# Field Stop Trench IGBT with Soft Fast Recovery Diode

## 120 A, 650 V

# AFGY120T65SPD

AFGY120T65SPD which is AEC Q101 qualified offers very low conduction and switch losses for a high efficiency operation in various applications, rugged transient reliability and low EMI.

Meanwhile, this part also offers an advantage of outstanding parallel operation performance with balance current sharing.

### Features

- AEC−Q101 Qualified
- Very Low Saturation Voltage: $V_{CE(Sat)}$ = 1.6 V (Typ.) @ $I_C$ = 120 A
- Maximum Junction Temperature: $T_J$ = 175°C
- Positive Temperature Co−efficient for Easy Parallel Operating
- Tight Parameter Distribution
- High Input Impedance
- 100% of the Parts are Tested for $I_{LM}$
- Short Circuit Ruggedness
- Co−packed with Soft Fast Recovery Diode

### Typical Applications

- Traction Inverter for HEV/EV
- Auxiliary DC/AC Converters
- Motor Drives
- Other Power−Train Applications Requiring High Power Switch

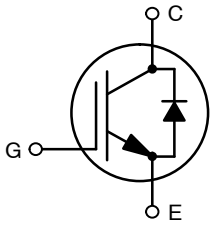
### MAXIMUM RATINGS

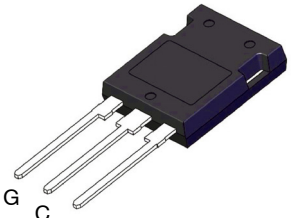
| Rating | Symbol | Value | Unit |
|---|---|---|---|
| Collector−to−Emitter Voltage | $V_{CES}$ | 650 | V |
| Gate−to−Emitter Voltage<br>Transient Gate−to−Emitter Voltage | $V_{GES}$ | ±20<br>±30 | V |
| Collector Current (Note 1) @ $T_C$ = 25°C<br>@ $T_C$ = 100°C | $I_C$ | 160<br>120 | A |
| Pulsed Collector Current | $I_{LM}$ | 360 | A |
| Pulsed Collector Current | $I_{CM}$ | 360 | A |
| Diode Forward Current (Note 1) @ $T_C$ = 25°C<br>@ $T_C$ = 100°C | $I_F$ | 160<br>120 | A |
| Maximum Power Dissipation @ $T_C$ = 25°C<br>@ $T_C$ = 100°C | $P_D$ | 714<br>357 | W |
| Short Circuit Withstand Time @ $T_C$ = 25°C | SCWT | 6 | μs |
| Voltage Transient Ruggedness (Note 2) | dV/dt | 10 | V/ns |
| Operating Junction / Storage Temperature Range | $T_J$, $T_{STG}$ | −55 to +175 | °C |
| Maximum Lead Temp. for Soldering Purposes, 1/8″ from case for 5 seconds | $T_L$ | 265 | °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.

1. Value limit by bond wire
2. $V_{CC}$ = 400 V, $V_{GE}$ = 15 V, $I_C$ = 360 A, Inductive Load

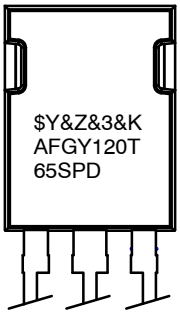
**120 A, 650 V,**
**$V_{CESat}$ = 1.6 V**




**TO−247−3LD**
**CASE 340CU**

### MARKING DIAGRAM




| | |
|---|---|
| $Y | = **onsemi** Logo |
| &Z | = Assembly Plant Code |
| &3 | = Date Code (Year & Week) |
| &K | = Lot Traceability Code |
| AFGY120T65SPD | = Specific Device Code |

### ORDERING INFORMATION

| Device | Package | Shipping |
|---|---|---|
| AFGY120T65SPD | TO−247−3LD | 30 Units / Tube |

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## THERMAL CHARACTERISTICS

| Rating | Symbol | Value | Unit |
|---|---|---|---|
| Thermal resistance junction−to−case, for IGBT | $R_{\theta JC}$ | 0.21 | °C/W |
| Thermal resistance junction−to−case, for Diode | $R_{\theta JC}$ | 0.32 | |
| Thermal resistance junction−to−ambient | $R_{\theta JA}$ | 40 | |

