# IGBT - Ultra Field Stop

# FGH40T120SQDNL4

This Insulated Gate Bipolar Transistor (IGBT) features a robust and cost effective Ultra Field Stop Trench construction, and provides superior performance in demanding switching applications, offering both low on−state voltage and minimal switching loss. The IGBT is well suited for UPS and solar applications. Incorporated into the device is a soft and fast co−packaged free wheeling diode with a low forward voltage.

### Features

- Extremely Efficient Trench with Field Stop Technology
- $T_{Jmax}$ = 175°C
- Soft Fast Reverse Recovery Diode
- Optimized for High Speed Switching
- These are Pb−Free Devices

### Typical Applications

- Solar Inverter
- Uninterruptible Power Inverter Supplies (UPS)
- Welding

### ABSOLUTE MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|---|---|---|
| Collector−emitter voltage | $V_{CES}$ | 1200 | V |
| Collector current<br>@ $T_C$ = 25°C<br>@ $T_C$ = 100°C | $I_C$ | <br>160<br>40 | A |
| Pulsed collector current, $T_{pulse}$ limited by $T_{Jmax}$ | $I_{CM}$ | 160 | A |
| Diode forward current<br>@ $T_C$ = 25°C<br>@ $T_C$ = 100°C | $I_F$ | <br>160<br>40 | A |
| Diode pulsed current, $T_{pulse}$ limited by $T_{Jmax}$ | $I_{FM}$ | 160 | A |
| Gate−emitter voltage<br>Transient gate−emitter voltage ($T_{pulse}$ = 5 μs, D < 0.10) | $V_{GE}$ | ±20<br>±30 | V |
| Power Dissipation<br>@ $T_C$ = 25°C<br>@ $T_C$ = 100°C | $P_D$ | <br>454<br>227 | W |
| Operating junction temperature range | $T_J$ | −55 to +175 | °C |
| Storage temperature range | $T_{stg}$ | −55 to +175 | °C |
| Lead temperature for soldering, 1/8″ from case for 5 seconds | $T_{SLD}$ | 260 | °C |

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.

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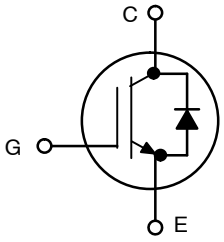
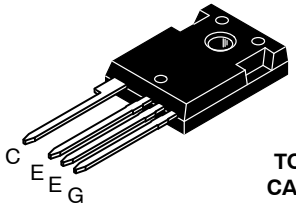
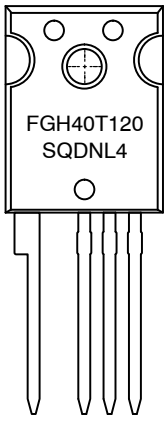
**40 A, 1200 V**
**$V_{CEsat}$ = 1.7 V**
**$E_{off}$ = 1.1 mJ**




**TO−247−4L**
**CASE 340CJ**

### MARKING DIAGRAM




### ORDERING INFORMATION

| Device | Package | Shipping |
|---|---|---|
| FGH40T120SQDNL4 | TO−247<br>(Pb−Free) | 30 Units / Rail |

## THERMAL CHARACTERISTICS

| Rating | Symbol | Value | Unit |
|---|---|---|---|
| Thermal resistance junction−to−case, for IGBT | $R_{\theta JC}$ | 0.33 | °C/W |
| Thermal resistance junction−to−case, for Diode | $R_{\theta JC}$ | 0.61 | °C/W |
| Thermal resistance junction−to−ambient | $R_{\theta JA}$ | 40 | °C/W |

## ELECTRICAL CHARACTERISTICS ($T_J$ = 25°C unless otherwise specified)

| Parameter | Test Conditions | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **STATIC CHARACTERISTIC** | | | | | | |
| Collector−emitter breakdown voltage, gate−emitter short−circuited | $V_{GE}$ = 0 V, $I_C$ = 500 μA | $V_{(BR)CES}$ | 1200<br>1250* | − | − | V |
| Collector−emitter saturation voltage | $V_{GE}$ = 15 V, $I_C$ = 40 A<br>$V_{GE}$ = 15 V, $I_C$ = 40 A, $T_J$ = 175°C | $V_{CEsat}$ | −<br>− | 1.78<br>2.3 | 1.95<br>− | V |
| Gate−emitter threshold voltage | $V_{GE}$ = $V_{CE}$, $I_C$ = 400 μA | $V_{GE(th)}$ | 4.5 | 5.5 | 6.5 | V |
| Collector−emitter cut−off current, gate−emitter short−circuited | $V_{GE}$ = 0 V, $V_{CE}$ = 1200 V<br>$V_{GE}$ = 0 V, $V_{CE}$ = 1200 V, $T_J$ = 175°C | $I_{CES}$ | −<br>− | −<br>0.6 | 0.4<br>− | mA |
| Gate leakage current, collector−emitter short−circuited | $V_{GE}$ = 20 V , $V_{CE}$ = 0 V | $I_{GES}$ | − | − | 200 | nA |

* Guaranteed by design.

