Automotive Grade SiC Power Module

BST400D12P4A101 Datasheet

Features

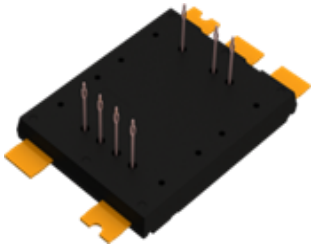
· TRCDRIVE pack™
with the 4th Generation SiC-MOSFET
· V_{DSS} = 1200V
· Low $R_{DS(on)}$
· High-speed switching possible
· Low switching losses
· Low stray inductance - 5.7nH
· Tvjmax = 175°C
· Compact design
· High power density
· Press-fit contact technology
· Integrated NTC temperature sensor
· Mountable on heatsink with thermal interface material (TIM)
· Weldable power terminals
· Cu clip technology
· Ag sinter technology for die mounting
· Higher power cycling capability
· 4.2kV DC 1s insulation

Construction

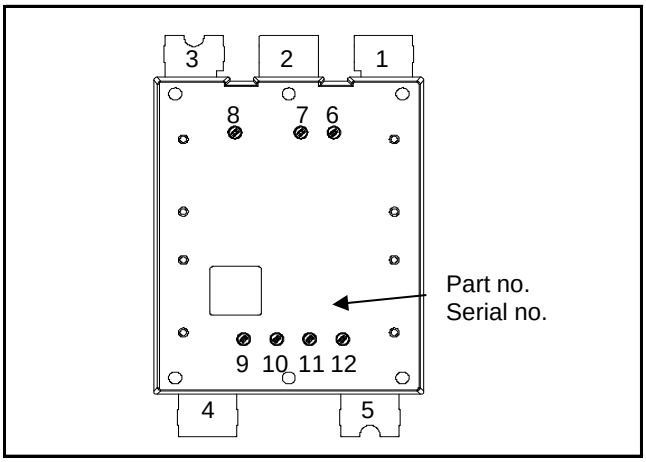
The power module is a half bridge module which implements SiC-MOSFETs.

Application

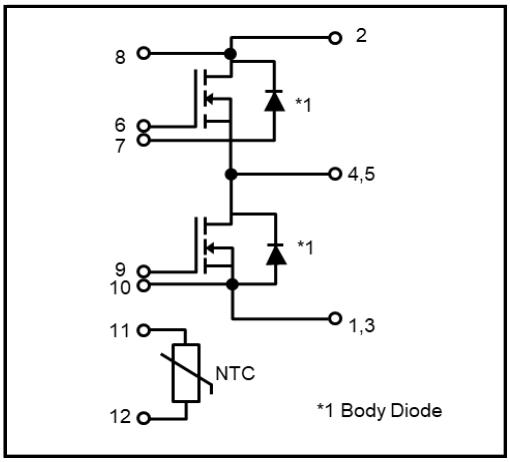
· Automotive application
· Inverter, Converter
· (Hybrid) electrical vehicles EV/HEV



Outline



Circuit diagram



Pin No.	Pin Name	Function
1	N	Negative Power
2	P	Positive Power
3	N	Negative Power
4	OUT	Output (S1D2)
5	OUT	Output (S1D2)
6	G1	High side MOSFET Gate
7	Ss1	High side MOSFET Source Sense
8	Ds1	High side MOSFET Drain Sense
9	G2	Low side MOSFET Gate
10	Ss2	Low side MOSFET Source Sense
11	NTC1	NTC
12	NTC2	NTC

Absolute maximum ratings (Tvj = 25°C unless otherwise specified)

Parameter	Symbol	Conditions	Rating	Unit
Drain - source voltage	V_{DSS}	V_{GS} = 0V	1200	V
Gate - source voltage (DC)	V_{GSS}		-4 to +21	
Gate - source voltage (t_{surge} < 300ns)	$V_{GSSsurge}$		-6 to +23	
Continuous drain current (DC)	I_D	Tvj = 175°C, Tc = 60°C, V_{GS} = 18V	394	A
Pulsed drain current	$I_{D,pulse}$	Pulse 1ms, Tvj = 175°C, V_{GS} = 18V Note 2), 5)	788	
Continuous source current (DC)	I_S	Tvj = 175°C, V_{GS} = 18V	394	
Pulsed source current	$I_{S,pulse}$	Pulse 1ms, Tvj = 175°C, V_{GS} = 18V Note 2)	788	
Body diode surge forward current	$I_{S,pulse}$	Pulse 1.5µs, Tvj = 175°C, V_{GS} = 0V Note 2), 4), 5)	788	
Total power dissipation Note 3), 5)	Ptot	Tc = 25°C	1667	W
Virtual junction temperature	Tvj		-40 to +175	°C
Storage temperature	Tstg		-40 to +125	

Note 1) If the product is used beyond absolute maximum ratings defined in the specifications, as its internal structure may be damaged, please replace the product with a new one.

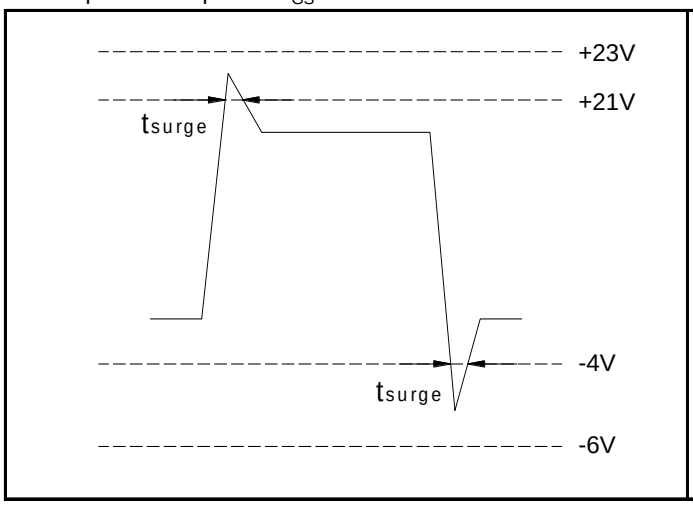
Note 2) Repetition rate should be kept within the range where temperature rise if die should not exceed Tvjmax.

Note 3) Case temperature (Tc) is defined on the mounting side surface of copper plate.

