IGBT for Automotive Applications

650 V, 40 A

AFGB40T65RQDN

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.

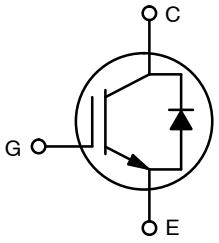
Features

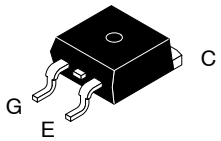
- Maximum Junction Temperature: T_J = 175°C
- Positive Temperature Coefficient for Easy Parallel Operation
- High Current Capability
- Low Saturation Voltage: $V_{CE(Sat)}$ = 1.55 V (Typ.) @ I_C = 40 A
- 100% of the Parts Tested for ILM (Note 2)
- High Input Impedance
- Fast Switching
- Tightened Parameter Distribution
- This Device is Pb−Free and RoHS Compliant

Typical Applications

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

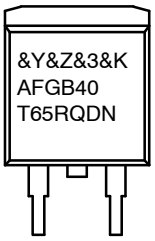
BV_{CES}	$V_{CE(sat)}$ TYP	I_C
650 V	1.55 V	40 A





D^2PAK
3 LEAD
CASE 418AJ

MARKING DIAGRAM



&Y	= Logo
&Z	= Assembly Plant Code
&3	= 3−Digit Date Code
&K	= 2−Digit Lot Traceability Code
AFGB40T65RQDN	= Specific Device Code

ORDERING INFORMATION

Device	Package	Shipping†
AFGB40T65RQDN	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 Transient Gate to Emitter Voltage T_{pulse} = 5 μs, D < 0.10	V_{GES}	±20 ±30	V
Collector Current (Note 1) @T_C = 25°C @T_C = 100°C	I_C	 68 40	A
Pulsed Collector Current (Note 2)	I_{LM}	160	A
Pulsed Collector Current (Note 3)	I_{CM}	160	A
Diode Forward Current (Note 1) @T_C = 25°C @T_C = 100°C	I_F	 68 40	A
Pulsed Diode Maximum Forward Current	I_{FM}	160	A
Non−Repetitive Forward Surge Current (Half − Sine Pulse, tp = 8.3 ms, T_C = 25°C) (Half − Sine Pulse, tp = 8.3 ms, T_C = 150°C)	$I_{F, SM}$	 136 118	A
Short Circuit Withstand Time V_{GE} = 15 V, V_{CC} = 400 V, T_C = 150°C	T_{SC}	 5	μs
Maximum Power Dissipation @T_C = 25°C @T_C = 100°C	P_D	 339.37 169.68	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 = 120 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	$R_{\theta JC}$	−	0.34	0.44	°C/W
Thermal Resistance Junction−to−Case, for Diode	$R_{\theta JC}$	−	0.79	1.03	
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	–	0.62	–	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 = 40 mA	3.75	4.90	6.05	V
Collector−Emitter Saturation Voltage	$V_{CE(sat)}$	I_C = 40 A, V_{GE} = 15 V, T_J = 25°C	–	1.55	1.82	V
		I_C = 40 A, V_{GE} = 15 V, T_J = 175°C	–	1.90	–	V
DYNAMIC CHARACTERISTICS						
Input Capacitance	C_{ies}	V_{CE} = 30 V, V_{GE} = 0 V, f = 1 MHz	–	2100	–	pF
Output Capacitance	C_{oes}		–	71	–	
Reverse Transfer Capacitance	C_{res}		–	9	–	
Gate Resistance	R_g	FREQ = 1 MHz	–	14	–	Ω
Gate Charge Total	Q_g	V_{CE} = 400 V, I_C = 40 A, V_{GE} = 15 V	–	51	–	nC
Gate−Emitter Charge	Q_{ge}		–	17	–	
Gate−Collector Charge	Q_{gc}		–	14	–	
SWITCHING CHARACTERISTICS, INDUCTIVE LOAD						
Turn−On Delay Time	$t_{d(on)}$	T_J = 25°C, V_{CC} = 400 V, I_C = 20 A, R_g = 3 Ω, V_{GE} = 15 V, Inductive Load	–	21	–	ns
Rise Time	t_r		–	21	–	
Turn−Off Delay Time	$t_{d(off)}$		–	77	–	
Fall Time	t_f		–	94	–	
Turn−On Switching Loss	E_{on}		–	0.47	–	mJ
Turn−Off Switching Loss	E_{off}		–	0.42	–	
Total Switching Loss	E_{ts}		–	0.89	–	
Turn−On Delay Time	$t_{d(on)}$	T_J = 25°C, V_{CC} = 400 V, I_C = 40 A, R_g = 3 Ω, V_{GE} = 15 V, Inductive Load	–	22	–	ns
Rise Time	t_r		–	45	–	
Turn−Off Delay Time	$t_{d(off)}$		–	66	–	
Fall Time	t_f		–	74	–	
Turn−On Switching Loss	E_{on}		–	1.18	–	mJ
Turn−Off Switching Loss	E_{off}		–	0.75	–	
Total Switching Loss	E_{ts}		–	1.93	–	
Turn−On Delay Time	$t_{d(on)}$	T_J = 175°C, V_{CC} = 400 V, I_C = 20 A, R_g = 3 Ω, V_{GE} = 15 V, Inductive Load	–	20	–	ns
Rise Time	t_r		–	24	–	
Turn−Off Delay Time	$t_{d(off)}$		–	96	–	
Fall Time	t_f		–	192	–	
Turn−On Switching Loss	E_{on}		–	0.79	–	mJ
Turn−Off Switching Loss	E_{off}		–	0.88	–	
Total Switching Loss	E_{ts}		–	1.67	–	

