

# Silicon Carbide (SiC) Module – 8 mohm SiC M3S MOSFET, 1200 V, TNPC Topology, F2 Package

## Product Preview

### NXH008T120M3F2PTHG

The NXH008T120M3F2PTHG is a power module containing an 8 mΩ / 1200 V SiC MOSFET TNPC and a thermistor with HPS DBC in an F2 package.

#### Features

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

#### Typical Applications

- Solar Inverter
- Uninterruptible Power Supplies
- Electric Vehicle Charging Stations
- Industrial Power

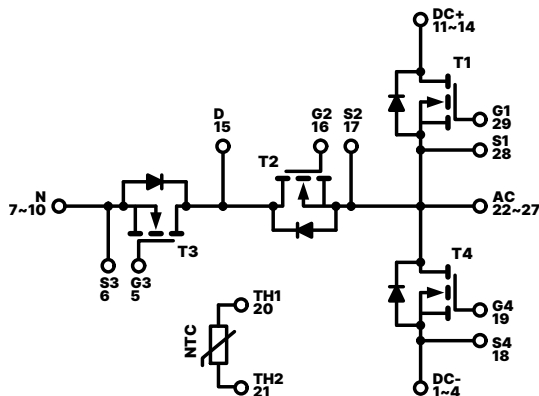
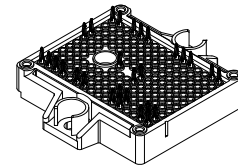


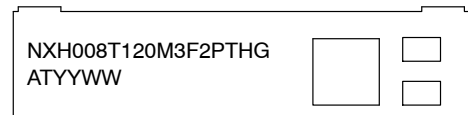
Figure 1. NXH008T120M3F2PTHG Schematic Diagram

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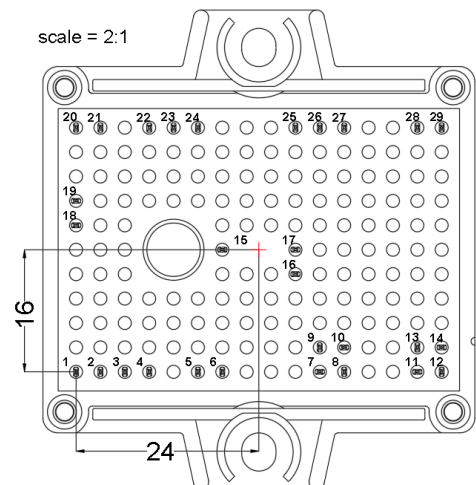
PIM29 56.7x42.5 (PRESS FIT)  
CASE 180HR

#### MARKING DIAGRAM



NXH008T120M3F2PTHG = Specific Device Code  
AT = Assembly & Test Site Code  
YYWW = 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.

# NXH008T120M3F2PTHG

## PIN FUNCTION DESCRIPTION

| Pin | Name | Description                |
|-----|------|----------------------------|
| 1   | DC – | DC Negative Bus connection |
| 2   | DC – | DC Negative Bus connection |
| 3   | DC – | DC Negative Bus connection |
| 4   | DC – | DC Negative Bus connection |
| 5   | G3   | T3 Gate                    |
| 6   | S3   | T3 Source                  |
| 7   | N    | DC Neutral Point           |
| 8   | N    | DC Neutral Point           |
| 9   | N    | DC Neutral Point           |
| 10  | N    | DC Neutral Point           |
| 11  | DC+  | DC Positive Bus connection |
| 12  | DC+  | DC Positive Bus connection |
| 13  | DC+  | DC Positive Bus connection |
| 14  | DC+  | DC Positive Bus connection |
| 15  | D    | Common point drain         |
| 16  | G2   | T2 Gate                    |
| 17  | S2   | T2 Source                  |
| 18  | S4   | T4 Source                  |
| 19  | G4   | T4 Gate                    |
| 20  | TH1  | Thermistor Connection 1    |
| 21  | TH2  | Thermistor Connection 2    |
| 22  | AC   | AC Phase Output            |
| 23  | AC   | AC Phase Output            |
| 24  | AC   | AC Phase Output            |
| 25  | AC   | AC Phase Output            |
| 26  | AC   | AC Phase Output            |
| 27  | AC   | AC Phase Output            |
| 28  | S1   | T1 Source                  |
| 29  | G1   | T1 Gate                    |

# NXH008T120M3F2PTHG

## MAXIMUM RATINGS

| Rating  | Symbol       | Value   | Unit               |
|---|--------------|---------|--------------------|
| <b>SiC MOSFET</b>   |              |         |                    |
| Drain–Source Voltage  | $V_{DS}$     | 1200    | V                  |
| Gate–Source Voltage   | $V_{GS}$     | +22/–10 | V                  |
| Continuous Drain Current @ $T_c = 80^{\circ}\text{C}$ ( $T_J = 175^{\circ}\text{C}$ ) | $I_D$        | 129     | A                  |
| Pulsed Drain Current ( $T_J = 175^{\circ}\text{C}$ ) (Note 2)                         | $I_{Dpulse}$ | 387     | A                  |
| Maximum Power Dissipation ( $T_J = 175^{\circ}\text{C}$ )                             | $P_{tot}$    | 371     | 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   | $^{\circ}\text{C}$ |
| TIM Layer Thickness       | $T_{TIM}$ | $160 \pm 20$ | $\mu\text{m}$      |

## INSULATION PROPERTIES

|  |          |          |           |
|--|----------|----------|-----------|
| Isolation test voltage, $t = 1$ sec, 60 Hz | $V_{is}$ | 4800     | $V_{RMS}$ |
| Creepage distance                          |          | 12.7     | mm        |
| CTI  |          | 600      |           |
| Substrate Ceramic Material                 |          | HPS      |           |
| Substrate Ceramic Material Thickness       |          | 0.38     | mm        |
| Substrate Warpage (Note 2)                 | W        | Max 0.18 | 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.

1. Refer to ELECTRICAL CHARACTERISTICS, RECOMMENDED OPERATING RANGES and/or APPLICATION INFORMATION for Safe Operating parameters.
2. Height difference between horizontal plane and substrate copper bottom.

## 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             |
|-----------------------------------|---|--------------|------|------|------|------------------|
| <b>SiC MOSFET CHARACTERISTICS</b> |   |              |      |      |      |                  |
| Zero Gate Voltage Drain Current   | $V_{GS} = 0\text{ V}$ , $V_{DS} = 1200\text{ V}$                            | $I_{DSS}$    | –    | –    | 300  | $\mu\text{A}$    |
| Drain–Source On Resistance        | $V_{GS} = 18\text{ V}$ , $I_D = 100\text{ A}$ , $T_J = 25^{\circ}\text{C}$  | $R_{DS(ON)}$ | –    | 8.5  | 11.5 | $\text{m}\Omega$ |
|                                   | $V_{GS} = 18\text{ V}$ , $I_D = 100\text{ A}$ , $T_J = 125^{\circ}\text{C}$ |              | –    | 12.9 | –    |                  |
|                                   | $V_{GS} = 18\text{ V}$ , $I_D = 100\text{ A}$ , $T_J = 150^{\circ}\text{C}$ |              | –    | 15   | –    |                  |
| Gate–Source Threshold Voltage     | $V_{GS} = V_{DS}$ , $I_D = 60\text{ mA}$                                    | $V_{GS(TH)}$ | 1.8  | 2.8  | 4.4  | V                |
| Gate Leakage Current              | $V_{GS} = -10\text{ V} / 20\text{ V}$ , $V_{DS} = 0\text{ V}$               | $I_{GSS}$    | –600 | –    | 600  | nA               |
| Input Capacitance                 | $V_{DS} = 800\text{ V}$ , $V_{GS} = 0\text{ V}$ , $f = 100\text{ kHz}$      | $C_{ISS}$    | –    | 9129 | –    | pF               |
| Reverse Transfer Capacitance      |   | $C_{RSS}$    | –    | 39   | –    |                  |
| Output Capacitance                |   | $C_{OSS}$    | –    | 493  | –    |                  |

