

# Silicon Carbide (SiC) Module – EliteSiC, 20 mohm SiC M1 MOSFET, 1200 V, 2-PACK Half Bridge Topology, F1 Package

## NXH020P120MNF1PTG, NXH020P120MNF1PG

The NXH020P120MNF1 is a power module containing an 20 mΩ/1200 V SiC MOSFET half bridge and a thermistor in an F1 package.

### Features

- 20 mΩ/1200 V SiC MOSFET Half Bridge
- Thermistor
- Options with Pre-applied Thermal Interface Material (TIM) and without Pre-applied TIM
- Press-fit Pins

### Typical Applications

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

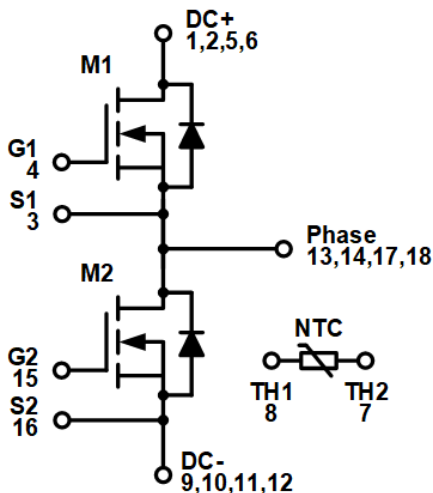
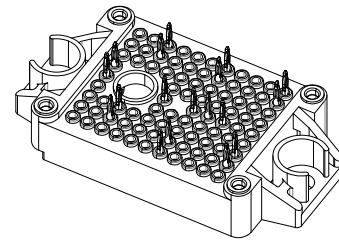
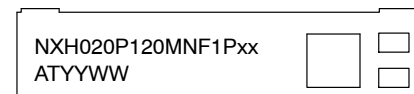


Figure 1. NXH020P120MNF1 Schematic Diagram



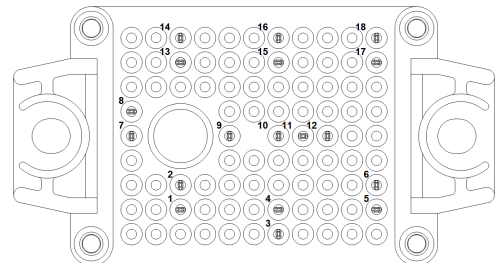
PIM18 33.8x42.5 (PRESS FIT)  
CASE 180BW

### MARKING DIAGRAM



NXH020P120MNF1PTG= Specific Device Code  
NXH020P120MNF1PG = 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.

# NXH020P120MNF1PTG, NXH020P120MNF1PG

## PIN FUNCTION DESCRIPTION

| Pin | Name  | Description                          |
|-----|-------|--------------------------------------|
| 1   | DC+   | DC Positive Bus connection           |
| 2   | DC+   | DC Positive Bus connection           |
| 3   | S1    | Q1 Kelvin Emitter (High side switch) |
| 4   | G1    | Q1 Gate (High side switch)           |
| 5   | DC+   | DC Positive Bus connection           |
| 6   | DC+   | DC Positive Bus connection           |
| 7   | TH2   | Thermistor Connection 2              |
| 8   | TH1   | Thermistor Connection 1              |
| 9   | DC-   | DC Negative Bus connection           |
| 10  | DC-   | DC Negative Bus connection           |
| 11  | DC-   | DC Negative Bus connection           |
| 12  | DC-   | DC Negative Bus connection           |
| 13  | PHASE | Center point of half bridge          |
| 14  | PHASE | Center point of half bridge          |
| 15  | G2    | Q2 Gate (Low side switch)            |
| 16  | S2    | Q2 Kelvin Emitter (High side switch) |
| 17  | PHASE | Center point of half bridge          |
| 18  | PHASE | Center point of half bridge          |

## MAXIMUM RATINGS

| Rating                                                                             | Symbol       | Value   | Unit             |
|------------------------------------------------------------------------------------|--------------|---------|------------------|
| <b>SiC MOSFET</b>                                                                  |              |         |                  |
| Drain-Source Voltage                                                               | $V_{DSS}$    | 1200    | V                |
| Gate-Source Voltage                                                                | $V_{GS}$     | +25/-15 | V                |
| Continuous Drain Current @ $T_C = 80^\circ\text{C}$ ( $T_J = 175^\circ\text{C}$ )  | $I_D$        | 51      | A                |
| Pulsed Drain Current ( $T_J = 175^\circ\text{C}$ )                                 | $I_{Dpulse}$ | 102     | A                |
| Maximum Power Dissipation @ $T_C = 80^\circ\text{C}$ ( $T_J = 175^\circ\text{C}$ ) | $P_{tot}$    | 211     | 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        |

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.

