

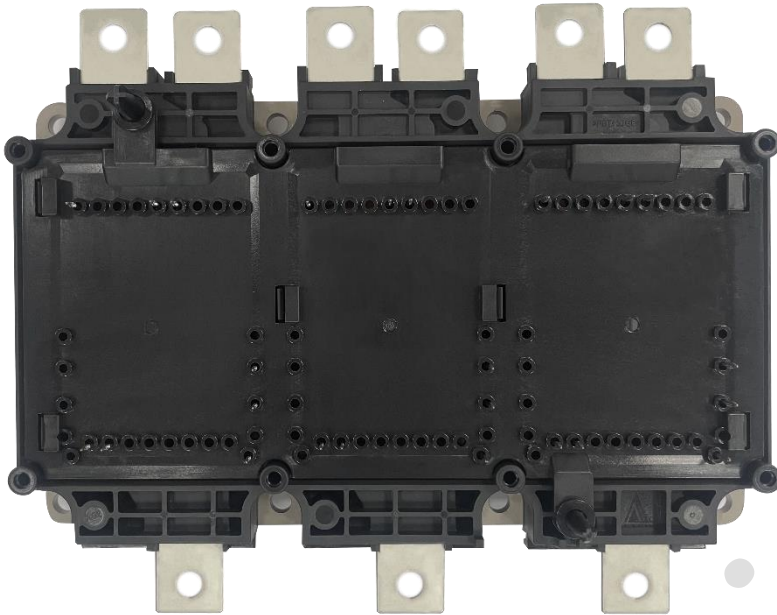


Power Module

AEPR20B12C1ST

**PRELIMINARY
DATASHEET**

V0.2, 2023/01



Applications

- Motor Drives
- All-Terrain Vehicles
- Automotive Applications
- Hybrid Electrical Vehicles (H) EV
- Commercial Agriculture Vehicles

Electrical Features

- Low $R_{DS(on)}$
- $T_j \text{ op} = 150^\circ\text{C}$
- Blocking voltage 1200V
- Low Switching Losses
- Low Inductive Design
- SiC High Performance Chip

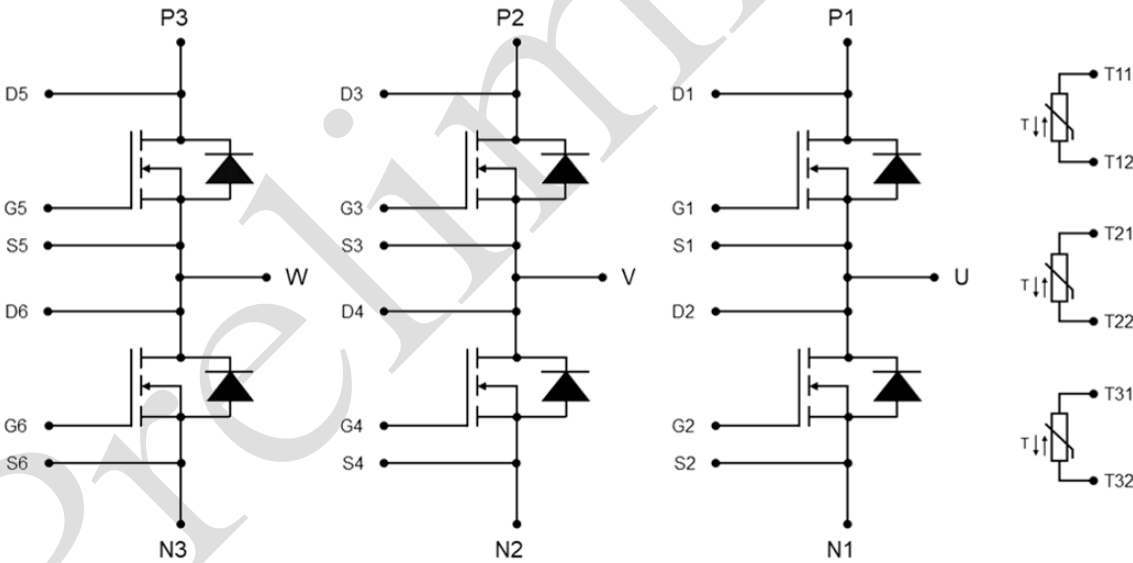
Mechanical Features

- Compact design
- 4.2KV DC Insulation
- UL 94 Module frame
- Temperature sense included
- Direct Water Cooling Base Plate
- Easy to Integrate 6-pack Topology
- Pb-free device and RoHS compliant
- Guiding elements for PCB and cooler assembly