# NXH008T120M3F2PTHG

## ELECTRICAL CHARACTERISTICS (continued)

T<sub>J</sub> = 25 °C unless otherwise noted

| Parameter                             | Test Conditions  | Symbol                | Min | Typ   | Max | Unit |
|---------------------------------------|--|-----------------------|-----|-------|-----|------|
| <b>SiC MOSFET CHARACTERISTICS</b>     |  |                       |     |       |     |      |
| Total Gate Charge                     | V <sub>DS</sub> = 800 V, V <sub>GS</sub> = -5/20 V, I <sub>D</sub> = 200 A   | Q <sub>G(TOTAL)</sub> | —   | 454   | —   | nC   |
| Gate–Source Charge                    |  | Q <sub>GS</sub>       | —   | 43    | —   | nC   |
| Gate–Drain Charge                     |  | Q <sub>GD</sub>       | —   | 101   | —   | nC   |
| Turn-on Delay Time                    | T <sub>J</sub> = 25°C<br>V <sub>DS</sub> = 400 V, I <sub>D</sub> = 100 A<br>V <sub>GS</sub> = -3 V / 18 V, R <sub>G</sub> = 2.7 Ω  | t <sub>d(on)</sub>    | —   | 41.5  | —   | ns   |
| Rise Time                             |  | t <sub>r</sub>        | —   | 20.6  | —   |      |
| Turn-off Delay Time                   |  | t <sub>d(off)</sub>   | —   | 137   | —   |      |
| Fall Time                             |  | t <sub>f</sub>        | —   | 15    | —   |      |
| Turn-on Switching Loss per Pulse      |  | E <sub>ON</sub>       | —   | 0.60  | —   | mJ   |
| Turn-off Switching Loss per Pulse     |  | E <sub>OFF</sub>      | —   | 0.26  | —   |      |
| Turn-on Delay Time                    | T <sub>J</sub> = 150°C<br>V <sub>DS</sub> = 400 V, I <sub>D</sub> = 100 A<br>V <sub>GS</sub> = -3 V / 18 V, R <sub>G</sub> = 2.7 Ω | t <sub>d(on)</sub>    | —   | 39    | —   | ns   |
| Rise Time                             |  | t <sub>r</sub>        | —   | 19.2  | —   |      |
| Turn-off Delay Time                   |  | t <sub>d(off)</sub>   | —   | 155   | —   |      |
| Fall Time                             |  | t <sub>f</sub>        | —   | 17    | —   |      |
| Turn-on Switching Loss per Pulse      |  | E <sub>ON</sub>       | —   | 0.61  | —   | mJ   |
| Turn off Switching Loss per Pulse     |  | E <sub>OFF</sub>      | —   | 0.32  | —   |      |
| Diode Forward Voltage                 | I <sub>D</sub> = 100 A, T <sub>J</sub> = 25°C  | V <sub>SD</sub>       | —   | 4.8   | 7.5 | V    |
|                                       | I <sub>D</sub> = 100 A, T <sub>J</sub> = 125°C   |                       | —   | 4.1   | —   |      |
|                                       | I <sub>D</sub> = 100 A, T <sub>J</sub> = 150°C   |                       | —   | 4.0   | —   |      |
| Thermal Resistance – Chip-to-Case     | T1, T2, T3, T4   | R <sub>thJC</sub>     | —   | 0.256 | —   | °C/W |
| Thermal Resistance – Chip-to-Heatsink | Thermal grease,<br>Thickness = 2 Mil +2%,<br>A = 2.8 W/mK  | R <sub>thJH</sub>     | —   | 0.451 | —   | °C/W |

## THERMISTOR CHARACTERISTICS

|                                       |                                  |                  |    |       |   |      |
|---------------------------------------|----------------------------------|------------------|----|-------|---|------|
| Nominal Resistance                    | TNTC = 25°C                      | R <sub>25</sub>  | —  | 5     | — | kΩ   |
|                                       | TNTC = 100°C                     | R <sub>100</sub> | —  | 493   | — | Ω    |
|                                       | TNTC = 150°C                     | R <sub>150</sub> | —  | 159.5 | — | Ω    |
| Deviation of R100                     | TNTC = 100°C                     | ΔR/R             | -5 | —     | 5 | %    |
| Power Dissipation – Recommended Limit | 0.15 mA. Non-Self-heating Effect | P <sub>D</sub>   | —  | 0.1   | — | mW   |
| Power Dissipation – Absolute Maximum  | 5 mA                             | P <sub>D</sub>   | —  | 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.

## ORDERING INFORMATION

| Orderable Part Number | Marking            | Package   | Shipping                |
|-----------------------|--------------------|---|-------------------------|
| NXH008T120M3F2PTHG    | NXH008T120M3F2PTHG | F2-TNPC: Case 180HR<br>Press-fit Pins with pre-applied<br>thermal interface material (TIM)<br>(Pb-Free / Halide Free) | 20 Units / Blister Tray |

