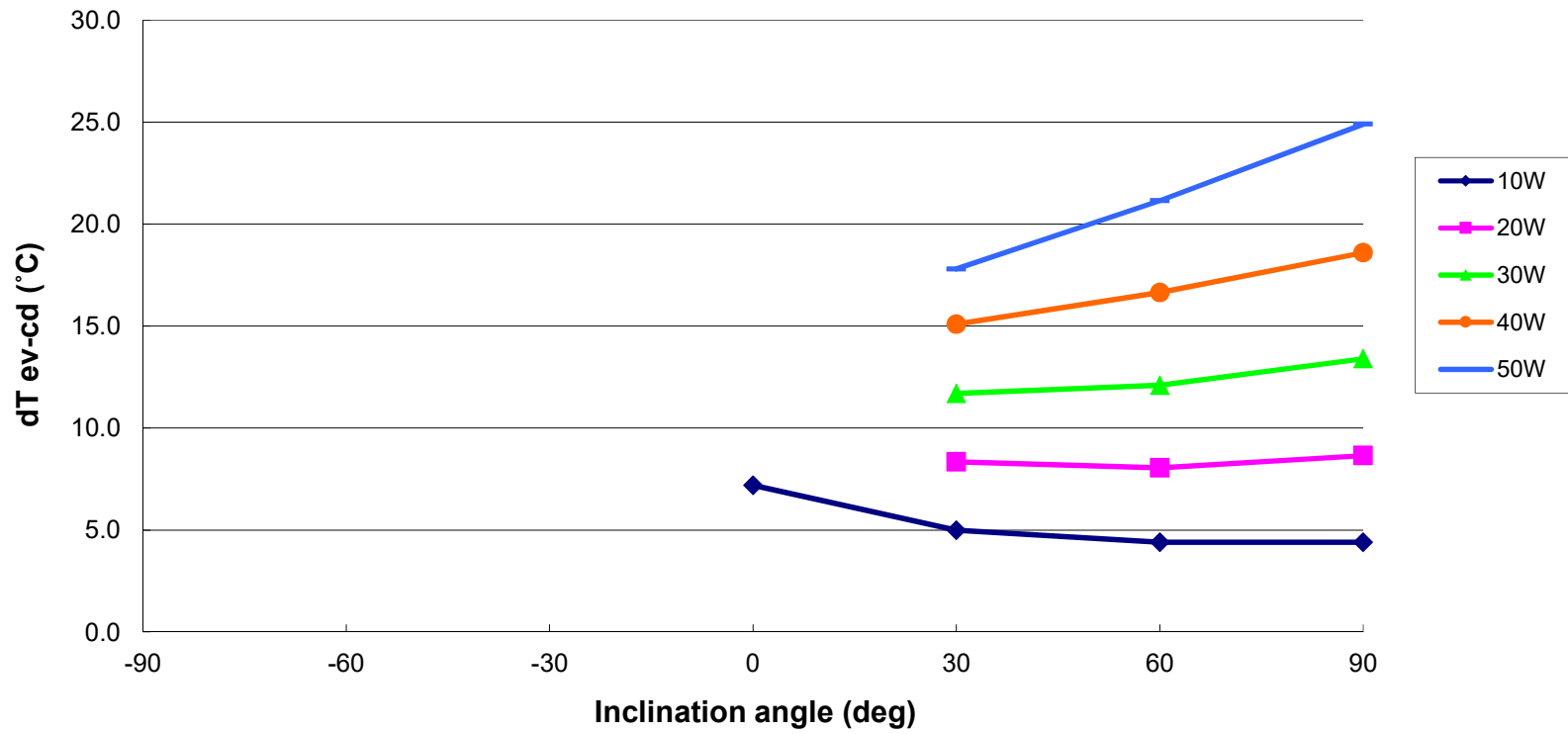


## Heat Pipe Test Report

Manufacturer		Enertron		Test conditions				Test date	12/15/2017					
Wick structure/ Working fluid		Sintered Powder Metal/ Methanol		Effective area (m2)		5.03E-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)		-10								
Diameter	±0.05 mm	8		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	4.40	0.44	6782	4.50	0.45	6631	-4.05	-8.45	-3.90	-4.00	-8.50	-8.40	
	20	8.65	0.43	6900	8.75	0.44	6821	1.95	-6.70	2.10	2.10	-6.60	-6.70	
	30	13.40	0.45	6681	13.55	0.45	6607	7.95	-5.45	8.20	8.20	-5.20	-5.50	
	40	18.60	0.47	6418	18.90	0.47	6316	14.65	-3.95	15.10	15.00	-3.60	-4.10	
	50	24.90	0.50	5992	25.35	0.51	5886	22.25	-2.65	22.90	22.90	-2.10	-2.80	
60	10	4.40	0.44	6782	4.45	0.45	6706	-4.00	-8.40	-3.90	-4.00	-8.40	-8.40	
	20	8.05	0.40	7414	8.05	0.40	7414	1.15	-6.90	1.20	1.20	-6.80	-6.90	
	30	12.10	0.40	7399	12.25	0.41	7308	6.75	-5.35	6.90	6.90	-5.20	-5.50	
	40	16.65	0.42	7169	16.75	0.42	7126	12.75	-3.90	12.90	13.00	-3.50	-4.10	
	50	21.15	0.42	7055	21.25	0.43	7022	18.65	-2.50	18.80	19.00	-1.90	-2.80	
30	10	5.00	0.50	5968	5.15	0.52	5794	-3.30	-8.30	-3.20	-3.20	-8.30	-8.40	
	20	8.35	0.42	7148	8.50	0.43	7022	1.40	-6.95	1.50	1.60	-6.80	-7.10	
	30	11.70	0.39	7652	11.95	0.40	7492	6.20	-5.50	6.40	6.50	-5.30	-5.70	
	40	15.10	0.38	7905	15.50	0.39	7701	10.95	-4.15	11.20	11.50	-3.90	-4.40	
	50	17.80	0.36	8382	18.25	0.37	8176	15.00	-2.80	15.30	15.60	-2.50	-3.10	
0	10	7.20	0.72	4145	7.25	0.73	4116	-1.45	-8.65	-1.40	-1.40	-8.60	-8.70	

