

# Silicon Carbide (SiC) Module – EliteSiC, 40 mΩ SiC M1 MOSFET, 1200 V, 4-PACK Full Bridge Topology, F1 Package

## NXH040F120MNF1PTG, NXH040F120MNF1PG

The NXH040F120MNF1 is a power module containing an 40 mΩ/1200 V SiC MOSFET full bridge and a thermistor in an F1 package.

### Features

- 40 mΩ/1200 V SiC MOSFET Half-Bridge
- 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

### Typical Applications

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

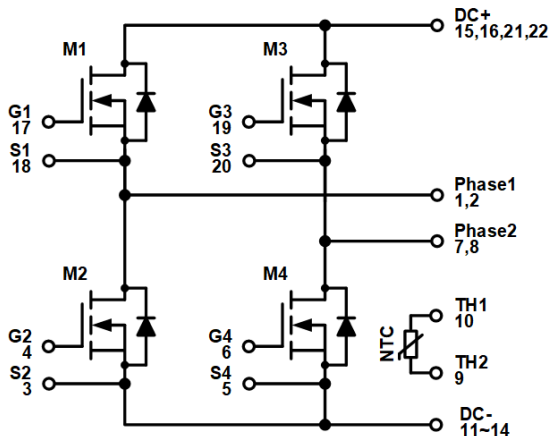
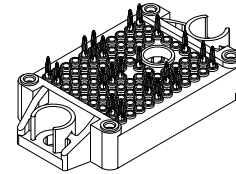


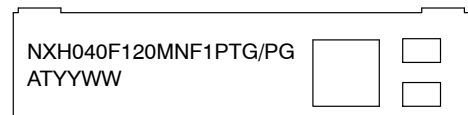
Figure 1. NXH040F120MNF1 Schematic Diagram

### PACKAGE PICTURE



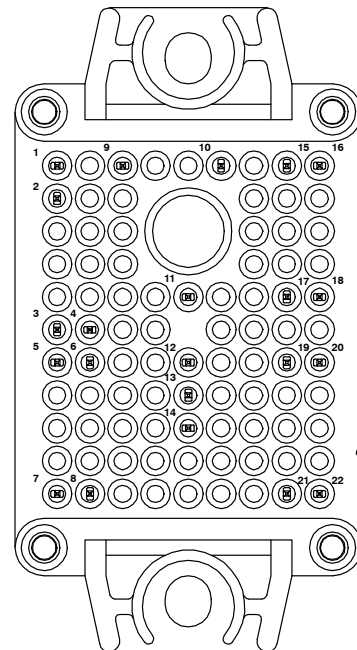
PIM22 33.8x42.5 (PRESS FIT)  
CASE 180BX

### MARKING DIAGRAM



XXXXX = 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.

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## PIN FUNCTION DESCRIPTION

| Pin | Name    | Description                          |
|-----|---------|--------------------------------------|
| 1   | Phase 1 | Center point of M1 and M2            |
| 2   | Phase 1 | Center point of M1 and M2            |
| 3   | S2      | M2 Kelvin Emitter (High side switch) |
| 4   | G2      | M2 Gate (High side switch)           |
| 5   | S4      | M4 Kelvin Emitter (High side switch) |
| 6   | G4      | M4 Gate (High side switch)           |
| 7   | AC2     | Center point of M3 and M4            |
| 8   | AC2     | Center point of M3 and M4            |
| 9   | TH2     | Thermistor Connection 2              |
| 10  | TH1     | Thermistor Connection 1              |
| 11  | DC-     | DC Negative Bus connection           |
| 12  | DC-     | DC Negative Bus connection           |
| 13  | DC-     | DC Negative Bus connection           |
| 14  | DC-     | DC Negative Bus connection           |
| 15  | DC+     | DC Positive Bus connection           |
| 16  | DC+     | DC Positive Bus connection           |
| 17  | G1      | M1 Gate (High side switch)           |
| 18  | S1      | M1 Kelvin Emitter (High side switch) |
| 19  | G3      | M3 Gate (Low side switch)            |
| 20  | S3      | M3 Kelvin Emitter (High side switch) |
| 21  | DC+     | DC Positive Bus connection           |
| 22  | DC+     | DC Positive Bus connection           |

## MAXIMUM RATINGS

| Rating                                                                             | Symbol       | Value   | Unit             |
|------------------------------------------------------------------------------------|--------------|---------|------------------|
| <b>SiC MOSFET</b>                                                                  |              |         |                  |
| Drain-Source Voltage                                                               | $V_{DS}$     | 1200    | V                |
| Gate-Source Voltage                                                                | $V_{GS}$     | +25/-15 | V                |
| Continuous Drain Current @ $T_C = 80^\circ\text{C}$ ( $T_J = 175^\circ\text{C}$ )  | $I_D$        | 30      | A                |
| Pulsed Drain Current ( $T_J = 175^\circ\text{C}$ )                                 | $I_{Dpulse}$ | 60      | A                |
| Maximum Power Dissipation @ $T_C = 80^\circ\text{C}$ ( $T_J = 175^\circ\text{C}$ ) | $P_{tot}$    | 113     | 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, $t = 1 \text{ s}$ , 60 Hz | $V_{is}$ | 4800 | $V_{RMS}$ |
| Creepage Distance                                 |          | 12.7 | 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.