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

| Parameter | Test Conditions | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | |
| Collector−emitter breakdown voltage, gate−emitter short−circuited | $V_{GE}$ = 0 V, $I_C$ = 1 mA | $BV_{CES}$ | 650 | – | – | V |
| Temperature Coefficient of Breakdown Voltage | $V_{GE}$ = 0 V, $I_C$ = 1 mA | $\frac{\Delta BV_{CES}}{\Delta T_J}$ | – | 0.6 | – | V/°C |
| Collector−emitter cut−off current, gate−emitter short−circuited | $V_{GE}$ = 0 V, $V_{CE}$ = 650 V | $I_{CES}$ | – | – | 40 | μA |
| Gate leakage current, collector−emitter short−circuited | $V_{GE}$ = 20 V, $V_{CE}$ = 0 V | $I_{GES}$ | – | – | ±250 | nA |
| **ON CHARACTERISTICS** | | | | | | |
| Gate−emitter threshold voltage | $V_{GE}$ = $V_{CE}$, $I_C$ = 120 mA | $V_{GE(th)}$ | 4.3 | 5.3 | 6.3 | V |
| Collector−emitter saturation voltage | $V_{GE}$ = 15 V, $I_C$ = 120 A<br>$V_{GE}$ = 15 V, $I_C$ = 120 A, $T_J$ = 175°C | $V_{CE(sat)}$ | –<br>– | 1.6<br>2.15 | 2.05<br>– | V |
| **DYNAMIC CHARACTERISTICS** | | | | | | |
| Input capacitance | $V_{CE}$ = 30 V, $V_{GE}$ = 0 V, f = 1 MHz | $C_{ies}$ | – | 4930 | – | pF |
| Output capacitance | | $C_{oes}$ | – | 375 | – | |
| Reverse transfer capacitance | | $C_{res}$ | – | 42 | – | |
| Internal Gate Resistance | f = 1 MHz | $R_G$ | – | 3 | – | Ω |
| Gate charge total | $V_{CE}$ = 400 V, $I_C$ = 120 A, $V_{GE}$ = 15 V | $Q_g$ | – | 125 | 187 | nC |
| Gate−to−emitter charge | | $Q_{ge}$ | – | 38 | – | |
| Gate−to−collector charge | | $Q_{gc}$ | – | 40 | – | |
| **SWITCHING CHARACTERISTICS, INDUCTIVE LOAD** | | | | | | |
| Turn−on delay time | $T_J$ = 25°C, $V_{CC}$ = 400 V, $I_C$ = 120 A, $R_G$ = 5.0 Ω, $V_{GE}$ = 15 V, Inductive Load | $t_{d(on)}$ | – | 40 | – | ns |
| Rise time | | $t_r$ | – | 104 | – | |
| Turn−off delay time | | $t_{d(off)}$ | – | 80 | – | |
| Fall time | | $t_f$ | – | 116 | – | |
| Turn−on switching loss | | $E_{on}$ | – | 6.6 | – | mJ |
| Turn−off switching loss | | $E_{off}$ | – | 3.8 | – | |
| Total switching loss | | $E_{ts}$ | – | 10.4 | – | |
| Turn−on delay time | $T_J$ = 175°C, $V_{CC}$ = 400 V, $I_C$ = 120 A, $R_G$ = 5.0 Ω, $V_{GE}$ = 15 V, Inductive Load | $t_{d(on)}$ | – | 36 | – | ns |
| Rise time | | $t_r$ | – | 112 | – | |
| Turn−off delay time | | $t_{d(off)}$ | – | 92 | – | |
| Fall time | | $t_f$ | – | 160 | – | |
| Turn−on switching loss | | $E_{on}$ | – | 10.5 | – | mJ |
| Turn−off switching loss | | $E_{off}$ | – | 4.9 | – | |
| Total switching loss | | $E_{ts}$ | – | 15.4 | – | |



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**ELECTRICAL CHARACTERISTICS** ($T_J$ = 25°C unless otherwise noted) (Continued)

| Parameter | Test Conditions | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **DIODE CHARACTERISTIC** | | | | | | |
| Diode Forward Voltage | $I_F$ = 120 A, $T_J$ = 25°C | $V_{FM}$ | – | 1.4 | 1.7 | V |
| | $I_F$ = 120 A, $T_J$ = 175°C | | – | 1.35 | – | |
| Reverse Recovery Energy | $I_F$ = 120 A, $dI_F/dt$ = 1000 A/μs, $V_{CE}$ = 400 V, $T_J$ = 25°C | $E_{rec}$ | – | 428 | – | μJ |
| | $I_F$ = 120 A, $dI_F/dt$ = 1000 A/μs, $V_{CE}$ = 400 V, $T_J$ = 175°C | | – | 2026 | – | |
| Diode Reverse Recovery Time | $I_F$ = 120 A, $dI_F/dt$ = 1000 A/μs, $V_{CE}$ = 400 V, $T_J$ = 25°C | $T_{rr}$ | – | 107 | – | ns |
| | $I_F$ = 120 A, $dI_F/dt$ = 1000 A/μs, $V_{CE}$ = 400 V, $T_J$ = 175°C | | – | 203 | – | |
| Diode Reverse Recovery Charge | $I_F$ = 120 A, $dI_F/dt$ = 1000 A/μs, $V_{CE}$ = 400 V, $T_J$ = 25°C | $Q_{rr}$ | – | 2237 | – | nC |
| | $I_F$ = 120 A, $dI_F/dt$ = 1000 A/μs, $V_{CE}$ = 400 V, $T_J$ = 175°C | | – | 8155 | – | |

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.



