



## Features

- 3rd generation SiC MOSFET technology
- Optimized package with separate driver source pin
- High blocking voltage with low on-resistance
- High-speed switching with low capacitances
- Fast intrinsic diode with low reverse recovery ( $Q_{rr}$ )
- Halogen free, RoHS compliant

## Benefits

- Reduce switching losses and minimize gate ringing
- Higher system efficiency
- Reduce cooling requirements
- Increase power density
- Increase system switching frequency

## Applications

- Renewable energy
- EV battery chargers
- High voltage DC/DC converters
- Switch Mode Power Supplies

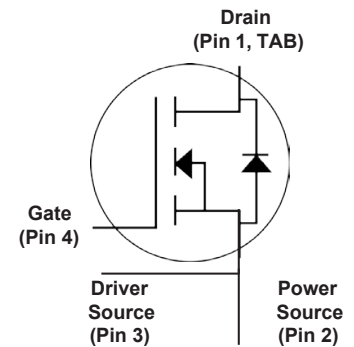


| Ordering Part Number | Package            | Qty(PCS) |
|----------------------|--------------------|----------|
| HNTH4L040N120M3S     | TO247-4L(TO-247-4) | 30       |



D S S G  
**TO247-4L**  
(TO-247-4)

## Package



## 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 (dynamic)            | -8/+19      | V                | AC ( $f > 1\text{ Hz}$ )                               | Note 1  |
| $V_{GSop}$     | Gate - Source Voltage (static)             | -4/+15      | V                | Static                                                 | Note 2  |
| $I_D$          | Continuous Drain Current                   | 63          | A                | $V_{GS} = 15\text{ V}$ , $T_c = 25^\circ\text{C}$      | Fig. 19 |
|                |                                            | 48          |                  | $V_{GS} = 15\text{ V}$ , $T_c = 100^\circ\text{C}$     |         |
| $I_{D(pulse)}$ | Pulsed Drain Current                       | 120         | A                | Pulse width $t_p$ limited by $T_{jmax}$                |         |
| $P_D$          | Power Dissipation                          | 283         | W                | $T_c = 25^\circ\text{C}$ , $T_j = 175^\circ\text{C}$   | Fig. 20 |
| $T_j, T_{stg}$ | Operating Junction and Storage Temperature | -40 to +175 | $^\circ\text{C}$ |                                                        |         |
| $T_L$          | Solder Temperature                         | 260         | $^\circ\text{C}$ | 1.6mm (0.063") from case for 10s                       |         |

Note (1): When using MOSFET Body Diode  $V_{GSmax} = -4\text{V}/+19\text{V}$

Note (2): MOSFET can also safely operate at  $0/+15\text{ V}$



**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                     | 1.8  | 2.5  | 3.6  | V             | $V_{DS} = V_{GS}, I_D = 11.5\text{ mA}$                                                                                                                            | Fig. 11      |
|               |                                            |      | 2.0  |      | V             | $V_{DS} = V_{GS}, I_D = 11.5\text{ mA}, T_J = 175^\circ\text{C}$                                                                                                   |              |
| $I_{DSS}$     | Zero Gate Voltage Drain Current            |      | 1    | 50   | $\mu\text{A}$ | $V_{DS} = 1200\text{ V}, V_{GS} = 0\text{ V}$                                                                                                                      |              |
| $I_{GSS}$     | Gate-Source Leakage Current                |      | 10   | 250  | nA            | $V_{GS} = 15\text{ V}, V_{DS} = 0\text{ V}$                                                                                                                        |              |
| $R_{DS(on)}$  | Drain-Source On-State Resistance           | 23   | 32   | 43   | m $\Omega$    | $V_{GS} = 15\text{ V}, I_D = 40\text{ A}$                                                                                                                          | Fig. 4, 5, 6 |
|               |                                            |      | 57.6 |      |               | $V_{GS} = 15\text{ V}, I_D = 40\text{ A}, T_J = 175^\circ\text{C}$                                                                                                 |              |
| $g_{fs}$      | Transconductance                           |      | 27   |      | S             | $V_{DS} = 20\text{ V}, I_{DS} = 40\text{ A}$                                                                                                                       | Fig. 7       |
|               |                                            |      | 22   |      |               | $V_{DS} = 20\text{ V}, I_{DS} = 40\text{ A}, T_J = 175^\circ\text{C}$                                                                                              |              |
| $C_{iss}$     | Input Capacitance                          |      | 3357 |      | pF            | $V_{GS} = 0\text{ V}, V_{DS} = 1000\text{ V}$<br>$f = 100\text{ kHz}$<br>$V_{AC} = 25\text{ mV}$                                                                   | Fig. 17, 18  |
| $C_{oss}$     | Output Capacitance                         |      | 129  |      |               |                                                                                                                                                                    |              |
| $C_{rss}$     | Reverse Transfer Capacitance               |      | 8    |      |               |                                                                                                                                                                    |              |
| $E_{oss}$     | $C_{oss}$ Stored Energy                    |      | 76   |      |               |                                                                                                                                                                    | Fig. 16      |
| $E_{ON}$      | Turn-On Switching Energy (SiC Diode FWD)   |      | 367  |      | $\mu\text{J}$ | $V_{DS} = 800\text{ V}, V_{GS} = -4\text{ V}/+15\text{ V}, I_D = 40\text{ A},$<br>$R_{G(ext)} = 2.5\Omega, L = 65.7\text{ }\mu\text{H}, T_J = 175^\circ\text{C}$   | Fig. 26      |
| $E_{OFF}$     | Turn Off Switching Energy (SiC Diode FWD)  |      | 123  |      |               |                                                                                                                                                                    |              |
| $E_{ON}$      | Turn-On Switching Energy (Body Diode FWD)  |      | 955  |      | $\mu\text{J}$ | $V_{DS} = 800\text{ V}, V_{GS} = -4\text{ V}/+15\text{ V}, I_D = 40\text{ A},$<br>$R_{G(ext)} = 2.5\Omega, L = 65.7\text{ }\mu\text{H}, T_J = 175^\circ\text{C}$   | Fig. 26      |
| $E_{OFF}$     | Turn Off Switching Energy (Body Diode FWD) |      | 107  |      |               |                                                                                                                                                                    |              |
| $t_{d(on)}$   | Turn-On Delay Time                         |      | 25   |      | ns            | $V_{DD} = 800\text{ V}, V_{GS} = -4\text{ V}/15\text{ V}$<br>$R_{G(ext)} = 2.5\Omega, I_D = 40\text{ A}, L = 65.7$<br>Timing relative to $V_{DS}$ , Inductive load | Fig. 27      |
| $t_r$         | Rise Time                                  |      | 18   |      |               |                                                                                                                                                                    |              |
| $t_{d(off)}$  | Turn-Off Delay Time                        |      | 32   |      |               |                                                                                                                                                                    |              |
| $t_f$         | Fall Time                                  |      | 9    |      |               |                                                                                                                                                                    |              |
| $R_{G(int)}$  | Internal Gate Resistance                   |      | 1.7  |      | $\Omega$      | $f = 1\text{ MHz}, V_{AC} = 25\text{ mV}$                                                                                                                          |              |
| $Q_{gs}$      | Gate to Source Charge                      |      | 40   |      | nC            | $V_{DS} = 800\text{ V}, V_{GS} = -4\text{ V}/15\text{ V}$<br>$I_D = 40\text{ A}$<br>Per IEC60747-8-4 pg 21                                                         | Fig. 12      |
| $Q_{gd}$      | Gate to Drain Charge                       |      | 34   |      |               |                                                                                                                                                                    |              |
| $Q_g$         | Total Gate Charge                          |      | 118  |      |               |                                                                                                                                                                    |              |

