

# Silicon Carbide (SiC) Module – 15 mohm SiC M3S MOSFET, 1200 V, 4-PACK Full Bridge Topology, F1 Package

## Product Preview

## NXH015F120M3F1PTG

The NXH015F120M3F1PTG is a power module containing 15 mΩ/1200 V SiC MOSFET full-bridge and a thermistor with Al<sub>2</sub>O<sub>3</sub> DBC in an F1 package.

### Features

- 15 mΩ /1200 V M3S SiC MOSFET Full-Bridge
- Al<sub>2</sub>O<sub>3</sub> 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

### Typical Applications

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

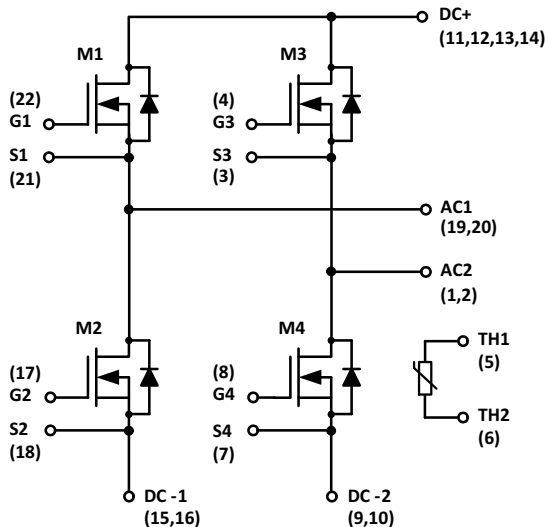
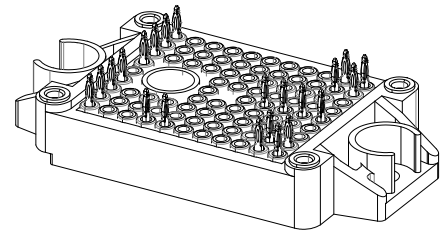


Figure 1. NXH015F120M3F1PTG Schematic Diagram

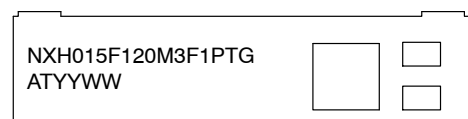
This document contains information on a product under development. onsemi reserves the right to change or discontinue this product without notice.

### PACKAGE PICTURE



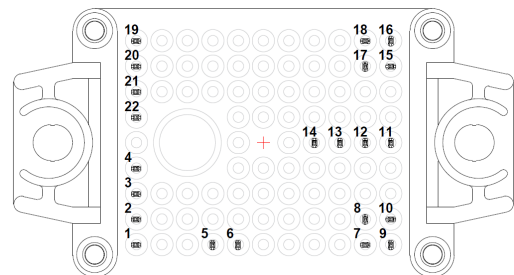
PIM22 33.8x42.5 (PRESS FIT)  
CASE 180HL

### MARKING DIAGRAM



NXH015F120M3F1PTG = 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.

# NXH015F120M3F1PTG

## PIN FUNCTION DESCRIPTION

| Pin | Name | Description                         |
|-----|------|-------------------------------------|
| 1   | AC2  | Center point of full bridge 2       |
| 2   | AC2  | Center point of full bridge 2       |
| 3   | S3   | M3 Kelvin Source (High Side switch) |
| 4   | G3   | M3 Gate (High Side switch)          |
| 5   | TH1  | Thermistor Connection 1             |
| 6   | TH2  | Thermistor Connection 2             |
| 7   | S4   | M4 Kelvin Source (Low side switch)  |
| 8   | G4   | M4 Gate (Low side switch)           |
| 9   | DC-2 | DC Negative Bus connection          |
| 10  | DC-2 | DC Negative Bus connection          |
| 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  | DC-1 | DC Negative Bus connection          |
| 16  | DC-1 | DC Negative Bus connection          |
| 17  | G2   | M2 Gate (Low side switch)           |
| 18  | S2   | M2 Kelvin Source (Low side switch)  |
| 19  | AC1  | Center point of full bridge 1       |
| 20  | AC1  | Center point of full bridge 1       |
| 21  | S1   | M1 Kelvin Source (High side switch) |
| 22  | G1   | M1 Gate (High side switch)          |

## MAXIMUM RATINGS

| Rating                                                                            | Symbol       | Value   | Unit             |
|-----------------------------------------------------------------------------------|--------------|---------|------------------|
| <b>SiC MOSFET</b>                                                                 |              |         |                  |
| Drain-Source Voltage                                                              | $V_{DSS}$    | 1200    | V                |
| Gate-Source Voltage                                                               | $V_{GS}$     | +22/-10 | V                |
| Continuous Drain Current @ $T_C = 80^\circ\text{C}$ ( $T_J = 175^\circ\text{C}$ ) | $I_D$        | 77      | A                |
| Pulsed Drain Current ( $T_J = 175^\circ\text{C}$ )                                | $I_{Dpulse}$ | 232     | A                |
| Maximum Power Dissipation ( $T_J = 175^\circ\text{C}$ )                           | $P_{tot}$    | 198     | 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        |
| CTI                                               |          | 600                     |           |
| Substrate Ceramic Material                        |          | $\text{Al}_2\text{O}_3$ |           |
| 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.

