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 Al₂O₃ DBC in an F1 package.

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

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.
### PIN FUNCTION DESCRIPTION

<table>
<thead>
<tr>
<th>Pin</th>
<th>Name</th>
<th>Description</th>
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<tbody>
<tr>
<td>1</td>
<td>AC2</td>
<td>Center point of full bridge 2</td>
</tr>
<tr>
<td>2</td>
<td>AC2</td>
<td>Center point of full bridge 2</td>
</tr>
<tr>
<td>3</td>
<td>S3</td>
<td>M3 Gate (High side switch)</td>
</tr>
<tr>
<td>4</td>
<td>G3</td>
<td>M3 Kelvin Emitter (High side switch)</td>
</tr>
<tr>
<td>5</td>
<td>TH1</td>
<td>Thermistor Connection 1</td>
</tr>
<tr>
<td>6</td>
<td>TH2</td>
<td>Thermistor Connection 2</td>
</tr>
<tr>
<td>7</td>
<td>S4</td>
<td>M4 Kelvin Emitter (Low side switch)</td>
</tr>
<tr>
<td>8</td>
<td>G4</td>
<td>M4 Gate (Low side switch)</td>
</tr>
<tr>
<td>9</td>
<td>DC−2</td>
<td>DC Negative Bus connection</td>
</tr>
<tr>
<td>10</td>
<td>DC−2</td>
<td>DC Negative Bus connection</td>
</tr>
<tr>
<td>11</td>
<td>DC+</td>
<td>DC Positive Bus connection</td>
</tr>
<tr>
<td>12</td>
<td>DC+</td>
<td>DC Positive Bus connection</td>
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<tr>
<td>13</td>
<td>DC+</td>
<td>DC Positive Bus connection</td>
</tr>
<tr>
<td>14</td>
<td>DC+</td>
<td>DC Positive Bus connection</td>
</tr>
<tr>
<td>15</td>
<td>DC−1</td>
<td>DC Negative Bus connection</td>
</tr>
<tr>
<td>16</td>
<td>DC−1</td>
<td>DC Negative Bus connection</td>
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<tr>
<td>17</td>
<td>G2</td>
<td>M2 Gate (Low side switch)</td>
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<tr>
<td>18</td>
<td>S2</td>
<td>M2 Kelvin Emitter (Low side switch)</td>
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<tr>
<td>19</td>
<td>AC1</td>
<td>Center point of full bridge 1</td>
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<tr>
<td>20</td>
<td>AC1</td>
<td>Center point of full bridge 1</td>
</tr>
<tr>
<td>21</td>
<td>S1</td>
<td>M1 Kelvin Emitter (High side switch)</td>
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<tr>
<td>22</td>
<td>G1</td>
<td>M1 Gate (High side switch)</td>
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### MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Rating</th>
<th>Symbol</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>SiC MOSFET</td>
<td>V_DSS</td>
<td>1200</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>V_GS</td>
<td>+22/−10</td>
<td>V</td>
</tr>
<tr>
<td>Continuous Drain Current @ T_C = 80°C (T_J = 175°C)</td>
<td>I_D</td>
<td>(87)</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>I_Pulse</td>
<td>(174)</td>
<td>A</td>
</tr>
<tr>
<td>Maximum Power Dissipation (T_J = 175°C)</td>
<td>P_tot</td>
<td>(233)</td>
<td>W</td>
</tr>
<tr>
<td>Minimum Operating Junction Temperature</td>
<td>T_MIN</td>
<td>−40</td>
<td>°C</td>
</tr>
<tr>
<td>Maximum Operating Junction Temperature</td>
<td>T_MAX</td>
<td>175</td>
<td>°C</td>
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### THERMAL PROPERTIES

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<th>Rating</th>
<th>Symbol</th>
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<th>Unit</th>
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<tr>
<td>Storage Temperature Range</td>
<td>T_stg</td>
<td>−40 to 150</td>
<td>°C</td>
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### INSULATION PROPERTIES

<table>
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<th>Rating</th>
<th>Symbol</th>
<th>Value</th>
<th>Unit</th>
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</thead>
<tbody>
<tr>
<td>Isolation Test Voltage, t = 1 s, 60 Hz</td>
<td>V_is</td>
<td>4800</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>V_RMS</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Creepage Distance</td>
<td></td>
<td>12.7</td>
<td>mm</td>
</tr>
<tr>
<td>CTI</td>
<td></td>
<td>600</td>
<td></td>
</tr>
<tr>
<td>Substrate Ceramic Material</td>
<td></td>
<td>Al_2O_3</td>
<td></td>
</tr>
<tr>
<td>Substrate Ceramic Material Thickness</td>
<td></td>
<td>(0.32)</td>
<td>mm</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Rating</th>
<th>Symbol</th>
<th>Min</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module Operating Junction Temperature</td>
<td>$T_J$</td>
<td>−40</td>
<td>150</td>
<td>°C</td>
</tr>
</tbody>
</table>

