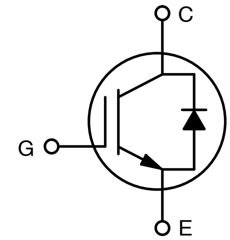
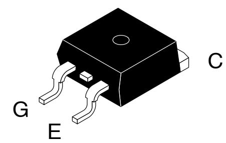
# IGBT for Automotive Applications

## 650 V, 30 A

# AFGB30T65RQDN

| $BV_{CES}$ | $V_{CE(sat)}$ TYP | $I_C$ |
|---|---|---|
| 650 V | 1.58 V | 30 A |




**D²PAK**
**3 LEAD**
**CASE 418AJ**

Using novel field stop IGBT technology, **onsemi**'s new series of FS4 IGBTs offer the optimum performance for automotive applications. This technology is Short circuit rated and offers high figure of merit with low conduction and switching losses.

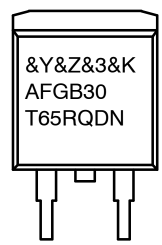
### Features

- Maximum Junction Temperature: $T_J$ = 175°C
- Positive Temperature Coefficient for Easy Parallel Operation
- High Current Capability
- Low Saturation Voltage: $V_{CE(Sat)}$ = 1.58 V (Typ.) @ $I_C$ = 30 A
- 100% of the Parts Tested for ILM (Note 2)
- High Input Impedance
- Fast Switching
- Tightened Parameter Distribution
- This Device is Pb−Free and RoHS Compliant

### Typical Applications

- E−compressor for HEV/EV
- PTC Heater for HEV/EV

### MARKING DIAGRAM




| | |
|---|---|
| &Y | = Logo |
| &Z | = Assembly Plant Code |
| &3 | = 3−Digit Date Code |
| &K | = 2−Digit Lot Traceability Code |
| AFGB30T65RQDN | = Specific Device Code |

### ORDERING INFORMATION

| Device | Package | Shipping† |
|---|---|---|
| AFGB30T65RQDN | D2PAK (TO−263) | 800 Units / Tape & Reel |

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specification Brochure, BRD8011/D.

**MAXIMUM RATINGS** ($T_C$ = 25°C unless otherwise stated)

| Parameter | Symbol | Value | Unit |
| --- | --- | --- | --- |
| Collector to Emitter Voltage | $V_{CES}$ | 650 | V |
| Gate to Emitter Voltage<br>Transient Gate to Emitter Voltage<br>$T_{pulse}$ = 5 μs, D < 0.10 | $V_{GES}$ | ±20<br>±30 | V |
| Collector Current (Note 1)<br>@$T_C$ = 25°C<br>@$T_C$ = 100°C | $I_C$ | <br>68<br>30 | A |
| Pulsed Collector Current (Note 2) | $I_{LM}$ | 120 | A |
| Pulsed Collector Current (Note 3) | $I_{CM}$ | 120 | A |
| Diode Forward Current (Note 1)<br>@$T_C$ = 25°C<br>@$T_C$ = 100°C | $I_F$ | <br>68<br>30 | A |
| Pulsed Diode Maximum Forward Current | $I_{FM}$ | 120 | A |
| Non−Repetitive Forward Surge Current<br>(Half−Sine Pulse, tp = 8.3 ms, $T_C$ = 25°C)<br>(Half−Sine Pulse, tp = 8.3 ms, $T_C$ = 150°C) | $I_{F, SM}$ | <br>140<br>100 | A |
| Short Circuit Withstand Time<br>$V_{GE}$ = 15 V, $V_{CC}$ = 400 V, $T_C$ = 150°C | $T_{SC}$ | <br>5 | μs |
| Maximum Power Dissipation<br>@$T_C$ = 25°C<br>@$T_C$ = 100°C | $P_D$ | <br>235.48<br>117.74 | W |
| Operating Junction and 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 limited by bond wire.
2. $V_{CC}$ = 400 V, $V_{GE}$ = 15 V, $I_C$ = 90 A, $R_G$ = 100 Ω, Inductive Load, 100% Tested.
3. Repetitive rating: pulse width limited by max. Junction temperature.

**THERMAL RESISTANCE RATINGS**

| Parameter | Symbol | Min | Typ | Max | Unit |
| --- | --- | --- | --- | --- | --- |
| Thermal Resistance Junction−to−Case, for IGBT | $R_{\theta JC}$ | − | 0.49 | 0.64 | °C/W |
| Thermal Resistance Junction−to−Case, for Diode | $R_{\theta JC}$ | − | 0.97 | 1.26 | |
| Thermal Resistance Junction−to−Ambient | $R_{\theta JA}$ | − | − | 40 | |