## 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.

# NXH020P120MNF1PTG, NXH020P120MNF1PG

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

| Parameter                             | Test Conditions                                                                                                                 | Symbol                | Min  | Typ    | Max | Unit |
|---------------------------------------|---------------------------------------------------------------------------------------------------------------------------------|-----------------------|------|--------|-----|------|
| <b>SIC MOSFET CHARACTERISTICS</b>     |                                                                                                                                 |                       |      |        |     |      |
| Drain–Source Breakdown Voltage        | V <sub>GS</sub> = 0 V, I <sub>D</sub> = 400 μA                                                                                  | V <sub>(BR)DSS</sub>  | 1200 | –      | –   | V    |
| Zero Gate Voltage Drain Current       | V <sub>GS</sub> = 0 V, V <sub>DS</sub> = 1200 V                                                                                 | I <sub>DSS</sub>      | –    | –      | 200 | μA   |
| Drain–Source On Resistance            | V <sub>GS</sub> = 20 V, I <sub>D</sub> = 50 A, T <sub>J</sub> = 25°C                                                            | R <sub>DS(ON)</sub>   | –    | 20     | 30  | mΩ   |
|                                       | V <sub>GS</sub> = 20 V, I <sub>D</sub> = 50 A, T <sub>J</sub> = 125°C                                                           |                       | –    | 28     | –   |      |
|                                       | V <sub>GS</sub> = 20 V, I <sub>D</sub> = 50 A, T <sub>J</sub> = 150°C                                                           |                       | –    | 31     | –   |      |
| Gate–Source Threshold Voltage         | V <sub>GS</sub> = V <sub>DS</sub> , I <sub>D</sub> = 20 mA                                                                      | V <sub>GS(TH)</sub>   | 1.8  | 2.81   | 4.3 | V    |
| Gate Leakage Current                  | V <sub>GS</sub> = –10/20 V, V <sub>DS</sub> = 0 V                                                                               | I <sub>GSS</sub>      | –500 | –      | 500 | nA   |
| Internal Gate Resistance              |                                                                                                                                 | R <sub>G</sub>        | –    | 1.1    | –   | Ω    |
| Input Capacitance                     | V <sub>DS</sub> = 800 V, V <sub>GS</sub> = 0 V, f = 1 MHz                                                                       | C <sub>ISS</sub>      | –    | 2420   | –   | pF   |
| Reverse Transfer Capacitance          |                                                                                                                                 | C <sub>RSS</sub>      | –    | 19     | –   |      |
| Output Capacitance                    |                                                                                                                                 | C <sub>OSS</sub>      | –    | 193    | –   |      |
| C <sub>OSS</sub> Stored Energy        | V <sub>DS</sub> = 0 V to 800 V, V <sub>GS</sub> = 0 V                                                                           | E <sub>OSS</sub>      | –    | 124    | –   | μJ   |
| Total Gate Charge                     | V <sub>DS</sub> = 800 V, V <sub>GS</sub> = 20 V, I <sub>D</sub> = 50 A                                                          | Q <sub>G(TOTAL)</sub> | –    | 213.5  | –   | nC   |
| Gate–Source Charge                    |                                                                                                                                 | Q <sub>GS</sub>       | –    | 50     | –   | nC   |
| Gate–Drain Charge                     |                                                                                                                                 | Q <sub>GD</sub>       | –    | 61.2   | –   | nC   |
| Turn–on Delay Time                    | T <sub>J</sub> = 25°C<br>V <sub>DS</sub> = 600 V, I <sub>D</sub> = 50 A<br>V <sub>GS</sub> = –5 V/18 V, R <sub>G</sub> = 2.7 Ω  | t <sub>d(on)</sub>    | –    | 44     | –   | ns   |
| Rise Time                             |                                                                                                                                 | t <sub>r</sub>        | –    | 8.8    | –   |      |
| Turn–off Delay Time                   |                                                                                                                                 | t <sub>d(off)</sub>   | –    | 105    | –   |      |
| Fall Time                             |                                                                                                                                 | t <sub>f</sub>        | –    | 8.4    | –   |      |
| Turn–on Switching Loss per Pulse      |                                                                                                                                 | E <sub>ON</sub>       | –    | 0.38   | –   | mJ   |
| Turn off Switching Loss per Pulse     |                                                                                                                                 | E <sub>OFF</sub>      | –    | 0.16   | –   |      |
| Turn–on Delay Time                    | T <sub>J</sub> = 150°C<br>V <sub>DS</sub> = 600 V, I <sub>D</sub> = 50 A<br>V <sub>GS</sub> = –5 V/18 V, R <sub>G</sub> = 2.7 Ω | t <sub>d(on)</sub>    | –    | 40.5   | –   | ns   |
| Rise Time                             |                                                                                                                                 | t <sub>r</sub>        | –    | 8.0    | –   |      |
| Turn–off Delay Time                   |                                                                                                                                 | t <sub>d(off)</sub>   | –    | 113    | –   |      |
| Fall Time                             |                                                                                                                                 | t <sub>f</sub>        | –    | 9.1    | –   |      |
| Turn–on Switching Loss per Pulse      |                                                                                                                                 | E <sub>ON</sub>       | –    | 0.49   | –   | mJ   |
| Turn off Switching Loss per Pulse     |                                                                                                                                 | E <sub>OFF</sub>      | –    | 0.16   | –   |      |
| Diode Forward Voltage                 | I <sub>D</sub> = 50 A, T <sub>J</sub> = 25°C                                                                                    | V <sub>SD</sub>       | –    | 3.93   | 6   | V    |
|                                       | I <sub>D</sub> = 50 A, T <sub>J</sub> = 150°C                                                                                   |                       | –    | 3.39   | –   |      |
| Thermal Resistance – Chip–to–case     | M1, M2                                                                                                                          | R <sub>thJC</sub>     | –    | 0.4495 | –   | °C/W |
| Thermal Resistance – Chip–to–heatsink | Thermal grease, Thickness = 2 Mil _2%, A = 2.8 W/mK                                                                             | R <sub>thJH</sub>     | –    | 0.7971 | –   | °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.

