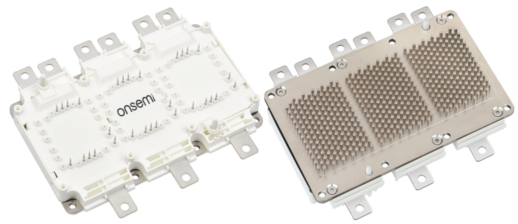
Silicon Carbide (SiC) Module – EliteSiC Power Module for Traction Inverter, Single-Side Direct Cooling, 2.2 mohm, 900 V, 6-Pack

NVXR22S90M2SPB



SSDC39 154.40x92.0 (SPB)
CASE 183AM

Product Description

The NVXR22S90M2SPB is part of the EliteSiC power module for traction inverter, a revolutionary high mobility compound semiconductor product family that offers increased performance, better efficiency, and higher power density in similar and highly compatible packaging solutions.

The module integrates 900 V SiC MOSFET in a 6−pack configuration. For assembly ease and reliability, a new generation of press−fit pins are integrated into the power module for signal terminals. In addition, it also integrates an optimized pin−fin heatsink in the baseplate.

To enhance reliability and thermal performance, sintering technology is applied for die attach. The module is designed to meet AQG324 automotive standard.

Features

- Direct Cooling w/ integrated Pin−fin Heatsink
- Silicon Nitride Isolator
- $T_{vj.Max}$ = 175°C for Continuous Operation
- Automotive Grade SiC MOSFET Chip Technologies
- Sintered Die Technology for High Reliability Performance
- Easy to Integrate 6−pack Topology
- Automotive Module AQG324 Compliant
- These Devices are Pb−Free and are RoHS Compliant

Typical Applications

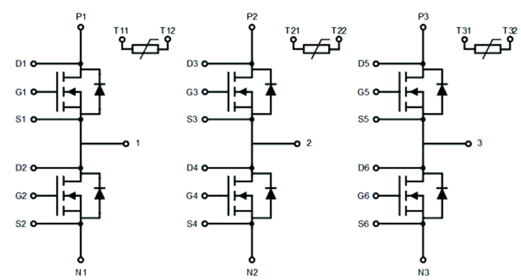
- Hybrid and Electric Vehicle Traction Inverter

MARKING DIAGRAM

XXXXXXXXXXXXXXXXXXXXXXX ATYYWW

XXXXX = Specific Device Code
AT = Assembly & Test Site Code
YYWW= Year and Work Week Code

PIN DESCRIPTION



ORDERING INFORMATION

Device	Package	Shipping
NVXR22S90M2SPB	SSDC39 (Pb−Free)	4 Units / Tray

Pin Description

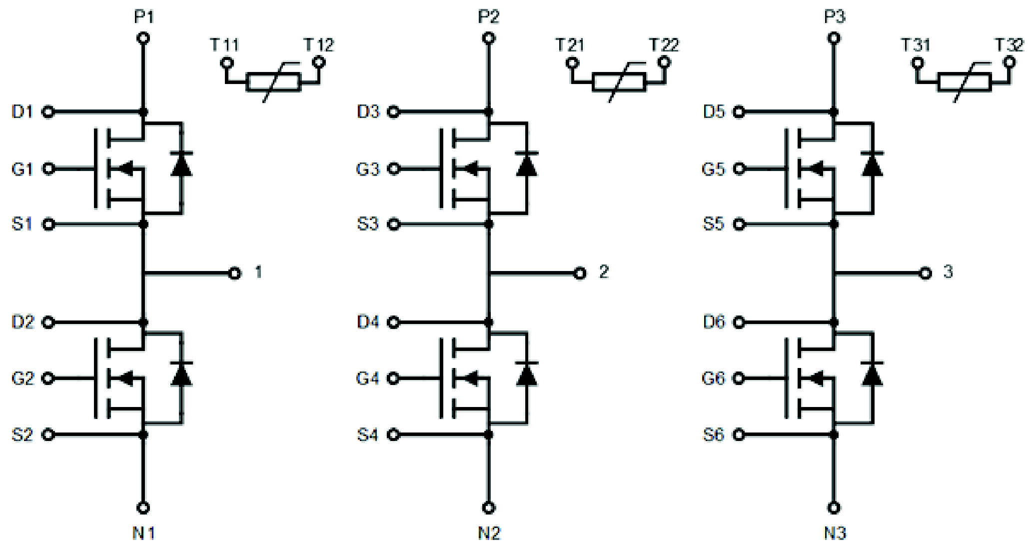


Figure 1. Pin Description

PIN FUNCTION DESCRIPTION

Pin #	Pin Function Description
P1, P2, P3	Positive Power Terminals
N1, N2, N3	Negative Power Terminals
1	Phase 1 Output
2	Phase 2 Output
3	Phase 3 Output
G1 – G6	SiC MOSFET Gate
S1 – S6	SiC MOSFET Source / Gate Return
D1 – D6	SiC MOSFET Drain Sense
T11, T12	Phase 1 Temperature Sensor Output
T21, T22	Phase 2 Temperature Sensor Output
T31, T32	Phase 3 Temperature Sensor Output