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

| Parameter | Symbol | Test Condition | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | |
| Collector–to–Emitter Breakdown Voltage, Gate–Emitter Short–Circuited | $BV_{CES}$ | $V_{GE}$ = 0 V, $I_C$ = 1 mA | 650 | – | – | V |
| Temperature Coefficient of Breakdown Voltage | $\Delta BV_{CES}/\Delta T_J$ | $V_{GE}$ = 0 V, $I_C$ = 1 mA | – | 0.61 | – | V/°C |
| Collector–Emitter Cut–Off Current, Gate–Emitter Short–Circuited | $I_{CES}$ | $V_{CE} = V_{CES}$, $V_{GE}$ = 0 V | – | – | 30 | μA |
| Gate Leakage Current, Collector–Emitter Short–Circuited | $I_{GES}$ | $V_{GE} = V_{GES}$, $V_{CE}$ = 0 V | – | – | ±400 | nA |
| **ON CHARACTERISTICS** | | | | | | |
| Gate–Emitter Threshold Voltage | $V_{GE(th)}$ | $V_{GE} = V_{CE}$, $I_C$ = 30 mA | 4.30 | 5.30 | 6.30 | V |
| Collector–Emitter Saturation Voltage | $V_{CE(sat)}$ | $I_C$ = 30 A, $V_{GE}$ = 15 V, $T_J$ = 25°C | – | 1.58 | 1.82 | V |
| | | $I_C$ = 30 A, $V_{GE}$ = 15 V, $T_J$ = 175°C | – | 1.94 | – | V |
| **DYNAMIC CHARACTERISTICS** | | | | | | |
| Input Capacitance | $C_{ies}$ | $V_{CE}$ = 30 V, $V_{GE}$ = 0 V, f = 1 MHz | – | 1580 | – | pF |
| Output Capacitance | $C_{oes}$ | | – | 54 | – | |
| Reverse Transfer Capacitance | $C_{res}$ | | – | 7 | – | |
| Gate Resistance | $R_g$ | FREQ = 1 MHz | – | 15 | – | Ω |
| Gate Charge Total | $Q_g$ | $V_{CE}$ = 400 V, $I_C$ = 30 A, $V_{GE}$ = 15 V | – | 38 | – | nC |
| Gate–Emitter Charge | $Q_{ge}$ | | – | 13 | – | |
| Gate–Collector Charge | $Q_{gc}$ | | – | 11 | – | |
| **SWITCHING CHARACTERISTICS, INDUCTIVE LOAD** | | | | | | |
| Turn–On Delay Time | $t_{d(on)}$ | $T_J$ = 25°C, $V_{CC}$ = 400 V, $I_C$ = 15 A, $R_g$ = 2.5 Ω, $V_{GE}$ = 15 V, Inductive Load | – | 20 | – | ns |
| Rise Time | $t_r$ | | – | 18 | – | |
| Turn-Off Delay Time | $t_{d(off)}$ | | – | 60 | – | |
| Fall Time | $t_f$ | | – | 92 | – | |
| Turn-On Switching Loss | $E_{on}$ | | – | 0.34 | – | mJ |
| Turn–Off Switching Loss | $E_{off}$ | | – | 0.32 | – | |
| Total Switching Loss | $E_{ts}$ | | – | 0.66 | – | |
| Turn-On Delay Time | $t_{d(on)}$ | $T_J$ = 25°C, $V_{CC}$ = 400 V, $I_C$ = 30 A, $R_g$ = 2.5 Ω, $V_{GE}$ = 15 V, Inductive Load | – | 18 | – | ns |
| Rise Time | $t_r$ | | – | 37 | – | |
| Turn-Off Delay Time | $t_{d(off)}$ | | – | 48 | – | |
| Fall Time | $t_f$ | | – | 75 | – | |
| Turn-On Switching Loss | $E_{on}$ | | – | 0.78 | – | mJ |
| Turn–Off Switching Loss | $E_{off}$ | | – | 0.56 | – | |
| Total Switching Loss | $E_{ts}$ | | – | 1.34 | – | |
| Turn–On Delay Time | $t_{d(on)}$ | $T_J$ = 175°C, $V_{CC}$ = 400 V, $I_C$ = 15 A, $R_g$ = 2.5 Ω, $V_{GE}$ = 15 V, Inductive Load | – | 20 | – | ns |
| Rise Time | $t_r$ | | – | 24 | – | |
| Turn-Off Delay Time | $t_{d(off)}$ | | – | 76 | – | |
| Fall Time | $t_f$ | | – | 184 | – | |
| Turn-On Switching Loss | $E_{on}$ | | – | 0.48 | – | mJ |
| Turn-Off Switching Loss | $E_{off}$ | | – | 0.67 | – | |
| Total Switching Loss | $E_{ts}$ | | – | 1.15 | – | |