| | | | | | | |
|---|---|---|---|---|---|---|
| Input capacitance | $V_{CE}$ = 20 V, $V_{GE}$ = 0 V, f = 1 MHz | $C_{ies}$ | − | 5000 | − | pF |
| Output capacitance | | $C_{oes}$ | − | 140 | − | |
| Reverse transfer capacitance | | $C_{res}$ | − | 80 | − | |
| Gate charge total | $V_{CE}$ = 600 V, $I_C$ = 40 A, $V_{GE}$ = 15 V | $Q_g$ | − | 221 | − | nC |
| Gate to emitter charge | | $Q_{ge}$ | − | 52 | − | |
| Gate to collector charge | | $Q_{gc}$ | − | 100 | − | |
| **SWITCHING CHARACTERISTIC, INDUCTIVE LOAD** | | | | | | |
| Turn−on delay time | $T_J$ = 25°C<br>$V_{CC}$ = 600 V, $I_C$ = 40 A<br>$R_g$ = 10 Ω<br>$V_{GE}$ = 0 to 15V | $t_{d(on)}$ | − | 46 | − | ns |
| Rise time | | $t_r$ | − | 33 | − | |
| Turn−off delay time | | $t_{d(off)}$ | − | 220 | − | |
| Fall time | | $t_f$ | − | 56 | − | |
| Turn−on switching loss | | $E_{on}$ | − | 1.4 | − | mJ |
| Turn−off switching loss | | $E_{off}$ | − | 1.1 | − | |
| Total switching loss | | $E_{ts}$ | − | 2.5 | − | |
| Turn−on delay time | $T_J$ = 175°C<br>$V_{CC}$ = 600 V, $I_C$ = 40 A<br>$R_g$ = 10 Ω<br>$V_{GE}$ = 0 to 15 V | $t_{d(on)}$ | − | 47 | − | ns |
| Rise time | | $t_r$ | − | 33 | − | |
| Turn−off delay time | | $t_{d(off)}$ | − | 240 | − | |
| Fall time | | $t_f$ | − | 132 | − | |
| Turn−on switching loss | | $E_{on}$ | − | 2.7 | − | mJ |
| Turn−off switching loss | | $E_{off}$ | − | 1.8 | − | |
| Total switching loss | | $E_{ts}$ | − | 4.5 | − | |
| **DIODE CHARACTERISTIC** | | | | | | |
| Forward voltage | $V_{GE}$ = 0 V, $I_F$ = 40 A<br>$V_{GE}$ = 0 V, $I_F$ = 40 A, $T_J$ = 175°C | $V_F$ | −<br>− | 3.4<br>3.1 | 3.8<br>− | V |
| Reverse recovery time | $T_J$ = 25°C<br>$I_F$ = 40 A, $V_R$ = 400 V<br>$di_F/dt$ = 500 A/μs | $t_{rr}$ | − | 166 | − | ns |
| Reverse recovery charge | | $Q_{rr}$ | − | 0.78 | − | μc |
| Reverse recovery current | | $I_{rrm}$ | − | 9.0 | − | A |
| Reverse recovery time | $T_J$ = 125°C<br>$I_F$ = 40 A, $V_R$ = 400 V<br>$di_F/dt$ = 500 A/μs | $t_{rr}$ | − | 390 | − | ns |
| Reverse recovery charge | | $Q_{rr}$ | − | 4.0 | − | μc |
| Reverse recovery current | | $I_{rrm}$ | − | 20 | − | A |

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.