FEATURES

- High speed, low loss SiC module
- High reliability, high durability module

Circuit Diagram





MOSFET

Maximum Rated Values

Parameter	Conditions	Symbol	Values	Unit
Drain-source voltage	$T_j = 25^\circ\text{C}$	V_{DSS}	1200	V
Gate-source voltage		V_{GS}	-5/+20	V
DC drain current	$V_{GS} = 15\text{ V}, T_F = 70^\circ\text{C}, T_j = 175^\circ\text{C}$	$I_{D\text{ nom}}$	400	A
Pulsed drain current	t_p limited by $T_{j, \text{max}}$	$I_{D\text{ pulse}}$	800	A

Characteristics Values

Parameter	Conditions		Symbol	Min.	Typ.	Max.	Unit
Drain-source on resistance	$I_D = 400\text{ A}, V_{GS} = 15\text{ V}$	$T_j = 25^\circ\text{C}$	$R_{DS(\text{on})}$		2.00	2.70	m Ω
	$I_D = 400\text{ A}, V_{GS} = 15\text{ V}$	$T_j = 150^\circ\text{C}$			4.00		
	$I_D = 400\text{ A}, V_{GS} = 15\text{ V}$	$T_j = 175^\circ\text{C}$			4.40		
Gate threshold voltage	$I_D = 210\text{ mA}, V_{GS} = V_{DS}$	$T_j = 25^\circ\text{C}$	$V_{GS\text{th}}$	2.70	3.60	4.50	V
Drain-source leakage current	$V_{DS} = 1200\text{ V}, V_{GS} = 0\text{ V}$	$T_j = 25^\circ\text{C}$	I_{DSS}			100	μA
Gate-source leakage current	$V_{DS} = 0\text{ V}, V_{GS} = 20\text{ V}$	$T_j = 25^\circ\text{C}$	I_{GSS}			400	nA
Gate Charge	$V_{GS} = -5\text{ V} / +15\text{ V},$ $V_{DS} = 600\text{ V}$	$T_j = 25^\circ\text{C}$	Q_g		2.5		μC
Input capacitance	$f = 1\text{ MHz}, V_{DS} = 200\text{ V}$ $V_{GS} = 0\text{ V}$	$T_j = 25^\circ\text{C}$	C_{iss}		46		nF
Output capacitance	$f = 1\text{ MHz}, V_{DS} = 200\text{ V}$ $V_{GS} = 0\text{ V}$	$T_j = 25^\circ\text{C}$	C_{oss}		2.8		nF
Reverse transfer capacitance	$f = 1\text{ MHz}, V_{DS} = 200\text{ V}$ $V_{GS} = 0\text{ V}$	$T_j = 25^\circ\text{C}$	C_{rss}		1.7		nF
Turn-on delay time, inductive load	$I_D = 400\text{ A}, V_{DS} = 600\text{ V}$ $V_{GS} = -5\text{ V} / +15\text{ V}$ $R_{GON} = 5.0\ \Omega$	$T_j = 25^\circ\text{C}$	$t_{d(\text{on})}$		110		ns
Rise time, inductive load	$I_D = 400\text{ A}, V_{DS} = 600\text{ V}$ $V_{GS} = -5\text{ V} / +15\text{ V}$ $R_{GON} = 5.0\ \Omega$	$T_j = 25^\circ\text{C}$	t_r		120		ns
Turn-on energy loss per pulse	$I_D = 400\text{ A}, V_{DS} = 600\text{ V}$ $L_S = 30\text{ nH}$ $V_{GS} = -5\text{ V} / +15\text{ V}$ $R_{GON} = 5.0\ \Omega,$ $di/dt = 2500\text{ A}/\mu\text{s} (25^\circ\text{C})$	$T_j = 25^\circ\text{C}$	E_{on}		31.0		mJ



