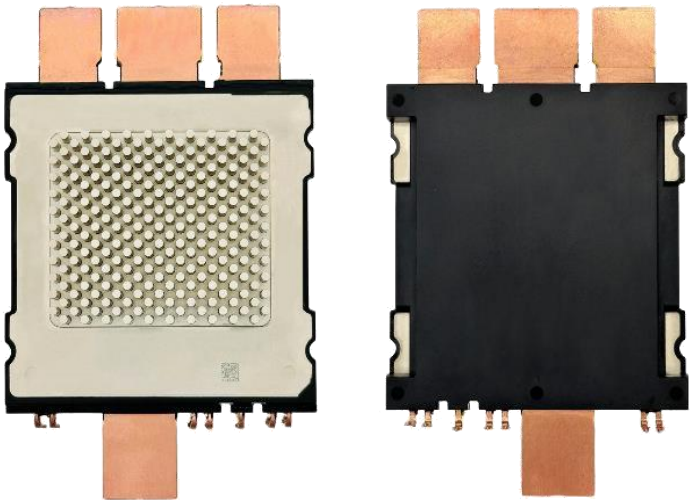
1200V SSC Power Module

ATSR20B12C1WT

PRELIMINARY
DATASHEET

V0.3, 2025/01

ATSR20B12C1WT
SiC SSC Power Module



Applications

- Motor Drives
- Automotive Applications
- Molded Package Optimized for EV Application
- PinFin Structure for Lowest Thermal Resistance

Features

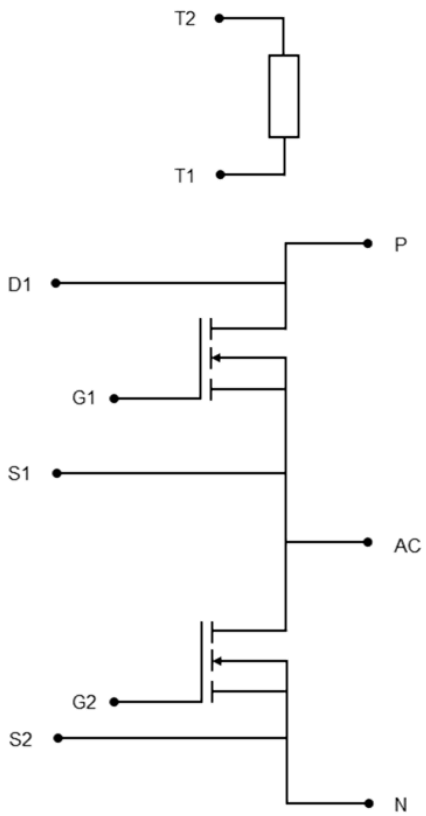
Electrical Features

- Low $R_{DS(on)}$
- $T_{j,op,max}$ = 175°C
- Blocking Voltage 1200V
- DC Drain Current 600A
- Low Switching Losses
- Low Inductive Design
- SiC MOSFET Technology

Mechanical Features

- Compact Design
- Sintered Ag Technology
- Si_3N_4 Ceramic Substrate
- NTC Temperature Sensor Included
- Comparative Tracking Index (CTI) > 600
- Press-Fit Pin Connection
- Direct Liquid Cooled PinFin Baseplate
- Pb-Free and RoHS Compliant

Circuit Diagram



MOSFET

Maximum Rated Values

Parameter	Conditions	Symbol	Values	Unit
Drain-source voltage	T_j = 25°C	V_{DSS}	1200	V
Gate-source voltage		V_{GS}	-10/+23	V
	Recommended operating values	V_{GS}	-5/+18	V
DC drain current	V_{GS} = 18V, T_F = 65°C, $T_{j,max}$ = 175°C	$I_{D\ nom}$	600	A
Pulsed drain current	t_p limited by $T_{j,\ max}$	$I_{D\ pulse}$	1200	A
Maximum junction temperature		$T_{j,max}$	175	°C