Materials

DBC Substrate: Si_3N_4 isolated substrate, basic isolation
Terminals: Copper + Tin electro−plating
Signal Leads: Copper + Tin plating
Pin−fin Base plate: Copper + Ni plating

Flammability Information

The module frame meets UL94V−0 flammability rating

MODULE CHARACTERISTICS (T_{vj} = 25°C, Unless Otherwise Specified)

Symbol	Parameter	Rating	Unit
T_{vj}	Operating Junction Temperature	–40 to 175	°C
T_{STG}	Storage Temperature Range	–40 to 125	°C
V_{ISO}	Isolation Voltage (AC, 50 Hz, 5 s)	4200	V
Ls_{DS}	Stray Inductance	8	nH
$R_{DD'+SS'}$	Module Lead Resistance, Terminals–Chip	0.6	mΩ
G	Module Weight	700	g
CTI	Comparative Tracking Index	>200	–
d_{creep}	Creepage: Terminal to Heatsink Terminal to Terminal	9.0 9.0	mm
d_{clear}	Clearance: Terminal to Heatsink Terminal to Terminal	4.5 4.5	mm

Symbol	Parameters	Conditions	Min	Typ	Max	Unit
Δp	Pressure Drop in Cooling Circuit	10 L/min, 65°C, 50/50 EGW	–	95	–	mbar
P (Note 1)	Maximum Pressure in Cooling Loop (relative)	$T_{Baseplate}$ < 40°C $T_{Baseplate}$ > 40°C	– –	– –	2.5 2.0	bar

1. EPDM rubber 50 durometer ‘O’ ring used.

ABSOLUTE MAXIMUM RATINGS (T_{vj} = 25°C, Unless Otherwise Specified)

Symbol	Parameter	Rating	Unit
V_{DS}	Drain–to–Source Voltage	900	V
V_{GS}	Gate–to–Source Voltage	+22/–8	V
I_{DS}	Continuous DC Drain Current, V_{GS} = 18 V, T_{vj} = 175°C, T_F = 65°C @ 10LPM, $R_{thj\_F.max}$ (Note 2)	510	A
$I_{DS.pulsed}$	Pulsed Drain Current @ V_{GS} = 18 V, limited by $T_{vj.Max}$	1020	A
$I_{SD.BD}$	Continuous DC Body Diode Current, V_{GS} = –5 V, T_{vj} = 175°C, T_F = 65°C @ 10LPM, using Ref. Heatsink (Note 2)	230	A
$I_{SD.pulsed}$	Pulsed Body Diode Current, V_{GS} =–5 V, limited by $T_{vj.Max}$	1020	A
P_{tot}	Total Power Dissipation $T_{vj.Max}$ = 175°C, T_F = 65°C, Ref. Heatsink (typ)	900	W

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.
2. Verified by characterization/design, not by test.

MOSFET CHARACTERISTICS (T_{vj} = 25°C, Unless Otherwise Specified)

