
	35	16.62	0.47	14893	18.72	0.53	13227	57.46	40.84	58.34	58.63	38.98	40.54
-30	10	3.03	0.30	23360	3.59	0.36	19720	39.78	36.76	40.32	39.82	36.20	36.77
	15	4.73	0.32	22427	5.56	0.37	19087	42.37	37.64	42.99	42.54	36.86	37.56
	20	7.96	0.40	17777	9.06	0.45	15618	46.20	38.24	46.76	46.73	37.20	38.17
	25	14.40	0.58	12279	16.12	0.64	10969	53.52	39.12	54.42	54.64	37.78	39.03
-60	10	3.56	0.36	19892	4.06	0.41	17423	40.26	36.71	40.65	40.35	36.15	36.73
	15	7.68	0.51	13819	8.59	0.57	12352	45.23	37.56	45.71	45.78	36.67	37.64
	20	18.79	0.94	7528	20.39	1.02	6940	56.94	38.15	57.92	58.07	36.99	38.22
-90	10	4.46	0.45	15849	4.96	0.50	14261	41.22	36.76	41.44	41.42	36.17	36.78
	15	10.38	0.69	10219	11.19	0.75	9486	47.96	37.58	48.27	48.38	36.64	37.63

**Heat pipe performance (dT vs Inclination angles at various heat loads)**

Heat pipe tested:  $\phi 6\text{mm} \times 250\text{mm}$  sintered powder metal/ water