## TYPICAL CHARACTERISTICS

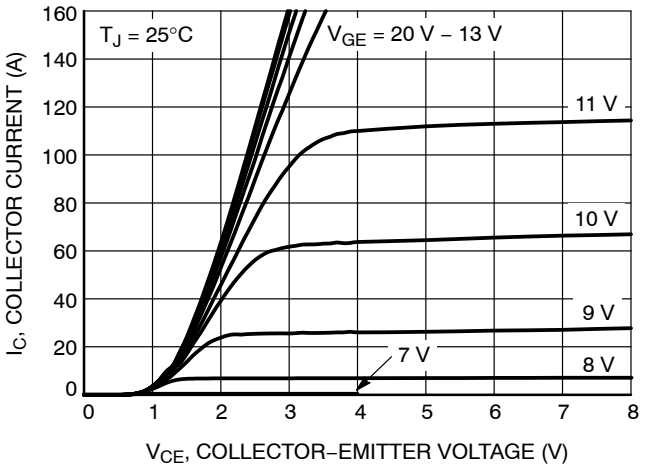



**Figure 1. Output Characteristics**

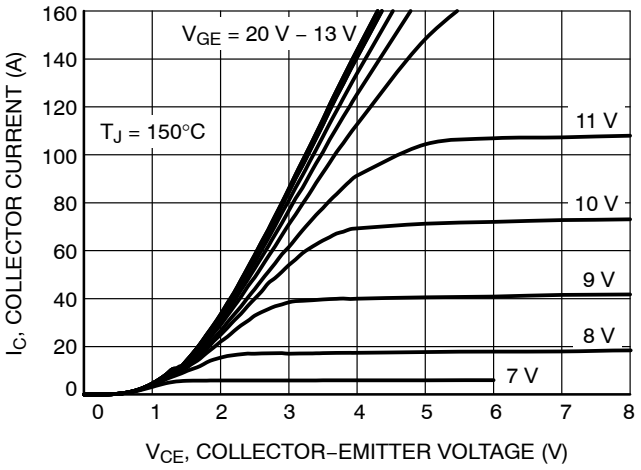



**Figure 2. Output Characteristics**

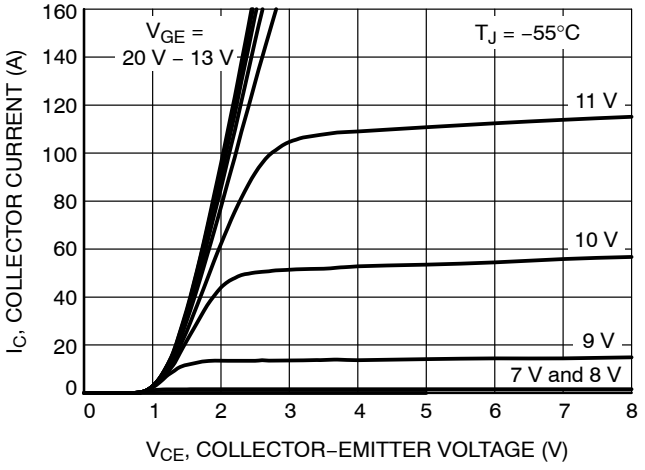



**Figure 3. Output Characteristics**

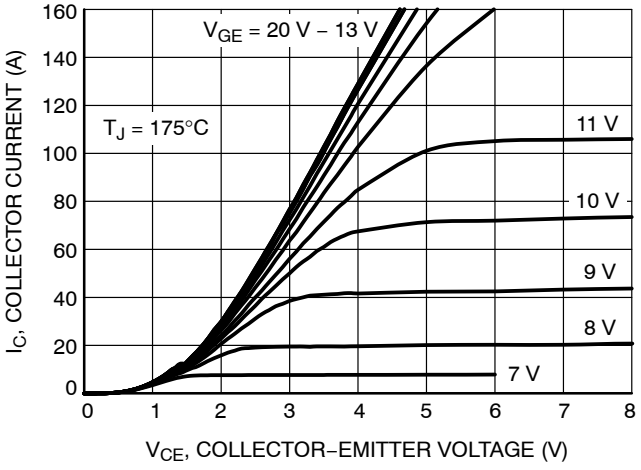



**Figure 4. Output Characteristics**

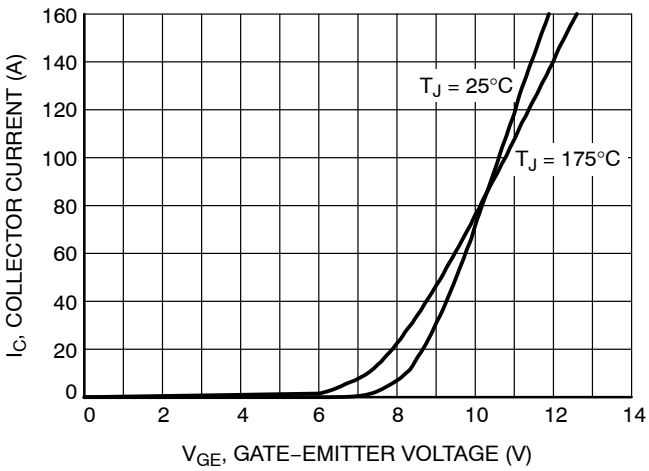



**Figure 5. Typical Transfer Characteristics**

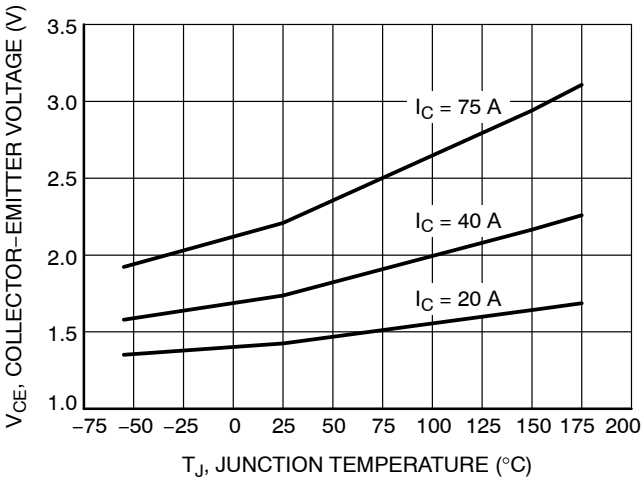



**Figure 6. $V_{CE(sat)}$ vs. $T_J$**

## TYPICAL CHARACTERISTICS

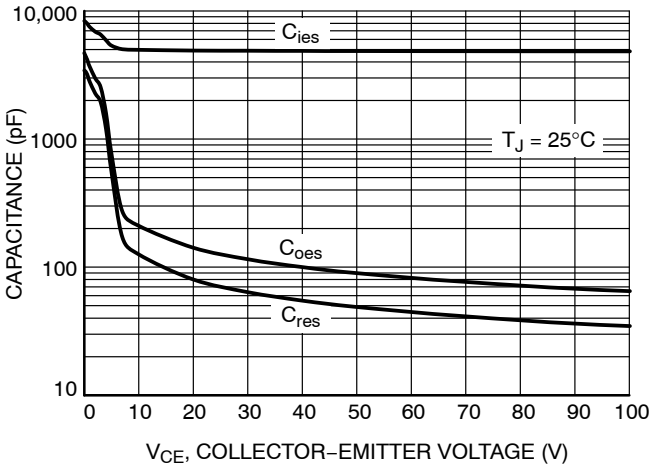



**Figure 7. Typical Capacitance**

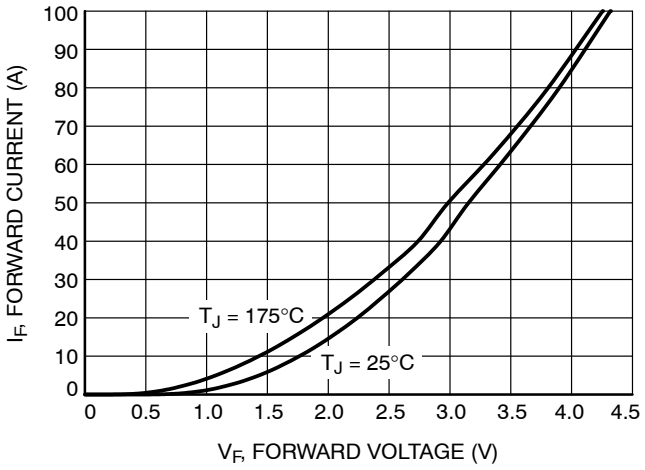



