



## Features

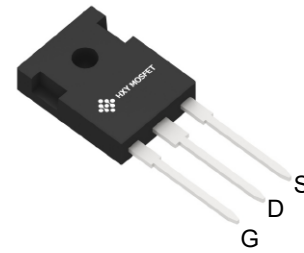
- High Blocking Voltage with Low On-Resistance
- High Speed Switching with Low Capacitances
- Easy to Parallel and Simple to Drive
- Resistant to Latch-Up
- Halogen Free, RoHS Compliant

## Benefits

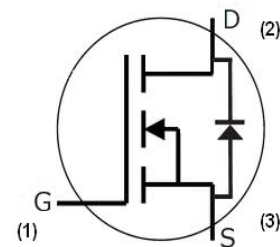
- Higher System Efficiency
- Reduced Cooling Requirements
- Increased Power Density
- Increased System Switching Frequency

## Applications

- Solar Inverters
- Switch Mode Power Supplies
- High Voltage DC/DC converters
- Battery Chargers
- Motor Drives
- Pulsed Power Applications



TO-247



| Part Number | Package | Qty(PCS) |
|-------------|---------|----------|
| CI60N120SM  | TO-247  | 30       |

## Maximum Ratings ( $T_C = 25^\circ\text{C}$ unless otherwise specified)

| Symbol         | Parameter                                  | Value       | Unit             | Test Conditions                                        | Note    |
|----------------|--------------------------------------------|-------------|------------------|--------------------------------------------------------|---------|
| $V_{DSmax}$    | Drain - Source Voltage                     | 1200        | V                | $V_{GS} = 0\text{ V}$ , $I_D = 100\text{ }\mu\text{A}$ |         |
| $V_{GSmax}$    | Gate - Source Voltage                      | -10/+25     | V                | Absolute maximum values                                |         |
| $V_{GSop}$     | Gate - Source Voltage                      | -5/+20      | V                | Recommended operational values                         |         |
| $I_D$          | Continuous Drain Current                   | 55          | A                | $V_{GS} = 20\text{ V}$ , $T_C = 25^\circ\text{C}$      | Fig. 19 |
|                |                                            | 36          |                  | $V_{GS} = 20\text{ V}$ , $T_C = 100^\circ\text{C}$     |         |
| $I_{D(pulse)}$ | Pulsed Drain Current                       | 160         | A                | Pulse width $t_p$ limited by $T_{jmax}$                | Fig. 22 |
| $P_D$          | Power Dissipation                          | 278         | W                | $T_C = 25^\circ\text{C}$ , $T_J = 150^\circ\text{C}$   | Fig. 20 |
| $T_J, T_{stg}$ | Operating Junction and Storage Temperature | -55 to +150 | $^\circ\text{C}$ |                                                        |         |
| $T_L$          | Solder Temperature                         | 260         | $^\circ\text{C}$ | 1.6mm (0.063") from case for 10s                       |         |
| $M_d$          | Mounting Torque                            | 1<br>8.8    | Nm<br>lbf-in     | M3 or 6-32 screw                                       |         |



**Electrical Characteristics** ( $T_C = 25^\circ\text{C}$  unless otherwise specified)

| Symbol        | Parameter                                      | Min. | Typ. | Max. | Unit             | Test Conditions                                                                                                                                                                        | Note       |
|---------------|------------------------------------------------|------|------|------|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| $V_{(BR)DSS}$ | Drain-Source Breakdown Voltage                 | 1200 |      |      | V                | $V_{GS} = 0\text{ V}, I_D = 100\text{ }\mu\text{A}$                                                                                                                                    |            |
| $V_{GS(th)}$  | Gate Threshold Voltage                         | 2.0  | 3.2  | 4    | V                | $V_{DS} = V_{GS}, I_D = 10\text{mA}$                                                                                                                                                   | Fig. 11    |
|               |                                                |      | 2.4  |      | V                | $V_{DS} = V_{GS}, I_D = 10\text{mA}, T_J = 150^\circ\text{C}$                                                                                                                          |            |
| $I_{DSS}$     | Zero Gate Voltage Drain Current                |      | 1    | 100  | $\mu\text{A}$    | $V_{DS} = 1200\text{ V}, V_{GS} = 0\text{ V}$                                                                                                                                          |            |
| $I_{GSS}$     | Gate-Source Leakage Current                    |      |      | 250  | nA               | $V_{GS} = 20\text{ V}, V_{DS} = 0\text{ V}$                                                                                                                                            |            |
| $R_{DS(on)}$  | Drain-Source On-State Resistance               |      | 44   | 52   | $\text{m}\Omega$ | $V_{GS} = 20\text{ V}, I_D = 40\text{ A}$                                                                                                                                              | Fig. 4,5,6 |
|               |                                                |      | 82   |      |                  | $V_{GS} = 20\text{ V}, I_D = 40\text{ A}, T_J = 150^\circ\text{C}$                                                                                                                     |            |
| $g_{fs}$      | Transconductance                               |      | 18.2 |      | S                | $V_{DS} = 20\text{ V}, I_{DS} = 40\text{ A}$                                                                                                                                           | Fig. 7     |
|               |                                                |      | 17.2 |      |                  | $V_{DS} = 20\text{ V}, I_{DS} = 40\text{ A}, T_J = 150^\circ\text{C}$                                                                                                                  |            |
| $C_{iss}$     | Input Capacitance                              |      | 2440 |      | pF               | $V_{GS} = 0\text{ V}$<br>$V_{DS} = 1000\text{ V}$<br>$f = 1\text{ MHz}$<br>$V_{AC} = 25\text{ mV}$                                                                                     | Fig. 17,18 |
| $C_{oss}$     | Output Capacitance                             |      | 171  |      |                  |                                                                                                                                                                                        |            |
| $C_{rss}$     | Reverse Transfer Capacitance                   |      | 11   |      |                  |                                                                                                                                                                                        | Fig 16     |
| $E_{oss}$     | $C_{oss}$ Stored Energy                        |      | 89   |      |                  |                                                                                                                                                                                        |            |
| $E_{ON}$      | Turn-On Switching Energy (Body Diode)          |      | 1.7  |      | mJ               | $V_{DS} = 800\text{ V}, V_{GS} = -5/20\text{ V}$<br>$I_D = 40\text{A}, R_{G(ext)} = 2.5\Omega, L = 99\text{ }\mu\text{H}$                                                              | Fig. 25    |
| $E_{OFF}$     | Turn Off Switching Energy (Body Diode)         |      | 0.4  |      |                  |                                                                                                                                                                                        |            |
| $E_{ON}$      | Turn-On Switching Energy (External SiC Diode)  |      | 1.3  |      |                  | $V_{DS} = 800\text{ V}, V_{GS} = -5/20\text{ V}$<br>$I_D = 40\text{A}, R_{G(ext)} = 2.5\Omega, L = 99\text{ }\mu\text{H}$                                                              |            |
| $E_{OFF}$     | Turn Off Switching Energy (External SiC Diode) |      | 0.4  |      |                  |                                                                                                                                                                                        |            |
| $t_{d(on)}$   | Turn-On Delay Time                             |      | 13   |      | ns               | $V_{DD} = 800\text{ V}, V_{GS} = -5/20\text{ V}$<br>$I_D = 40\text{ A}$<br>$R_{G(ext)} = 2.5\text{ }\Omega, R_L = 20\text{ }\Omega$ Timing relative to $V_{DS}$ Per IEC60747-8-4 pg 83 | Fig. 27    |
| $t_r$         | Rise Time                                      |      | 61   |      |                  |                                                                                                                                                                                        |            |
| $t_{d(off)}$  | Turn-Off Delay Time                            |      | 25   |      |                  |                                                                                                                                                                                        |            |
| $t_f$         | Fall Time                                      |      | 13   |      |                  |                                                                                                                                                                                        |            |
| $R_{G(int)}$  | Internal Gate Resistance                       |      | 1.8  |      | $\Omega$         | $f = 1\text{ MHz}, V_{AC} = 25\text{ mV}$                                                                                                                                              |            |
| $Q_{gs}$      | Gate to Source Charge                          |      | 34   |      | nC               | $V_{DS} = 800\text{ V}, V_{GS} = -5/20\text{ V}$<br>$I_D = 40\text{ A}$<br>Per IEC60747-8-4 pg 21                                                                                      | Fig. 12    |
| $Q_{gd}$      | Gate to Drain Charge                           |      | 42   |      |                  |                                                                                                                                                                                        |            |
| $Q_g$         | Total Gate Charge                              |      | 120  |      |                  |                                                                                                                                                                                        |            |