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

# NXH015F120M3F1PTG

## RECOMMENDED OPERATING RANGES

| Rating                                | Symbol | Min | Max | Unit |
|---------------------------------------|--------|-----|-----|------|
| Module Operating Junction Temperature | $T_J$  | -40 | 150 | °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       | $V_{GS} = 0\text{ V}$ , $V_{DS} = 1200\text{ V}$ , $T_J = 25^\circ\text{C}$                                                                      | $I_{DSS}$      | —    | —    | 200     | $\mu\text{A}$    |
| Drain-Source On Resistance            | $V_{GS} = 18\text{ V}$ , $I_D = 60\text{ A}$ , $T_J = 25^\circ\text{C}$                                                                          | $R_{DS(ON)}$   | —    | 14.8 | 19      | $\text{m}\Omega$ |
|                                       | $V_{GS} = 18\text{ V}$ , $I_D = 60\text{ A}$ , $T_J = 125^\circ\text{C}$                                                                         |                | —    | 24.7 | —       |                  |
|                                       | $V_{GS} = 18\text{ V}$ , $I_D = 60\text{ A}$ , $T_J = 150^\circ\text{C}$                                                                         |                | —    | 28.7 | —       |                  |
|                                       | $V_{GS} = 18\text{ V}$ , $I_D = 60\text{ A}$ , $T_J = 175^\circ\text{C}$                                                                         |                | —    | 33   | —       |                  |
| Gate-Source Threshold Voltage         | $V_{GS} = V_{DS}$ , $I_D = 30\text{ mA}$                                                                                                         | $V_{GS(TH)}$   | 2.04 | 2.4  | 4.4     | V                |
| Recommended Gate Voltage              |                                                                                                                                                  | $V_{G0P}$      | -3   | —    | +18     | V                |
| Gate-to-Source Leakage Current        | $V_{GS} = +22/-10\text{ V}$ , $V_{DS} = 0\text{ V}$                                                                                              | $I_{GSS}$      | —    | —    | $\pm 2$ | $\mu\text{A}$    |
| Input Capacitance                     | $V_{GS} = 0\text{ V}$ , $f = 1\text{ MHz}$ , $V_{DS} = 800\text{ V}$                                                                             | $C_{ISS}$      | —    | 4696 | —       | pF               |
| Reverse Transfer Capacitance          |                                                                                                                                                  | $C_{RSS}$      | —    | 20.1 | —       |                  |
| Output Capacitance                    |                                                                                                                                                  | $C_{OSS}$      | —    | 287  | —       |                  |
| Total Gate Charge                     | $V_{GS} = -3/18\text{ V}$ , $V_{DS} = 800\text{ V}$ , $I_D = 30\text{ A}$                                                                        | $Q_{G(TOTAL)}$ | —    | 211  | —       | nC               |
| Gate-Source Charge                    |                                                                                                                                                  | $Q_{GS}$       | —    | 16   | —       |                  |
| Gate-Drain Charge                     |                                                                                                                                                  | $Q_{GD}$       | —    | 50   | —       |                  |
| Internal Gate Resistance              | $f = 1\text{ MHz}$                                                                                                                               | $R_{GINT}$     | —    | 1.65 | —       | $\Omega$         |
| Turn-on Delay Time                    | $T_J = 25^\circ\text{C}$ ,<br>$V_{DS} = 800\text{ V}$ , $I_D = 60\text{ A}$ ,<br>$V_{GS} = -3\text{ V}/18\text{ V}$ , $R_G = 2.2\text{ }\Omega$  | $t_{d(on)}$    | —    | 33.3 | —       | ns               |
| Rise Time                             |                                                                                                                                                  | $t_r$          | —    | 8.6  | —       |                  |
| Turn-off Delay Time                   |                                                                                                                                                  | $t_{d(off)}$   | —    | 103  | —       |                  |
| Fall Time                             |                                                                                                                                                  | $t_f$          | —    | 7.5  | —       |                  |
| Turn-on Switching Loss per Pulse      |                                                                                                                                                  | $E_{ON}$       | —    | 0.67 | —       | mJ               |
| Turn off Switching Loss per Pulse     |                                                                                                                                                  | $E_{OFF}$      | —    | 0.28 | —       |                  |
| Turn-on Delay Time                    | $T_J = 150^\circ\text{C}$ ,<br>$V_{DS} = 800\text{ V}$ , $I_D = 60\text{ A}$ ,<br>$V_{GS} = -3\text{ V}/18\text{ V}$ , $R_G = 2.2\text{ }\Omega$ | $t_{d(on)}$    | —    | 31.9 | —       | ns               |
| Rise Time                             |                                                                                                                                                  | $t_r$          | —    | 8.1  | —       |                  |
| Turn-off Delay Time                   |                                                                                                                                                  | $t_{d(off)}$   | —    | 111  | —       |                  |
| Fall Time                             |                                                                                                                                                  | $t_f$          | —    | 8.1  | —       |                  |
| Turn-on Switching Loss per Pulse      |                                                                                                                                                  | $E_{ON}$       | —    | 1.06 | —       | mJ               |
| Turn off Switching Loss per Pulse     |                                                                                                                                                  | $E_{OFF}$      | —    | 0.33 | —       |                  |
| Diode Forward Voltage                 | $V_{GS} = -3\text{ V}$ , $I_{SD} = 60\text{ A}$ , $T_J = 25^\circ\text{C}$                                                                       | $V_{SD}$       | —    | 4.67 | 6.2     | V                |
|                                       | $V_{GS} = -3\text{ V}$ , $I_{SD} = 60\text{ A}$ , $T_J = 125^\circ\text{C}$                                                                      |                | —    | 4.45 | —       |                  |
|                                       | $V_{GS} = -3\text{ V}$ , $I_{SD} = 60\text{ A}$ , $T_J = 150^\circ\text{C}$                                                                      |                | —    | 4.4  | —       |                  |
| Thermal Resistance – Chip-to-Case     | M1, M2, M3, M4                                                                                                                                   | $R_{thJC}$     | —    | 0.48 | —       | °C/W             |
| Thermal Resistance – Chip-to-Heatsink |                                                                                                                                                  | $R_{thJH}$     | —    | 0.86 | —       | °C/W             |

## THERMISTOR CHARACTERISTICS

|                                       |                                  |              |    |       |   |            |
|---------------------------------------|----------------------------------|--------------|----|-------|---|------------|
| Nominal Resistance                    | $T = 25^\circ\text{C}$           | $R_{25}$     | —  | 5     | — | k $\Omega$ |
|                                       | $T = 100^\circ\text{C}$          | $R_{100}$    | —  | 493   | — | $\Omega$   |
|                                       | $T = 150^\circ\text{C}$          | $R_{150}$    | —  | 159.5 | — | $\Omega$   |
| Deviation of $R_{100}$                | $T = 100^\circ\text{C}$          | $\Delta R/R$ | -5 | —     | 5 | %          |
| Power Dissipation – Recommended Limit | 0.15 mA, Non-self-heating Effect | $P_D$        | —  | 0.1   | — | mW         |