**Figure 8. Diode Forward Characteristics**

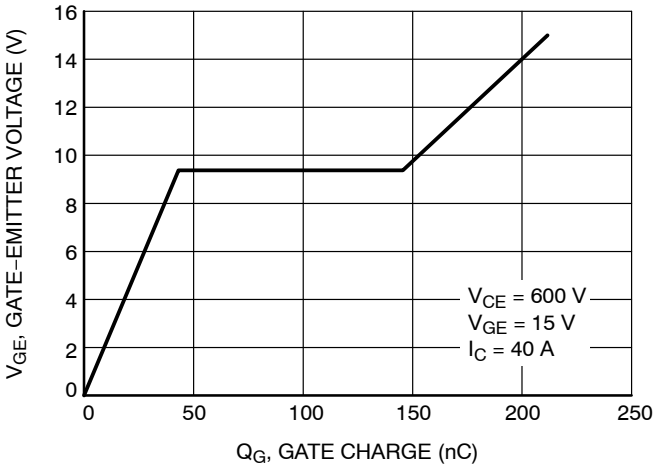



**Figure 9. Typical Gate Charge**

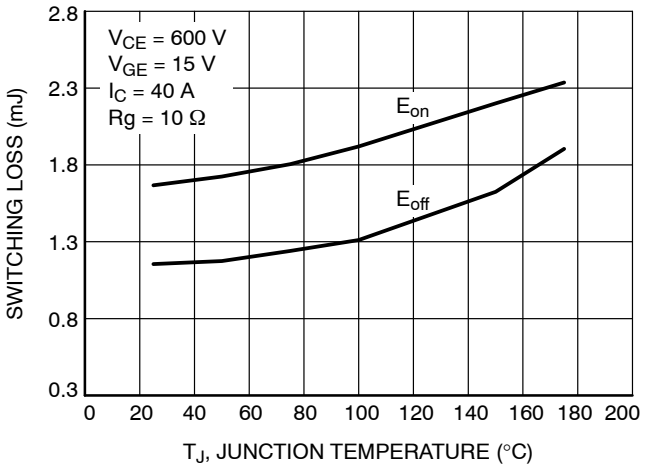



**Figure 10. Switching Loss vs. Temperature**

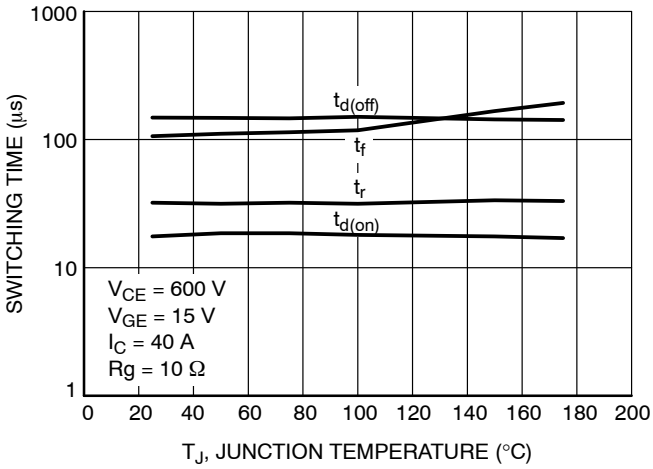



**Figure 11. Switching Time vs. Temperature**

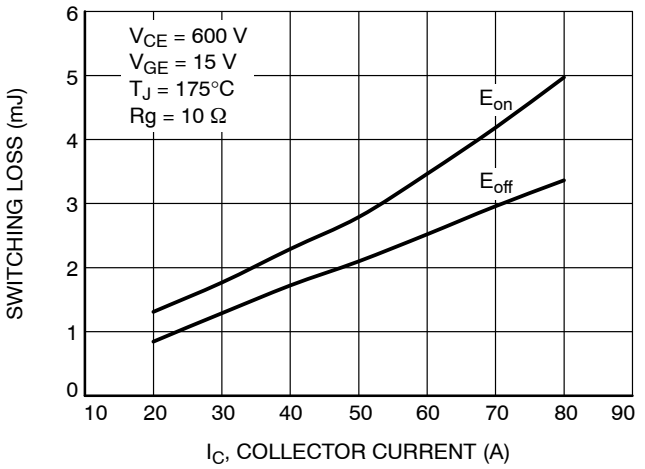



**Figure 12. Switching Loss vs. IC**

## TYPICAL CHARACTERISTICS

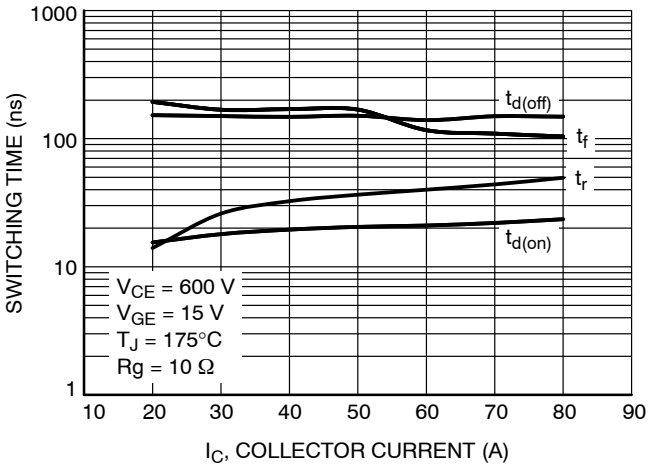



**Figure 13. Switching Time vs. IC**

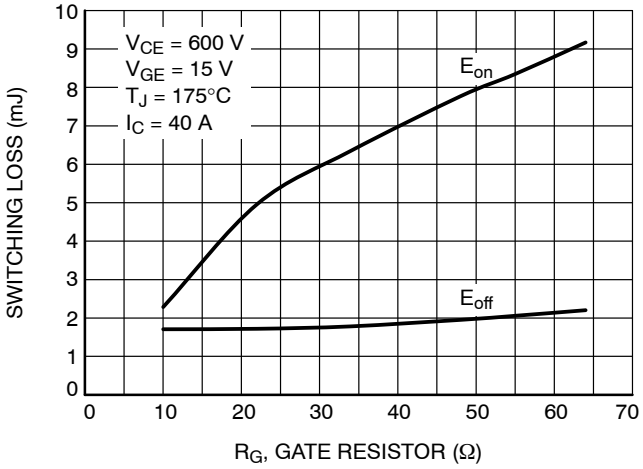



**Figure 14. Switching Loss vs. RG**

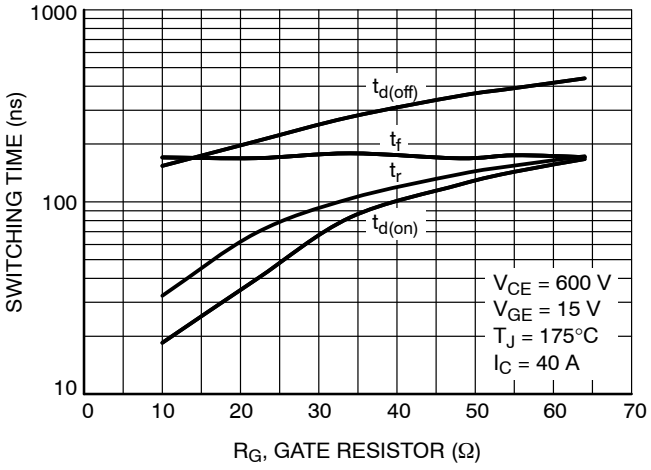