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## TYPICAL CHARACTERISTICS

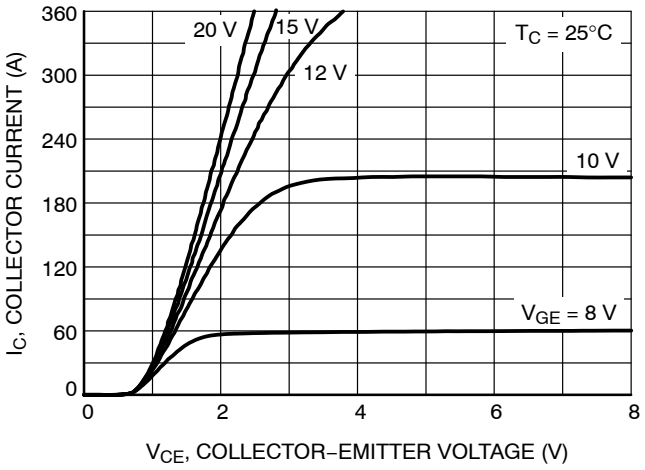



**Figure 1. Typical Output Characteristics**

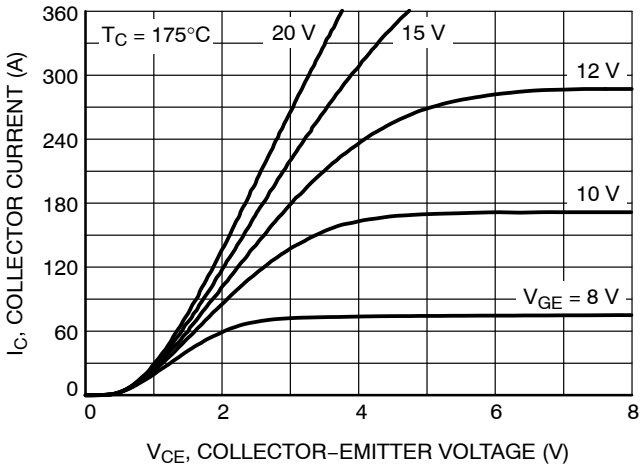



**Figure 2. Typical Output Characteristics**

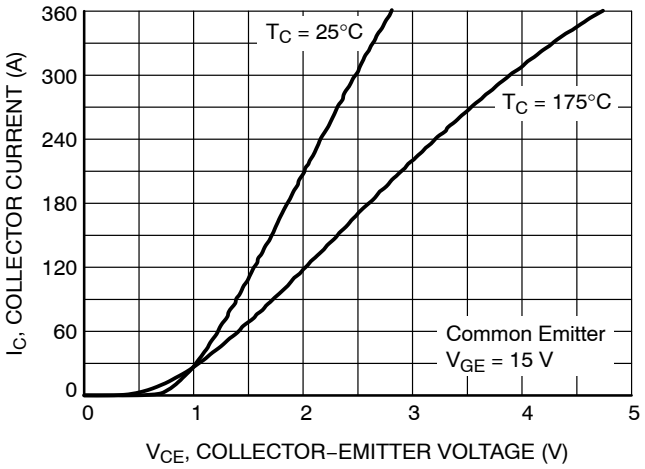



**Figure 3. Typical Saturation Voltage**

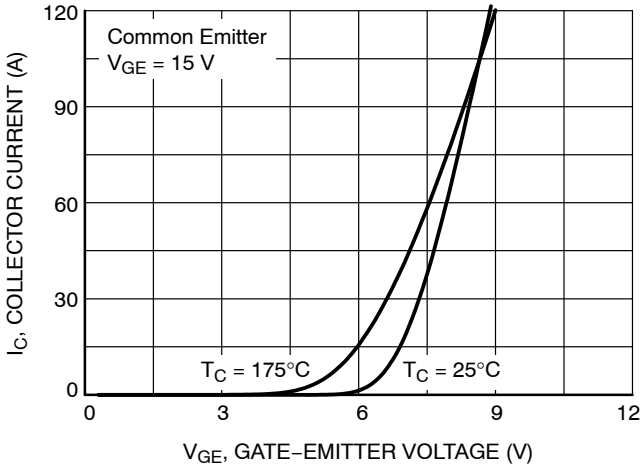



**Figure 4. Transfer Characteristics**

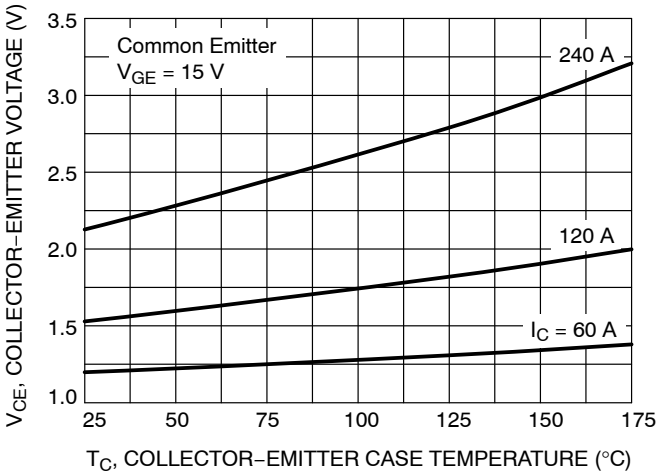



**Figure 5. Saturation Voltage vs. Case Temperature**

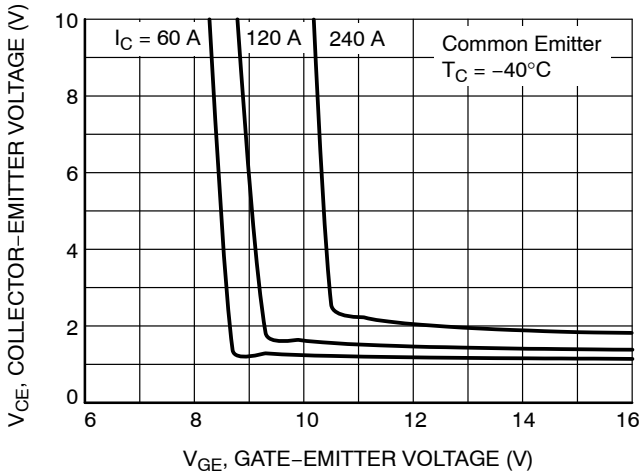