# NXH015F120M3F1PTG

## ELECTRICAL CHARACTERISTICS (continued) (T<sub>J</sub> = 25 °C unless otherwise noted)

| Parameter                            | Test Conditions          | Symbol | Min | Typ  | Max | Unit |
|--------------------------------------|--------------------------|--------|-----|------|-----|------|
| <b>THERMISTOR CHARACTERISTICS</b>    |                          |        |     |      |     |      |
| Power Dissipation – Absolute Maximum | 5 mA                     |        |     | 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

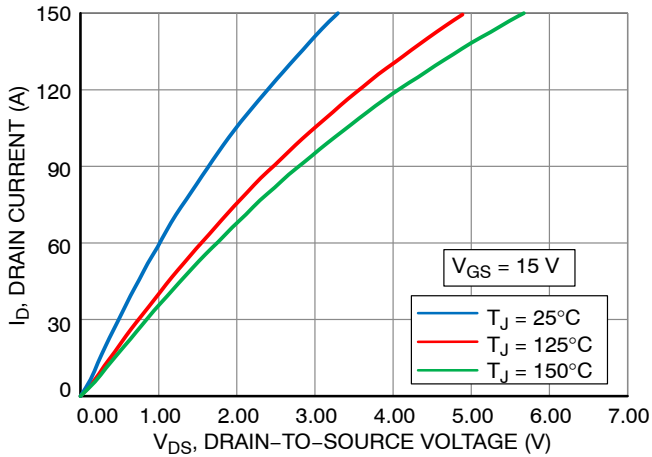
| Orderable Part Number | Marking           | Package                                                                                                                  | Shipping                |
|-----------------------|-------------------|--------------------------------------------------------------------------------------------------------------------------|-------------------------|
| NXH015F120M3F1PTG     | NXH015F120M3F1PTG | F1FULLBR: Case 180HL<br>Press-fit Pins with pre-applied<br>thermal interface material (TIM)<br>(Pb-Free and Halide-Free) | 28 Units / Blister Tray |



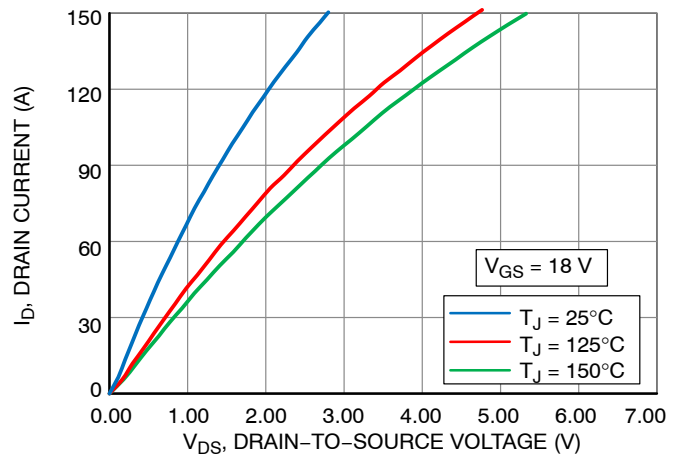
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## TYPICAL CHARACTERISTICS

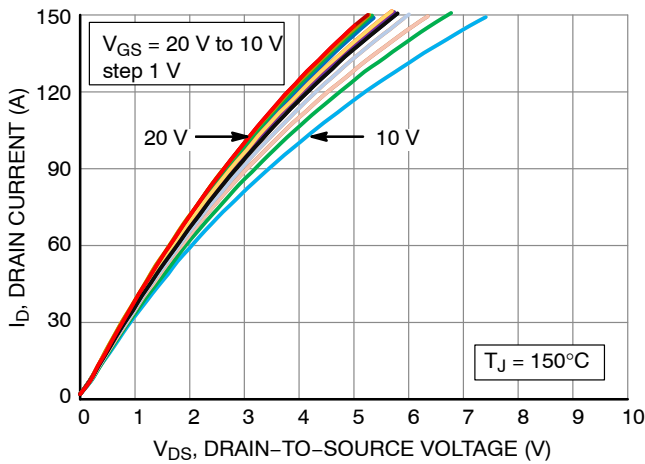
M1, M2, M3, M4 SIC MOSFET CHARACTERISTIC



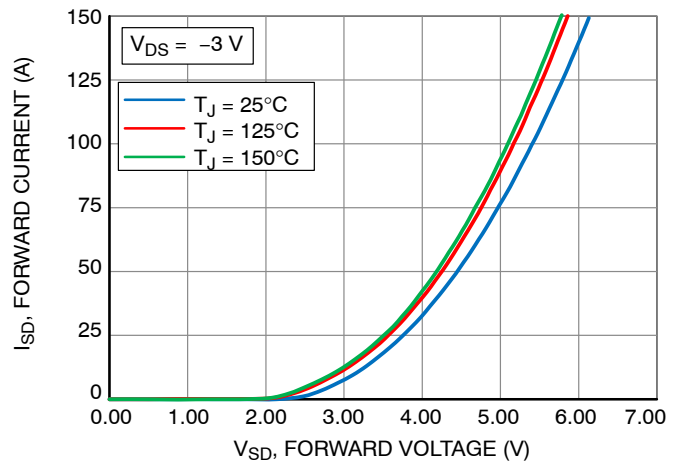
**Figure 2. MOSFET Typical Output Characteristic  $V_{GS} = 15\text{ V}$**



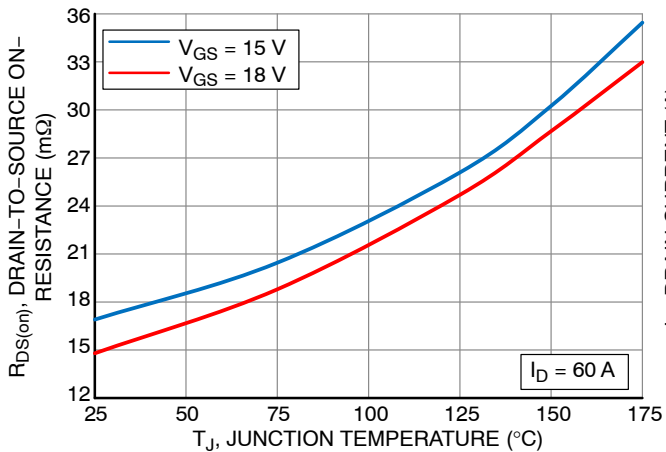
**Figure 3. MOSFET Typical Output Characteristic  $V_{GS} = 18\text{ V}$**