**Figure 15. Switching Time vs. RG**

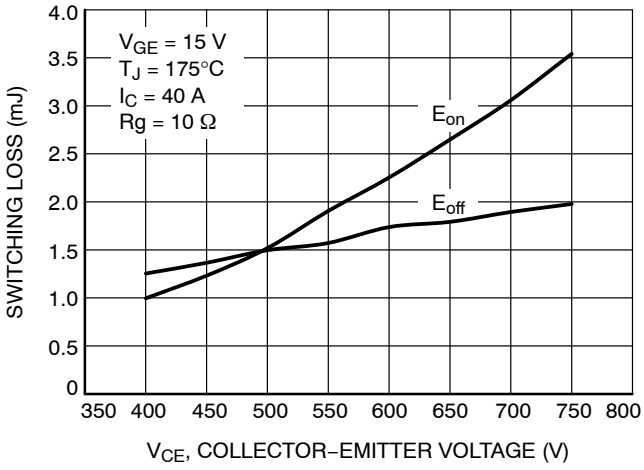



**Figure 16. Switching Loss vs. $V_{CE}$**

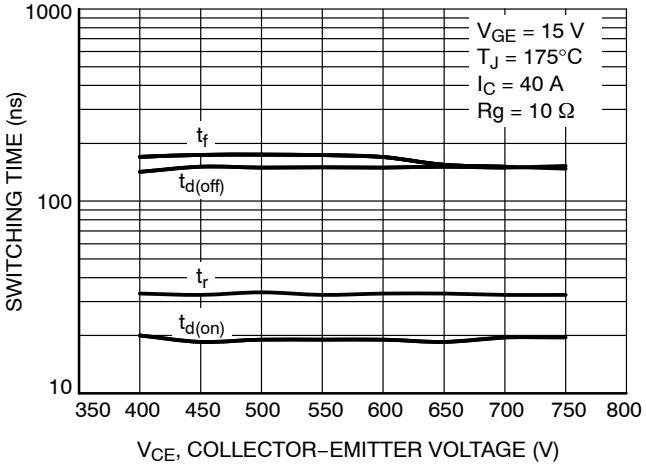



**Figure 17. Switching Time vs. $V_{CE}$**

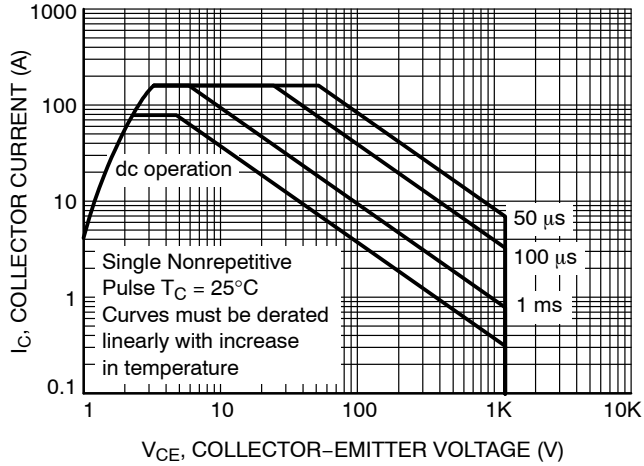



**Figure 18. Safe Operating Area**

## TYPICAL CHARACTERISTICS

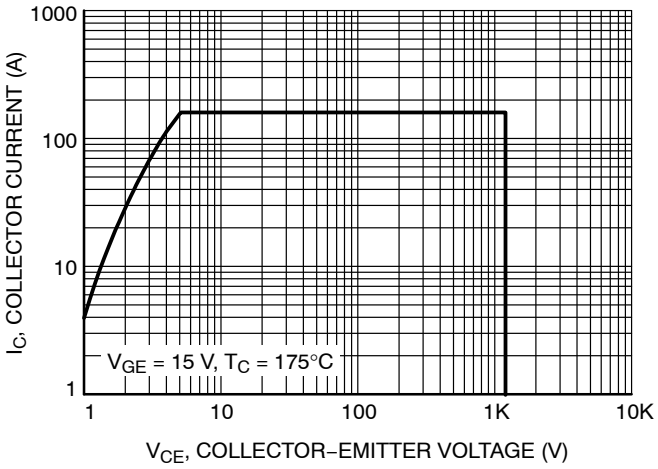



**Figure 19. Reverse Bias Safe Operating Area**

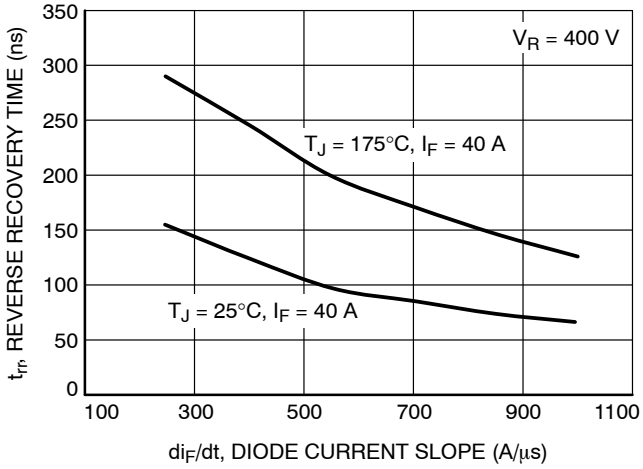



**Figure 20. $t_{rr}$ vs. $di_F/dt$**

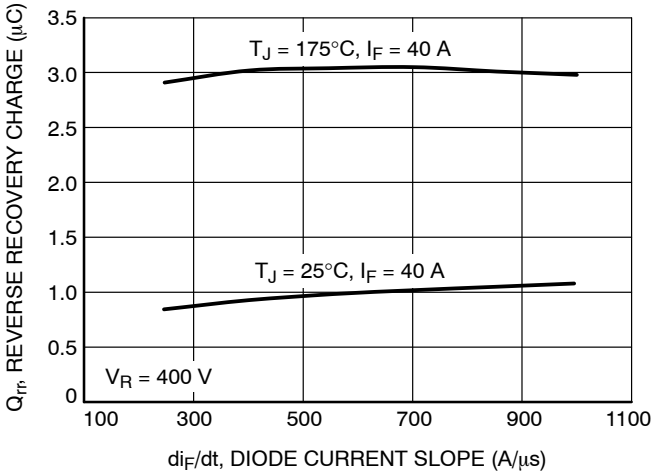



**Figure 21. $Q_{rr}$ vs. $di_F/dt$**

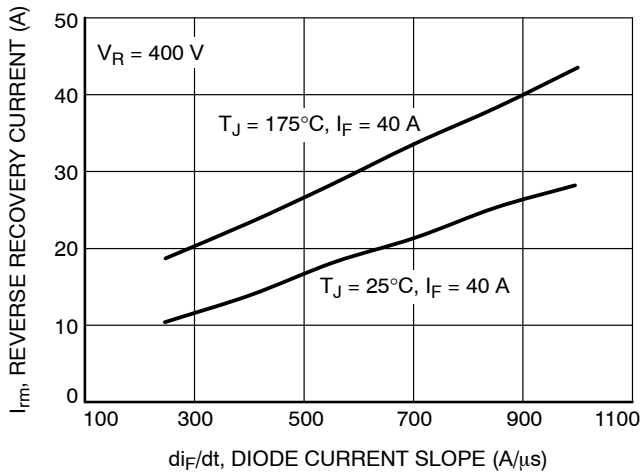