**Figure 6. Saturation Voltage vs. $V_{GE}$**



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## TYPICAL CHARACTERISTICS

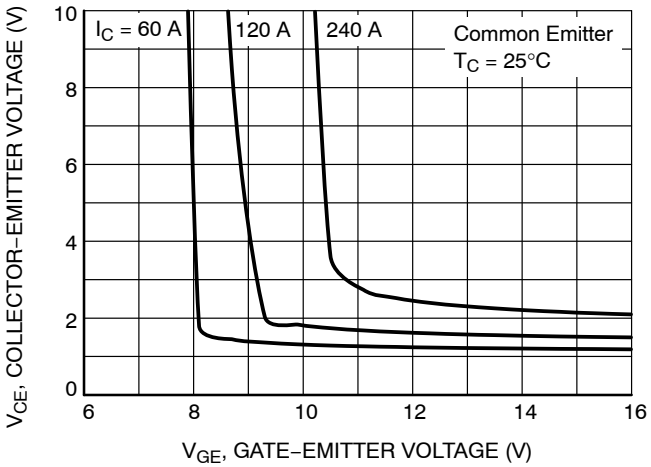



**Figure 7. Saturation Voltage vs. $V_{CE}$**

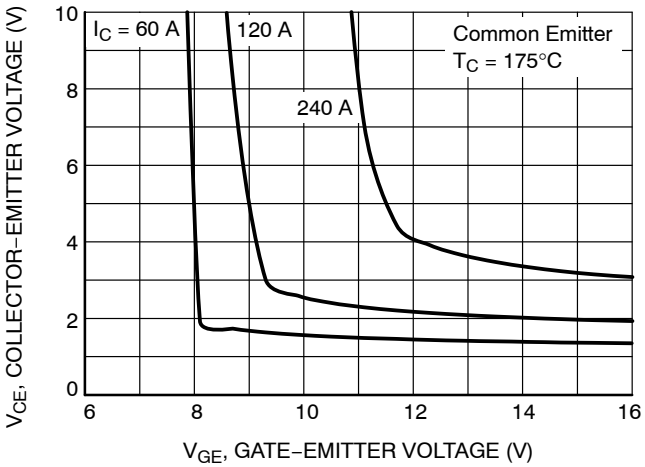



**Figure 8. Saturation Voltage vs. $V_{CE}$**

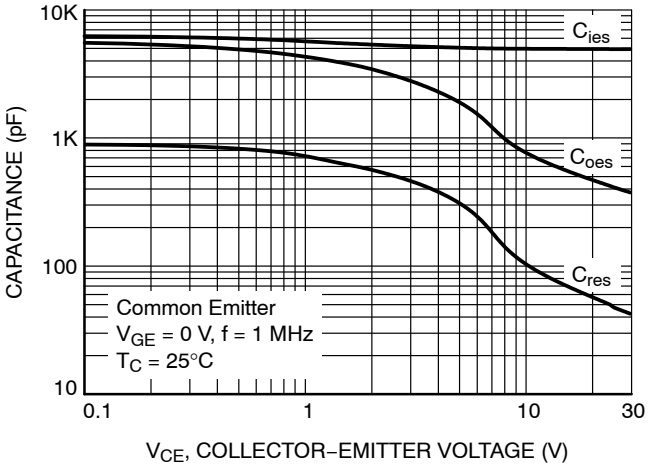



**Figure 9. Capacitance Characteristics**

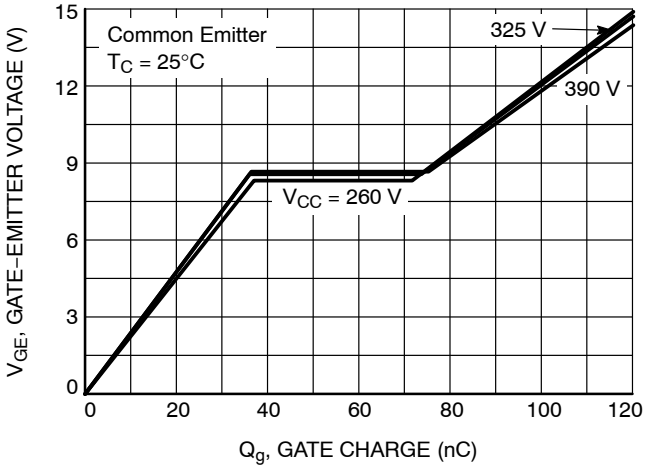