Symbol	Parameters	Conditions		Min	Typ.	Max	Unit
$R_{DS(ON)}$	Drain – Source On Resistance	V_{GS} = 18 V, I_D = 510 A	T_{vj} = 25°C T_{vj} = 175°C	– –	2.20 3.10	2.70 –	mΩ
I_{DSS}	Zero Gate Voltage Drain Current	V_{GS} = 0 V, V_{DS} = 900 V	T_{vj} = 25°C T_{vj} = 175°C	– –	– 2	600 –	μA mA
I_{GSS}	Gate – Source Leakage Current	V_{GS} = 18 V, V_{DS} = 0 V		–	–	6	μA
$V_{GS(TH)}$	Threshold Voltage	V_{GS} = V_{DS} , I_D = 150 mA		1.8	2.7	4.3	V
g_{fs}	Forward Transconductance	V_{DS} = 20 V, I_D = 510 A		–	300	–	S
Q_G	Total Gate Charge	V_{GS} = –5/18 V, V_{DS} = 400 V, I_D = 510 A		–	1.8	–	μC
$R_{g.int}$	Internal gate resistance			–	0.9	–	Ω
C_{iss}	Input Capacitance	V_{DS} = 400V, V_{GS} = 0V, f = 100 kHz		–	35	–	nF
C_{oss}	Output Capacitance			–	2.5	–	nF
C_{rss}	Reverse Transfer Capacitance			–	0.2	–	nF
$T_{d.on}$	Turn on delay, inductive load	I_D = 510 A, V_{DS} = 400 V, V_{GS} = +18 / −5 V, $R_{g.on}$ = 5.0 Ω	T_{vj} = 25°C T_{vj} = 175°C	– –	106 88	– –	ns
T_r	Rise time, inductive load		T_{vj} = 25°C T_{vj} = 175°C	– –	94 94	– –	ns
$T_{d.off}$	Turn off delay, inductive load	I_D = 510 A, V_{DS} = 400 V, V_{GS} = +18 / −5 V, $R_{g.off}$ = 2.4 Ω	T_{vj} = 25°C T_{vj} = 175°C	– –	295 345	– –	ns
T_f	Fall time, inductive load		T_{vj} = 25°C T_{vj} = 175°C	– –	48 59	– –	ns
E_{on}	Turn On Switching Loss (including diode reverse recovery loss)	I_D = 510 A, V_{DS} = 400 V, V_{GS} = +18 / −5 V, L_S = 19 nH, $R_{g.on}$ = 5.0 Ω	di/dt =4.2 A/ns, T_{vj} = 25°C di/dt = 4.7 A/ns, T_{vj} = 175°C	– –	14 12	– –	mJ
E_{off}	Turn Off Switching Loss	I_D = 510 A, V_{DS} = 400 V, V_{GS} = +18 / −5 V, L_S = 19 nH, $R_{g.off}$ = 2.4 Ω	dv/dt = 6.1 V/ns T_{vj} = 25°C dv/dt = 6.1 V/ns T_{vj} = 175°C	– –	12 13	– –	mJ
E_{SC}	Short Circuit Energy withstand	V_{GS} = 18 V, V_{DD} = 400 V	T_{vj} = 25 °C T_{vj} = 175 °C	– –	8.7 7.0	– –	J

BODY DIODE CHARACTERISTICS (T_{vj} = 25°C, Unless Otherwise Specified)

Parameters		Conditions		Min	Typ	Max	Unit
V_{SD}	Diode Forward Voltage	V_{GS} = –5 V, I_{SD} = 230 A	T_{vj} = 25°C T_{vj} = 175°C	–	4.0 3.5	–	V
E_{rr}	Reverse Recovery Energy	I_{SD} = 510 A, V_R = 400 V, V_{GS} = –5 V, $R_{g.on}$ = 5.0 Ω	di/dt = 4.2 A/ns, T_{vj} = 25°C di/dt = 4.7 A/ns, T_{vj} = 175°C	– –	0.4 1.0	– –	mJ
Q_{rr}	Recovered Charge		T_{vj} = 25°C T_{vj} = 175°C	– –	2.4 5.0	– –	μC
I_{rr}	Peak Reverse Recovery Current		T_{vj} = 25°C T_{vj} = 175°C	– –	113 168	– –	A

NTC SENSOR CHARACTERISTICS (T_{vj} = 25°C, Unless Otherwise Specified)

Parameters		Conditions	Min	Typ	Max	Unit
R_{25}	Rated Resistance	T_c = 25°C	–	5	–	kΩ
ΔR/R	Deviation of R25	T_c = 25°C, R25 = 5 kΩ	–5	–	5	%
P_{25}	Power Dissipation	T_c = 25°C	–	–	25	mW
$B_{25/50}$	B–Value	R = R_{25} exp [$B_{25/50}$ (1/T–1/298)]	–	3375	–	K
$B_{25/80}$	B–Value	R = R_{25} exp [$B_{25/80}$ (1/T–1/298)]	–	3411	–	K
$B_{25/120}$	B–Value	R = R_{25} exp [$B_{25/120}$ (1/T–1/298)]	–	3433	–	K

THERMAL CHARACTERISTICS

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
$R_{th,J–F}$	FET Junction to Fluid	R_{th}, Junction to Fluid, 10 L/min, 65°C, 50/50 EGW	–	0.12	0.131	°C/W