**ELECTRICAL CHARACTERISTICS** ($T_J$ = 25°C unless otherwise stated) (continued)

| Parameter | Symbol | Test Condition | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **SWITCHING CHARACTERISTICS, INDUCTIVE LOAD** | | | | | | |
| Turn-On Delay Time | $t_{d(on)}$ | $T_J$ = 175°C, $V_{CC}$ = 400 V, $I_C$ = 30 A, $R_g$ = 2.5 Ω, $V_{GE}$ = 15 V, Inductive Load | – | 20 | – | ns |
| Rise Time | $t_r$ | | – | 40 | – | |
| Turn-Off Delay Time | $t_{d(off)}$ | | – | 60 | – | |
| Fall Time | $t_f$ | | – | 144 | – | |
| Turn–On Switching Loss | $E_{on}$ | | – | 1.10 | – | mJ |
| Turn-Off Switching Loss | $E_{off}$ | | – | 1.11 | – | |
| Total Switching Loss | $E_{ts}$ | | – | 2.21 | – | |
| **DIODE CHARACTERISTICS** | | | | | | |
| Diode Forward Voltage | $V_F$ | $T_J$ = 25°C, $I_F$ = 30 A | – | 1.71 | 2.10 | V |
| | | $T_J$ = 175°C, $I_F$ = 30 A | – | 1.76 | – | |
| **DIODE SWITCHING CHARACTERISTIC, INDUCTIVE LOAD** | | | | | | |
| Reverse Recovery Energy | $E_{REC}$ | $T_J$ = 25°C, $V_R$ = 400 V, $I_F$ = 15 A, $di_F/dt$ = 1000 A/μs | – | 36 | – | μJ |
| Diode Reverse Recovery Time | $T_{rr}$ | | – | 33 | – | ns |
| Diode Reverse Recovery Charge | $Q_{rr}$ | | – | 283 | – | nC |
| Reverse Recovery Energy | $E_{REC}$ | $T_J$ = 25°C, $V_R$ = 400 V, $I_F$ = 30 A, $di_F/dt$ = 1000 A/μs | – | 56 | – | μJ |
| Diode Reverse Recovery Time | $T_{rr}$ | | – | 44 | – | ns |
| Diode Reverse Recovery Charge | $Q_{rr}$ | | – | 408 | – | nC |
| Reverse Recovery Energy | $E_{REC}$ | $T_J$ = 175°C, $V_R$ = 400 V, $I_F$ = 15 A, $di_F/dt$ = 1000 A/μs | – | 154 | – | μJ |
| Diode Reverse Recovery Time | $T_{rr}$ | | – | 68 | – | ns |
| Diode Reverse Recovery Charge | $Q_{rr}$ | | – | 768 | – | nC |
| Reverse Recovery Energy | $E_{REC}$ | $T_J$ = 175°C, $V_R$ = 400 V, $I_F$ = 30 A, $di_F/dt$ = 1000 A/μs | – | 224 | – | μJ |
| Diode Reverse Recovery Time | $T_{rr}$ | | – | 91 | – | ns |
| Diode Reverse Recovery Charge | $Q_{rr}$ | | – | 1075 | – | nC |

