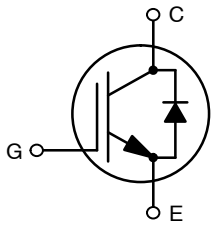
# IGBT - Power, Co-PAK, N-Channel, Field Stop VII, (FS7), SCR, Power TO247-3L

## 1200 V, 1.4 V, 25 A

# AFGHL25T120RWD

| $BV_{CES}$ | $V_{CE(sat)}$ TYP | $I_C$ MAX |
|---|---|---|
| 1200 V | 1.4 V | 25 A |




### Description

Using the novel field stop 7th generation IGBT technology and the Gen7 Diode in TO247 3−lead package, this device offers the optimum performance with low on state voltage and minimal switching losses for both hard and soft switching topologies in automotive applications.

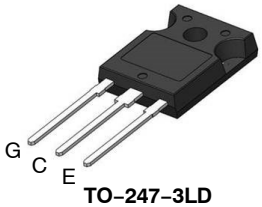
### Features

- Extremely Efficient Trench with Field Stop Technology
- Maximum Junction Temperature − $T_J$ = 175°C
- Short Circuit Rated and Low Saturation Voltage
- Fast Switching and Tightened Parameter Distribution
- AEC−Q101 Qualified, PPAP Available Upon Request
- This Device is Pb−Free, Halogen Free/BFR Free and is RoHS Compliant

### Applications

- Automotive E−compressor
- Automotive EV PTC Heater
- OBC

**COPACK IGBT**




**TO−247−3LD**
**CASE 340CX**

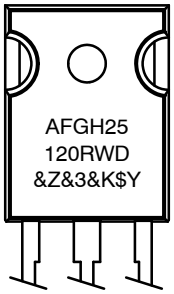
**MAXIMUM RATINGS** ($T_J$ = 25°C unless otherwise noted)

| Parameter | | Symbol | Value | Unit |
|---|---|---|---|---|
| Collector−to−Emitter Voltage | | $V_{CE}$ | 1200 | V |
| Gate−to−Emitter Voltage | | $V_{GE}$ | ±20 | |
| Transient Gate−to−Emitter Voltage | | | ±30 | |
| Collector Current | $T_C$ = 25°C | $I_C$ | 50 | A |
| | $T_C$ = 100°C | | 25 | |
| Power Dissipation | $T_C$ = 25°C | $P_D$ | 468 | W |
| | $T_C$ = 100°C | | 234 | |
| Pulsed Collector Current | $T_C$ = 25°C, $t_p$ = 10 μs (Note 1) | $I_{CM}$ | 75 | A |
| Diode Forward Current | $T_C$ = 25°C | $I_F$ | 50 | |
| | $T_C$ = 100°C | | 25 | |
| Pulsed Diode Maximum Forward Current | $T_C$ = 25°C, $t_p$ = 10 μs (Note 1) | $I_{FM}$ | 75 | |
| Short Circuit Withstand Time $V_{GE}$ = 15 V, $V_{CC}$ = 800 V, $T_C$ = 150°C | | $T_{SC}$ | 6 | μs |
| Operating Junction and Storage Temperature Range | | $T_J$, $T_{stg}$ | −55 to +175 | °C |
| Lead Temperature for Soldering Purposes | | $T_L$ | 260 | |

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. Repetitive rating: Pulse width limited by max. junction temperature

**MARKING DIAGRAM**




| | |
|---|---|
| AFGH25120RWD | = Specific Device Code |
| &Z | = Assembly Plant Code |
| &3 | = 3−Digit Date Code |
| &K | = 2−Digit Lot Traceability Code |
| $Y | = **onsemi** Logo |

**ORDERING INFORMATION**

| Device | Package | Shipping |
|---|---|---|
| AFGHL25T120RWD | TO247−3L (Pb−Free) | 30 Units / Tube |

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## THERMAL CHARACTERISTICS

| Parameter | Symbol | Value | Unit |
|---|---|---|---|
| Thermal Resistance Junction−to−Case, for IGBT | $R_{\theta JC}$ | 0.32 | °C/W |
| Thermal Resistance Junction−to−Case, for Diode | | 0.59 | |
| Thermal Resistance Junction−to−Ambient | $R_{\theta JA}$ | 40 | |