## NXH020P120MNF1PTG, NXH020P120MNF1PG

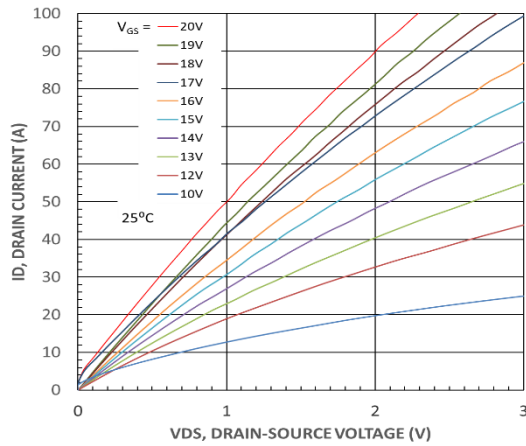
### ORDERING INFORMATION

| Orderable Part Number | Marking           | Package                                                                                                                  | Shipping                |
|-----------------------|-------------------|--------------------------------------------------------------------------------------------------------------------------|-------------------------|
| NXH020P120MNF1PG      | NXH020P120MNF1PG  | F1-2PACK: Case 180BW<br>Press-fit Pins<br>(Pb-Free and Halide-Free)                                                      | 28 Units / Blister Tray |
| NXH020P120MNF1PTG     | NXH020P120MNF1PTG | F1-2PACK: Case 180BW<br>Press-fit Pins with pre-applied<br>thermal interface material (TIM)<br>(Pb-Free and Halide-Free) | 28 Units / Blister Tray |

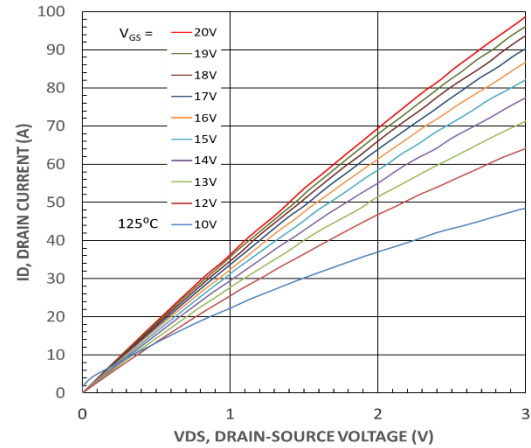
# NXH020P120MNF1PTG, NXH020P120MNF1PG

## TYPICAL CHARACTERISTICS

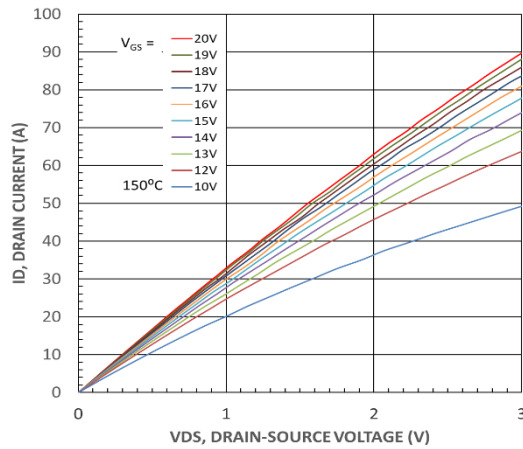
SIC MOSFET (M1, M2)



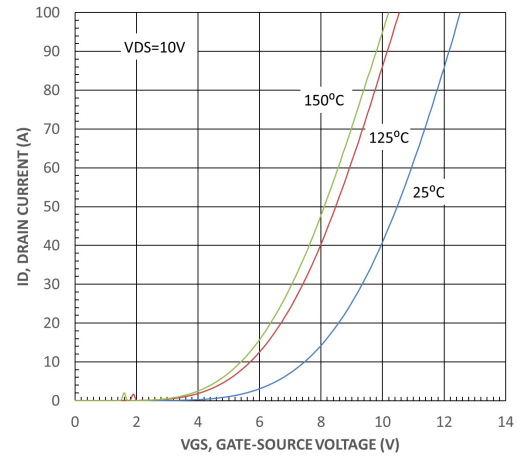
**Figure 2. MOSFET Typical Output Characteristics**



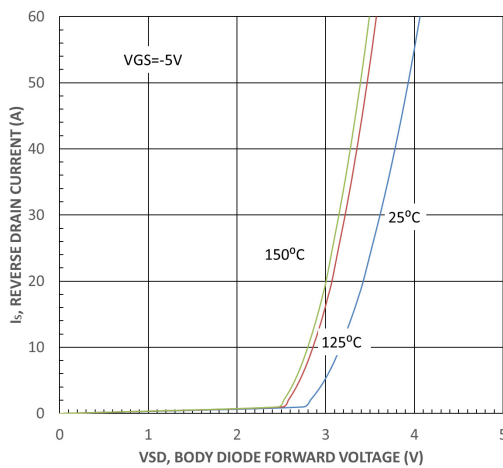
**Figure 3. MOSFET Typical Output Characteristics**



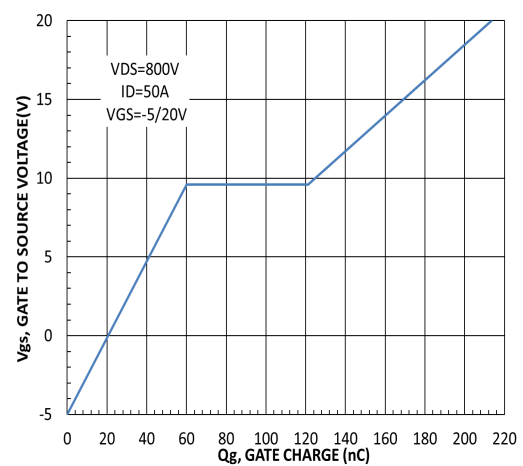
**Figure 4. MOSFET Typical Output Characteristics**



**Figure 5. MOSFET Typical Transfer Characteristics**



**Figure 6. Body Diode Forward Characteristics**



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

TYPICAL CHARACTERISTICS

SIC MOSFET (M1, M2)

