# SIC MOSFET

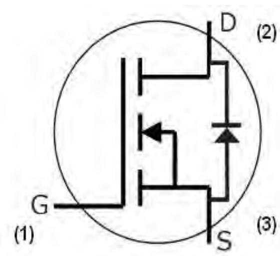
CI60N120SM

## Features

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

## Package

TO-247-3




## 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

## Maximum Ratings ($T_C$ = 25 ˚C unless otherwise specified)

| Symbol | Parameter | Value | Unit | Test Conditions | Note |
|---|---|---|---|---|---|
| $V_{DSmax}$ | Drain - Source Voltage | 1200 | V | $V_{GS}$ = 0 V, $I_D$ = 100 μA | |
| $V_{GSmax}$ | 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 | 60 | A | $V_{GS}$ = 20 V, $T_C$ = 25˚C | Fig. 19 |
| | | 40 | | $V_{GS}$ = 20 V, $T_C$ = 100˚C | |
| $I_{D(pulse)}$ | Pulsed Drain Current | 160 | A | Pulse width $t_P$ limited by $T_{jmax}$ | Fig. 22 |
| $P_D$ | Power Dissipation | 330 | W | $T_C$=25˚C, $T_J$ = 150 ˚C | Fig. 20 |
| $T_J$ , $T_{stg}$ | Operating Junction and Storage Temperature | -55 to +150 | ˚C | | |
| $T_L$ | Solder Temperature | 260 | ˚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˚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 V, $I_D$ = 100 μA | |
| $V_{GS(th)}$ | Gate Threshold Voltage | 2.0 | 2.4 | 4 | V | $V_{DS}$ = $V_{GS}$ , $I_D$ = 10mA | Fig. 11 |
| | | | 2.1 | | V | $V_{DS}$ = $V_{GS}$, $I_D$ = 10mA,$T_J$ = 150 °C | |
| $I_{DSS}$ | Zero Gate Voltage Drain Current | | 1 | 100 | μA | $V_{DS}$ = 1200 V, $V_{GS}$ = 0 V | |
| $I_{GSS}$ | Gate-Source Leakage Current | | | 250 | nA | $V_{GS}$ = 20 V, $V_{DS}$ = 0 V | |
| $R_{DS(on)}$ | Drain-Source On-State Resistance | | 40 | 52 | mΩ | $V_{GS}$ = 20 V, $I_D$ = 40 A | Fig. 4,5,6 |
| | | | 84 | | | $V_{GS}$ = 20 V, $I_D$ = 40 A, $T_J$ = 150 °C | |
| $g_{fs}$ | Transconductance | | 11.4 | | S | $V_{DS}$= 20 V, $I_{DS}$= 40 A | Fig. 7 |
| | | | 10.1 | | | $V_{DS}$= 20 V, $I_{DS}$= 40 A, $T_J$ = 150 °C | |
| $C_{iss}$ | Input Capacitance | | 3500 | | pF | $V_{GS}$ = 0 V<br>$V_{DS}$ = 1000 V<br>f = 1 MHz<br>$V_{AC}$ = 25 mV | Fig. 17,18 |
| $C_{oss}$ | Output Capacitance | | 180 | | | | |
| $C_{rss}$ | Reverse Transfer Capacitance | | 37 | | | | |
| $E_{oss}$ | $C_{oss}$ Stored Energy | | 105 | | μJ | | Fig 16 |
| $E_{AS}$ | Avalanche Energy, Single Pluse | | 1.7 | | J | $I_D$ = 40A, $V_{DD}$ = 50V | Fig. 29 |
| $E_{ON}$ | Turn-On Switching Energy | | 1.5 | | mJ | $V_{DS}$ = 800 V, $V_{GS}$ = -5/20 V<br>$I_D$ = 40A, $R_{G(ext)}$ = 2.5Ω, L= 80 μH | Fig. 25 |
| $E_{OFF}$ | Turn Off Switching Energy | | 0.7 | | | | |
| $t_{d(on)}$ | Turn-On Delay Time | | 60 | | ns | $V_{DD}$ = 800 V, $V_{GS}$ = -5/20 V<br>$I_D$ = 40 A<br>$R_{G(ext)}$ = 2.5 Ω, $R_L$ = 20 Ω<br>Timing relative to $V_{DS}$<br>Per IEC60747-8-4 pg 83 | Fig. 27 |
| $t_r$ | Rise Time | | 140 | | | | |
| $t_{d(off)}$ | Turn-Off Delay Time | | 50 | | | | |
| $t_f$ | Fall Time | | 42 | | | | |
| $R_{G(int)}$ | Internal Gate Resistance | | 0.8 | | Ω | f = 1 MHz, $V_{AC}$ = 25 mV | |
| $Q_{gs}$ | Gate to Source Charge | | 40 | | nC | $V_{DS}$ = 800 V, $V_{GS}$ = -5/20 V<br>$I_D$ = 40 A<br>Per IEC60747-8-4 pg 21 | Fig. 12 |
| $Q_{gd}$ | Gate to Drain Charge | | 55 | | | | |
| $Q_g$ | Total Gate Charge | | 205 | | | | |

## Reverse Diode Characteristics

| Symbol | Parameter | Typ. | Max. | Unit | Test Conditions | Note |
|---|---|---|---|---|---|---|
| $V_{SD}$ | Diode Forward Voltage | 3.6 | | V | $V_{GS}$ = - 5 V, $I_{SD}$ = 20 A, $T_J$ = 25 °C | Fig. 8, 9, 10 |
| | | 3.3 | | V | $V_{GS}$ = - 5 V, $I_{SD}$ = 20 A, $T_J$ = 150 °C | |
| $I_S$ | Continuous Diode Forward Current | | 60 | A | $T_C$= 25 °C | Note 1 |
| $t_{rr}$ | Reverse Recovery Time | 54 | | ns | $V_{GS}$ = - 5 V, $I_{SD}$ = 40 A $T_J$ = 25 °C<br>VR = 800 V<br>dif/dt = 1000 A/μs | 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 $V_{GS}$ = -5V