**Reverse Diode Characteristics** ( $T_c = 25^\circ\text{C}$  unless otherwise specified)

| Symbol        | Parameter                        | Typ. | Max. | Unit | Test Conditions                                                                                                                                 | Note          |
|---------------|----------------------------------|------|------|------|-------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| $V_{SD}$      | Diode Forward Voltage            | 4.6  |      | V    | $V_{GS} = -4\text{ V}, I_{SD} = 20\text{ A}, T_J = 25^\circ\text{C}$                                                                            | Fig. 8, 9, 10 |
|               |                                  | 4.2  |      | V    | $V_{GS} = -4\text{ V}, I_{SD} = 20\text{ A}, T_J = 175^\circ\text{C}$                                                                           |               |
| $I_S$         | Continuous Diode Forward Current |      | 62   | A    | $V_{GS} = -4\text{ V}, T_c = 25^\circ\text{C}$                                                                                                  | Note 1        |
| $I_{S,pulse}$ | Diode pulse Current              |      | 120  | A    | $V_{GS} = -4\text{ V}, \text{pulse width } t_p \text{ limited by } T_{Jmax}$                                                                    | Note 1        |
| $t_{rr}$      | Reverse Recover time             | 27   |      | ns   | $V_{GS} = -4\text{ V}, I_{SD} = 40\text{ A}, V_R = 800\text{ V}$<br>$\text{dif}/\text{dt} = 2250\text{ A}/\mu\text{s}, T_J = 175^\circ\text{C}$ | Note 1        |
| $Q_{rr}$      | Reverse Recovery Charge          | 478  |      | nC   |                                                                                                                                                 |               |
| $I_{rrm}$     | Peak Reverse Recovery Current    | 27   |      | A    |                                                                                                                                                 |               |