## ELECTRICAL CHARACTERISTICS OF IGBT

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** ($T_J$ = 25°C unless otherwise specified) | | | | | | |
| Collector−to−Emitter Breakdown Voltage | $BV_{CES}$ | $V_{GE}$ = 0 V, $I_C$ = 1 mA | 1200 | – | – | V |
| Collector−to−Emitter Breakdown Voltage Temperature Coefficient | $\Delta BV_{CES}$ / $\Delta T_J$ | $V_{GE}$ = 0 V, $I_C$ = 9.99 mA | – | 1226 | – | mV/°C |
| Zero Gate Voltage Collector Current | $I_{CES}$ | $V_{GE}$ = 0 V, $V_{CE}$ = $V_{CES}$ | – | – | 40 | μA |
| Gate−to−Emitter leakage Current | $I_{GES}$ | $V_{GE}$ = ±20 V, $V_{CE}$ = 0 V | – | – | ±400 | nA |
| **ON CHARACTERISTICS** | | | | | | |
| Gate Threshold Voltage | $V_{GE(th)}$ | $V_{GE}$ = $V_{CE}$, $I_C$ = 25 mA, $T_J$ = 25°C | 5.1 | 6.0 | 6.9 | V |
| Gate−to−Emitter Saturation Voltage | $V_{CE(sat)}$ | $V_{GE}$ = 15 V, $I_C$ = 25 A, $T_J$ = 25°C | – | 1.4 | 1.73 | V |
| | | $V_{GE}$ = 15 V, $I_C$ = 25 A, $T_J$ = 175°C | – | 1.62 | – | |
| **DYNAMIC CHARACTERISTICS** | | | | | | |
| Input Capacitance | $C_{IES}$ | $V_{CE}$ = 30 V, $V_{GE}$ = 0 V, f = 1 MHz | – | 3054 | – | pF |
| Output Capacitance | $C_{OES}$ | | – | 126 | – | |
| Reverse Transfer Capacitance | $C_{RES}$ | | – | 15.4 | – | |
| Total Gate Charge | $Q_G$ | $V_{CE}$ = 600 V, $I_C$ = 25 A, $V_{GE}$ = 15 V | – | 113 | – | nC |
| Gate−to−Emitter Charge | $Q_{GE}$ | | – | 27.2 | – | |
| Gate−to−Collector Charge | $Q_{GC}$ | | – | 49.5 | – | |
| **SWITCHING CHARACTERISTIC, INDUCTIVE LOAD** | | | | | | |
| Turn−On Delay Time | $t_{d(on)}$ | $V_{CE}$ = 600 V, $V_{GE}$ = 0/15 V, $I_C$ = 12.5 A, $R_G$ = 4.7 Ω, $T_J$ = 25°C | – | 33.8 | – | ns |
| Turn−Off Delay Time | $t_{d(off)}$ | | – | 223 | – | |
| Rise Time | $t_r$ | | – | 19.7 | – | |
| Fall Time | $t_f$ | | – | 192 | – | |
| Turn−On Switching Loss | $E_{on}$ | | – | 0.55 | – | mJ |
| Turn−Off Switching Loss | $E_{off}$ | | – | 0.86 | – | |
| Total Switching Loss | $E_{ts}$ | | – | 1.41 | – | |
| Turn−On Delay Time | $t_{d(on)}$ | $V_{CE}$ = 600 V, $V_{GE}$ = 0/15 V, $I_C$ = 25 A, $R_G$ = 4.7 Ω, $T_J$ = 25°C | – | 36.9 | – | ns |
| Turn−Off Delay Time | $t_{d(off)}$ | | – | 175 | – | |
| Rise time | $t_r$ | | – | 35.4 | – | |
| Fall Time | $t_f$ | | – | 126 | – | |
| Turn−On Switching Loss | $E_{on}$ | | – | 1.57 | – | mJ |
| Turn−Off Switching Loss | $E_{off}$ | | – | 1.06 | – | |
| Total Switching Loss | $E_{ts}$ | | – | 2.62 | – | |