Characteristics Values

Parameter	Conditions		Symbol	Min.	Typ.	Max.	Unit
Drain-source on resistance	I_D = 600A, V_{GS} = 18V	T_j = 25°C	$R_{DS(on)}$		2.0	2.6	mΩ
	I_D = 600A, V_{GS} = 18V	T_j = 150°C			3.1		
	I_D = 600A, V_{GS} = 18V	T_j = 175°C			3.5		
Gate threshold voltage	I_D = 215 mA, V_{GS} = V_{DS}	T_j = 25°C	$V_{GS,th}$	1.80	2.50	3.30	V
		T_j = 150°C			1.90		
		T_j = 175°C			1.80		
Drain-source leakage current	V_{DS} = 1200V, V_{GS} = 0V	T_j = 25°C	I_{DSS}			100	µA
		T_j = 150°C				1	mA
		T_j = 175°C				5	mA
Gate-source leakage current	V_{DS} = 0V, V_{GS} = 20V	T_j = 25°C	I_{GSS}			400	nA
Gate charge	V_{GS} = -5V / + 18V V_{DS} = 800V, I_D = 600A	T_j = 25°C	Q_G		2.0		µC
Input capacitance	f = 100 kHz, V_{DS} = 800V V_{GS} = 0V	T_j = 25°C	C_{iss}		52.1		nF
Output capacitance	f = 100 kHz, V_{DS} = 800V V_{GS} = 0V	T_j = 25°C	C_{oss}		2.5		nF
Reverse transfer capacitance	f = 100 kHz, V_{DS} = 800V V_{GS} = 0V	T_j = 25°C	C_{rss}		0.24		nF
Turn-on delay time inductive load	I_D = 600A, V_{DS} = 800V V_{GS} = -5V / + 18V $R_{G,on}$ = 2.2 Ω	T_j = 25°C	$t_{d(on)}$		85		ns
		T_j = 175°C			70		
Rise time, inductive load	I_D = 600A, V_{DS} = 800V V_{GS} = -5V / + 18V $R_{G,on}$ = 2.2 Ω	T_j = 25°C	t_r		83		ns
		T_j = 175°C			80		

Parameter	Conditions		Symbol	Min.	Typ.	Max.	Unit
Turn-on energy loss per pulse	I_D = 600A, V_{DS} = 800V L_S = 30 nH V_{GS} = -5V / + 18V $R_{G,on}$ = 2.2 Ω di/dt = 8.4 A/ns (25°C) di/dt = 9.1 A/ns (175°C)	T_j = 25°C T_j = 175°C	E_{on}		33.5 32.0		mJ
Turn-off delay time Inductive load	I_D = 600A, V_{DS} = 800V V_{GS} = -5V / + 18V $R_{G,off}$ = 1.5 Ω	T_j = 25°C T_j = 175°C	$t_{d(off)}$		360 375		ns
Fall time, inductive load	I_D = 600A, V_{DS} = 800V V_{GS} = -5V / + 18V $R_{G,off}$ = 1.5 Ω	T_j = 25°C T_j = 175°C	t_f		54 61		ns
Turn-off energy loss per pulse	I_D = 600A, V_{DS} = 800V L_S = 30 nH V_{GS} = -5V / + 18V $R_{G,off}$ = 1.5 Ω dv/dt = 10.4 V/ns (25°C) dv/dt = 10.2 V/ns (175°C)	T_j = 25°C T_j = 175°C	E_{off}		48.9 49.0		mJ
Short circuit current	V_{DD} = 800V V_{GS} = -5V / + 18V $R_{G,on}$ = 2.2 Ω $R_{G,off}$ = 1.5 Ω t_{sc} ≤ 1.5 µs	T_j = 175°C	I_{SC}		8000		A
Thermal resistance Junction to cooling fluid	Per MOSFETs ΔV/Δt = 10 dm^3/min T_F = 65°C		$R_{th,JF}$		0.074		K/W
Operated temperature condition			$T_{j,op}$	-40		175	°C

Body diode

Maximum Rated Values

Parameter	Conditions	Symbol	Values	Unit
DC body diode forward current	V_{GS} = -5V, T_j = 175°C	I_{SD}	600	A
Pulsed body diode current	t_p limited by $T_{j,max}$	$I_{SD\ pulse}$	1200	A