**Thermal Characteristics**

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



## Typical Performance

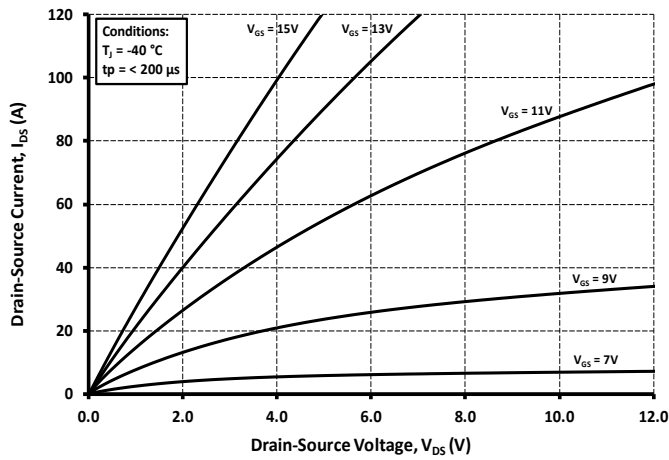


Figure 1. Output Characteristics  $T_J = -40^\circ\text{C}$

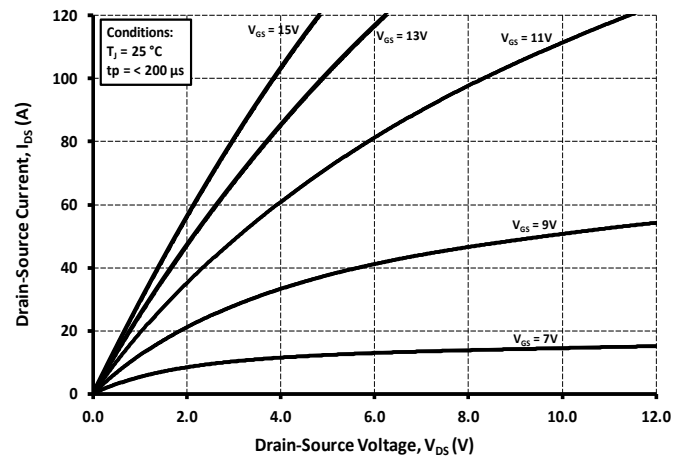


Figure 2. Output Characteristics  $T_J = 25^\circ\text{C}$

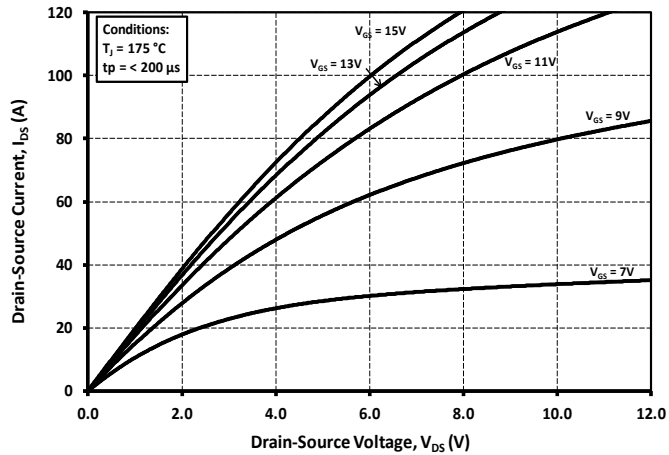


Figure 3. Output Characteristics  $T_J = 175^\circ\text{C}$

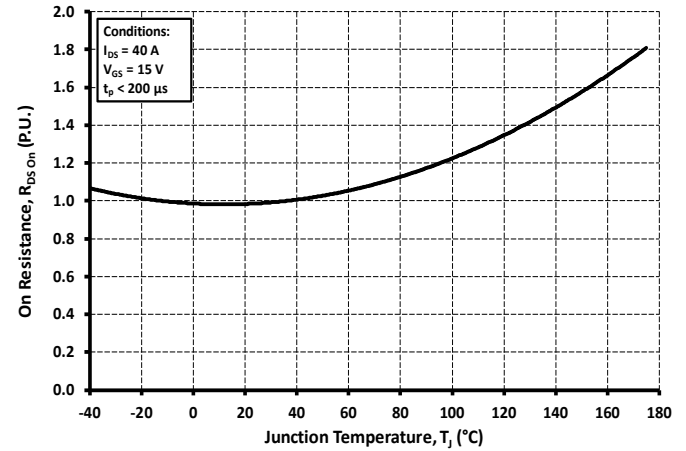


Figure 4. Normalized On-Resistance vs. Temperature

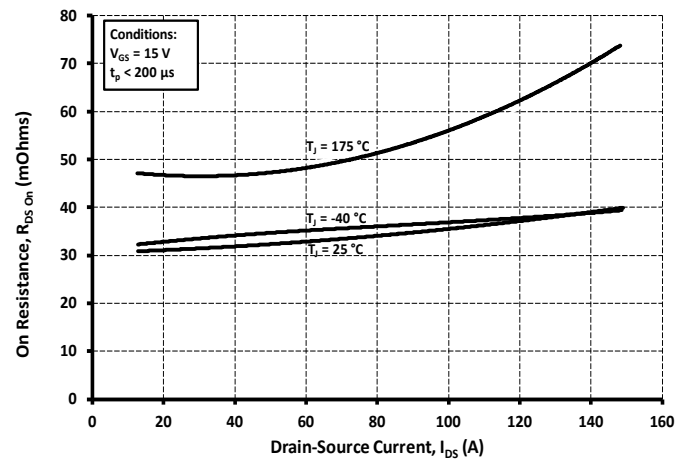


Figure 5. On-Resistance vs. Drain Current For Various Temperatures

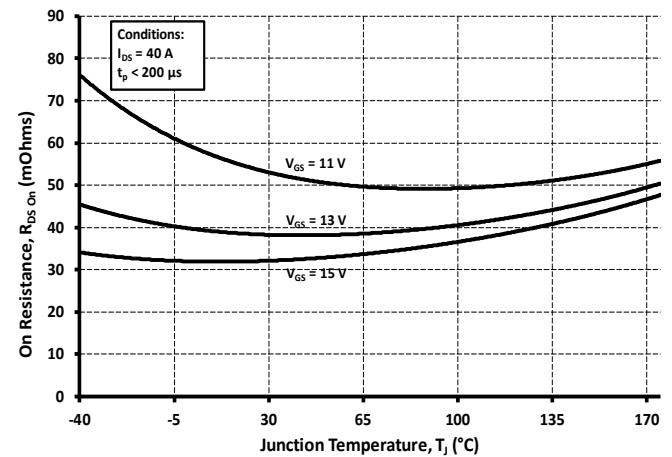