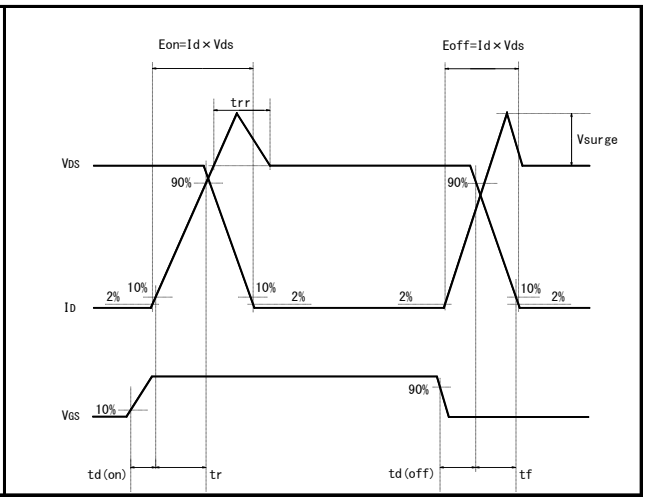
Note 4) Repetitive pulse, PW≦1.5µs, Duty cycle≦5%

Note 5) Tvj is less than 175°C.

<Example of acceptable V_{GS} waveform>



＜Wavelength for switching test＞



Module (Tvj = 25°C unless otherwise specified)

Parameter	Symbol	Conditions	Values			Unit
			Min.	Typ.	Max.	
Isolation test voltage	V_{isol}	Terminals to baseplate DC 1s	4200	–	–	V
Stray inductance	L_s		–	5.7	–	nH
Comparative tracking index	CTI		400≤CTI<600			–
Creepage distance	–	Terminal to heat sink	8.0	–	–	mm
		Terminal to terminal	7.4	–	–	
Clearance	–	Terminal to heat sink	6.4	–	–	mm
		Terminal to terminal	5.1	–	–	
Thermal resistance, junction - case	$R_{th(j-c)}$	1/2 module Note 3)	–	–	90	°C/kW
Module lead resistance, terminals - chip	$R_{DD'+SS'}$		–	0.29	–	mΩ
Weight	G		–	52	–	g

MOSFET electrical characteristics (Tvj = 25°C unless otherwise specified)

Parameter	Symbol	Conditions		Values			Unit
				Min.	Typ.	Max.	
Drain - source on resistance	$R_{DS(on)}$	I_D = 350A, V_{GS} = 18V	Tvj = 25°C	—	2.8	3.5	mΩ
			Tvj = 150°C	—	5.3	—	
			Tvj = 175°C	—	6.6	8.6	
Zero gate voltage drain current	$I_{DSS,leak}$	V_{DS} = 1200V, V_{GS} = 0V		—	—	320	μA
Gate - source threshold voltage	$V_{GS(th)}$	V_{DS} = 10V, I_D = 150mA Note 6)		2.8	—	4.8	V
Gate - source leakage current	I_{GSS}	V_{GS} = +21V, V_{DS} = 0V		—	—	0.4	μA
		V_{GS} = -4V, V_{DS} = 0V		-0.4	—	—	
Turn - on delay time	$t_{d(on)}$	$V_{GS(on)}$ = 18V, $V_{GS(off)}$ = 0V V_{DS} = 800V I_D = 350A $R_{G(on)}$ = 6.8Ω, $R_{G(off)}$ = 3.3Ω Inductive load		—	119	—	ns
Rise time	t_r			—	102	—	
Turn - off delay time	$t_{d(off)}$			—	198	—	
Fall time	t_f			—	42	—	
Turn - on switching loss	E_{on}			—	46	—	mJ
Turn - off switching loss	E_{off}			—	18	—	
Input capacitance	C_{iss}	V_{DS} = 800V, V_{GS} = 0V, 1MHz		—	31	—	nF
Total gate charge	Q_g	$V_{GS(on)}$ = 18V, $V_{GS(off)}$ = 0V V_{DS} = 800V I_D = 272A		—	1158	—	nC
Gate - source charge	Q_{gs}			—	334	—	
Gate - drain charge	Q_{gd}			—	180	—	
Internal gate resistance	R_{Gint}	Tvj = 25°C		—	0.25	—	Ω

Body diode electrical characteristics (Tvj = 25°C unless otherwise specified)

Parameter	Symbol	Conditions		Values			Unit
				Min.	Typ.	Max.	
Souce - drain voltage	$V_{F,SD}$	V_{GS} = 0V, I_S = 350A	Tvj = 25°C	—	3.7	—	V
			Tvj = 150°C	—	3.9	—	
			Tvj = 175°C	—	3.9	—	
Reverse recovery time	t_{rr}	$V_{GS(on)}$ = 18V, $V_{GS(off)}$ = 0V V_{DS} = 800V I_D = 350A $R_{G(on)}$ = 6.8Ω, $R_{G(off)}$ = 3.3Ω Inductive load		—	37	—	ns
Recoverd charge	Q_{rr}			—	2445	—	nC
Peak reverse recovery current	I_{rr}			—	110	—	A
Reverse recovery energy	E_{rr}			—	0.1	—	mJ

NTC Thermistor electrical characteristics (Tvj = 25°C unless otherwise specified)

Parameter	Symbol	Conditions	Values			Unit
			Min.	Typ.	Max.	
NTC rated resistance	R_{25}	Tc = 25°C	—	4.950	—	kΩ
	R_{98}	Tc = 98°C	—	0.5185	—	
Deviation of R25	ΔR/R	Tc = 25°C	-5	—	5	%
Power dissipation	P_{25}	Tc = 25°C	—	—	50	mW
NTC B Value	$B_{25/98}$	$R = R_{25} \exp [B_{25/98}(1/T - 1/(298.15K))]$	—	3420	—	K

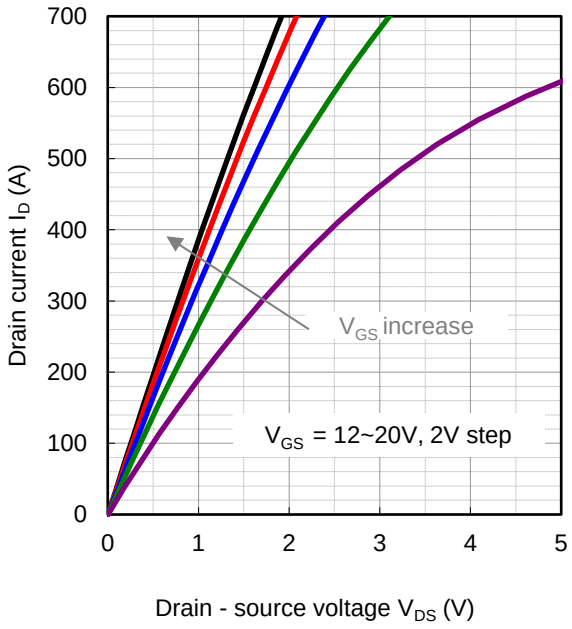
Note 6) Tested after applying V_{GS} = 21V for 100ms.