## Reverse Diode Characteristics

| Symbol                | Parameter                        | Typ. | Max. | Unit | Test Conditions                                                                                                                              | Note          |
|-----------------------|----------------------------------|------|------|------|----------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| $V_{SD}$              | Diode Forward Voltage            | 4.0  |      | V    | $V_{GS} = -5\text{ V}, I_{SD} = 20\text{ A}, T_J = 25\text{ }^{\circ}\text{C}$                                                               | Fig. 8, 9, 10 |
|                       |                                  | 3.6  |      | V    | $V_{GS} = -5\text{ V}, I_{SD} = 20\text{ A}, T_J = 150\text{ }^{\circ}\text{C}$                                                              |               |
| $I_S$                 | Continuous Diode Forward Current |      | 60   | A    | $T_C = 25\text{ }^{\circ}\text{C}$                                                                                                           | Note 1        |
| $I_{S, \text{pulse}}$ | Diode Pulse Current              |      | 160  | A    | $V_{GS} = -5\text{ V},$<br>Pulse width $t_p$ limited by $T_{jmax}$                                                                           |               |
| $t_{rr}$              | Reverse Recovery Time            | 54   |      | ns   | $V_{GS} = -5\text{ V}, I_{SD} = 40\text{ A}, T_J = 25\text{ }^{\circ}\text{C}$<br>$VR = 800\text{ V}$<br>$di/dt = 1000\text{ A}/\mu\text{s}$ | Note 1        |
| $Q_{rr}$              | Reverse Recovery Charge          | 283  |      | nC   |                                                                                                                                              |               |
| $I_{rrm}$             | Peak Reverse Recovery Current    | 15   |      | A    |                                                                                                                                              |               |

Note (1): When using SiC Body Diode the maximum recommended  $V_{GS} = -5\text{V}$

## Thermal Characteristics

| Symbol          | Parameter                                   | Typ. | Max. | Unit                        | Test Conditions | Note    |
|-----------------|---------------------------------------------|------|------|-----------------------------|-----------------|---------|
| $R_{\theta JC}$ | Thermal Resistance from Junction to Case    | 0.33 | 0.45 | $^{\circ}\text{C}/\text{W}$ |                 | Fig. 21 |
| $R_{\theta JA}$ | Thermal Resistance from Junction to Ambient |      | 40   |                             |                 |         |