# NXH008T120M3F2PTHG

## TYPICAL CHARACTERISTICS

### M1/M2 SIC MOSFET CHARACTERISTIC

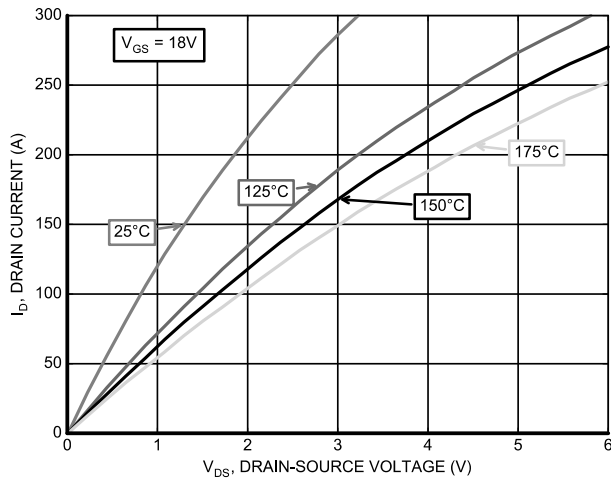


Figure 2. MOSFET Typical Output Characteristic

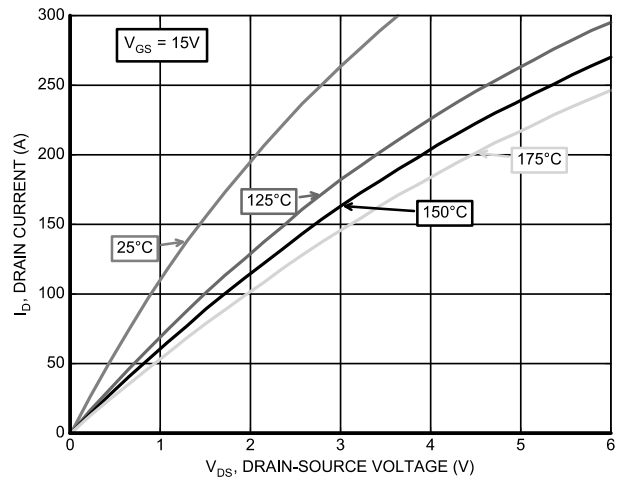


Figure 3. MOSFET Typical Output Characteristic

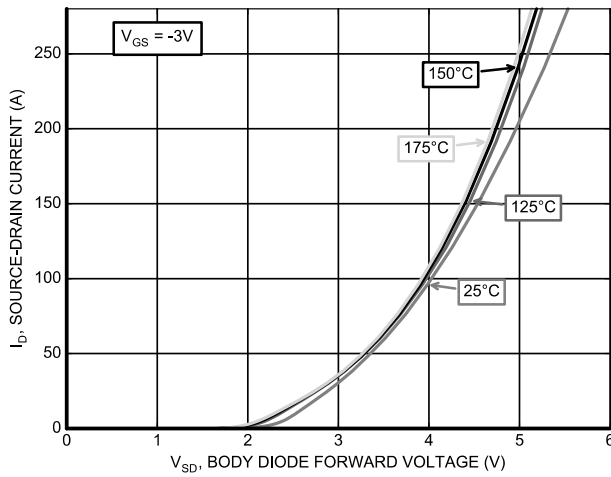


Figure 4.  $I_D$  vs.  $V_{SD}$

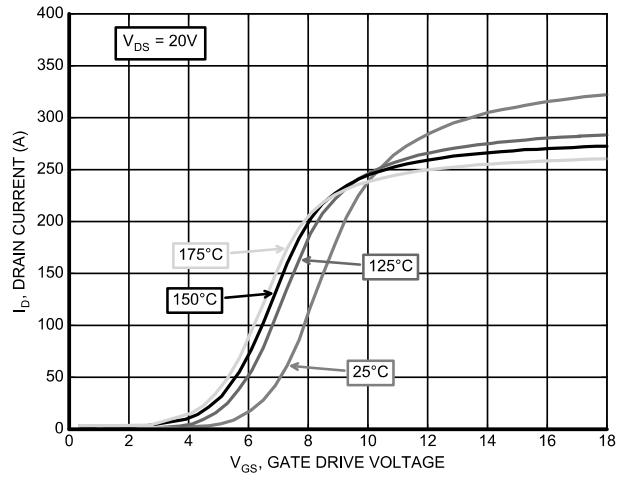


Figure 5.  $I_D$  vs.  $V_{GS}$

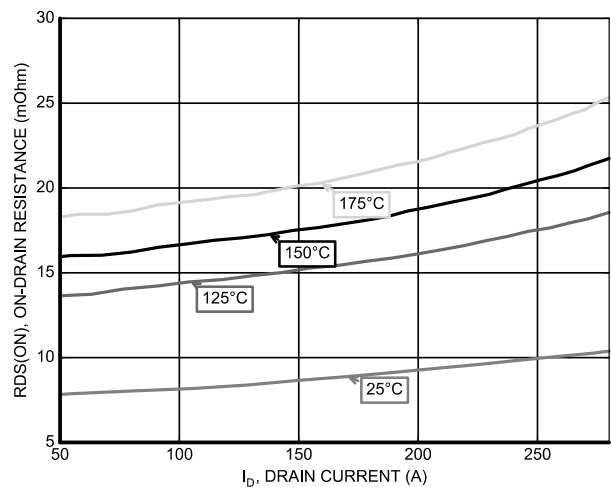


Figure 6.  $R_{DS(ON)}$  vs.  $I_D$

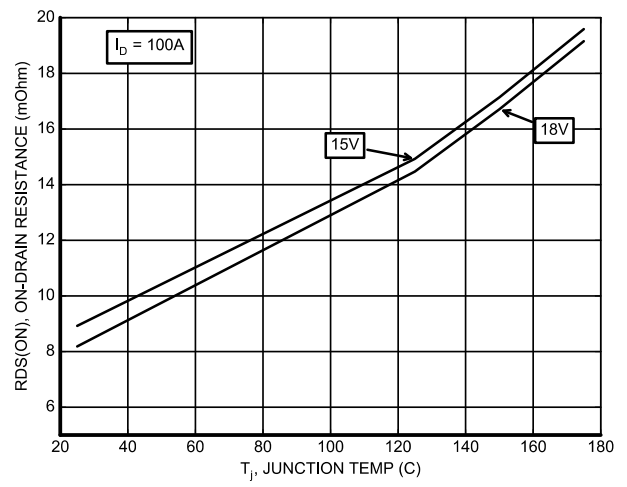


Figure 7.  $R_{DS(ON)}$  vs.  $T_J$

**TYPICAL CHARACTERISTICS**  
M1/M2 SIC MOSFET CHARACTERISTIC

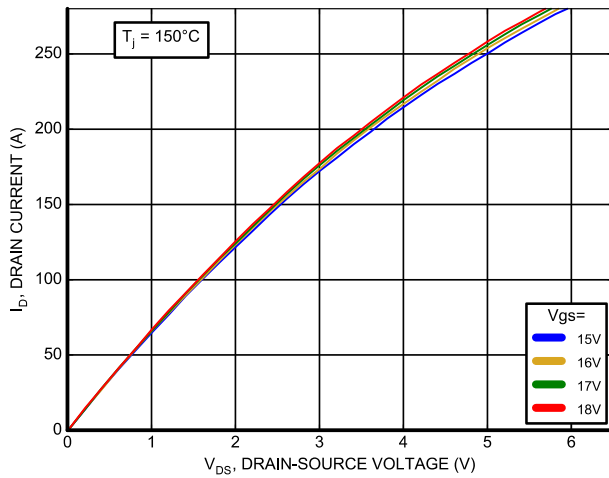


Figure 8.  $I_D$  vs.  $V_{DS}$

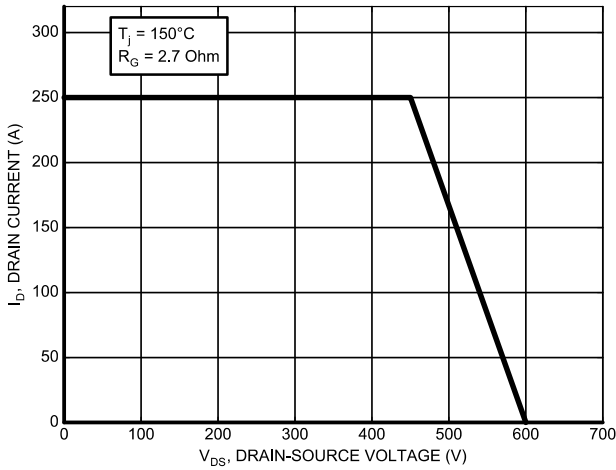


Figure 9.  $I_D$  vs.  $V_{SD}$

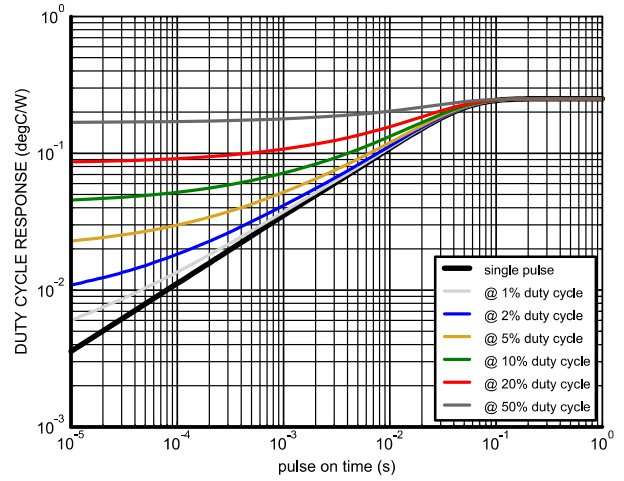


Figure 10. Duty Cycle Response vs. Pulse On Time

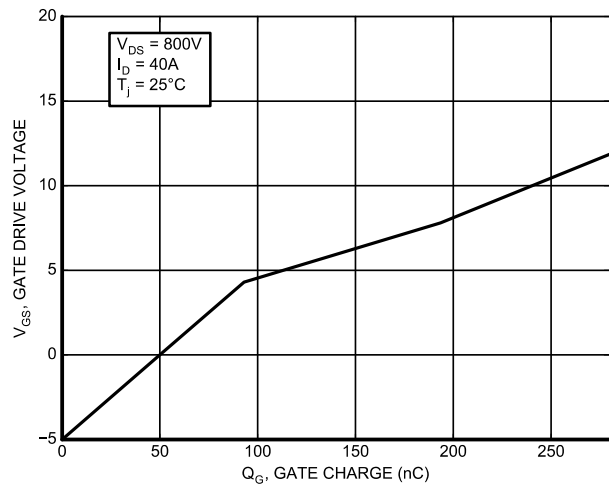


Figure 11.  $V_{GS}$  vs.  $Q_G$

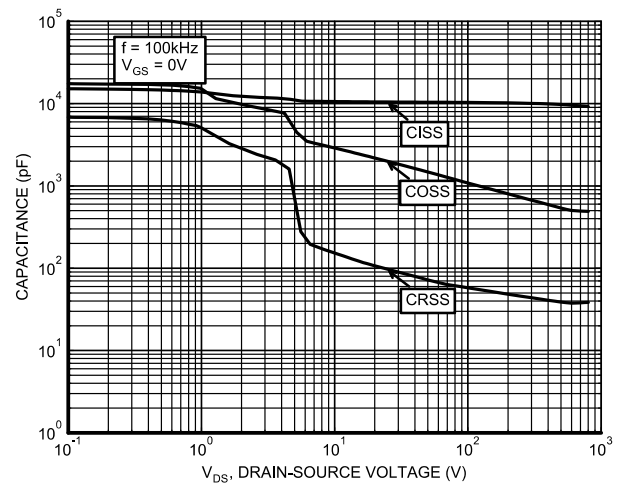


Figure 12. Capacitance vs.  $V_{DS}$

TYPICAL CHARACTERISTICS – HB COMMUTATION PATH

M1/M2 SIC MOSFET SWITCHING CHARACTERISTIC

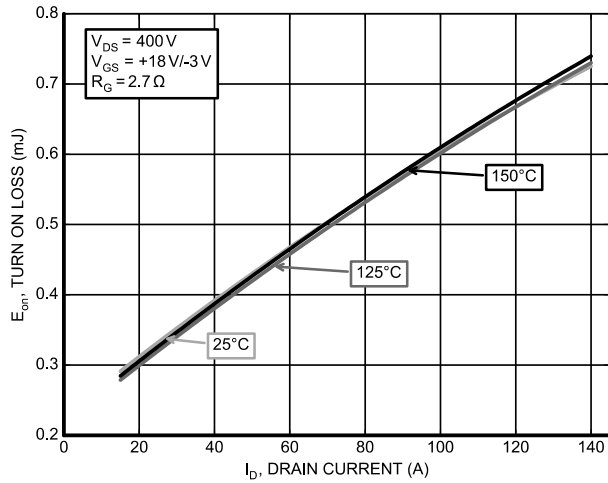