**ELECTRICAL CHARACTERISTICS OF IGBT** (continued)

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **SWITCHING CHARACTERISTIC, INDUCTIVE LOAD** | | | | | | |
| Turn−On Delay Time | $t_{d(on)}$ | $V_{CE}$ = 600 V, $V_{GE}$ = 0/15 V, $I_C$ = 12.5 A, $R_G$ = 4.7 Ω, $T_J$ = 175°C | – | 37.7 | – | ns |
| Turn−Off Delay Time | $t_{d(off)}$ | | – | 315 | – | |
| Rise Time | $t_r$ | | – | 27.1 | – | |
| Fall Time | $t_f$ | | – | 384 | – | |
| Turn−On Switching Loss | $E_{on}$ | | – | 0.78 | – | mJ |
| Turn−Off Switching Loss | $E_{off}$ | | – | 1.6 | – | |
| Total Switching Loss | $E_{ts}$ | | – | 2.38 | – | |
| Turn−On Delay Time | $t_{d(on)}$ | $V_{CE}$ = 600 V, $V_{GE}$ = 0/15 V, $I_C$ = 25 A, $R_G$ = 4.7 Ω, $T_J$ = 175°C | – | 42.2 | – | ns |
| Turn−Off Delay Time | $t_{d(off)}$ | | – | 235 | – | |
| Rise Time | $t_r$ | | – | 46.5 | – | |
| Fall Time | $t_f$ | | – | 242 | – | |
| Turn−On Switching Loss | $E_{on}$ | | – | 2.23 | – | mJ |
| Turn−Off Switching Loss | $E_{off}$ | | – | 1.9 | – | |
| Total Switching Loss | $E_{ts}$ | | – | 4.14 | – | |
| **DIODE CHARACTERISTICS** | | | | | | |
| Diode Forward Voltage | $V_F$ | $I_F$ = 25 A, $T_J$ = 25°C | – | 1.7 | 2.0 | V |
| | | $I_F$ = 25 A, $T_J$ = 175°C | – | 1.67 | – | |
| **DIODE SWITCHING CHARACTERISTIC, INDUCTIVE LOAD** | | | | | | |
| Reverse Recovery Time | $t_{rr}$ | $V_R$ = 600 V, $I_F$ = 12.5 A, $dI_F/dt$ = 500 A/μs, $T_J$ = 25°C | – | 133 | – | ns |
| Reverse Recovery Charge | $Q_{rr}$ | | – | 1179 | – | nC |
| Reverse Recovery Energy | $E_{rec}$ | | – | 0.39 | – | mJ |
| Peak Reverse Recovery Current | $I_{RRM}$ | | – | 22.1 | – | A |
| Reverse Recovery Time | $t_{rr}$ | $V_R$ = 600 V, $I_F$ = 25 A, $dI_F/dt$ = 500 A/μs, $T_J$ = 25°C | – | 173 | – | ns |
| Reverse Recovery Charge | $Q_{rr}$ | | – | 2136 | – | nC |
| Reverse Recovery Energy | $E_{rec}$ | | – | 0.65 | – | mJ |
| Peak Reverse Recovery Current | $I_{RRM}$ | | – | 28.4 | – | A |
| Reverse Recovery Time | $t_{rr}$ | $V_R$ = 600 V, $I_F$ = 12.5 A, $dI_F/dt$ = 500 A/μs, $T_J$ = 175°C | – | 180 | – | ns |
| Reverse Recovery Charge | $Q_{rr}$ | | – | 1775 | – | nC |
| Reverse Recovery Energy | $E_{rec}$ | | – | 0.67 | – | mJ |
| Peak Reverse Recovery Current | $I_{RRM}$ | | – | 24.5 | – | A |
| Reverse Recovery Time | $t_{rr}$ | $V_R$ = 600 V, $I_F$ = 25 A, $dI_F/dt$ = 500 A/μs, $T_J$ = 175°C | – | 229 | – | ns |
| Reverse Recovery Charge | $Q_{rr}$ | | – | 3383 | – | nC |
| Reverse Recovery Energy | $E_{rec}$ | | – | 1.16 | – | mJ |
| Peak Reverse Recovery Current | $I_{RRM}$ | | – | 34 | – | 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