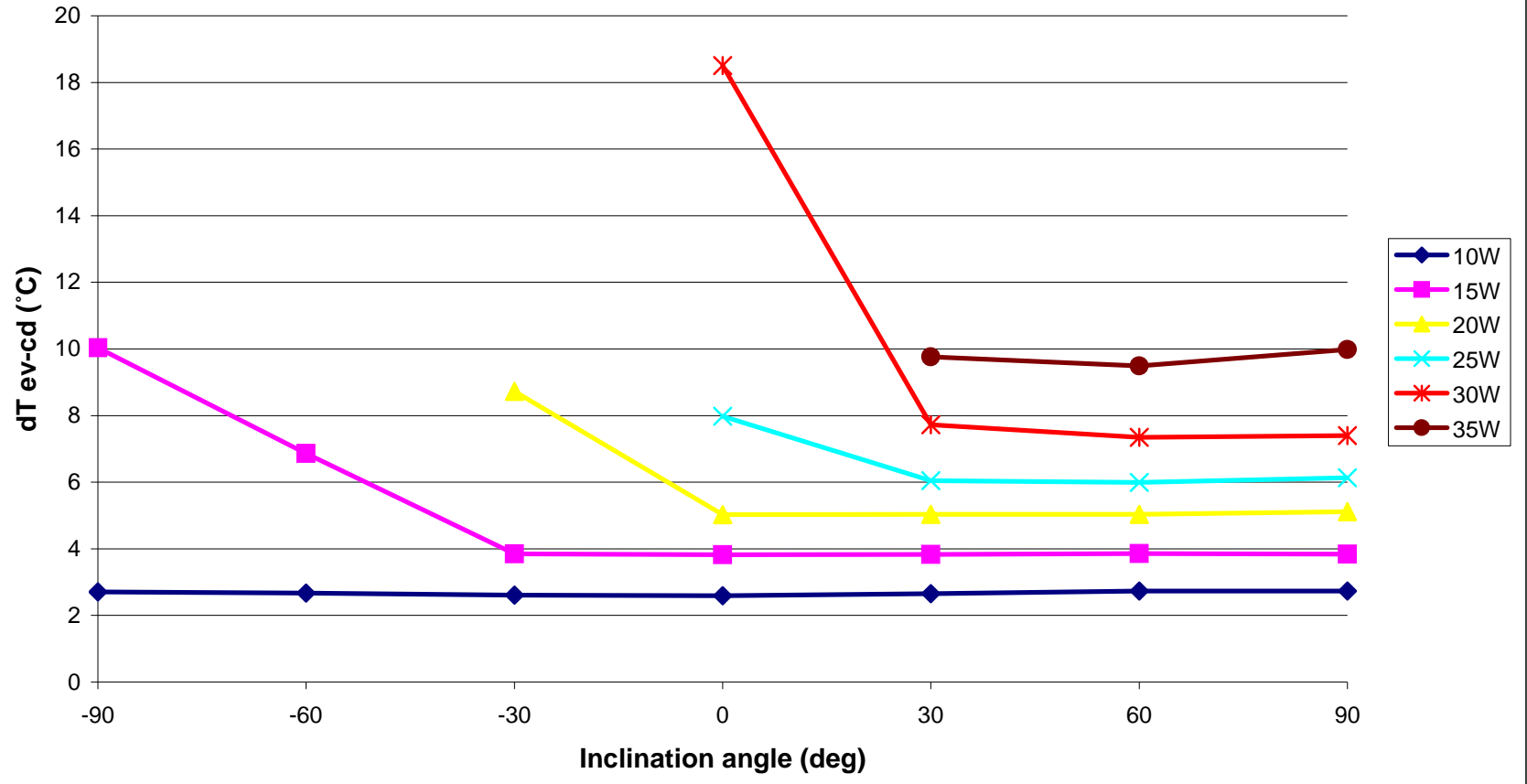


## Heat Pipe Test Report

Manufacturer		Enertron				Test conditions				Test date	9/7/2011		
Wick structure/ Working fluid		Sintered Powder Metal/ Water				Effective area (m2)		2.83E-05		Note: ev- Evaporator of heat pipe cd- Condenser of heat pipe eb- Evaporator Block cb- Condenser Block			
Pipe specification		C110 Copper 0.3mm wall thickness				Coolant temp (°C)		35					
Diameter	±0.05 mm	6				Contact length of ev/cd (mm)		50					
Length	±0.10 mm	275				At 90° the evaporator is directly below the condenser; 0° is horizontal.							
Flatten thickness	±0.05 mm	n/a											
Bend angle	±1 deg	n/a											
Inclination Angle (°)	Heat Load (W)	dT ev-cd (°C)	Thermal resistance ev-cd (°C/W)	Thermal conductivity ev-cd (W/mK)	dT eb-cb (°C)	Thermal resistance eb-cb (°C/W)	Thermal Conductivity eb-cb (W/mK)	Measured Temperature T (°C)					
								ev	cd	eb1	eb2	cb1	cb2
90	10	2.73	0.27	29107	3.51	0.35	22665	39.59	36.86	40.10	39.90	36.56	36.43
	15	3.84	0.26	31093	5.04	0.34	23707	41.75	37.91	42.44	42.13	37.37	37.13
	20	5.11	0.26	31140	6.61	0.33	24071	43.92	38.81	44.74	44.38	38.15	37.74
	25	6.13	0.25	32438	8.25	0.33	24120	46.03	39.90	47.27	46.66	39.01	38.43
	30	7.40	0.25	32283	9.94	0.33	24010	48.30	40.91	49.65	48.99	39.65	39.10
	35	9.99	0.29	27891	12.89	0.37	21616	51.90	41.91	53.34	52.64	40.63	39.57
60	10	2.74	0.27	29085	3.45	0.35	23066	39.60	36.86	40.04	39.87	36.60	36.41
	15	3.86	0.26	30940	5.01	0.33	23840	41.70	37.84	42.42	42.08	37.36	37.11
	20	5.03	0.25	31629	6.67	0.33	23858	43.89	38.86	44.79	44.42	38.14	37.73