Figure 6. On-Resistance vs. Temperature For Various Gate Voltage



## Typical Performance

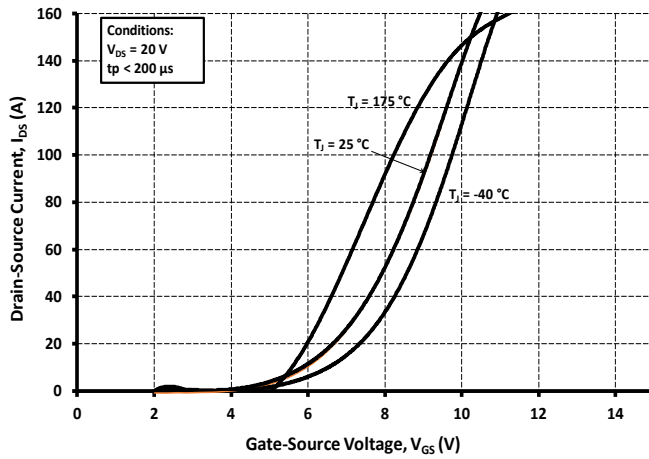


Figure 7. Transfer Characteristic for Various Junction Temperatures

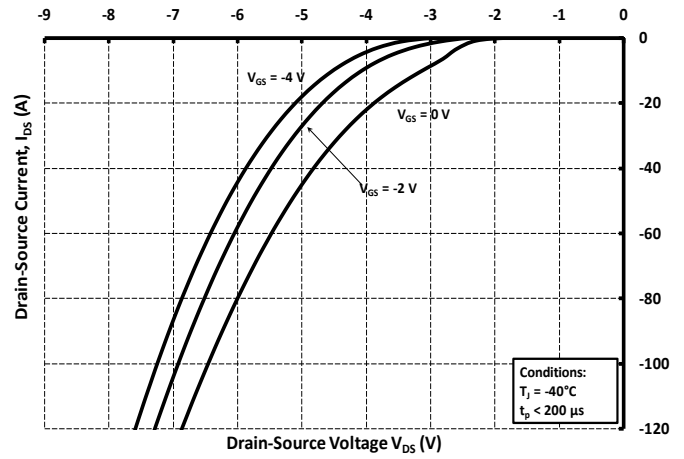


Figure 8. Body Diode Characteristic at  $-40\text{ }^\circ\text{C}$

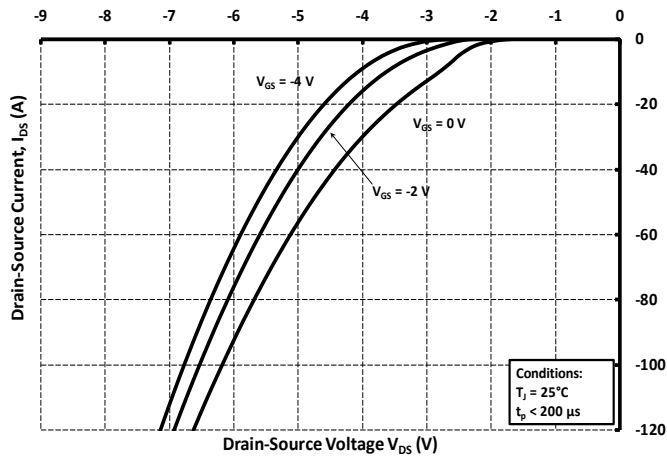


Figure 9. Body Diode Characteristic at  $25\text{ }^\circ\text{C}$

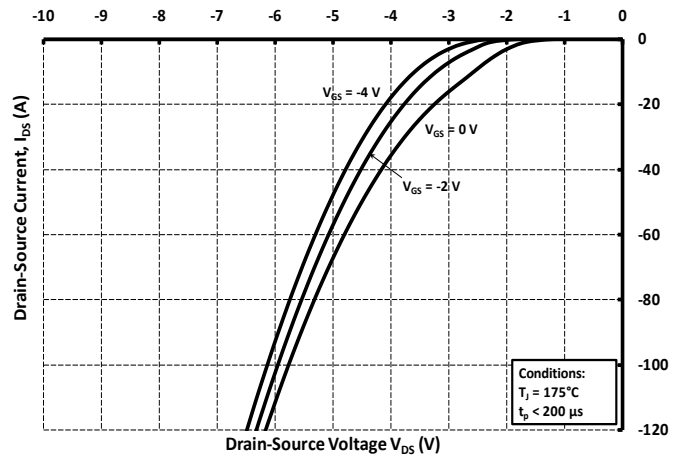


Figure 10. Body Diode Characteristic at  $175\text{ }^\circ\text{C}$

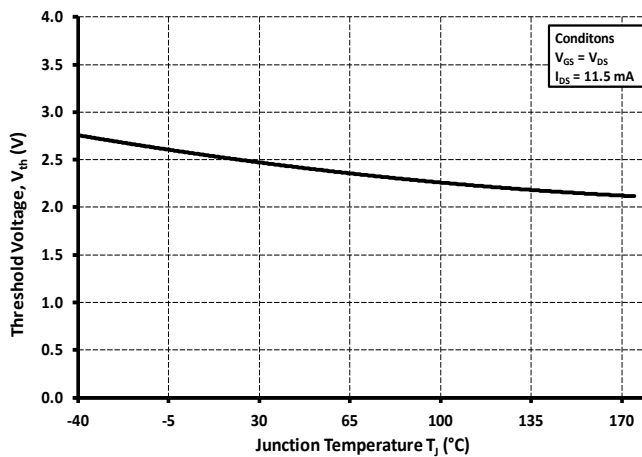


Figure 11. Threshold Voltage vs. Temperature

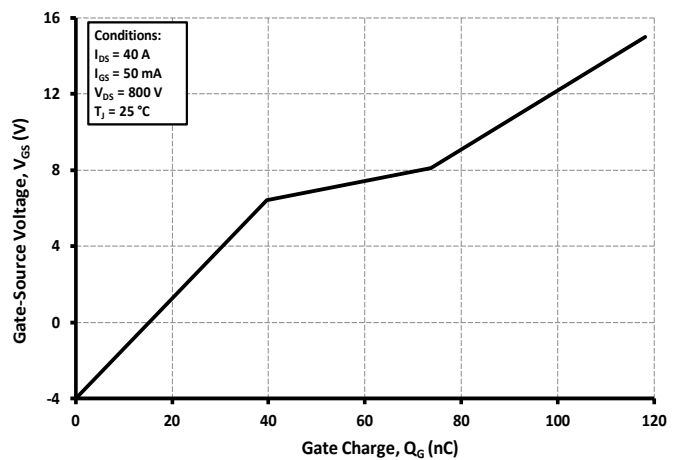


Figure 12. Gate Charge Characteristics