## Typical Performance

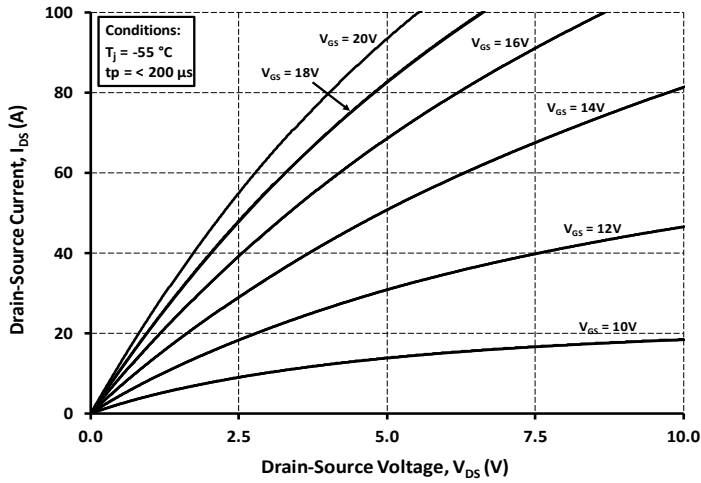


Figure 1. Output Characteristics  $T_J = -55\text{ }^{\circ}\text{C}$

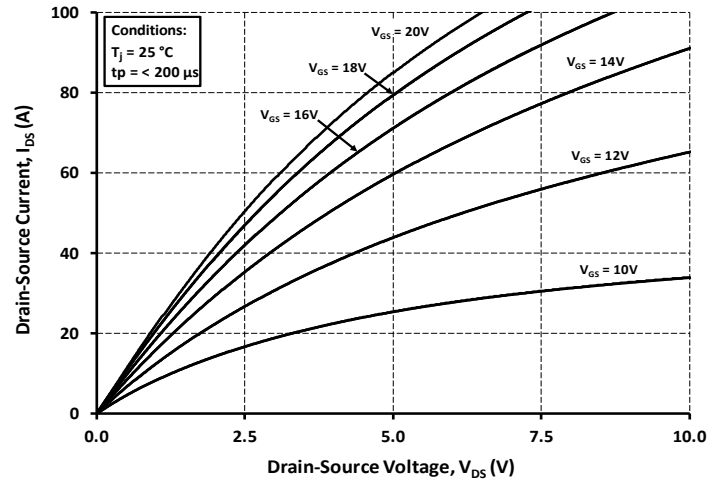


Figure 2. Output Characteristics  $T_J = 25\text{ }^{\circ}\text{C}$

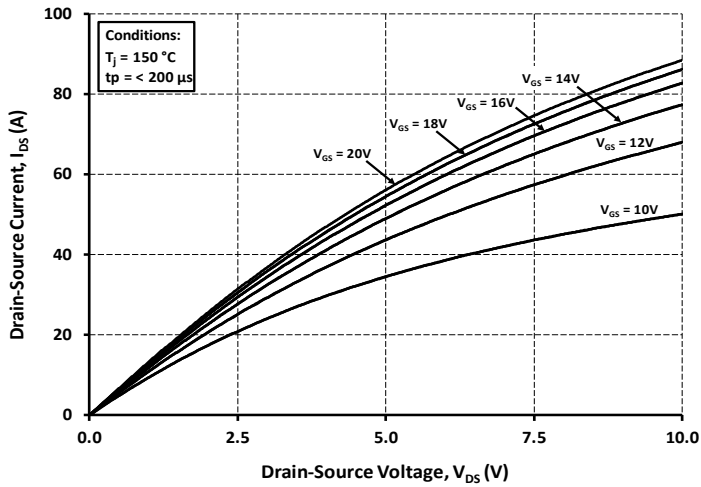


Figure 3. Output Characteristics  $T_J = 150\text{ }^{\circ}\text{C}$

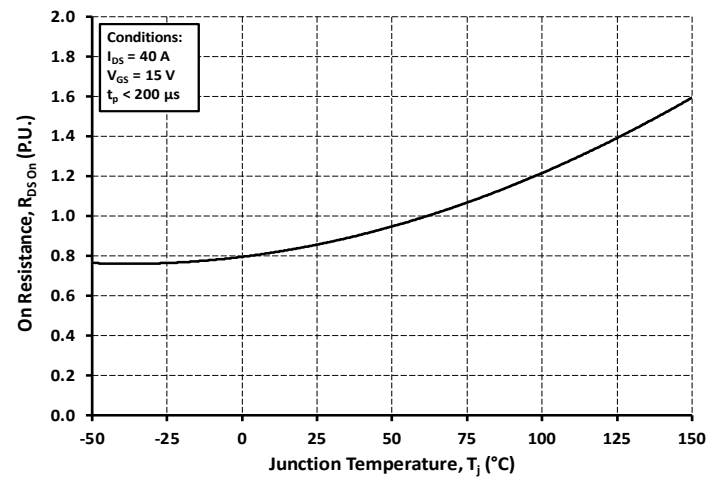


Figure 4. Normalized On-Resistance vs. Temperature

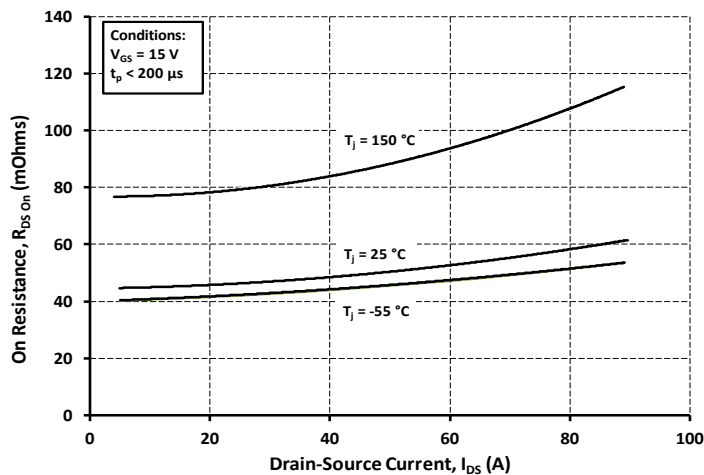


Figure 5. On-Resistance vs. Drain Current  
For Various Temperatures