Characteristics Values

Parameter	Conditions		Symbol	Typ.	Max.	Unit
Forward voltage	I_{SD} = 600A, V_{GS} = -5V	T_j = 25°C T_j = 150°C T_j = 175°C	V_{SD}	5.50 5.05 4.95		V
Peak reverse recovery current	I_{SD} = 600A, V_R = 800V V_{GS} = -5V	T_j = 25°C T_j = 175°C	I_{RM}	145 295		A
Recovered charge	I_{SD} = 600A, V_R = 800V V_{GS} = -5V	T_j = 25°C T_j = 175°C	Q_{rr}	3.5 14.6		µC
Reverse recovery energy	I_{SD} = 600A, V_R = 800V V_{GS} = -5V -di/dt = 9.3 A/ns (25°C) -di/dt = 8.4 A/ns (175°C)	T_j = 25°C T_j = 175°C	E_{rec}	3.3 10.0		mJ

NTC-Thermistor

Characteristics Values

Parameter	Conditions	Symbol	Min.	Typ.	Max.	Unit
Rated resistance	T_c = 25°C	R_{25}		5.0		kΩ
Resistance tolerance	T_c = 100°C	ΔR/R	-5		5	%
B-value	$R_2 = R_{25}$ exp [$B_{25/50}$(1/T_2 – 1/(298.15 K))]	$B_{25/50}$		3375		K
B-value	$R_2 = R_{25}$ exp [$B_{25/80}$(1/T_2 – 1/(298.15 K))]	$B_{25/80}$		3411		K
B-value	$R_2 = R_{25}$ exp [$B_{25/100}$(1/T_2 – 1/(298.15 K))]	$B_{25/100}$		3433		K

Module

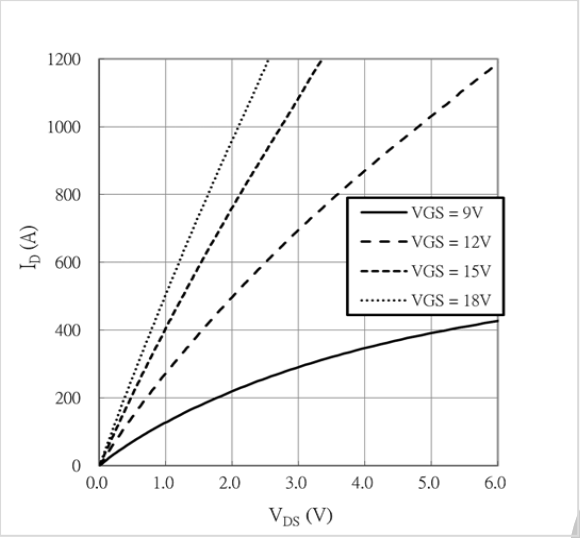
Parameter	Conditions	Symbol	Value	Unit
Dimensions	Terminal (AC) to Terminal (DC)	L	110	mm
	Mold body width	W	69	mm
	Mold body length	L	74	mm
	Baseplate surface to the pressfit pinis(inserted in the PCB)	H	17.35	mm
Module baseplate material			Cu + Ni	
Module internal isolation material	Basic isolation (class 1, IEC 61140)		Si_3N_4	
Creepage distance	Terminal to baseplate	$d_{Creep,TH}$	8.5	mm
Creepage distance	Terminal to terminal	$d_{Creep,TT}$	8	mm
Clearance distance	Terminal to baseplate	$d_{Clear,TH}$	6.9	mm
Clearance distance	Terminal to terminal	$d_{Clear,TT}$	3.3	mm

Parameter	Conditions	Symbol	Min.	Typ.	Max.	Unit
Module stray inductance		L_{sDS}		< 6		nH
Comparative tracking index [1)]		CTI		> 600		
Storage temperature		T_{stg}	-40		150	°C
Weight		G		290		g