**Figure 10. Gate Charge Characteristics**

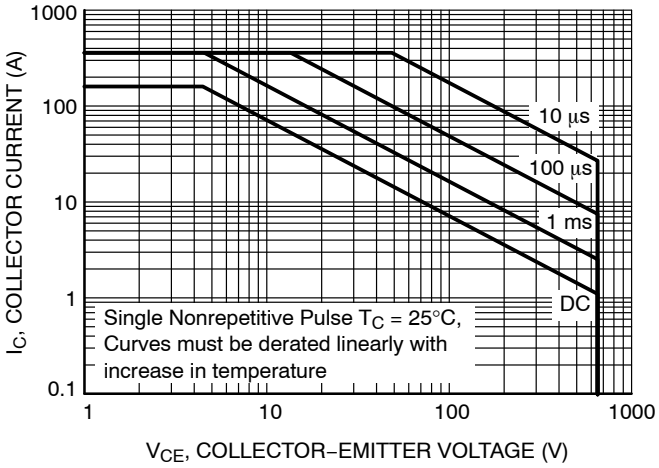



**Figure 11. SOA Characteristics**

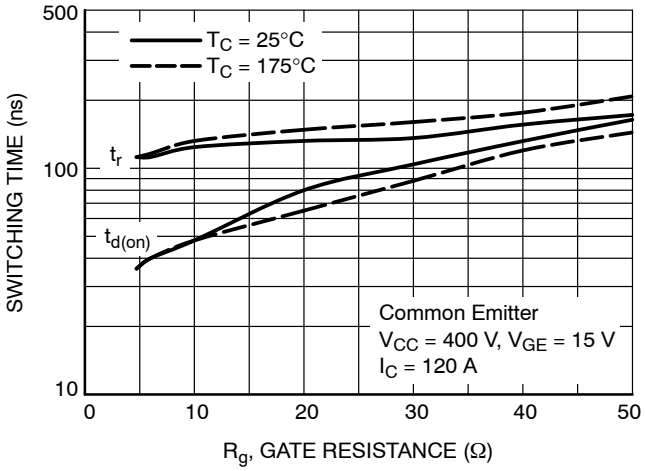



**Figure 12. Turn−On Characteristics vs. Gate Resistance**



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## TYPICAL CHARACTERISTICS

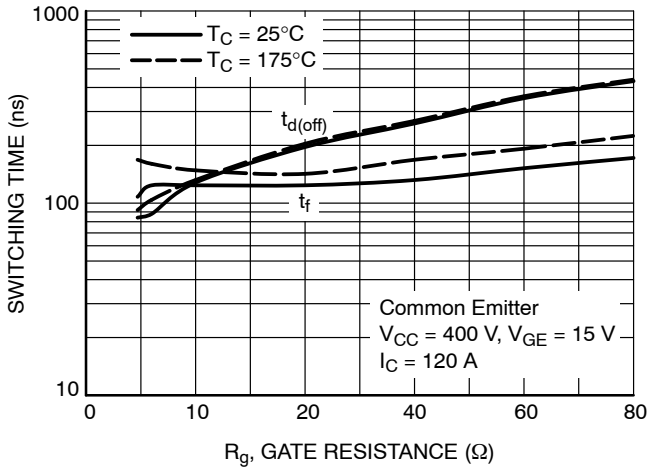



**Figure 13. Turn−Off Characteristics vs. Gate Resistance**

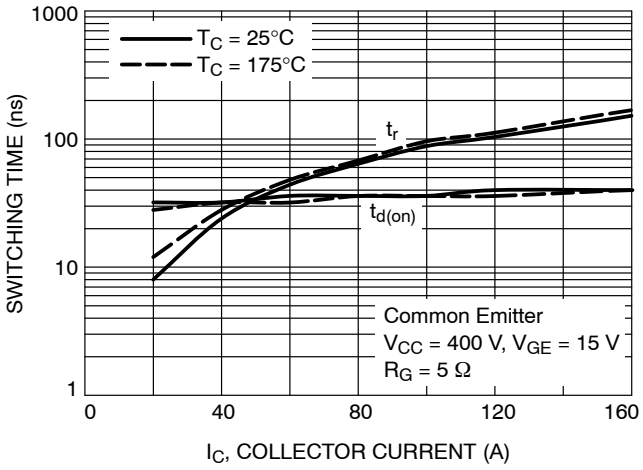



**Figure 14. Turn−On Characteristics vs. Collector Current**

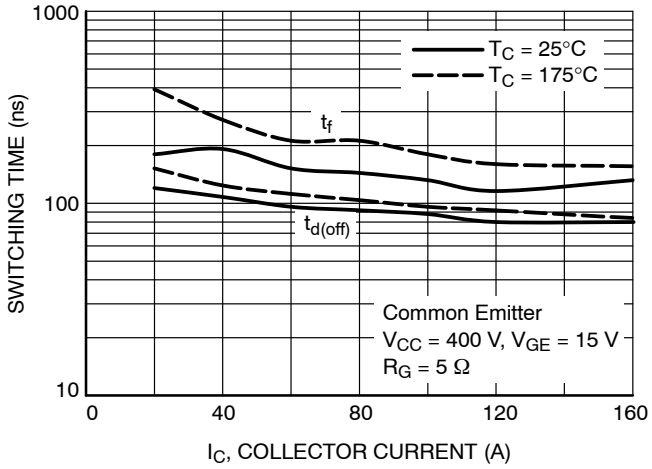