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## RECOMMENDED OPERATING RANGES

| Rating                                | Symbol | Min | Max | Unit |
|---------------------------------------|--------|-----|-----|------|
| Module Operating Junction Temperature | $T_J$  | -40 | 175 | °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

|                                       |                                                                                                                                          |                |      |       |     |                  |
|---------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|----------------|------|-------|-----|------------------|
| Drain-Source Breakdown Voltage        | $V_{GS} = 0\text{ V}, I_D = 200\text{ }\mu\text{A}$                                                                                      | $V_{(BR)DSS}$  | 1200 | —     | —   | V                |
| Zero Gate Voltage Drain Current       | $V_{GS} = 0\text{ V}, V_{DS} = 1200\text{ V}$                                                                                            | $I_{DSS}$      | —    | —     | 100 | $\mu\text{A}$    |
| Drain-Source On Resistance            | $V_{GS} = 20\text{ V}, I_D = 25\text{ A}, T_J = 25^\circ\text{C}$                                                                        | $R_{DS(ON)}$   | —    | 42    | 56  | $\text{m}\Omega$ |
|                                       | $V_{GS} = 20\text{ V}, I_D = 25\text{ A}, T_J = 125^\circ\text{C}$                                                                       |                | —    | 55    | —   |                  |
|                                       | $V_{GS} = 20\text{ V}, I_D = 25\text{ A}, T_J = 150^\circ\text{C}$                                                                       |                | —    | 61    | —   |                  |
| Gate-Source Threshold Voltage         | $V_{GS} = V_{DS}, I_D = 10\text{ mA}$                                                                                                    | $V_{GS(TH)}$   | 1.8  | 2.81  | 4.3 | V                |
| Gate Leakage Current                  | $V_{GS} = -10\text{ V}/20\text{ V}, V_{DS} = 0\text{ V}$                                                                                 | $I_{GSS}$      | -500 | —     | 500 | nA               |
| Input Capacitance                     | $V_{DS} = 800\text{ V}, V_{GS} = 0\text{ V}, f = 1\text{ MHz}$                                                                           | $C_{ISS}$      | —    | 1 505 | —   | pF               |
| Reverse Transfer Capacitance          |                                                                                                                                          | $C_{RSS}$      | —    | 12    | —   |                  |
| Output Capacitance                    |                                                                                                                                          | $C_{OSS}$      | —    | 159   | —   |                  |
| Total Gate Charge                     | $V_{DS} = 800\text{ V}, V_{GS} = 20\text{ V}, I_D = 25\text{ A}$                                                                         | $Q_{G(TOTAL)}$ | —    | 122.1 | —   | nC               |
| Gate-Source Charge                    |                                                                                                                                          | $Q_{GS}$       | —    | 32.2  | —   |                  |
| Gate-Drain Charge                     |                                                                                                                                          | $Q_{GD}$       | —    | 34.7  | —   |                  |
| Turn-on Delay Time                    | $T_J = 25^\circ\text{C},$<br>$V_{DS} = 600\text{ V}, I_D = 25\text{ A},$<br>$V_{GS} = -5\text{ V}/18\text{ V}, R_G = 2.2\text{ }\Omega$  | $t_{d(on)}$    | —    | 30.8  | —   | ns               |
| Rise Time                             |                                                                                                                                          | $t_r$          | —    | 3.04  | —   |                  |
| Turn-off Delay Time                   |                                                                                                                                          | $t_{d(off)}$   | —    | 59.8  | —   |                  |
| Fall Time                             |                                                                                                                                          | $t_f$          | —    | 7.42  | —   |                  |
| Turn-on Switching Loss per Pulse      |                                                                                                                                          | $E_{ON}$       | —    | 0.06  | —   | mJ               |
| Turn off Switching Loss per Pulse     |                                                                                                                                          | $E_{OFF}$      | —    | 0.10  | —   |                  |
| Turn-on Delay Time                    | $T_J = 150^\circ\text{C},$<br>$V_{DS} = 600\text{ V}, I_D = 25\text{ A},$<br>$V_{GS} = -5\text{ V}/18\text{ V}, R_G = 2.2\text{ }\Omega$ | $t_{d(on)}$    | —    | 30.2  | —   | ns               |
| Rise Time                             |                                                                                                                                          | $t_r$          | —    | 3.19  | —   |                  |
| Turn-off Delay Time                   |                                                                                                                                          | $t_{d(off)}$   | —    | 64.4  | —   |                  |
| Fall Time                             |                                                                                                                                          | $t_f$          | —    | 5.83  | —   |                  |
| Turn-on Switching Loss per Pulse      |                                                                                                                                          | $E_{ON}$       | —    | 0.05  | —   | mJ               |
| Turn off Switching Loss per Pulse     |                                                                                                                                          | $E_{OFF}$      | —    | 0.12  | —   |                  |
| Diode Forward Voltage                 | $I_D = 25\text{ A}, T_J = 25^\circ\text{C}$                                                                                              | $V_{SD}$       | —    | 3.97  | 6   | V                |
|                                       | $I_D = 25\text{ A}, T_J = 125^\circ\text{C}$                                                                                             |                | —    | 3.52  | —   |                  |
|                                       | $I_D = 25\text{ A}, T_J = 150^\circ\text{C}$                                                                                             |                | —    | 3.44  | —   |                  |
| Reverse Recovery Time                 | $T_J = 25^\circ\text{C},$<br>$V_{DS} = 600\text{ V}, I_D = 25\text{ A},$<br>$V_{GS} = -5\text{ V}/18\text{ V}, R_G = 2.2\text{ }\Omega$  | $t_{rr}$       | —    | 18.25 | —   | ns               |
| Reverse Recovery Charge               |                                                                                                                                          | $Q_{rr}$       | —    | 700   | —   | nC               |
| Peak Reverse Recovery Current         |                                                                                                                                          | $I_{RRM}$      | —    | 61    | —   | A                |
| Peak Rate of Fall of Recovery Current |                                                                                                                                          | $di/dt$        | —    | 7629  | —   | A/ $\mu\text{s}$ |
| Reverse Recovery Energy               |                                                                                                                                          | $E_{rr}$       | —    | 405   | —   | $\mu\text{J}$    |

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## 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>     |                                                                                                                                  |                   |     |        |     |      |
| Reverse Recovery Time                 | T <sub>J</sub> = 25°C,<br>V <sub>DS</sub> = 600 V, I <sub>D</sub> = 25 A,<br>V <sub>GS</sub> = -5 V/18 V, R <sub>G</sub> = 2.2 Ω | t <sub>rr</sub>   | —   | 20.81  | —   | ns   |
| Reverse Recovery Charge               |                                                                                                                                  | Q <sub>rr</sub>   | —   | 1250   | —   | nC   |
| Peak Reverse Recovery Current         |                                                                                                                                  | I <sub>RRM</sub>  | —   | 97     | —   | A    |
| Peak Rate of Fall of Recovery Current |                                                                                                                                  | di/dt             | —   | 11 414 | —   | A/μs |
| Reverse Recovery Energy               |                                                                                                                                  | E <sub>rr</sub>   | —   | 753    | —   | μJ   |
| Thermal Resistance – Chip-to-Case     | M1, M2, M3, M4                                                                                                                   | R <sub>thJC</sub> | —   | 0.8356 | —   | °C/W |
| Thermal Resistance – Chip-to-Heatsink | Thermal grease,<br>Thickness = 2 Mil ±2%,<br>A = 2.8 W/mK                                                                        | R <sub>thJH</sub> | —   | 1.291  | —   | °C/W |

