

Silicon Carbide (SiC) Module – 22 mohm, 1200 V, SiC M3S MOSFET, 6-PACK, F1 Package

Product Preview

NXH022S120M3F1PTG

The NXH022S120M3F1PTG is a power module containing 22 mΩ / 1200 V SiC MOSFET 6-PACK and a thermistor with Al2O3 DBC in an F1 package.

Features

- 22 mΩ / 1200 V M3S SiC MOSFET 6-PACK
- Al2O3 DBC
- Thermistor
- Options with Pre-Applied Thermal Interface Material (TIM) and without Pre-Applied TIM
- Press-Fit Pins
- These Devices are Pb-Free, Halide Free and are RoHS Compliant

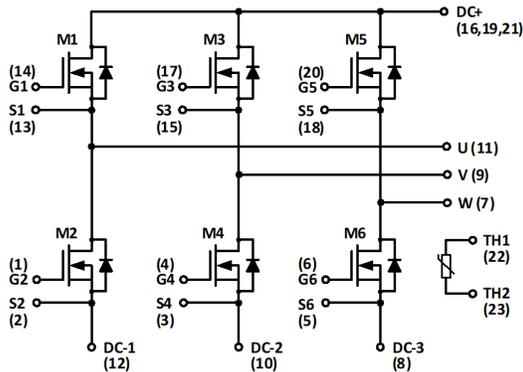
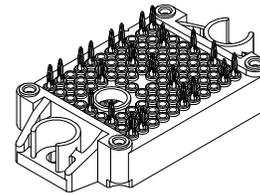


Figure 1. NXH022S120M3F1PTG Schematic Diagram

PACKAGE PICTURE



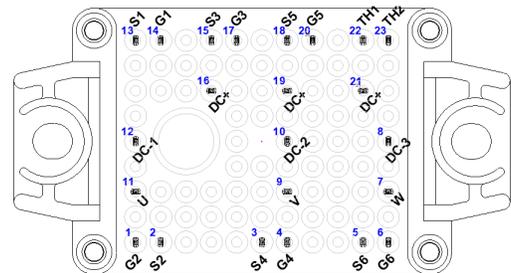
PIM23 33.80x42.50x12.00
CASE 180DA

MARKING DIAGRAM



NXH022S120M3F1PTG = Specific Device Code
AT = Assembly & Test Site Code
YWW = Year and Work Week Code

PIN CONNECTIONS



See Pin Function Description for pin names

ORDERING INFORMATION

See detailed ordering and shipping information on page 4 of this data sheet.

NXH022S120M3F1PTG

PIN FUNCTION DESCRIPTION

| Pin | Name | Description |
|-----|------|-------------------------------------|
| 1 | G2 | M2 Gate (Low side switch) |
| 2 | S2 | M2 Kelvin Source (Low side switch) |
| 3 | S4 | M4 Kelvin Source (Low side switch) |
| 4 | G4 | M4 Gate (Low side switch) |
| 5 | S6 | M6 Kelvin Source (Low side switch) |
| 6 | G6 | M6 Gate (Low side switch) |
| 7 | W | W Terminal |
| 8 | DC-3 | DC Negative Bus Connection |
| 9 | V | V Terminal |
| 10 | DC-2 | DC Negative Bus Connection |
| 11 | U | U Terminal |
| 12 | DC-1 | DC Negative Bus Connection |
| 13 | S1 | M1 Kelvin Source (High side switch) |
| 14 | G1 | M1 Gate (High side switch) |
| 15 | S3 | M3 Kelvin Source (High side switch) |
| 16 | DC+ | DC Positive Bus Connection |
| 17 | G3 | M3 Gate (High side switch) |
| 18 | S5 | M5 Kelvin Source (High side switch) |
| 19 | DC+ | DC Positive Bus Connection |
| 20 | G5 | M5 Gate (High side switch) |
| 21 | DC+ | DC Positive Bus Connection |
| 22 | TH1 | Thermistor Connection 1 |
| 23 | TH2 | Thermistor Connection 2 |

NXH022S120M3F1PTG

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|--------------|---------|------------------|
| SiC MOSFET | | | |
| Drain–Source Voltage | V_{DSS} | 1200 | V |
| Gate–Source Voltage | V_{GS} | +22/–10 | V |
| Continuous Drain Current @ $T_c = 80^\circ\text{C}$ ($T_J = 175^\circ\text{C}$) | I_D | 48 | A |
| Pulsed Drain Current ($T_J = 150^\circ\text{C}$) | I_{Dpulse} | 144 | A |
| Maximum Power Dissipation ($T_J = 175^\circ\text{C}$) | P_{tot} | 116 | W |
| Minimum Operating Junction Temperature | T_{JMIN} | –40 | $^\circ\text{C}$ |
| Maximum Operating Junction Temperature | T_{JMAX} | 175 | $^\circ\text{C}$ |

THERMAL PROPERTIES

| | | | |
|---------------------------|-----------|------------|------------------|
| Storage Temperature Range | T_{stg} | –40 to 150 | $^\circ\text{C}$ |
|---------------------------|-----------|------------|------------------|

INSULATION PROPERTIES

| | | | |
|--|----------|-------------------------|-----------|
| Isolation Test Voltage, $t = 1$ s, 60 Hz | V_{is} | 4800 | V_{RMS} |
| Creepage Distance | | 12.7 | mm |
| CTI | | 600 | |
| Substrate Ceramic Material | | Al_2O_3 | |
| Substrate Ceramic Material Thickness | | 0.32 | mm |

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.