## Thermal Characteristics

| Symbol | Parameter | Typ. | Max. | Unit | Test Conditions | Note |
|---|---|---|---|---|---|---|
| $R_{θJC}$ | Thermal Resistance from Junction to Case | 0.34 | 0.38 | °C/W | | Fig. 21 |
| $R_{θJC}$ | Thermal Resistance from Junction to Ambient | | 40 | | | |

## Typical Performance

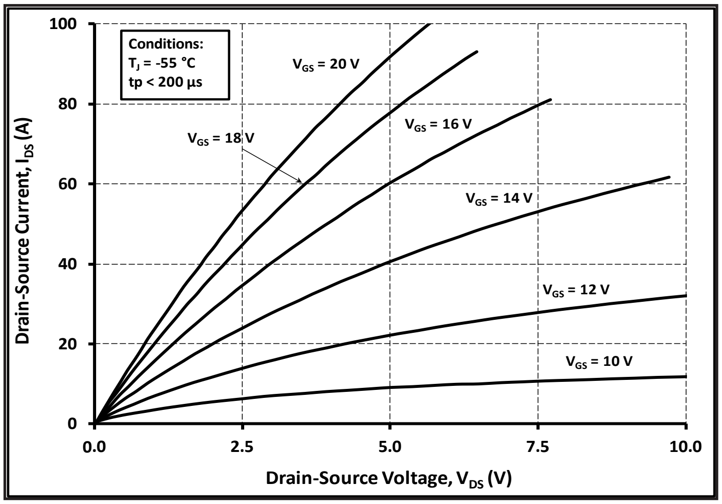



Figure 1. Output Characteristics $T_J$ = -55 °C

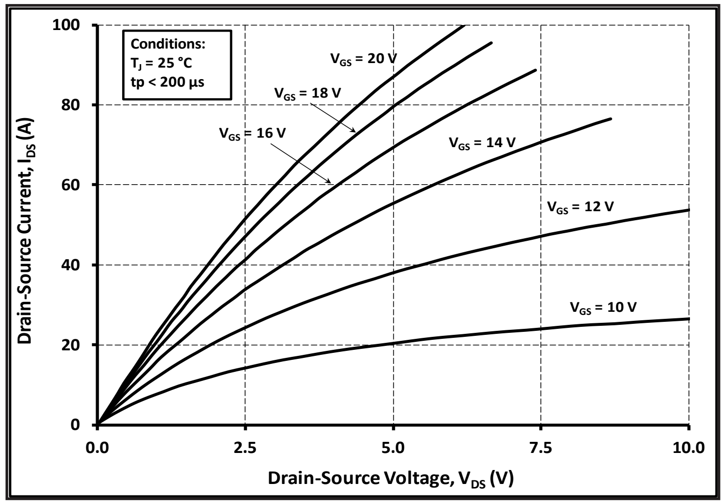



Figure 2. Output Characteristics $T_J$ = 25 °C

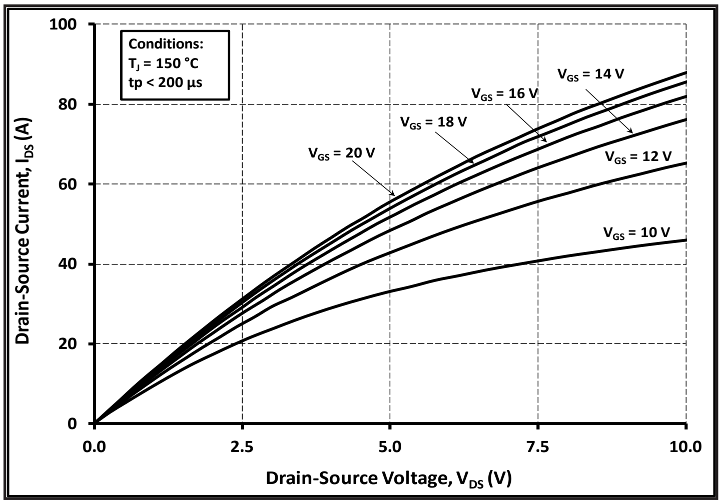