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

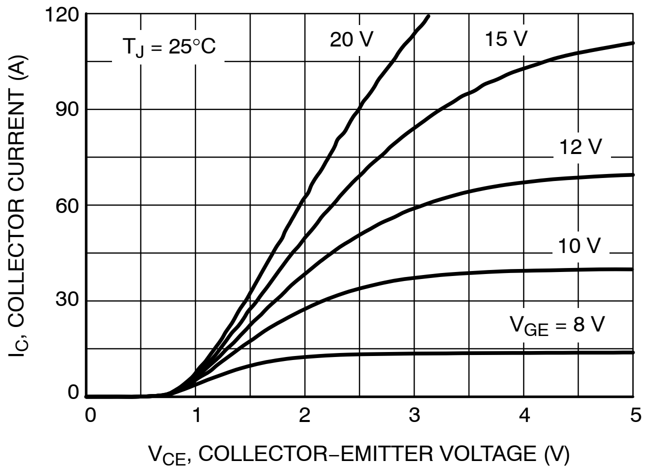



**Figure 1. Typical Output Characteristics (25°C)**

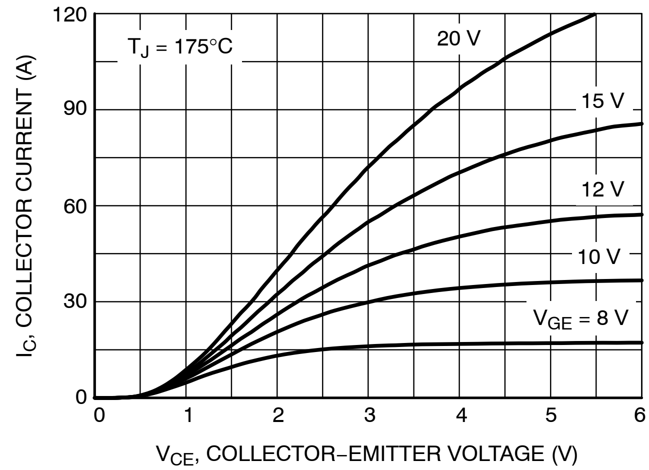



**Figure 2. Typical Output Characteristics (175°C)**

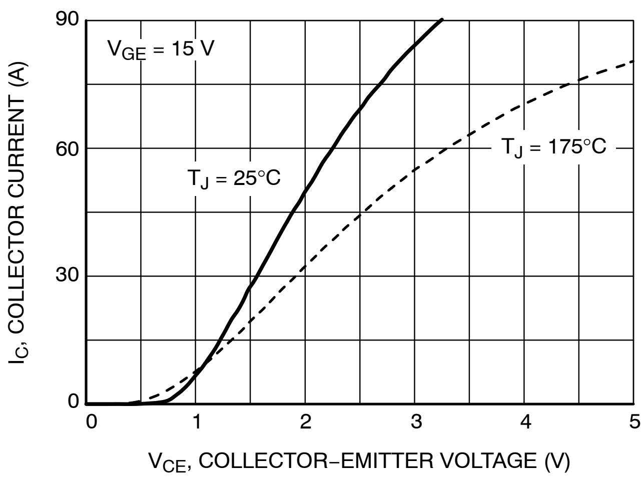



**Figure 3. Typical Saturation Voltage Characteristics**

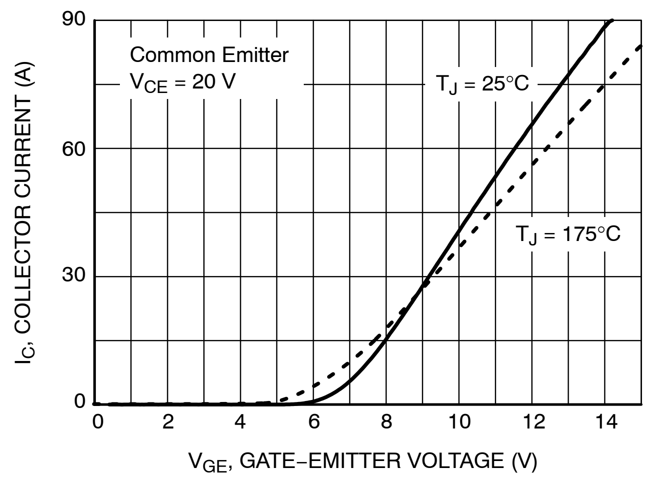



**Figure 4. Typical Transfer Characteristics**

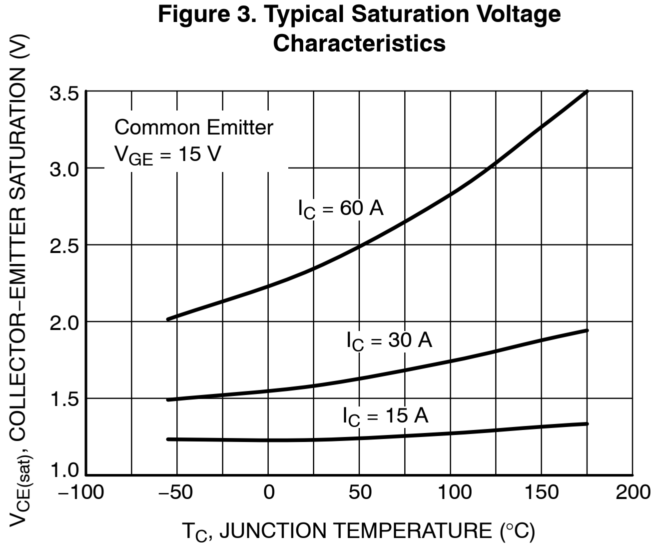