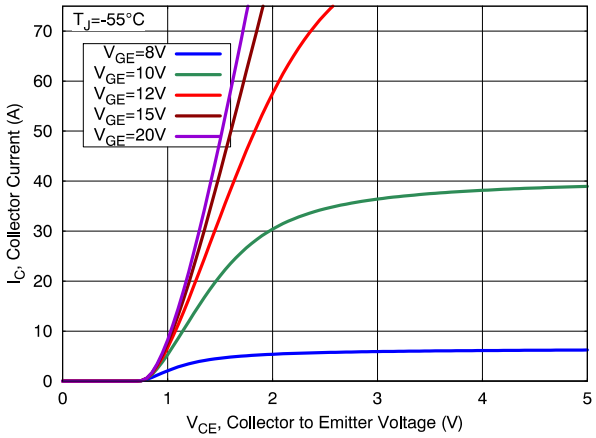



**Figure 1. Output Characteristics**

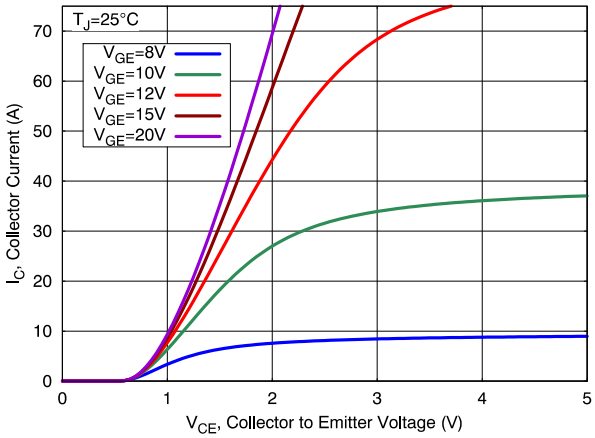



**Figure 2. Output Characteristics**

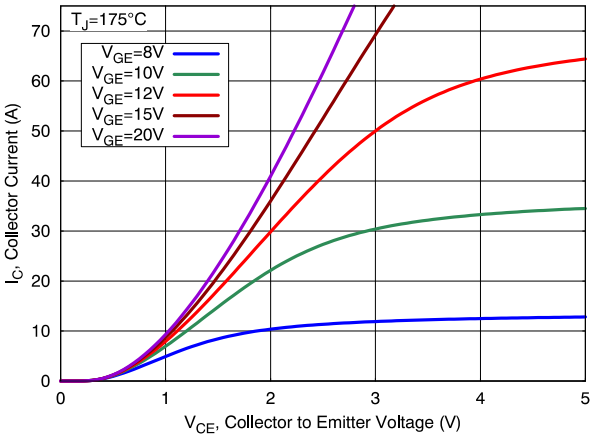



**Figure 3. Output Characteristics**

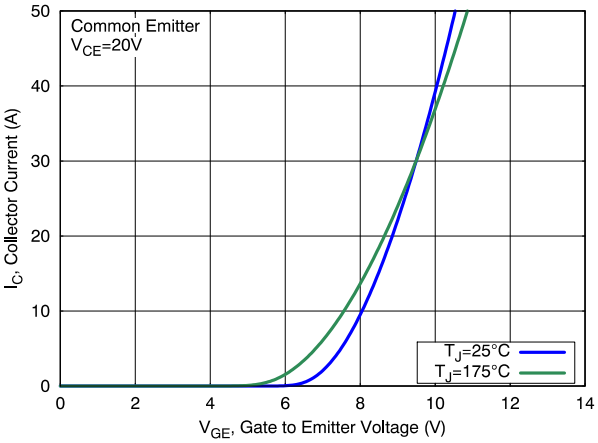



**Figure 4. Transfer Characteristics**

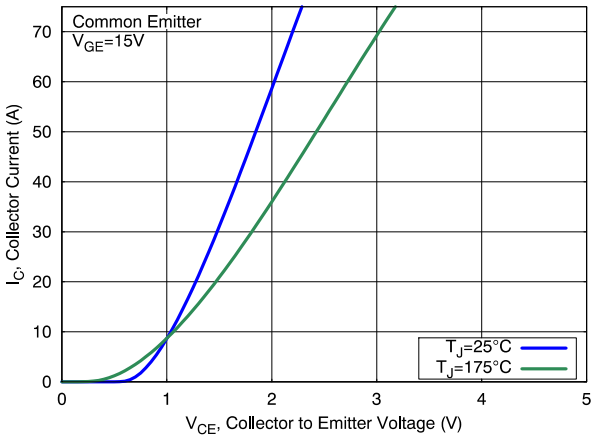



**Figure 5. Saturation Characteristics**

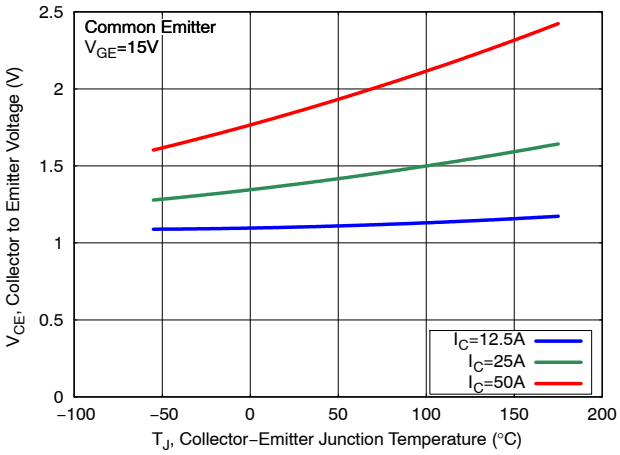



**Figure 6. Saturation Voltage vs. Junction Temperature**

## TYPICAL CHARACTERISTICS

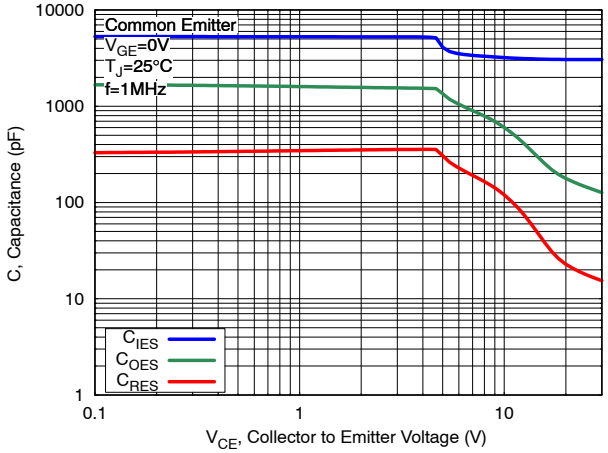



**Figure 7. Capacitance Characteristics**

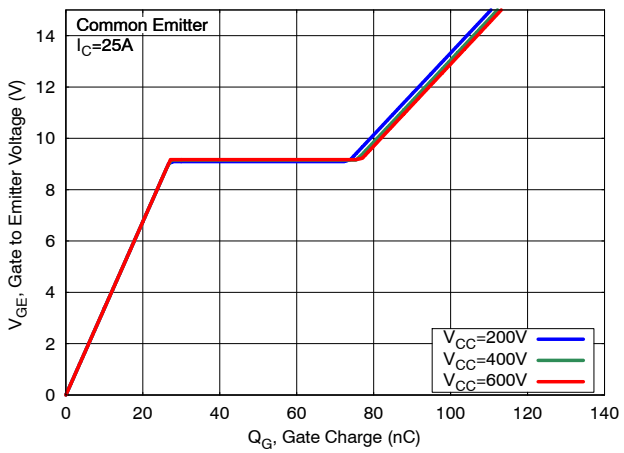