Figure 3. Output Characteristics $T_J$ = 150 °C

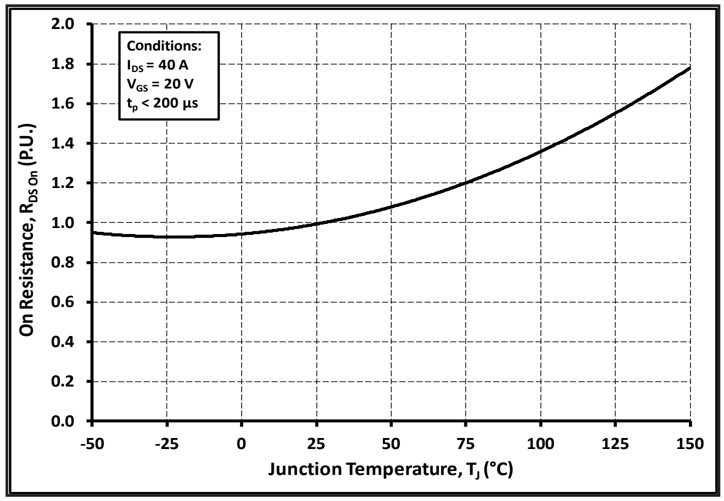



Figure 4. Normalized On-Resistance vs. Temperature

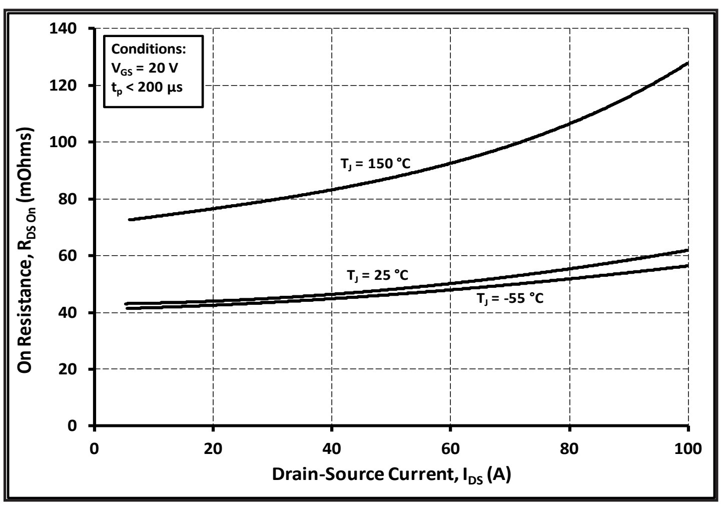



Figure 5. On-Resistance vs. Drain Current
For Various Temperatures

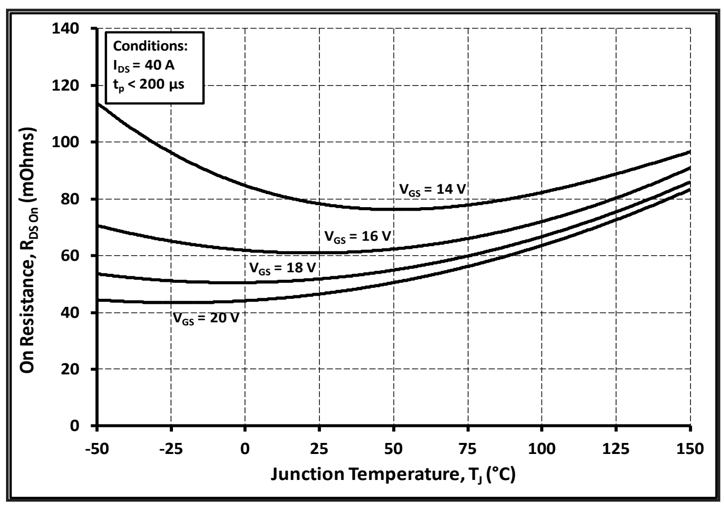



Figure 6. On-Resistance vs. Temperature
For Various Gate Voltage

## Typical Performance

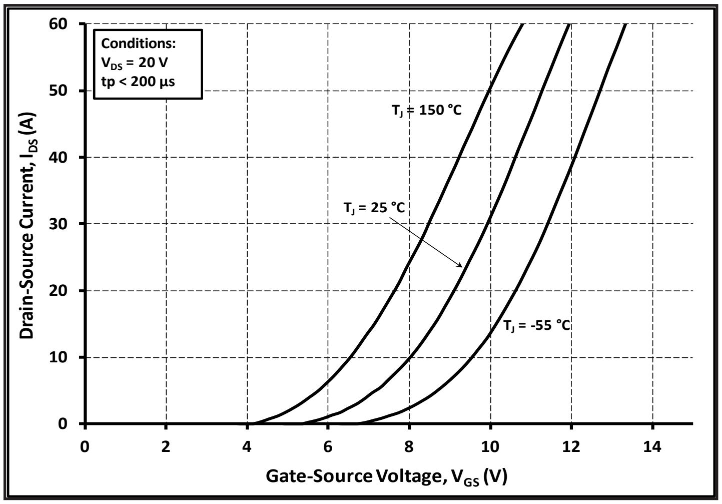



Figure 7. Transfer Characteristic for Various Junction Temperatures