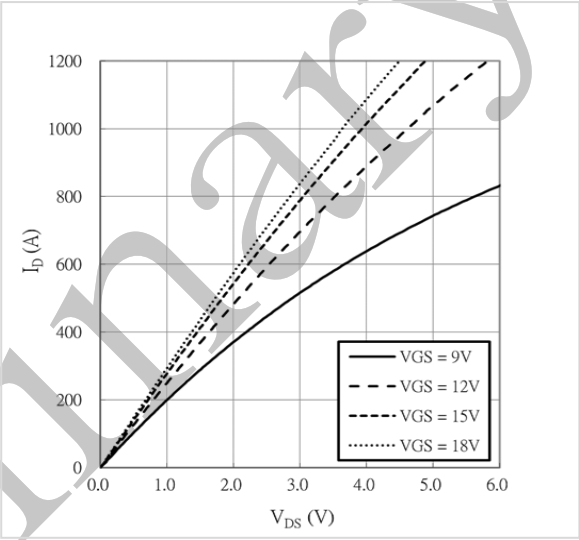
[1)] Extracted by following UL 746A

Characteristics Diagrams

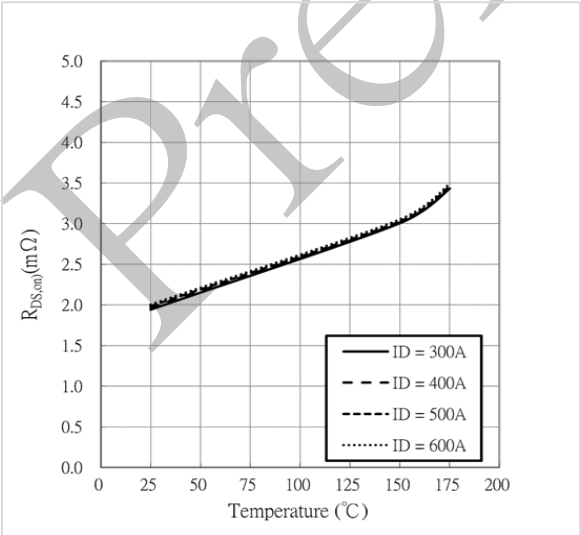
MOSFET, Output characteristics
T_j = 25°C, I_D = f(V_{DS})



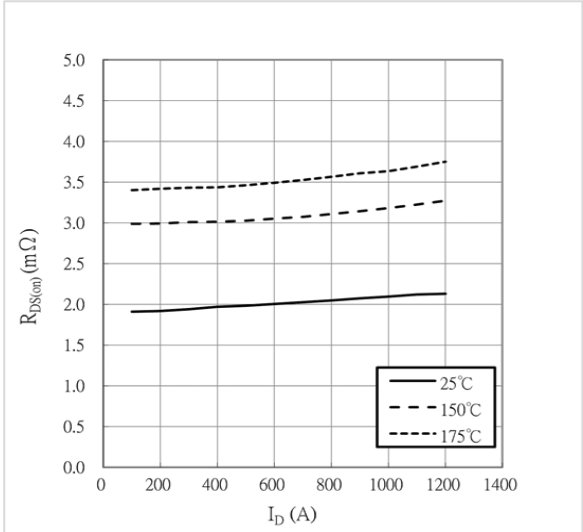
MOSFET, Output characteristics
T_j = 175°C, I_D = f(V_{DS})



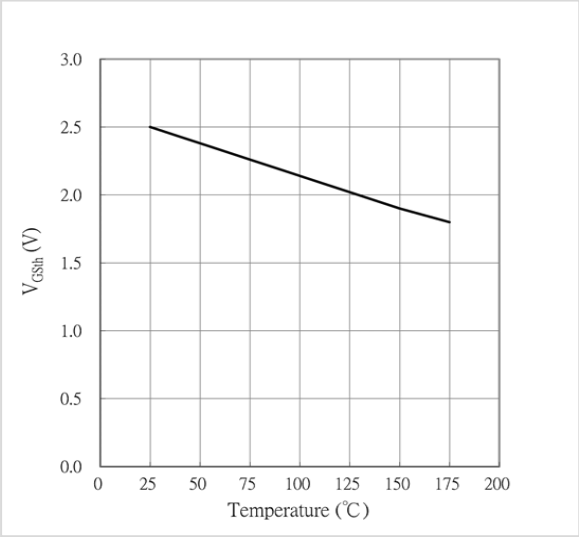
Typical temperature dependence of $R_{DS(on)}$
V_{GS} = 18V, $R_{DS(on)}$ = f(T_j)