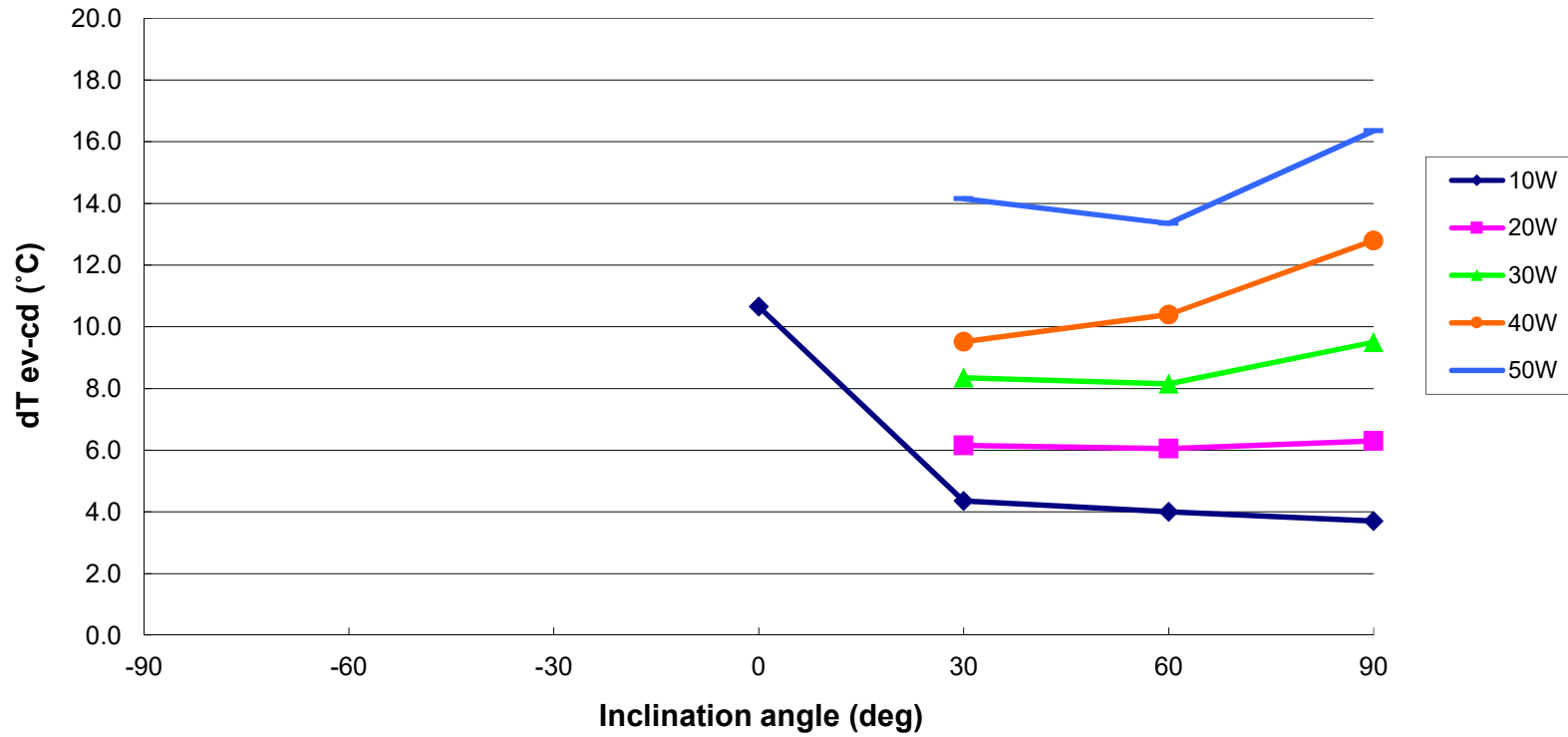
**Heat pipe performance (dT vs Inclination angles at various heat loads)**  
Heat pipe tested: 8mm x 200mm sintered powder metal/methanol