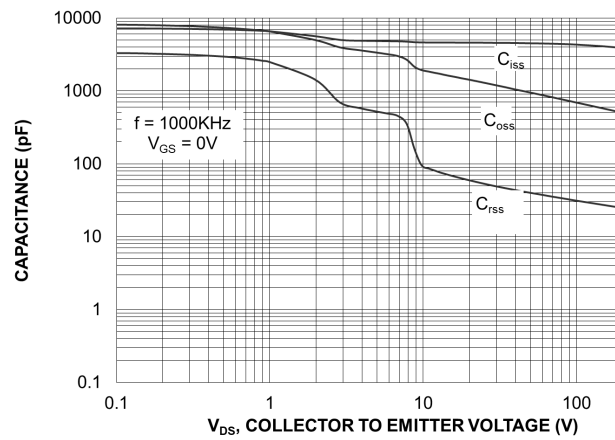


Figure 8. Capacitance vs. Drain-to-Source Voltage

## TYPICAL CHARACTERISTICS

### M1/M2 MOSFET SWITCHING CHARACTERISTICS

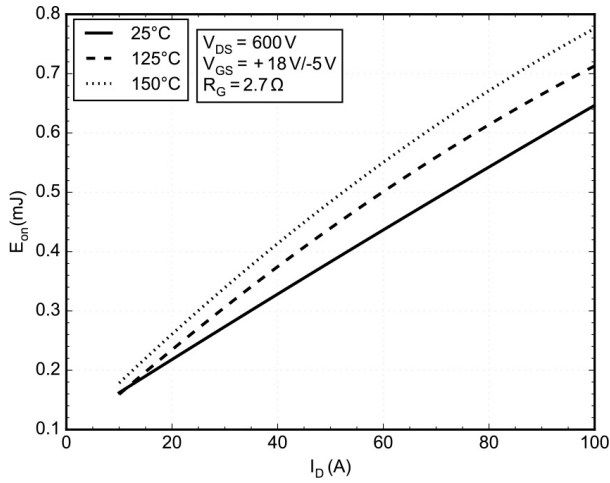


Figure 9. Typical Switching Loss Eon vs. ID

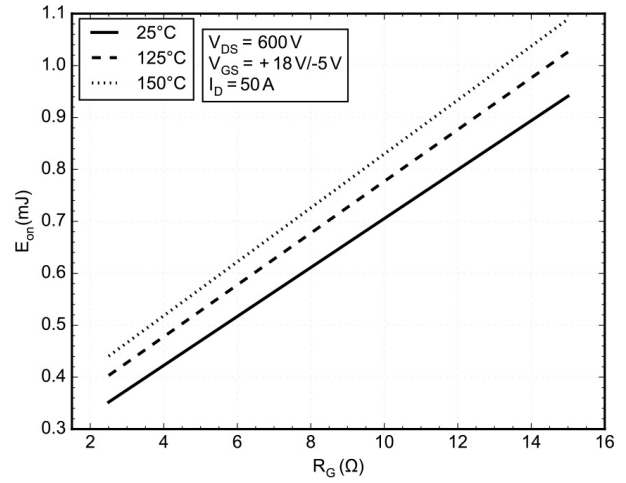


Figure 10. Typical Switching Loss Eon vs.  $R_G$

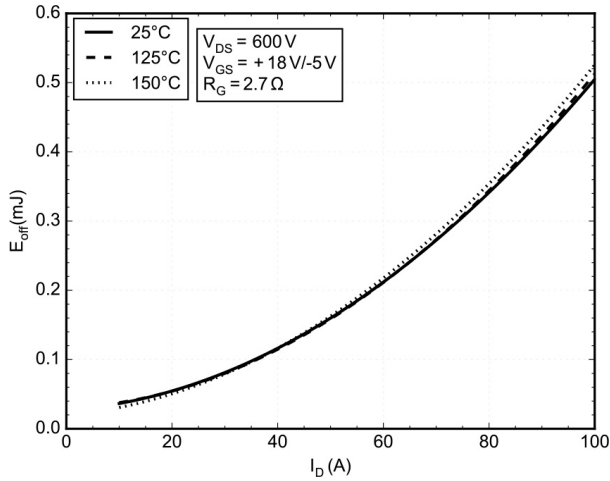


Figure 11. Typical Switching Loss Eoff vs. ID

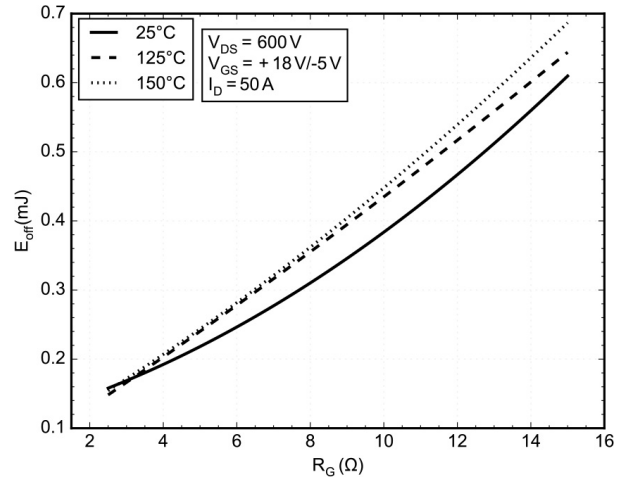


Figure 12. Typical Switching Loss Eoff vs.  $R_G$