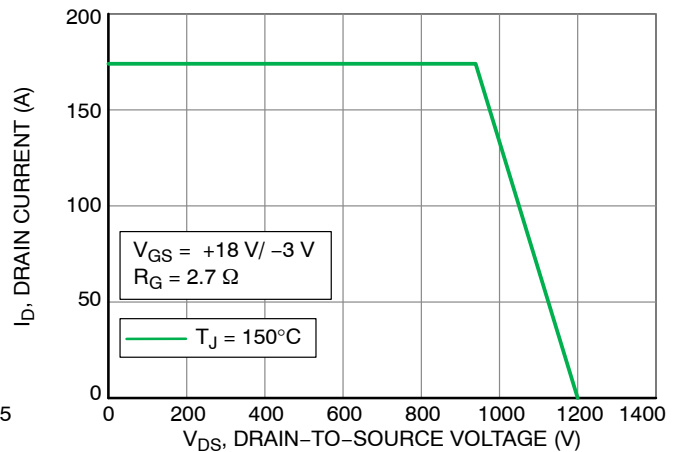
**Figure 4. MOSFET Typical Output Characteristic  $V_{GS} = \text{var.}$**



**Figure 5. Body Diode Forward Characteristic**



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

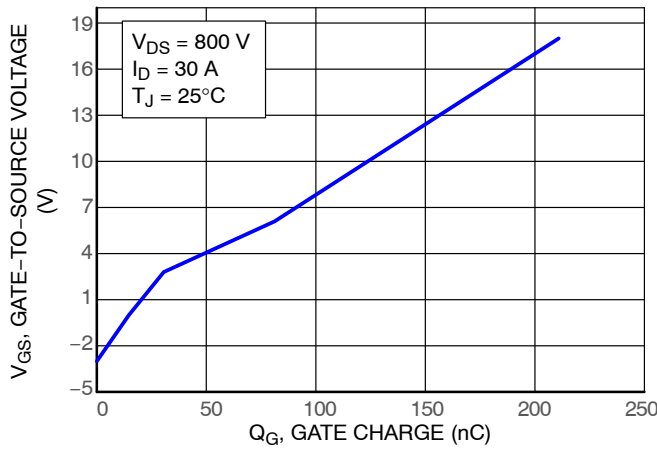


**Figure 7. Reverse Bias Safe Operating Area (RBSOA)**

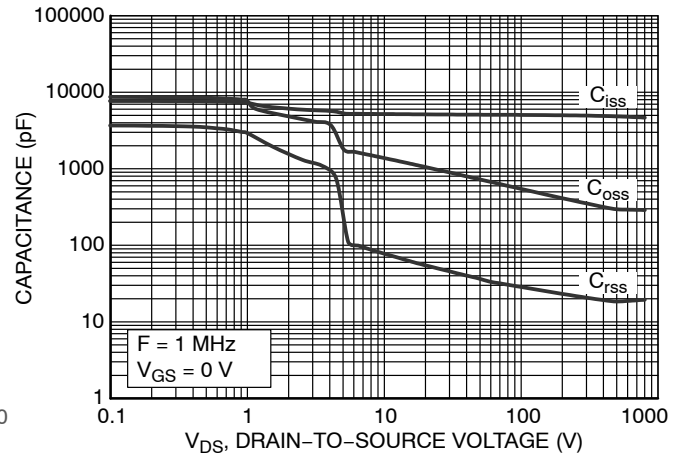
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## TYPICAL CHARACTERISTICS

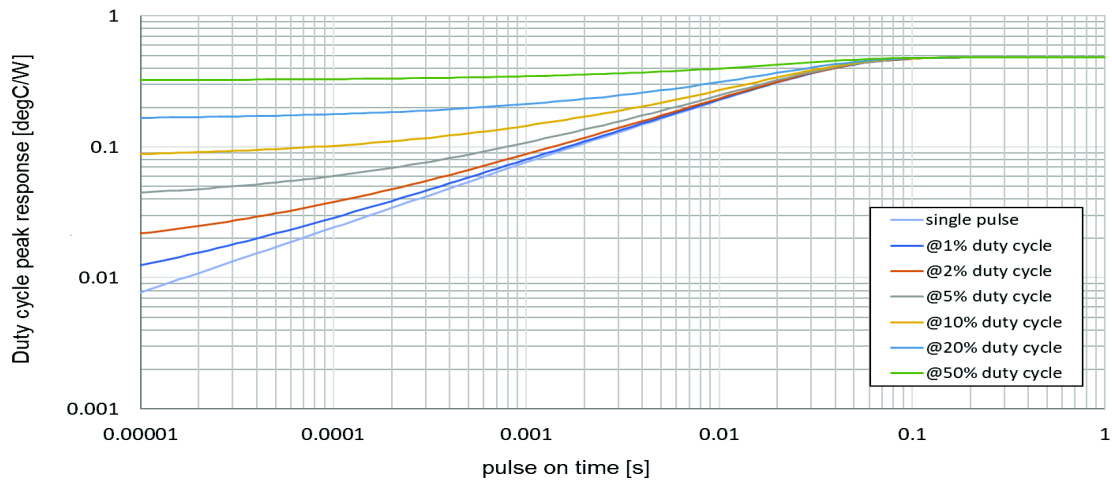
M1, M2, M3, M4 SIC MOSFET CHARACTERISTIC



