Automotive Grade SiC Power Module

BST25B2P4K01-VC

Datasheet

Features

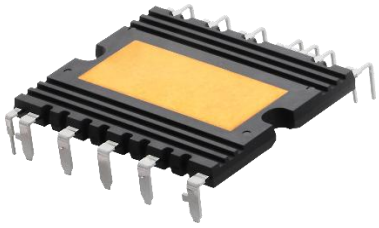
· HSDIP20 package
with the 4th Generation SiC-MOSFET
· V_{DSS} = 1200V
· Low $R_{DS(on)}$
· High-speed switching possible
· Low switching losses
· Tvjmax = 175°C
· Compact design
· With high thermal conductivity isolation
· Integrated NTC temperature sensor
· 4.2kV AC 1s insulation

Construction

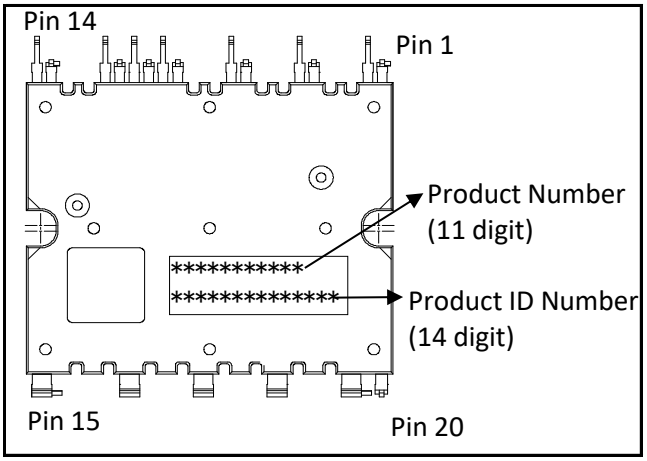
The power module is a full bridge module which implements SiC-MOSFETs.

Application

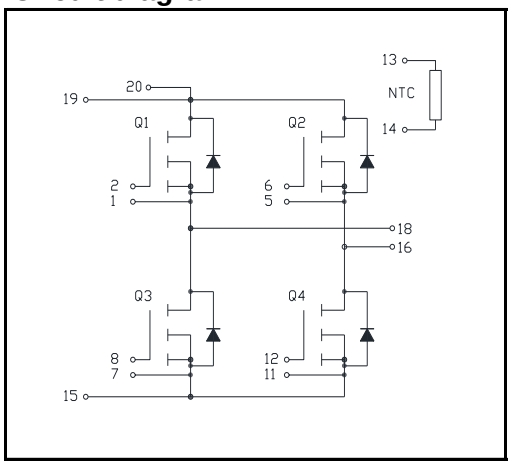
· Automotive application
· Inverter, Converter
· (Hybrid) electrical vehicles EV/HEV



Outline



Circuit diagram



Pin No.	Pin Name	Function
1	S1	MOSFET Source
2	G1	MOSFET Gate
3	N.C	Non connect
4	N.C	Non connect
5	S2	MOSFET Source
6	G2	MOSFET Gate
7	S3	MOSFET Source
8	G3	MOSFET Gate
9	N.C	Non connect
10	N.C	Non connect

Pin No.	Pin Name	Function
11	S4	MOSFET Source
12	G4	MOSFET Gate
13	T1	Thermistor
14	T2	Thermistor
15	N	Negative power
16	W	Output
17	N.C	Non connect
18	U	Output
19	P	Positive Power
20	Ps	Positive Power sense

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)	$V_{GSSsurge}$		-4 to +23	
Continuous drain current (DC)	I_D	Tc = 25°C, V_{GS} = 18V	25	A
		Tc = 100°C, V_{GS} = 18V	17	
Pulsed drain current	$I_{D,pulse}$	Pulse 1ms, Tc = 25°C, V_{GS} = 18V Note 2), 5)	57	
		Pulse 1ms, Tc = 100°C, V_{GS} = 18V Note 2), 5)	40	
Continuous source current (DC)	I_S	Tc = 25°C, V_{GS} = 18V	25	
Pulsed source current	$I_{S,pulse}$	Pulse 1.5µs, Tc = 25°C, V_{GS} = 18V Note 2)	57	
Body diode surge forward current	$I_{S,pulse}$	Pulse 1.5µs, Tc = 100°C, V_{GS} = 0V Note 2), 4), 5)	26	
Total power dissipation Note 3), 5)	Ptot	Tc = 25°C	152	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 cooper surface just under the chips.
Note 4) Repetitive pulse, PW≦1.5µs, Duty cycle≦5%
Note 5) Tvj is less than 175°C.

Figure 1. Example of acceptable V_{GS} waveform

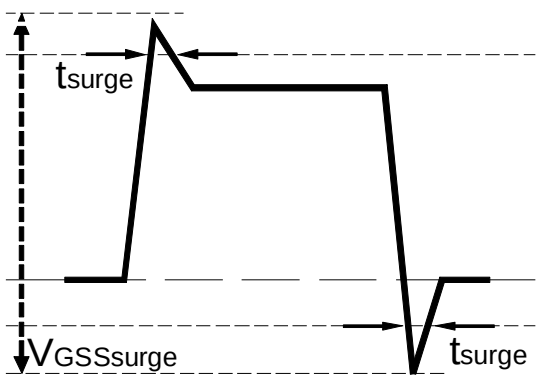
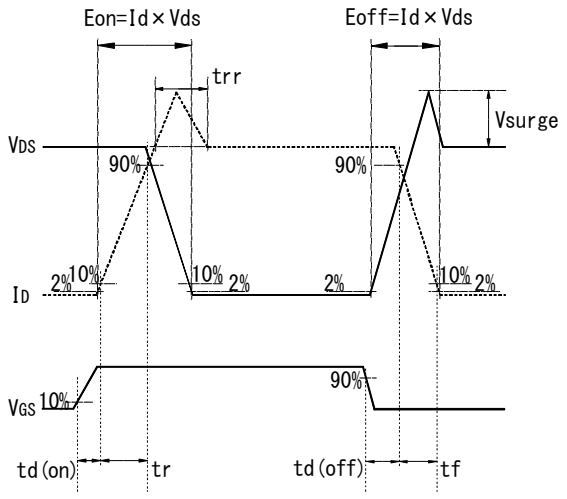