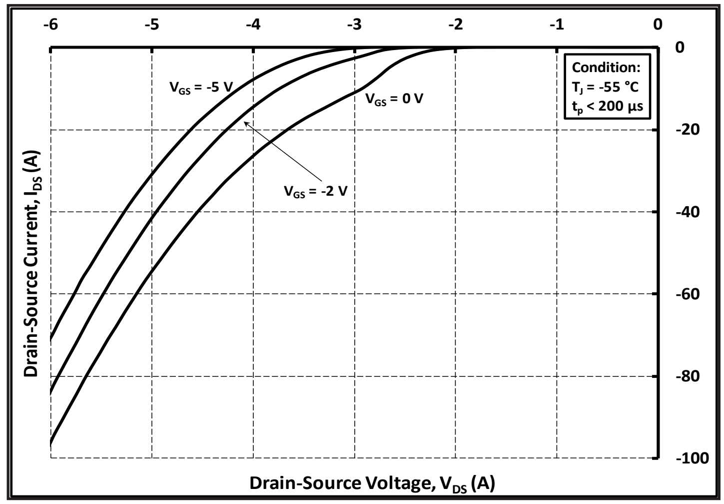



Figure 8. Body Diode Characteristic at -55 °C

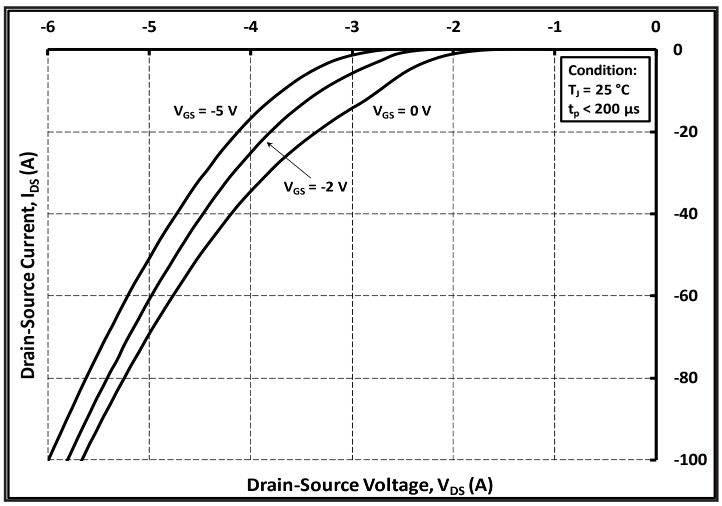



Figure 9. Body Diode Characteristic at 25 °C

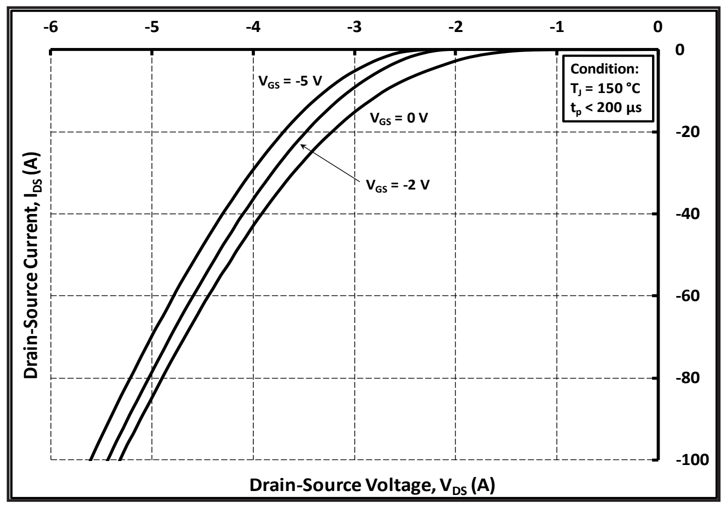



Figure 10. Body Diode Characteristic at 150 °C

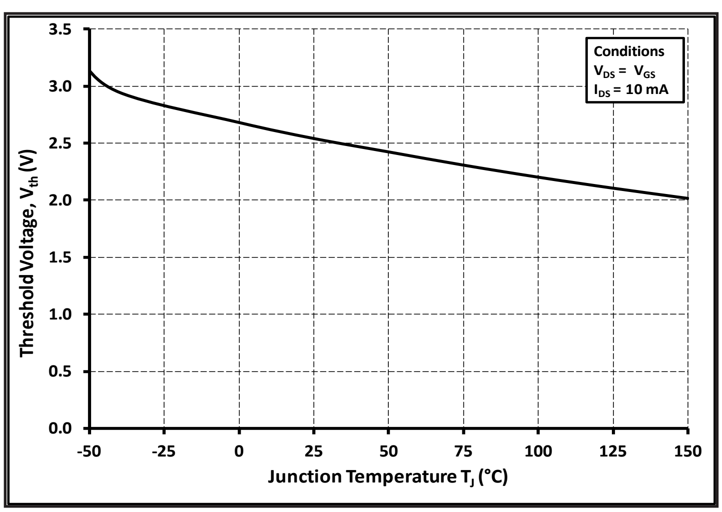



Figure 11. Threshold Voltage vs. Temperature

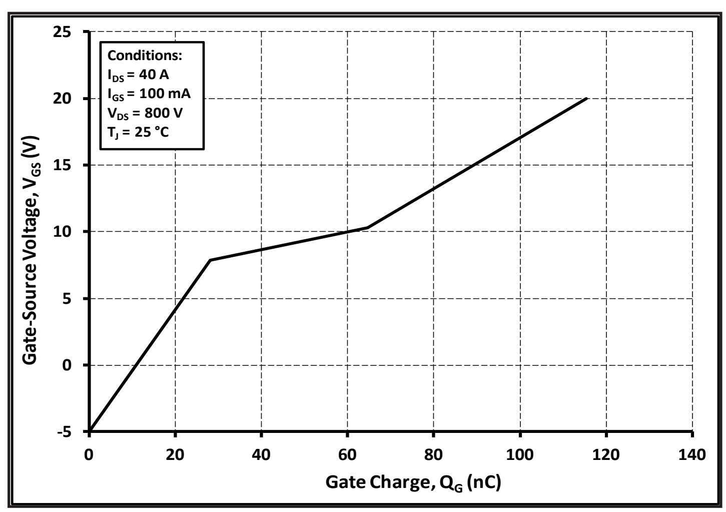



Figure 12. Gate Charge Characteristics

## Typical Performance

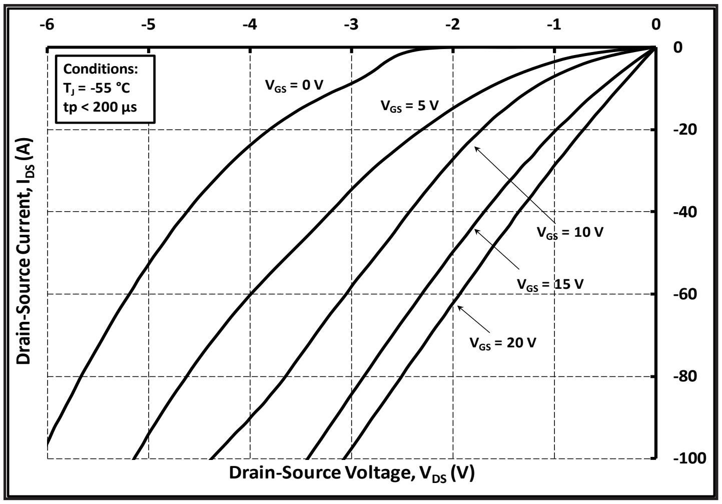