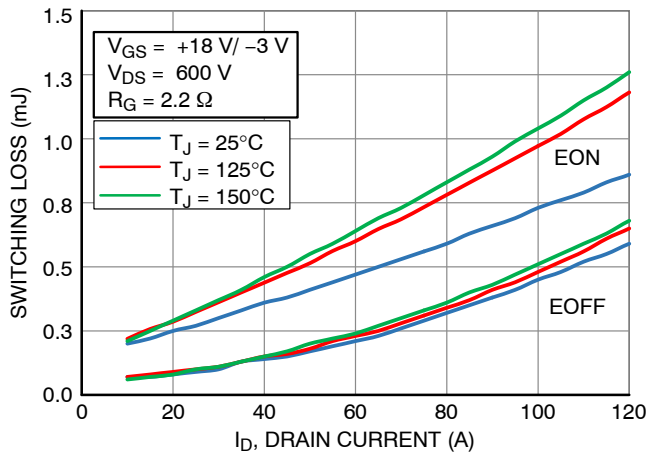
**Figure 8. Gate-to-Source Voltage vs. Gate Charge**



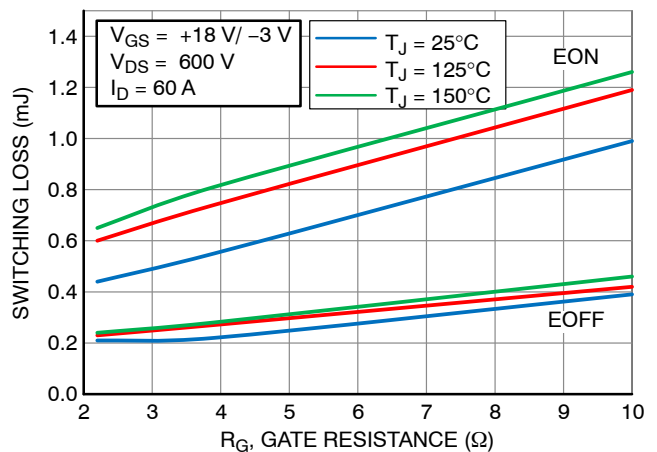
**Figure 9. Capacitance vs. Drain-to-Source Voltage**



**Figure 10. Duty Cycle vs. Junction-to-Case Transient Thermal Impedance**



**Figure 11. Switching Loss vs. Drain Current**  
 $V_{DS} = 600 \text{ V}$

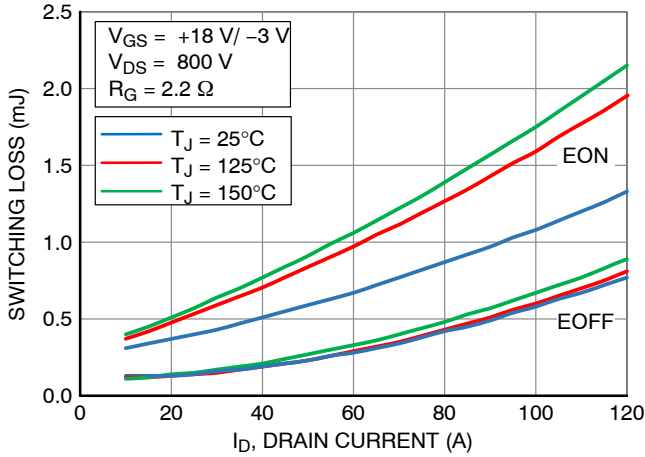


**Figure 12. Switching Loss vs. Gate Resistance**  
 $V_{DS} = 600 \text{ V}$

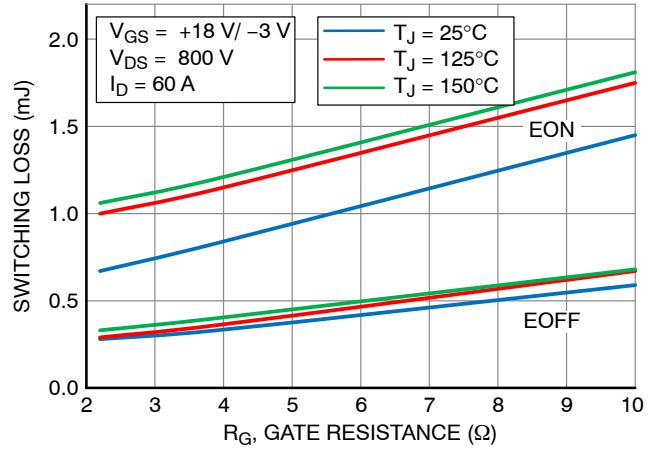
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## TYPICAL CHARACTERISTICS

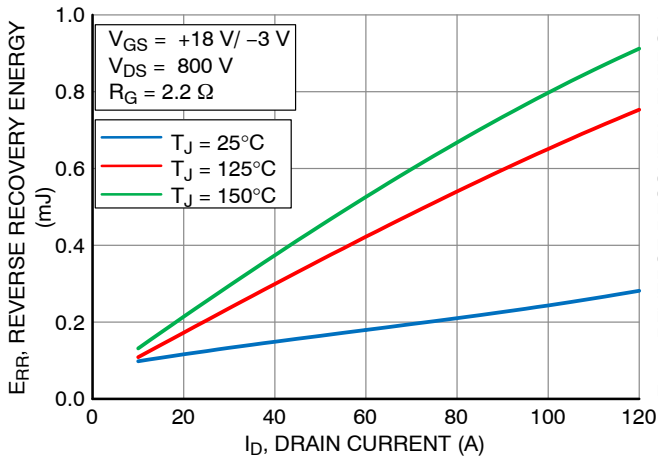
M1, M2, M3, M4 SIC MOSFET CHARACTERISTIC



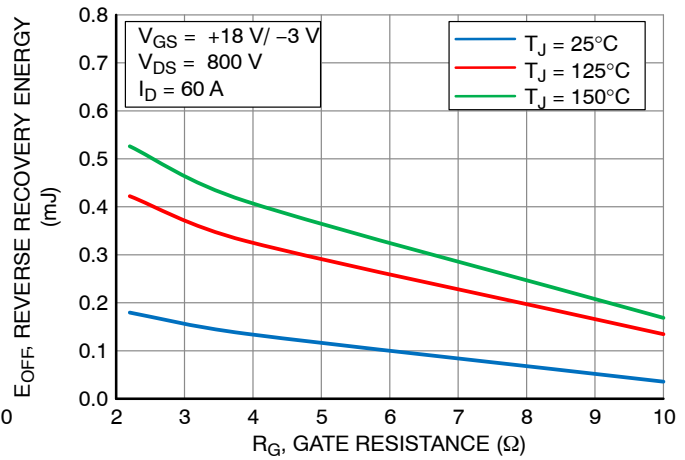
**Figure 13. Switching Loss vs. Drain Current**  
 $V_{DS} = 800 \text{ V}$