## Typical Performance

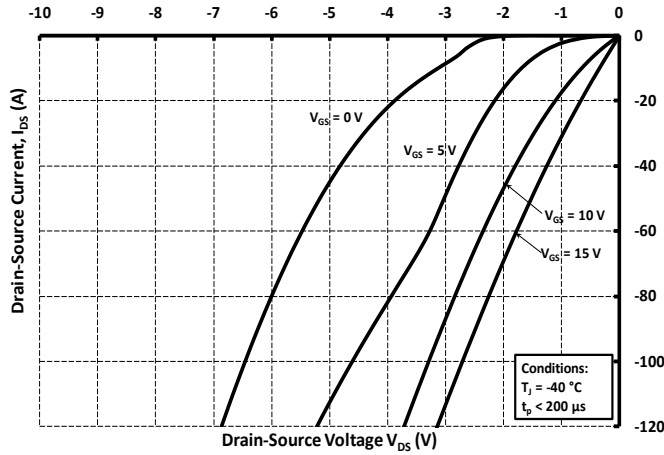


Figure 13. 3rd Quadrant Characteristic at  $-40\text{ }^{\circ}\text{C}$

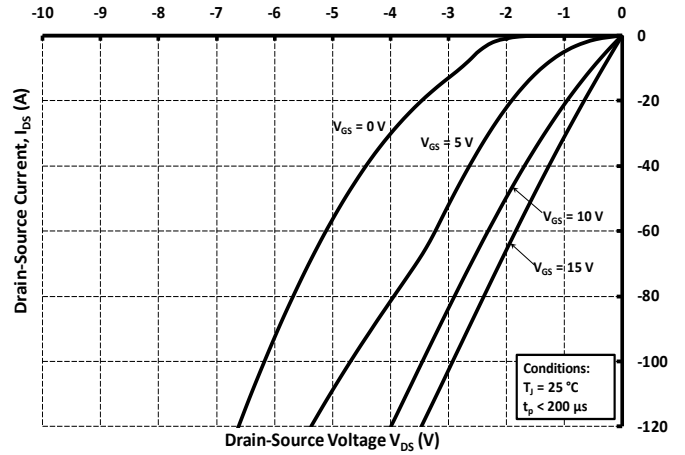


Figure 14. 3rd Quadrant Characteristic at  $25\text{ }^{\circ}\text{C}$

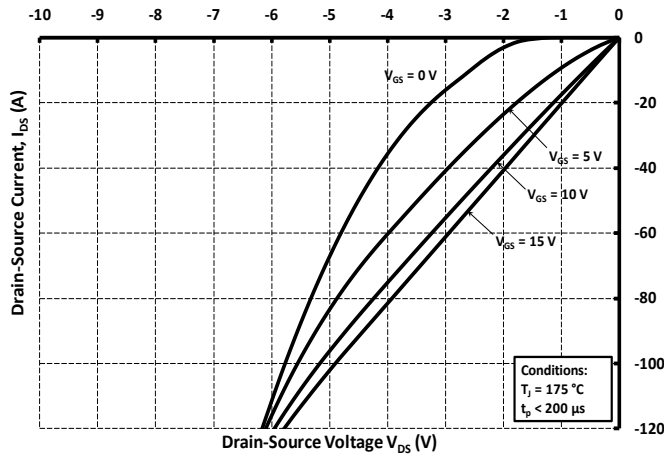


Figure 15. 3rd Quadrant Characteristic at  $175\text{ }^{\circ}\text{C}$

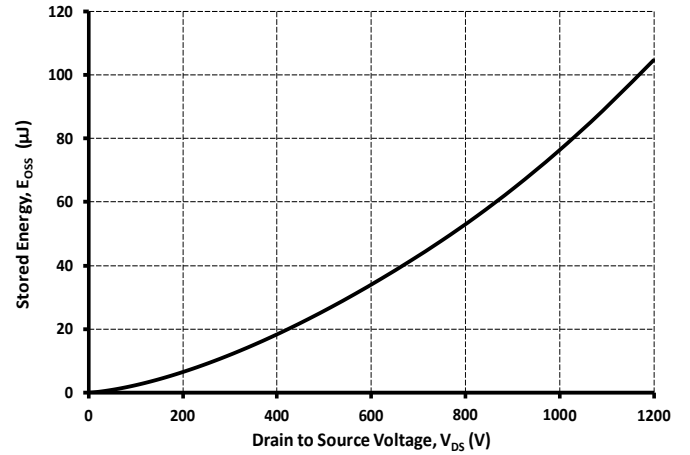


Figure 16. Output Capacitor Stored Energy

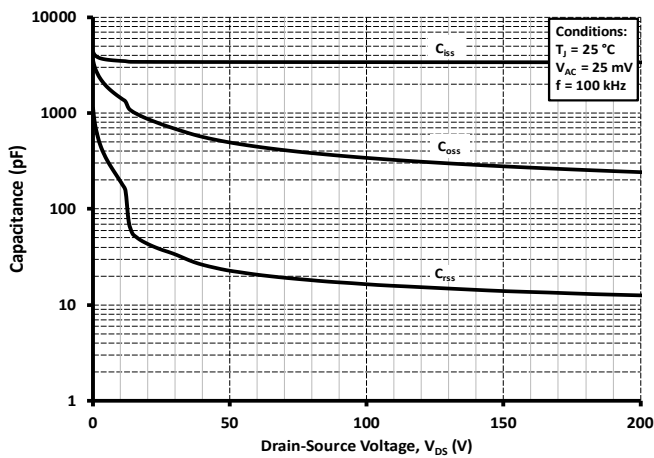


Figure 17. Capacitances vs. Drain-Source Voltage (0 - 200V)

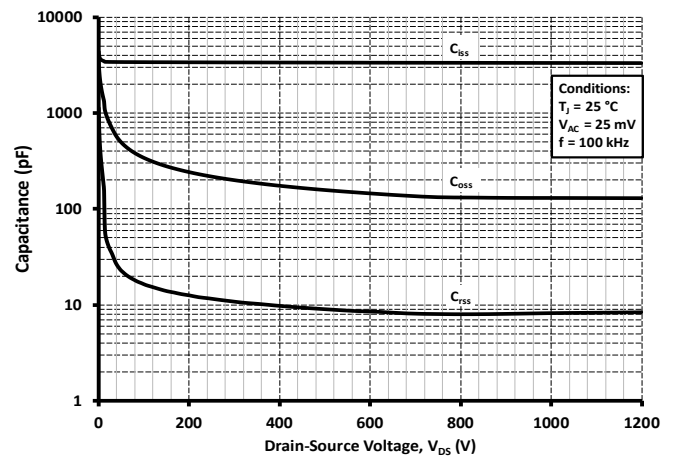


Figure 18. Capacitances vs. Drain-Source Voltage (0 - 1200V)