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Turn-off delay time, inductive load	$I_D = 400\text{ A}$, $V_{DS} = 600\text{ V}$ $V_{GS} = -5\text{ V} / +15\text{ V}$ $R_{Goff} = 5.0\ \Omega$	$T_j = 25^\circ\text{C}$	$t_{d(off)}$	330	ns
Fall time, inductive load	$I_D = 400\text{ A}$, $V_{DS} = 600\text{ V}$ $V_{GS} = -5\text{ V} / +15\text{ V}$ $R_{Goff} = 5.0\ \Omega$	$T_j = 25^\circ\text{C}$	t_f	75	ns
Turn-off energy loss per pulse	$I_D = 400\text{ A}$, $V_{DS} = 600\text{ V}$ $L_S = 30\text{ nH}$ $V_{GS} = -5\text{ V} / +15\text{ V}$ $R_{Goff} = 5.0\ \Omega$, $dV/dt = 9700\text{ A}/\mu\text{s}$ (25°C)	$T_j = 25^\circ\text{C}$	E_{off}	13.0	mJ
Thermal resistance, junction to cooling fluid	Per MOSFET; $\Delta V/\Delta T = 10\text{ dm}^3/\text{min}$, $T_F = 60^\circ\text{C}$		R_{thJF}	0.12	K/W

Body diode

Maximum Rated Values

Parameter	Conditions	Symbol	Values	Unit
DC body diode forward current	$V_{GS} = -5\text{ V}$, $T_j = 175^\circ\text{C}$	I_{SD}	210	A
Pulsed body diode current	t_p limited by $T_{j, max}$	$I_{SD\ pulse}$	800	A

Characteristics Values

Parameter	Conditions	Symbol	Typ.	Max.	Unit	
Forward voltage	$I_{SD} = 400\text{ A}$, $V_{GS} = -5\text{ V}$	$T_j = 25^\circ\text{C}$	V_{SD}	4.25	6.15	V
Peak reverse recovery current	$I_{SD} = 400\text{ A}$, $V_R = 600\text{ V}$ $V_{GE} = -5\text{ V}$	$T_j = 25^\circ\text{C}$	I_{RM}	60		A
Recovered charge	$I_{SD} = 400\text{ A}$, $V_R = 600\text{ V}$ $V_{GE} = -5\text{ V}$	$T_j = 25^\circ\text{C}$	Q_{rr}	1.75		μC
Reverse recovery energy	$I_{SD} = 400\text{ A}$, $V_R = 600\text{ V}$ $V_{GE} = -5\text{ V}$ $-di/dt = 3300\text{ A}/\mu\text{s}$ (25°C)	$T_j = 25^\circ\text{C}$	E_{rec}	0.15		mJ



NTC-Thermistor

Characteristics Values

Parameter	Conditions	Symbol	Typ.	Max.	Unit
Rated resistance	$T_c = 25^\circ\text{C}$	R_{25}	5.0		k Ω
Resistance tolerance	$T_c = 100^\circ\text{C}$	$\Delta R/R$		5	%
B-value	$R_2 = R_{25} \exp [B_{25/50}(1/T_2 - 1/(298.15 \text{ K}))]$	$B_{25/50}$	3375		K
B-value	$R_2 = R_{25} \exp [B_{25/80}(1/T_2 - 1/(298.15 \text{ K}))]$	$B_{25/80}$	3411		K
B-value	$R_2 = R_{25} \exp [B_{25/100}(1/T_2 - 1/(298.15 \text{ K}))]$	$B_{25/100}$	3433		K