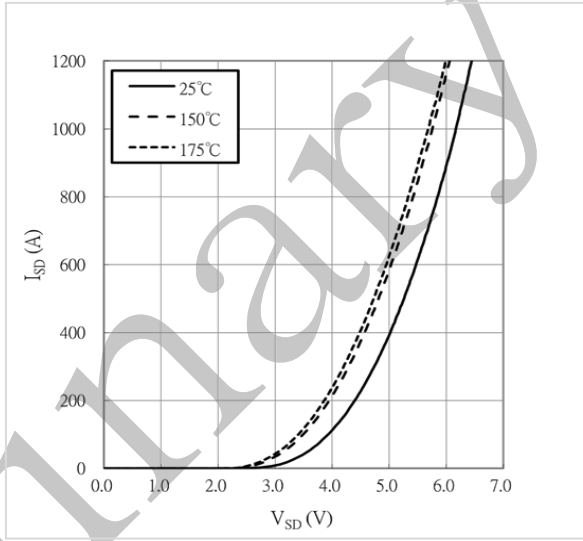
Typical I_D dependence of $R_{DS(on)}$
V_{GS} = 18V, $R_{DS(on)}$ = f(I_D)



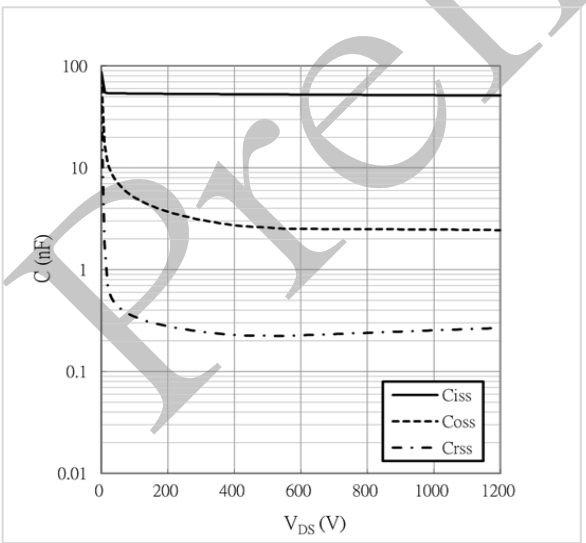
Typical temperature dependence of threshold voltage, $V_{GS,th} = f(T_j)$



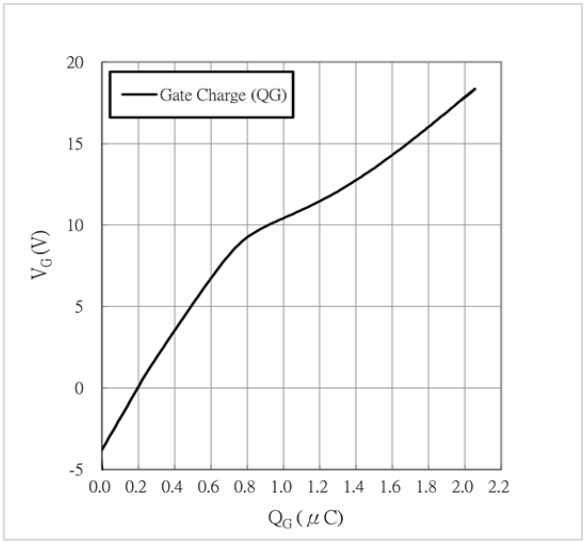
Body diode, Forward characteristics
V_{GS} = -5V, $I_{SD} = f(V_{SD})$