TYPICAL CHARACTERISTICS

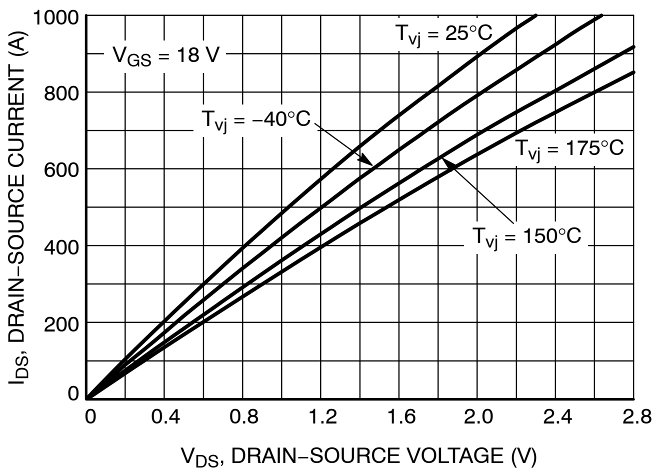


Figure 2. Output Characteristics

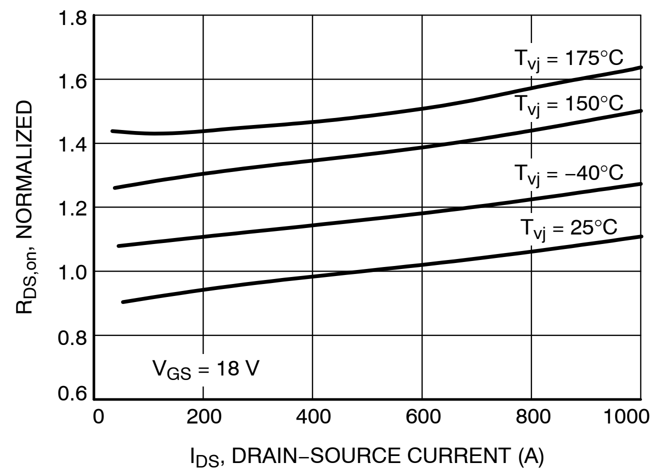


Figure 3. Normalized On−state Resistance vs. Drain Current

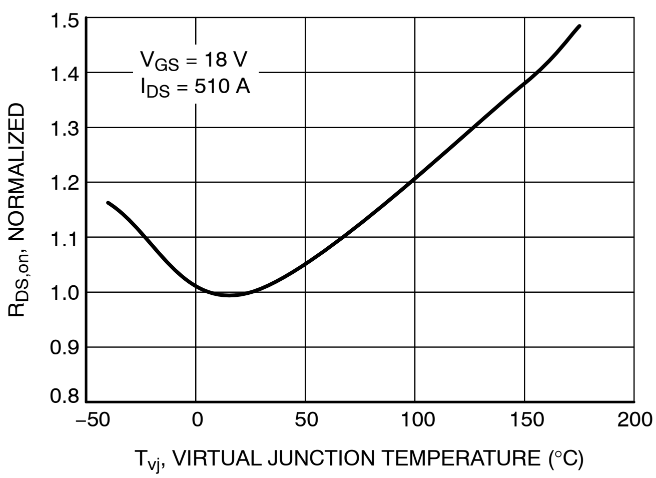


Figure 4. Normalized On−state Resistance vs. Temperature

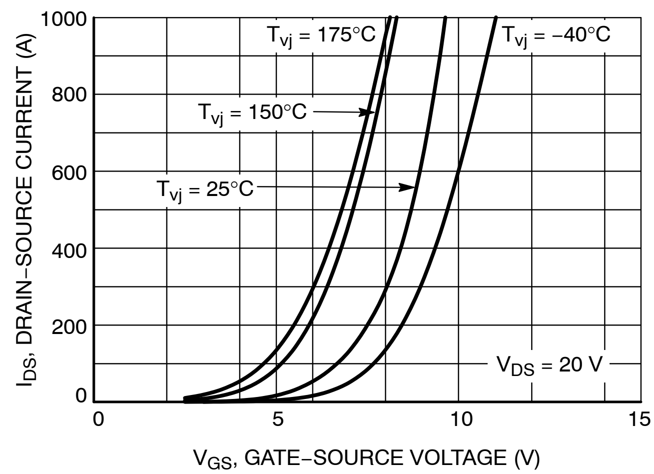


Figure 5. Transfer Characteristic

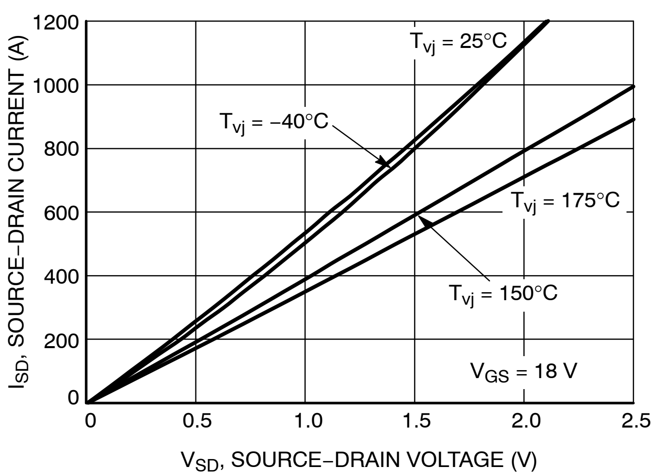