	25	6.00	0.24	33174	8.04	0.32	24753	45.80	39.80	46.96	46.43	38.90	38.42
	30	7.35	0.25	32481	9.86	0.33	24202	48.21	40.86	49.55	48.88	39.62	39.08
	35	9.49	0.27	29352	12.47	0.36	22332	51.37	41.89	52.95	52.13	40.53	39.60
30	10	2.66	0.27	29950	3.43	0.34	23173	39.60	36.94	40.10	39.83	36.56	36.51
	15	3.83	0.26	31191	5.01	0.33	23826	41.68	37.86	42.36	42.05	37.30	37.09
	20	5.04	0.25	31591	6.61	0.33	24063	43.85	38.81	44.77	44.38	38.15	37.77
	25	6.05	0.24	32883	8.11	0.32	24519	45.85	39.80	47.06	46.48	38.90	38.42
	30	7.72	0.26	30920	10.50	0.35	22728	48.79	41.06	50.22	49.50	39.69	39.02
	35	9.76	0.28	28537	12.82	0.37	21731	51.61	41.85	53.11	52.49	40.43	39.54
0	10	2.59	0.26	30713	3.41	0.34	23323	39.53	36.94	40.07	39.74	36.56	36.43
	15	3.82	0.25	31256	5.00	0.33	23892	41.68	37.86	42.36	42.09	37.36	37.10
	20	5.02	0.25	31679	6.64	0.33	23984	43.88	38.86	44.83	44.36	38.13	37.78
	25	7.98	0.32	24927	9.66	0.39	20605	47.53	39.55	48.27	48.15	38.64	38.47
	30	18.51	0.62	12897	21.52	0.72	11095	58.97	40.46	60.12	60.90	38.80	39.19
-30	10	2.61	0.26	30454	3.36	0.34	23712	39.52	36.91	40.03	39.80	36.64	36.49
	15	3.85	0.26	30996	5.03	0.34	23712	41.71	37.86	42.40	42.07	37.34	37.07
	20	8.73	0.44	18233	10.35	0.52	15376	47.36	38.64	47.98	48.28	37.74	37.82
-60	10	2.67	0.27	29815	3.45	0.35	23046	39.57	36.90	40.09	39.87	36.58	36.46
	15	6.86	0.46	17403	8.09	0.54	14749	44.61	37.75	45.08	45.35	37.05	37.19
-90	10	2.71	0.27	29386	3.49	0.35	22808	39.59	36.88	40.08	39.88	36.53	36.45
	15	10.04	0.67	11891	11.67	0.78	10225	47.80	37.76	48.55	48.89	36.94	37.15