Module

Parameter	Conditions	Symbol	Value	Unit
Isolation test voltage	RMS, f = 0 Hz, t = 1 sec	V_{ISOL}	4.2	kV
Module baseplate material			Cu + Ni	
Module internal isolation material			Si3N4	
Creepage distance	Terminal to Heat sink	d_{cree}	9.0	mm
	Terminal to Terminal		9.0	
Clearance	Terminal to heat sink	d_{clear}	4.5	mm
	Terminal to Terminal		4.5	
Comparative tracking index ¹⁾		CTI	> 200	

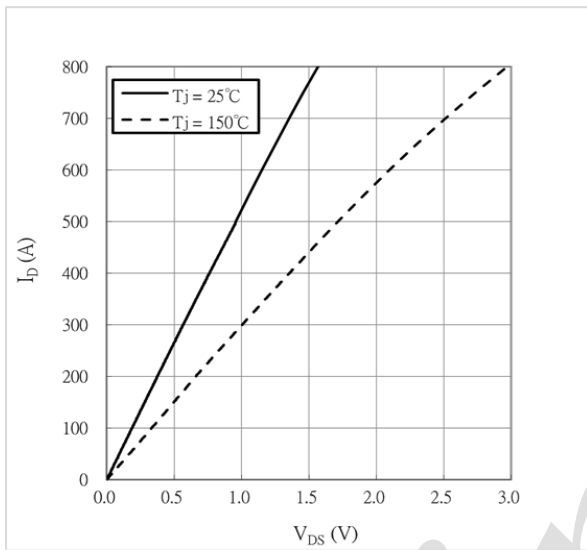
Parameter	Conditions	Symbol	Min.	Typ.	Max.	Unit
Module stray inductance		L_{SCE}		9		nH
Storage temperature		T_{stg}	-40		125	$^\circ\text{C}$
Weight		G		745		g

¹⁾ Extracted by following UL 746A

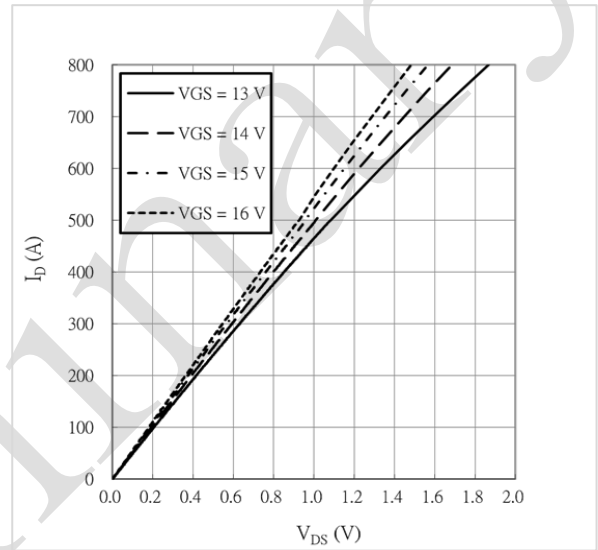


Characteristics Diagrams

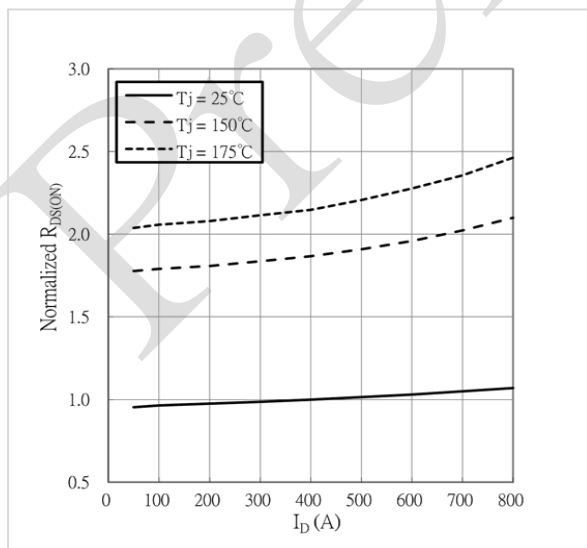
Output characteristics, MOSFET
 $V_{GS} = 15\text{ V}$, $I_D = f(V_{DS})$