## THERMISTOR CHARACTERISTICS

|                                       |                                  |                  |    |       |   |      |
|---------------------------------------|----------------------------------|------------------|----|-------|---|------|
| Nominal Resistance                    | T <sub>NTC</sub> = 25°C          | R <sub>25</sub>  | —  | 5     | — | kΩ   |
| Nominal Resistance                    | T <sub>NTC</sub> = 100°C         | R <sub>100</sub> | —  | 493   | — | Ω    |
| Nominal Resistance                    | T <sub>NTC</sub> = 150°C         | R <sub>150</sub> | —  | 159.5 | — | Ω    |
| Deviation of R <sub>100</sub>         | T <sub>NTC</sub> = 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                |
|-----------------------|-------------------|--------------------------------------------------------------------------------------------------------------|-------------------------|
| NXH040F120MNF1PTG     | NXH040F120MNF1PTG | F1-4PACK<br>Press-fit Pins with pre-applied<br>thermal interface material (TIM)<br>(Pb-Free and Halide-Free) | 28 Units / Blister Tray |
| NXH040F120MNF1PG      | NXH040F120MNF1PG  | F1-4PACK<br>Press-fit Pins<br>(Pb-Free and Halide-Free)                                                      | 28 Units / Blister Tray |

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## TYPICAL CHARACTERISTICS (25°C UNLESS OTHERWISE NOTED)