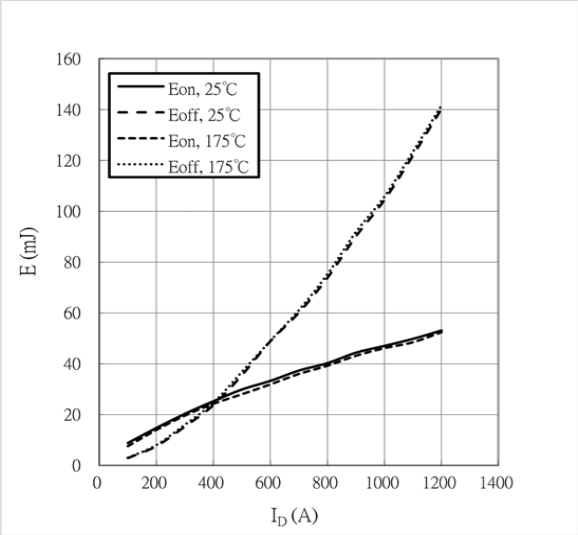
MOSFET, Capacitance characteristics
V_{GS} = 0V, T_j = 25°C, f = 100 kHz, $C = f(V_{DS})$



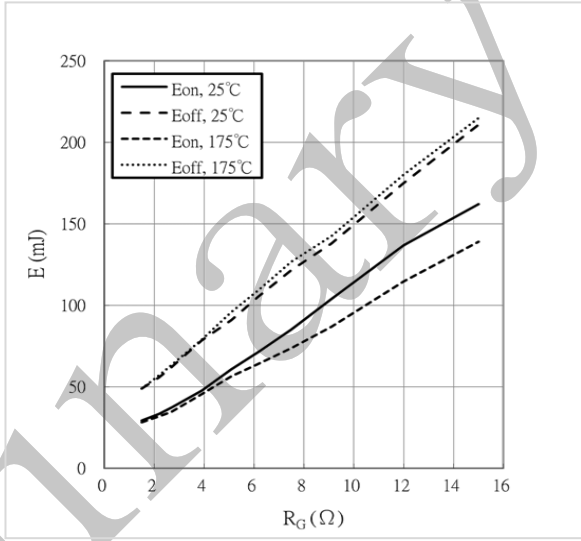
MOSFET, Total gate charge characteristics
V_{DS} = 800V, I_D = 600A, T_j = 25°C, $V_{GS} = f(Q_G)$



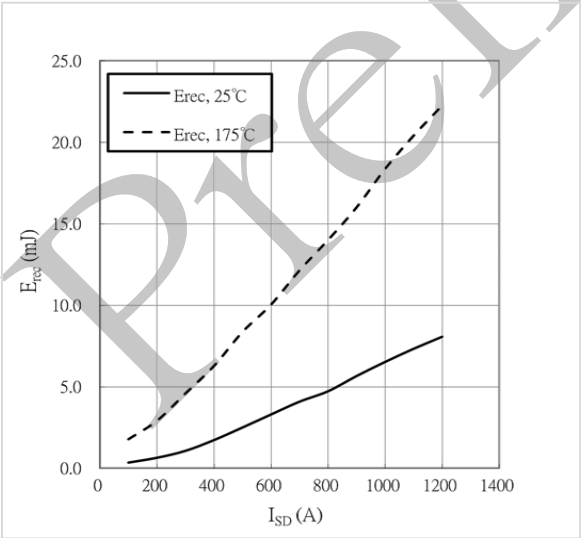
MOSFET, Switching losses VS. I_D
V_{GS} = -5V / +18V, $R_{G,on}$ = 2.2Ω, $R_{G,off}$ =1.5Ω
V_{DS} = 800V, E_{on} & E_{off} = f(I_D)



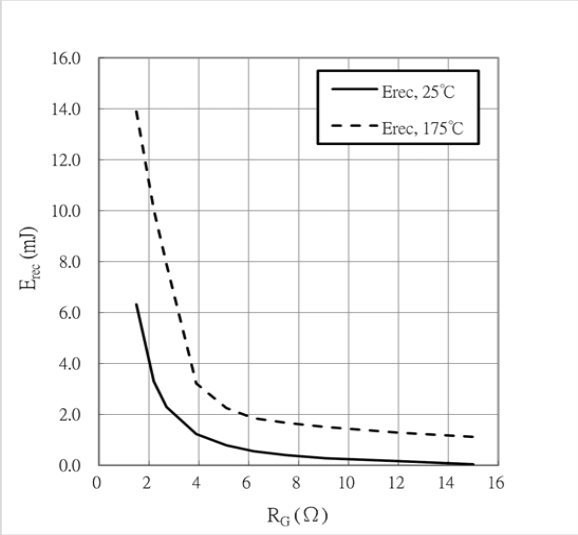
MOSFET, Switching losses VS. R_G
V_{GS} = -5V / +18V, V_{DS} = 800V, I_D = 600A
E_{on} & E_{off} = f(R_G)