Figure 13. 3rd Quadrant Characteristic at -55 °C

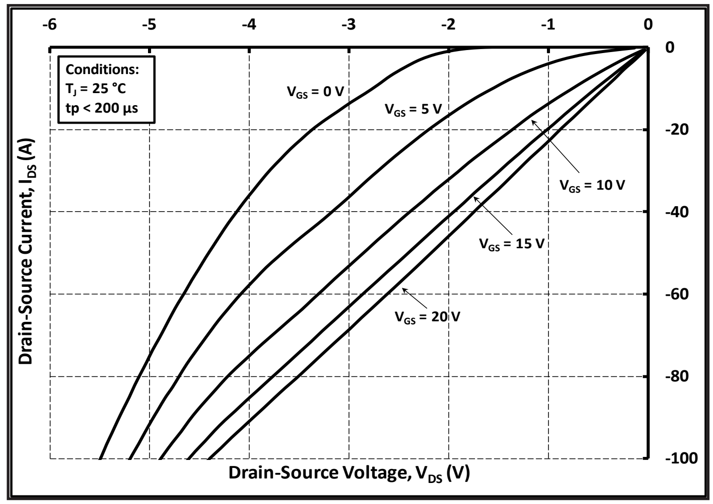



Figure 14. 3rd Quadrant Characteristic at 25 °C

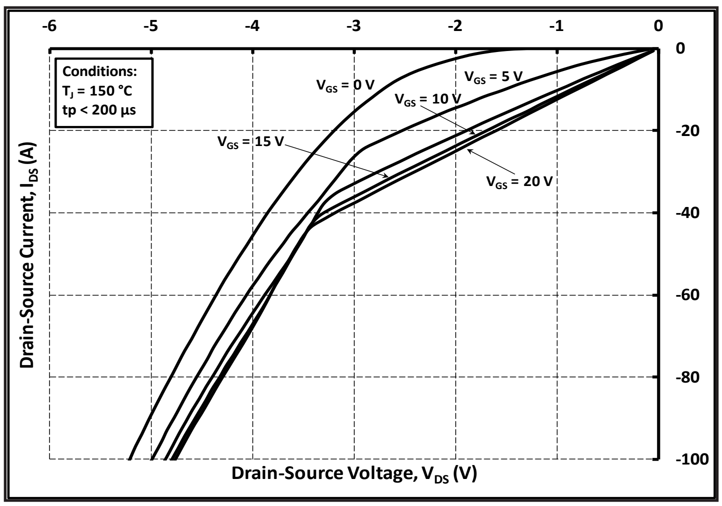



Figure 15. 3rd Quadrant Characteristic at 150 °C

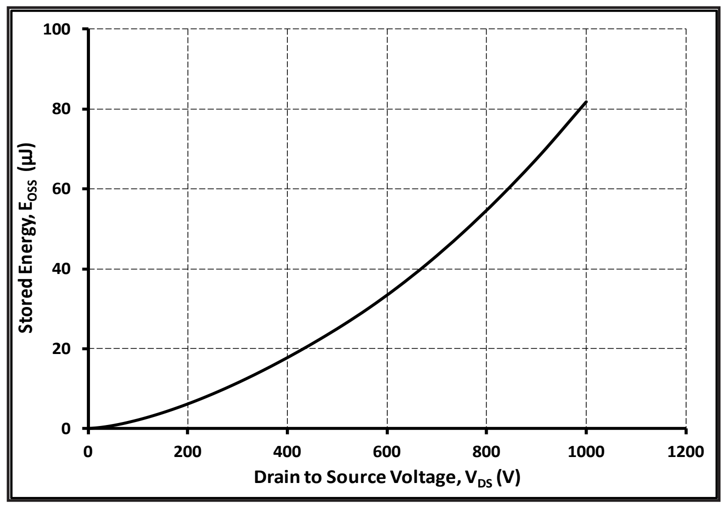



Figure 16. Output Capacitor Stored Energy

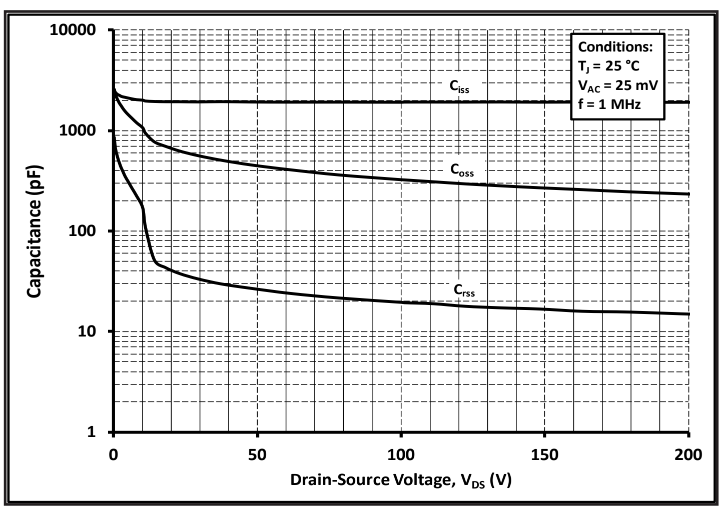



Figure 17. Capacitances vs. Drain-Source Voltage (0-200 V)

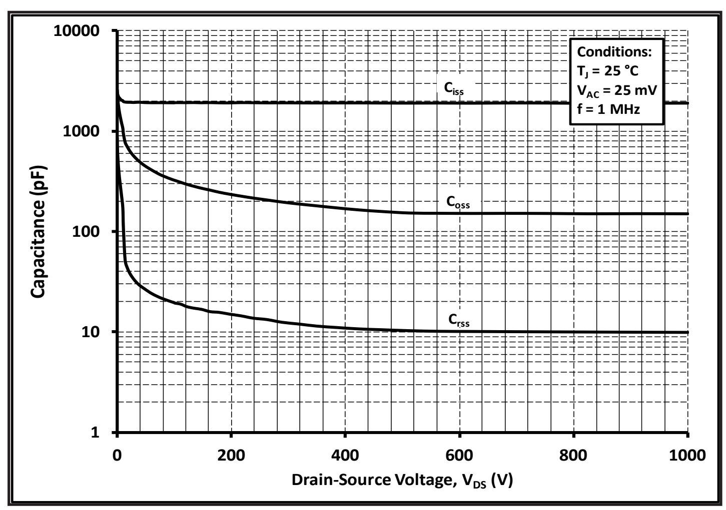



Figure 18. Capacitances vs. Drain-Source Voltage (0-1000 V)