**Figure 5. Saturation Voltage vs. Case**

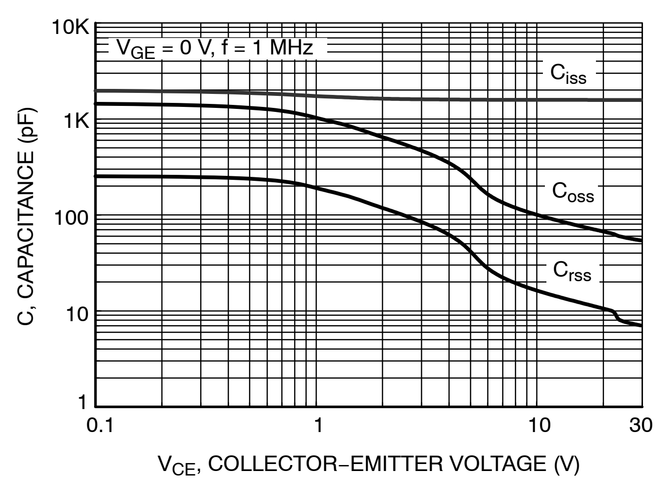



**Figure 6. Capacitance Characteristics**

## TYPICAL CHARACTERISTICS (Continued)

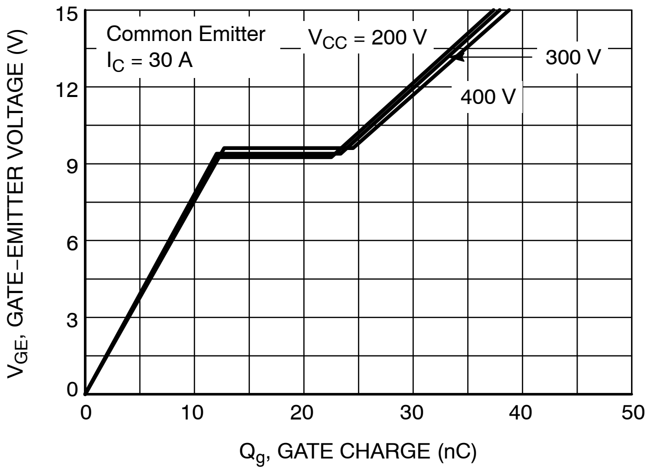



**Figure 7. Gate Charge Characteristics**

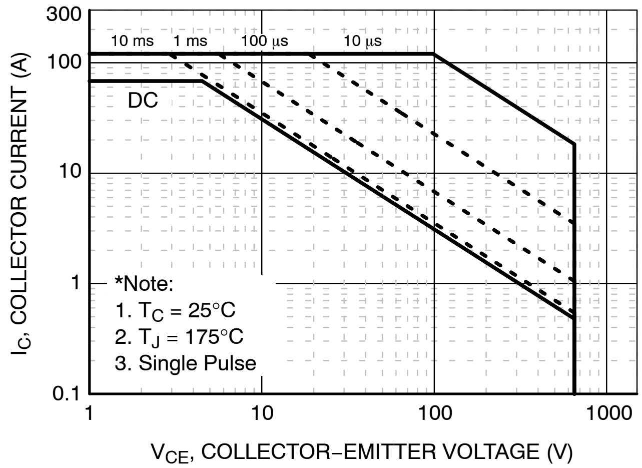



**Figure 8. SOA Characteristics**

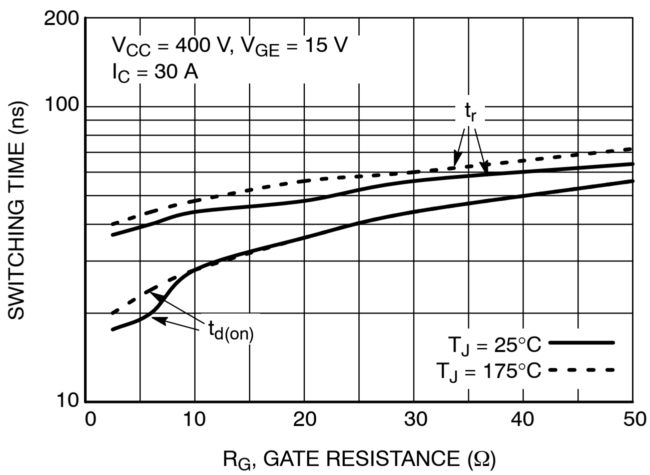



**Figure 9. Turn−On Characteristics vs. Gate Resistance**

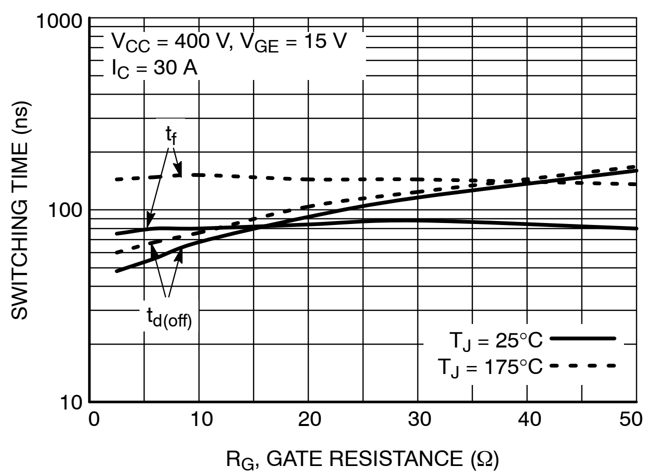