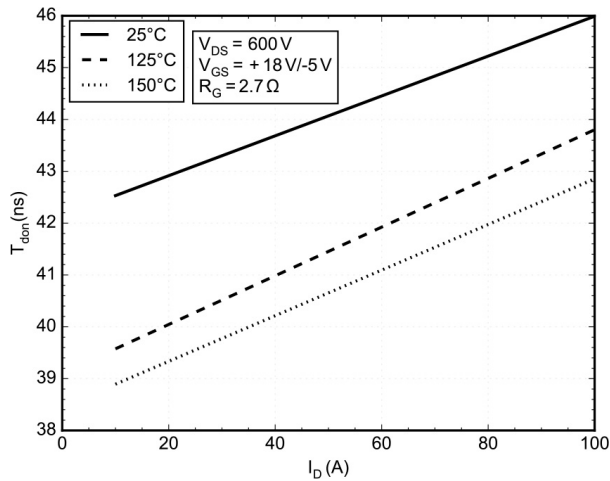


Figure 13. Typical Turn-On Switching Tdon vs. ID

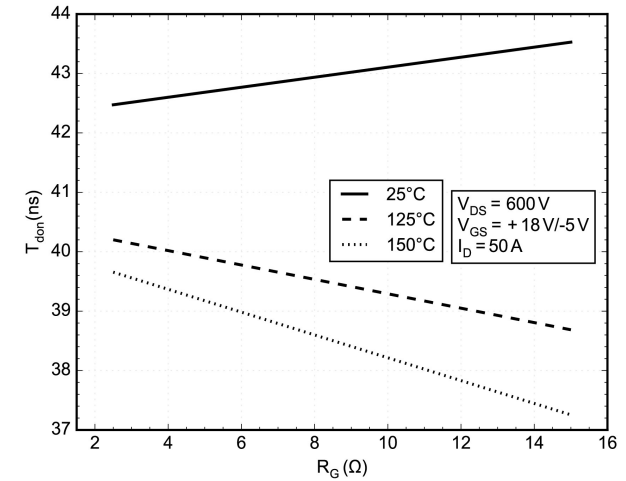


Figure 14. Typical Turn-On Switching Tdon vs.  $R_G$

**TYPICAL CHARACTERISTICS**  
M1/M2 MOSFET SWITCHING CHARACTERISTICS

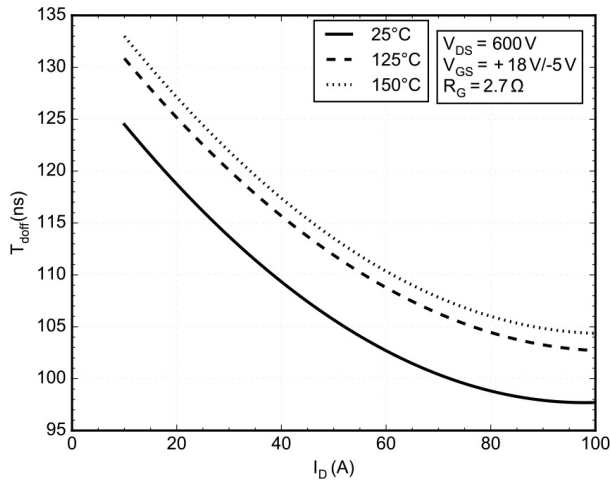


Figure 15. Typical Turn-Off Switching Tdoff vs. ID

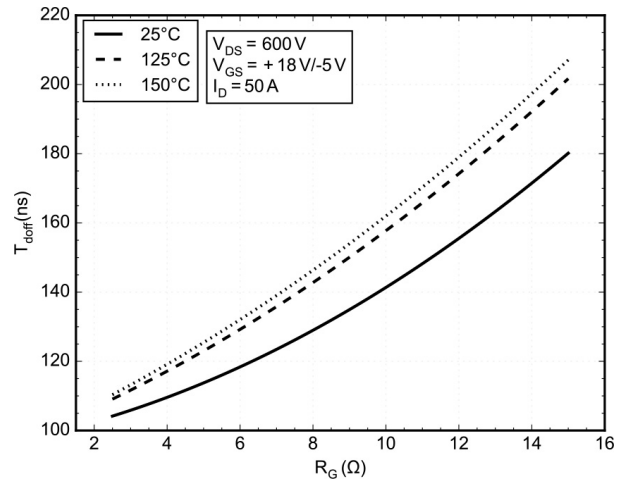


Figure 16. Typical Turn-Off Switching Tdoff vs.  $R_G$

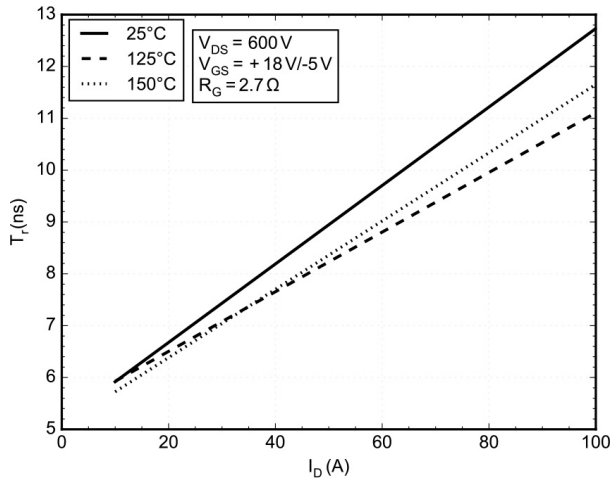


Figure 17. Typical Turn-On Switching  $T_r$  vs. ID