**Figure 8. Gate Charge Characteristics**

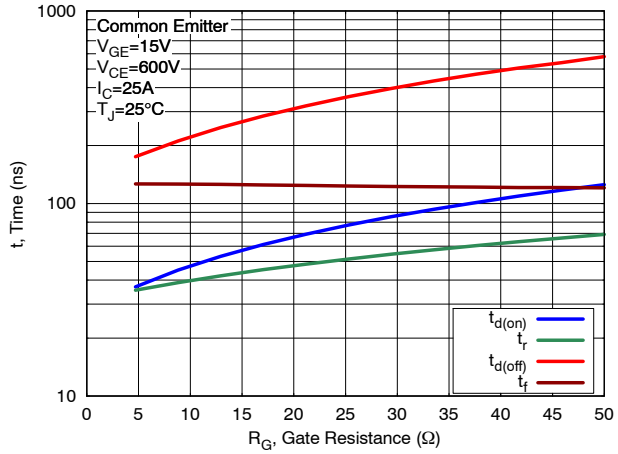



**Figure 9. Switching Time vs Gate Resistance**

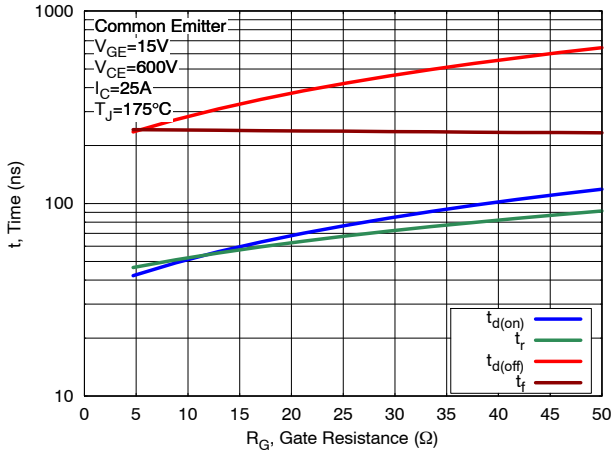



**Figure 10. Switching Time vs Gate Resistance**

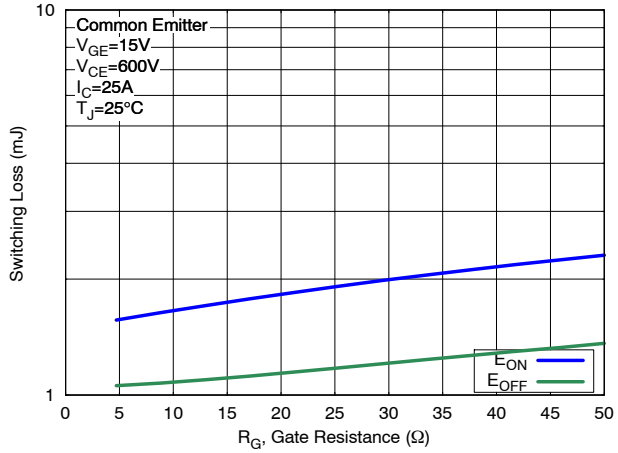



**Figure 11. Switching Loss vs Gate Resistance**

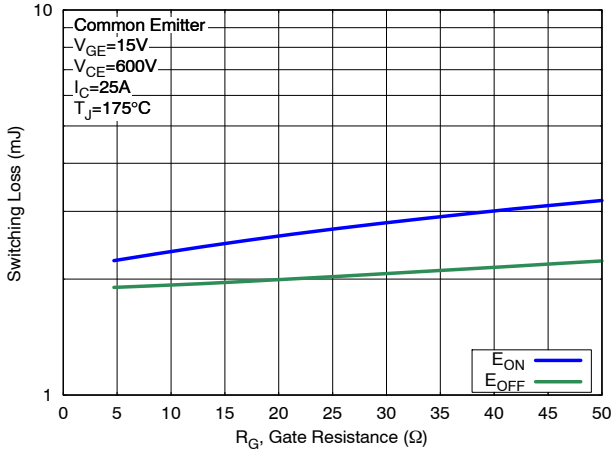



**Figure 12. Switching Loss vs Gate Resistance**

## TYPICAL CHARACTERISTICS

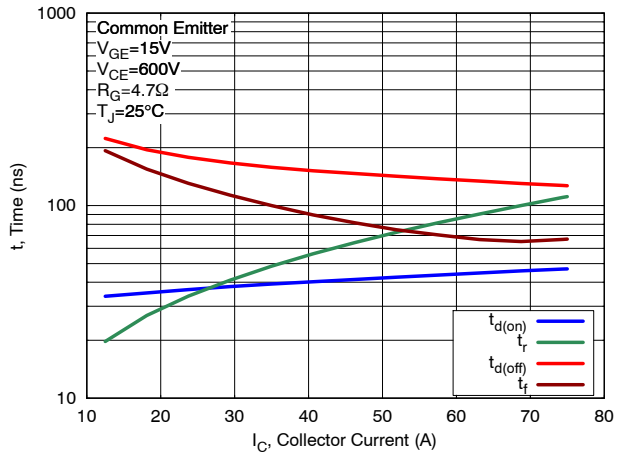



**Figure 13. Switching Time vs Collector Current**

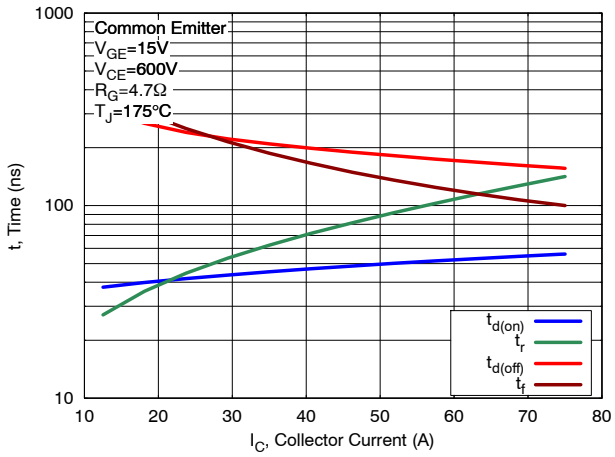



**Figure 14. Switching Time vs Collector Current**

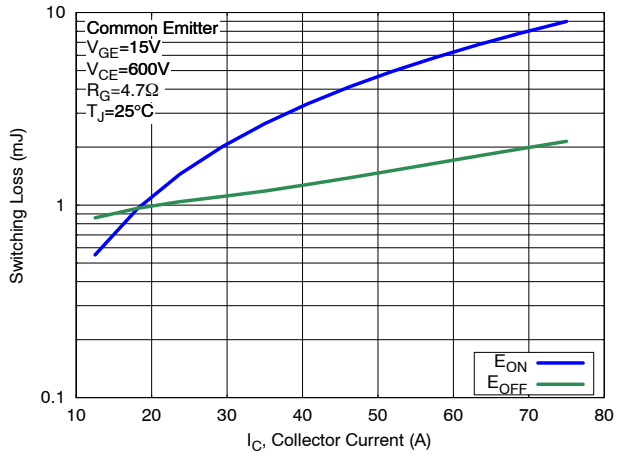