Figure 13.  $E_{on}$  vs.  $I_D$

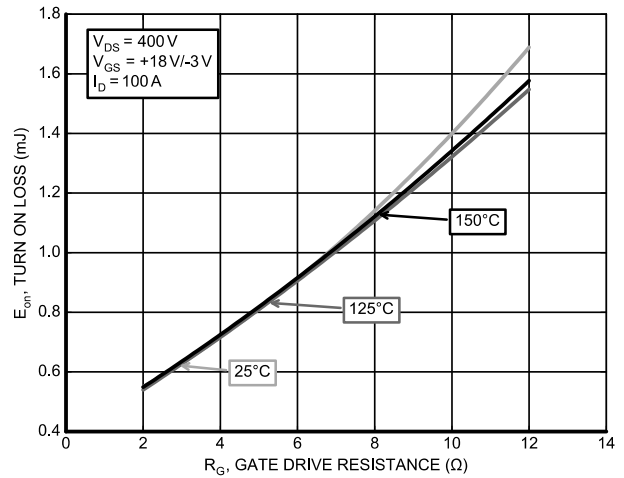


Figure 14.  $E_{on}$  vs.  $R_G$

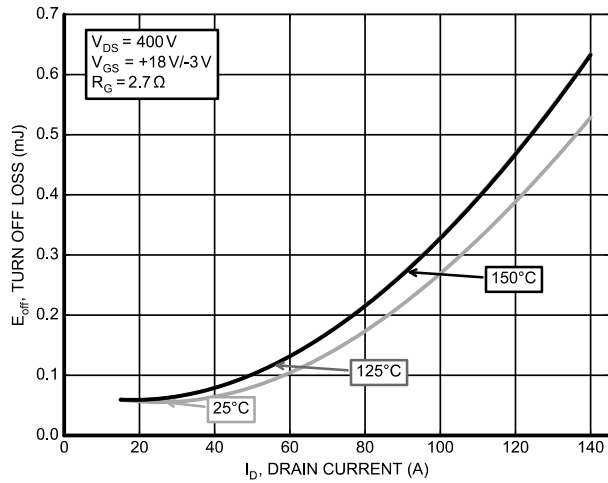


Figure 15.  $E_{off}$  vs.  $I_D$

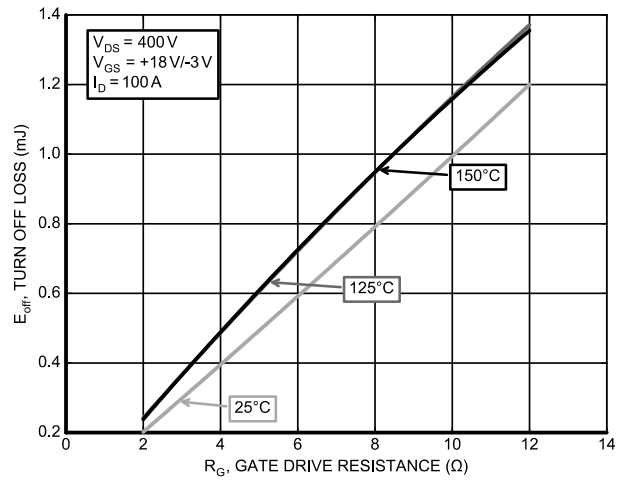


Figure 16.  $E_{off}$  vs.  $R_G$

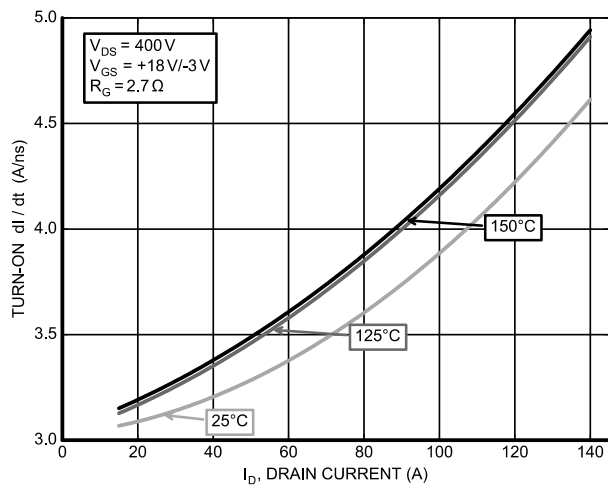


Figure 17. Turn-on  $di/dt$  vs.  $I_D$

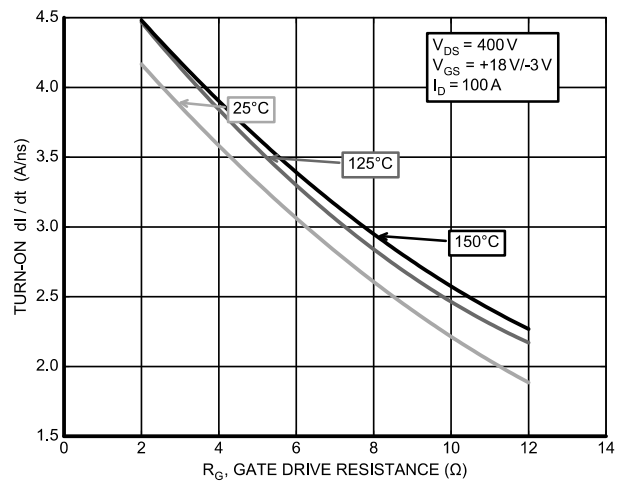


Figure 18. Turn-on  $di/dt$  vs.  $R_G$

**TYPICAL CHARACTERISTICS – HB COMMUTATION PATH**  
M1/M2 SIC MOSFET SWITCHING CHARACTERISTIC

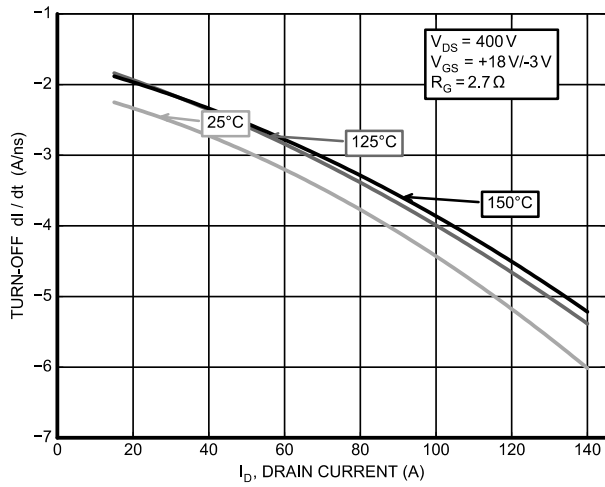


Figure 19. Turn-off  $di/dt$  vs.  $I_D$

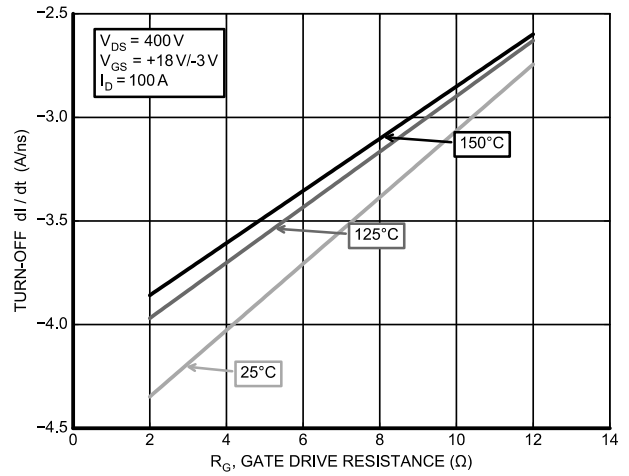


Figure 20. Turn-off  $di/dt$  vs.  $R_G$

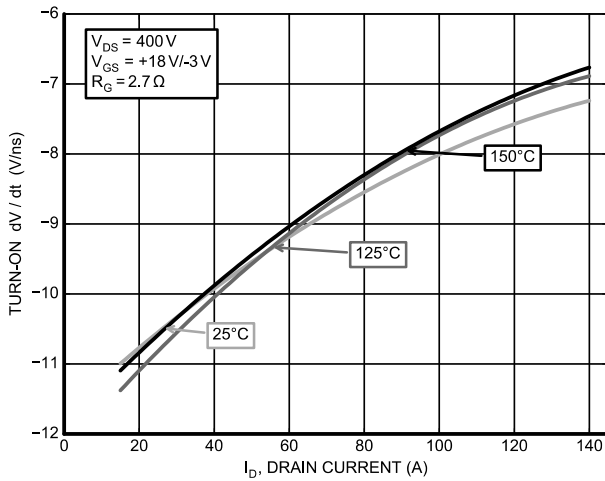


Figure 21. Turn-on  $dV/dt$  vs.  $I_D$

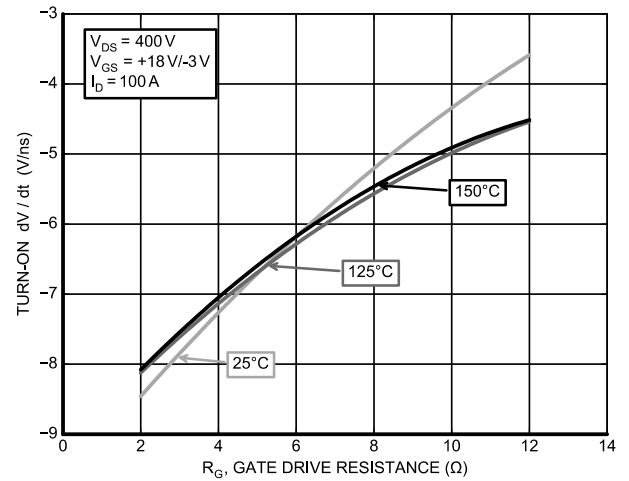


Figure 22. Turn-on  $dV/dt$  vs.  $R_G$

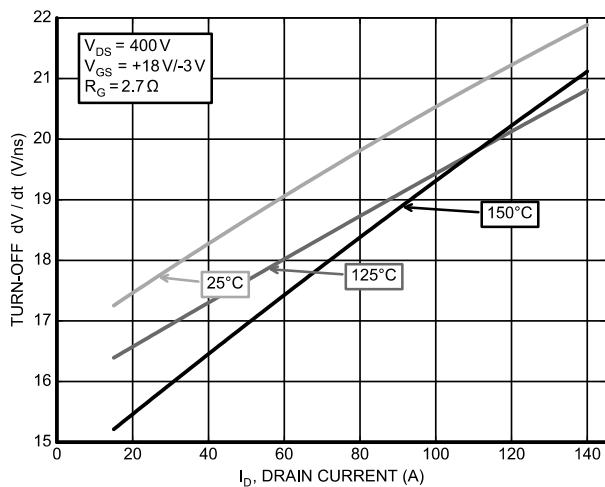


Figure 23. Turn-off  $dV/dt$  vs.  $I_D$

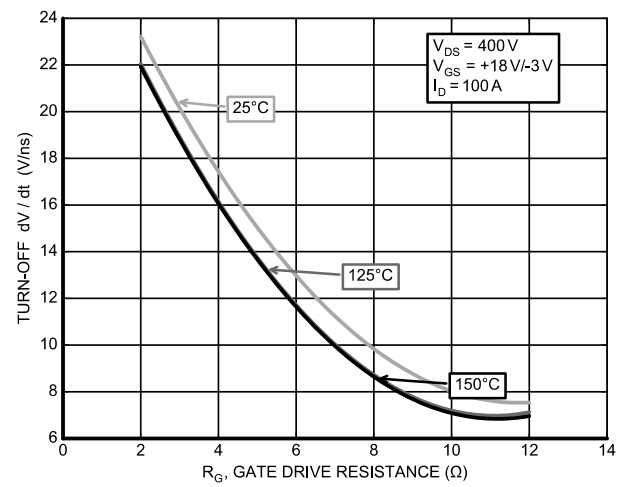


Figure 24. Turn-off  $dV/dt$  vs.  $R_G$



TYPICAL CHARACTERISTICS – HB COMMUTATION PATH

M1/M2 SIC MOSFET SWITCHING CHARACTERISTIC

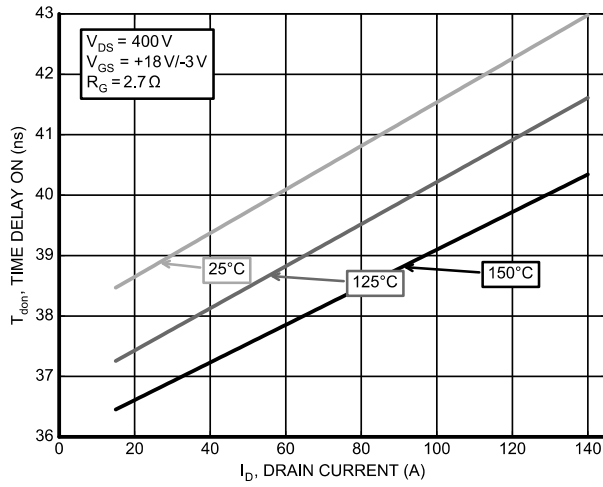