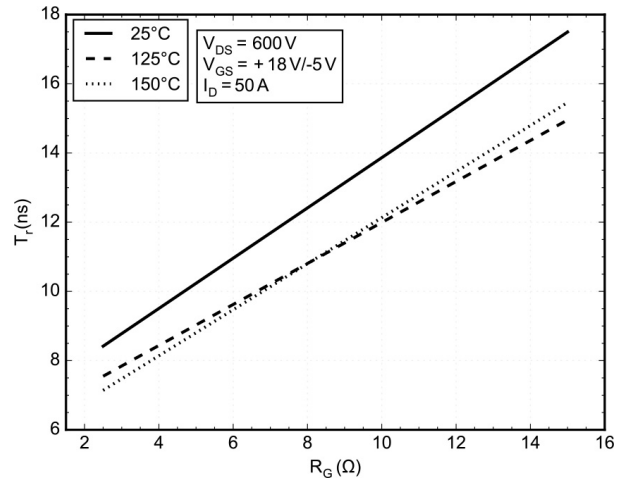


Figure 18. Typical Turn-On Switching  $T_r$  vs.  $R_G$

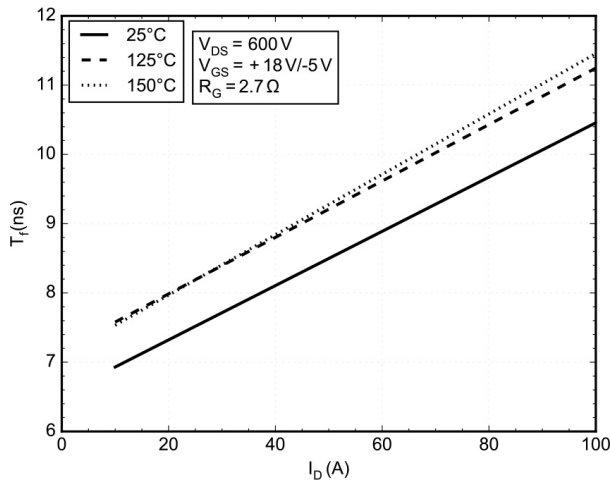


Figure 19. Typical Turn-Off Switching  $T_f$  vs. ID

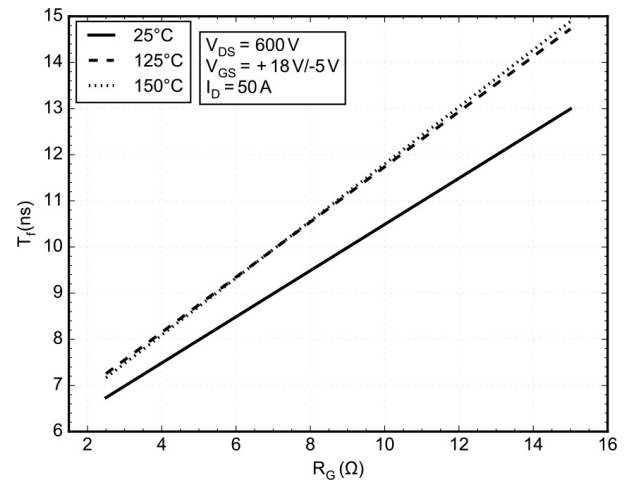


Figure 20. Typical Turn-Off Switching  $T_f$  vs.  $R_G$



**TYPICAL CHARACTERISTICS**  
M1/M2 MOSFET SWITCHING CHARACTERISTICS

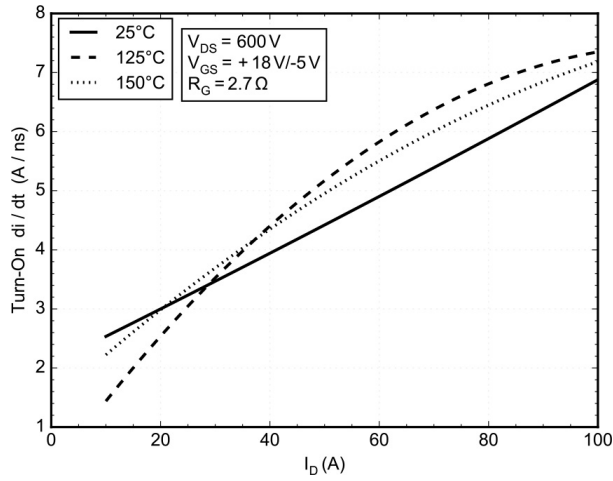


Figure 21. di/dt ON vs. ID

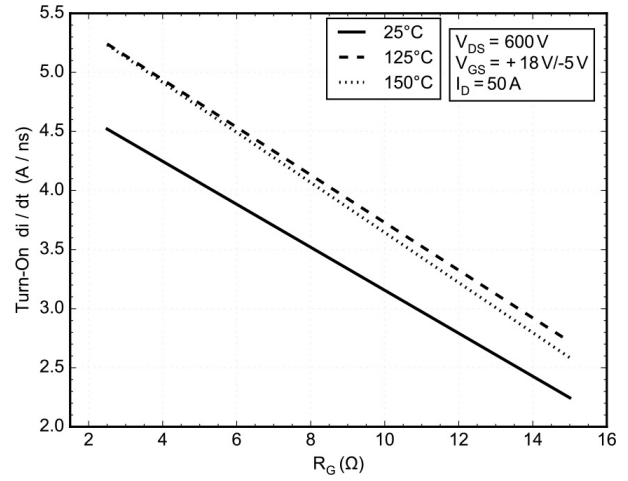


Figure 22. di/dt ON vs.  $R_G$