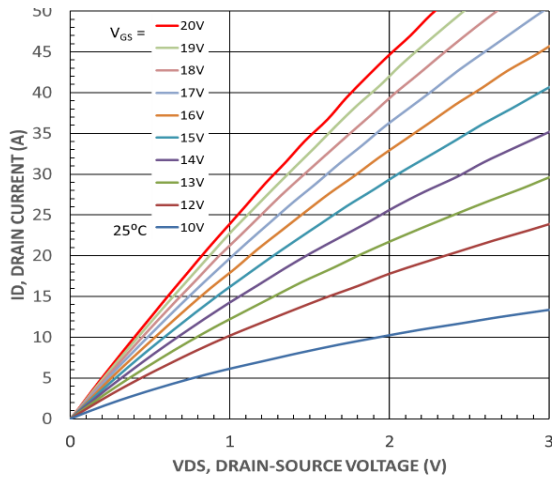


Figure 2. MOSFET Typical Output Characteristics

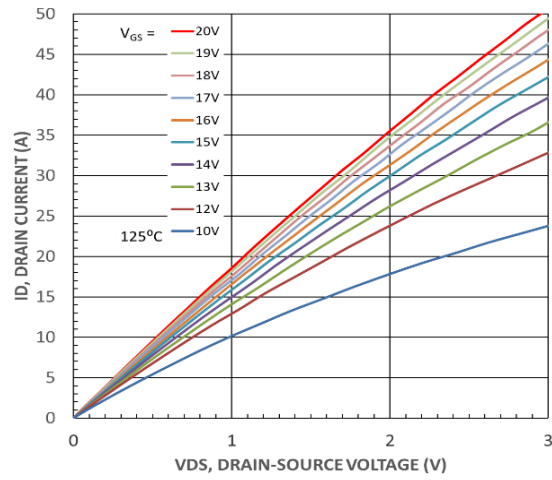


Figure 3. MOSFET Typical Output Characteristics

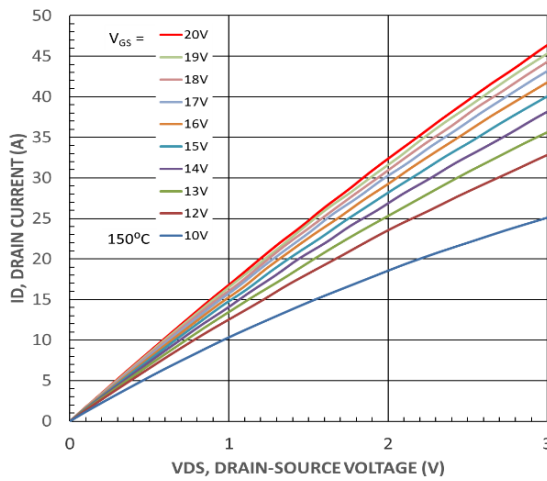


Figure 4. MOSFET Typical Output Characteristics

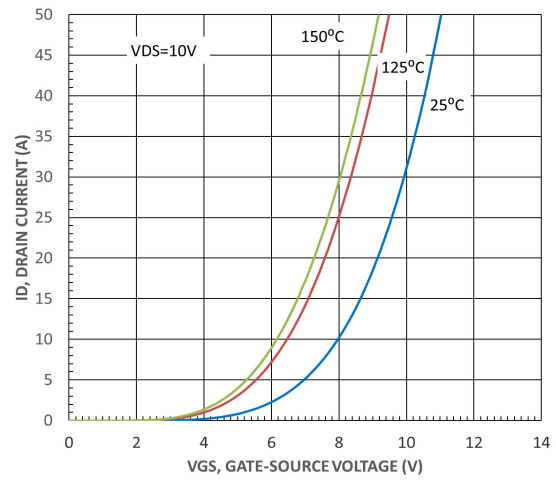


Figure 5. MOSFET Typical Transfer Characteristics

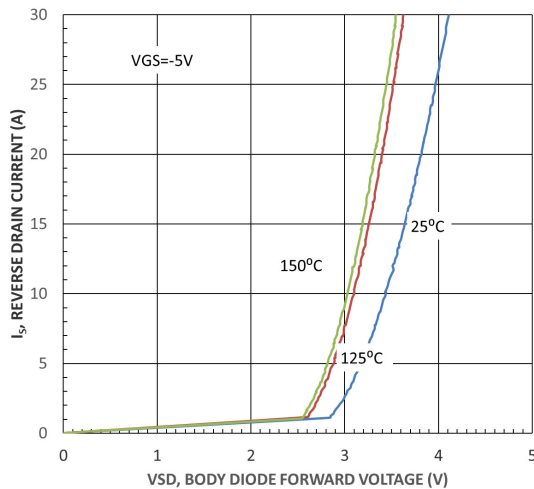


Figure 6. Body Diode Forward Characteristic