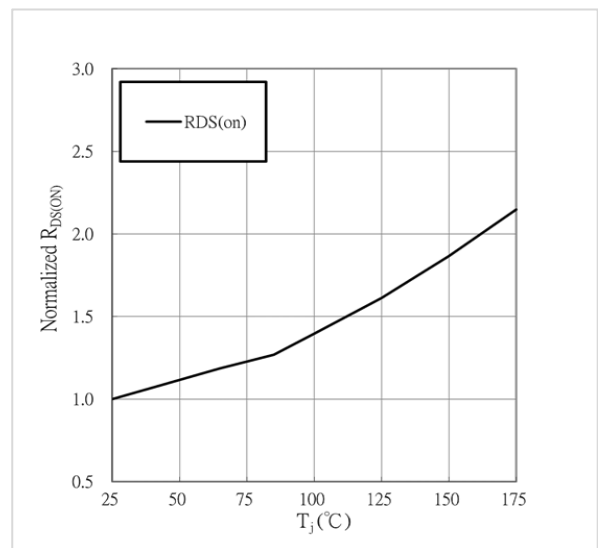
Output characteristics, MOSFET
 $T_j = 25^\circ\text{C}$, $I_D = f(V_{DS})$



Drain source on-resistance, MOSFET
 $V_{GS} = 15\text{ V}$, $R_{DS(on)} = f(I_D)$



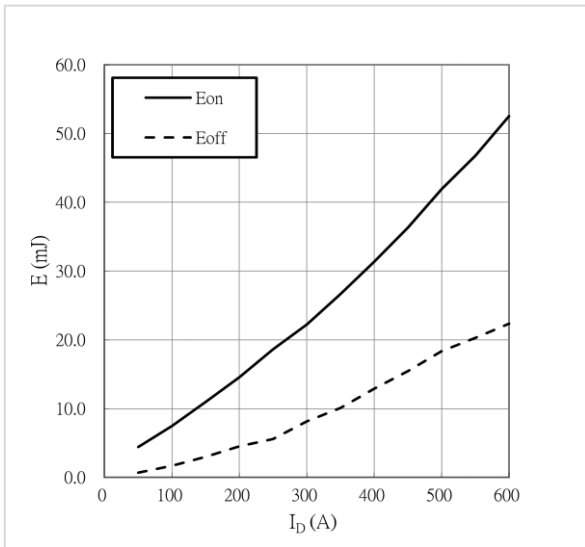
Drain source on-resistance, MOSFET
 $I_D = 400\text{ A}$, $V_{GS} = 15\text{ V}$, $R_{DS(on)} = f(T_j)$





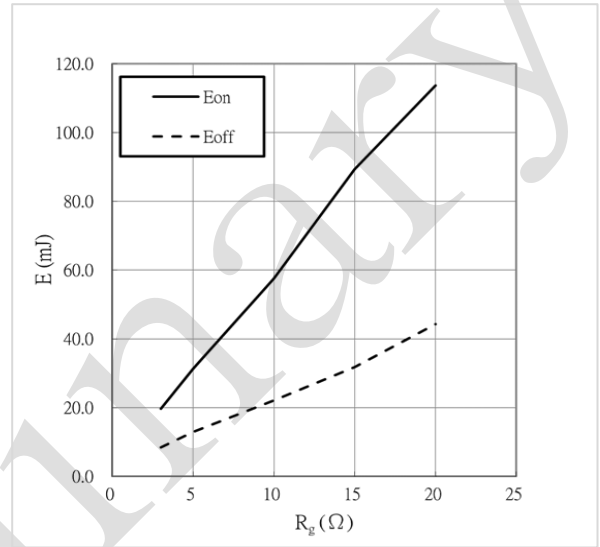
Switching losses (typical), MOSFET

$V_{DS} = 600\text{ V}$, $R_{GON} = 5\ \Omega$, $R_{Goff} = 5\ \Omega$,
 $V_{GS} = -5/15\text{ V}$, $T_j = 25^\circ\text{C}$, $E = f(I_D)$