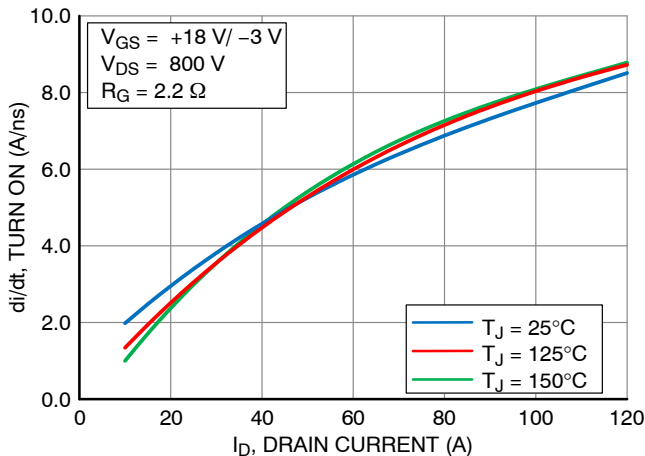
**Figure 14. Switching Loss vs. Gate Resistance**  
 $V_{DS} = 800 \text{ V}$



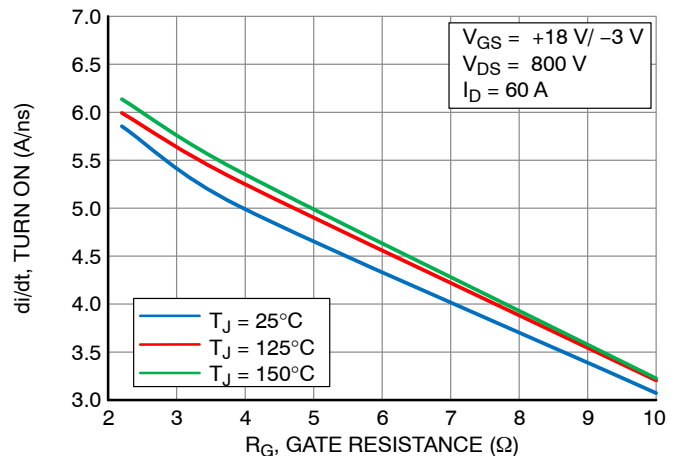
**Figure 15. Reverse Recovery Energy vs. Drain Current**  
 $V_{DS} = 800 \text{ V}$



**Figure 16. Reverse Recovery Energy vs. Gate Resistance**  
 $V_{DS} = 800 \text{ V}$



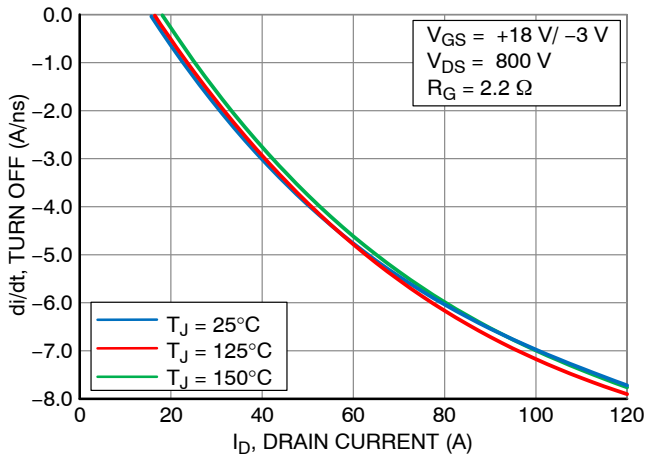
**Figure 17. di/dt Turn ON vs. Drain Current**  
 $V_{DS} = 800 \text{ V}$



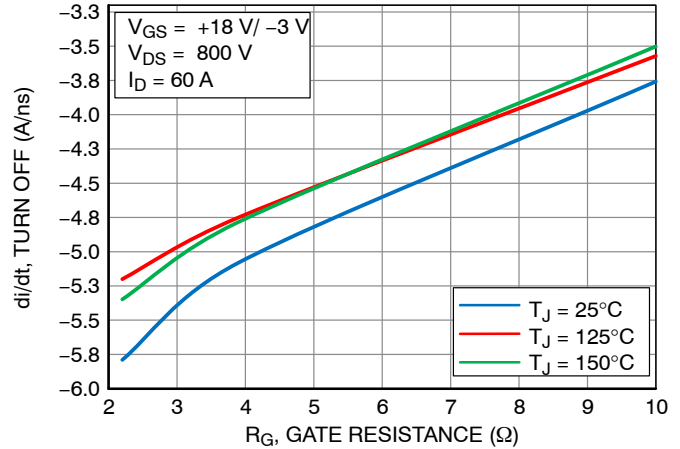
**Figure 18. di/dt Turn ON vs. Gate Resistance**  
 $V_{DS} = 800 \text{ V}$

## TYPICAL CHARACTERISTICS

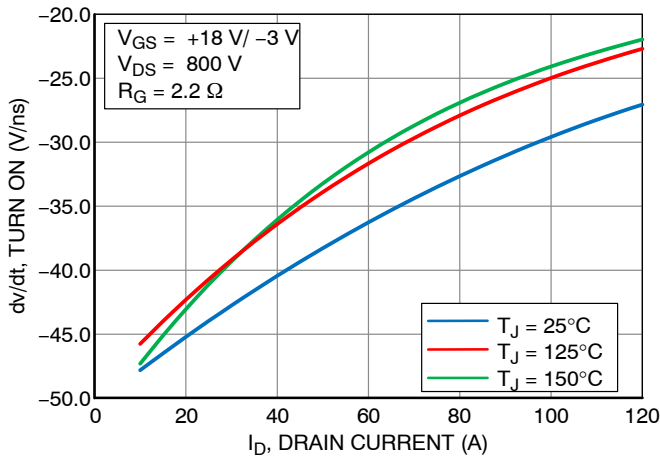
M1, M2, M3, M4 SIC MOSFET CHARACTERISTIC