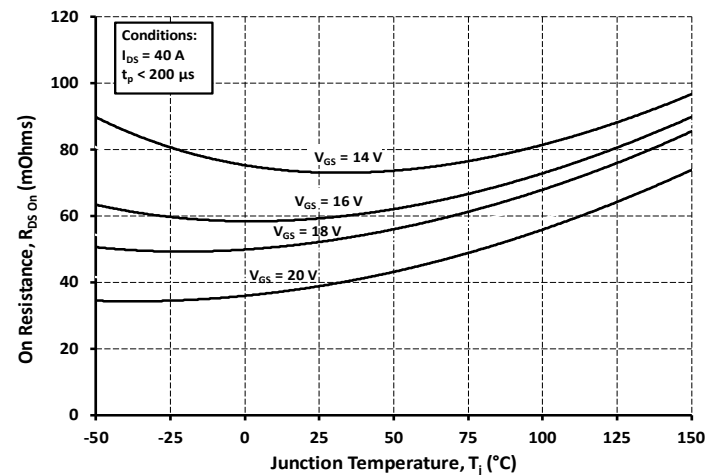


Figure 6. On-Resistance vs. Temperature  
For Various Gate Voltage

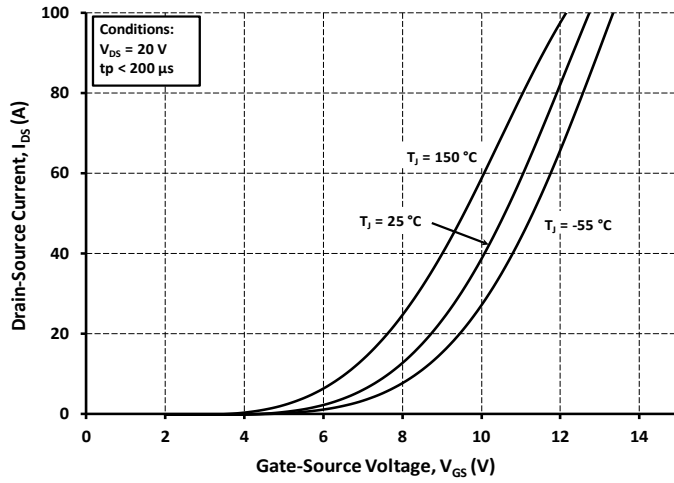


Figure 7. Transfer Characteristic for Various Junction Temperatures

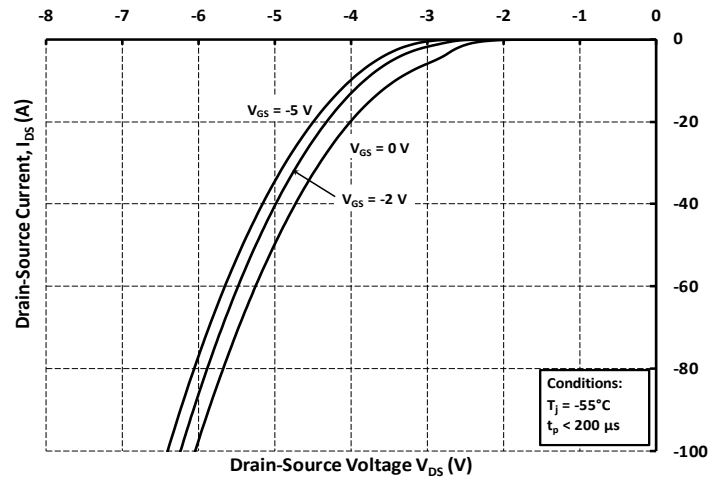


Figure 8. Body Diode Characteristic at -55 °C

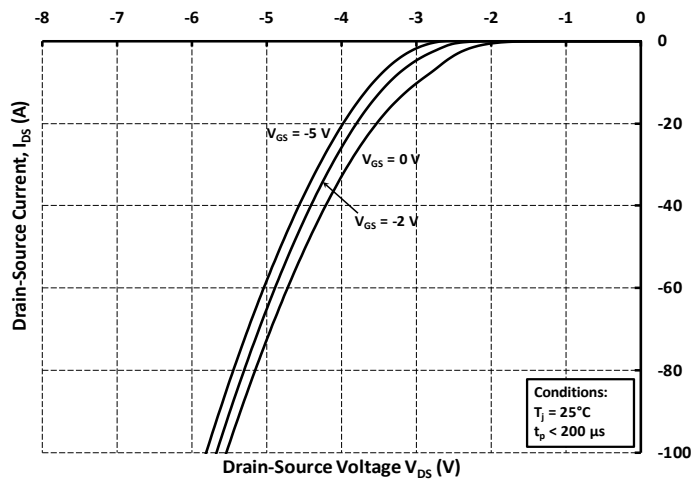


Figure 9. Body Diode Characteristic at 25 °C

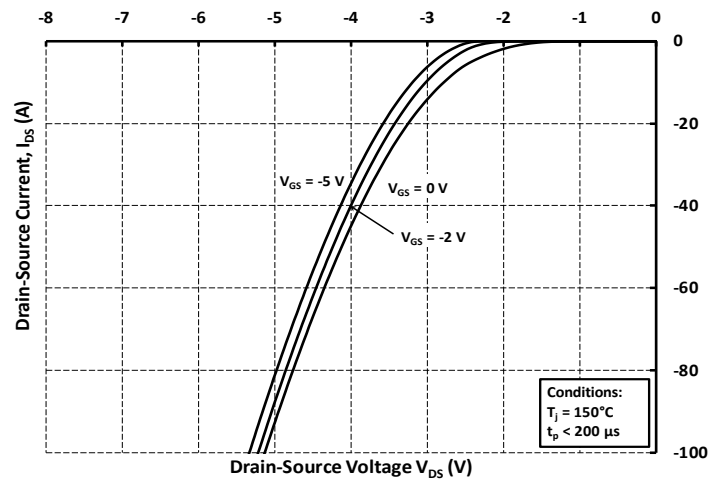


Figure 10. Body Diode Characteristic at 150 °C

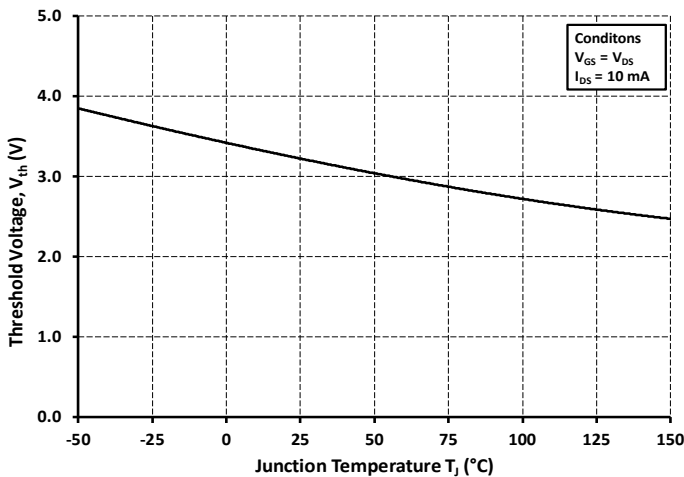


Figure 11. Threshold Voltage vs. Temperature