Figure 25.  $T_{don}$  vs.  $I_D$

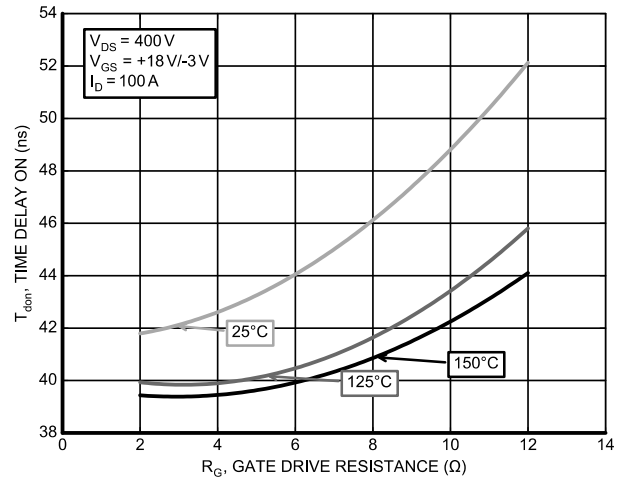


Figure 26.  $T_{don}$  vs.  $R_G$

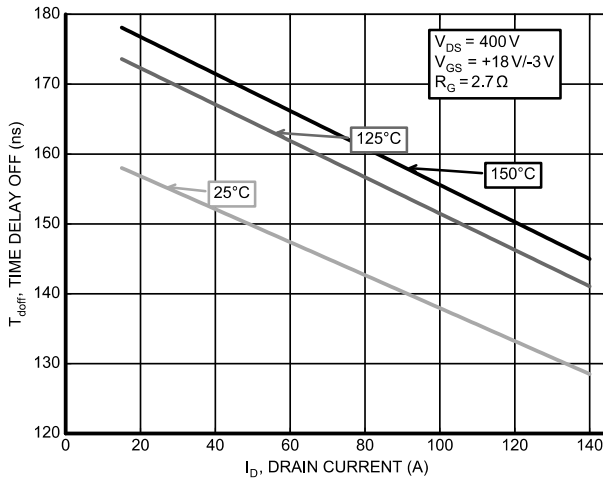


Figure 27.  $T_{doff}$  vs.  $I_D$

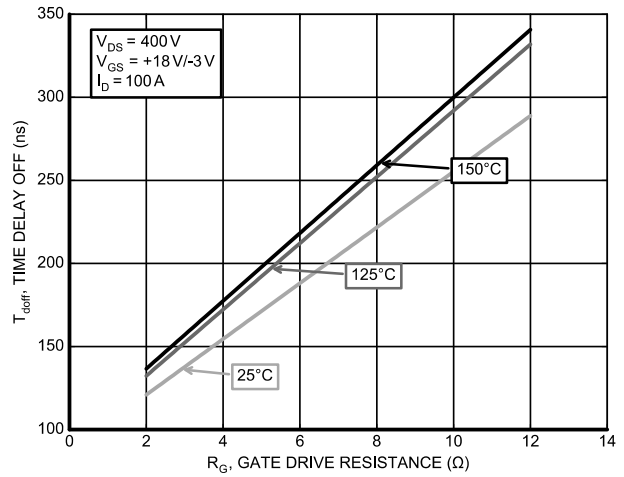


Figure 28.  $T_{doff}$  vs.  $R_G$

TYPICAL CHARACTERISTICS – NP COMMUTATION PATH

M1/M2 SIC MOSFET SWITCHING CHARACTERISTIC

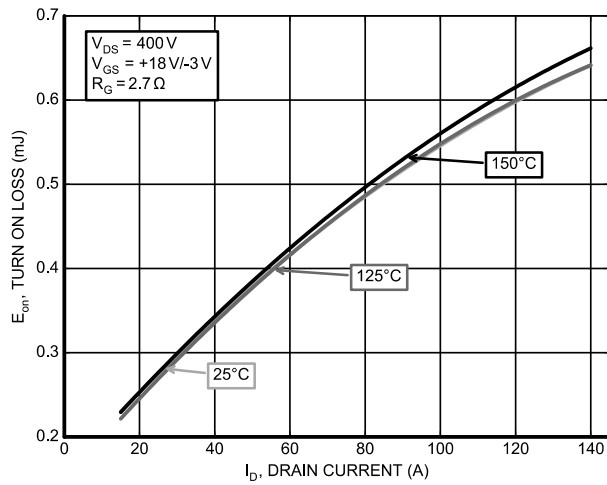


Figure 29.  $E_{on}$  vs.  $I_D$

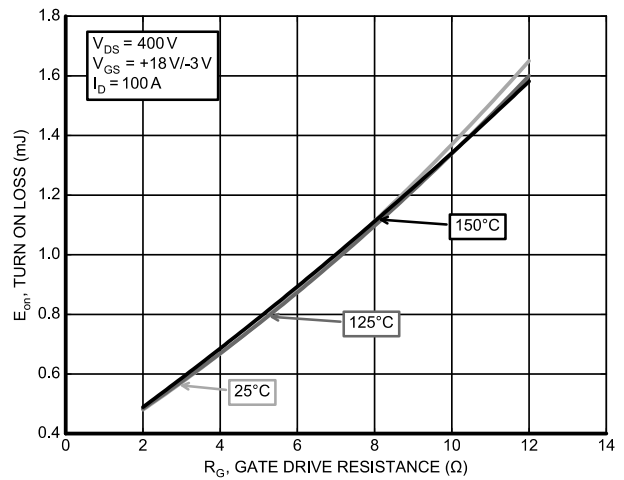


Figure 30.  $E_{on}$  vs.  $R_G$

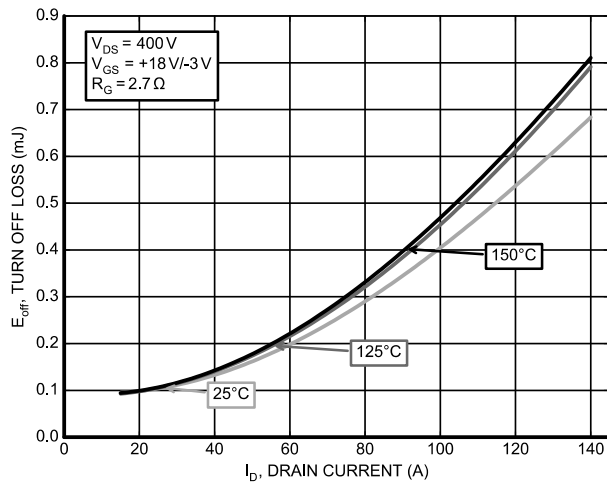


Figure 31.  $E_{off}$  vs.  $I_D$

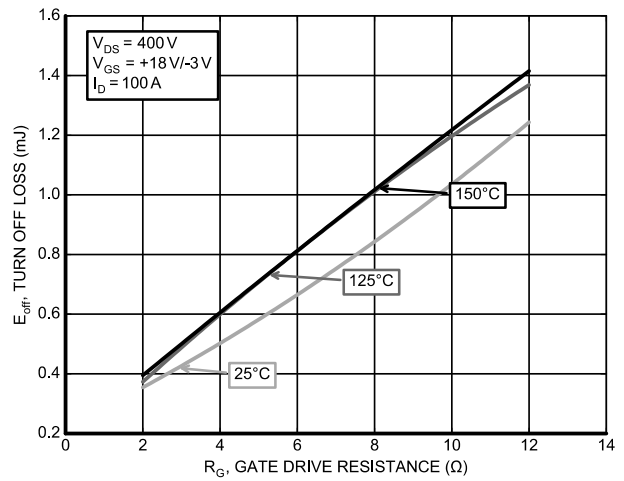


Figure 32.  $E_{off}$  vs.  $R_G$

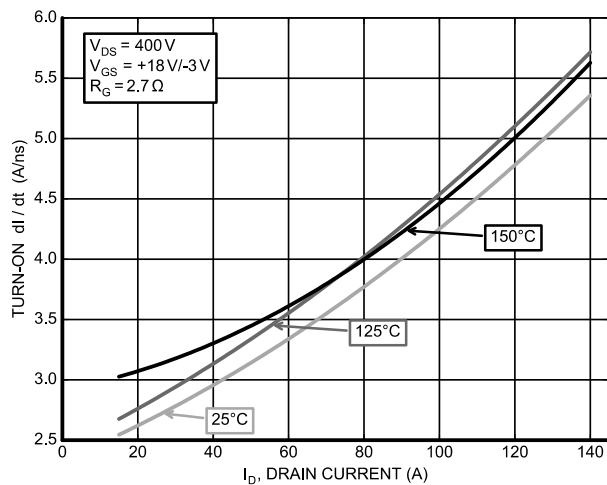


Figure 33. Turn-on  $di/dt$  vs.  $I_D$

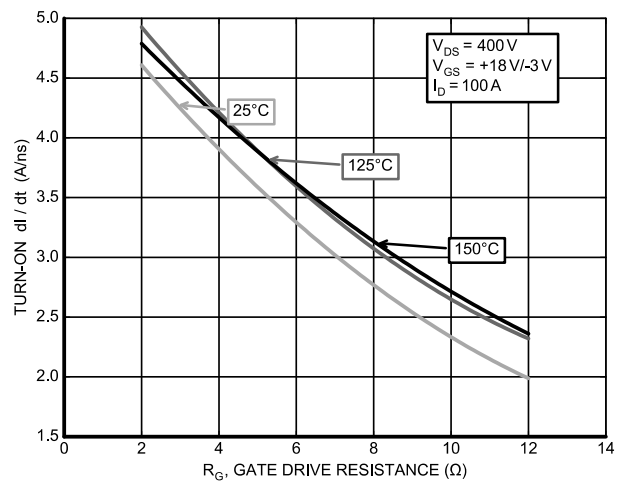


Figure 34. Turn-on  $di/dt$  vs.  $R_G$

TYPICAL CHARACTERISTICS – NP COMMUTATION PATH

M1/M2 SIC MOSFET SWITCHING CHARACTERISTIC

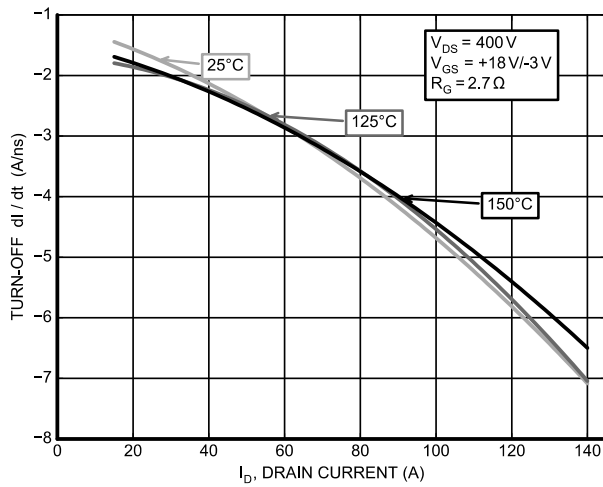


Figure 35. Turn-off  $di/dt$  vs.  $I_D$

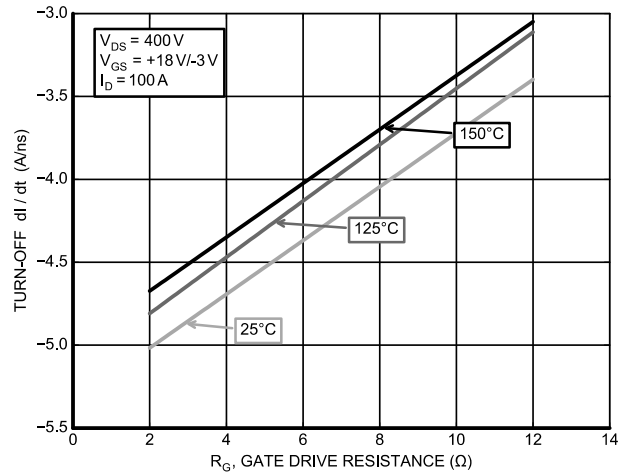


Figure 36. Turn-off  $di/dt$  vs.  $R_G$

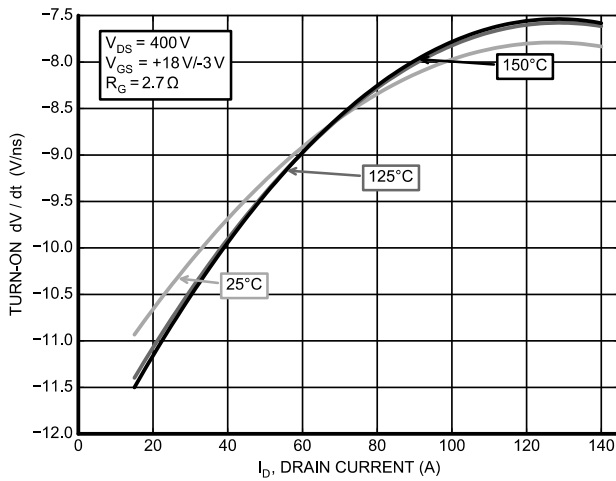


Figure 37. Turn-on  $dV/dt$  vs.  $I_D$