## Typical Performance

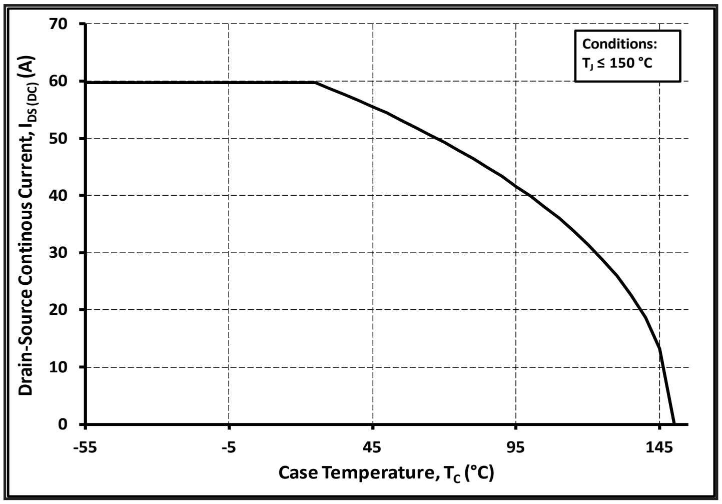



Figure 19. Continuous Drain Current Derating vs. Case Temperature

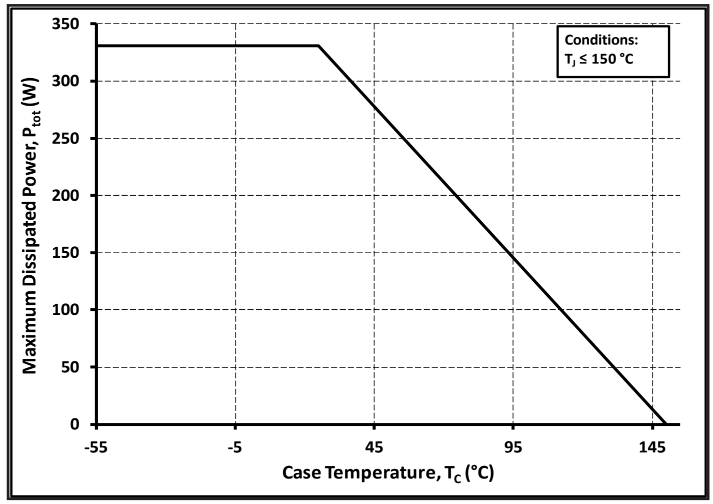



Figure 20. Maximum Power Dissipation Derating vs. Case Temperature

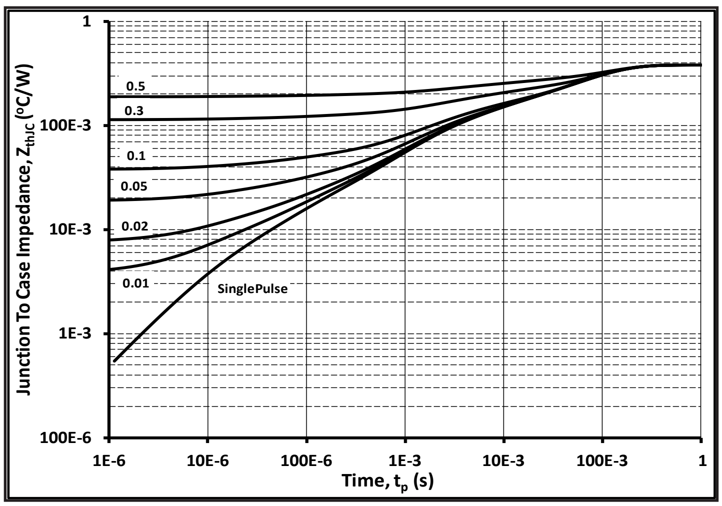



Figure 21. Transient Thermal Impedance (Junction - Case)

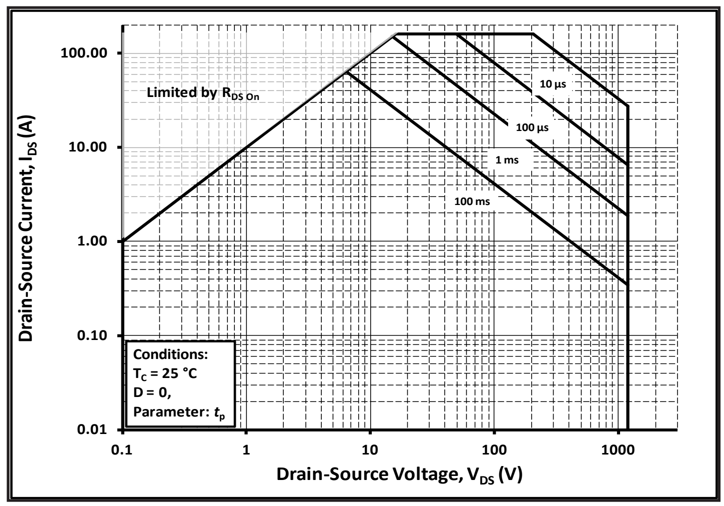



Figure 22. Safe Operating Area

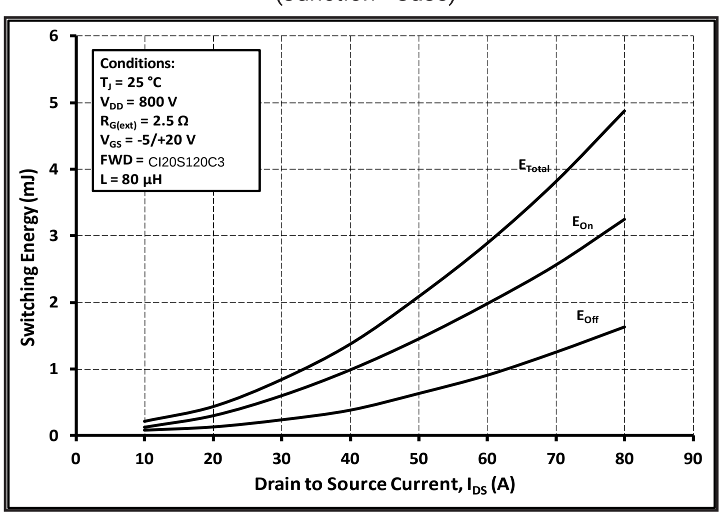



Figure 23. Clamped Inductive Switching Energy vs. Drain Current ($V_{DD}$ = 800V)