Figure 2. Wavelength for switching test



Module (Tvj = 25°C unless otherwise specified)

Parameter	Symbol	Conditions	Values			Unit
			Min.	Typ.	Max.	
Isolation test voltage	V_{isol}	All terminals to baseplate AC 60Hz 1sec.	4200	—	—	V_{rms}
Stray inductance	L_s	Terminal P to Terminal N	—	46	—	nH
Creepage distance	—	Terminal to heat sink	13.9	—	—	mm
		Terminal to terminal	8.2	—	—	
Clearance distance	—	Terminal to heat sink	10.2	—	—	mm
		Terminal to terminal	4.3	—	—	
Module flatness (Heatsink side)	—	Measurement point is shown in Figure 3.	0	—	100	μm
Mounting torque	—	Mounting to heatsink with M3 screw Note 6)	0.59	0.69	0.78	N·m
Terminal pulling strength	—	Load:4.9N(Control terminal), 9.8N(Power terminal) Note 7)	10	—	—	s
Terminal bending strength	—	Load:2.45N (Control terminal), 4.9N(Power terminal) Note7)	2	—	—	time
Thermal resistance, junction - case	$R_{th(j-c)}$	1 arm heating Note 3)	—	0.72	0.99	°C/W

Note 6) 8 mm (outside diameter) plain washers (ISO 7089 to 7094) are recommended.
Note 7) EIAJ-ED-4701/400
Note 8) Rth(j-c) was measured after 1chip heating. Heatsink temperature was keep in 25°C.
The Rth(j-c) result was calculated from measured structure function, based on JESD51-14 guideline.
100μm thickness of thermally conductive grease was introduced between module and heatsink and fastened with two M4 screws with 0.85N・m torque.
Note 9) When installing a module to a heat sink, excessive uneven fastening force might apply stress to inside chips or ceramic of heat sink plate, which will break or crack or degrade a module.
An example of recommended fastening sequence is shown in Figure 5. The temporary fastening torque is set to 20 to 30% of the maximum torque rating.

Figure 3. Measurement point of module flatness

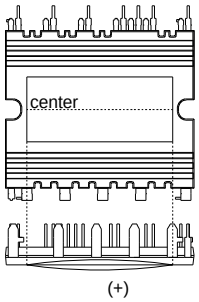


Figure 4. Flatness after installing to a heatsink (when using a heat radiation sheet)

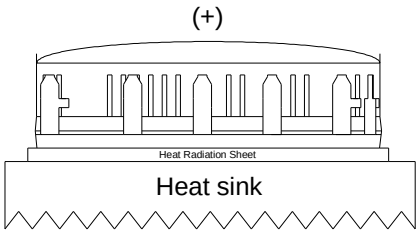
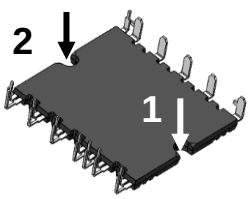


Figure 5. Example of recommended fastening sequence



Temporary fastening: 1→2
Permanent fastening: 1→2

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 = 12A, V_{GS} = 18V	Tvj = 25°C	—	62	—	mΩ
		I_D = 25A, V_{GS} = 18V	Tvj = 25°C	—	67	89	
			Tvj = 175°C	—	164	—	
Zero gate voltage drain current	I_{DSS}	V_{DS} = 1200V, V_{GS} = 0V		—	—	80	μA
Drain-Source breakdown voltage	$V_{(BR)DSS}$	V_{GS} = 0V, I_D=5.3mA, T_{vj}=25°C		1200	—	—	V
Gate - source threshold voltage	$V_{GS(th)}$	V_{DS} = 10V, I_D = 6.45mA Note 12)		2.8	—	4.8	V
Gate - source leakage current	I_{GSS}	V_{GS} = +21V, V_{DS} = 0V		—	—	0.1	μA
		V_{GS} = -4V, V_{DS} = 0V		-0.1	—	—	
Turn - on delay time	$t_{d(on)}$	$V_{GS(on)}$ = 18V, $V_{GS(off)}$ = 0V V_{DS} = 800V I_D = 25A $R_{G(on)}$ = 8.2Ω, $R_{G(off)}$ = 12Ω Inductive load		—	10	—	ns
Rise time	t_r			—	10	—	
Turn - off delay time	$t_{d(off)}$			—	70	—	
Fall time	t_f			—	10	—	
Turn - on switching loss	E_{on}			—	0.44	—	mJ
Turn - off switching loss	E_{off}			—	0.27	—	
Input capacitance	C_{iss}	V_{DS} = 800V, V_{GS} = 0V, 1MHz		—	1.5	—	nF
Total gate charge	Q_g	$V_{GS(on)}$ = 18V, $V_{GS(off)}$ = 0V V_{DS} = 800V I_D = 12A		—	64	—	nC
Gate - source charge	Q_{gs}			—	14	—	
Gate - drain charge	Q_{gd}			—	17	—	
Internal gate resistance	R_{Gint}	Tvj = 25°C		—	1	—	Ω

Note 10) Evenly apply thermally-conductive grease with 100μm to 200μm thickness over the contact surface between the module and the heat sink. Pay attention not to have any dirt left on the contact surface between the module and the heat sink.
It is recommended to install a module directly to a heat sink after applying grease.