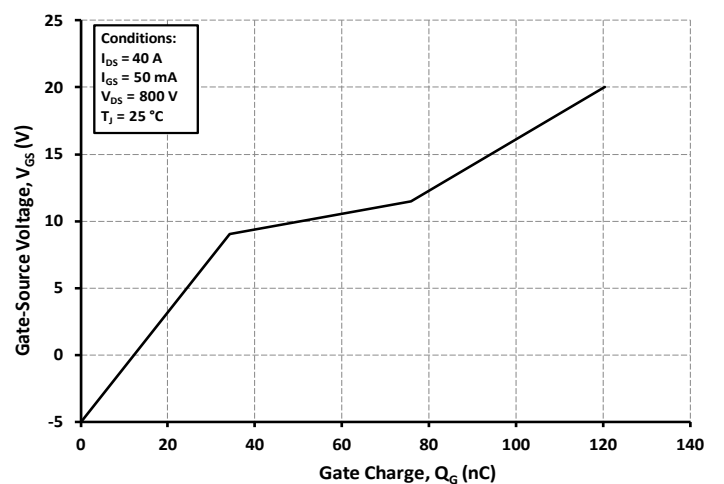


Figure 12. Gate Charge Characteristics

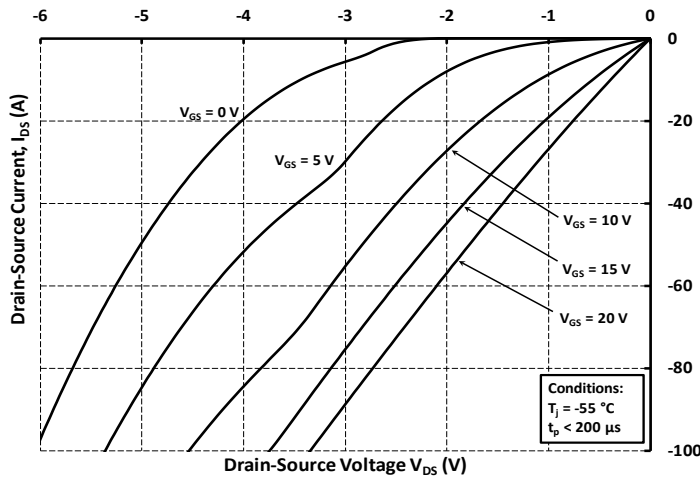


Figure 13. 3rd Quadrant Characteristic at -55 °C

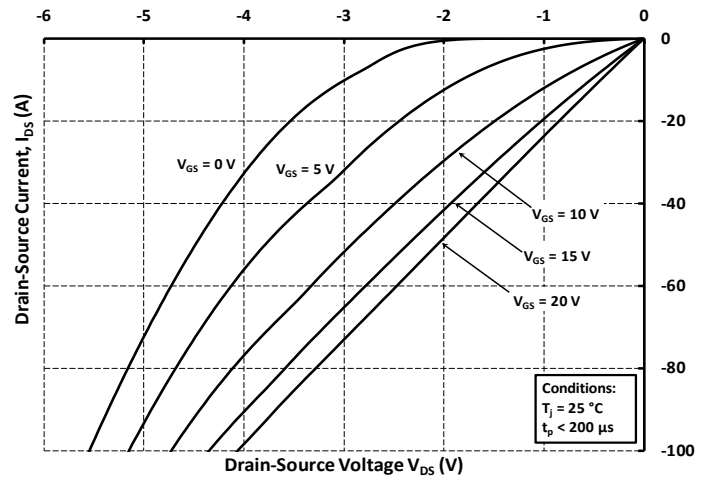


Figure 14. 3rd Quadrant Characteristic at 25 °C

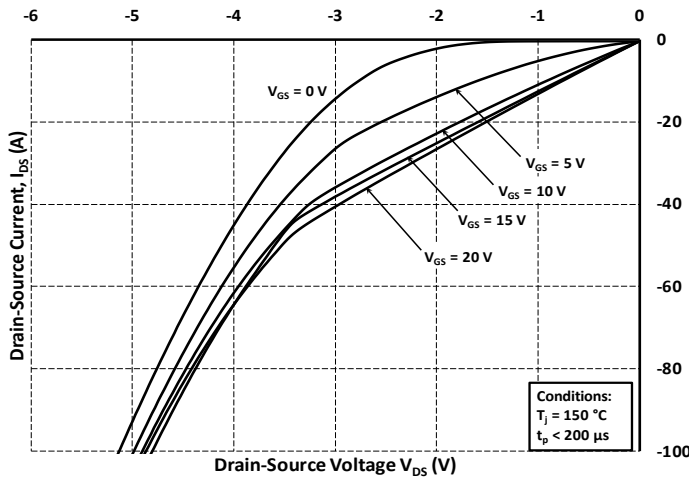


Figure 15. 3rd Quadrant Characteristic at 150 °C

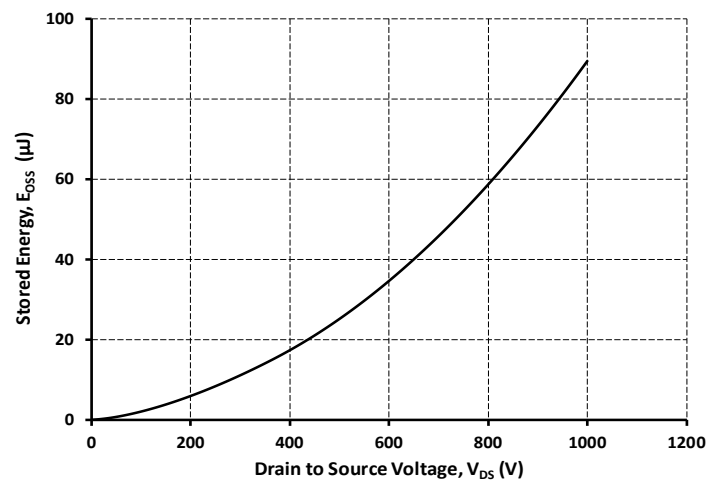


Figure 16. Output Capacitor Stored Energy

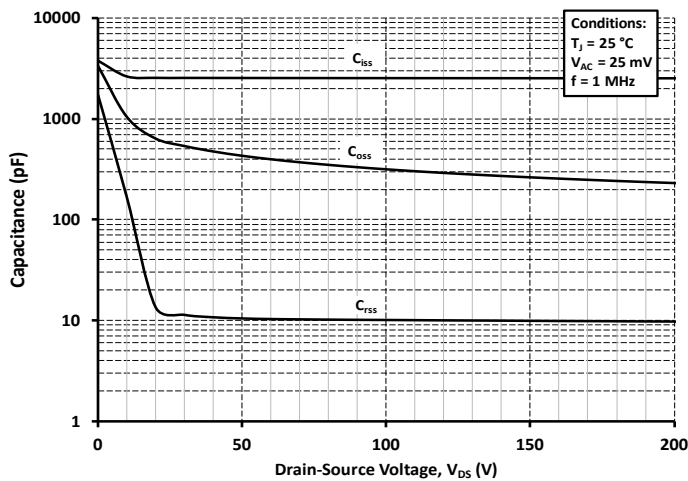


Figure 17. Capacitances vs. Drain-Source Voltage (0-200 V)