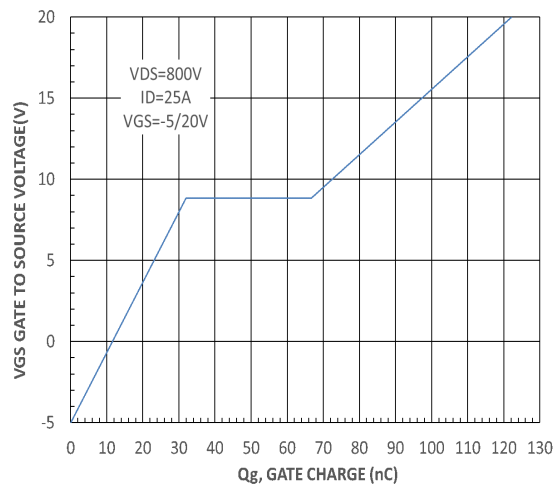
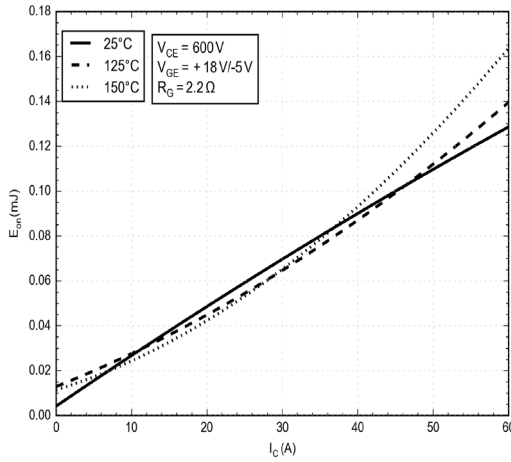
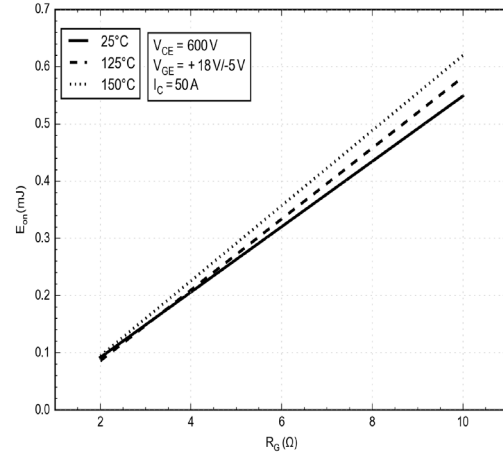


Figure 7. Gate-to-Source Voltage vs. Total Charge

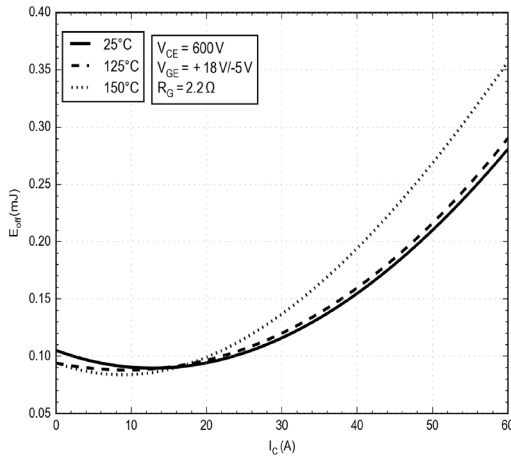
**TYPICAL CHARACTERISTICS (CONTINUED)**  
(25°C UNLESS OTHERWISE NOTED)



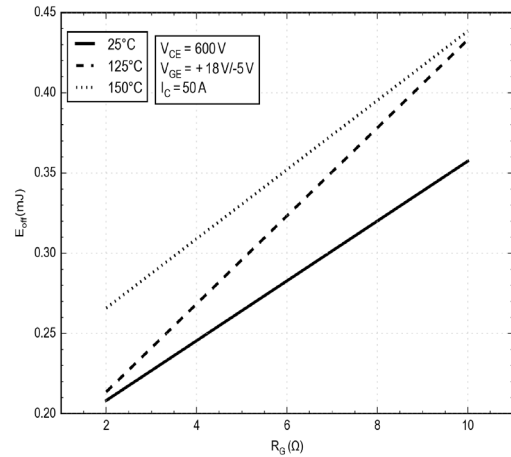
**Figure 8. Typical Switching Loss  $E_{ON}$  vs.  $I_C$**



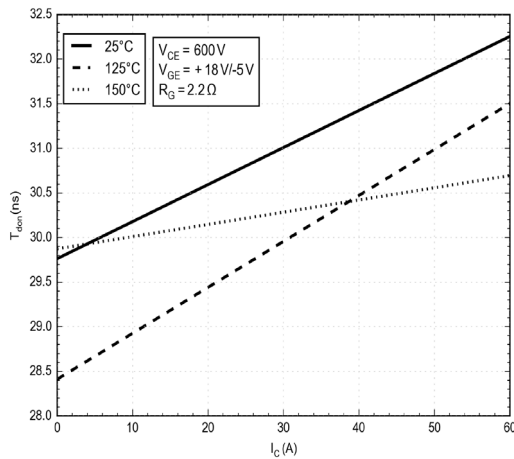
**Figure 9. Typical Switching Loss  $E_{ON}$  vs.  $R_G$**