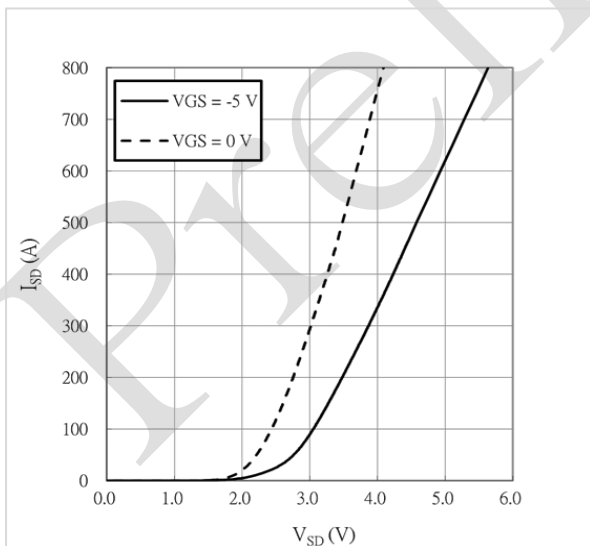


Switching losses (typical), MOSFET

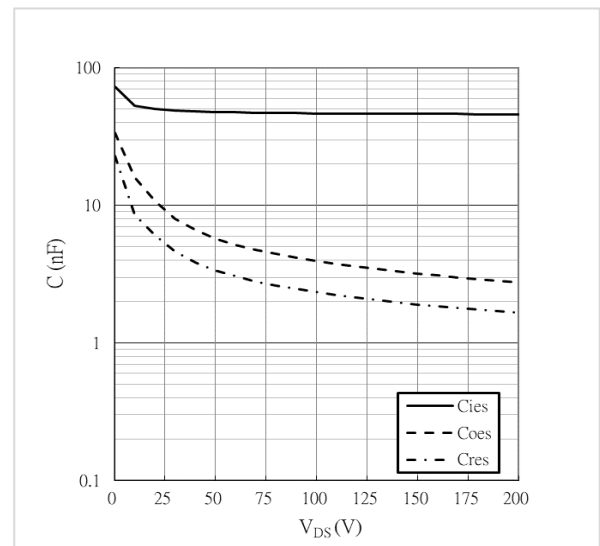
$V_{DS} = 600\text{ V}$, $I_D = 400\text{ A}$, $V_{GS} = -5/15\text{ V}$,
 $T_j = 25^\circ\text{C}$, $E = f(R_g)$



Forward characteristics of body diode,
MOSFET, $T_j = 25^\circ\text{C}$, $I_{SD} = f(V_{SD})$

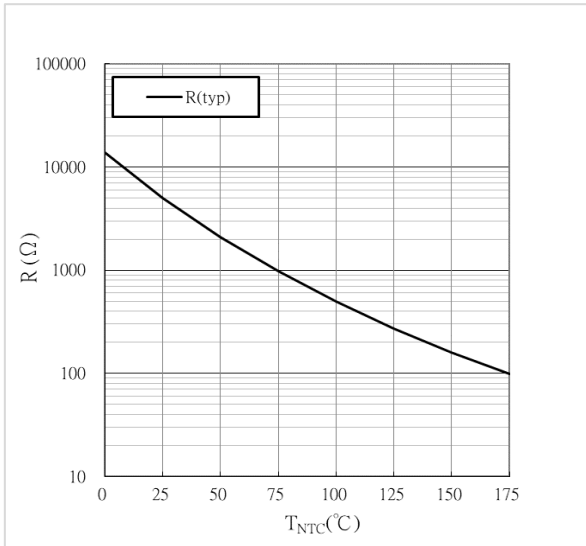


Capacitance characteristics MOSFET,
 $V_{GS} = 0\text{ V}$, $T_j = 25^\circ\text{C}$, $f = 1\text{ MHz}$, $C = f(V_{DS})$