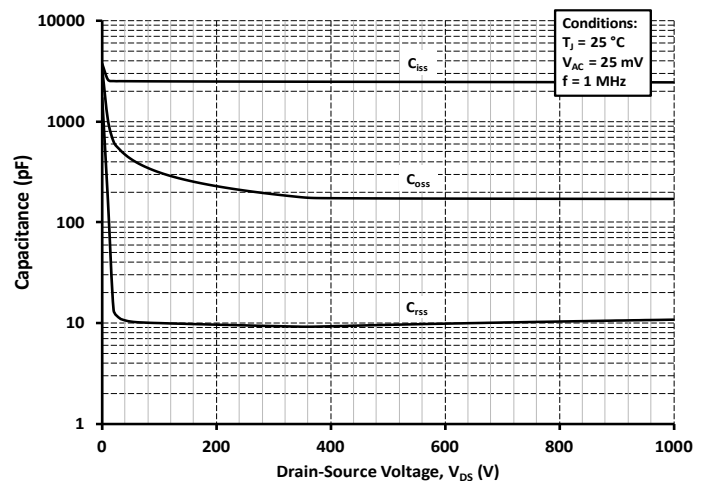


Figure 18. Capacitances vs. Drain-Source Voltage (0-1000 V)

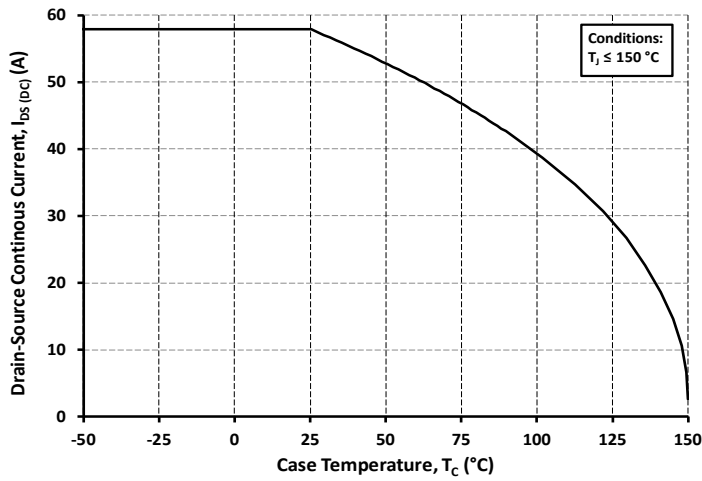


Figure 19. Continuous Drain Current Derating vs. Case Temperature

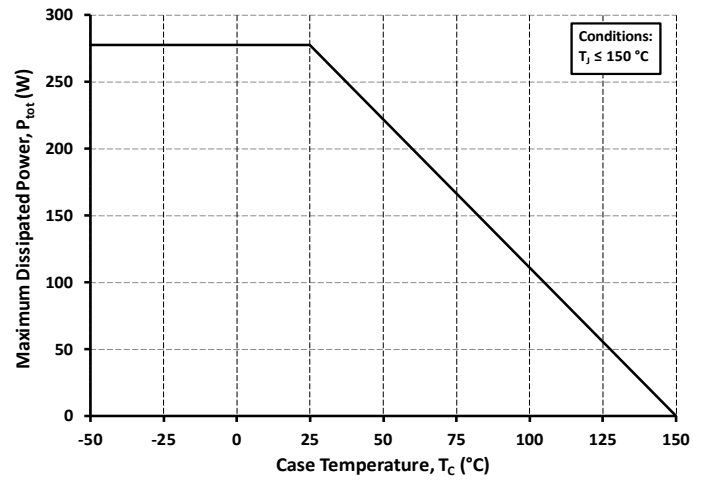


Figure 20. Maximum Power Dissipation Derating vs. Case Temperature

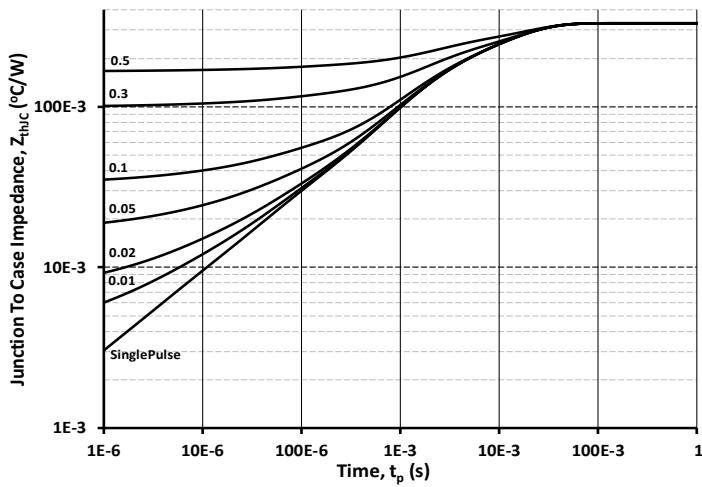


Figure 21. Transient Thermal Impedance (Junction - Case)

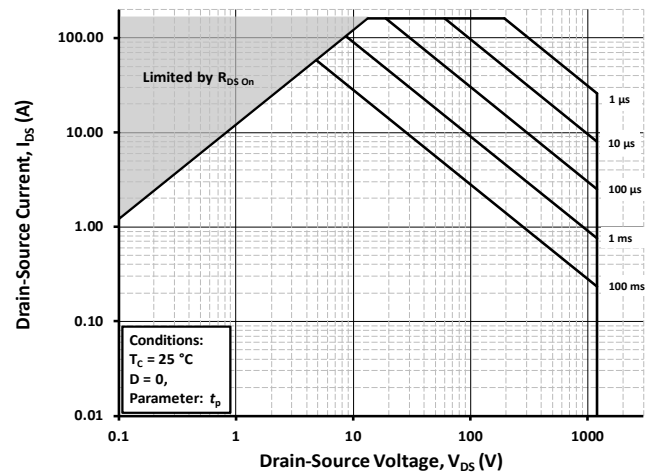


Figure 22. Safe Operating Area

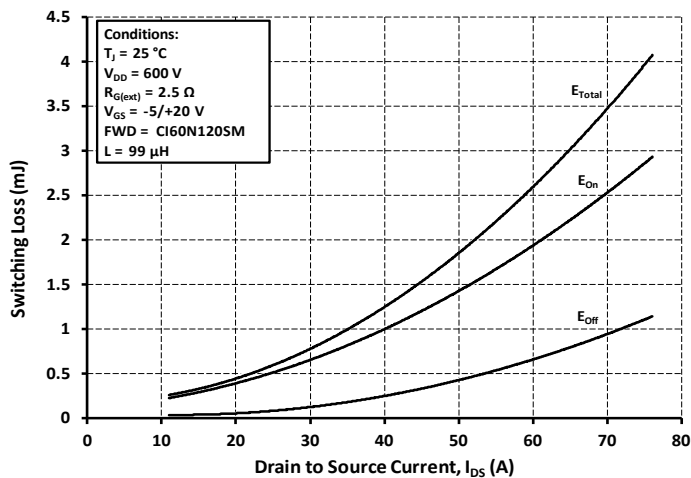


Figure 23. Clamped Inductive Switching Energy vs. Drain Current ( $V_{DD} = 600V$ )