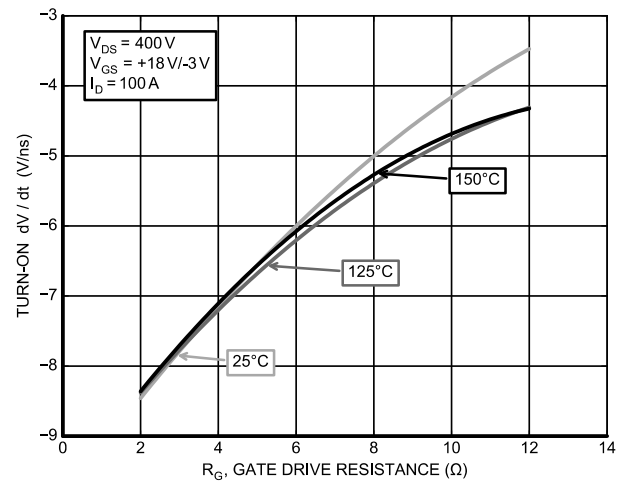


Figure 38. Turn-on  $dV/dt$  vs.  $R_G$

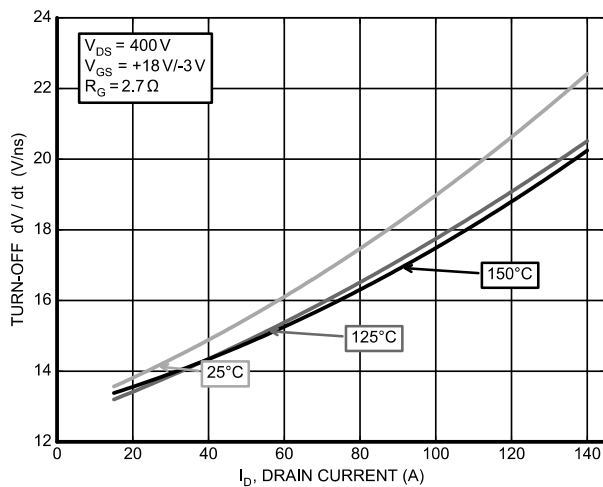


Figure 39. Turn-off  $dV/dt$  vs.  $I_D$

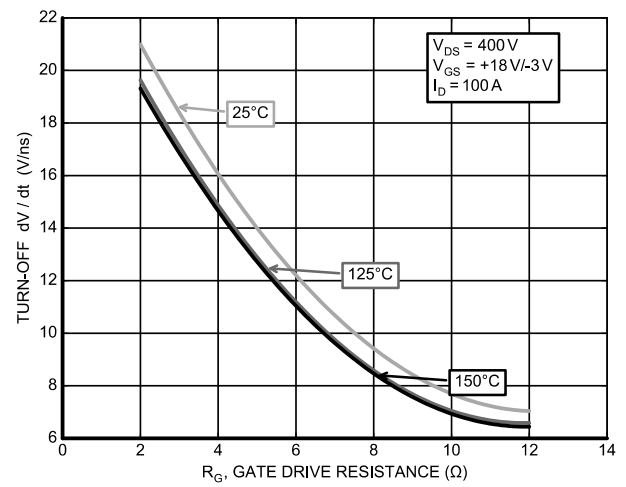


Figure 40. Turn-off  $dV/dt$  vs.  $R_G$

**TYPICAL CHARACTERISTICS – NP COMMUTATION PATH**  
M1/M2 SIC MOSFET SWITCHING CHARACTERISTIC

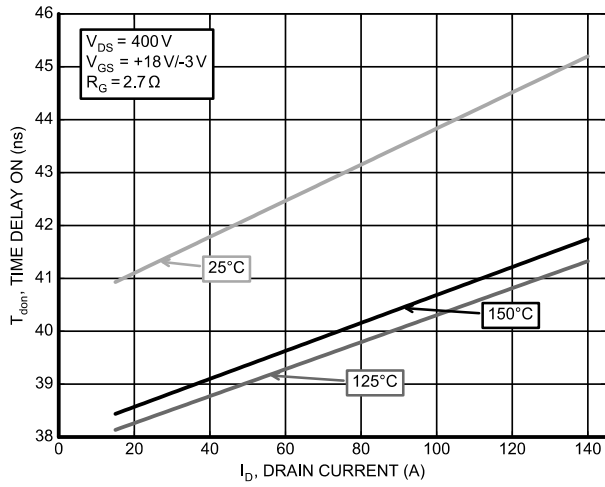


Figure 41.  $T_{don}$  vs.  $I_D$

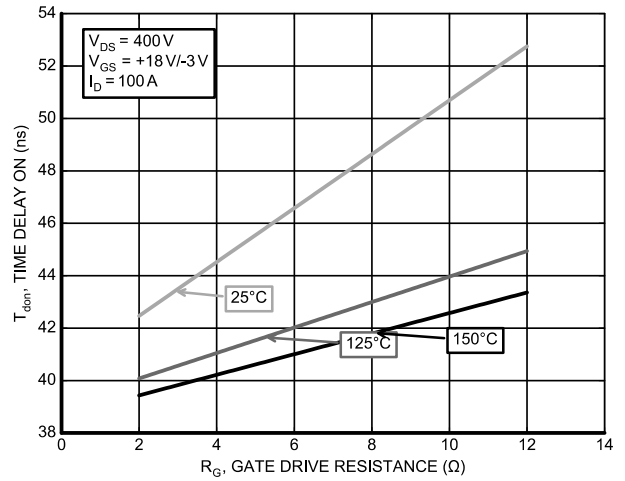


Figure 42.  $T_{don}$  vs.  $R_G$

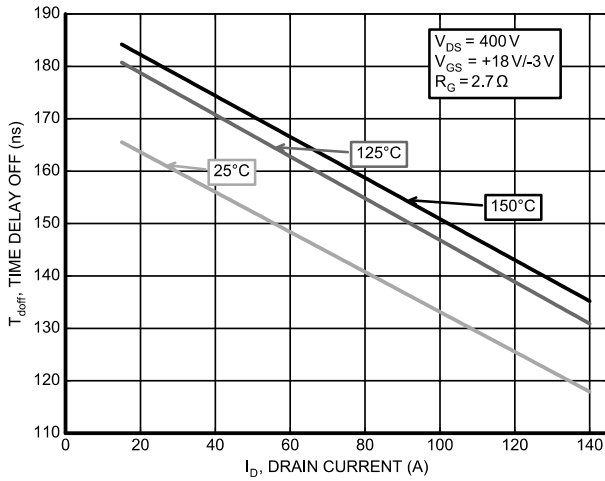


Figure 43.  $T_{doff}$  vs.  $I_D$

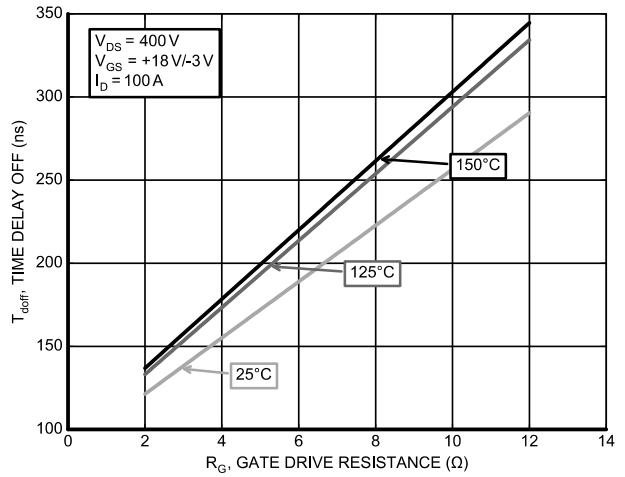


Figure 44.  $T_{doff}$  vs.  $R_G$

# NXH008T120M3F2PTHG

## CAUER NETWORKS – M1, M2

| Cauer Element # | M1,2      |            |
|-----------------|-----------|------------|
|                 | Rth (K/W) | Cth (Ws/K) |
| 1               | 0.0016488 | 0.0032258  |
| 2               | 0.0034479 | 0.0010545  |
| 3               | 0.017527  | 0.0051619  |
| 4               | 0.051792  | 0.014565   |
| 5               | 0.094906  | 0.085644   |
| 6               | 0.055154  | 1.6903     |
| 7               | 0.034307  | 4.576      |

NXH008T120M3F2PTHG