**Figure 10. Turn−Off Characteristics vs. Gate Resistance**

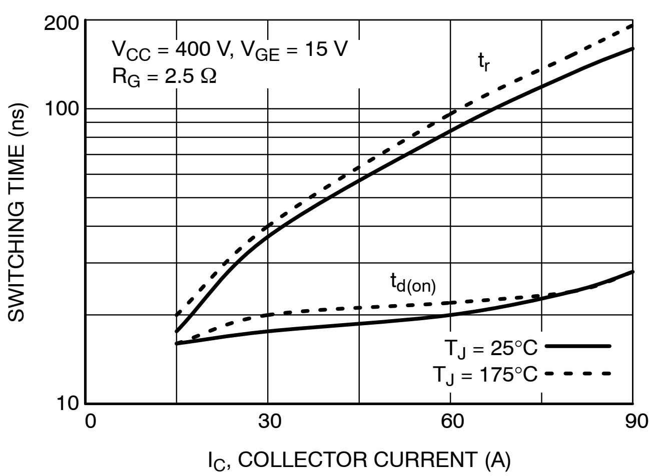



**Figure 11. Turn−On Characteristics vs. Collector Current**

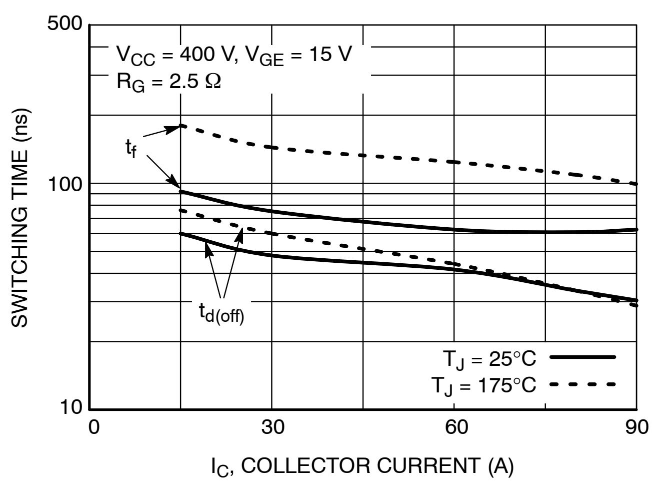



**Figure 12. Turn−Off Characteristics vs. Collector Current**

## TYPICAL CHARACTERISTICS (Continued)

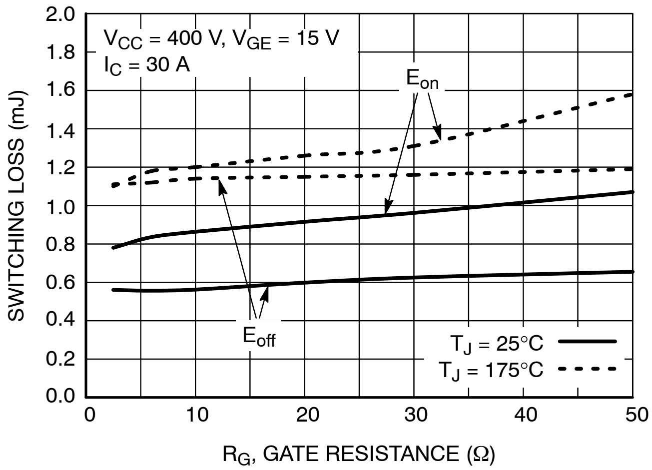



**Figure 13. Switching Loss vs. Gate Resistance**

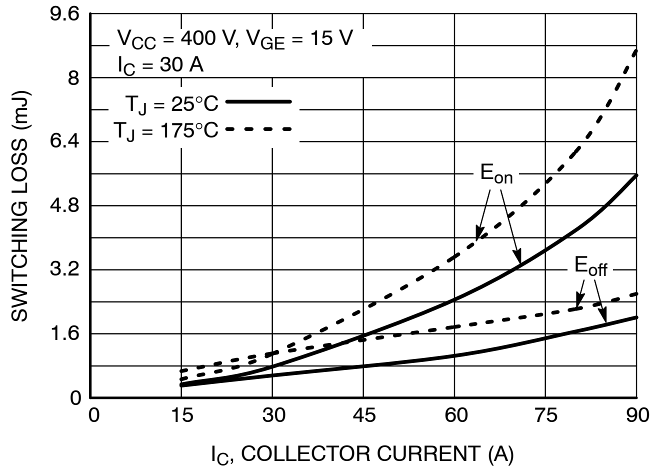



**Figure 14. Switching Loss vs. Collector Current**

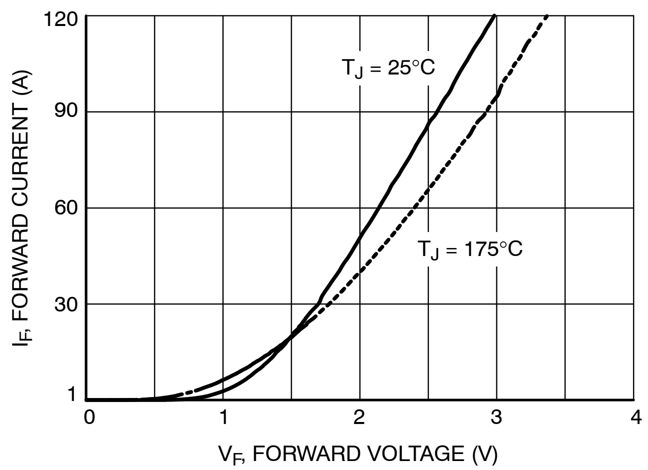