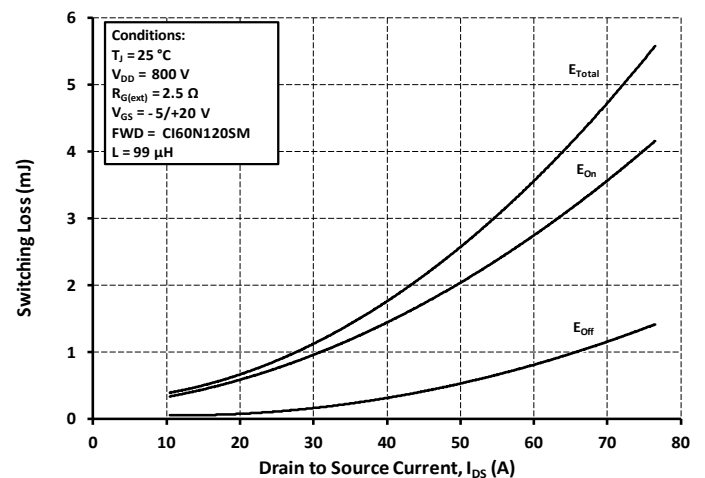


Figure 24. Clamped Inductive Switching Energy vs. Drain Current ( $V_{DD} = 800V$ )

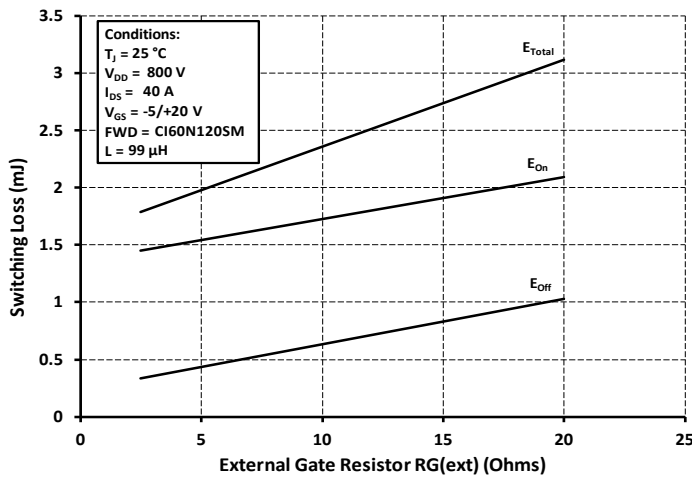


Figure 25. Clamped Inductive Switching Energy vs.  $R_{G(ext)}$

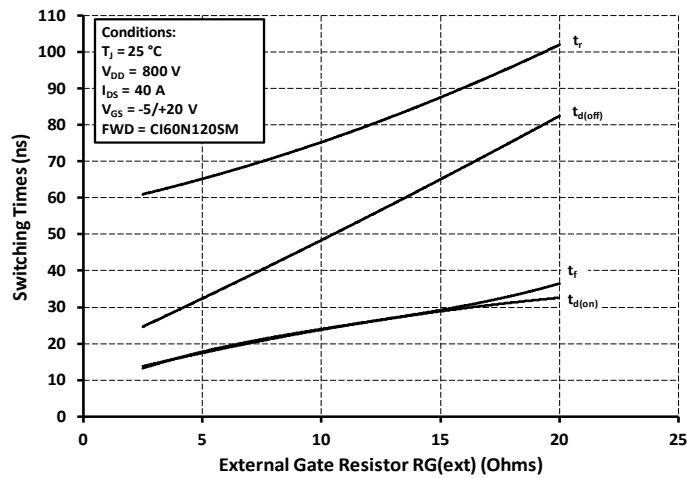


Figure 27. Switching Times vs.  $R_{G(ext)}$

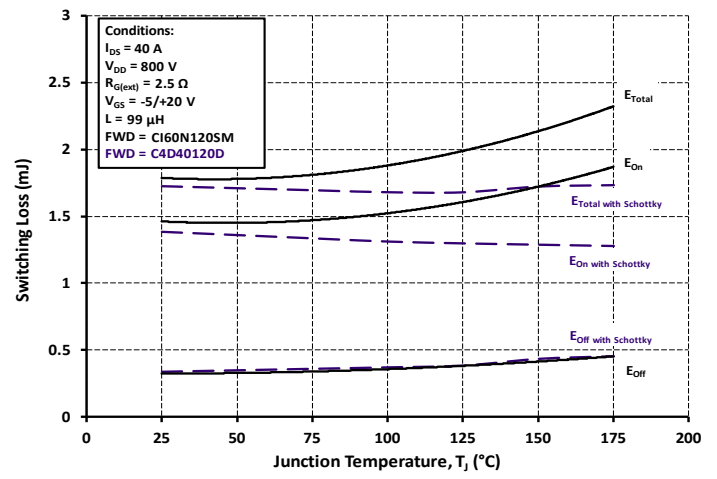
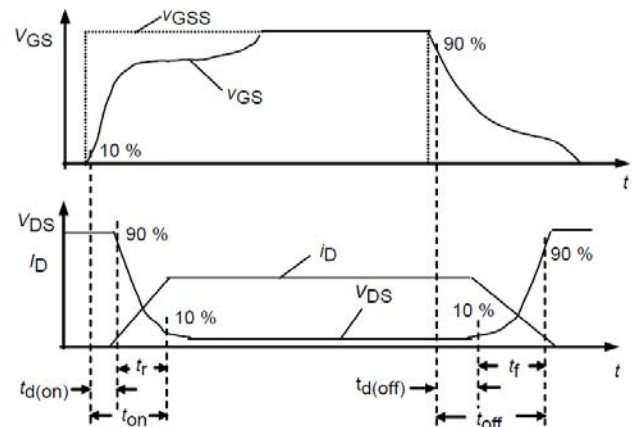