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 = 40 A, R_g = 3 Ω, V_{GE} = 15 V, Inductive Load	–	24	–	ns
Rise Time	t_r		–	51	–	
Turn-Off Delay Time	$t_{d(off)}$		–	80	–	
Fall Time	t_f		–	152	–	
Turn−On Switching Loss	E_{on}		–	1.71	–	mJ
Turn-Off Switching Loss	E_{off}		–	1.37	–	
Total Switching Loss	E_{ts}		–	3.08	–	
DIODE CHARACTERISTICS						
Diode Forward Voltage	V_F	T_J = 25°C, I_F = 40 A	–	1.68	2.10	V
		T_J = 175°C, I_F = 40 A	–	1.75	–	
DIODE SWITCHING CHARACTERISTIC, INDUCTIVE LOAD						
Reverse Recovery Energy	E_{REC}	T_J = 25°C, V_R = 400 V, I_F = 20 A, di_F/dt = 1000 A/μs	–	59	–	μJ
Diode Reverse Recovery Time	T_{rr}		–	40	–	ns
Diode Reverse Recovery Charge	Q_{rr}		–	413	–	nC
Reverse Recovery Energy	E_{REC}	T_J = 25°C, V_R = 400 V, I_F = 40 A, di_F/dt = 1000 A/μs	–	85	–	μJ
Diode Reverse Recovery Time	T_{rr}		–	52	–	ns
Diode Reverse Recovery Charge	Q_{rr}		–	543	–	nC
Reverse Recovery Energy	E_{REC}	T_J = 175°C, V_R = 400 V, I_F = 20 A, di_F/dt = 1000 A/μs	–	203	–	μJ
Diode Reverse Recovery Time	T_{rr}		–	73	–	ns
Diode Reverse Recovery Charge	Q_{rr}		–	984	–	nC
Reverse Recovery Energy	E_{REC}	T_J = 175°C, V_R = 400 V, I_F = 40 A, di_F/dt = 1000 A/μs	–	282	–	μJ
Diode Reverse Recovery Time	T_{rr}		–	96	–	ns
Diode Reverse Recovery Charge	Q_{rr}		–	1334	–	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

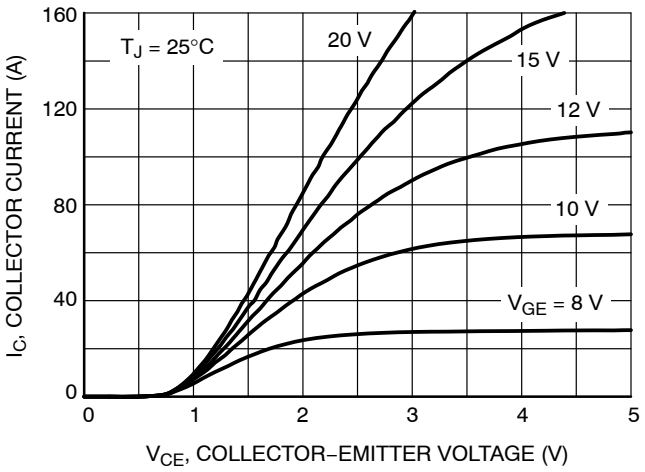


Figure 1. Typical Output Characteristics (25°C)