RECOMMENDED OPERATING RANGES

| Rating | Symbol | Min | Max | Unit |
|---------------------------------------|--------|-----|-----|------------------|
| Module Operating Junction Temperature | T_J | –40 | 150 | $^\circ\text{C}$ |

Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

ELECTRICAL CHARACTERISTICS ($T_J = 25^\circ\text{C}$ unless otherwise noted)

| Parameter | Test Conditions | Symbol | Min | Typ | Max | Unit |
|-------------------------------------|---|----------------|------|------|---------|---------------|
| SiC MOSFET CHARACTERISTICS | | | | | | |
| Zero Gate Voltage Drain Current | $V_{GS} = 0$ V, $V_{DS} = 1200$ V, $T_J = 25^\circ\text{C}$ | I_{DSS} | – | – | 100 | μA |
| Drain–Source On Resistance (Note 1) | $V_{GS} = 18$ V, $I_D = 50$ A, $T_J = 25^\circ\text{C}$ | $R_{DS(ON)}$ | – | 22.6 | 30 | m Ω |
| | $V_{GS} = 18$ V, $I_D = 50$ A, $T_J = 125^\circ\text{C}$ | | – | 38.6 | – | |
| | $V_{GS} = 18$ V, $I_D = 50$ A, $T_J = 150^\circ\text{C}$ | | – | 43.8 | – | |
| | $V_{GS} = 18$ V, $I_D = 50$ A, $T_J = 175^\circ\text{C}$ | | – | 50.6 | – | |
| Gate–Source Threshold Voltage | $V_{GS} = V_{DS}$, $I_D = 20$ mA | $V_{GS(TH)}$ | 2.04 | 2.72 | 4.4 | V |
| Recommended Gate Voltage | | V_{GOP} | –3 | – | +18 | V |
| Gate–to–Source Leakage Current | $V_{GS} = +22/–10$ V, $V_{DS} = 0$ V | I_{GSS} | – | – | ± 1 | μA |
| Input Capacitance | $V_{GS} = 0$ V, $f = 1$ MHz, $V_{DS} = 800$ V | C_{ISS} | – | 3246 | – | pF |
| Reverse Transfer Capacitance | | C_{RSS} | – | 14 | – | |
| Output Capacitance | | C_{OSS} | – | 157 | – | |
| Total Gate Charge | $V_{GS} = –3/18$ V, $V_{DS} = 800$ V, $I_D = 50$ A | $Q_{G(TOTAL)}$ | – | 138 | – | nC |
| Gate–Source Charge | | Q_{GS} | – | 29 | – | nC |
| Gate–Drain Charge | | Q_{GD} | – | 33 | – | nC |

NXH022S120M3F1PTG

ELECTRICAL CHARACTERISTICS (T_J = 25°C unless otherwise noted) (continued)

| Parameter | Test Conditions | Symbol | Min | Typ | Max | Unit |
|---------------------------------------|--|---------------------|-----|--------|-----|------|
| SiC MOSFET CHARACTERISTICS | | | | | | |
| Turn-on Delay Time | T _J = 25°C V _{DS} = 800 V, I _D = 50 A V _{GS} = -3/18 V, R _G = 10 Ω | t _{d(on)} | - | 25.75 | - | ns |
| Rise Time | | t _r | - | 10.4 | - | |
| Turn-off Delay Time | | t _{d(off)} | - | 105.98 | - | |
| Fall Time | | t _f | - | 5.31 | - | |
| Turn-on Switching Loss per Pulse | | E _{ON} | - | 0.66 | - | mJ |
| Turn-off Switching Loss per Pulse | | E _{OFF} | - | 0.47 | - | |
| Turn-on Delay Time | T _J = 150°C V _{DS} = 800 V, I _D = 50 A V _{GS} = -3/18 V, R _G = 10 Ω | t _{d(on)} | - | 25.61 | - | ns |
| Rise Time | | t _r | - | 8.73 | - | |
| Turn-off Delay Time | | t _{d(off)} | - | 117.56 | - | |
| Fall Time | | t _f | - | 5.17 | - | |
| Turn-on Switching Loss per Pulse | | E _{ON} | - | 0.83 | - | mJ |
| Turn-off Switching Loss per Pulse | | E _{OFF} | - | 0.56 | - | |
| Diode Forward Voltage | I _{SD} = 50 A, V _{GS} = -3 V, T _J = 25°C, | V _{SD} | - | 5.21 | 6.2 | V |
| | I _{SD} = 50 A, V _{GS} = -3 V, T _J = 125°C | | - | 5.11 | - | |
| | I _{SD} = 50 A, V _{GS} = -3 V, T _J = 150°C | | - | 5.02 | - | |
| Thermal Resistance – Chip-to-Case | M1, M2, M3, M4, M5, M6 | R _{thJC} | - | 0.816 | - | °C/W |
| Thermal Resistance – Chip-to-Heatsink | Thermal grease, Thickness = 2 Mil ±2%, A = 2.8 W/mK | R _{thJH} | - | 1.263 | - | °C/W |

THERMISTOR CHARACTERISTICS

| | | | | | | |
|---------------------------------------|----------------------------------|------------------|----|-------|---|------|
| Nominal Resistance | T = 25°C | R ₂₅ | - | 5 | - | kΩ |
| | T = 100°C | R ₁₀₀ | - | 457 | - | Ω |
| | T = 150°C | R ₁₅₀ | - | 159.5 | - | Ω |
| Deviation of R ₁₀₀ | T = 100°C | ΔR/R | -5 | - | 5 | % |
| Power Dissipation – Recommended Limit | 0.15 mA, Non-self-heating Effect | P _D | - | 0.1 | - | mW |
| Power Dissipation – Absolute Maximum | 5 mA | P _D | - | 34.2 | - | mW |
| Power Dissipation Constant | | | - | 1.4 | - | mW/K |
| B-value | B(25/50), tolerance ±2% | | - | 3375 | - | K |
| B-value | B(25/100), tolerance ±2% | | - | 3436 | - | K |

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

1. Refer to ELECTRICAL CHARACTERISTICS, RECOMMENDED OPERATING RANGES and/or APPLICATION INFORMATION for Safe Operating parameters.