Note 7) Not include the resistance from terminals to chip.

Note 8) SiC devices have lower short circuit withstand capability due to high current density.
Please be advised to pay careful attention to short circuit accident
and try to adjust protection time to shutdown them as short as possible.

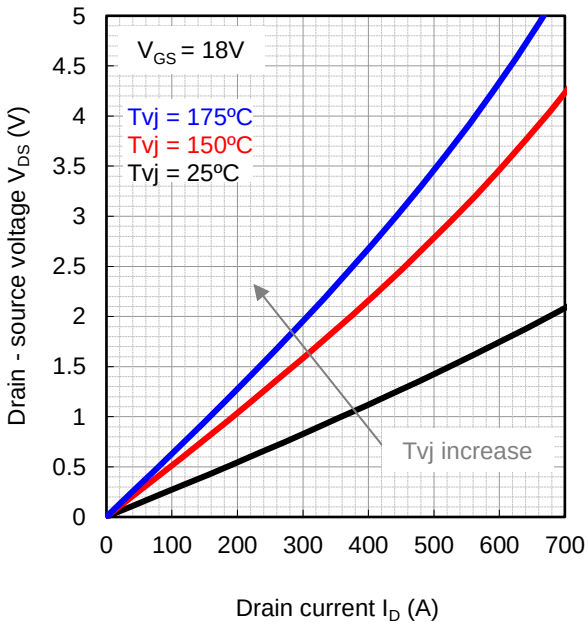
Electrical characteristic curves (Typical)

Figure 1. Output characteristic at 25°C (Typ.)



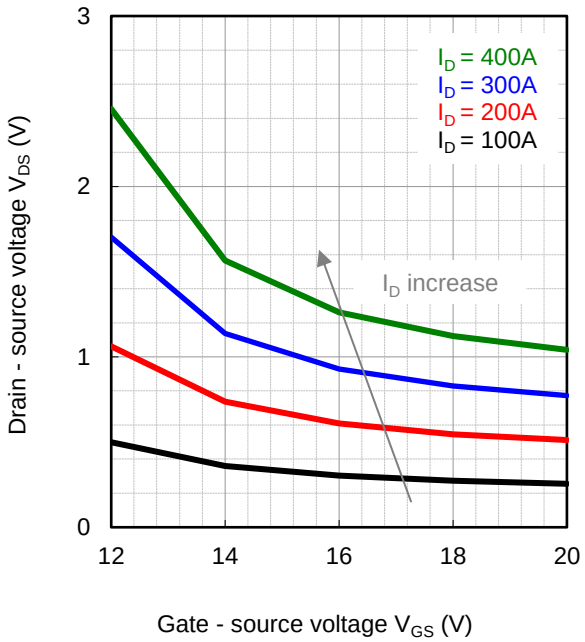
Note 7)

Figure 2. Drain - source voltage characteristic (Typ.)



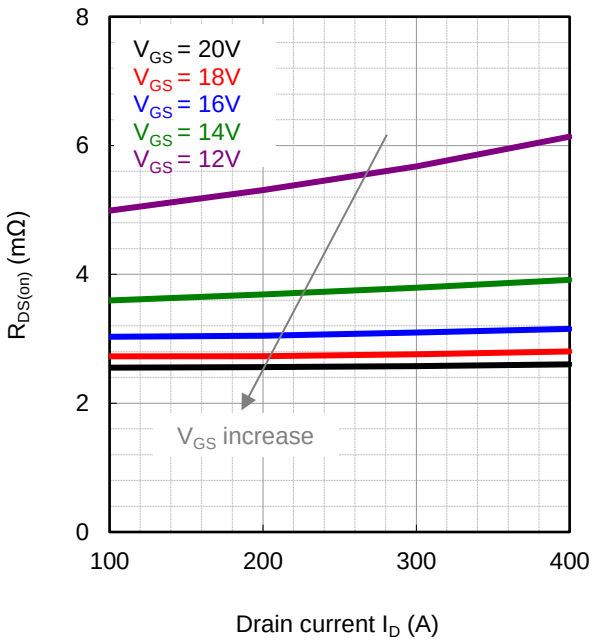
Note 7)

Figure 3. Drain - source voltage characteristic at 25°C (Typ.)



Note 7)

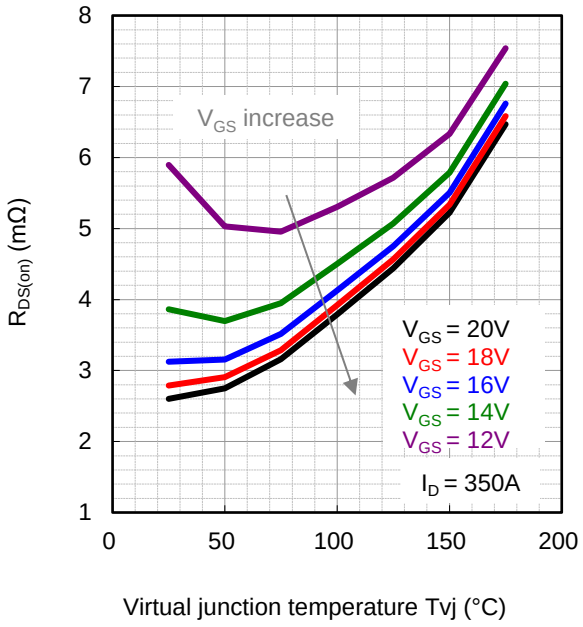
Figure 4. Drain current vs. $R_{DS(on)}$ at 25°C (Typ.)