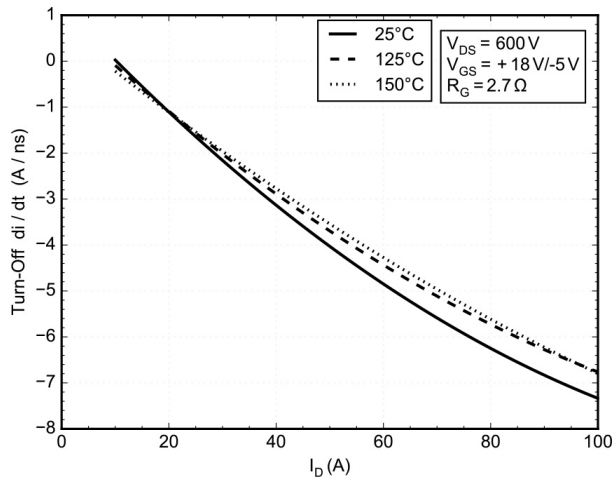


Figure 23. di/dt OFF vs. ID

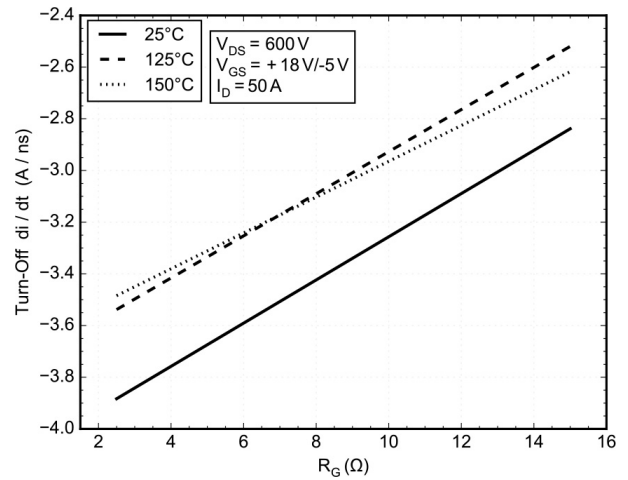


Figure 24. di/dt OFF vs.  $R_G$

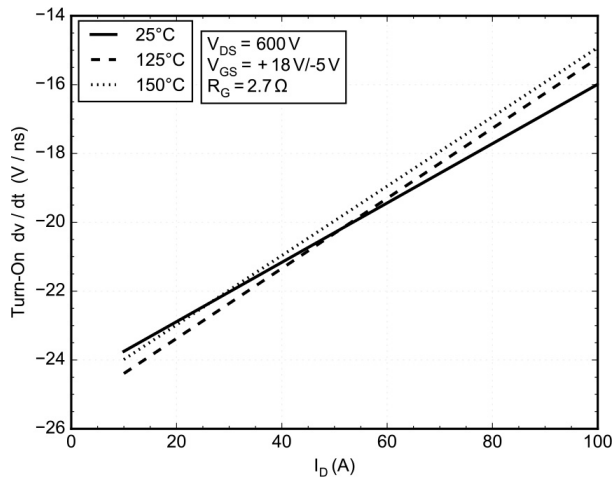


Figure 25. dv/dt ON vs. ID

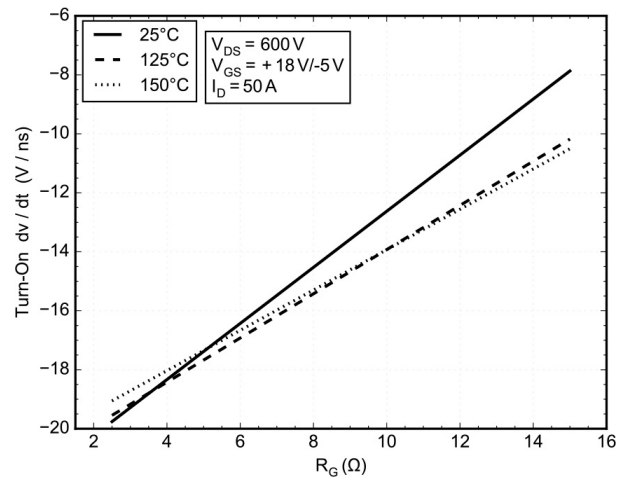


Figure 26. dv/dt ON vs.  $R_G$

**TYPICAL CHARACTERISTICS**  
M1/M2 MOSFET SWITCHING CHARACTERISTICS

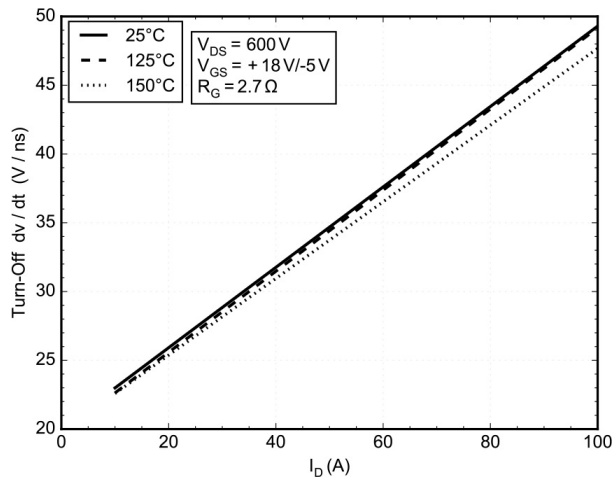


Figure 27.  $dv/dt$  OFF vs.  $I_D$

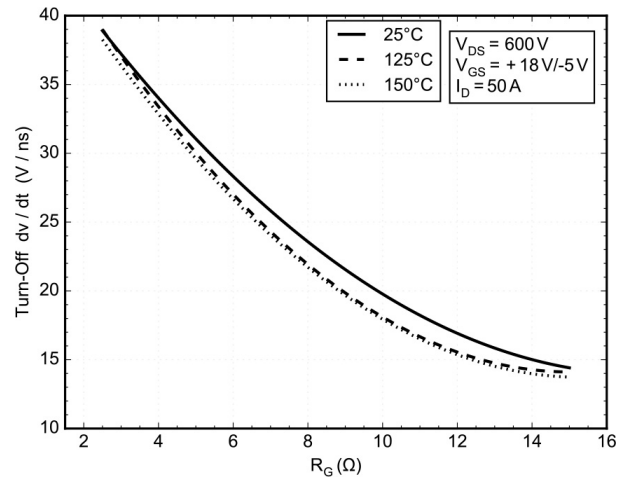
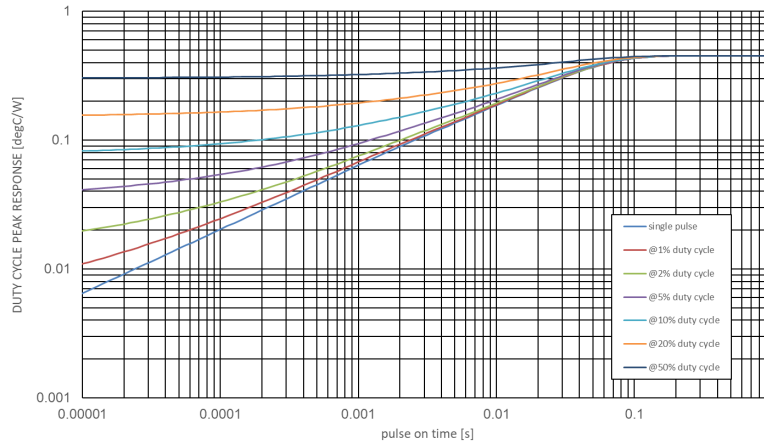