**Figure 15. Turn−Off Characteristics vs. Collector Current**

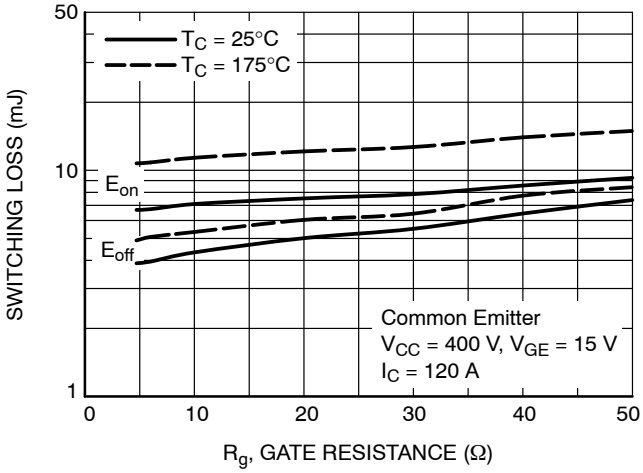



**Figure 16. Switching Loss vs. Gate Resistance**

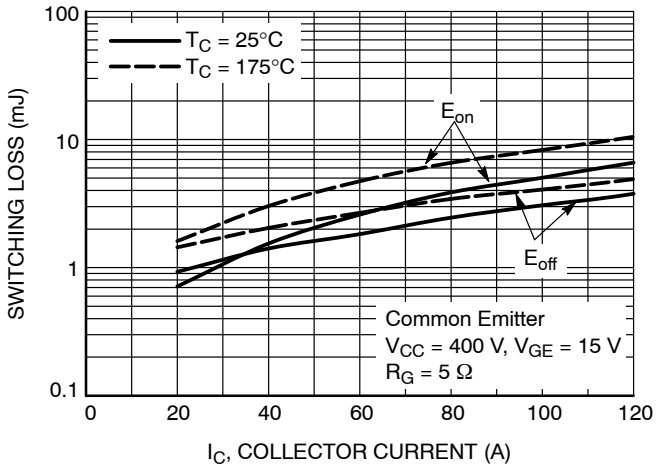



**Figure 17. Switching Loss vs. Collector Current**

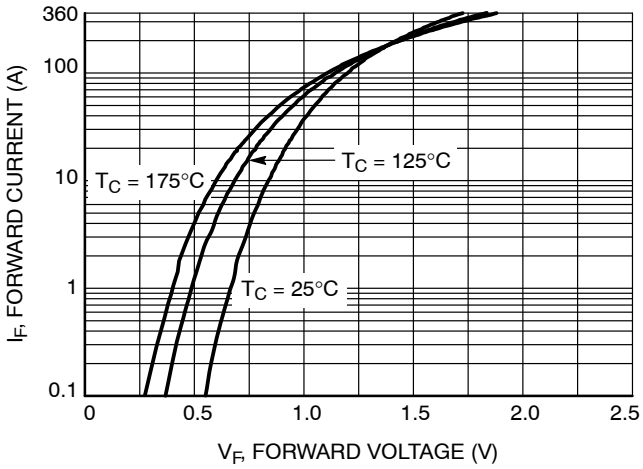



**Figure 18. Forward Characteristics**



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## TYPICAL CHARACTERISTICS

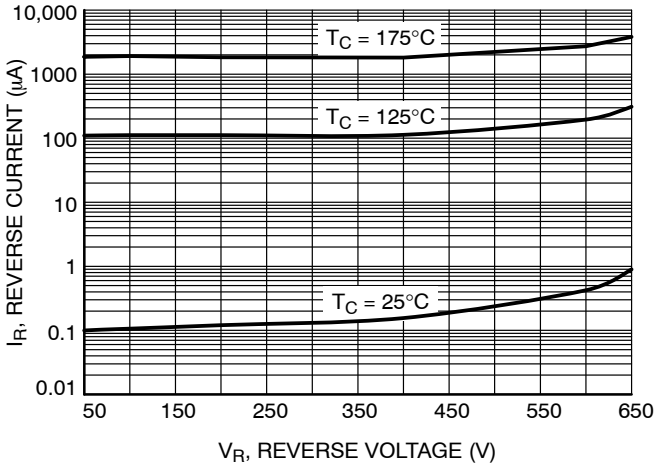



**Figure 19. Reverse Current**

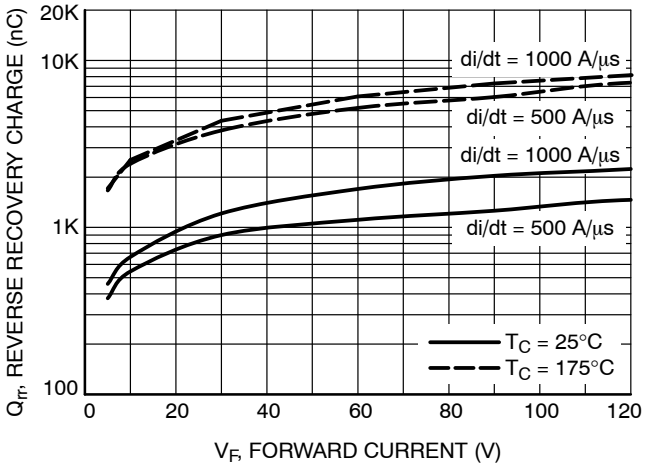