Note 7)

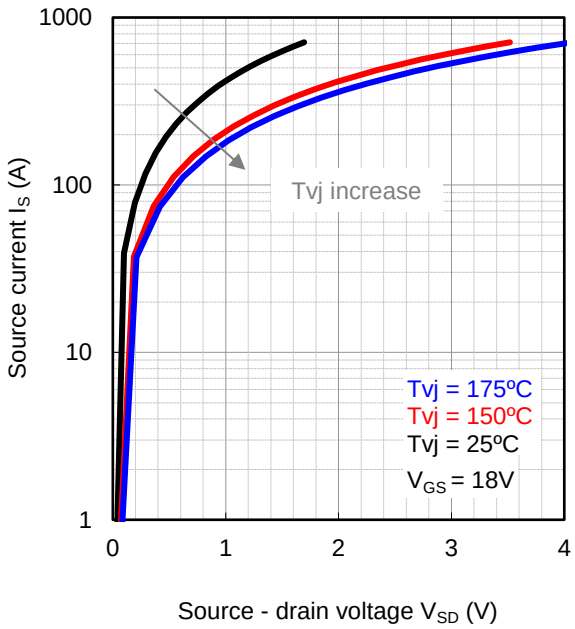
Electrical characteristic curves (Typical)

Figure 5. $R_{DS(on)}$ vs. Tvj characteristic (Typ.)



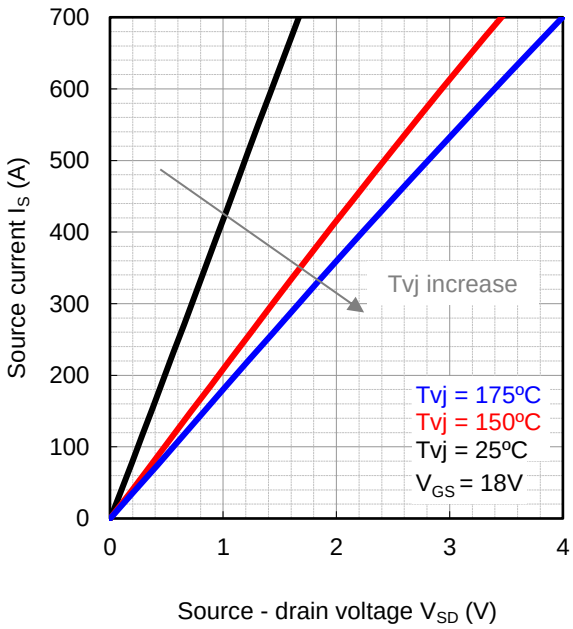
Note 7)

Figure 6. Forward characteristic of diode
V_{GS} = 18V (Typ.)



Note 7)

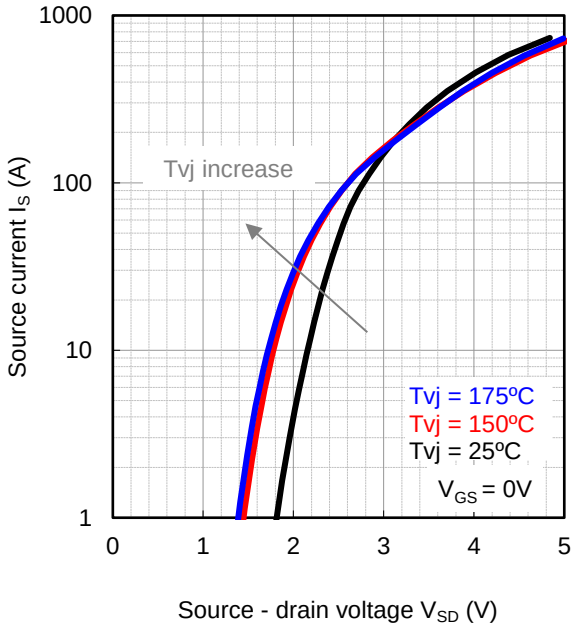
Figure 7. Forward characteristic of diode
V_{GS} = 18V (Typ.)



Note 7)

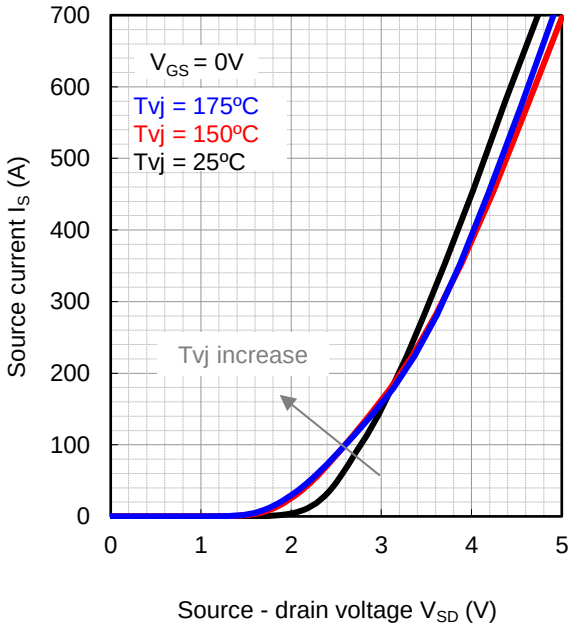
Electrical characteristic curves (Typical)

Figure 8. Forward characteristic of diode
V_{GS} = 0V (Typ.)



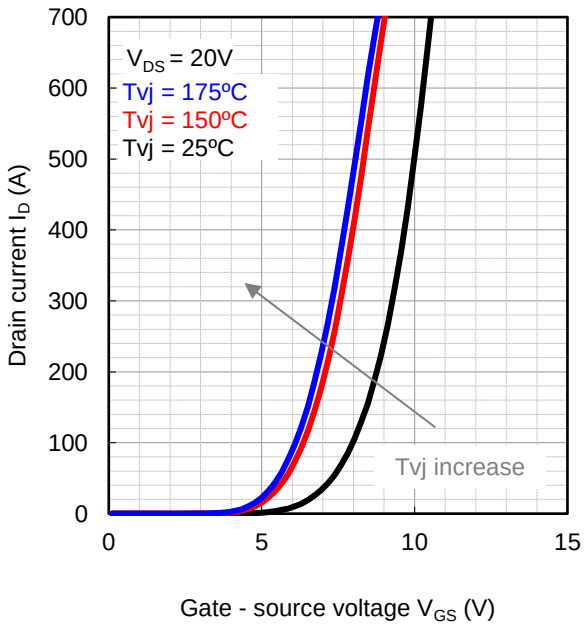
Note 7)

Figure 9. Forward characteristic of diode
V_{GS} = 0V (Typ.)