**Figure 15. Forward Characteristics**

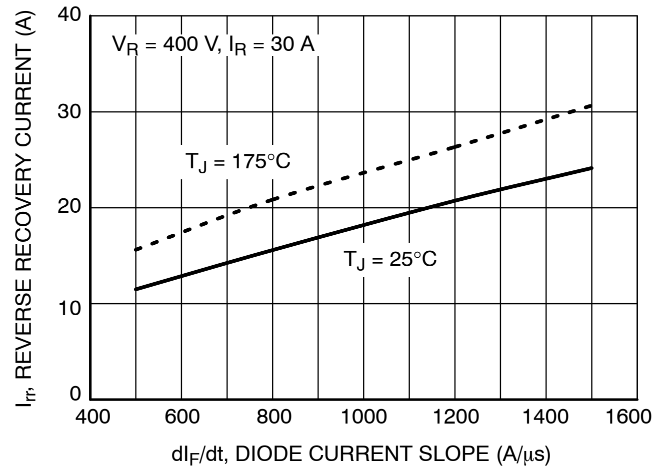



**Figure 16. Reverse Recovery Current**

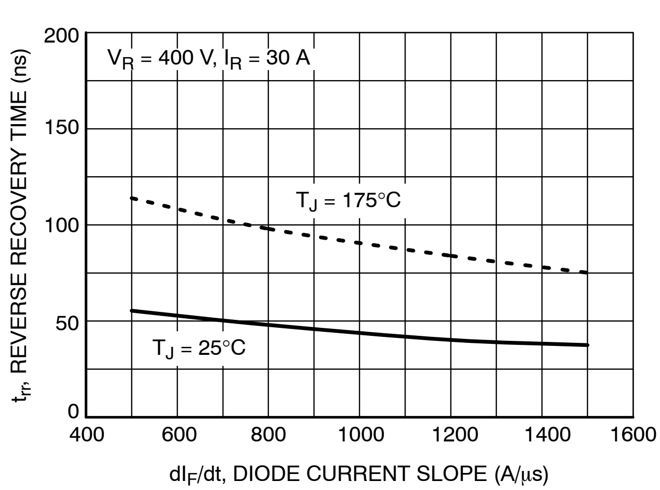



**Figure 17. Reverse Recovery Time**

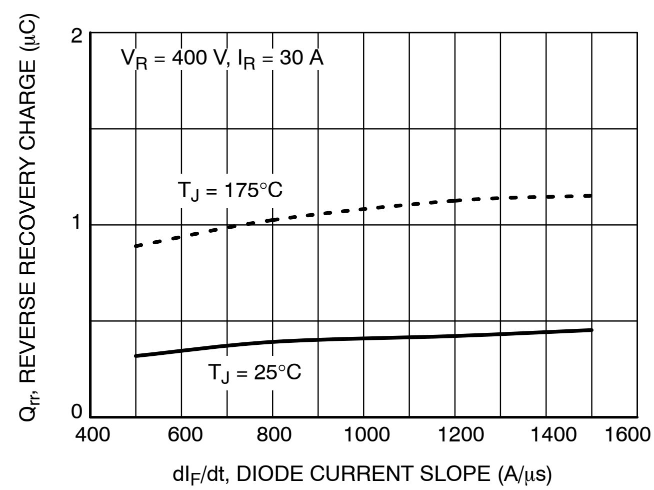



**Figure 18. Stored Charge**

## TYPICAL CHARACTERISTICS (Continued)

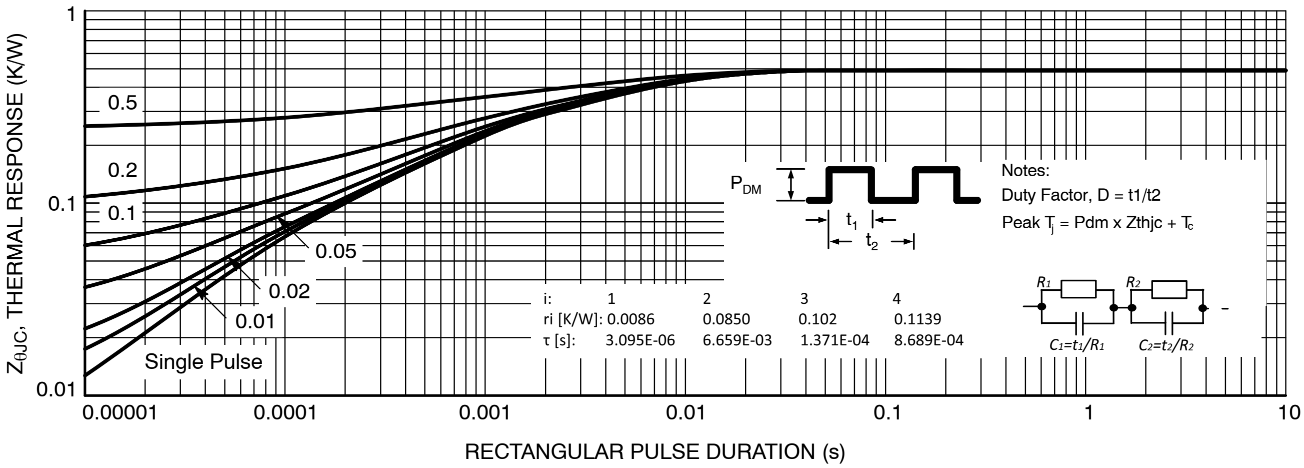



**Figure 19. Transient Thermal Impedance of IGBT**

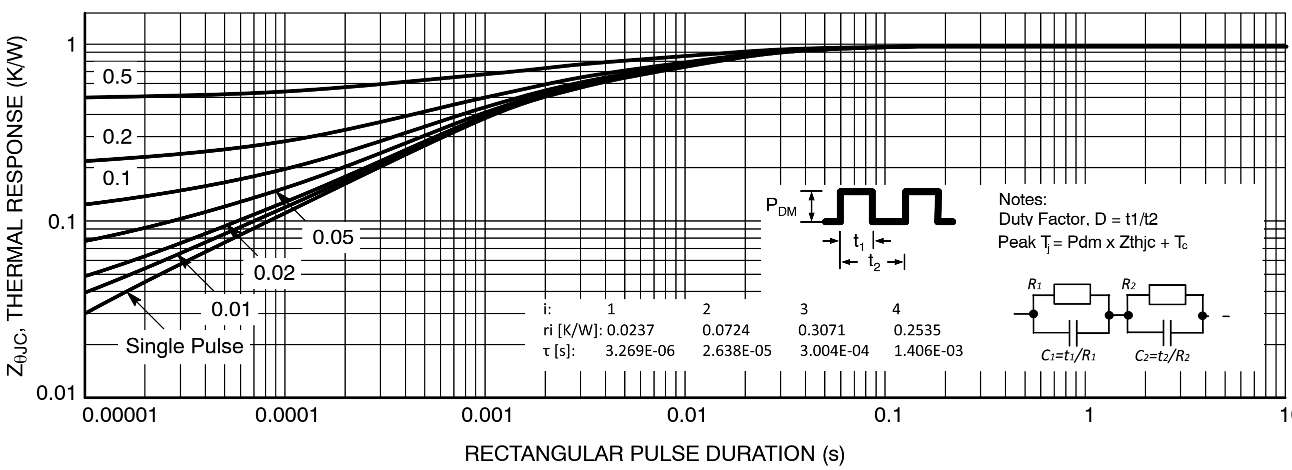
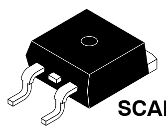