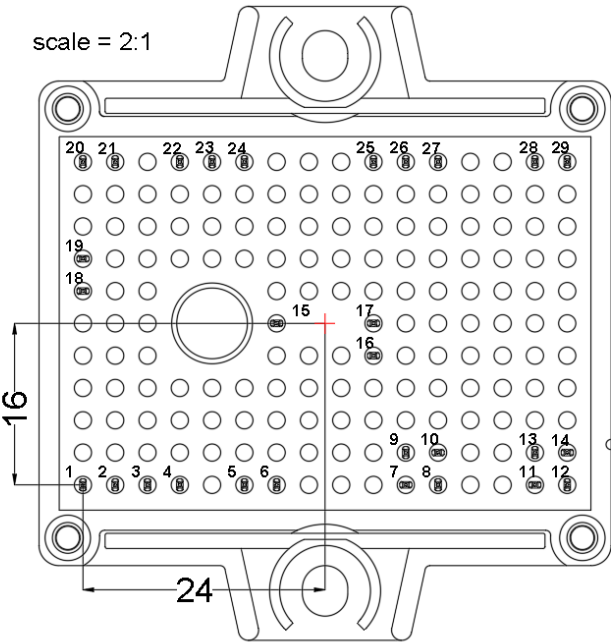


Figure 45. Pin Connections

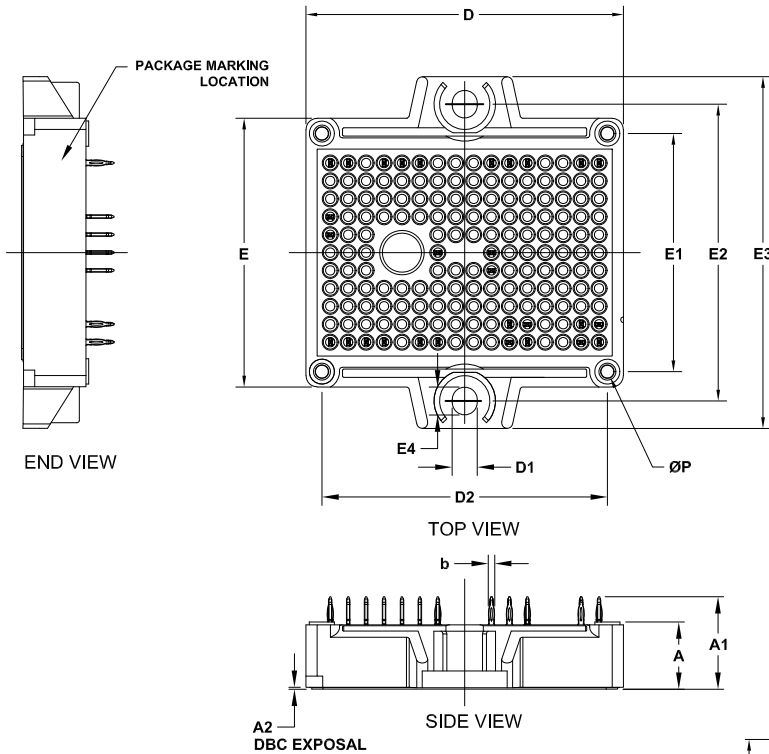
PIN FUNCTIONS

| Pin # | X    | Y   | Function | Pin # | X    | Y    | Function |
|-------|------|-----|----------|-------|------|------|----------|
| 1     | 0    | 0   | DC-      | 16    | 28.8 | 12.8 | G2       |
| 2     | 3.2  | 0   | DC-      | 17    | 28.8 | 16   | S2       |
| 3     | 6.4  | 0   | DC-      | 18    | 0    | 19.2 | S4       |
| 4     | 9.6  | 0   | DC-      | 19    | 0    | 22.4 | G4       |
| 5     | 16   | 0   | G3       | 20    | 0    | 32   | TH1      |
| 6     | 19.2 | 0   | S3       | 21    | 3.2  | 32   | TH2      |
| 7     | 32   | 0   | N        | 22    | 9.6  | 32   | AC       |
| 8     | 35.2 | 0   | N        | 23    | 12.8 | 32   | AC       |
| 9     | 32   | 3.2 | N        | 24    | 16   | 32   | AC       |
| 10    | 35.2 | 3.2 | N        | 25    | 28.8 | 32   | AC       |
| 11    | 44.8 | 0   | DC+      | 26    | 32   | 32   | AC       |
| 12    | 48   | 0   | DC+      | 27    | 35.2 | 32   | AC       |
| 13    | 44.8 | 3.2 | DC+      | 28    | 44.8 | 32   | S1       |
| 14    | 48   | 3.2 | DC+      | 29    | 48   | 32   | G1       |