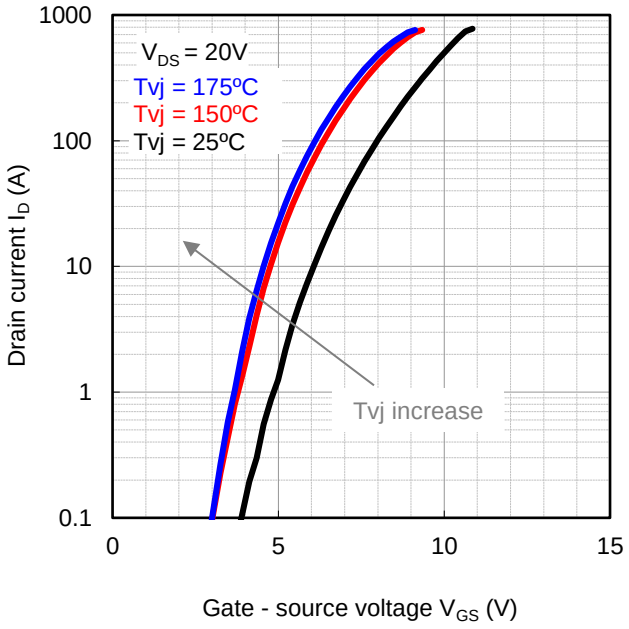
Note 7)

Figure 10. Drain current vs. Gate - source voltage (Typ.)



Note 7)

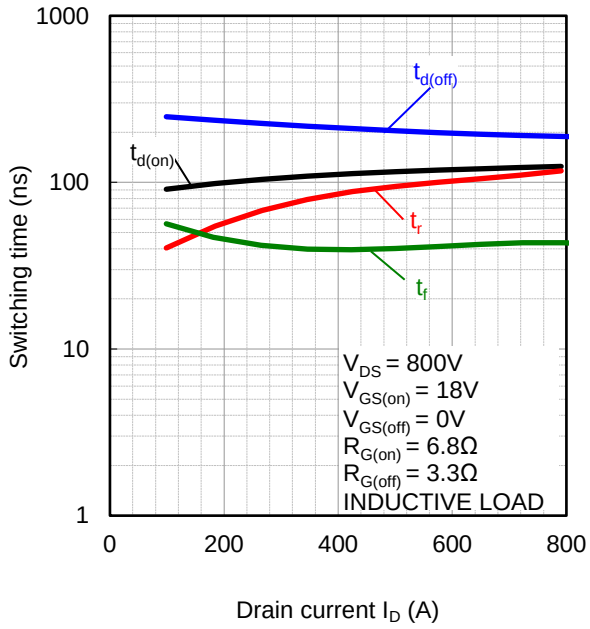
Figure 11. Drain current vs. Gate - source voltage (Typ.)



Note 7)

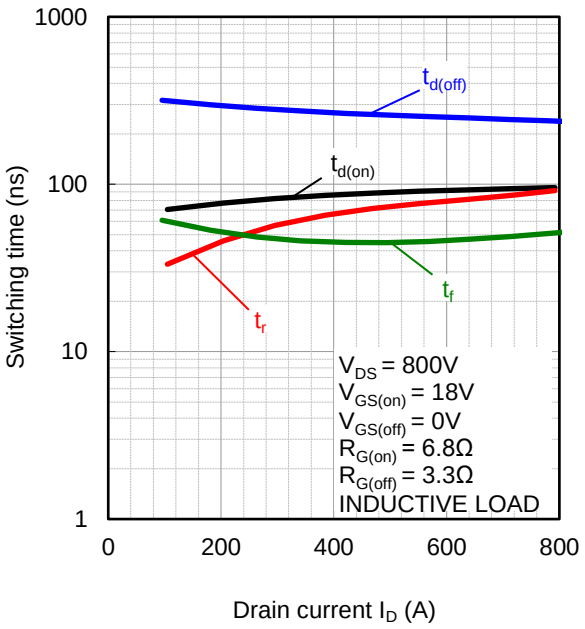
Electrical characteristic curves (Typical)

Figure 12. Switching time vs. Drain current at 25°C (Typ.)



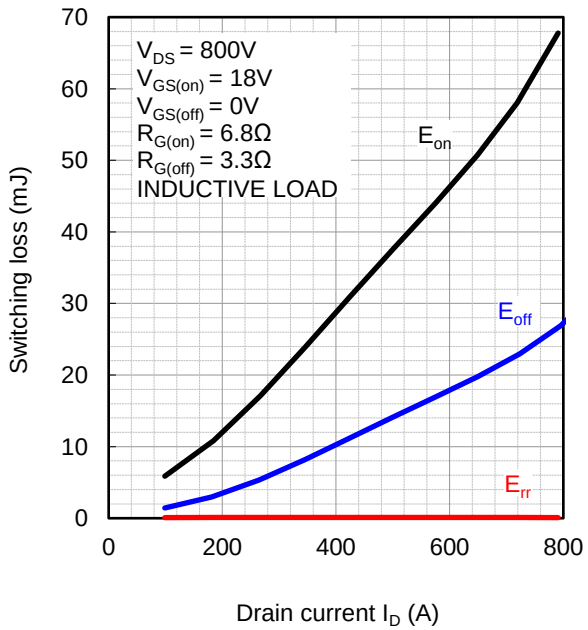
Note 7)

Figure 13. Switching time vs. Drain current at 175°C (Typ.)



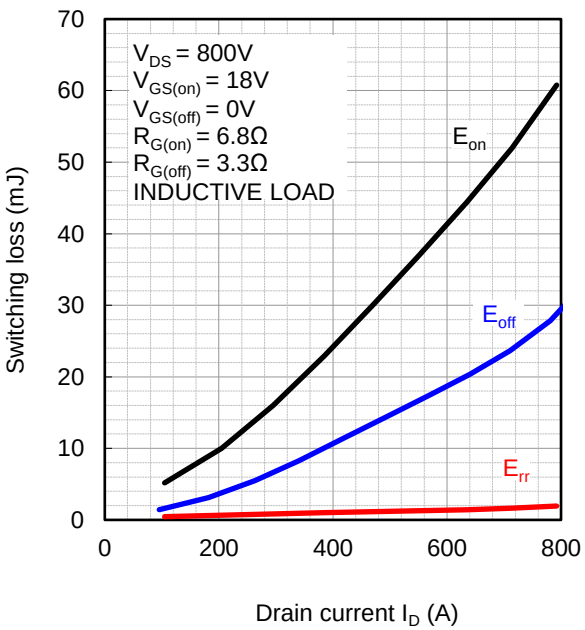
Note 7)

Figure 14. Switching loss vs. Drain current at 25°C (Typ.)