ORDERING INFORMATION

| Orderable Part Number | Marking | Package | Shipping |
|-----------------------|-------------------|---|-------------------------|
| NXH022S120M3F1PTG | NXH022S120M3F1PTG | F1: Case 180DA Press-fit Pins with pre-applied thermal interface material (TIM) (Pb-Free / Halide Free) | 28 Units / Blister Tray |

NXH022S120M3F1PTG

TYPICAL CHARACTERISTIC (M1-M6 SiC MOSFET CHARACTERISTIC)

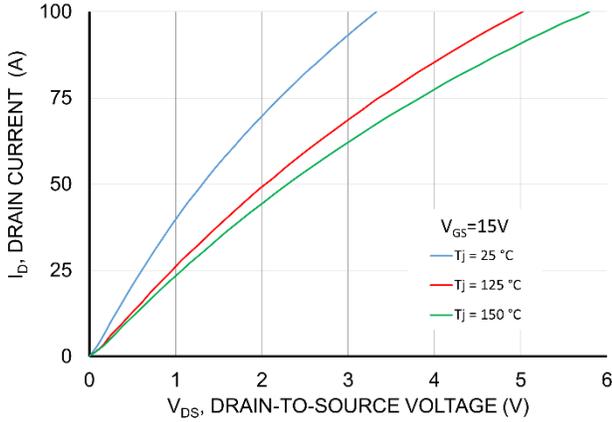


Figure 2. MOSFET Typical Output Characteristic
 $V_{GS} = 15\text{ V}$

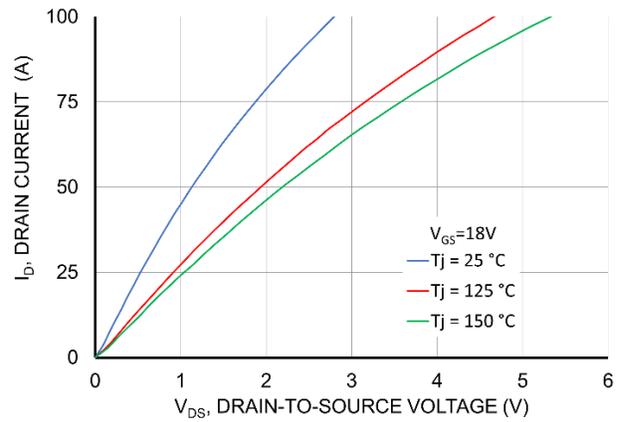


Figure 3. MOSFET Typical Output Characteristic
 $V_{GS} = 18\text{ V}$

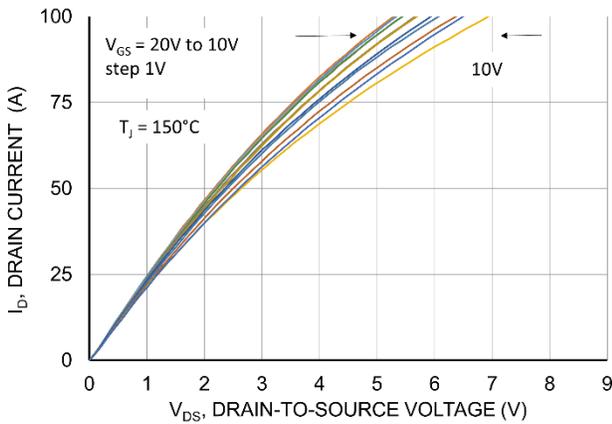


Figure 4. MOSFET Typical Transfer Characteristic
 $V_{GS} = \text{var.}$

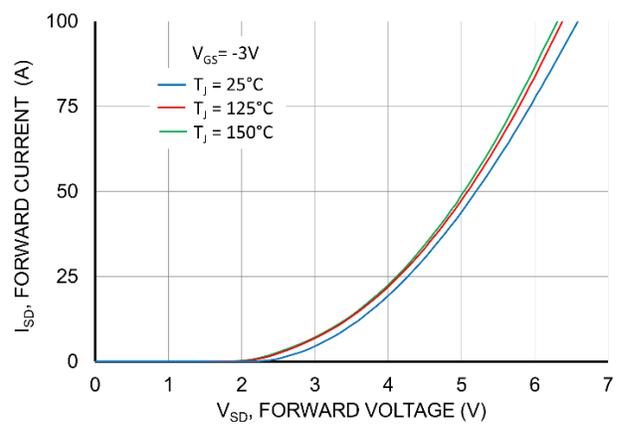


Figure 5. Body Diode Forward Characteristic

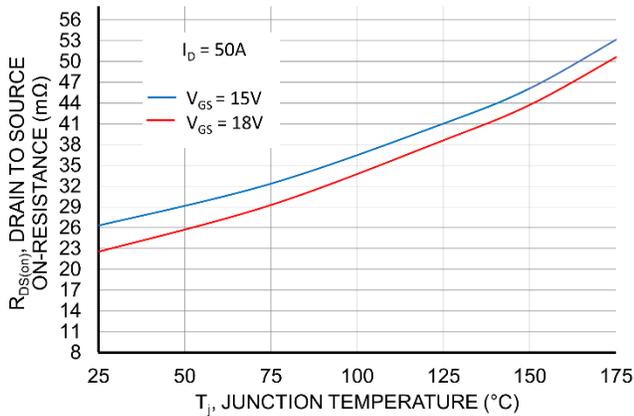


Figure 6. $R_{DS(ON)}$ Drain to Source On Resistance vs. Junction Temperature

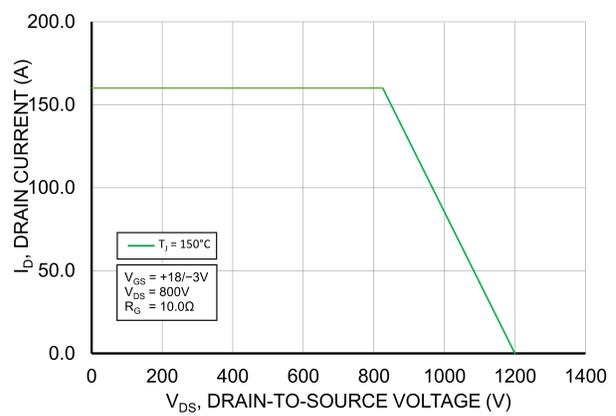


Figure 7. Reverse Bias Safe Operating Area (RBSOA)