Note 11) When installing a module to a heat sink, inserting a heat radiation sheet between a module and a heat sink might apply stress depending on thickness and elastic modulus of the sheet to inside chips or ceramic of heat sink plate, which will break or crack or degrade a module.
When using a heat radiation sheet, it is needed to prevent power module from bending into + side of Figure 4.

Note 12) Tested after applying V_{GS} = 21V for 100ms.

Note 13) 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.

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

Parameter	Symbol	Conditions		Values			Unit
				Min.	Typ.	Max.	
Souce - drain voltage	V_{SD}	V_{GS} = 0V, I_S = 25A	Tvj = 25°C	–	4.2	–	V
			Tvj = 175°C	–	4.8	–	
		V_{GS} =18V, I_S = 25A	Tvj = 25°C	–	1.4	–	
			Tvj = 175°C	–	3.4	–	

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	–	10	–	kΩ
NTC B Value	$B_{50/25}$		–	3380	–	K
Maximum operating current	–		–	–	0.1	mA

Electrical characteristic curves (Typical)

Figure 6. Output characteristic at 25°C (Typ.)

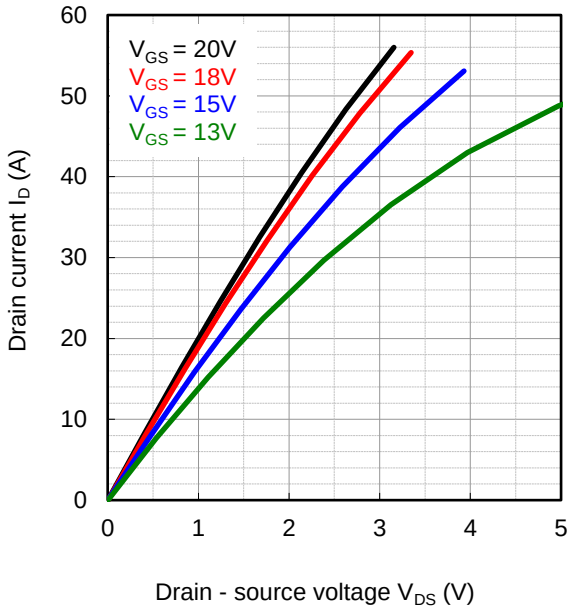


Figure 7. Drain - source voltage characteristic (Typ.)

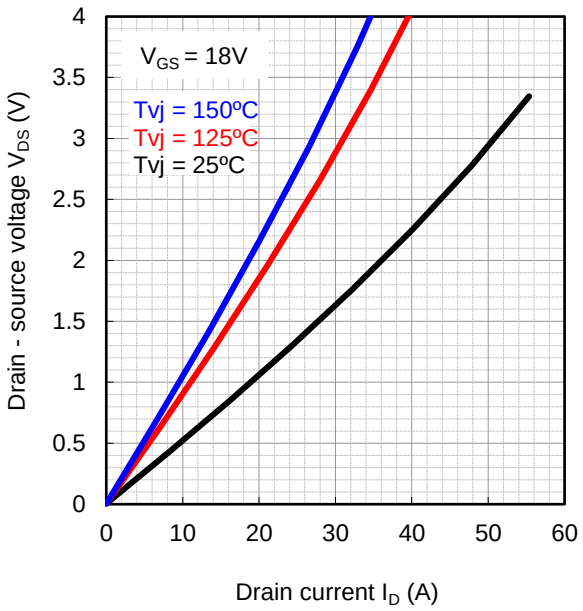
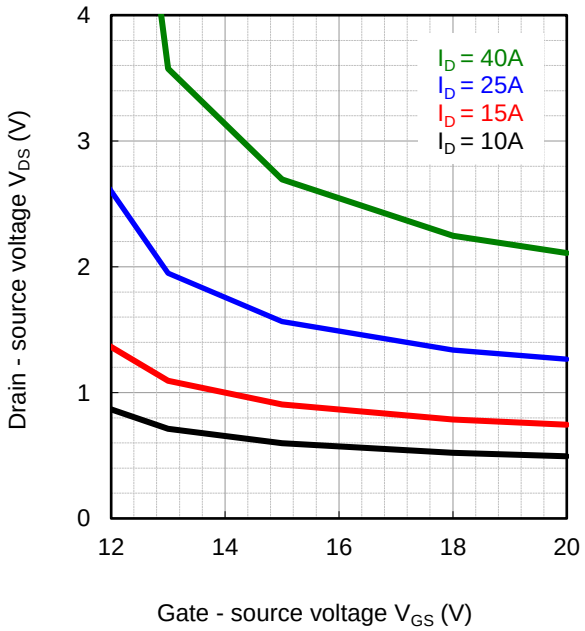


Figure 8. Drain - source voltage characteristic at 25°C (Typ.)



Electrical characteristic curves (Typical)

Figure 9. $R_{DS(on)}$ vs. Tvj characteristic (Typ.)

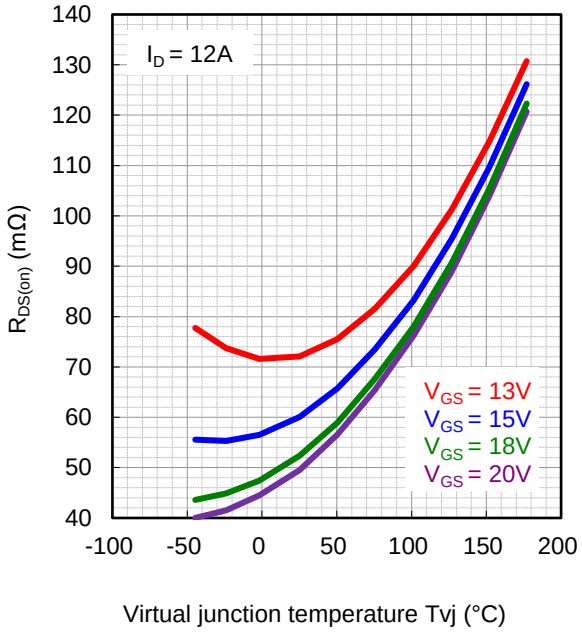


Figure 10. Forward characteristic of diode
V_{GS} = 18V (Typ.)