Figure 6. 3rd Quadrant Characteristic at V_{GS} = 18 V

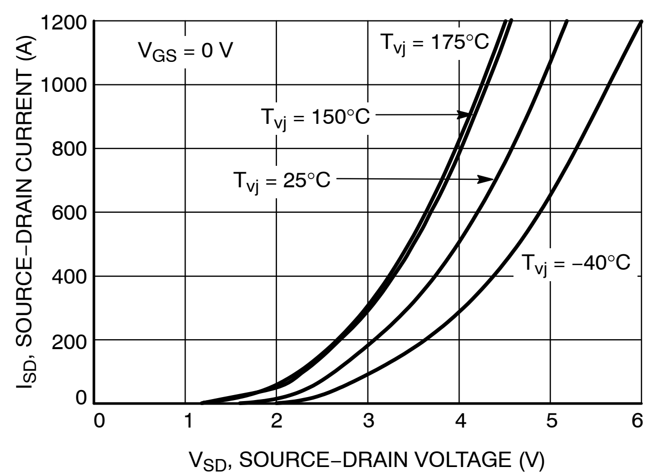


Figure 7. 3rd Quadrant Characteristic at V_{GS} = 0 V

TYPICAL CHARACTERISTICS

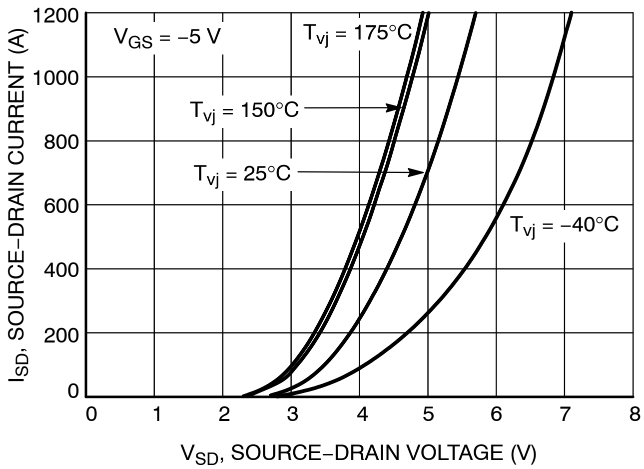


Figure 8. 3rd Quadrant Characteristic at V_{GS} = −5 V

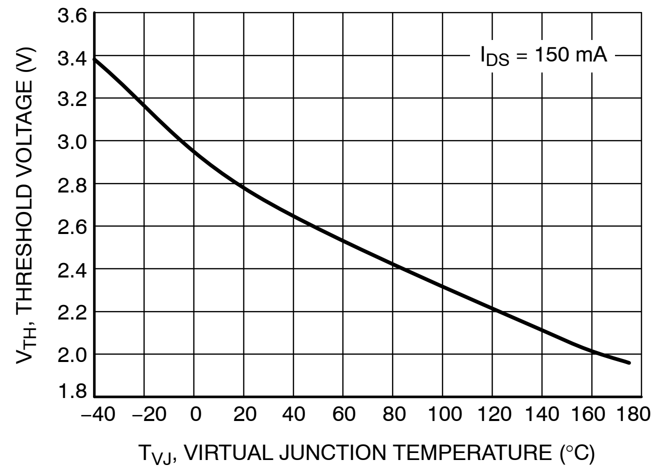


Figure 9. Gate Threshold Voltage vs. Temperature

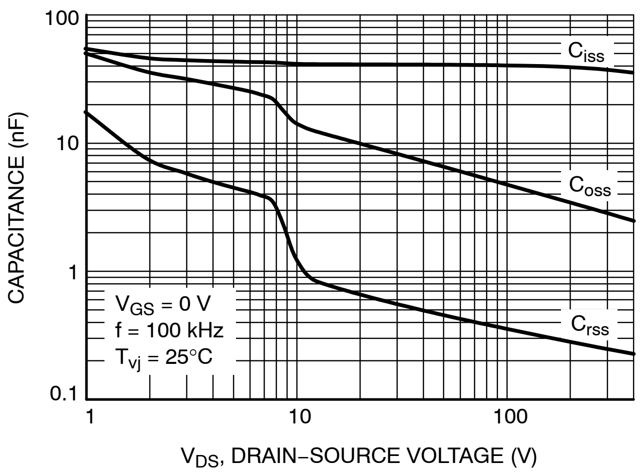


Figure 10. Typical Capacitance vs. Drain−Source Voltage