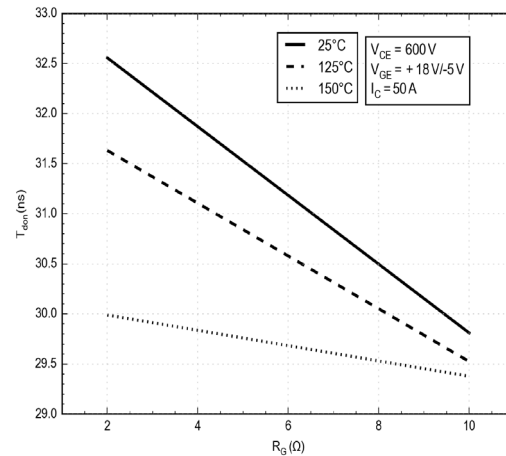
**Figure 10. Typical Switching Loss  $E_{OFF}$  vs.  $I_C$**



**Figure 11. Typical Switching Loss  $E_{OFF}$  vs.  $R_G$**



**Figure 12. Typical Turn-On Switching  $T_{don}$  vs.  $I_C$**



**Figure 13. Typical Turn-On Switching  $T_{don}$  vs.  $R_G$**

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## TYPICAL CHARACTERISTICS (CONTINUED) (25°C UNLESS OTHERWISE NOTED)

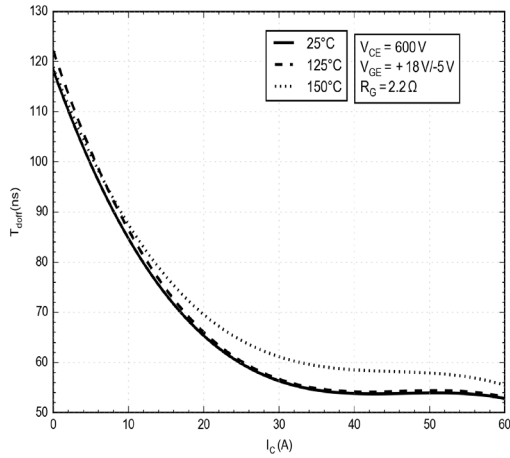


Figure 14. Typical Turn-Off Switching  $T_{doff}$  vs.  $I_C$

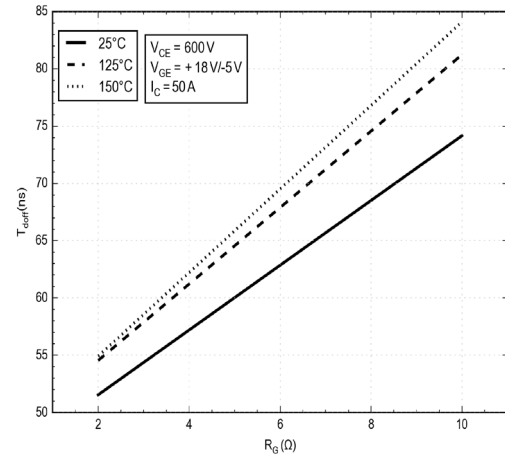


Figure 15. Typical Turn-Off Switching  $T_{doff}$  vs.  $R_G$

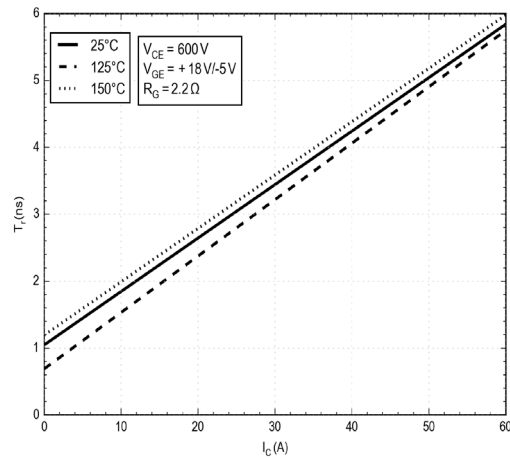


Figure 16. Typical Turn-On Switching  $T_r$  vs.  $I_C$

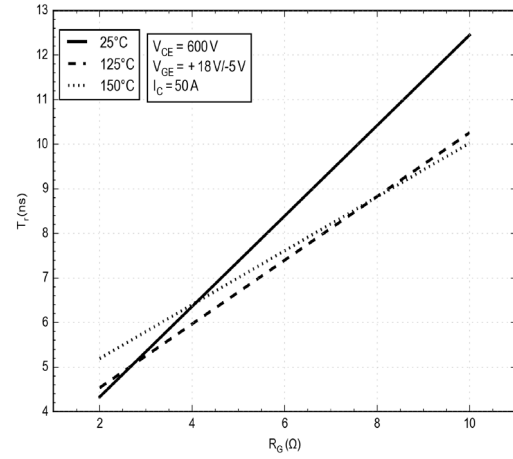


Figure 17. Typical Turn-On Switching  $T_r$  vs.  $R_G$

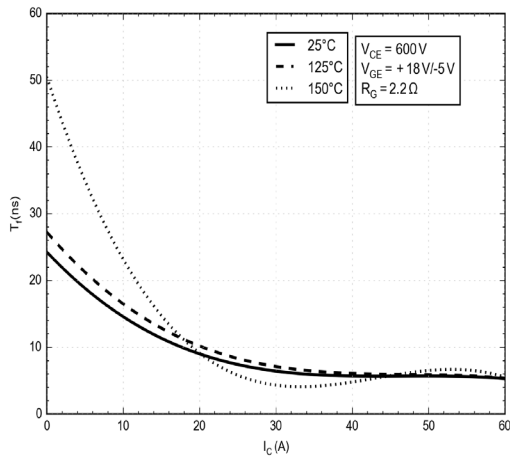


Figure 18. Typical Turn-Off Switching  $T_f$  vs.  $I_C$

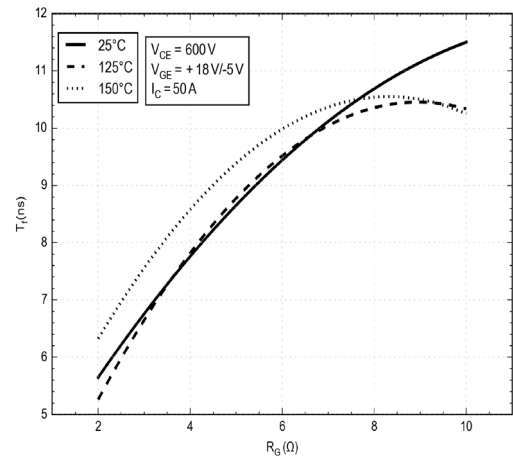


Figure 19. Typical Turn-Off Switching  $T_f$  vs.  $R_G$

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## TYPICAL CHARACTERISTICS (CONTINUED) (25°C UNLESS OTHERWISE NOTED)