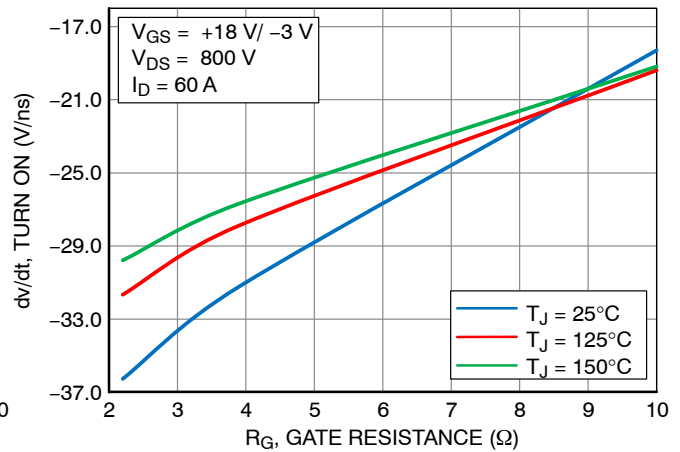
**Figure 19. di/dt Turn OFF vs. Drain Current**  
 $V_{DS} = 800 \text{ V}$



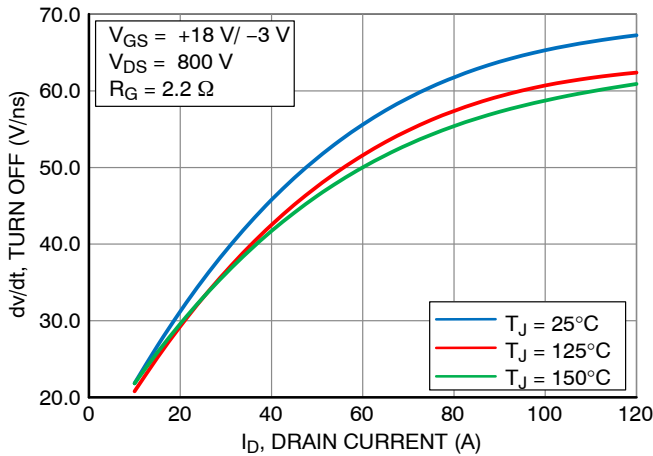
**Figure 20. di/dt Turn OFF vs. Gate Resistance**  
 $V_{DS} = 800 \text{ V}$



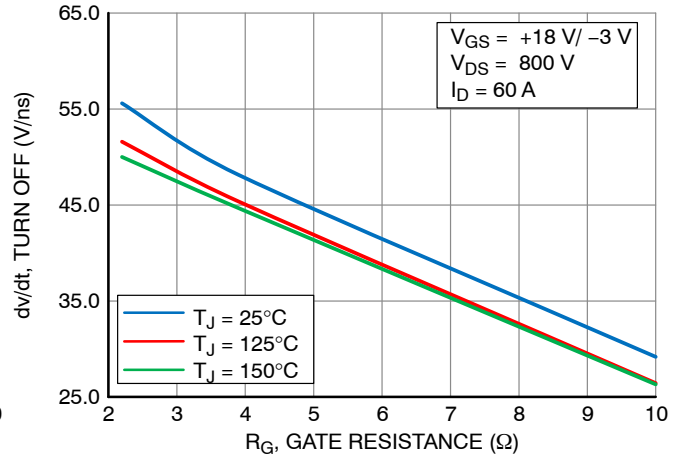
**Figure 21. dv/dt Turn ON vs. Drain Current**  
 $V_{DS} = 800 \text{ V}$



**Figure 22. dv/dt Turn ON vs. Gate Resistance**  
 $V_{DS} = 800 \text{ V}$



**Figure 23. dv/dt Turn OFF vs. Drain Current**  
 $V_{DS} = 800 \text{ V}$



**Figure 24. dv/dt Turn OFF vs. Gate Resistance**  
 $V_{DS} = 800 \text{ V}$

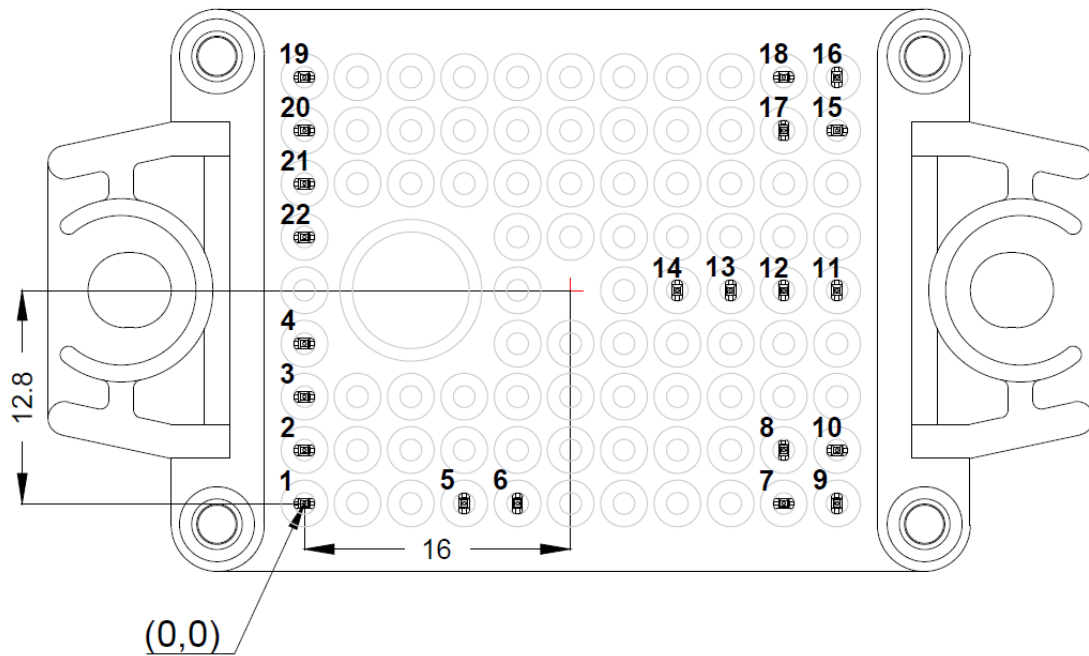
# NXH015F120M3F1PTG

**Table 1. CAUER NETWORKS**

| Cauer Element # | Rth (K/W) | Cth (Ws/K) |
|-----------------|-----------|------------|
| 1               | 0.0004413 | 0.0013801  |
| 2               | 0.0029539 | 0.0003074  |
| 3               | 0.0066160 | 0.0005317  |
| 4               | 0.0326540 | 0.0026575  |
| 5               | 0.0988730 | 0.0081213  |
| 6               | 0.1850100 | 0.0419900  |
| 7               | 0.0817340 | 1.1620000  |