**Figure 15. Switching Loss vs Collector Current**

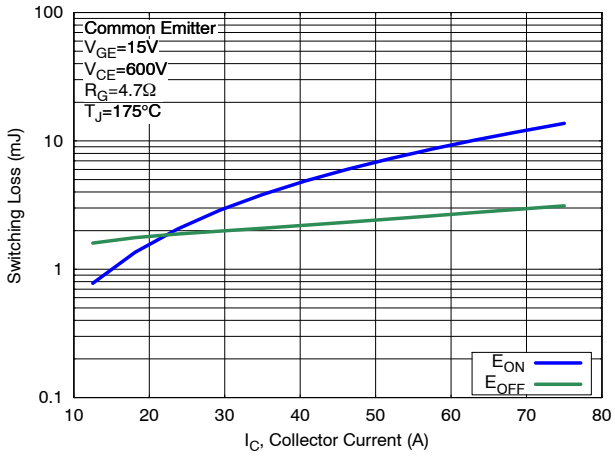



**Figure 16. Switching Loss vs Collector Current**

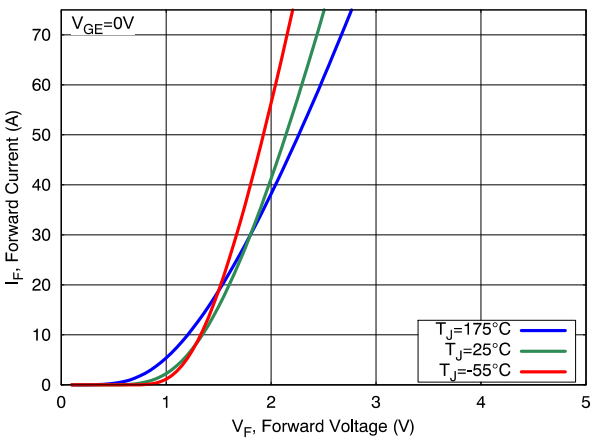



**Figure 17. Diode Forward Characteristics**

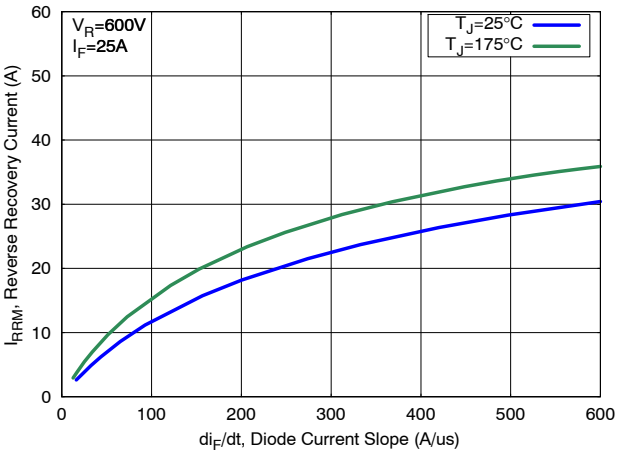



**Figure 18. Diode Reverse Recovery Current**

## TYPICAL CHARACTERISTICS

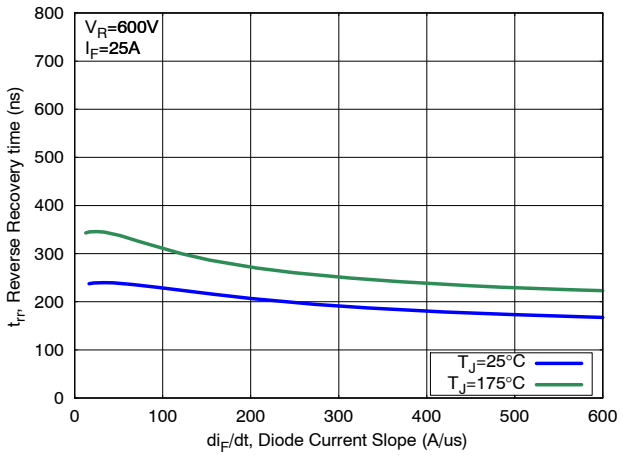



**Figure 19. Diode Reverse Recovery Current**

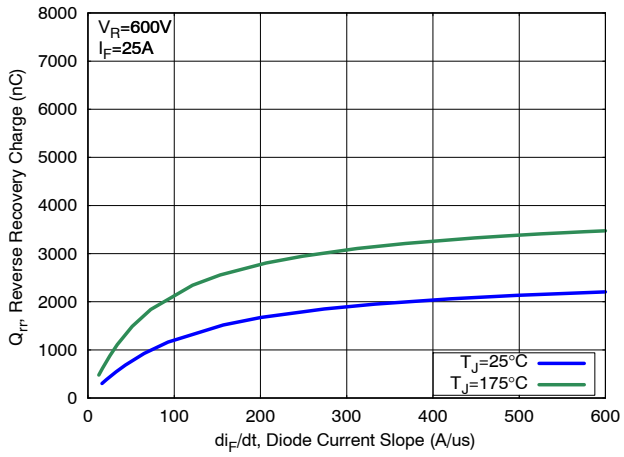



**Figure 20. Diode Stored Charge Characteristics**

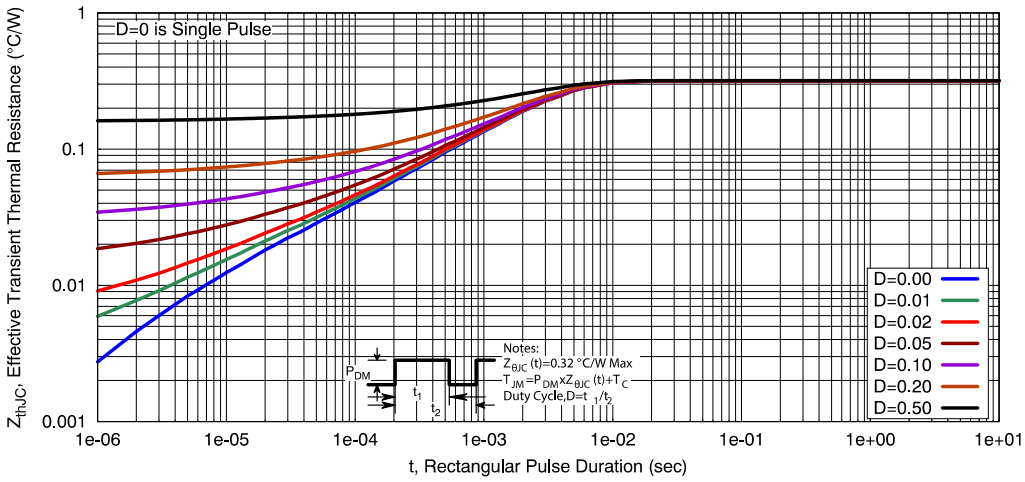



**Figure 21. Transient Thermal Impedance of IGBT**

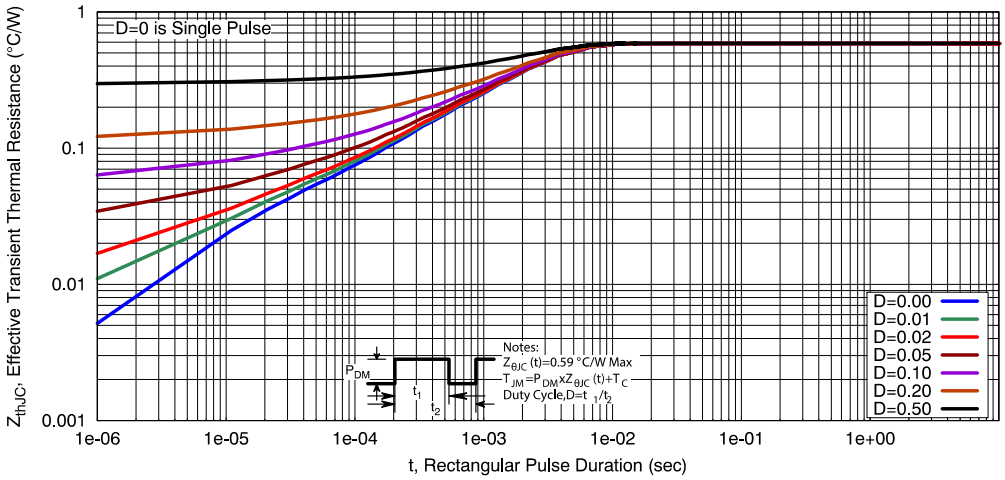