Note 7)

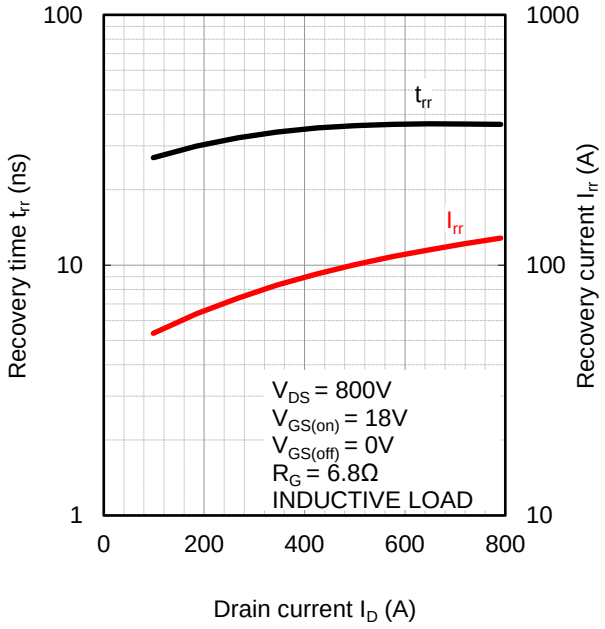
Figure 15. Switching loss vs. Drain current at 175°C (Typ.)



Note 7)

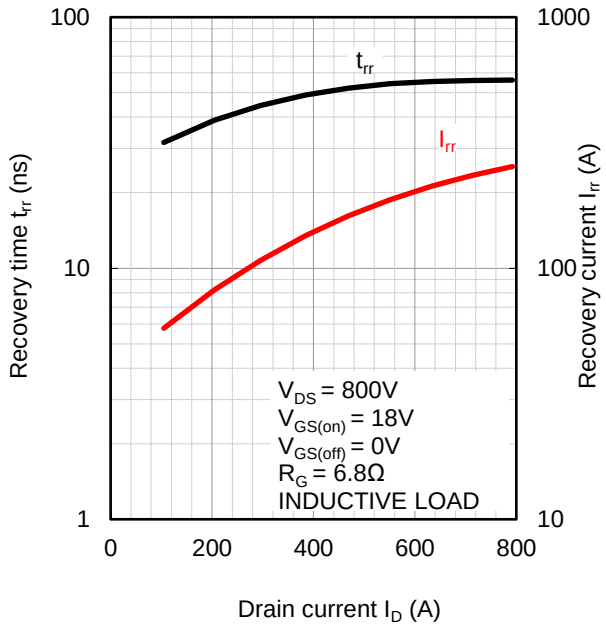
Electrical characteristic curves (Typical)

Figure 16. Recovery characteristic vs. Drain current at 25°C (Typ.)



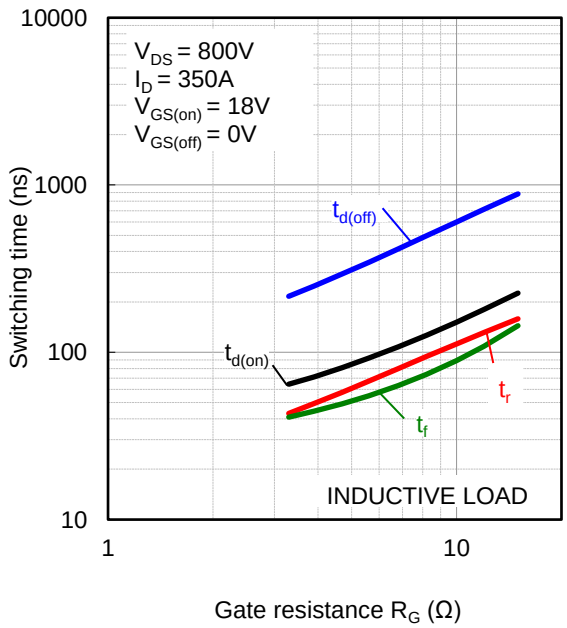
Note 7)

Figure 17. Recovery characteristic vs. Drain current at 175°C (Typ.)



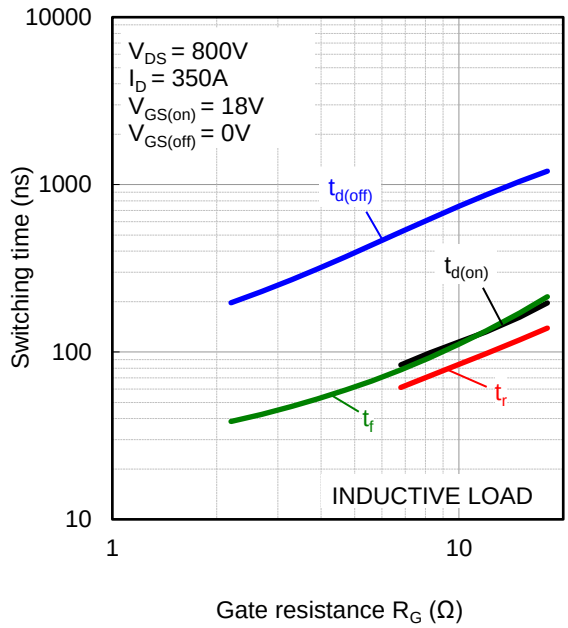
Note 7)

Figure 18. Switching time vs. Gate resistance at 25°C (Typ.)



Note 7)

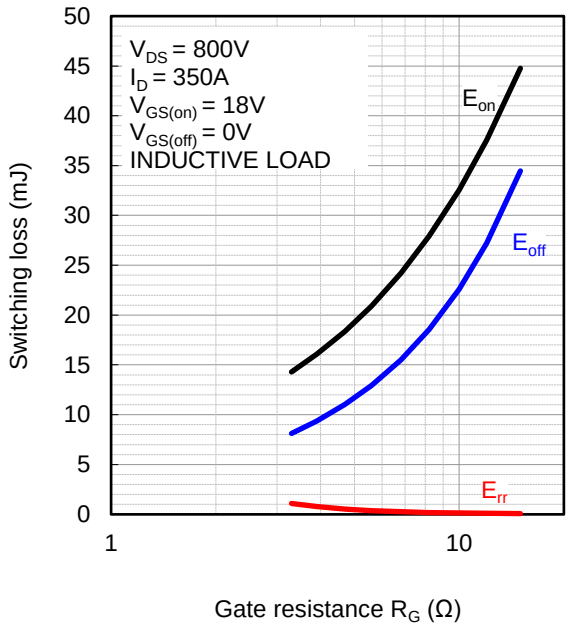
Figure 19. Switching time vs. Gate resistance at 175°C (Typ.)