Figure 28.  $dv/dt$  OFF vs.  $R_G$

**TYPICAL CHARACTERISTICS**  
SIC MOSFET (M1/M2)



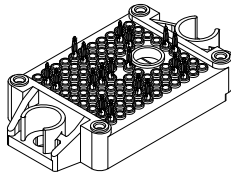
**Figure 29. MOSFET Junction-to-Case Transient Thermal Impedance**

**Table 1. FOSTER NETWORKS – M1, M2**

| Foster Element # | M1        |            | M2        |            |
|------------------|-----------|------------|-----------|------------|
|                  | Rth (K/W) | Cth (Ws/K) | Rth (K/W) | Cth (Ws/K) |
| 1                | 0.017325  | 0.008638   | 0.026614  | 0.005297   |
| 2                | 0.022329  | 0.043836   | 0.014274  | 0.064284   |
| 3                | 0.016565  | 0.107000   | 0.006208  | 0.315671   |
| 4                | 0.041616  | 0.125888   | 0.075096  | 0.078283   |
| 5                | 0.338223  | 0.099402   | 0.338851  | 0.124492   |

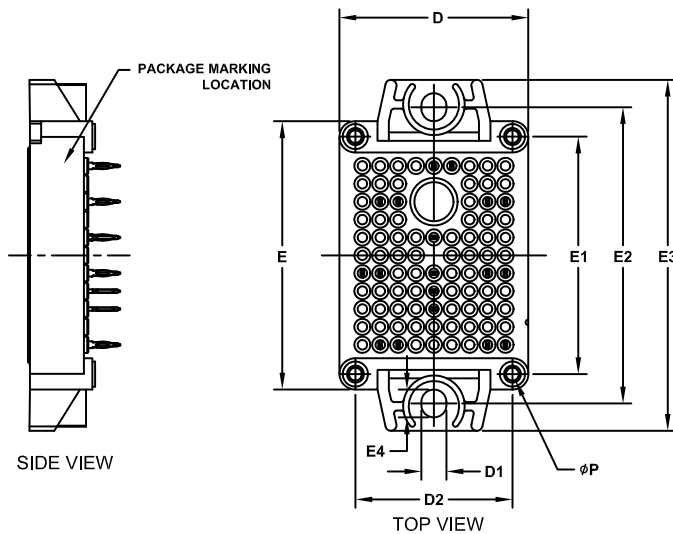
**Table 2. CAUER NETWORKS – M1, M2**

| Cauer Element # | M1        |            | M2        |            |
|-----------------|-----------|------------|-----------|------------|
|                 | Rth (K/W) | Cth (Ws/K) | Rth (K/W) | Cth (Ws/K) |
| 1               | 0.034247  | 0.006027   | 0.038327  | 0.004380   |
| 2               | 0.073342  | 0.018048   | 0.072292  | 0.025045   |
| 3               | 0.106345  | 0.041141   | 0.118744  | 0.030910   |
| 4               | 0.100786  | 0.040901   | 0.069379  | 0.066961   |
| 5               | 0.121340  | 0.076490   | 0.162299  | 0.074739   |



PIM18 33.8x42.5 (PRESS FIT)  
CASE 180BW  
ISSUE B

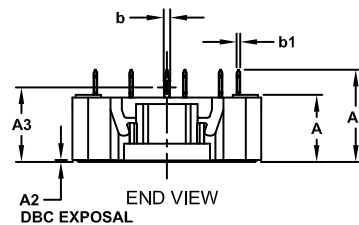
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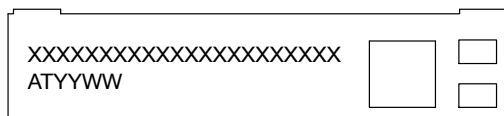
NOTES:

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  |

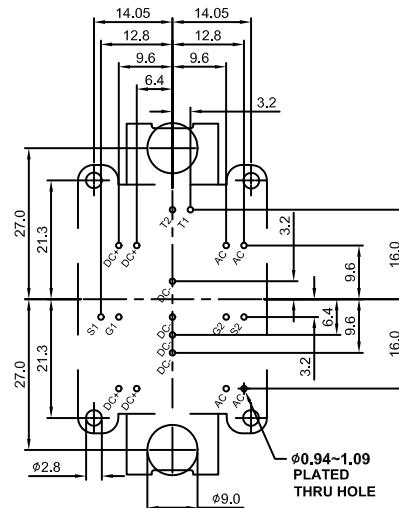


GENERIC  
MARKING DIAGRAM\*



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

|                  |                             |                                                                                                                                                                                  |
|------------------|-----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
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| DESCRIPTION:     | PIM18 33.8x42.5 (PRESS FIT) | PAGE 1 OF 1                                                                                                                                                                      |

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