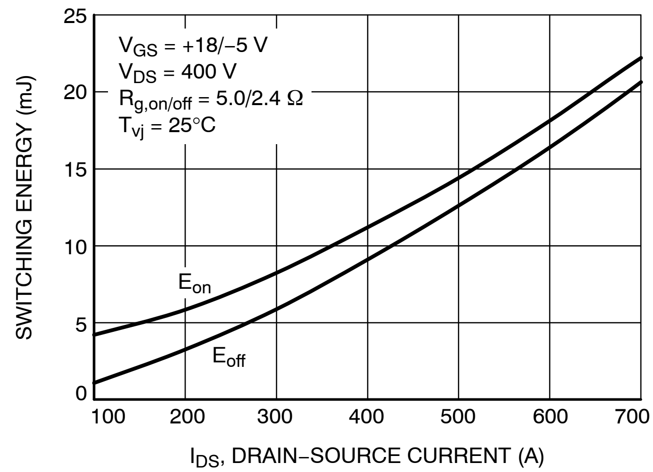


Figure 11. Switching Energies at 25°C

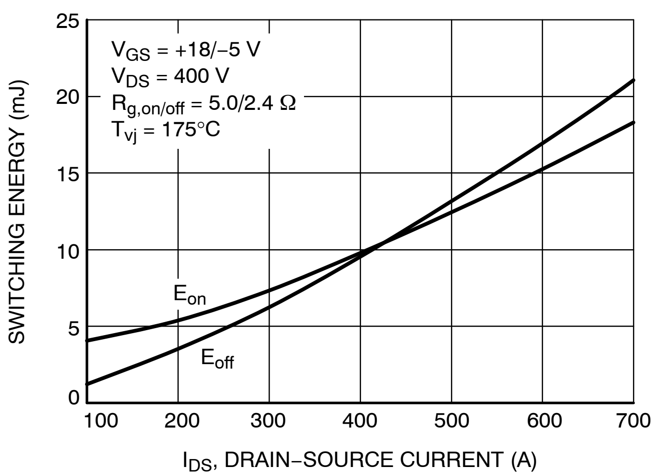


Figure 12. Switching Energies at 175°C

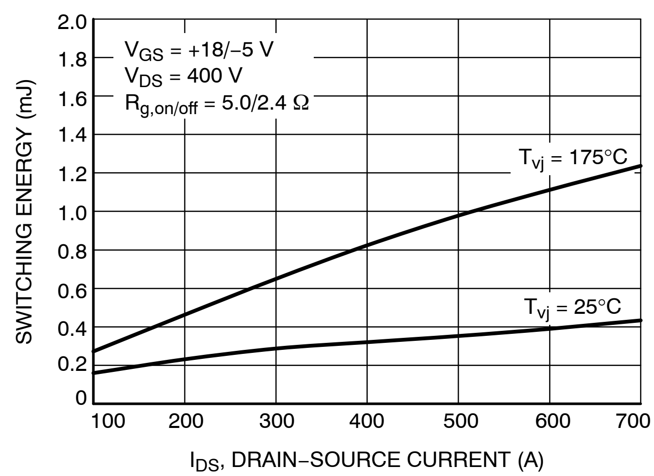


Figure 13. Reverse Recovery Energy vs. Drain−Source Current

TYPICAL CHARACTERISTICS

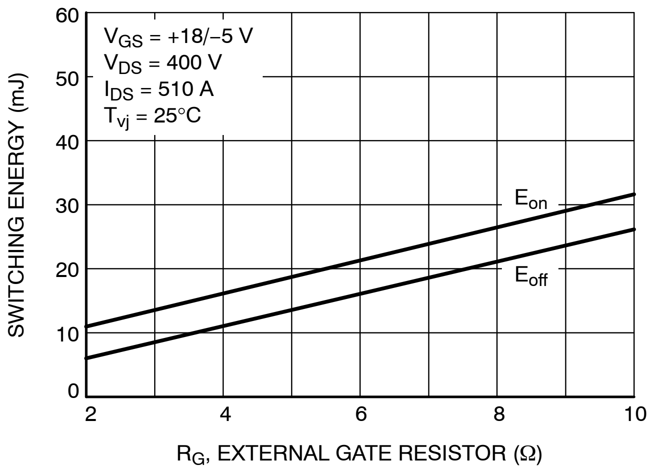


Figure 14. Switching Energies vs. External Gate Resistor

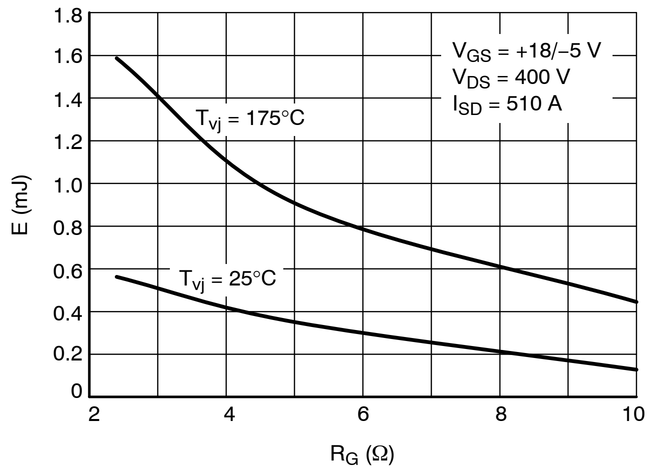