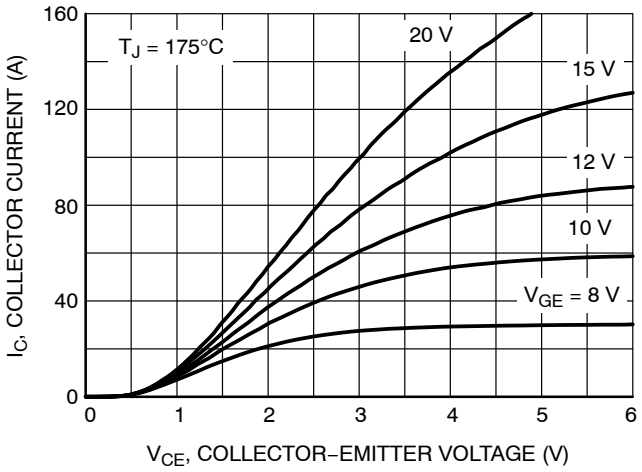


Figure 2. Typical Output Characteristics (175°C)

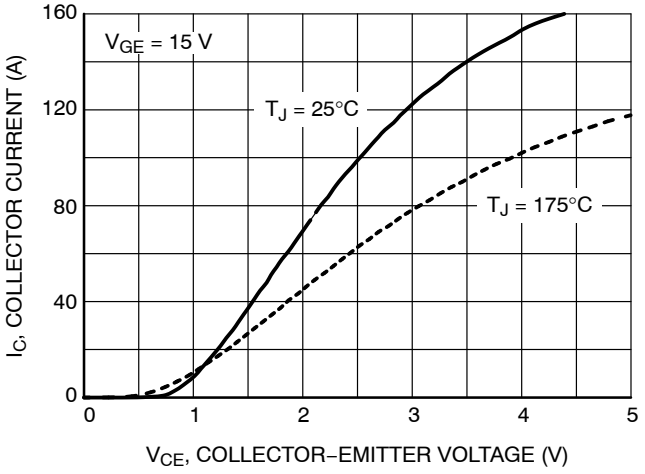


Figure 3. Typical Saturation Voltage Characteristics

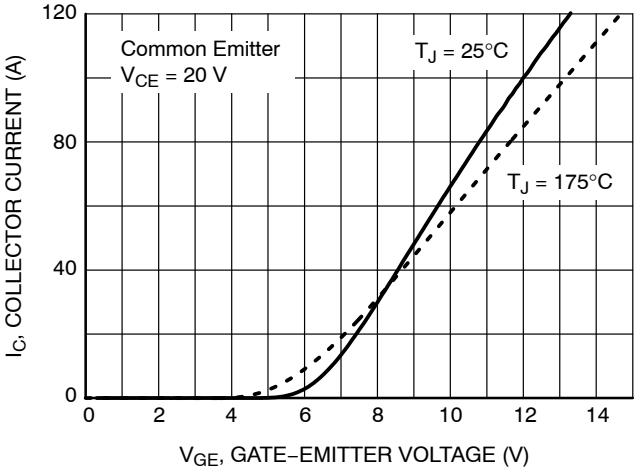


Figure 4. Typical Transfer Characteristics

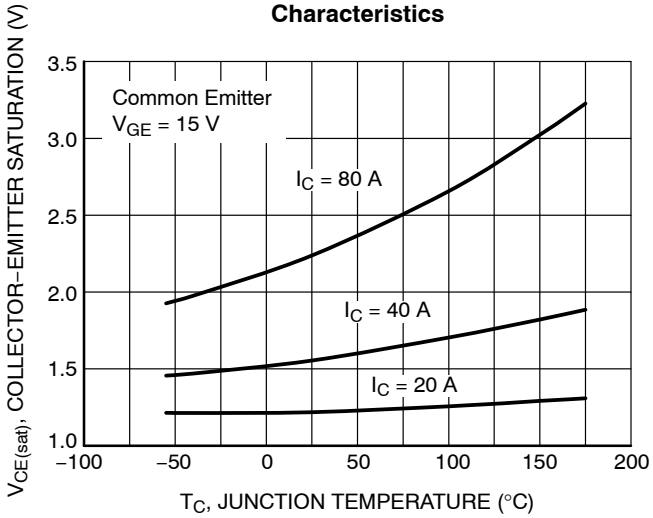


Figure 5. Saturation Voltage vs. Case