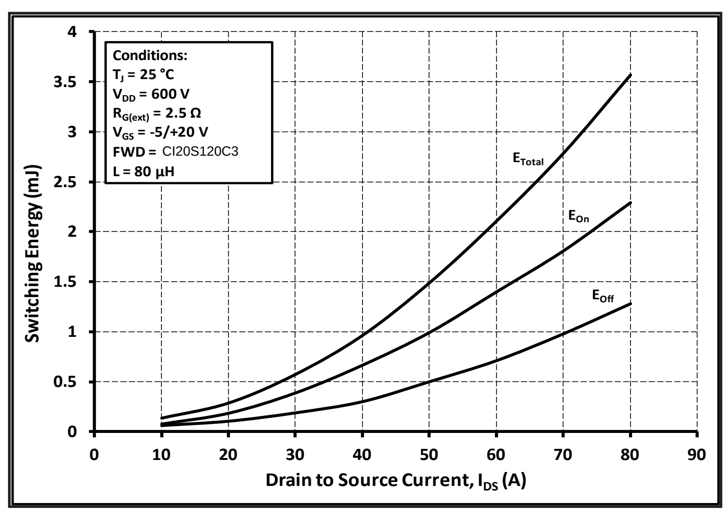



Figure 24. Clamped Inductive Switching Energy vs. Drain Current ($V_{DD}$ = 600V)