**Figure 20. Stored Charge**

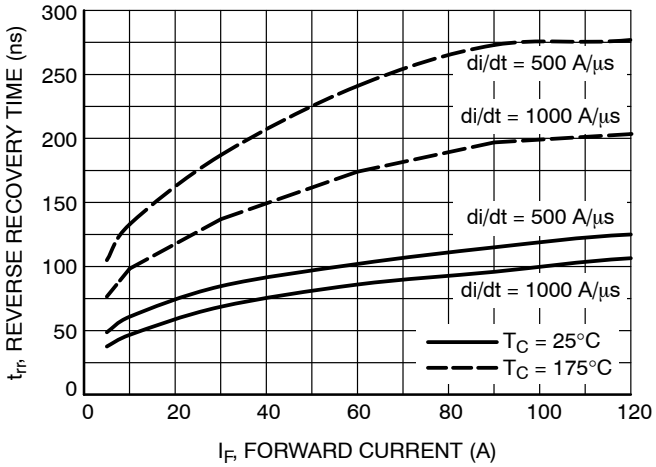



**Figure 21. Reverse Recovery Time**

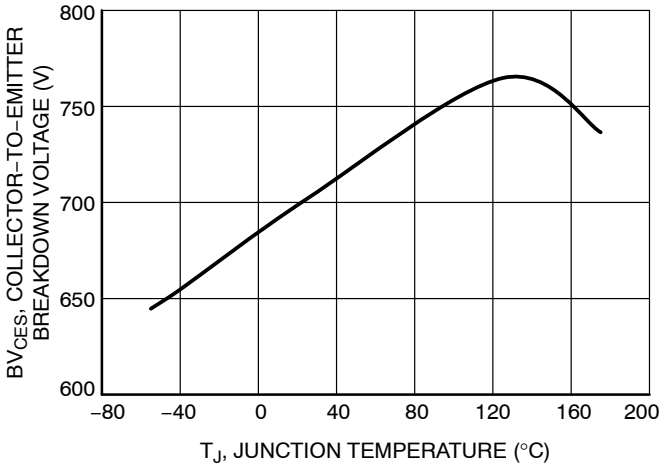



**Figure 22. Collector−to−Emitter Breakdown Voltage vs. Junction Temperature**



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## TYPICAL CHARACTERISTICS

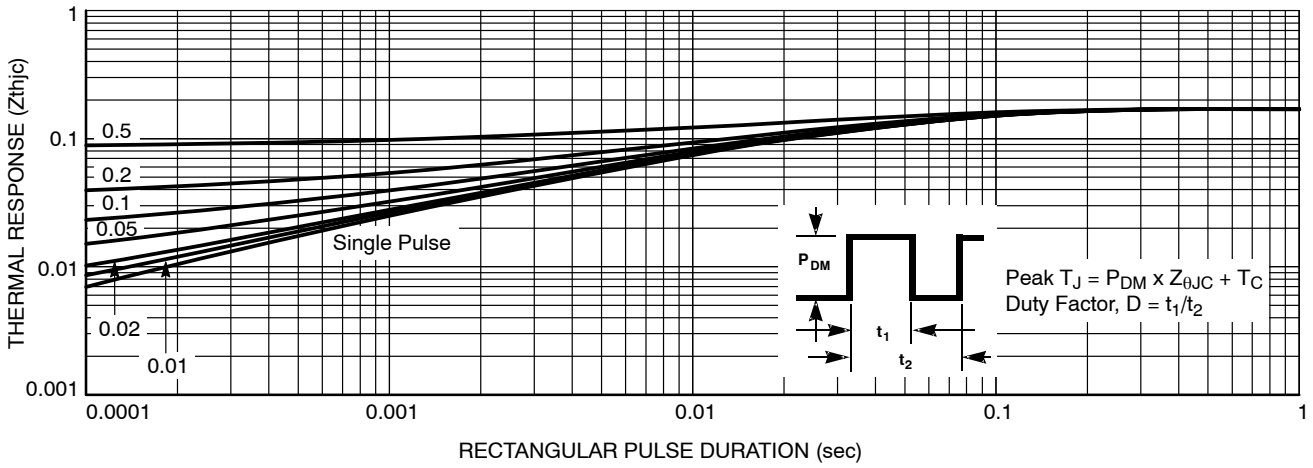



**Figure 23. Transient Thermal Impedance of IGBT**

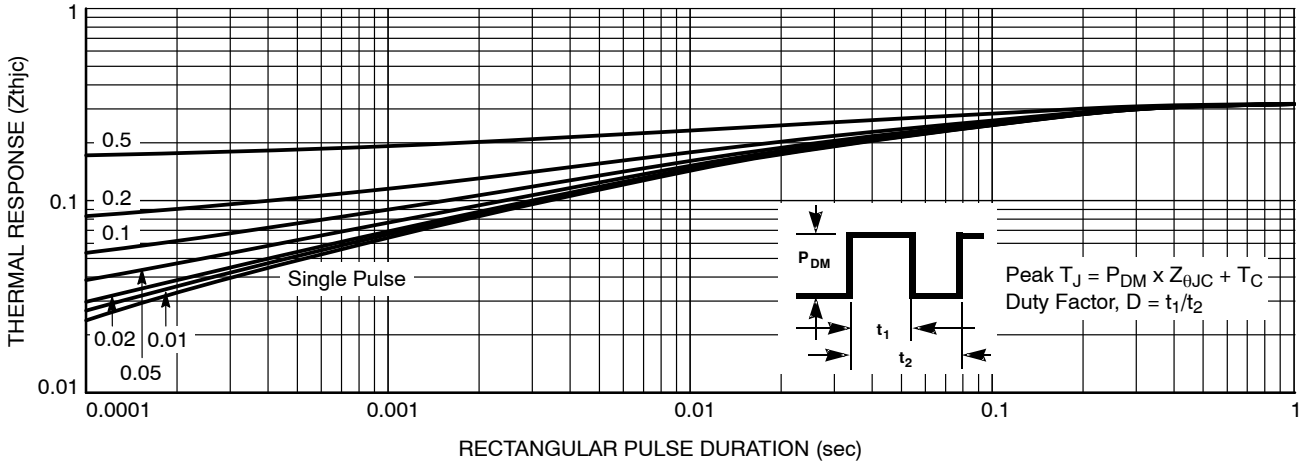
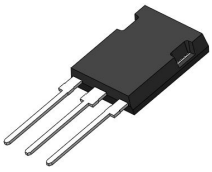