Figure 15. Reverse Recovery Energy vs External Gate Resistor

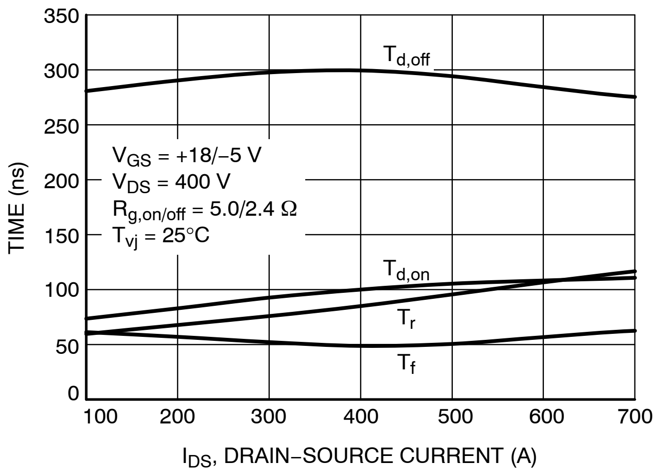


Figure 16. Timing Characteristics vs. Drain−Source Current

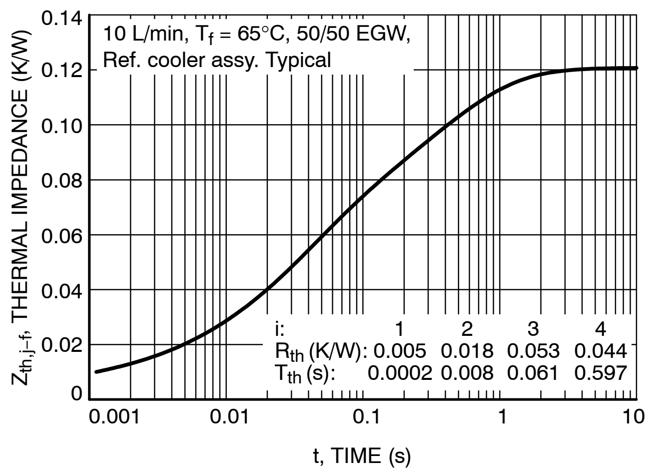


Figure 17. Typical Thermal Impedance, Junction to Fluid

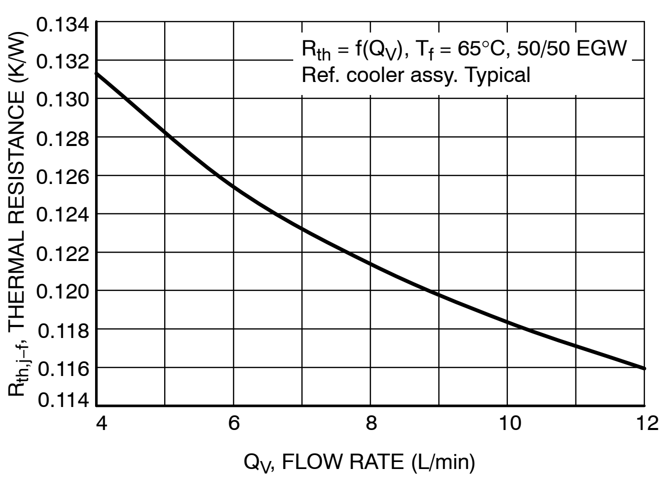


Figure 18. Typical Thermal Resistance vs. Flow Rate

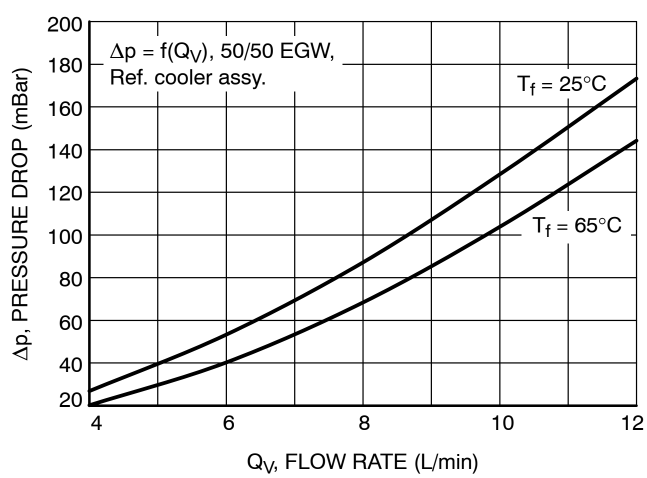


Figure 19. Pressure Drop in Cooling Circuit