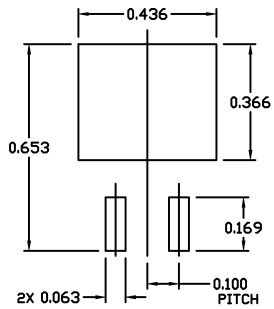

**Figure 20. Transient Thermal Impedance of Diode**



SCALE 1:1

**D²PAK−3 (TO−263, 3−LEAD)**
CASE 418AJ
ISSUE F

DATE 11 MAR 2021



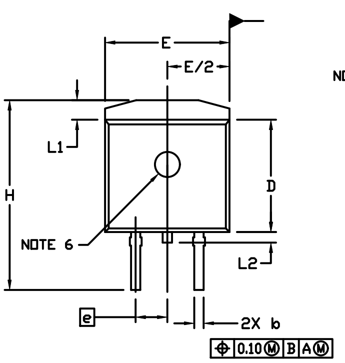

RECOMMENDED
MOUNTING FOOTPRINT

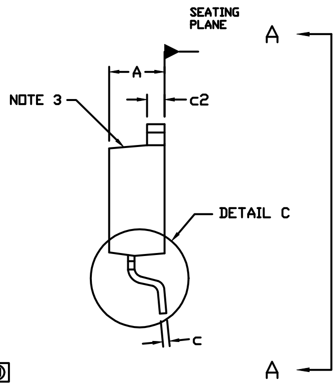
* For additional information on our Pb−Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

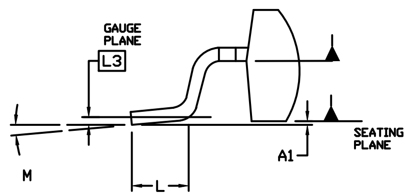
NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 2009.
2. CONTROLLING DIMENSION: INCHES
3. CHAMFER OPTIONAL.
4. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.005 PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY AT DATUM H.
5. THERMAL PAD CONTOUR IS OPTIONAL WITHIN DIMENSIONS E, L1, D1, AND E1.
6. OPTIONAL MOLD FEATURE.
7. ①, ② ... OPTIONAL CONSTRUCTION FEATURE CALL OUTS.

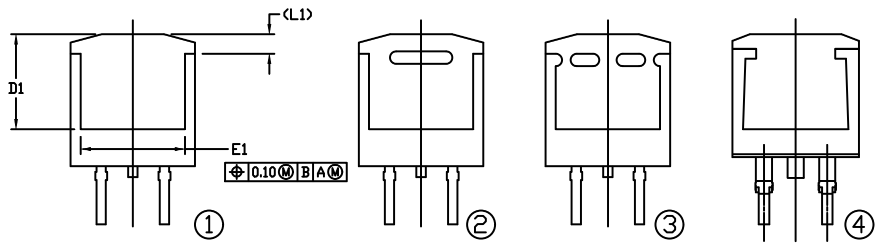
| DIM | INCHES | | MILLIMETERS | |
|---|---|---|---|---|
| | MIN. | MAX. | MIN. | MAX. |
| A | 0.160 | 0.190 | 4.06 | 4.83 |
| A1 | 0.000 | 0.010 | 0.00 | 0.25 |
| b | 0.020 | 0.039 | 0.51 | 0.99 |
| c | 0.012 | 0.029 | 0.30 | 0.74 |
| c2 | 0.045 | 0.065 | 1.14 | 1.65 |
| D | 0.330 | 0.380 | 8.38 | 9.65 |
| D1 | 0.260 | --- | 6.60 | --- |
| E | 0.380 | 0.420 | 9.65 | 10.67 |
| E1 | 0.245 | --- | 6.22 | --- |
| e | 0.100 BSC | | 2.54 BSC | |
| H | 0.575 | 0.625 | 14.60 | 15.88 |
| L | 0.070 | 0.110 | 1.78 | 2.79 |
| L1 | --- | 0.066 | --- | 1.68 |
| L2 | --- | 0.070 | --- | 1.78 |
| L3 | 0.010 BSC | | 0.25 BSC | |
| M | 0° | 8° | 0° | 8° |



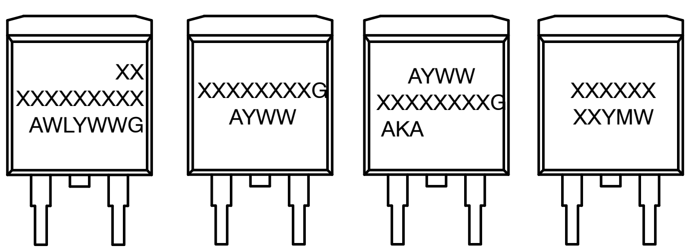

DETAIL C
TIP LEADFORM
ROTATED 90° CW




VIEW A−A

VIEW A−A
OPTIONAL CONSTRUCTIONS

**GENERIC MARKING DIAGRAMS***




**IC** **Standard** **Rectifier** **SSG**

XXXXXX = Specific Device Code
A = Assembly Location
WL = Wafer Lot
Y = Year
WW = Work Week
W = Week Code (SSG)
M = Month Code (SSG)
G = Pb−Free Package
AKA = Polarity Indicator

*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.

| **DOCUMENT NUMBER:** | **98AON56370E** | Electronic versions are uncontrolled except when accessed directly from the Document Repository. Printed versions are uncontrolled except when stamped “CONTROLLED COPY” in red. |
|---|---|---|
| **DESCRIPTION:** | **D²PAK−3 (TO−263, 3−LEAD)** | **PAGE 1 OF 1** |

## ADDITIONAL INFORMATION

**TECHNICAL PUBLICATIONS**:
**Technical Library:** www.onsemi.com/design/resources/technical−documentation
**onsemi Website:** www.onsemi.com

**ONLINE SUPPORT:** www.onsemi.com/support
**For additional information, please contact your local Sales Representative at**
www.onsemi.com/support/sales

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