NXH022S120M3F1PTG

TYPICAL CHARACTERISTIC (M1-M6 SiC MOSFET CHARACTERISTIC) (CONTINUED)

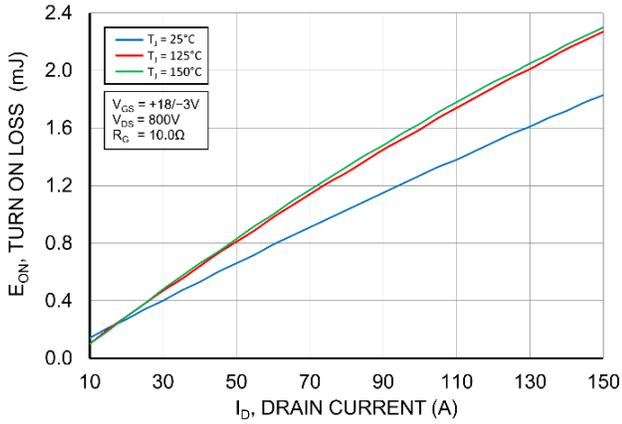


Figure 8. Switching On Loss vs. Drain Current
V_{DS} = 800 V

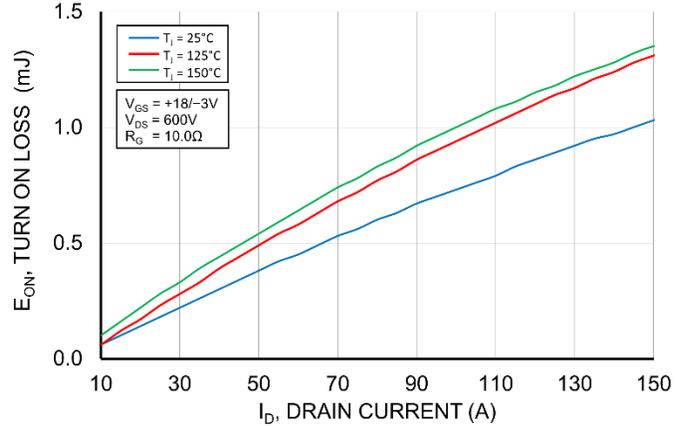


Figure 9. Switching On Loss vs. Drain Current
V_{DS} = 600 V

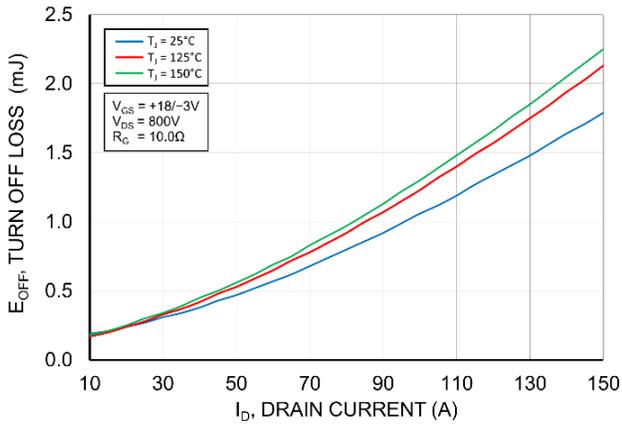


Figure 10. Switching Off Loss vs. Drain Current
V_{DS} = 800 V

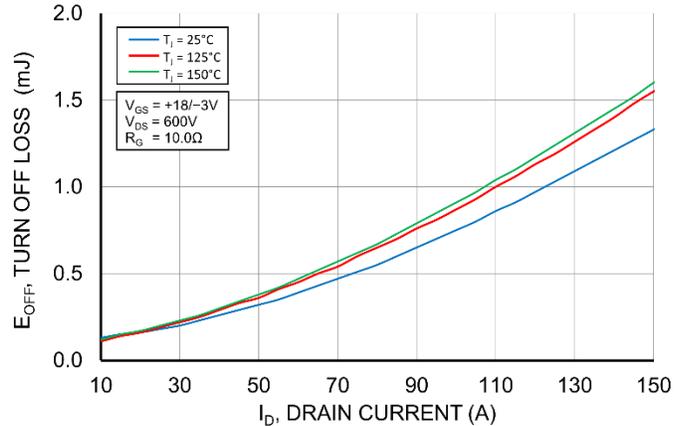


Figure 11. Switching Off Loss vs. Drain Current
V_{DS} = 600 V

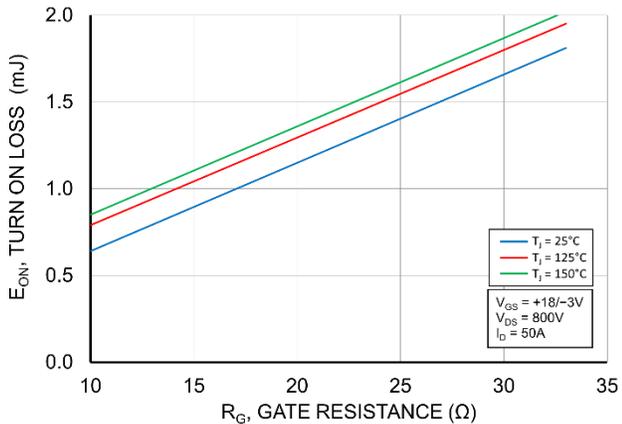


Figure 12. Switching On Loss vs. Gate Resistance
V_{DS} = 800 V

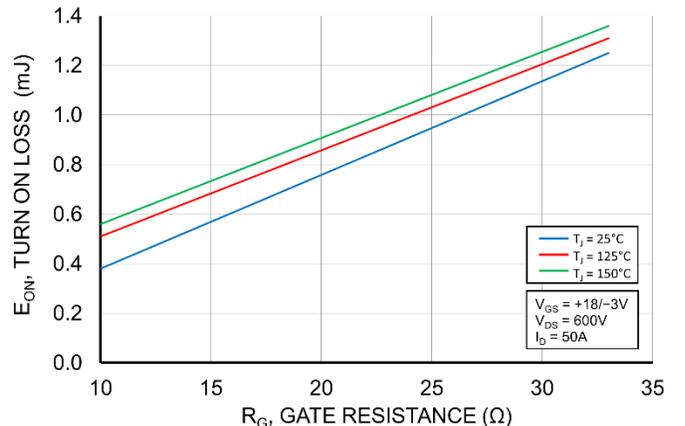


Figure 13. Switching On Loss vs. Gate Resistance
V_{DS} = 600 V

NXH022S120M3F1PTG

TYPICAL CHARACTERISTIC (M1/M2 SiC MOSFET CHARACTERISTIC) (CONTINUED)