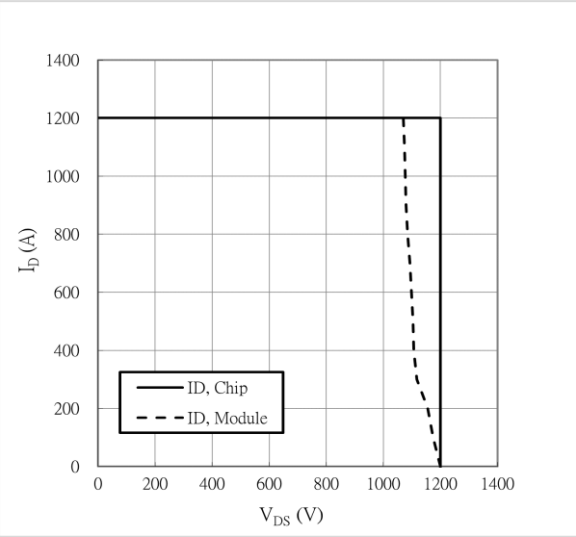
Body diode, Switching losses VS. I_{SD}
V_{GS} = -5V / +18V, $R_{G,on}$ = 2.2Ω, $R_{G,off}$ = 1.5Ω
V_{DS} = 800V, E_{rec} = f(I_{SD})



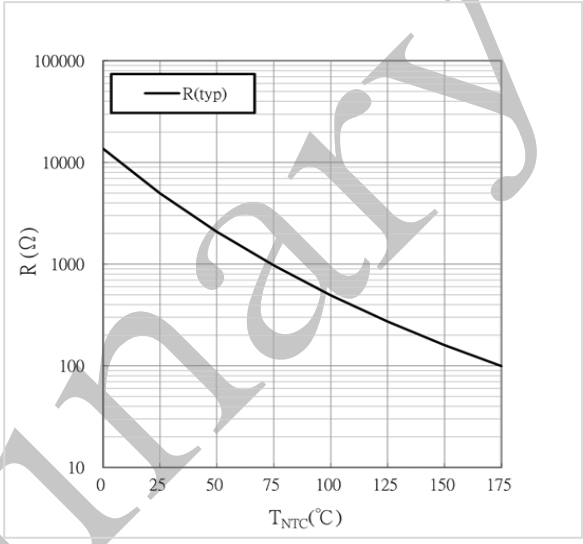
Body diode, Switching losses VS. R_G
V_{GS} = -5V / +18V, V_{DS} = 800V, I_{SD} = 600A
E_{rec} = f(R_G)



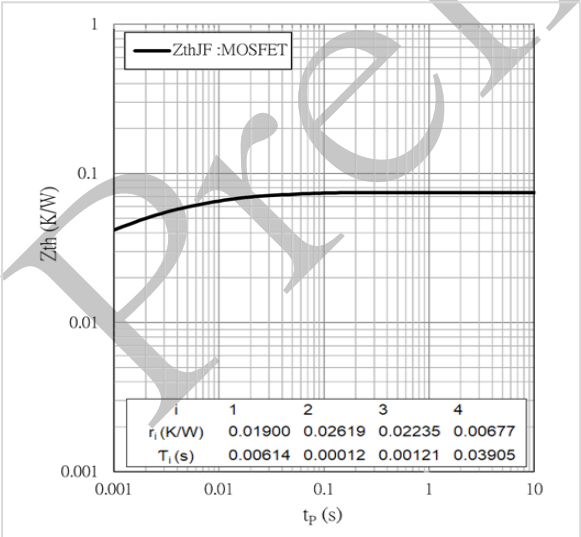
MOSFET, Reverse bias safe operating area (RBSOA)V_{GS} = -5V/ +18V, $R_{G,on}$ = 2.2Ω
$R_{G,off}$ = 1.5Ω, T_j = 175°C, $I_D = f(V_{DS})$