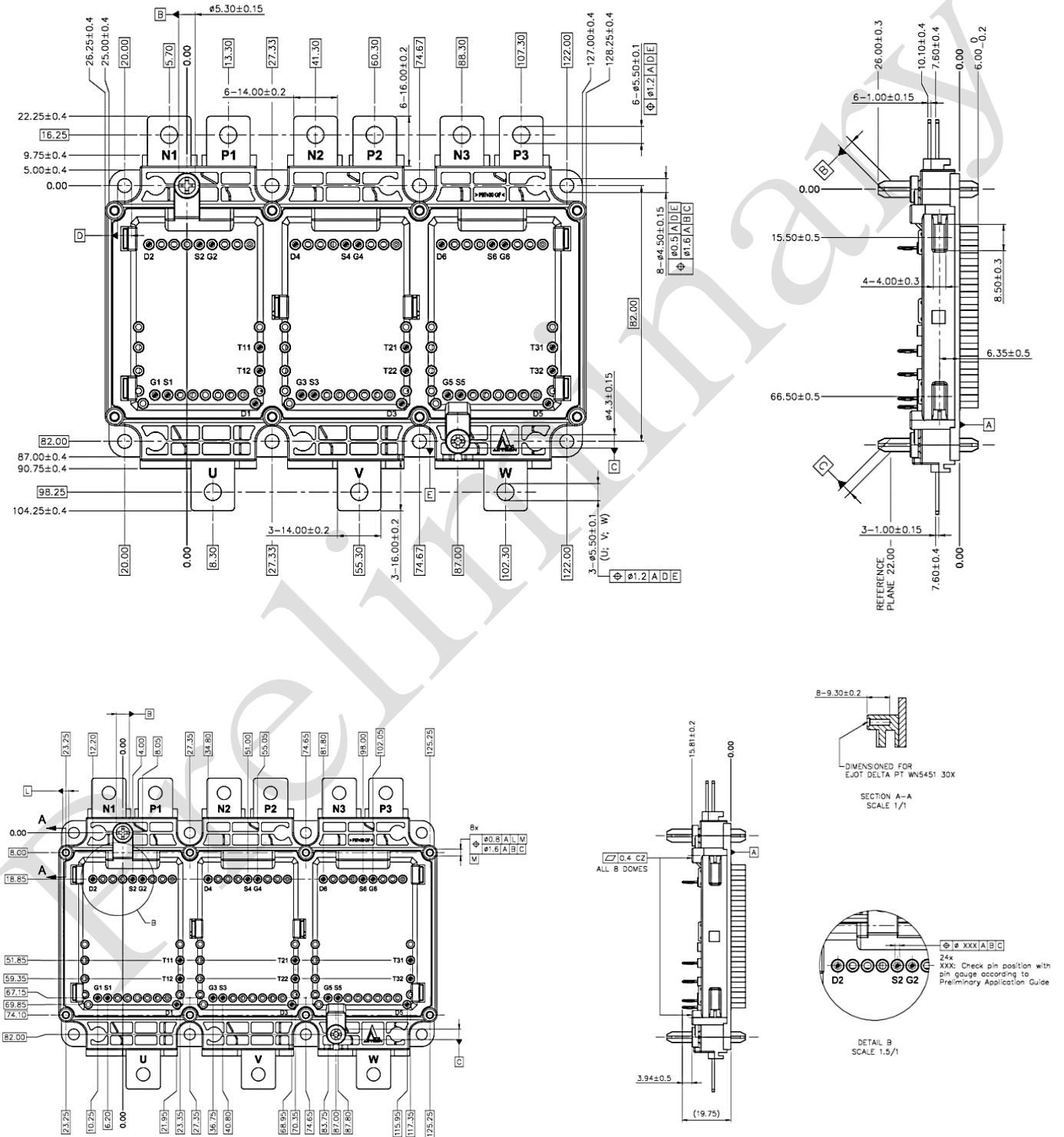


NTC-Thermistor-temperature characteristics





Package Outlines



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