Figure 26. Clamped Inductive Switching Energy vs. Temperature



IEC 1161/04

Figure 28. Switching Times Definition



## Test Circuit Schematic

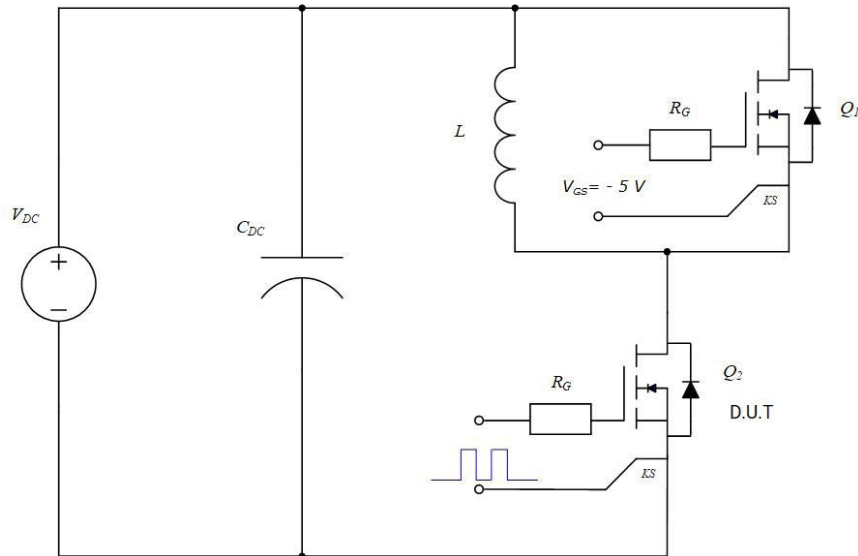


Figure 29. Clamped Inductive Switching  
Waveform Test Circuit

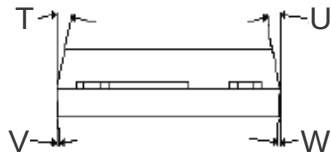
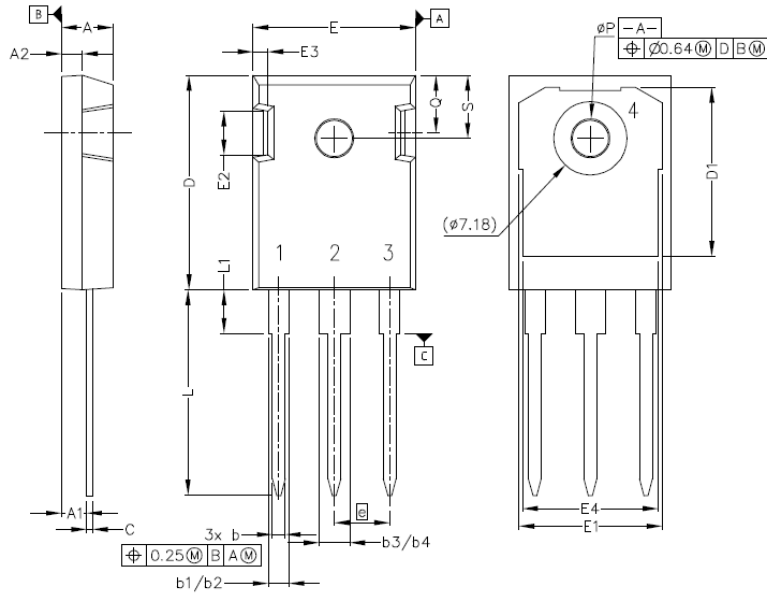
## ESD Ratings

| ESD Test | Resulting Classification |
|----------|--------------------------|
| ESD-HBM  | 3A (4000V - 8000V)       |
| ESD-CDM  | C3 ( $\geq 1000V$ )      |



## Package Dimensions

Package T0-247

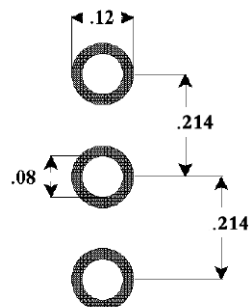


### Pinout Information:

- Pin 1 = Gate
- Pin 2, 4 = Drain
- Pin 3 = Source

| POS | Inches   |      | Millimeters |       |
|-----|----------|------|-------------|-------|
|     | Min      | Max  | Min         | Max   |
| A   | .190     | .205 | 4.83        | 5.21  |
| A1  | .090     | .100 | 2.29        | 2.54  |
| A2  | .075     | .085 | 1.91        | 2.16  |
| b   | .042     | .052 | 1.07        | 1.33  |
| b1  | .075     | .095 | 1.91        | 2.41  |
| b2  | .075     | .085 | 1.91        | 2.16  |
| b3  | .113     | .133 | 2.87        | 3.38  |
| b4  | .113     | .123 | 2.87        | 3.13  |
| c   | .022     | .027 | 0.55        | 0.68  |
| D   | .819     | .831 | 20.80       | 21.10 |
| D1  | .640     | .695 | 16.25       | 17.65 |
| D2  | .037     | .049 | 0.95        | 1.25  |
| E   | .620     | .635 | 15.75       | 16.13 |
| E1  | .516     | .557 | 13.10       | 14.15 |
| E2  | .145     | .201 | 3.68        | 5.10  |
| E3  | .039     | .075 | 1.00        | 1.90  |
| E4  | .487     | .529 | 12.38       | 13.43 |
| e   | .214 BSC |      | 5.44 BSC    |       |
| N   | 3        |      | 3           |       |
| L   | .780     | .800 | 19.81       | 20.32 |
| L1  | .161     | .173 | 4.10        | 4.40  |
| ØP  | .138     | .144 | 3.51        | 3.65  |
| Q   | .216     | .236 | 5.49        | 6.00  |
| S   | .238     | .248 | 6.04        | 6.30  |
| T   | 9°       | 11°  | 9°          | 11°   |
| U   | 9°       | 11°  | 9°          | 11°   |
| V   | 2°       | 8°   | 2°          | 8°    |
| W   | 2°       | 8°   | 2°          | 8°    |

## Recommended Solder Pad Layout



T0247-3L



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