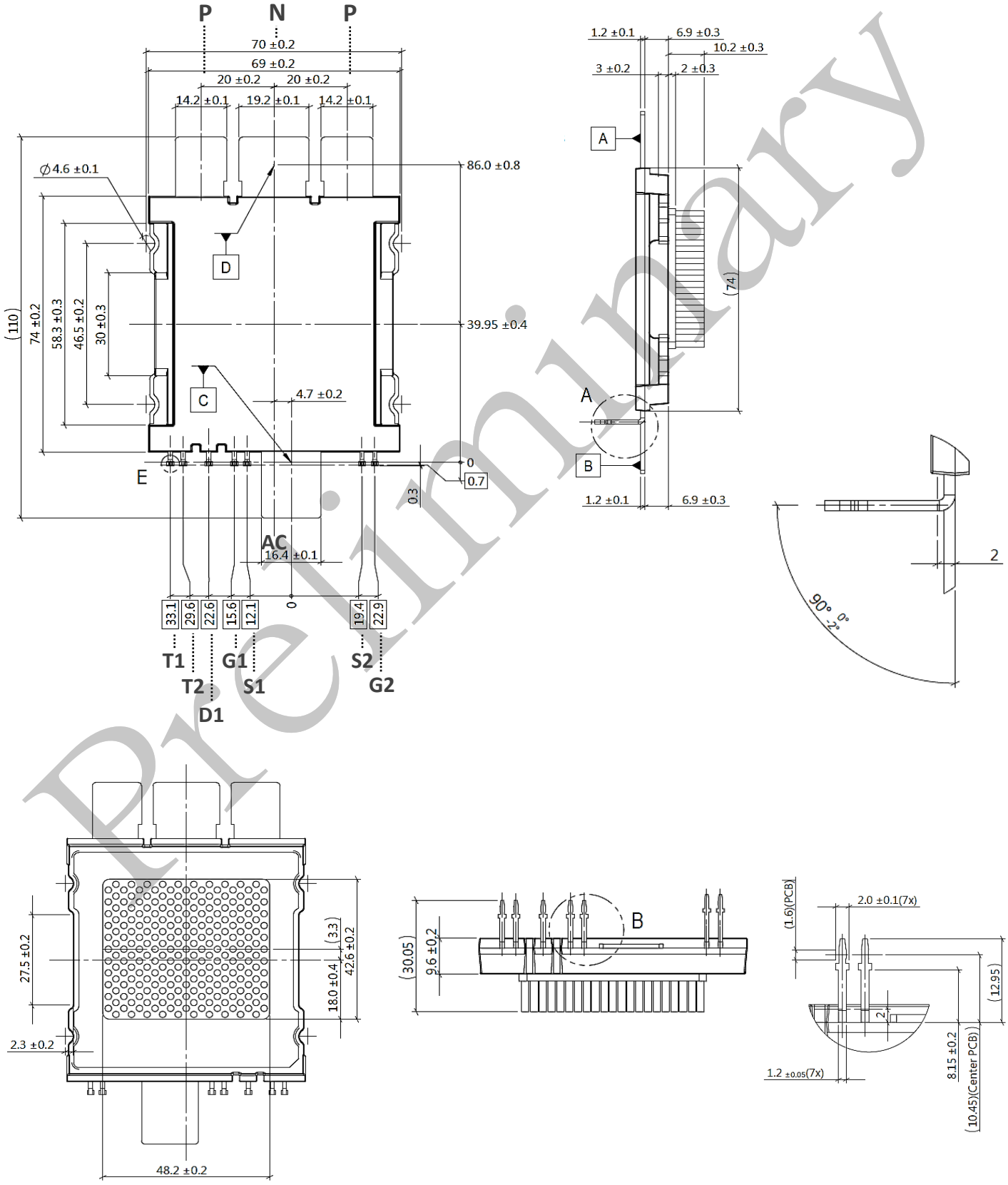
NTC-Thermistor-temperature characteristics
$R = f(T_{NTC})$



MOSFET, Transient thermal impedance
$Z_{thJF} = f(t_P)$
$\Delta V/\Delta t$ = 10 dm^3/min, T_F = 65°C



Package Outlines



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