**Figure 22. $I_{rm}$ vs. $di_F/dt$**

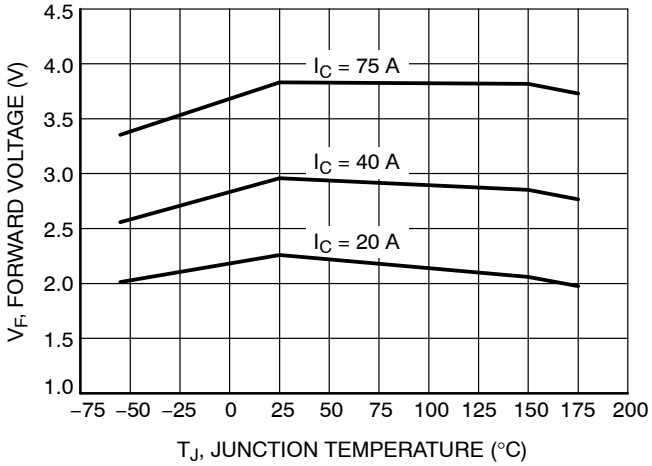



**Figure 23. $V_F$ vs. $T_J$**

## TYPICAL CHARACTERISTICS

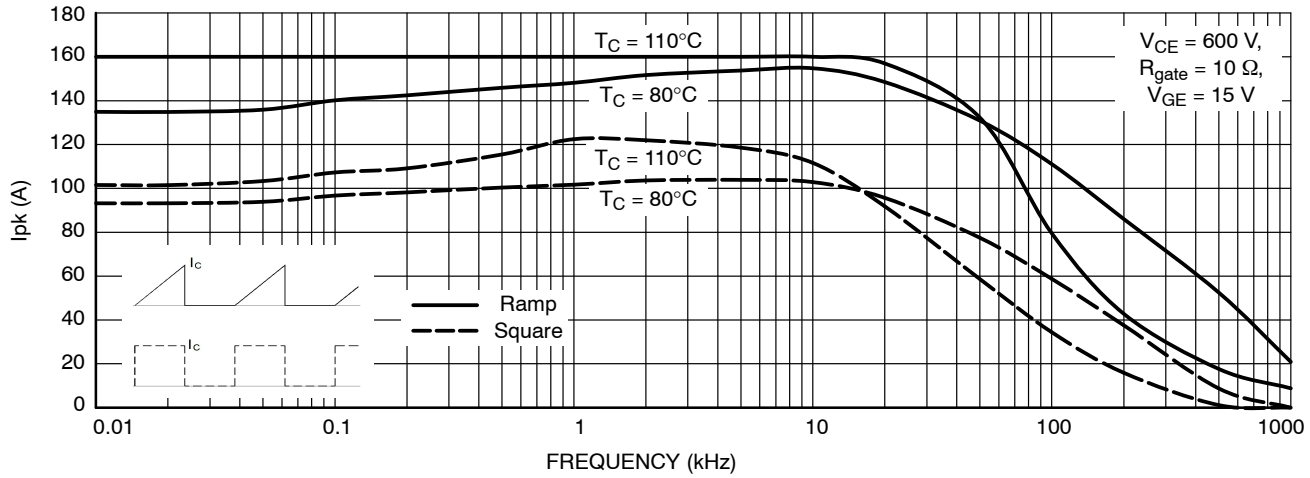



**Figure 24. Collector Current vs. Switching Frequency**

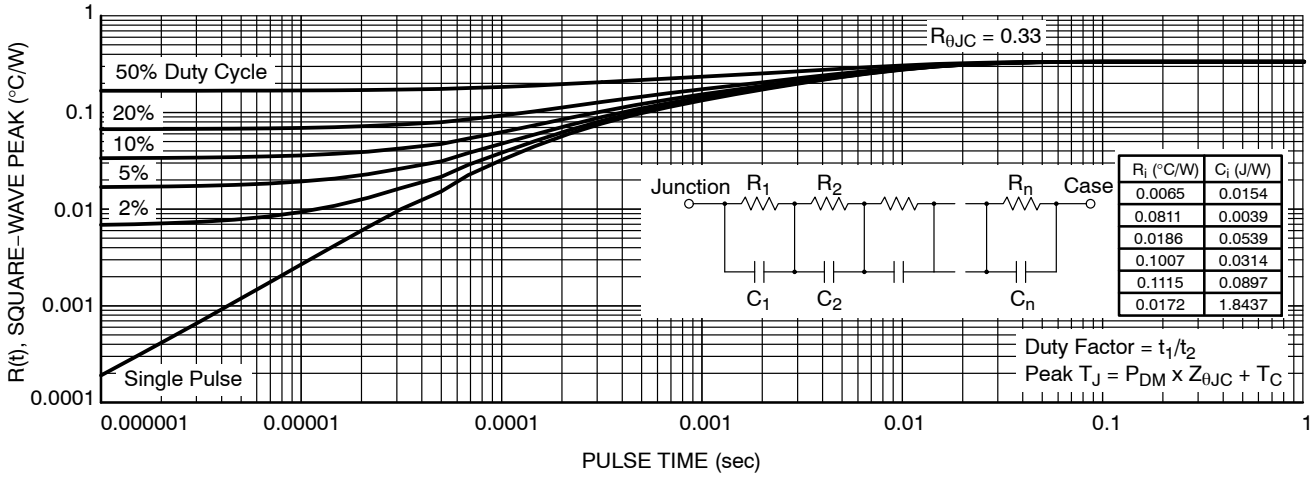



**Figure 25. IGBT Transient Thermal Impedance**

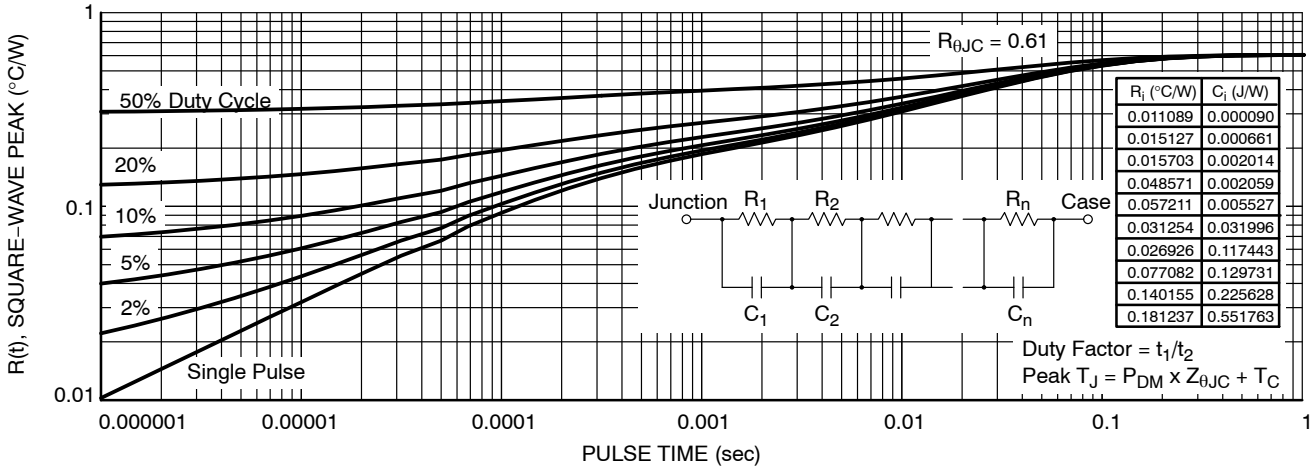



**Figure 26. Diode Transient Thermal Impedance**

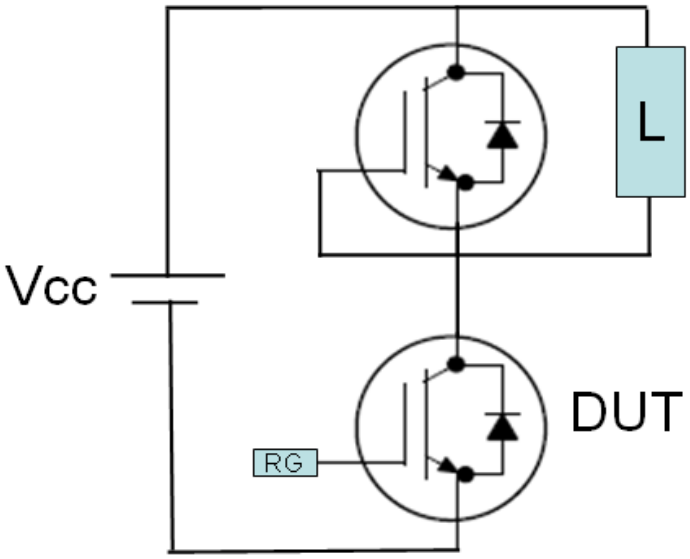



**Figure 27. Test Circuit for Switching Characteristics**

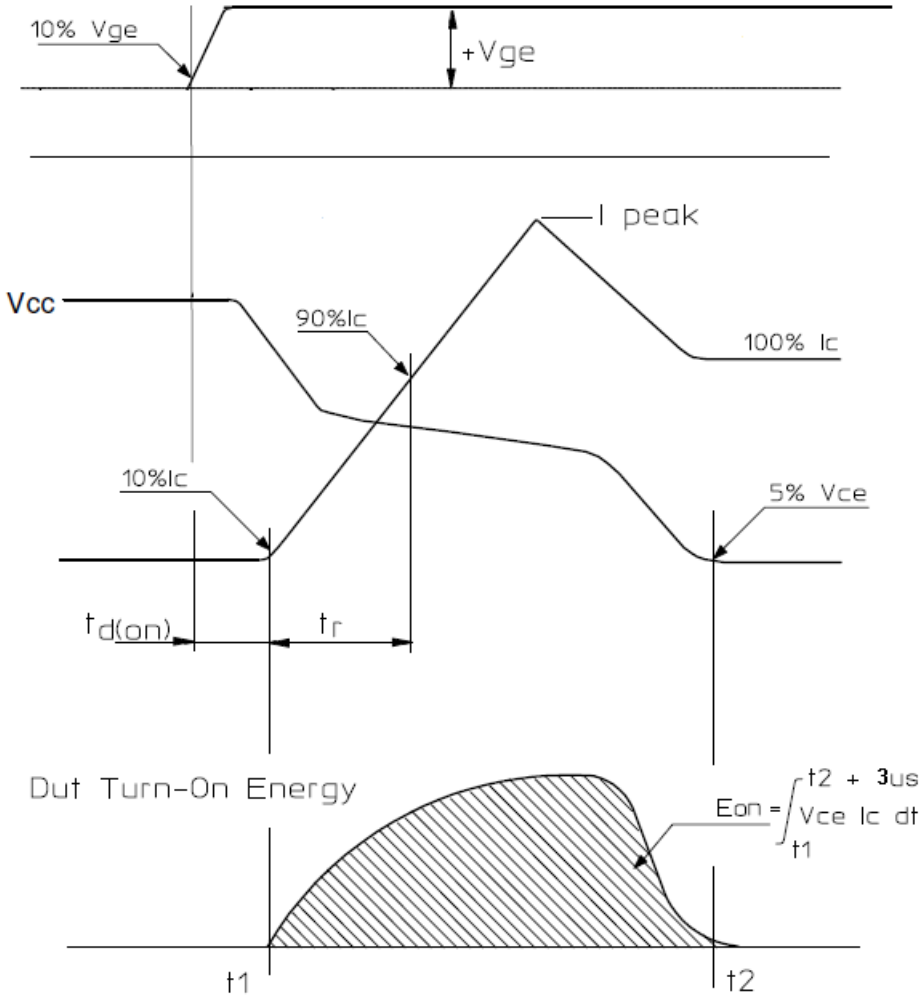



**Figure 28. Definition of Turn On Waveform**

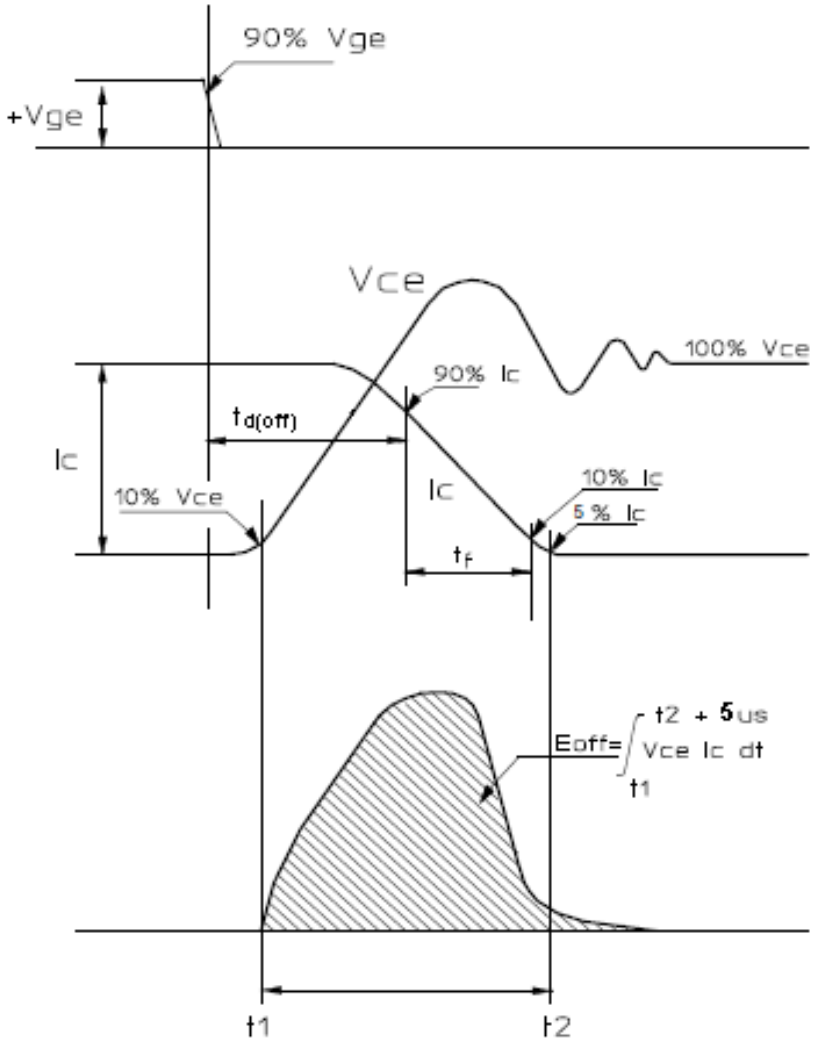