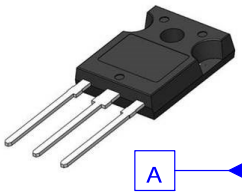
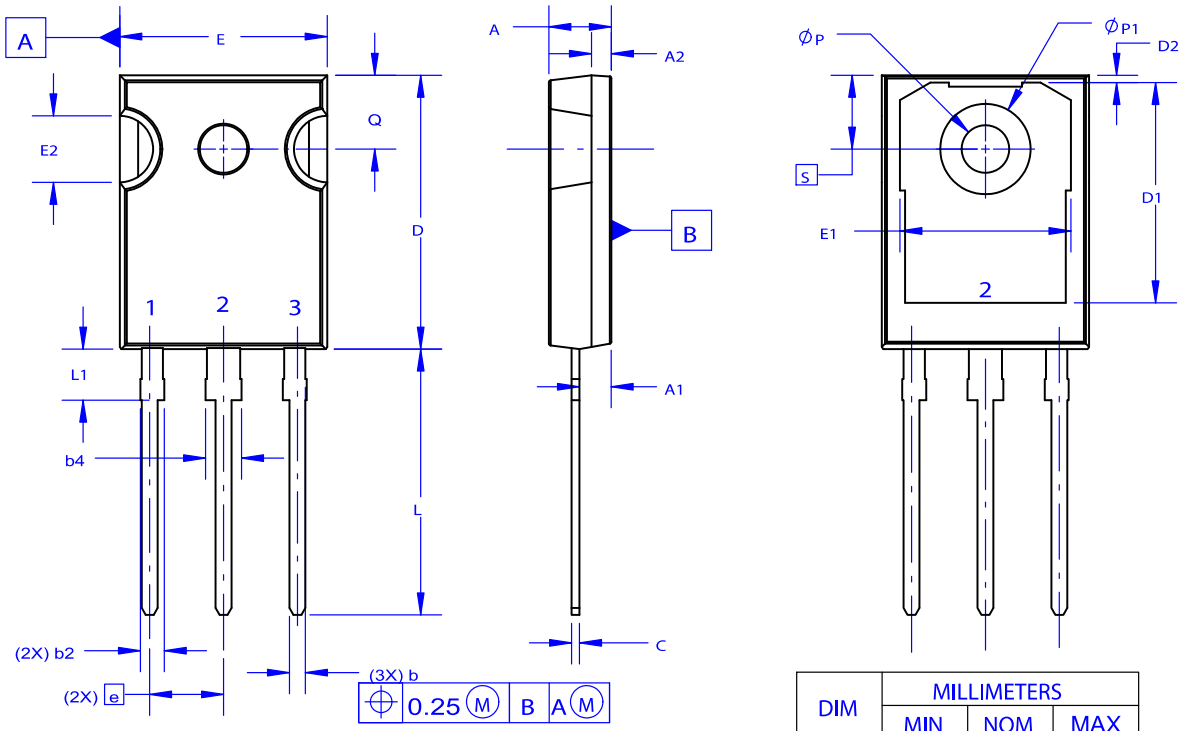



**Figure 22. Transient Thermal Impedance of Diode**

**TO−247−3LD**
CASE 340CX
ISSUE A

DATE 06 JUL 2020






NOTES: UNLESS OTHERWISE SPECIFIED.

A. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH, AND TIE BAR EXTRUSIONS.
B. ALL DIMENSIONS ARE IN MILLIMETERS.
C. DRAWING CONFORMS TO ASME Y14.5 - 2009.
D. DIMENSION A1 TO BE MEASURED IN THE REGION DEFINED BY L1.
E. LEAD FINISH IS UNCONTROLLED IN THE REGION DEFINED BY L1.

| DIM | MILLIMETERS | | |
|---|---|---|---|
| | MIN | NOM | MAX |
| A | 4.58 | 4.70 | 4.82 |
| A1 | 2.20 | 2.40 | 2.60 |
| A2 | 1.40 | 1.50 | 1.60 |
| D | 20.32 | 20.57 | 20.82 |
| E | 15.37 | 15.62 | 15.87 |
| E2 | 4.96 | 5.08 | 5.20 |
| e | ~ | 5.56 | ~ |
| L | 19.75 | 20.00 | 20.25 |
| L1 | 3.69 | 3.81 | 3.93 |
| ØP | 3.51 | 3.58 | 3.65 |
| Q | 5.34 | 5.46 | 5.58 |
| S | 5.34 | 5.46 | 5.58 |
| b | 1.17 | 1.26 | 1.35 |
| b2 | 1.53 | 1.65 | 1.77 |
| b4 | 2.42 | 2.54 | 2.66 |
| c | 0.51 | 0.61 | 0.71 |
| D1 | 13.08 | ~ | ~ |
| D2 | 0.51 | 0.93 | 1.35 |
| E1 | 12.81 | ~ | ~ |
| ØP1 | 6.60 | 6.80 | 7.00 |

**GENERIC MARKING DIAGRAM***

XXXXX = Specific Device Code
A = Assembly Location
Y = Year
WW = Work Week
G = Pb−Free Package

*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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