**Heat pipe performance (dT vs Inclination angles at various heat loads)**

Heat pipe tested:  $\phi 6\text{mm} \times 275\text{mm}$  sintered powder metal/ water

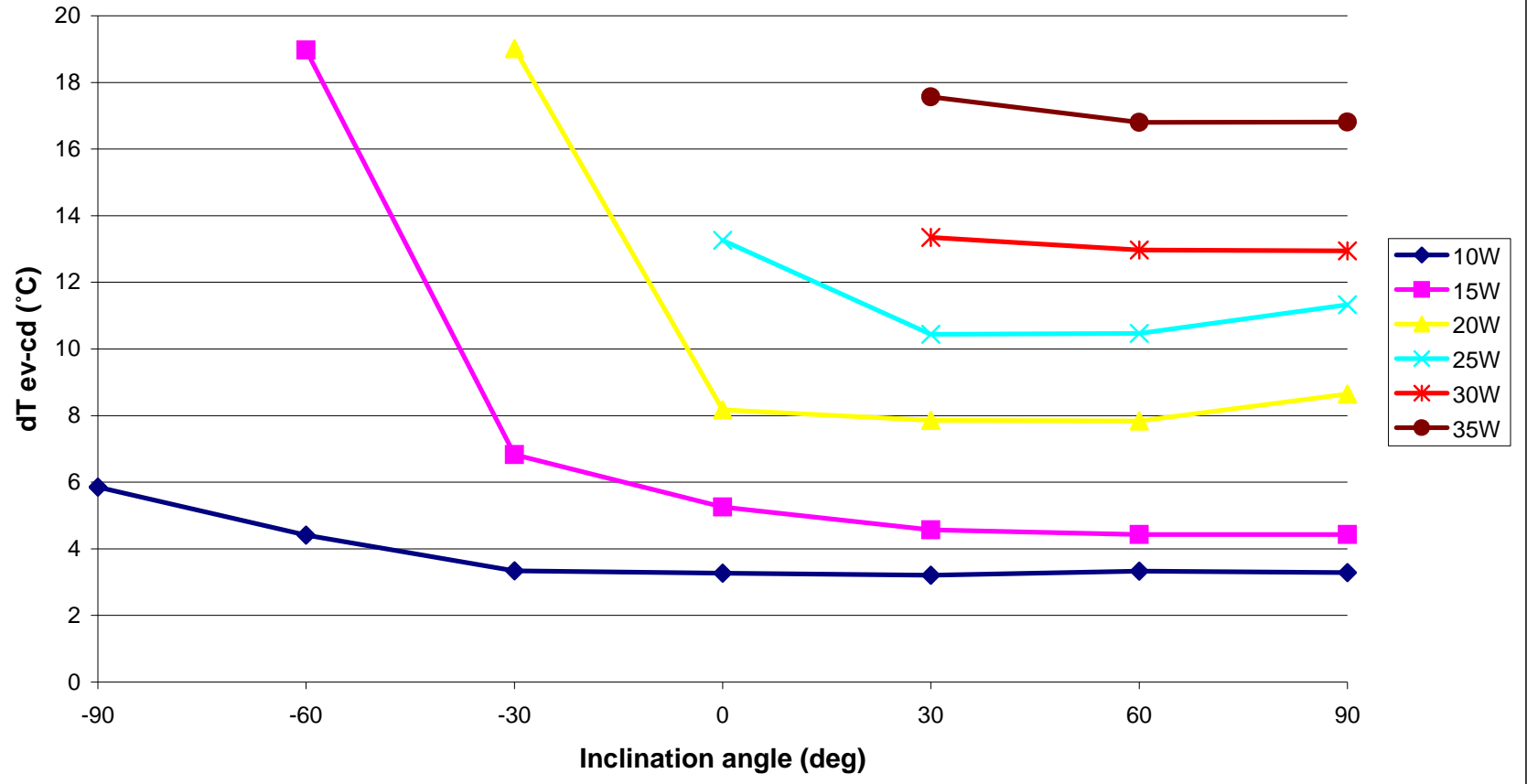


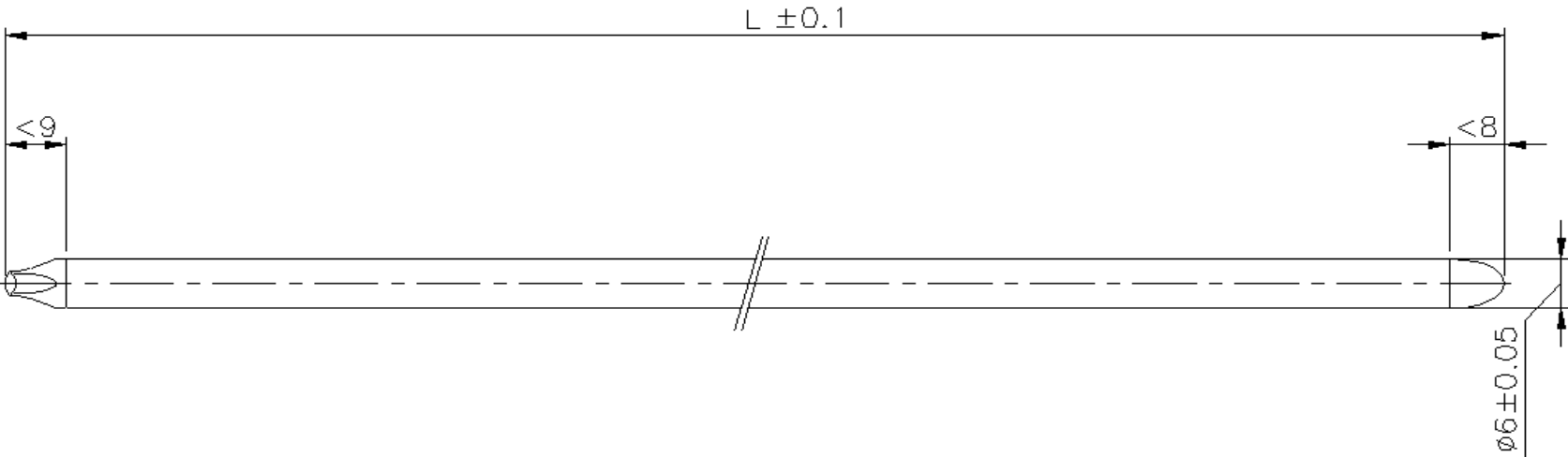
## Heat Pipe Test Report

Manufacturer		Enertron				Test conditions			Test date	9/9/2011				
Wick structure/ Working fluid		Sintered Powder Metal/ Water				Effective area (m2)		2.83E-05	Note: ev- Evaporator of heat pipe cd- Condenser of heat pipe eb- Evaporator Block cb- Condenser Block					
Pipe specification		C110 Copper 0.3mm wall thickness				Coolant temp (°C)		35						
Diameter	±0.05 mm	6				Contact length of ev/cd (mm)		50						
Length	±0.10 mm	300				At 90° the evaporator is directly below the condenser; 0° is horizontal.								
Flatten thickness	±0.05 mm	n/a												
Bend angle	±1 deg	n/a												
Inclination Angle (°)	Heat Load (W)	dT ev-cd (°C)	Thermal resistance ev-cd (°C/W)	Thermal conductivity ev-cd (W/mK)	dT eb-cb (°C)	Thermal resistance eb-cb (°C/W)	Thermal Conductivity eb-cb (W/mK)	Measured Temperature T (°C)						
								ev	cd	eb1	eb2	cb1	cb2	
90	10	3.29	0.33	26883	3.92	0.39	22556	39.55	36.26	40.15	39.67	35.84	36.14	
	15	4.43	0.30	29939	5.33	0.36	24907	41.83	37.40	42.77	41.94	36.86	37.20	
	20	8.65	0.43	20456	9.84	0.49	17979	47.35	38.70	48.04	47.68	37.81	38.24	
	25	11.33	0.45	19508	12.78	0.51	17294	50.82	39.49	51.50	51.24	38.31	38.87	
	30	12.95	0.43	20488	14.87	0.50	17841	53.17	40.23	54.06	53.79	38.73	39.38	
	35	16.81	0.48	18413	19.16	0.55	16153	57.99	41.19	59.06	58.92	39.48	40.19	
60	10	3.33	0.33	26521	3.79	0.38	23311	39.53	36.20	40.11	39.60	35.91	36.22	
	15	4.43	0.30	29959	5.34	0.36	24860	41.84	37.41	42.77	41.87	36.77	37.20	