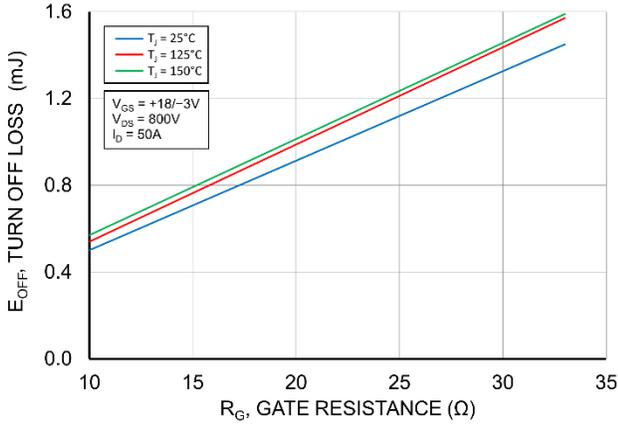


Figure 14. Switching Off Loss vs. Gate Resistance
 $V_{DS} = 800\text{ V}$

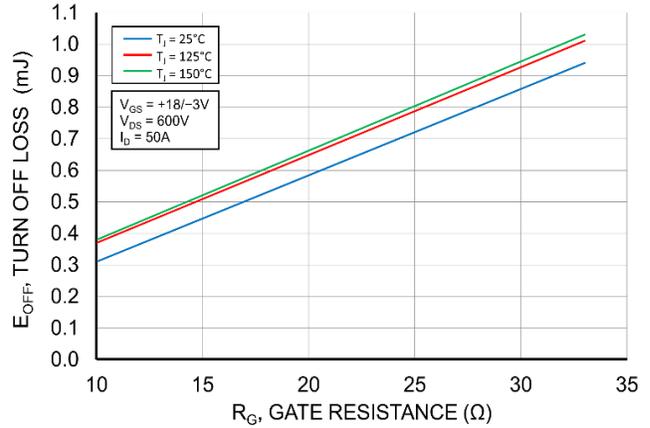


Figure 15. Switching Off Loss vs. Gate Resistance
 $V_{DS} = 600\text{ V}$

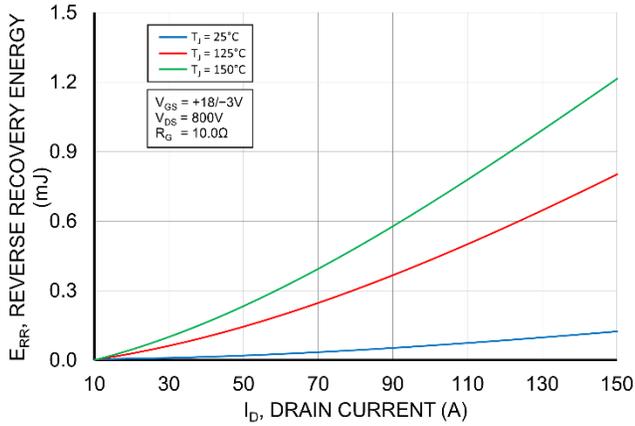


Figure 16. Reverse Recovery Loss vs. Gate Resistance

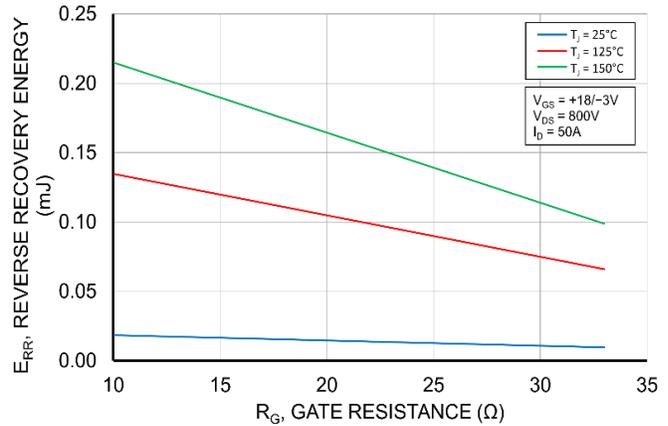


Figure 17. Reverse Recovery Loss vs. Gate Resistance

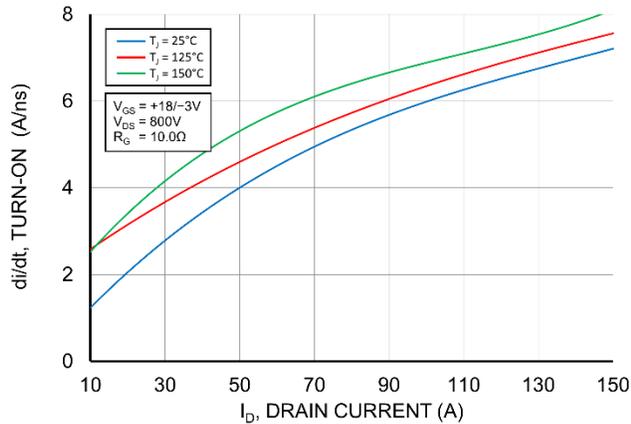


Figure 18. di/dt Turn On vs. Drain Current

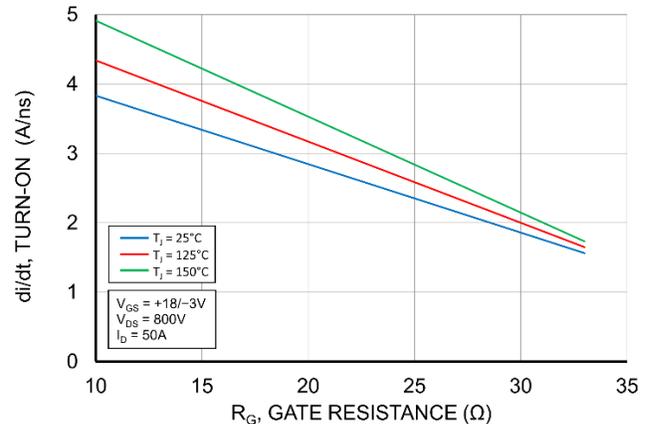


Figure 19. di/dt Turn On vs. Gate Resistance

NXH022S120M3F1PTG

TYPICAL CHARACTERISTIC (M1/M2 SiC MOSFET CHARACTERISTIC) (CONTINUED)