Note 7)

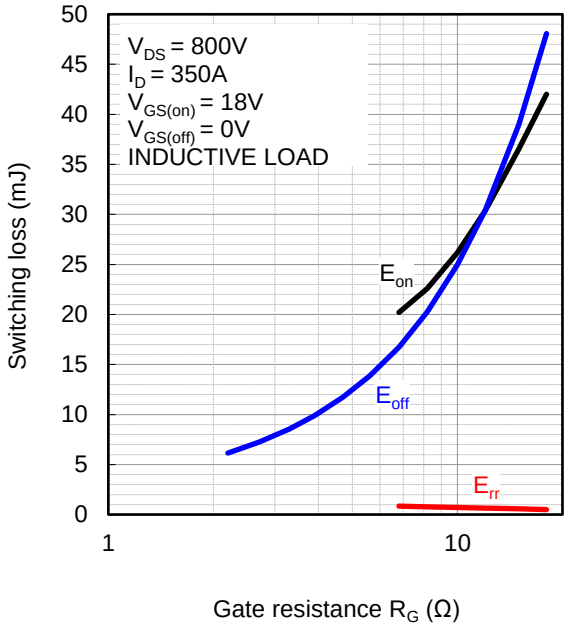
Electrical characteristic curves (Typical)

Figure 20. Switching loss vs. Gate resistance at 25°C (Typ.)



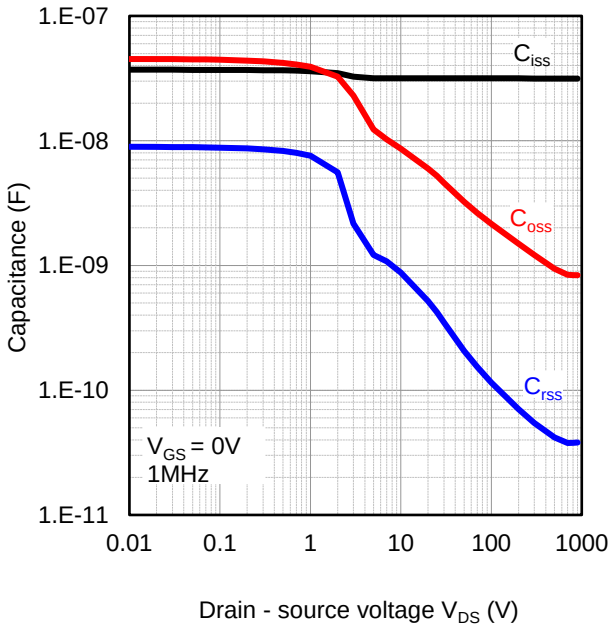
Note 7)

Figure 21. Switching loss vs. Gate resistance at 175°C (Typ.)



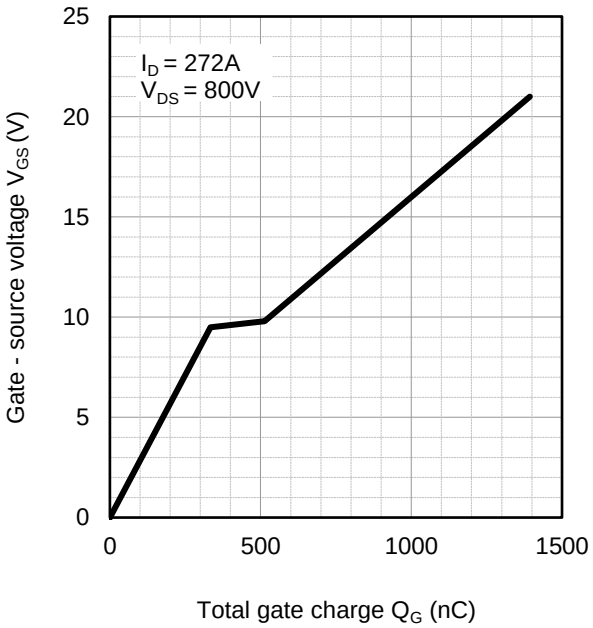
Note 7)

Figure 22. Capacitance vs. Drain - source voltage at 25°C (Typ.)



Note 7)

Figure 23. Gate charge characteristic at 25°C (Typ.)



Note 7)

Electrical characteristic curves (Typical)

Figure 24. Transient thermal impedance (Typ.)

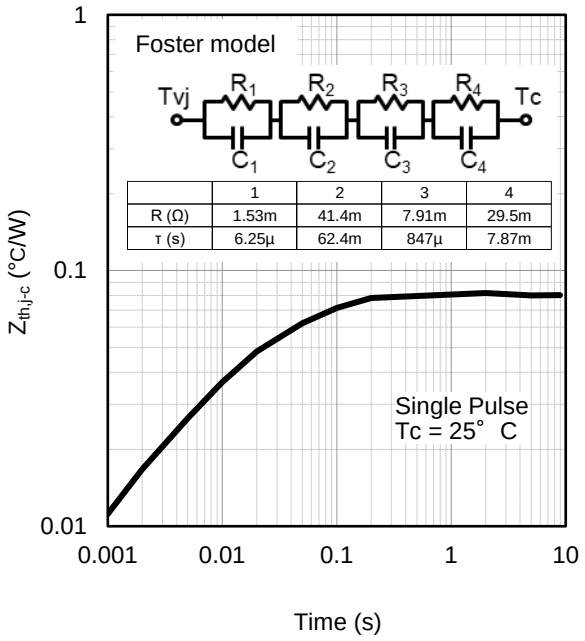


Figure 25. Maximum safe operating area

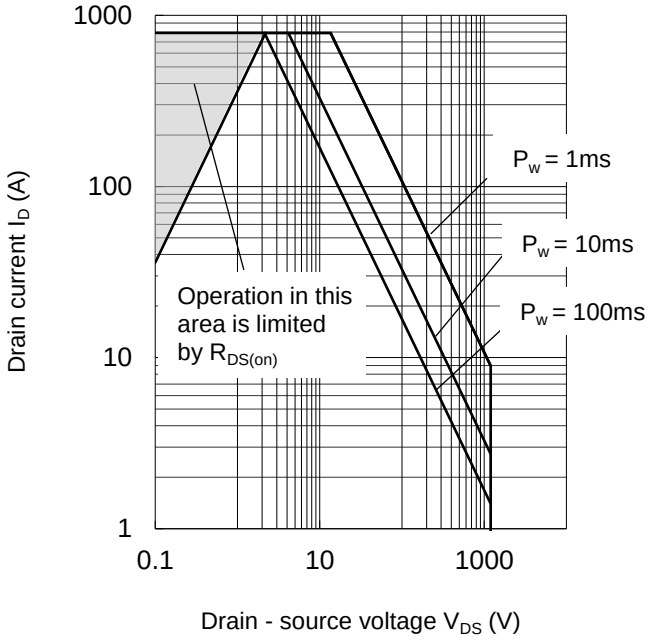


Figure 26. NTC Thermistor temperature characteristic (Typ.)