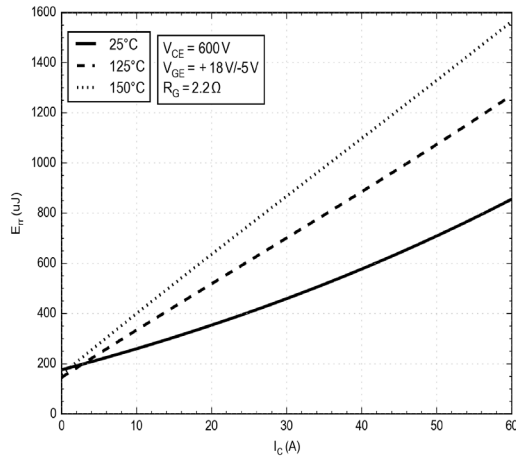


Figure 20. Typical Reverse Recovery Energy vs.  $I_C$

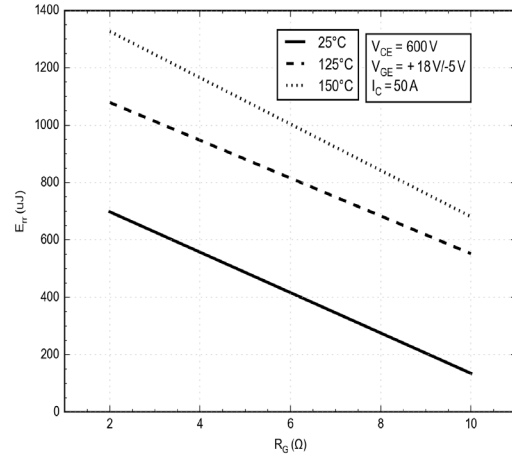


Figure 21. Typical Reverse Recovery Energy vs.  $R_G$

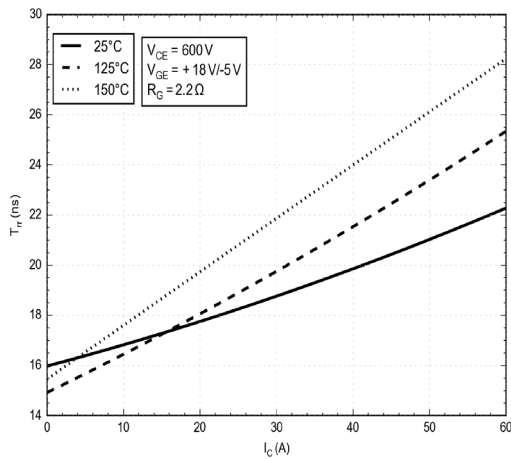


Figure 22. Typical Reverse Recovery Time vs.  $I_C$

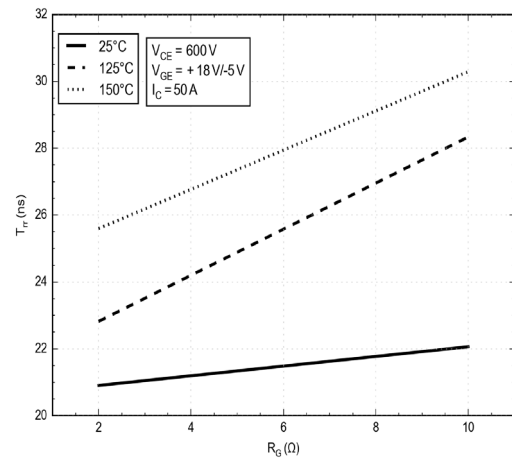


Figure 23. Typical Reverse Recovery Time vs.  $R_G$

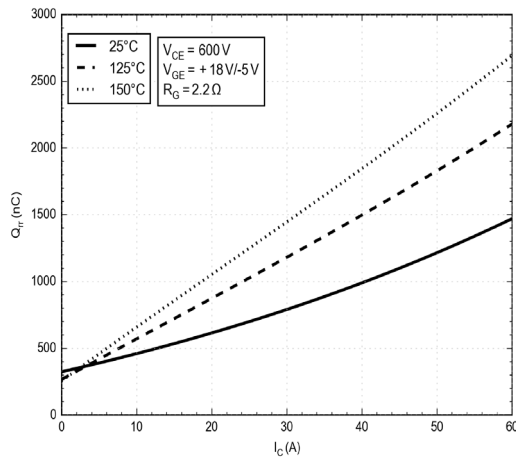


Figure 24. Typical Reverse Recovery Charge vs.  $I_C$

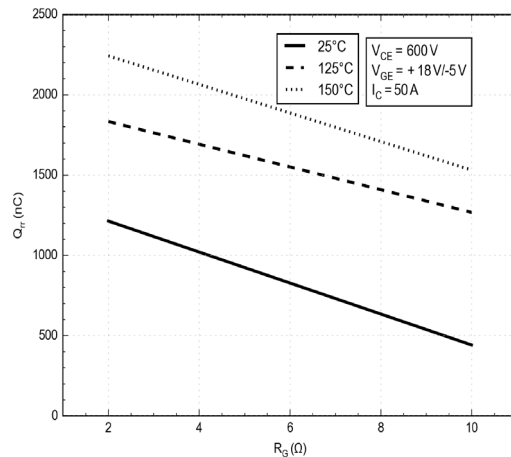


Figure 25. Typical Reverse Recovery Charge vs.  $R_G$



## TYPICAL CHARACTERISTICS (CONTINUED) (25°C UNLESS OTHERWISE NOTED)

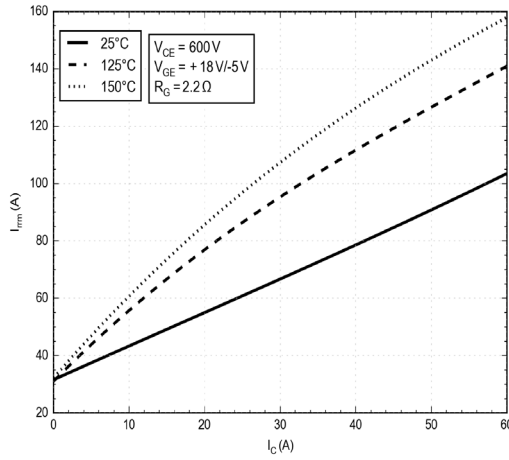


Figure 26. Typical Reverse Recovery Current vs.  $I_C$

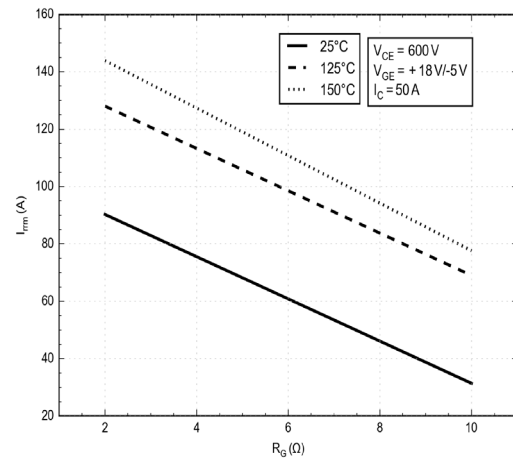


Figure 27. Typical Reverse Recovery Current vs.  $R_G$

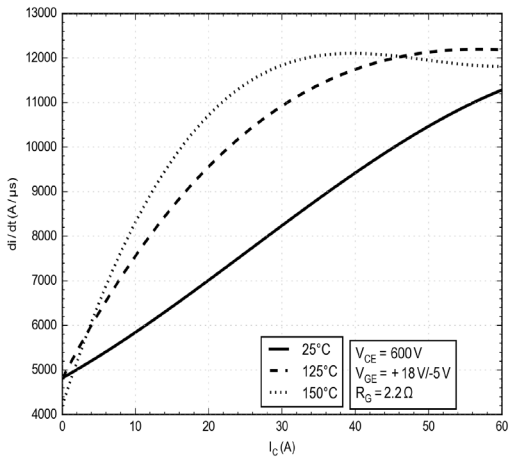


Figure 28. Typical  $di/dt$  vs.  $I_C$

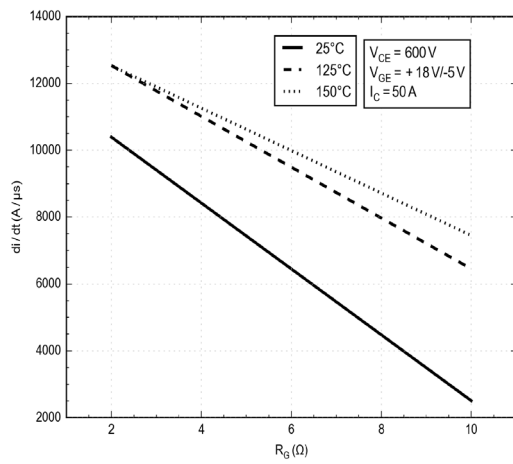


Figure 29. Typical  $di/dt$  vs.  $R_G$

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## TYPICAL CHARACTERISTICS (CONTINUED) (25°C UNLESS OTHERWISE NOTED)