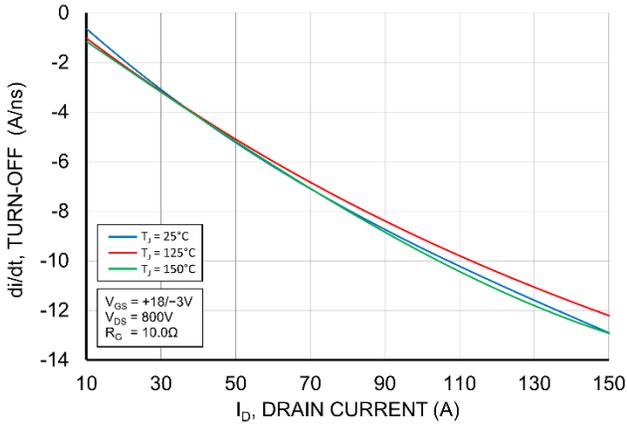


Figure 20. di/dt Turn Off vs. Drain Current

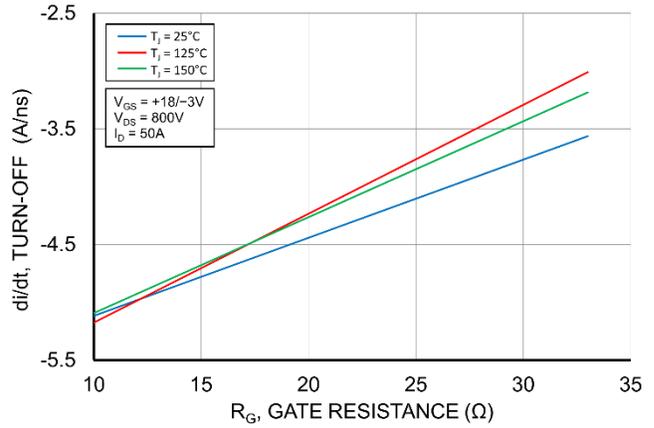


Figure 21. di/dt Turn Off vs. Gate Resistance

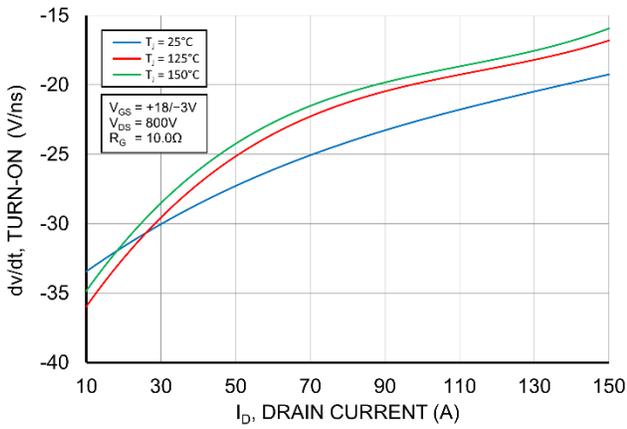


Figure 22. dv/dt Turn On vs. Drain Current

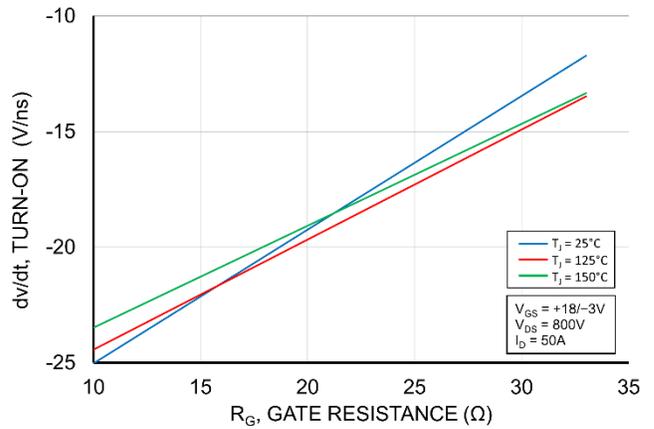


Figure 23. dv/dt Turn On vs. Gate Resistance

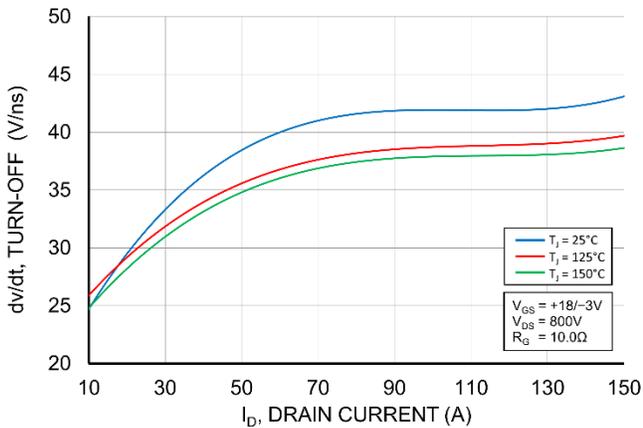


Figure 24. dv/dt Turn Off vs. Drain Current