## Typical Performance

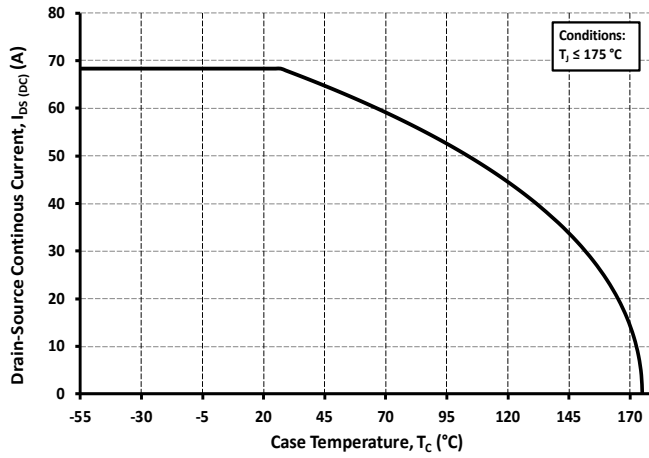


Figure 19. Continuous Drain Current Derating vs. Case Temperature

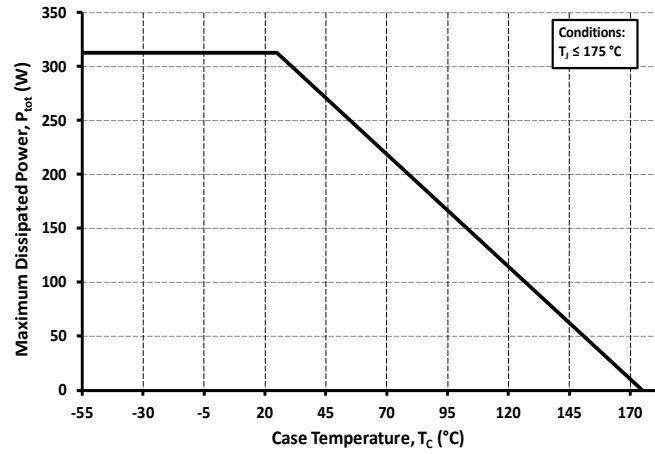


Figure 20. Maximum Power Dissipation Derating vs. Case Temperature

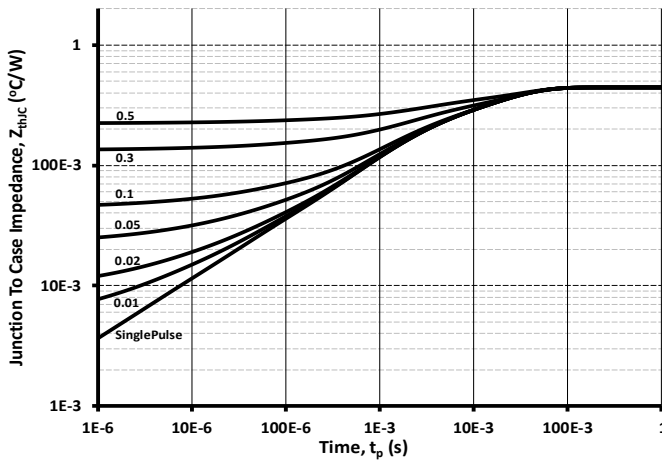


Figure 21. Transient Thermal Impedance (Junction - Case)

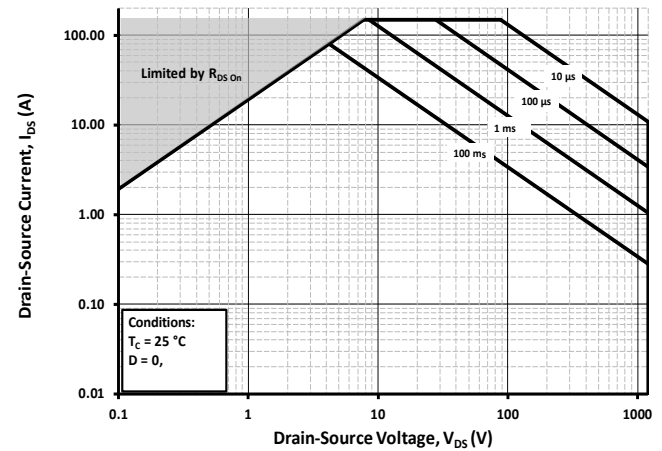


Figure 22. Safe Operating Area

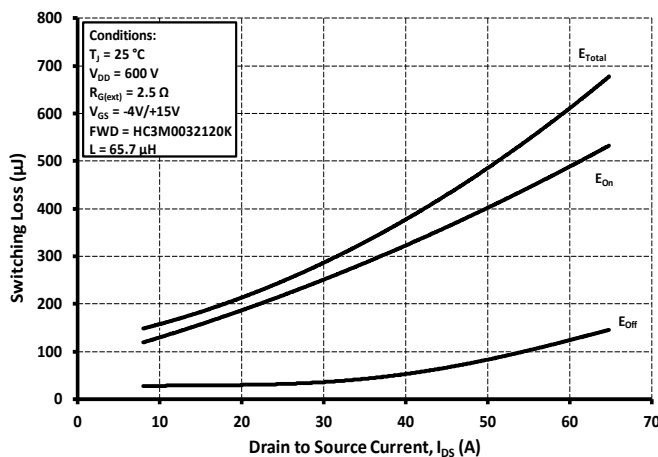


Figure 23. Clamped Inductive Switching Energy vs. Drain Current ( $V_{DD} = 600V$ )

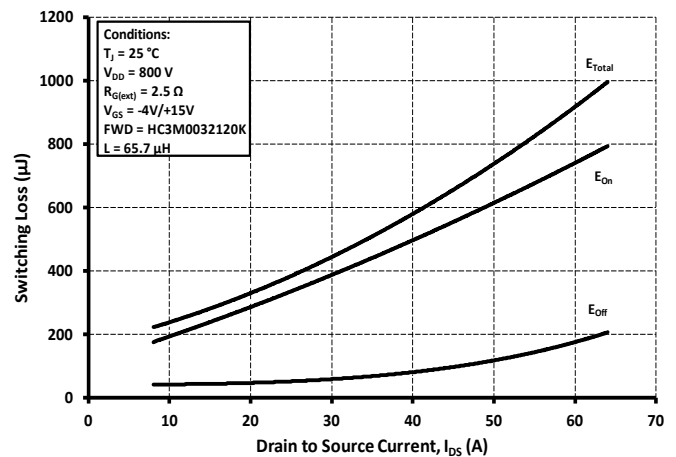


Figure 24. Clamped Inductive Switching Energy vs. Drain Current ( $V_{DD} = 800V$ )