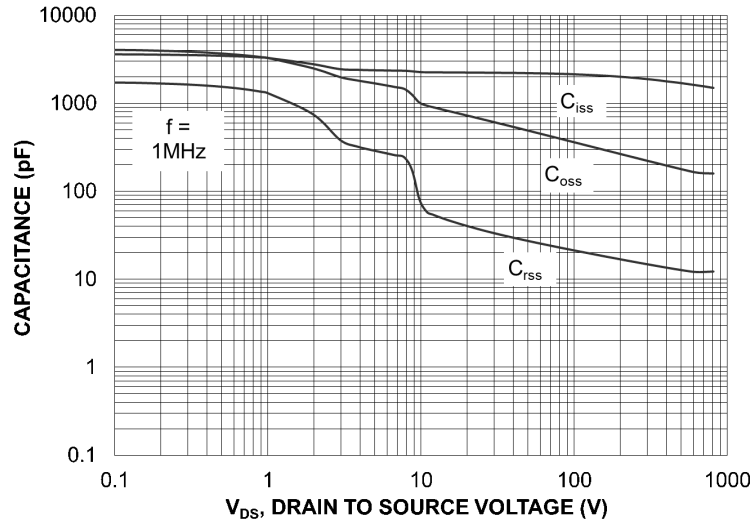


Figure 30. Capacitance vs. Drain-to-Source Voltage

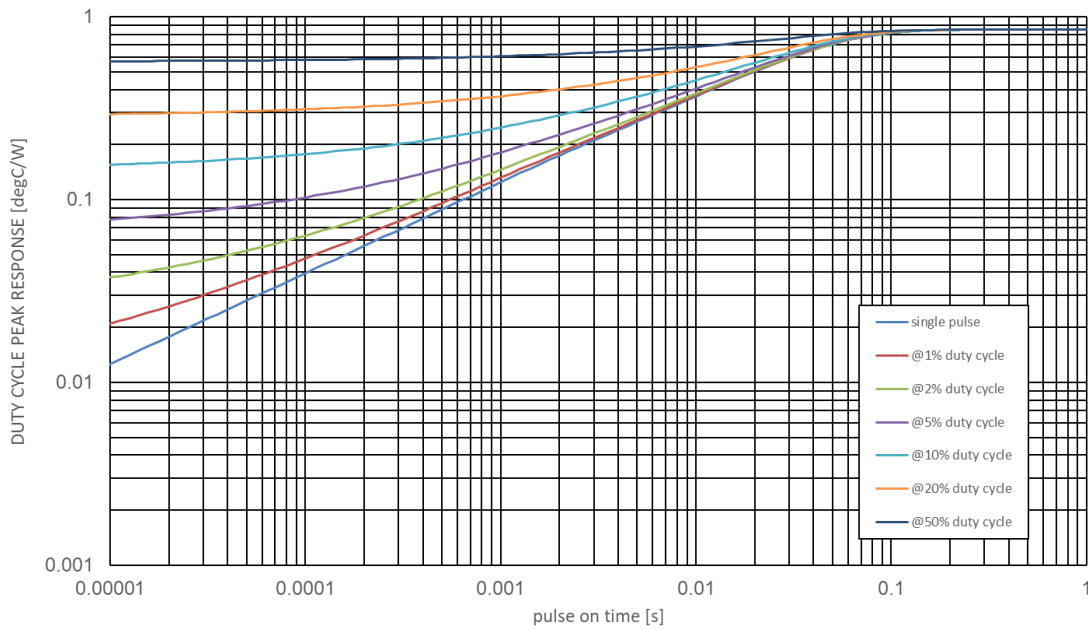


Figure 31. MOSFET Junction-to-Case Transient Thermal Impedance

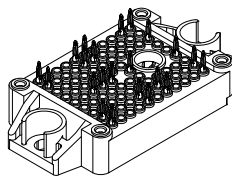
# NXH040F120MNF1PTG, NXH040F120MNF1PG

**Table 1. FOSTER NETWORKS – M1, M2, M3, M4**

| Foster<br>Element # | M1, M3    |            | M2, M4    |            |
|---------------------|-----------|------------|-----------|------------|
|                     | Rth (K/W) | Cth (Ws/K) | Rth (K/W) | Cth (Ws/K) |
| 1                   | 0.051996  | 0.002404   | 0.054881  | 0.002284   |
| 2                   | 0.046504  | 0.020373   | 0.010554  | 0.082427   |
| 3                   | 0.008903  | 0.221087   | 0.064895  | 0.028973   |
| 4                   | 0.165341  | 0.039489   | 0.094862  | 0.058574   |
| 5                   | 0.600991  | 0.065660   | 0.610507  | 0.052914   |

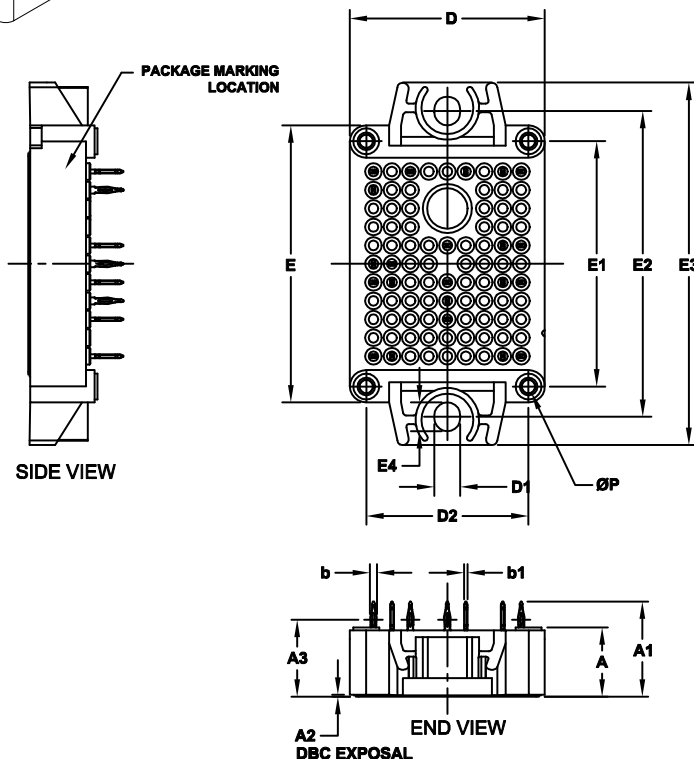
**Table 2. CAUER NETWORKS – M1, M2, M3, M4**

| Cauer<br>Element # | M1, M3    |            | M2, M4    |            |
|--------------------|-----------|------------|-----------|------------|
|                    | Rth (K/W) | Cth (Ws/K) | Rth (K/W) | Cth (Ws/K) |
| 1                  | 0.076857  | 0.001961   | 0.076754  | 0.001921   |
| 2                  | 0.141063  | 0.010485   | 0.182594  | 0.011596   |
| 3                  | 0.274014  | 0.018050   | 0.136313  | 0.018196   |
| 4                  | 0.113973  | 0.038620   | 0.215815  | 0.019717   |
| 5                  | 0.267827  | 0.046224   | 0.224225  | 0.049799   |

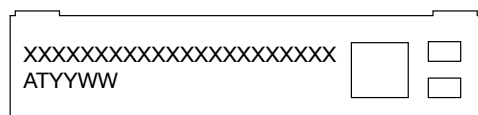


**PIM22 33.8x42.5 (PRESS FIT)**  
CASE 180BX  
ISSUE A

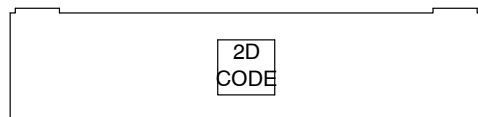
DATE 20 AUG 2021



### GENERIC MARKING DIAGRAM\*



FRONTSIDE MARKING



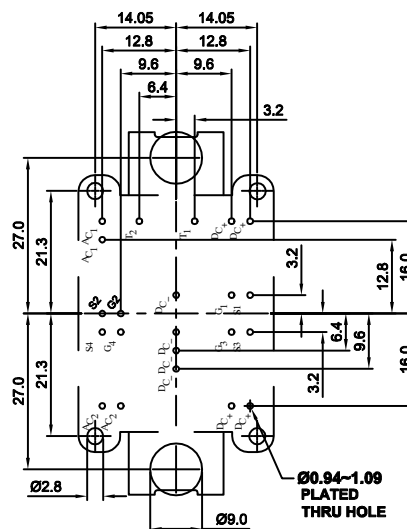
## BACKSIDE MARKING

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

**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   | 33.50       | 33.80 | 34.10 |
| D1  | 4.40        | 4.50  | 4.60  |
| D2  | 27.95       | 28.10 | 28.25 |
| 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

\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "▪", may or may not be present. Some products may not follow the Generic Marking.

|                         |                                    |                                                                                                                                                                                     |
|-------------------------|------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
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| <b>DESCRIPTION:</b>     | <b>PIM22 33.8x42.5 (PRESS FIT)</b> | <b>PAGE 1 OF 1</b>                                                                                                                                                                  |

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