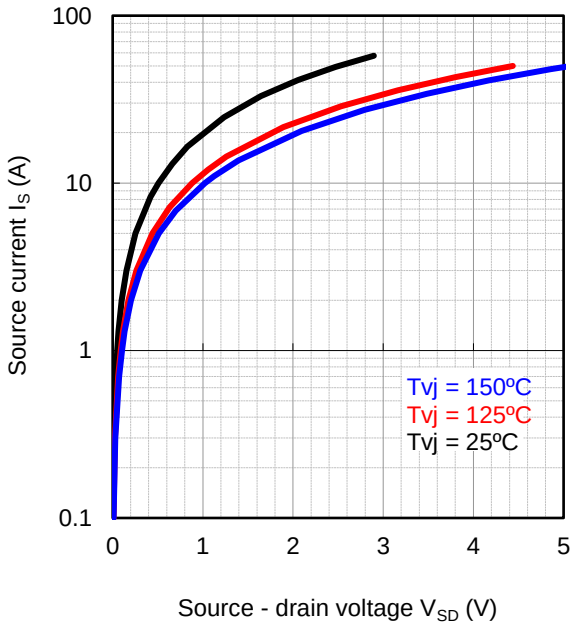
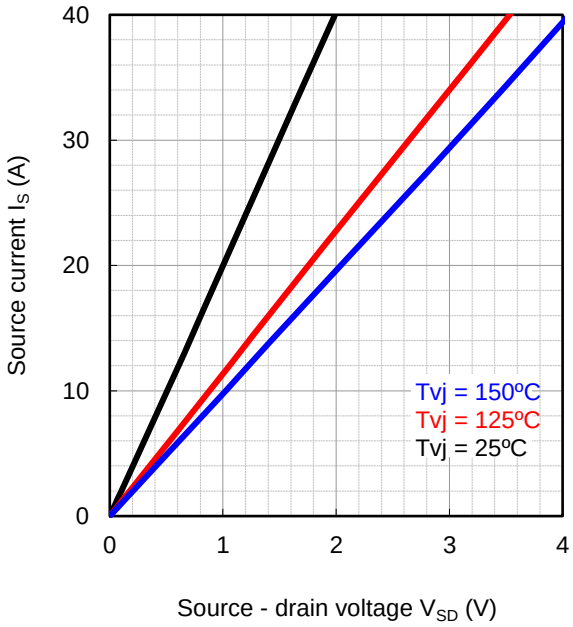


Figure 11. Forward characteristic of diode
V_{GS} = 18V (Typ.)



Electrical characteristic curves (Typical)

Figure 12. Forward characteristic of diode
V_{GS} = 0V (Typ.)

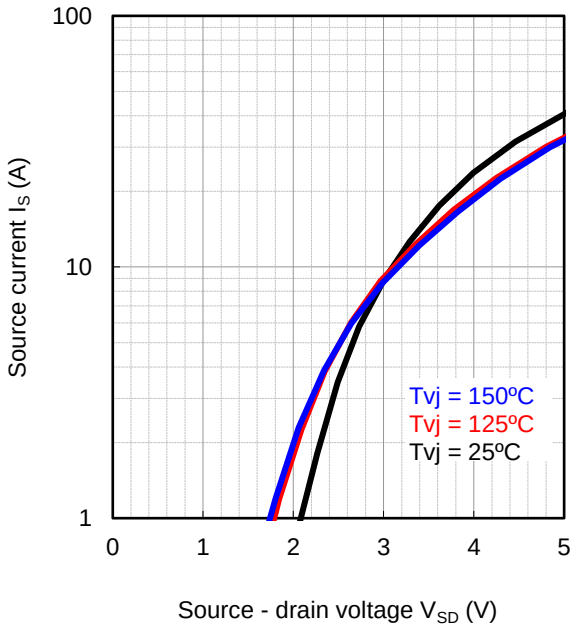


Figure 13. Forward characteristic of diode
V_{GS} = 0V (Typ.)

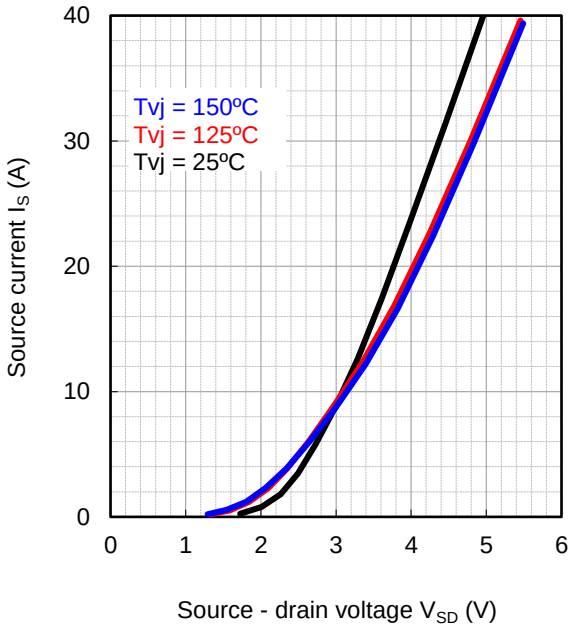


Figure 14. Drain current vs. Gate - source voltage (Typ.)