**Figure 24. Transient Thermal Impedance of Diode**

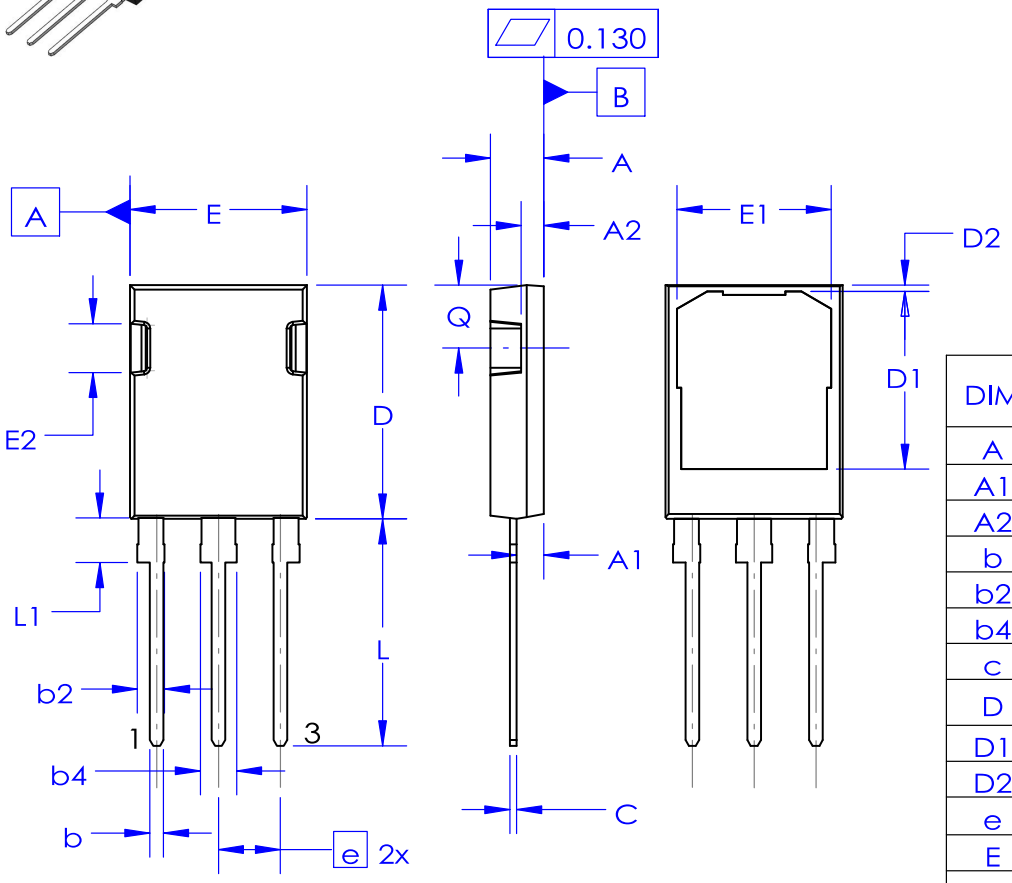


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CASE 340CU
ISSUE B

DATE 28 OCT 2021

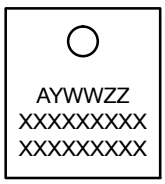



| DIM | MILLIMETERS | | |
|---|---|---|---|
| | MIN | NOM | MAX |
| A | 4.60 | 4.70 | 4.80 |
| A1 | 2.10 | 2.40 | 2.70 |
| A2 | 1.70 | 2.00 | 2.30 |
| b | 1.16 | 1.20 | 1.26 |
| b2 | 2.20 | 2.40 | 2.60 |
| b4 | 3.00 | 3.20 | 3.40 |
| c | 0.59 | 0.60 | 0.66 |
| D | 20.40 | 20.60 | 20.80 |
| D1 | 15.47 | 15.67 | 15.87 |
| D2 | 0.25 | 0.55 | 0.85 |
| e | 5.45 BSC | | |
| E | 15.40 | 15.60 | 15.80 |
| E1 | 13.40 | 13.60 | 13.80 |
| E2 | 4.12 | 4.30 | 4.52 |
| L | 19.70 | 20.00 | 20.30 |
| L1 | 3.65 | 3.85 | 4.05 |
| Q | 5.35 | 5.55 | 5.75 |

NOTES:

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

**GENERIC MARKING DIAGRAM***




XXXX = Specific Device Code
A = Assembly Site Code
Y = Year
WW = Work Week
ZZ = Assembly Lot Code

*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.

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