TYPICAL CHARACTERISTICS

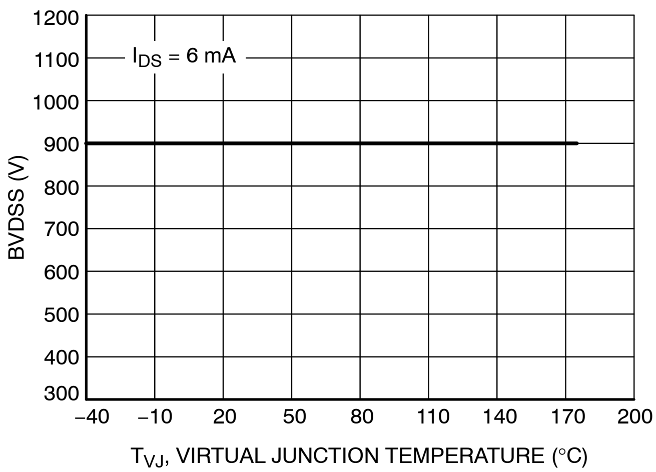


Figure 20. MOSFET Breakdown Voltage vs. T_{VJ}

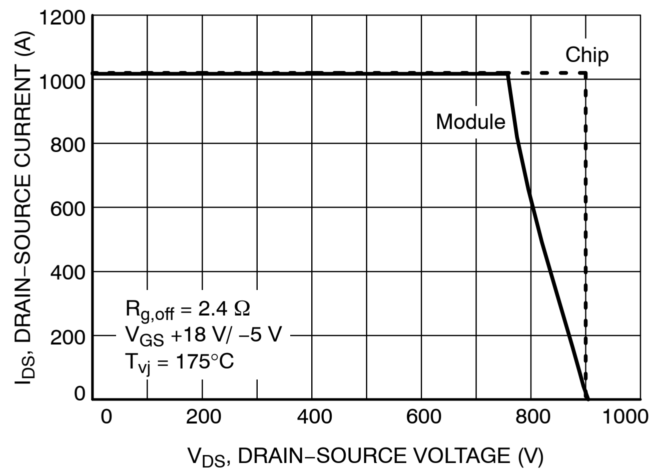


Figure 21. MOSFET RBSOA of Chip and Module

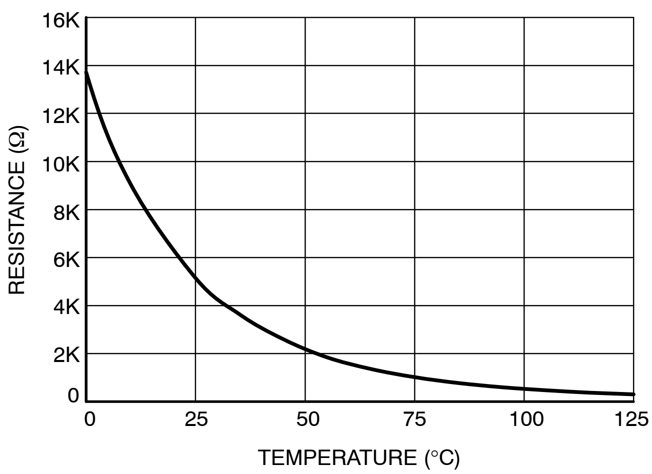


Figure 22. NTC Resistance vs. Temperature

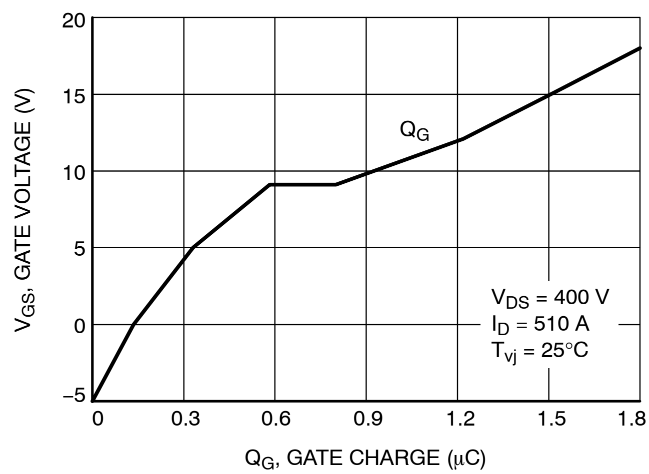


Figure 23. Gate Charge vs. Gate−Source Voltage

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