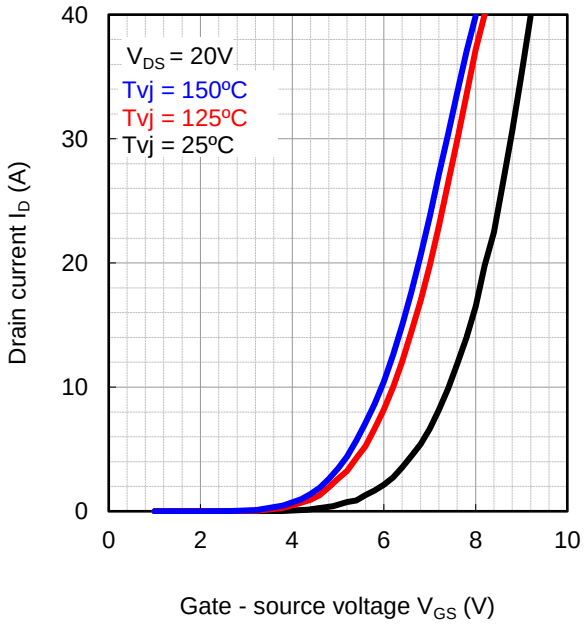
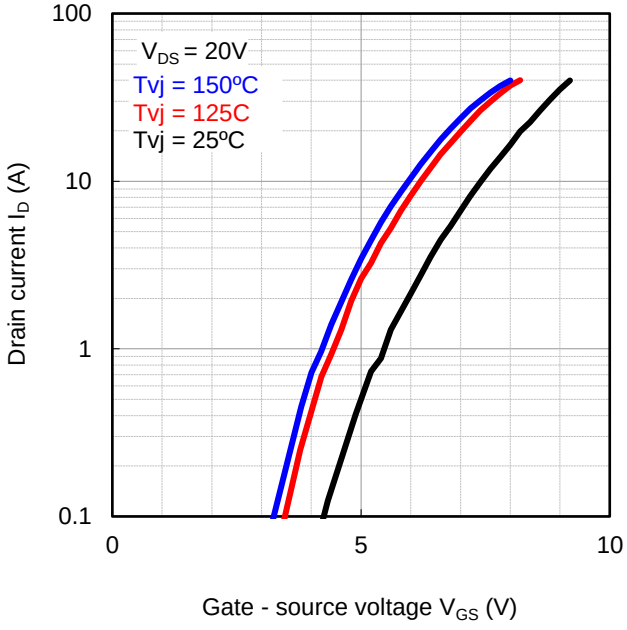


Figure 15. Drain current vs. Gate - source voltage (Typ.)



Electrical characteristic curves (Typical)

Figure 16. Switching time vs. Drain current at 25°C (Typ.)

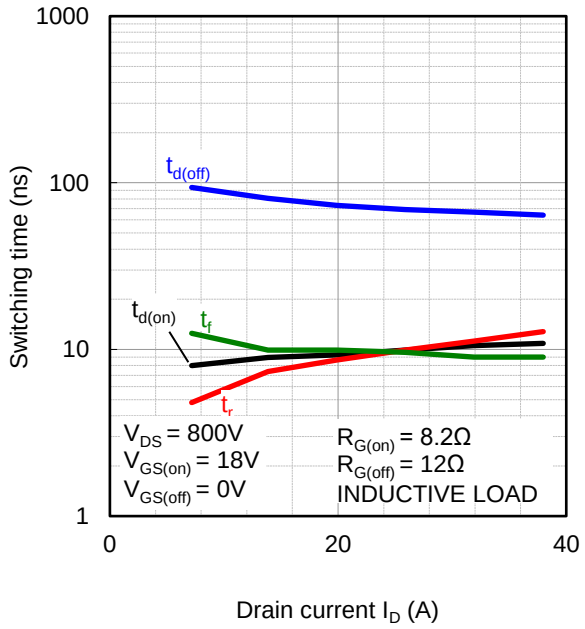


Figure 17. Switching time vs. Drain current at 150°C (Typ.)

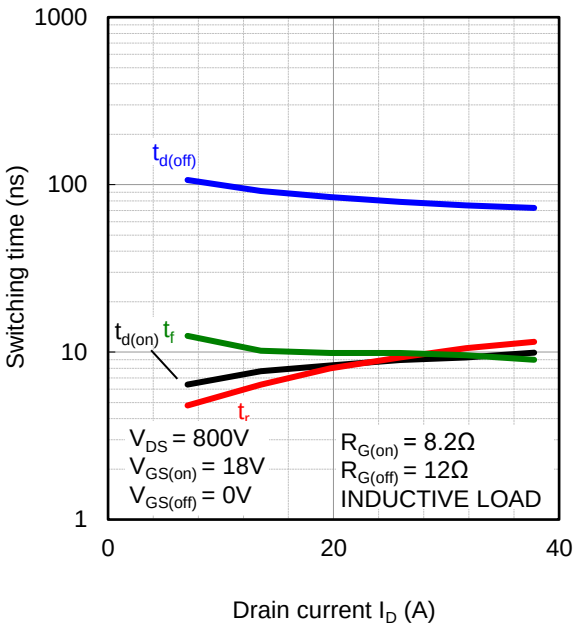


Figure 18. Switching loss vs. Drain current at 25°C (Typ.)