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 ($T_J = 25$ °C unless otherwise noted)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Symbol</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SiC MOSFET CHARACTERISTICS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Zero Gate Voltage Drain Current</td>
<td>$V_{GS} = 0$ V, $V_{DS} = 1200$ V, $T_J = 25$ °C</td>
<td>$I_{DSS}$</td>
<td>−</td>
<td>−</td>
<td>200</td>
<td>μA</td>
</tr>
<tr>
<td>Drain–Source On Resistance</td>
<td>$V_{GS} = 18$ V, $I_D = 60$ A, $T_J = 25$ °C</td>
<td>$R_{DS(ON)}$</td>
<td>−</td>
<td>14.8</td>
<td>19</td>
<td>mΩ</td>
</tr>
<tr>
<td></td>
<td>$V_{GS} = 18$ V, $I_D = 60$ A, $T_J = 125$ °C</td>
<td>−</td>
<td>24.7</td>
<td>−</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$V_{GS} = 18$ V, $I_D = 60$ A, $T_J = 150$ °C</td>
<td>−</td>
<td>28.7</td>
<td>−</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$V_{GS} = 18$ V, $I_D = 60$ A, $T_J = 175$ °C</td>
<td>−</td>
<td>33</td>
<td>−</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gate–Source Threshold Voltage</td>
<td>$V_{GS} = V_{DS}, I_D = 30$ mA</td>
<td>$V_{GS(TH)}$</td>
<td>2.04</td>
<td>2.4</td>
<td>4.4</td>
<td>V</td>
</tr>
<tr>
<td>Recommended Gate Voltage</td>
<td></td>
<td>$V_{GOp}$</td>
<td>−3</td>
<td>−</td>
<td>+18</td>
<td>V</td>
</tr>
<tr>
<td>Gate–to–Source Leakage Current</td>
<td>$V_{GS} = +22/-10$ V, $V_{DS} = 0$ V</td>
<td>$I_{GSS}$</td>
<td>−</td>
<td>−</td>
<td>±2</td>
<td>μA</td>
</tr>
<tr>
<td>Input Capacitance</td>
<td>$V_{GS} = 0$ V, $f = 1$ MHz, $V_{DS} = 800$ V</td>
<td>$C_{ISS}$</td>
<td>−</td>
<td>4696</td>
<td>−</td>
<td>pF</td>
</tr>
<tr>
<td>Reverse Transfer Capacitance</td>
<td></td>
<td>$C_{RSS}$</td>
<td>−</td>
<td>20.1</td>
<td>−</td>
<td></td>
</tr>
<tr>
<td>Output Capacitance</td>
<td></td>
<td>$C_{OSS}$</td>
<td>−</td>
<td>287</td>
<td>−</td>
<td></td>
</tr>
<tr>
<td>Total Gate Charge</td>
<td>$V_{GS} = -3/18$ V, $V_{DS} = 800$ V, $I_D = 30$ A</td>
<td>$Q_{G(TOTAL)}$</td>
<td>−</td>
<td>211</td>
<td>−</td>
<td>nC</td>
</tr>
<tr>
<td>Gate–Source Charge</td>
<td></td>
<td>$Q_{GS}$</td>
<td>−</td>
<td>16</td>
<td>−</td>
<td>nC</td>
</tr>
<tr>
<td>Gate–Drain Charge</td>
<td></td>
<td>$Q_{GD}$</td>
<td>−</td>
<td>50</td>
<td>−</td>
<td>nC</td>
</tr>
<tr>
<td>Turn–on Delay Time</td>
<td>$T_J = 25$ °C, $V_{DS} = 800$ V, $I_D = 60$ A, $V_{GS} = -3/18$ V, $R_G = 2.2$ Ω</td>
<td>$\tau_{(on)}$</td>
<td>−</td>
<td>33.3</td>
<td>−</td>
<td>ns</td>
</tr>
<tr>
<td>Rise Time</td>
<td></td>
<td>$\tau_{r}$</td>
<td>−</td>
<td>8.6</td>
<td>−</td>
<td></td>
</tr>
<tr>
<td>Turn–off Delay Time</td>
<td></td>
<td>$\tau_{(off)}$</td>
<td>−</td>
<td>103</td>
<td>−</td>
<td></td>
</tr>
<tr>
<td>Fall Time</td>
<td></td>
<td>$\tau_{f}$</td>
<td>−</td>
<td>7.5</td>
<td>−</td>
<td></td>
</tr>
<tr>
<td>Turn–on Switching Loss per Pulse</td>
<td></td>
<td>$E_{ON}$</td>
<td>−</td>
<td>0.67</td>
<td>−</td>
<td>mJ</td>
</tr>
<tr>
<td>Turn off Switching Loss per Pulse</td>
<td></td>
<td>$E_{OFF}$</td>
<td>−</td>
<td>0.28</td>
<td>−</td>
<td></td>
</tr>
<tr>
<td>Diode Forward Voltage</td>
<td>$V_{GS} = -3$ V, $I_{SD} = 60$ A, $T_J = 25$ °C</td>
<td>$V_{SD}$</td>
<td>−</td>
<td>4.67</td>
<td>6.2</td>
<td>V</td>
</tr>
<tr>
<td>Thermal Resistance – Chip–to–Case</td>
<td>M1, M2, M3, M4</td>
<td>$R_{INJC}$</td>
<td>−</td>
<td>0.48</td>
<td>−</td>
<td>°C/W</td>
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<tr>
<td>Thermal Resistance – Chip–to–Heatsink</td>
<td></td>
<td>$R_{INJH}$</td>
<td>−</td>
<td>0.86</td>
<td>−</td>
<td>°C/W</td>
</tr>
</tbody>
</table>