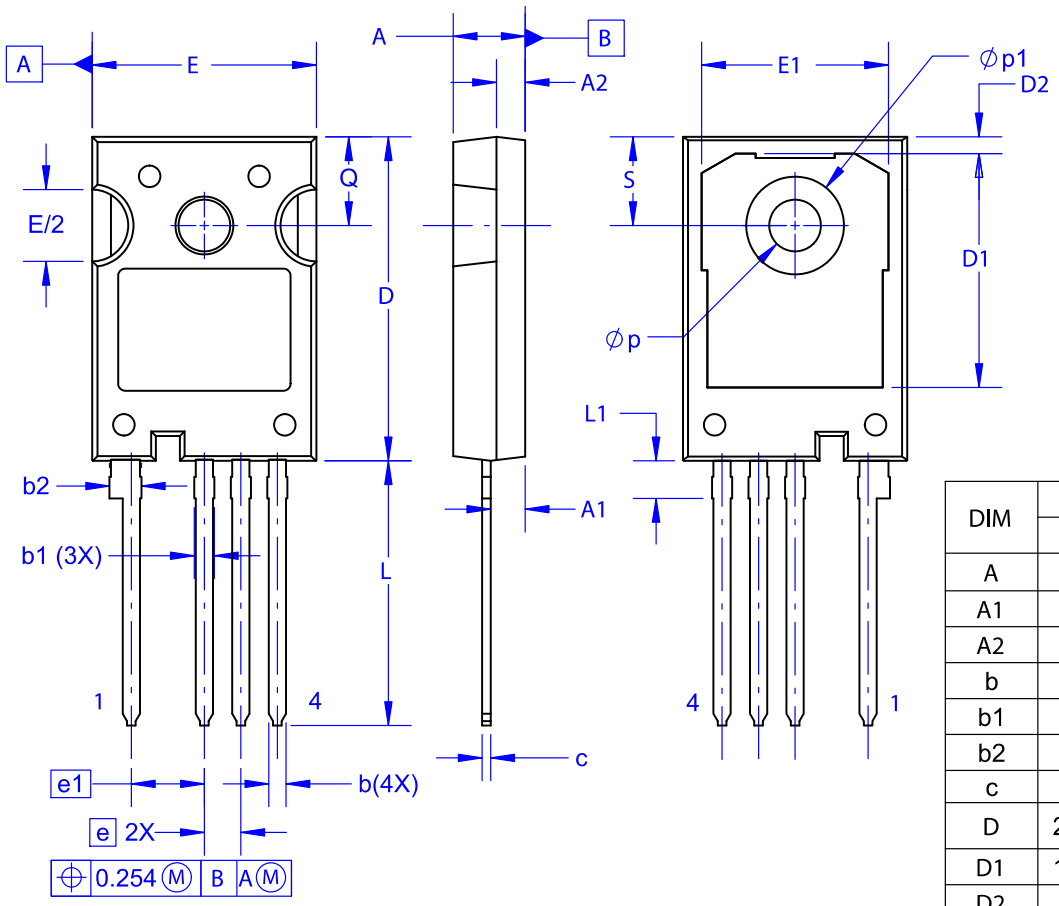

**Figure 29. Definition of Turn Off Waveform**

# MECHANICAL CASE OUTLINE
## PACKAGE DIMENSIONS

ON Semiconductor®

**TO−247−4LD**
CASE 340CJ
ISSUE A

DATE 16 SEP 2019




| DIM | MILLIMETERS | | |
|---|---|---|---|
| | MIN | NOM | MAX |
| A | 4.80 | 5.00 | 5.20 |
| A1 | 2.10 | 2.40 | 2.70 |
| A2 | 1.80 | 2.00 | 2.20 |
| b | 1.07 | 1.20 | 1.33 |
| b1 | 1.20 | 1.40 | 1.60 |
| b2 | 2.02 | 2.22 | 2.42 |
| c | 0.50 | 0.60 | 0.70 |
| D | 22.34 | 22.54 | 22.74 |
| D1 | 16.00 | 16.25 | 16.50 |
| D2 | 0.97 | 1.17 | 1.37 |
| e | 2.54 BSC | | |
| e1 | 5.08 BSC | | |
| E | 15.40 | 15.60 | 15.80 |
| E1 | 12.80 | 13.00 | 13.20 |
| E/2 | 4.80 | 5.00 | 5.20 |
| L | 18.22 | 18.42 | 18.62 |
| L1 | 2.42 | 2.62 | 2.82 |
| p | 3.40 | 3.60 | 3.80 |
| p1 | 6.60 | 6.80 | 7.00 |
| Q | 5.97 | 6.17 | 6.37 |
| S | 5.97 | 6.17 | 6.37 |

NOTES:

A. NO INDUSTRY STANDARD APPLIES TO THIS PACKAGE.
B. DIMENSIONS ARE EXCLUSIVE OF BURRS,MOLD FLASH,AND TIE BAR EXTRUSIONS.
C. ALL DIMENSIONS ARE IN MILLIMETERS.
D. DRAWING CONFORMS TO ASME Y14.5-2009.

| | | |
|---|---|---|
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| **DESCRIPTION:** | **TO−247−4LD** | **PAGE 1 OF 1** |

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