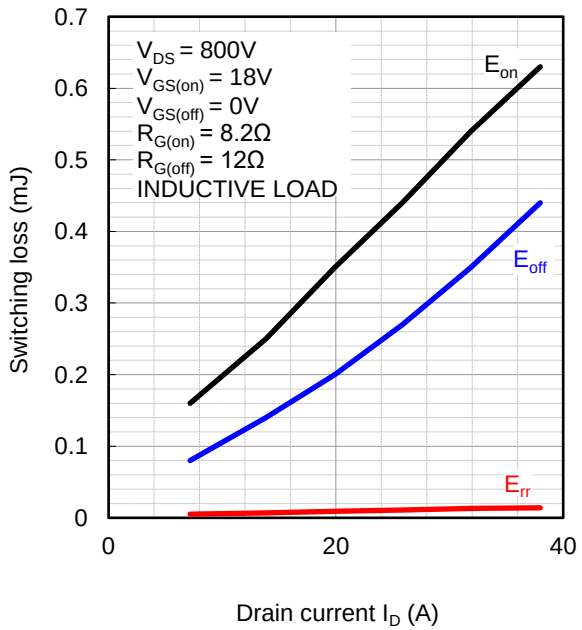
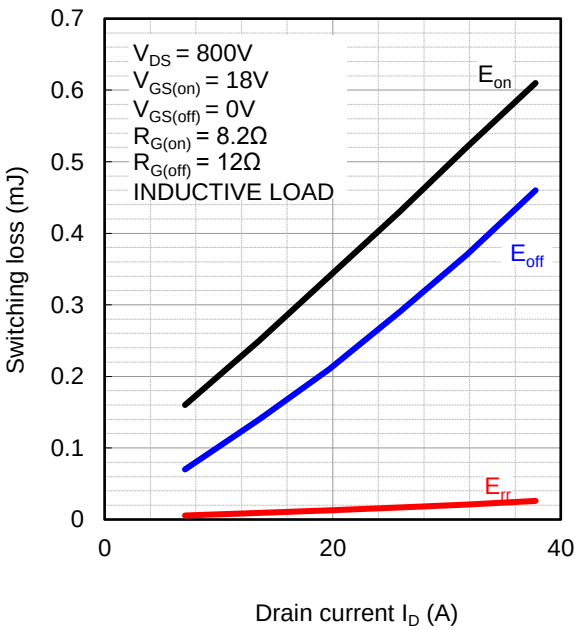


Figure 19. Switching loss vs. Drain current at 150°C (Typ.)



Electrical characteristic curves (Typical)

Figure 20. Recovery characteristic vs. Drain current at 25°C (Typ.)

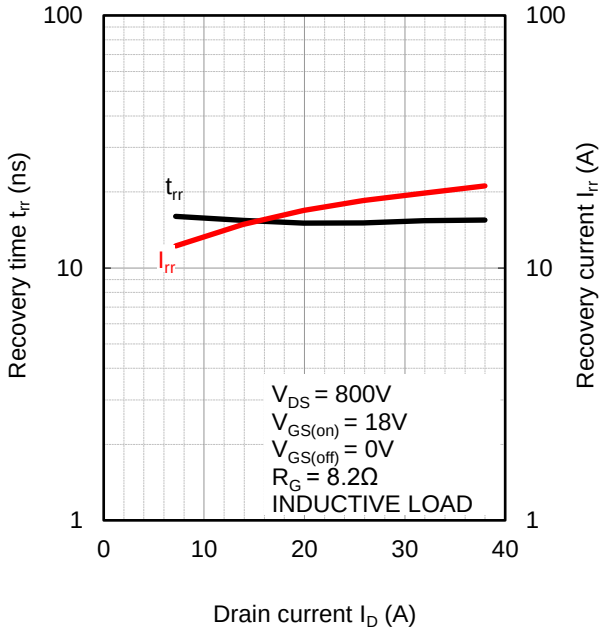


Figure 21. Recovery characteristic vs. Drain current at 150°C (Typ.)

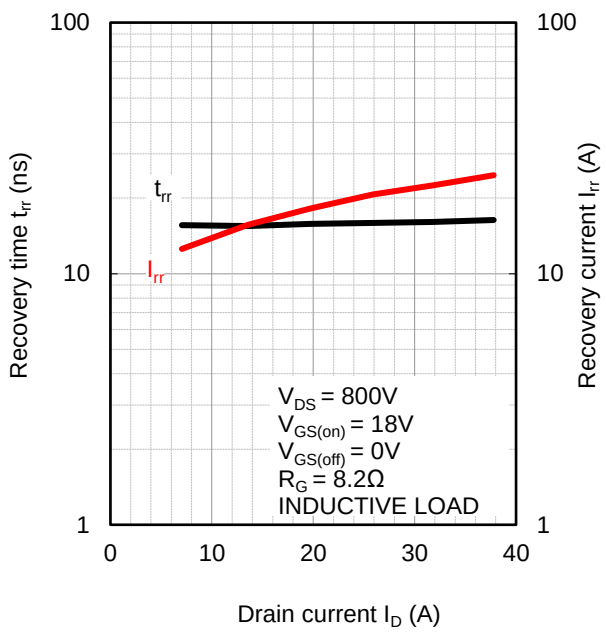


Figure 22. Switching time vs. Gate resistance at 25°C (Typ.)

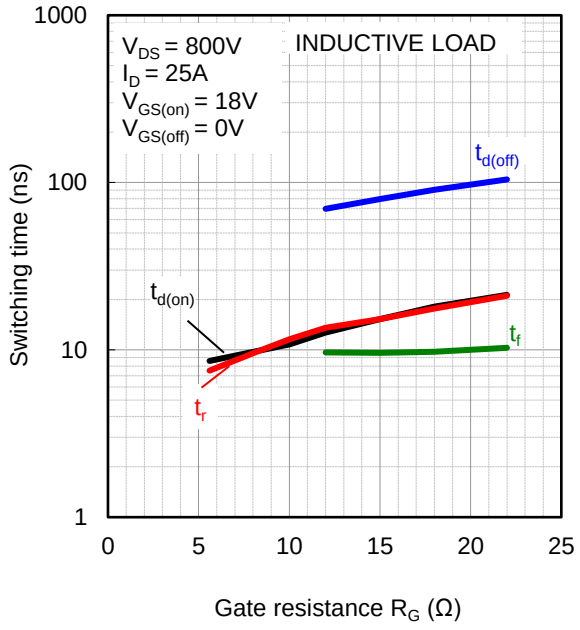
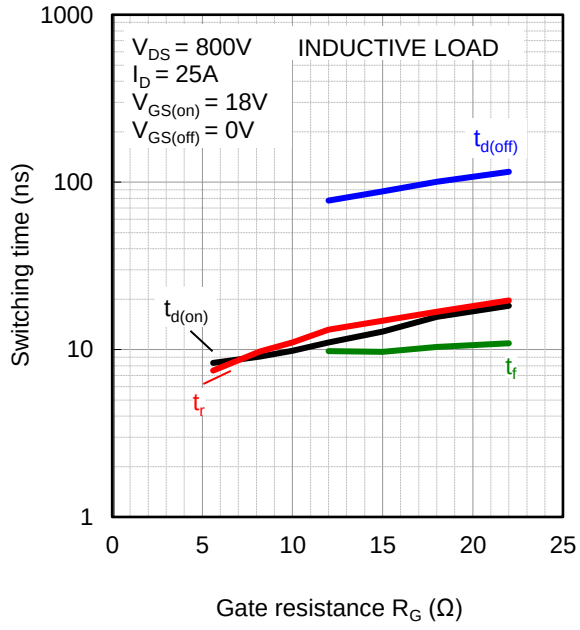