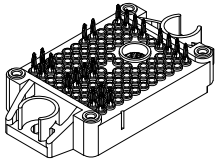
## PIN POSITION INFORMATION

scale = 2.5 : 1



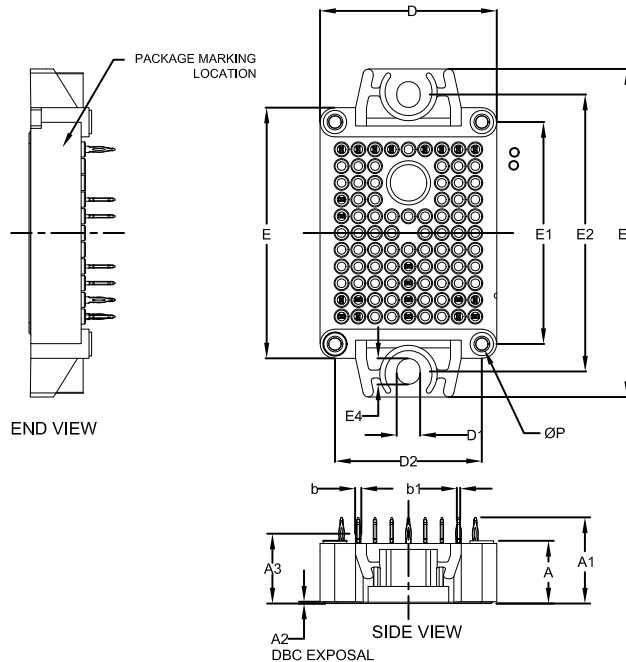
## PIN POSITION

| Pin # | X    | Y    | Function | Pin # | X    | Y    | Function |
|-------|------|------|----------|-------|------|------|----------|
| 1     | 0    | 0    | AC2      | 12    | 28.8 | 12.8 | DC+      |
| 2     | 0    | 3.2  | AC2      | 13    | 25.6 | 12.8 | DC+      |
| 3     | 0    | 6.4  | S3       | 14    | 22.4 | 12.8 | DC+      |
| 4     | 0    | 9.6  | G3       | 15    | 32   | 22.4 | DC-1     |
| 5     | 9.6  | 0    | TH1      | 16    | 32   | 25.6 | DC-1     |
| 6     | 12.8 | 0    | TH2      | 17    | 28.8 | 22.4 | G2       |
| 7     | 28.8 | 0    | S4       | 18    | 28.8 | 25.6 | S2       |
| 8     | 28.8 | 3.2  | G4       | 19    | 0    | 25.6 | AC1      |
| 9     | 32   | 0    | DC-2     | 20    | 0    | 22.4 | AC1      |
| 10    | 32   | 3.2  | DC-2     | 21    | 0    | 19.2 | S1       |
| 11    | 32   | 12.8 | DC+      | 22    | 0    | 16   | G1       |



PIM22 33.80x42.50x10.00  
CASE 180HL  
ISSUE O

DATE 29 AUG 2023



NOTES:

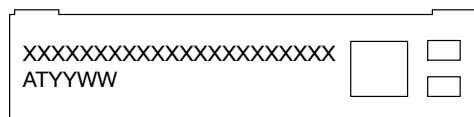
1. CONTROLLING DIMENSION: MILLIMETERS
2. PIN POSITION TOLERANCE IS  $\pm 0.4\text{mm}$
3. PRESS FIT PIN

| 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  |

PIN POSITION TABLE:

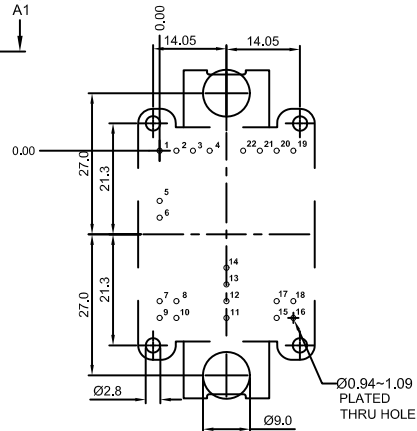
| Pin | X    | Y    | Function | Pin | X    | Y    | Function |
|-----|------|------|----------|-----|------|------|----------|
| 1   | 0    | 0    | AC2      | 12  | 28.8 | 12.8 | DC+      |
| 2   | 0    | 3.2  | AC2      | 13  | 25.6 | 12.8 | DC+      |
| 3   | 0    | 6.4  | S3       | 14  | 22.4 | 12.8 | DC+      |
| 4   | 0    | 9.6  | G3       | 15  | 32   | 22.4 | DC-1     |
| 5   | 9.6  | 0    | TH1      | 16  | 32   | 25.6 | DC-1     |
| 6   | 12.8 | 0    | TH2      | 17  | 28.8 | 22.4 | G2       |
| 7   | 28.8 | 0    | S4       | 18  | 28.8 | 25.6 | S2       |
| 8   | 28.8 | 3.2  | G4       | 19  | 0    | 25.6 | AC1      |
| 9   | 32   | 0    | DC-2     | 20  | 0    | 22.4 | AC1      |
| 10  | 32   | 3.2  | DC-2     | 21  | 0    | 19.2 | S1       |
| 11  | 32   | 12.8 | DC+      | 22  | 0    | 16   | G1       |

GENERIC  
MARKING DIAGRAM\*



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

\*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.



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, SOLDERRM/D.

|                  |                         |                                                                                                                                                                                  |
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