## Typical Performance

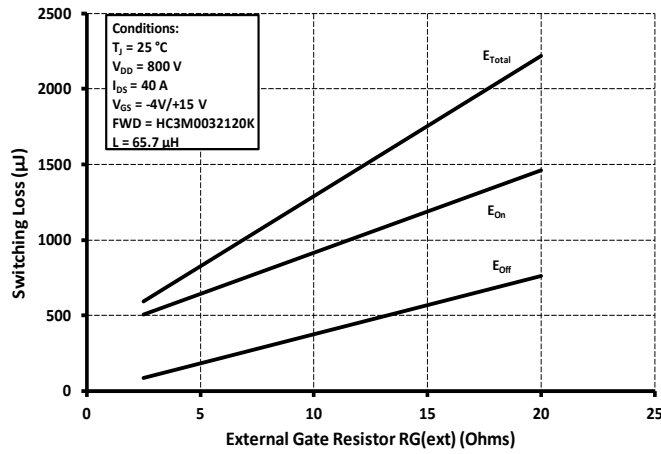


Figure 25. Clamped Inductive Switching Energy vs.  $R_{G(\text{ext})}$

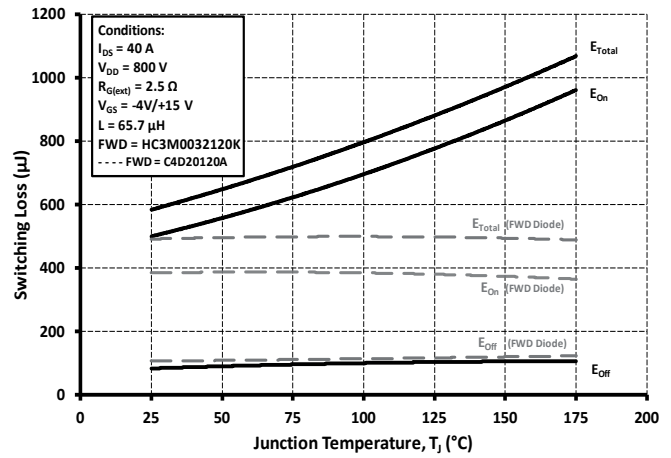


Figure 26. Clamped Inductive Switching Energy vs. Temperature

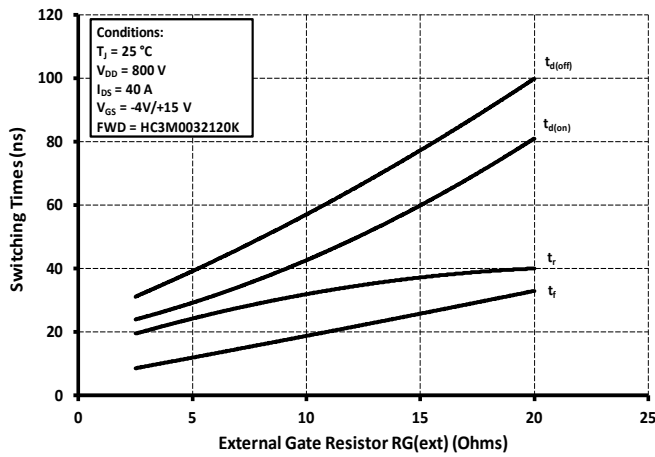


Figure 27. Switching Times vs.  $R_{G(\text{ext})}$

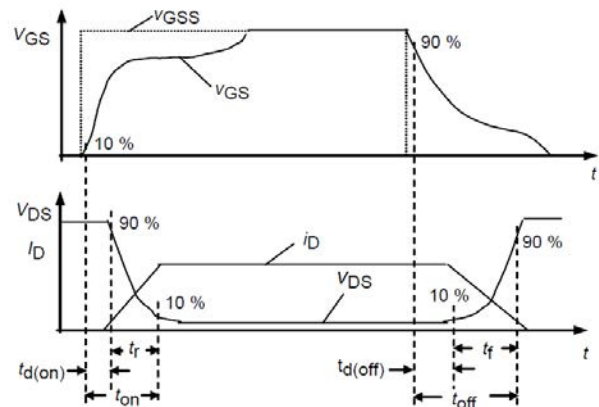


Figure 28. Switching Times Definition



## Test Circuit Schematic

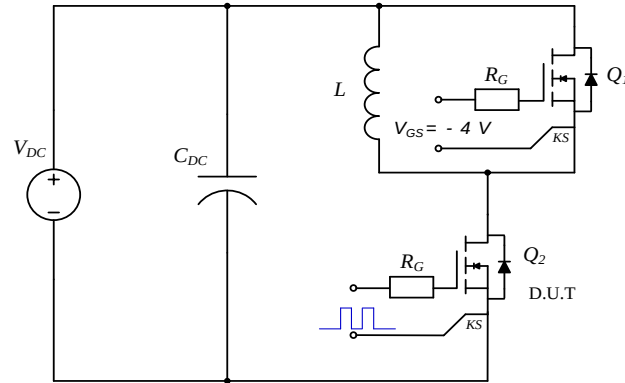


Figure 29. Clamped Inductive Switching  
Waveform Test Circuit

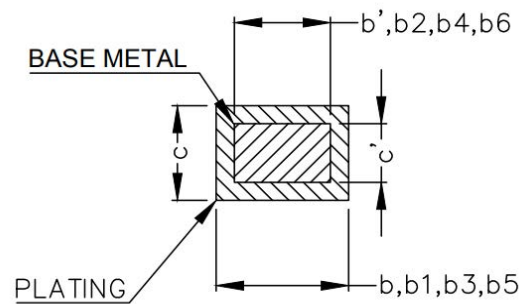
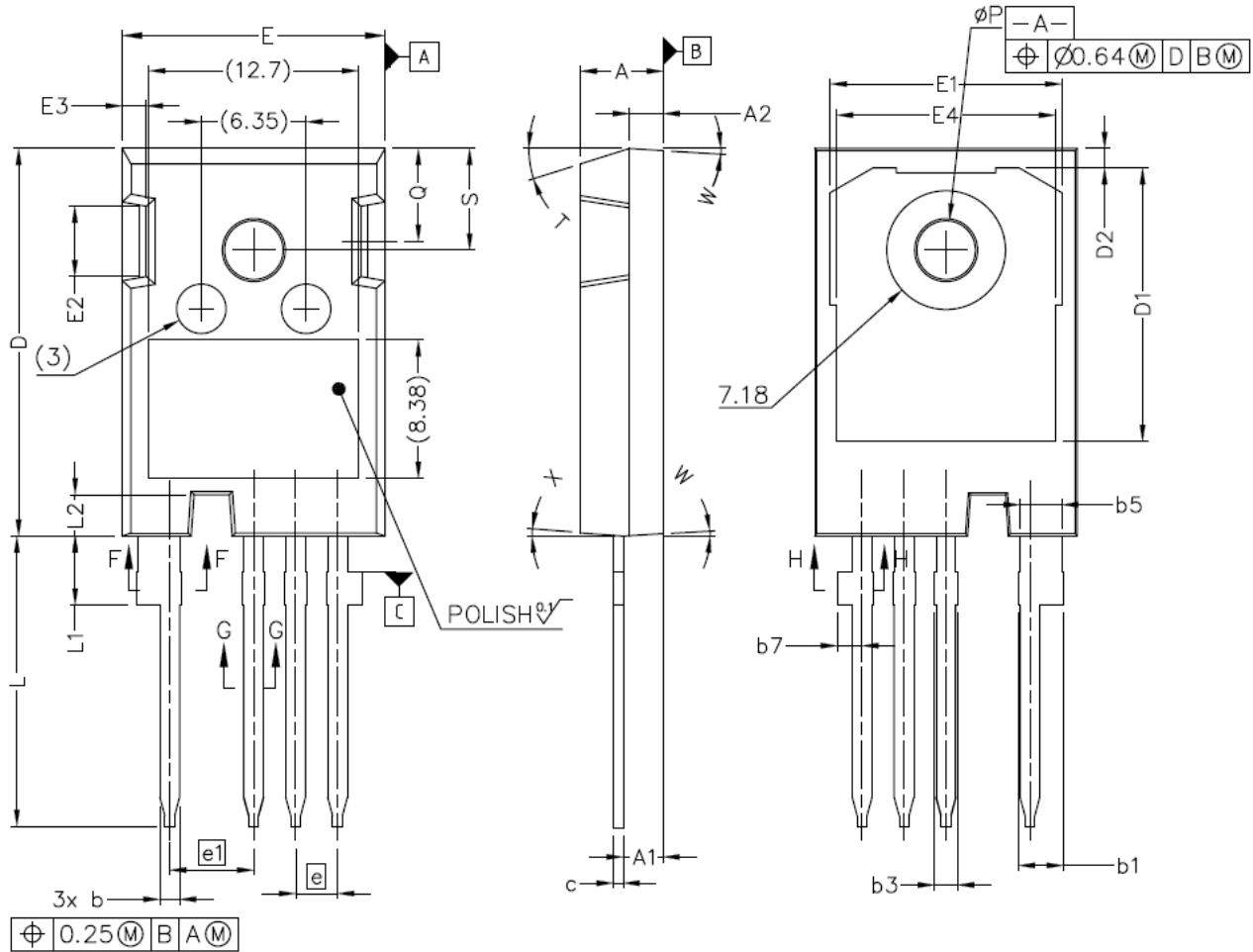
Note (3): Turn-off and Turn-on switching energy and timing values measured using SiC MOSFET Body Diode as shown above.





## Package Dimensions

Package T0247-4L(T0-247-4)



SECTION "F-F", "G-G" AND "H-H"  
SCALE: NONE



## Package Dimensions

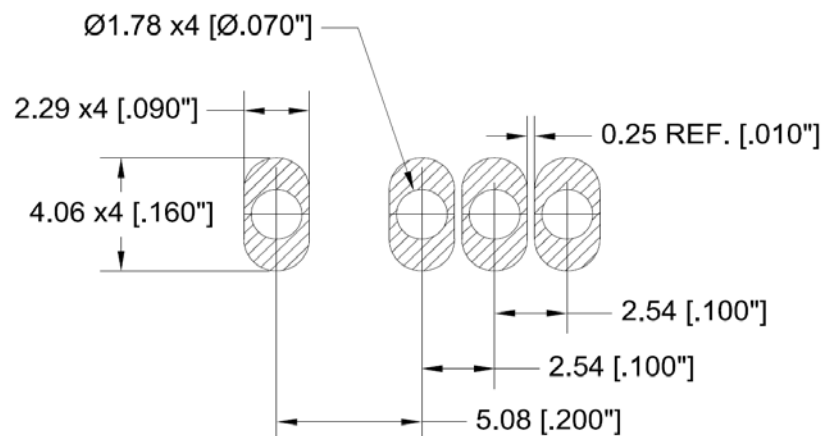
Package T0247-4L(T0-247-4)

NOTE ;

1. ALL METAL SURFACES: TIN PLATED, EXCEPT AREA OF CUT
2. DIMENSIONING & TOLERANCEING CONFIRM TO ASME Y14.5M-1994.
3. ALL DIMENSIONS ARE IN MILLIMETERS.  
ANGLES ARE IN DEGREES.
4. 'N' IS THE NUMBER OF TERMINAL POSITIONS

| SYM | MILLIMETERS |       |