### THERMISTOR CHARACTERISTICS

| Nominal Resistance                           | $T = 25$ °C | $R_{25}$ | −   | 5   | −   | kΩ   |
|                                              | $T = 100$ °C | $R_{100}$ | −   | 457 | −   | Ω    |
|                                              | $T = 150$ °C | $R_{150}$ | −   | 159.5| −   | Ω    |
| Deviation of $R_{100}$                       | $T = 100$ °C | $\Delta R/R$ | −5 | −   | 5   | %    |
| Power Dissipation – Recommended Limit        | 0.15 mA, Non–self–heating Effect | $P_D$ | −   | 0.1 | −   | mW   |
| Power Dissipation – Absolute Maximum         | 5 mA         | −         | 34.2| mW  |
ELECTRICAL CHARACTERISTICS (continued) (T_J = 25 °C unless otherwise noted)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Symbol</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
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<tr>
<td>Power Dissipation Constant</td>
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<td>–</td>
<td>1.4</td>
<td>–</td>
<td>mW/K</td>
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<tr>
<td>B–value B(25/50), tolerance ±2%</td>
<td></td>
<td></td>
<td>–</td>
<td>3375</td>
<td>–</td>
<td>K</td>
</tr>
<tr>
<td>B–value B(25/100), tolerance ±2%</td>
<td></td>
<td></td>
<td>–</td>
<td>3436</td>
<td>–</td>
<td>K</td>
</tr>
</tbody>
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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

<table>
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<tr>
<th>Orderable Part Number</th>
<th>Marking</th>
<th>Package</th>
<th>Shipping</th>
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<tr>
<td>NXH015F120M3F1PTG</td>
<td>NXH015F120M3F1PTG</td>
<td>F1FULLBR: Case 180HL Press–fit Pins with pre–applied thermal interface material (TIM) (Pb–Free and Halide–Free)</td>
<td>28 Units / Blister Tray</td>
</tr>
</tbody>
</table>
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)
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

Figure 12. Switching Loss vs. Gate Resistance
TYPICAL CHARACTERISTICS
M1, M2, M3, M4 SiC MOSFET CHARACTERISTIC

Figure 13. Switching Loss vs. Drain Current
V_DS = 800 V

Figure 14. Switching Loss vs. Gate Resistance
V_DS = 800 V

Figure 15. Reverse Recovery Energy vs. Drain Current
V_DS = 800 V

Figure 16. Reverse Recovery Energy vs. Gate Resistance
V_DS = 800 V

Figure 17. di/dt Turn ON vs. Drain Current
V_DS = 800 V

Figure 18. di/dt Turn ON vs. Gate Resistance
V_DS = 800 V
**TYPICAL CHARACTERISTICS**

M1, M2, M3, M4 SiC MOSFET CHARACTERISTIC

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**Figure 19.** $\frac{d}{dt}$ Turn OFF vs. Drain Current

$V_{DS} = 800$ V

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**Figure 21.** $\frac{d}{dt}$ Turn ON vs. Drain Current