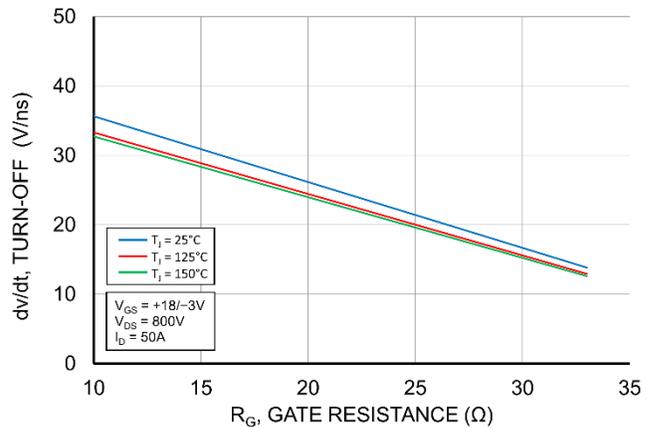


Figure 25. dv/dt Turn Off vs. Gate Resistance

NXH022S120M3F1PTG

TYPICAL CHARACTERISTIC (M1/M2 SiC MOSFET CHARACTERISTIC) (CONTINUED)

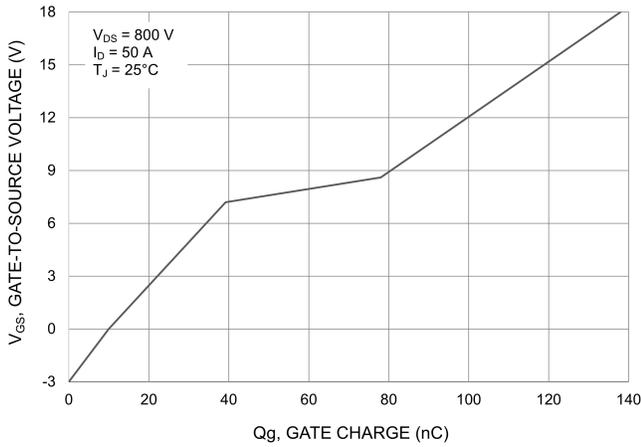


Figure 26. Gate-to-Source Voltage vs. Total Charge

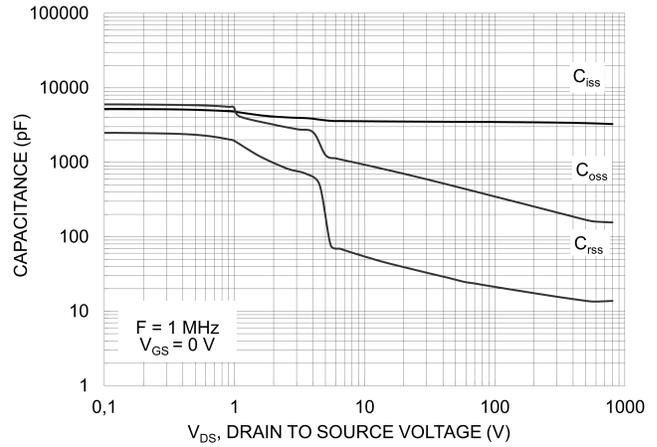


Figure 27. Capacitance vs. Drain-to-Source Voltage

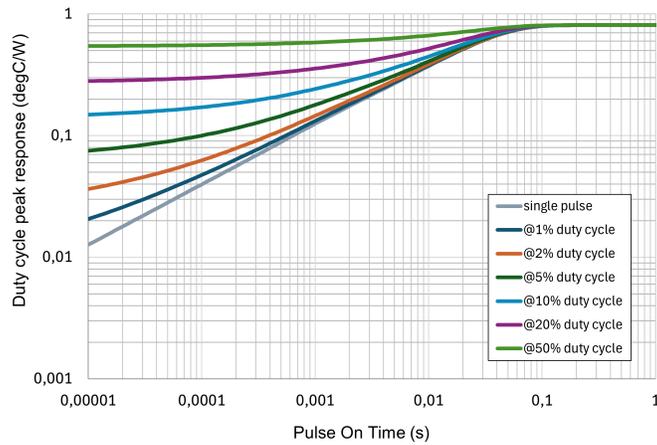
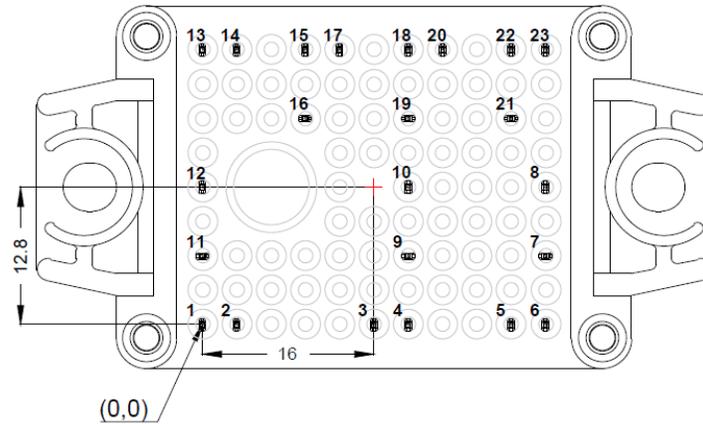