| 15    | 19.2 | 16  | D        |       |      |      |          |

# NXH008T120M3F2PTHG

## PACKAGE DIMENSIONS

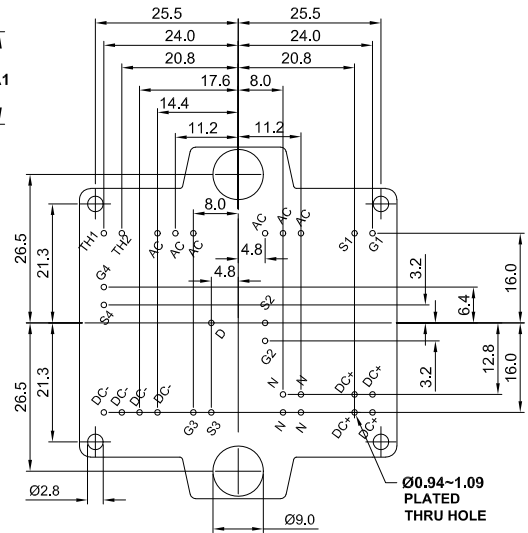
PIM29, 56.7x42.5 (PRESS FIT)  
CASE 180HR  
ISSUE O



### NOTES:

1. CONTROLLING DIMENSION: MILLIMETERS
2. PIN POSITION TOLERANCE IS  $\pm 0.4\text{mm}$

| DIM | MILLIMETERS |       |       |
|-----|-------------|-------|-------|
|     | MIN.        | NOM.  | MAX.  |
| A   | 11.65       | 12.00 | 12.35 |
| A1  | 16.00       | 16.50 | 17.00 |
| A2  | 0.00        | 0.35  | 0.60  |
| A3  | 12.85       | 13.35 | 13.85 |
| b   | 1.15        | 1.20  | 1.25  |
| b1  | 0.59        | 0.64  | 0.69  |
| D   | 56.40       | 56.70 | 57.00 |
| D1  | 4.40        | 4.50  | 4.60  |
| D2  | 50.85       | 51.00 | 51.15 |
| E   | 47.70       | 48.00 | 48.30 |
| E1  | 42.35       | 42.50 | 42.65 |
| E2  | 52.90       | 53.00 | 53.10 |
| E3  | 62.30       | 62.80 | 63.30 |
| E4  | 4.90        | 5.00  | 5.10  |
| P   | 2.20        | 2.30  | 2.40  |



### RECOMMENDED MOUNTING PATTERN

\* For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDER RM/D.

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