|-----|-------------|-------|
|     | MIN         | MAX   |
| A   | 4.83        | 5.21  |
| A1  | 2.29        | 2.54  |
| A2  | 1.91        | 2.16  |
| b`  | 1.07        | 1.28  |
| b   | 1.07        | 1.33  |
| b1  | 2.39        | 2.94  |
| b2  | 2.39        | 2.84  |
| b3  | 1.07        | 1.60  |
| b4  | 1.07        | 1.50  |
| b5  | 2.39        | 2.69  |
| b6  | 2.39        | 2.64  |
| b7  | 1.30        | 1.70  |
| c`  | 0.55        | 0.65  |
| c   | 0.55        | 0.68  |
| D   | 23.30       | 23.60 |
| D1  | 16.25       | 17.65 |
| D2  | 0.95        | 1.25  |
| E   | 15.75       | 16.13 |

| SYM | MILLIMETERS |       |
|-----|-------------|-------|
|     | MIN         | MAX   |
| E1  | 13.10       | 14.15 |
| E2  | 3.68        | 5.10  |
| E3  | 1.00        | 1.90  |
| E4  | 12.38       | 13.43 |
| e   | 2.54 BSC    |       |
| e1  | 5.08 BSC    |       |
| N*  | 4           |       |
| L   | 17.31       | 17.82 |
| L1  | 3.97        | 4.37  |
| L2  | 2.35        | 2.65  |
| Ø P | 3.51        | 3.65  |
| Q   | 5.49        | 6.00  |
| S   | 6.04        | 6.30  |
| T   | 17.5° REF.  |       |
| W   | 3.5° REF.   |       |
| X   | 4° REF.     |       |





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