## Heat Pipe Test Report

Manufacturer		Enertron		Test conditions				Test date	12/15/2017					
Wick structure/ Working fluid		Sintered Powder Metal/ Methanol		Effective area (m2)		5.03E-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)		-10								
Diameter	±0.05 mm	8		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	3.70	0.37	10754	3.80	0.38	10471	-4.85	-8.55	-4.80	-4.70	-8.60	-8.50	
	20	6.30	0.32	12631	6.65	0.33	11967	-0.50	-6.80	-0.40	-0.30	-7.10	-6.90	
	30	9.50	0.32	12565	9.95	0.33	11997	4.25	-5.25	4.30	4.50	-5.60	-5.50	
	40	12.80	0.32	12434	13.45	0.34	11833	9.00	-3.80	9.10	9.40	-4.20	-4.20	
	50	16.35	0.33	12168	17.15	0.34	11600	13.95	-2.40	14.10	14.40	-2.90	-2.90	
60	10	4.00	0.40	9947	4.05	0.41	9824	-4.50	-8.50	-4.50	-4.40	-8.50	-8.50	
	20	6.05	0.30	13153	6.30	0.32	12631	-0.80	-6.85	-0.70	-0.70	-7.00	-7.00	
	30	8.15	0.27	14646	8.70	0.29	13720	2.75	-5.40	2.90	3.10	-5.70	-5.70	
	40	10.40	0.26	15303	11.05	0.28	14403	6.25	-4.15	6.50	6.70	-4.40	-4.50	
	50	13.35	0.27	14902	14.30	0.29	13912	10.60	-2.75	11.00	11.20	-3.10	-3.30	
30	10	4.35	0.44	9147	4.40	0.44	9043	-4.10	-8.45	-4.10	-4.10	-8.50	-8.50	
	20	6.15	0.31	12939	6.25	0.31	12732	-0.90	-7.05	-0.90	-0.90	-7.20	-7.10	
	30	8.35	0.28	14295	8.70	0.29	13720	2.75	-5.60	2.90	2.90	-5.80	-5.80	
	40	9.52	0.24	16724	11.45	0.29	13900	6.65	-2.87	6.80	6.80	-4.60	-4.70	
	50	14.15	0.28	14060	14.65	0.29	13580	11.10	-3.05	11.20	11.30	-3.30	-3.50	
0	10	10.65	1.07	3736	10.75	1.08	3701	2.40	-8.25	2.40	2.40	-8.30	-8.40	

**Heat pipe performance (dT vs Inclination angles at various heat loads)**  
Heat pipe tested: 8mm x 250mm sintered powder metal/methanol



## Heat Pipe Test Report

Manufacturer		Enertron		Test conditions				Test date	12/15/2017					
Wick structure/ Working fluid		Sintered Powder Metal/ Methanol		Effective area (m2)		5.03E-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)		-10								
Diameter	±0.05 mm	8		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	3.70	0.37	13442	3.80	0.38	13088	-4.60	-8.30	-4.50	-4.50	-8.20	-8.40	
	20	6.85	0.34	14521	7.00	0.35	14210	0.15	-6.70	0.20	0.30	-6.60	-6.90	
	30	10.55	0.35	14143	10.70	0.36	13945	5.40	-5.15	5.50	5.70	-4.80	-5.40	
	40	13.55	0.34	14682	13.85	0.35	14364	9.95	-3.60	10.10	10.40	-3.10	-4.10	
	50	16.70	0.33	14891	16.90	0.34	14715	14.45	-2.25	14.50	14.80	-1.60	-2.90	
60	10	3.60	0.36	13816	3.70	0.37	13442	-4.60	-8.20	-4.60	-4.60	-8.20	-8.40	
	20	6.50	0.33	15303	6.65	0.33	14958	-0.30	-6.80	-0.20	-0.20	-6.70	-7.00	
	30	9.65	0.32	15462	9.80	0.33	15225	4.20	-5.45	4.30	4.40	-5.20	-5.70	
	40	13.20	0.33	15071	13.40	0.34	14847	9.20	-4.00	9.20	9.60	-3.60	-4.40	
	50	16.90	0.34	14715	17.25	0.35	14416	14.45	-2.45	14.60	15.00	-1.90	-3.00	
30	10	4.20	0.42	11842	4.30	0.43	11566	-4.10	-8.30	-4.00	-4.00	-8.20	-8.40	
	20	7.10	0.36	14010	7.15	0.36	13912	0.15	-6.95	0.20	0.30	-6.70	-7.10	
	30	9.15	0.31	16307	9.35	0.31	15958	3.65	-5.50	3.70	4.00	-5.20	-5.80	
	40	10.80	0.27	18421	10.95	0.27	18168	6.55	-4.25	6.50	6.90	-3.90	-4.60	
	50	12.85	0.26	19352	13.00	0.26	19129	9.95	-2.90	9.90	10.30	-2.40	-3.40	

**Heat pipe performance (dT vs Inclination angles at various heat loads)**  
Heat pipe tested: 8mm x 300mm sintered powder metal/methanol