Figure 23. Switching time vs. Gate resistance at 150°C (Typ.)



Electrical characteristic curves (Typical)

Figure 24. Switching loss vs. Gate resistance at 25°C (Typ.)

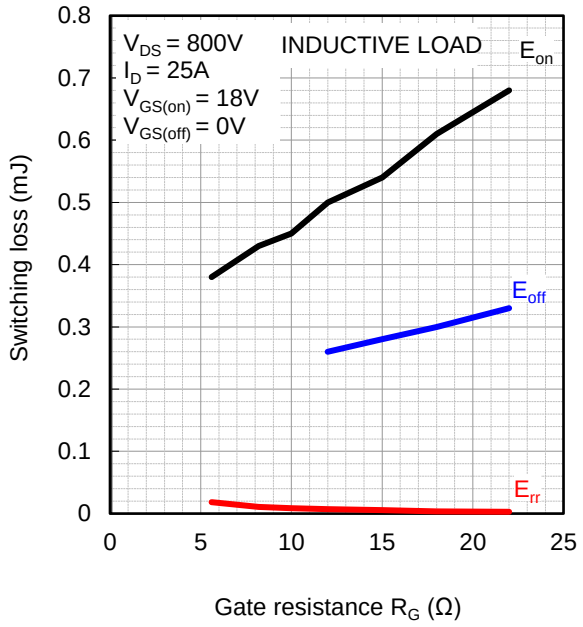


Figure 25. Switching loss vs. Gate resistance at 150°C (Typ.)

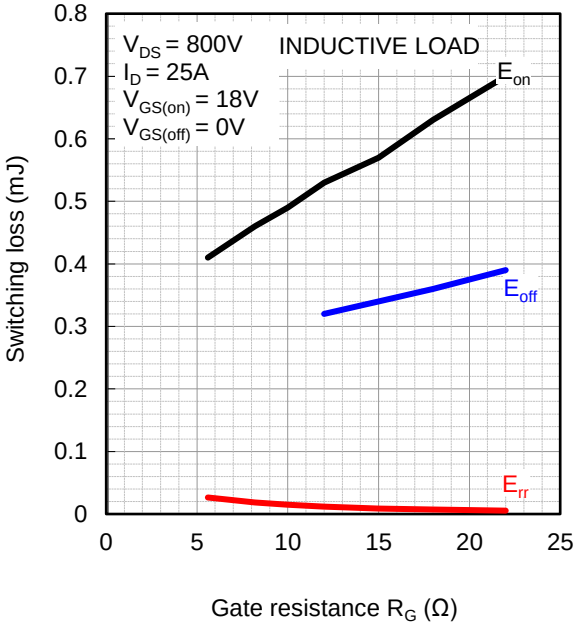


Figure 26. Capacitance vs. Drain - source voltage at 25°C (Typ.)

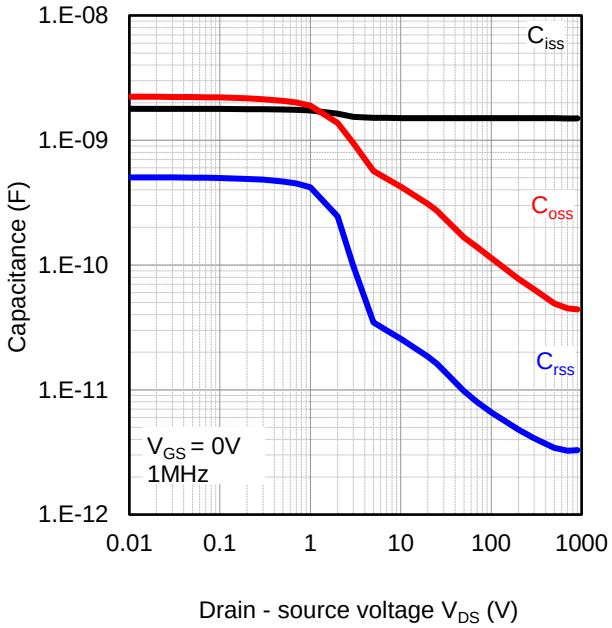
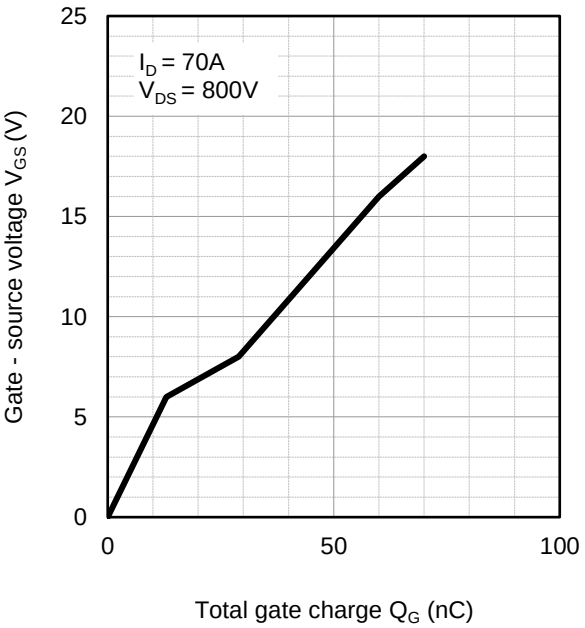
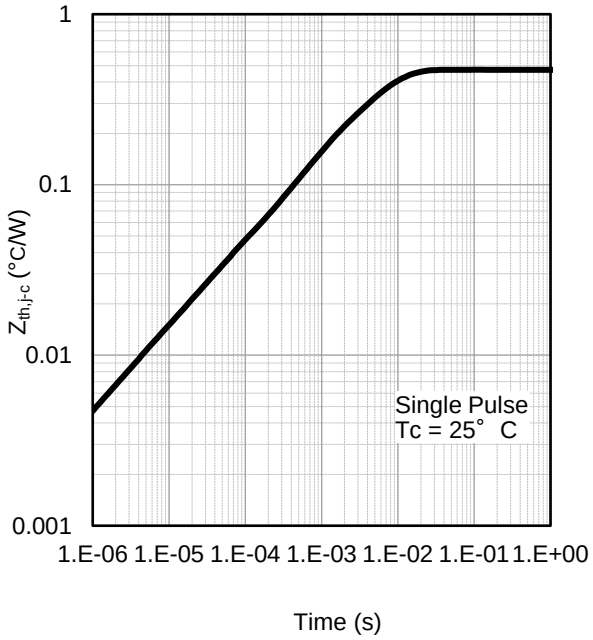