$V_{DS} = 800$ V

---

**Figure 23.** $\frac{d}{dt}$ Turn OFF vs. Drain Current

$V_{DS} = 800$ V

---

**Figure 20.** $\frac{d}{dt}$ Turn OFF vs. Gate Resistance

$V_{DS} = 800$ V

---

**Figure 22.** $\frac{d}{dt}$ Turn ON vs. Gate Resistance

$V_{DS} = 800$ V

---

**Figure 24.** $\frac{d}{dt}$ Turn OFF vs. Gate Resistance

$V_{DS} = 800$ V

---

$V_{GS} = +18$ V/$-3$ V

$V_{DS} = 800$ V

$R_{G} = 2.2$ $\Omega$

---

$T_{J} = 25$ °C

$T_{J} = 125$ °C

$T_{J} = 150$ °C

---

$0$ $20$ $40$ $60$ $80$ $100$ $120$

---

$0$ $20$ $40$ $60$ $80$ $100$ $120$

---

$0$ $20$ $40$ $60$ $80$ $100$ $120$

---

$0$ $20$ $40$ $60$ $80$ $100$ $120$

---
Table 1. CAUER NETWORKS

<table>
<thead>
<tr>
<th>Cauer Element #</th>
<th>Rth (K/W)</th>
<th>Cth (Ws/K)</th>
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<tbody>
<tr>
<td>1</td>
<td>0.0004413</td>
<td>0.0013801</td>
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<tr>
<td>2</td>
<td>0.0029539</td>
<td>0.0003074</td>
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<td>3</td>
<td>0.0066160</td>
<td>0.0005317</td>
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<td>4</td>
<td>0.0326540</td>
<td>0.0026575</td>
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<td>5</td>
<td>0.0988730</td>
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<td>0.1850100</td>
<td>0.0419900</td>
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<tr>
<td>7</td>
<td>0.0817340</td>
<td>1.1620000</td>
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PIN POSITION INFORMATION

scale = 2.5 : 1

PIN POSITION

<table>
<thead>
<tr>
<th>Pin #</th>
<th>X</th>
<th>Y</th>
<th>Function</th>
<th>Pin #</th>
<th>X</th>
<th>Y</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>AC2</td>
<td>12</td>
<td>28.8</td>
<td>12.8</td>
<td>DC+</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>3.2</td>
<td>AC2</td>
<td>13</td>
<td>25.6</td>
<td>12.8</td>
<td>DC+</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>6.4</td>
<td>S3</td>
<td>14</td>
<td>22.4</td>
<td>12.8</td>
<td>DC+</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
<td>9.6</td>
<td>G3</td>
<td>15</td>
<td>32</td>
<td>22.4</td>
<td>DC−1</td>
</tr>
<tr>
<td>5</td>
<td>9.6</td>
<td>0</td>
<td>TH1</td>
<td>16</td>
<td>32</td>
<td>25.6</td>
<td>DC−1</td>
</tr>
<tr>
<td>6</td>
<td>12.8</td>
<td>0</td>
<td>TH2</td>
<td>17</td>
<td>28.8</td>
<td>22.4</td>
<td>G2</td>
</tr>
<tr>
<td>7</td>
<td>28.8</td>
<td>0</td>
<td>S4</td>
<td>18</td>
<td>28.8</td>
<td>25.6</td>
<td>S2</td>
</tr>
<tr>
<td>8</td>
<td>28.8</td>
<td>3.2</td>
<td>G4</td>
<td>19</td>
<td>0</td>
<td>25.6</td>
<td>AC1</td>
</tr>
<tr>
<td>9</td>
<td>32</td>
<td>0</td>
<td>DC−2</td>
<td>20</td>
<td>0</td>
<td>22.4</td>
<td>AC1</td>
</tr>
<tr>
<td>10</td>
<td>32</td>
<td>3.2</td>
<td>DC−2</td>
<td>21</td>
<td>0</td>
<td>19.2</td>
<td>S1</td>
</tr>
<tr>
<td>11</td>
<td>32</td>
<td>12.8</td>
<td>DC+</td>
<td>22</td>
<td>0</td>
<td>16</td>
<td>G1</td>
</tr>
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</table>
PACKAGE DIMENSIONS

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

DATE 29 AUG 2023

NOTES:
1. CONTROLLING DIMENSION: MILLIMETERS
2. PIN POSITION TOLERANCE IS ± 0.4mm
3. PRESS FIT PIN

MILLIMETERS

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GENERIC MARKING DIAGRAM*

*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.

*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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