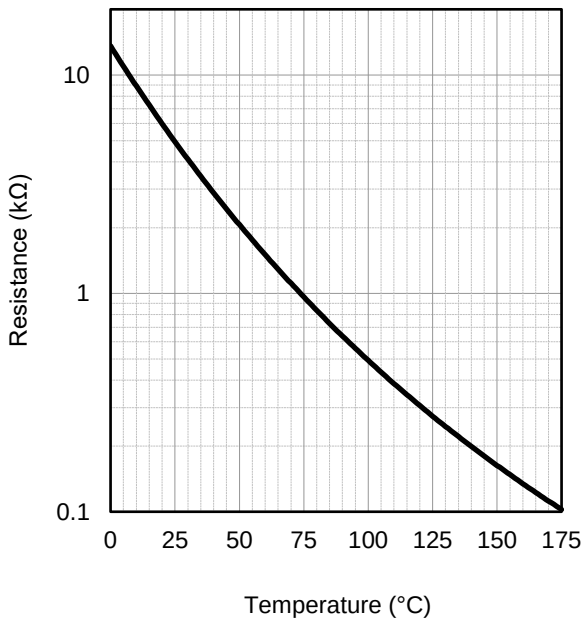
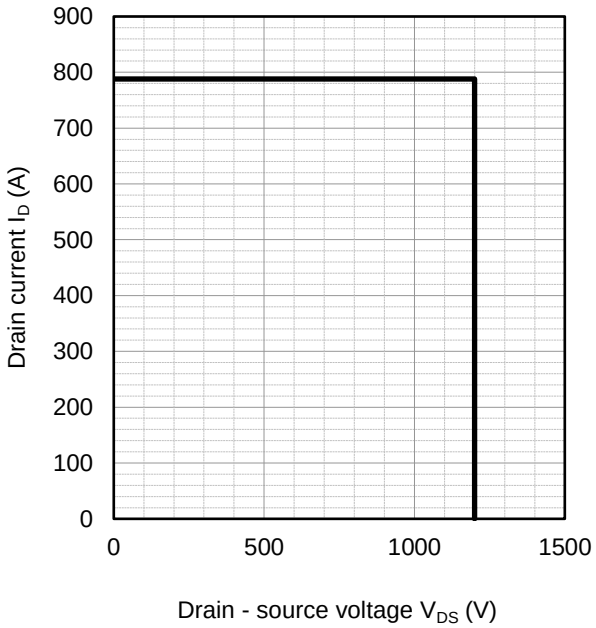
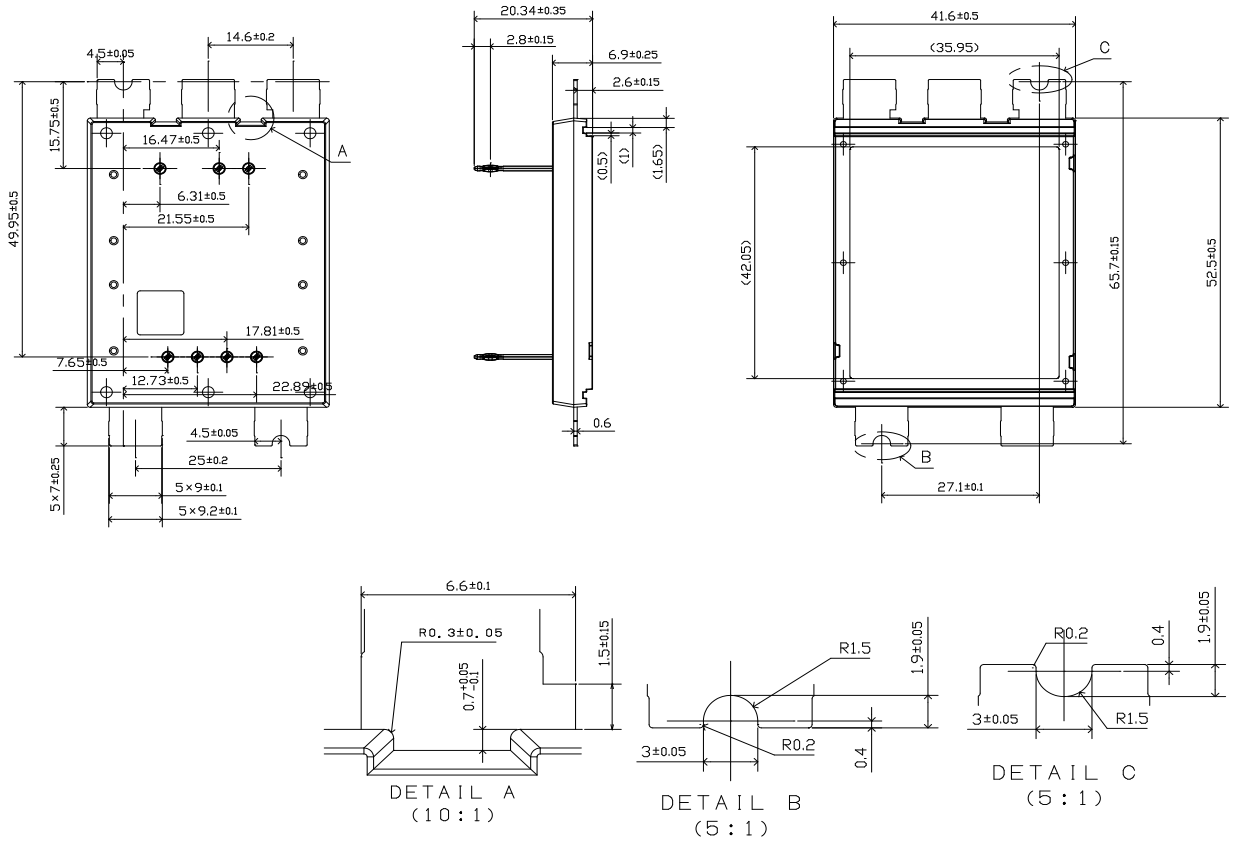


Figure 27. MOSFET RBSOA (Typ.)



Package outlines

Unit : mm



Notes

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ROHM SEMICONDUCTOR

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