Figure 27. Gate charge characteristic at 25°C (Typ.)



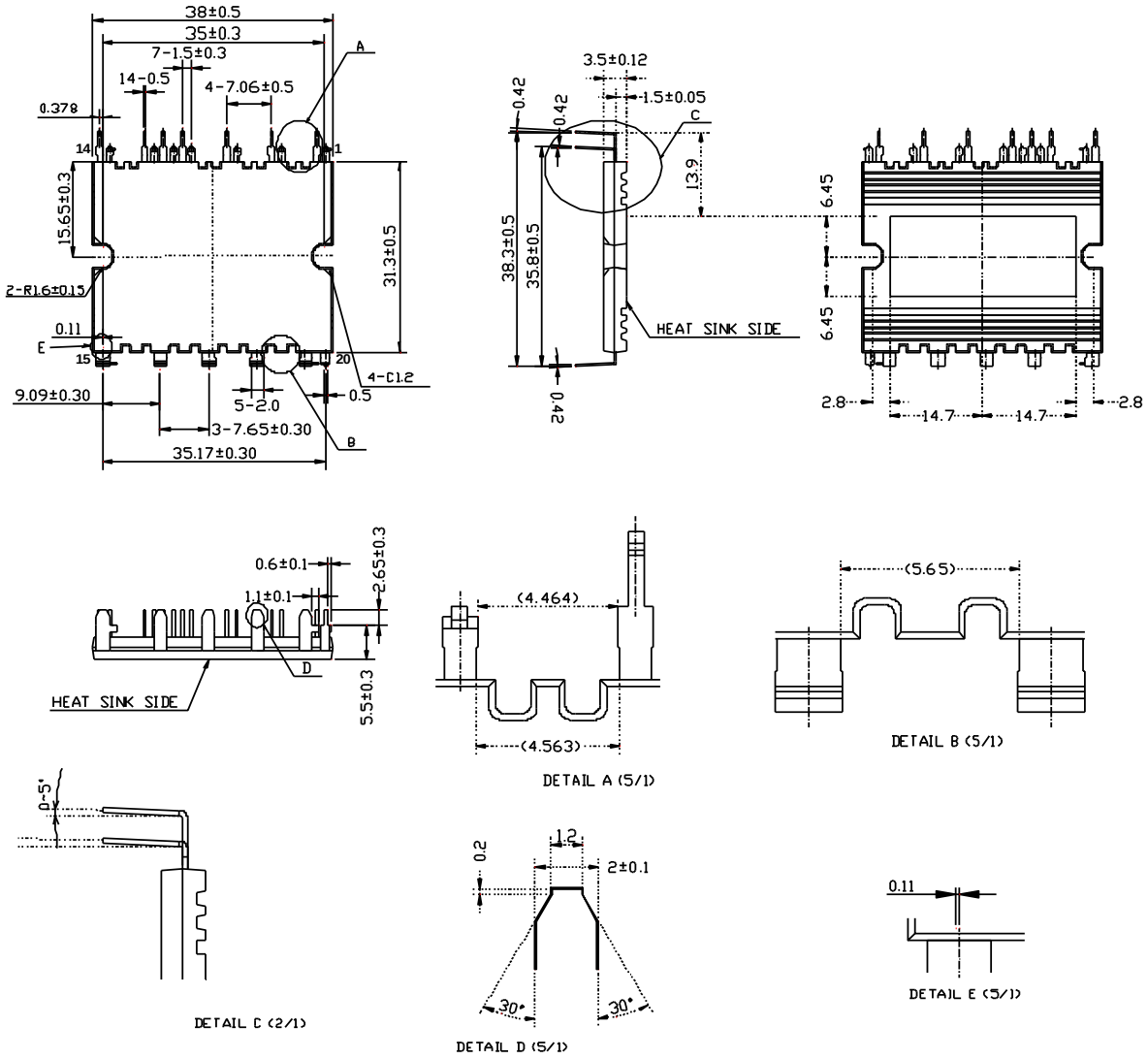
Electrical characteristic curves (Typical)

Figure 28. Transient thermal impedance (Typ.)



Package outlines

Unit : mm



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