Figure 28. Duty Cycle Response vs. Pulse On Time

NXH022S120M3F1PTG

Table 1. CAUER NETWORKS

| Cauer Element # | Rth (K/W) | Cth (Ws/K) |
|-----------------|-----------|------------|
| 1 | 0.0004 | 0.0006 |
| 2 | 0.0112 | 0.0003 |
| 3 | 0.0064 | 0.0006 |
| 4 | 0.105 | 0.0013 |
| 5 | 0.1388 | 0.0071 |
| 6 | 0.2554 | 0.0215 |
| 7 | 0.1847 | 0.0576 |



* Pin position

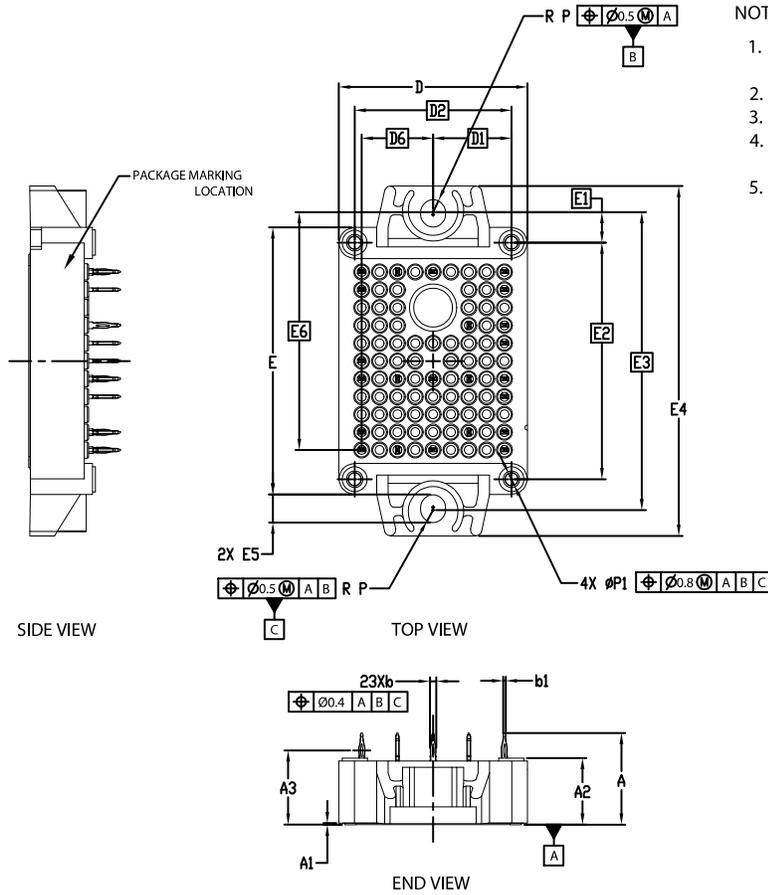
| Pin # | X | Y | Function | Pin # | X | Y | Function |
|-------|------|------|----------|-------|------|------|----------|
| 1 | 0 | 0 | G2 | 13 | 0 | 25.6 | S1 |
| 2 | 3.2 | 0 | S2 | 14 | 3.2 | 25.6 | G1 |
| 3 | 16 | 0 | S4 | 15 | 9.6 | 25.6 | S3 |
| 4 | 19.2 | 0 | G4 | 16 | 9.6 | 19.2 | DC+ |
| 5 | 28.8 | 0 | S6 | 17 | 12.8 | 25.6 | G3 |
| 6 | 32 | 0 | G6 | 18 | 19.2 | 25.6 | S5 |
| 7 | 32 | 6.4 | W | 19 | 19.2 | 19.2 | DC+ |
| 8 | 32 | 12.8 | DC-3 | 20 | 22.4 | 25.6 | G5 |
| 9 | 19.2 | 6.4 | V | 21 | 28.8 | 19.2 | DC+ |
| 10 | 19.2 | 12.8 | DC-2 | 22 | 28.8 | 25.6 | TH1 |
| 11 | 0 | 6.4 | U | 23 | 32 | 25.6 | TH2 |
| 12 | 0 | 12.8 | DC-1 | | | | |

Figure 29.

NXH022S120M3F1PTG

PACKAGE DIMENSIONS

PIM23 33.80x42.50x12.00
CASE 180DA
ISSUE O



NOTES:

1. DIMENSIONING AND TOLERANCING CONFORM TO ASME Y14.5 - 2018.
2. ALL DIMENSIONS ARE IN MILLIMETERS.
3. PIN-GRID IS 3.2mm.
4. PACKAGE MARKING ARE LOCATED ON BOTH SIDES OF THE PACKAGE.
5. THE PINS ARE TIN PLATED.

| DIM | MILLIMETERS | | |
|-----|-------------|-------|-------|
| | MIN | NOM | MAX |
| A | 16.00 | 16.50 | 17.00 |
| A1 | 0.00 | 0.35 | 0.60 |
| A2 | 11.65 | 12.00 | 12.35 |
| b | 0.95 | 1.20 | 1.25 |
| D | 33.50 | 33.80 | 34.10 |
| D1 | 14.05 BSC | | |
| D2 | 28.10 BSC | | |
| D6 | 12.80 BSC | | |
| E | 47.70 | 48.00 | 48.30 |
| E1 | 5.50 BSC | | |
| E2 | 42.50 BSC | | |
| E3 | 53.00 BSC | | |
| E4 | 62.30 | 62.80 | 63.30 |
| E5 | 4.90 | 5.00 | 5.10 |
| E6 | 42.75BSC | | |
| P | 2.20 | 2.25 | 2.30 |
| P1 | 2.20 | 2.30 | 2.40 |

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