	20	7.84	0.39	22556	8.99	0.45	19671	46.19	38.35	46.83	46.52	37.46	37.91	
	25	10.46	0.42	21127	11.99	0.48	18433	49.78	39.32	50.57	50.24	38.15	38.69	
	30	12.97	0.43	20450	14.76	0.49	17976	53.12	40.15	54.03	53.72	38.81	39.43	
	35	16.80	0.48	18420	19.27	0.55	16060	58.07	41.27	59.08	58.98	39.41	40.11	
30	10	3.21	0.32	27562	3.75	0.37	23610	39.55	36.34	40.14	39.61	35.96	36.29	
	15	4.57	0.30	29034	5.46	0.36	24295	41.97	37.40	42.83	42.07	36.78	37.21	
	20	7.85	0.39	22522	8.97	0.45	19706	46.25	38.40	46.89	46.55	37.53	37.96	
	25	10.44	0.42	21171	12.01	0.48	18404	49.78	39.33	50.50	50.29	38.09	38.67	
	30	13.35	0.44	19871	15.23	0.51	17417	53.55	40.20	54.44	54.15	38.73	39.41	
	35	17.57	0.50	17613	19.73	0.56	15684	58.50	40.93	59.47	59.40	39.40	40.00	
0	10	3.27	0.33	27023	3.85	0.38	22972	39.62	36.34	40.25	39.71	35.96	36.30	
	15	5.25	0.35	25243	6.01	0.40	22072	42.61	37.36	43.28	42.71	36.81	37.16	
	20	8.17	0.41	21642	9.39	0.47	18833	46.52	38.35	47.18	46.89	37.42	37.87	
	25	13.26	0.53	16665	14.71	0.59	15031	52.31	39.05	53.02	53.01	37.91	38.72	
-30	10	3.34	0.33	26473	3.94	0.39	22441	39.77	36.43	40.38	39.90	36.07	36.33	
	15	6.83	0.46	19433	7.58	0.51	17490	44.23	37.41	44.71	44.51	36.80	37.26	
	20	19.01	0.95	9301	20.78	1.04	8508	57.16	38.15	58.22	58.36	37.06	37.95	
-60	10	4.41	0.44	20036	4.98	0.50	17769	40.93	36.51	41.30	41.14	36.10	36.39	
	15	18.97	1.26	6992	20.33	1.36	6523	56.26	37.30	57.14	57.22	36.50	37.19	
-90	10	5.86	0.59	15102	6.43	0.64	13745	42.42	36.57	42.72	42.67	35.99	36.53	

**Heat pipe performance (dT vs Inclination angles at various heat loads)**

Heat pipe tested:  $\phi 6\text{mm} \times 300\text{mm}$  sintered powder metal/ water





unit: mm