## Typical Performance

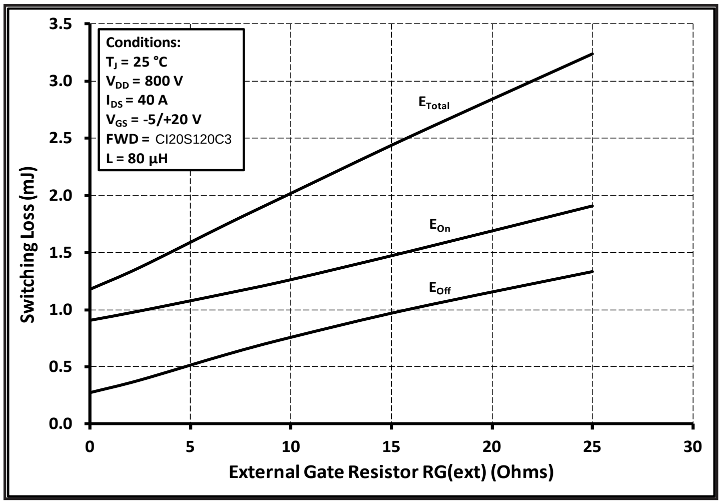



Figure 25. Clamped Inductive Switching Energy vs. $R_{G(ext)}$

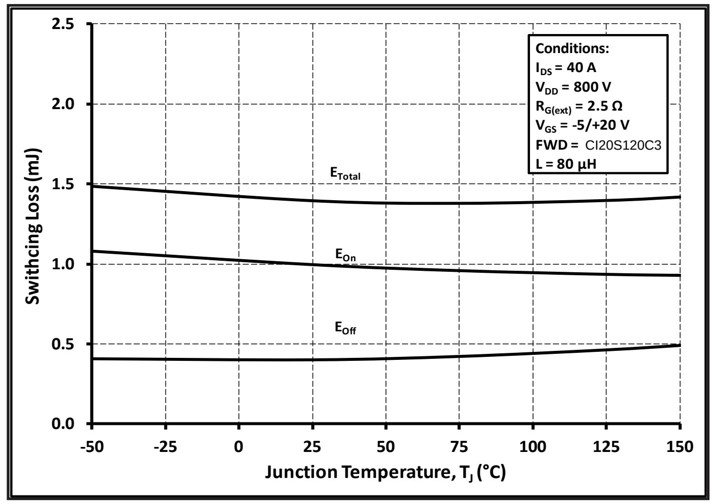



Figure 26. Clamped Inductive Switching Energy vs. Temperature

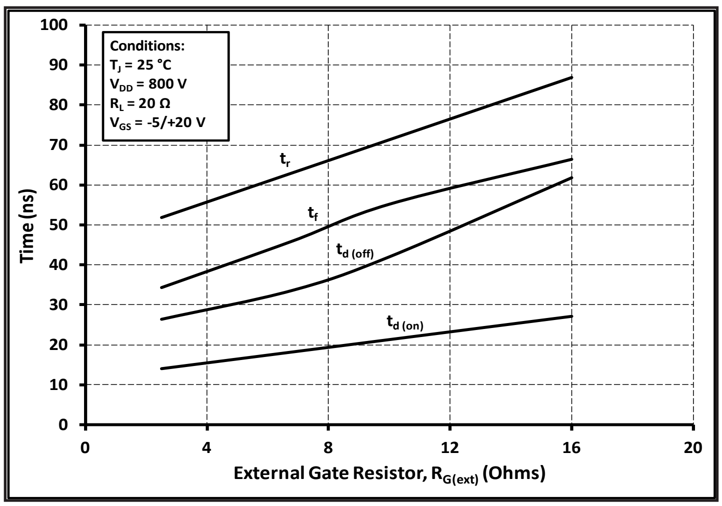



Figure 27. Switching Times vs. $R_{G(ext)}$

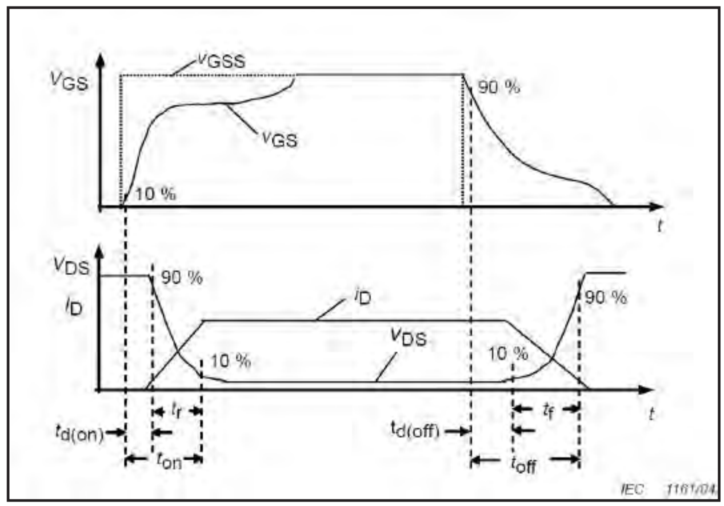



Figure 28. Switching Times Definition

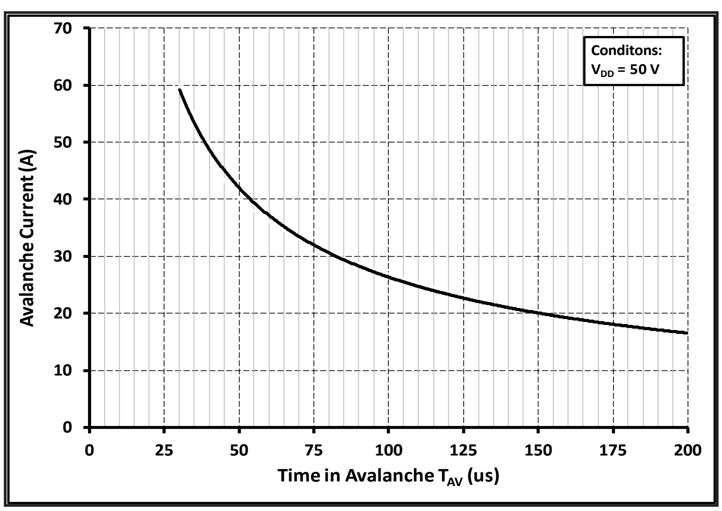



Figure 29. Single Avalanche SOA curve

## Test Circuit Schematic

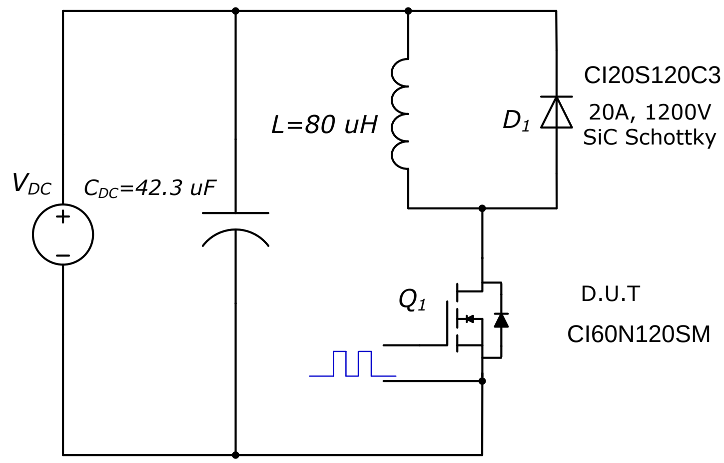



Figure 30. Clamped Inductive Switching Waveform Test Circuit

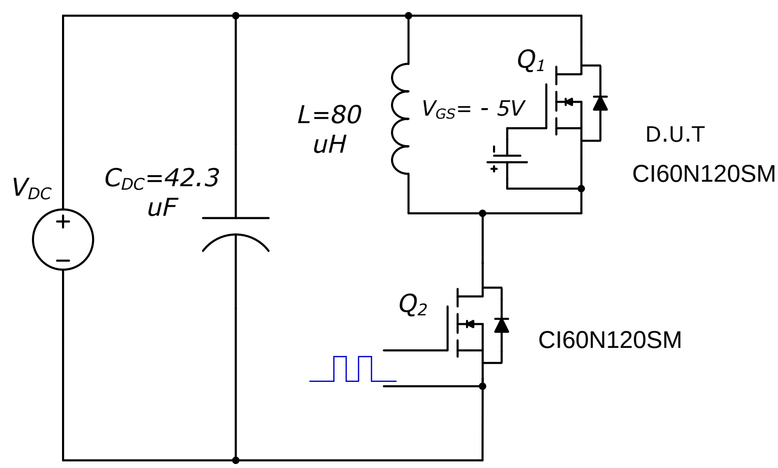
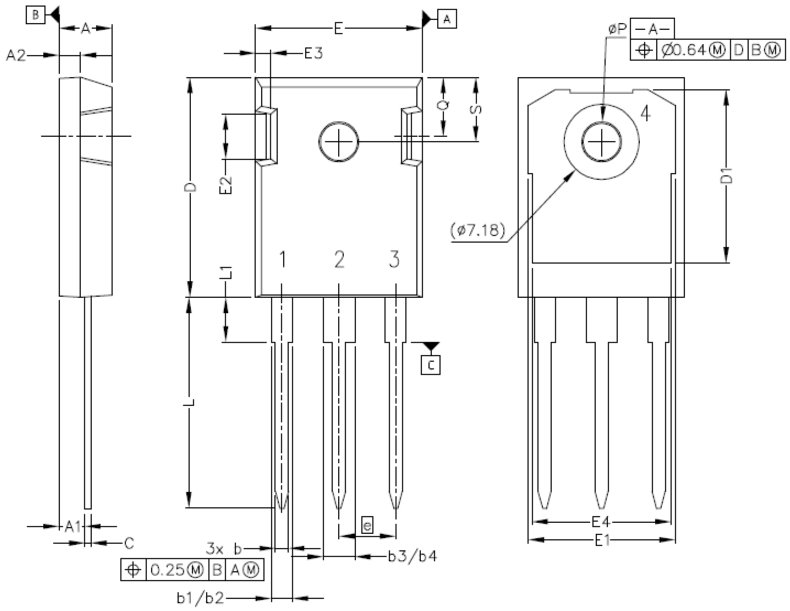
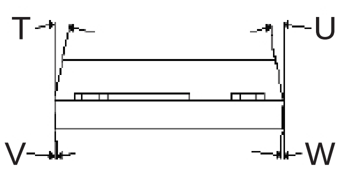



Figure 31. Body Diode Recovery Test Circuit

## Package Dimensions

Package TO-247-3




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° |