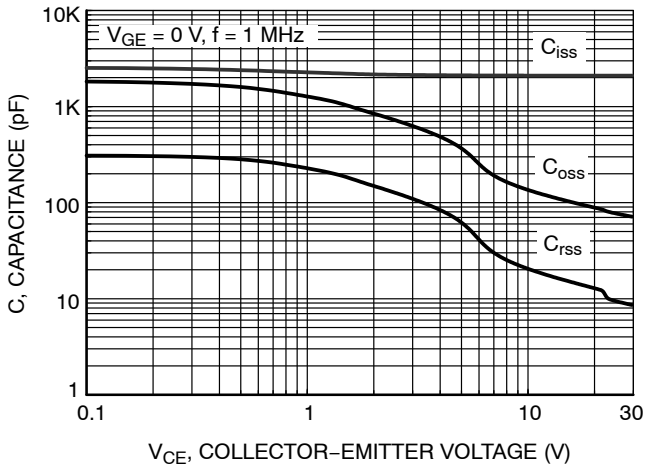


Figure 6. Capacitance Characteristics

TYPICAL CHARACTERISTICS (Continued)

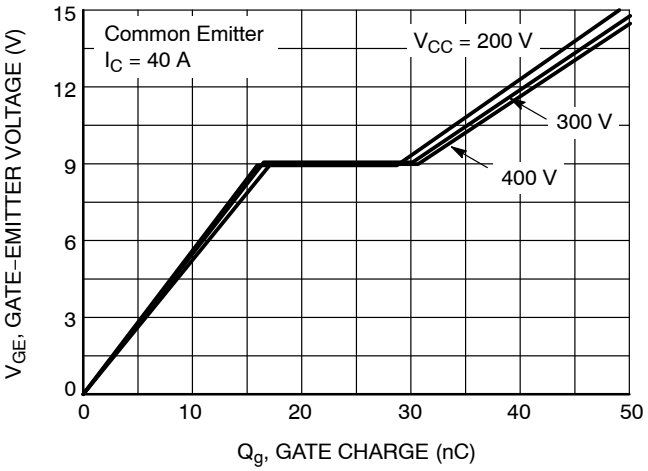


Figure 7. Gate Charge Characteristics

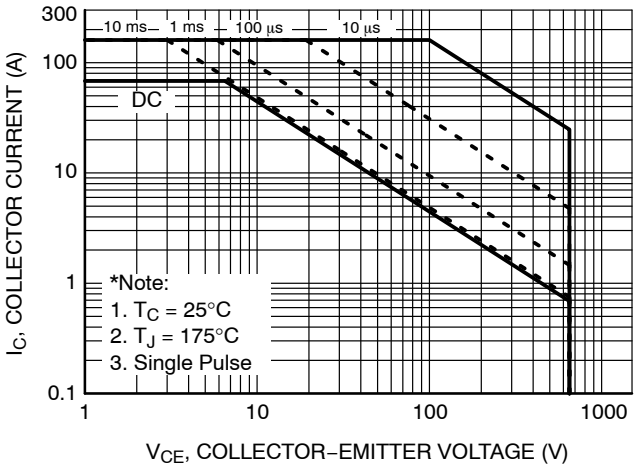


Figure 8. SOA Characteristics

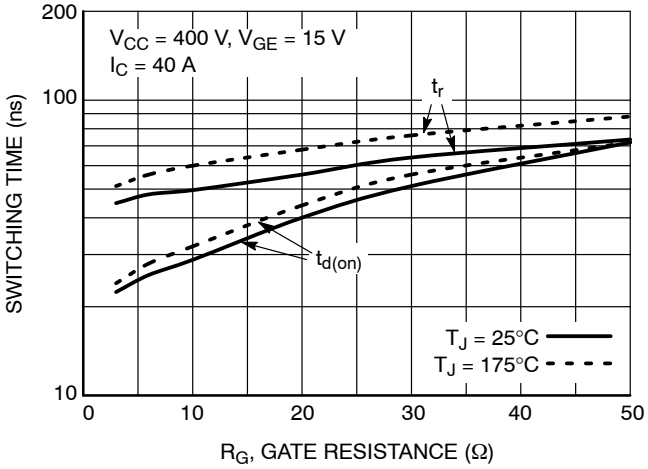


Figure 9. Turn−On Characteristics vs. Gate Resistance

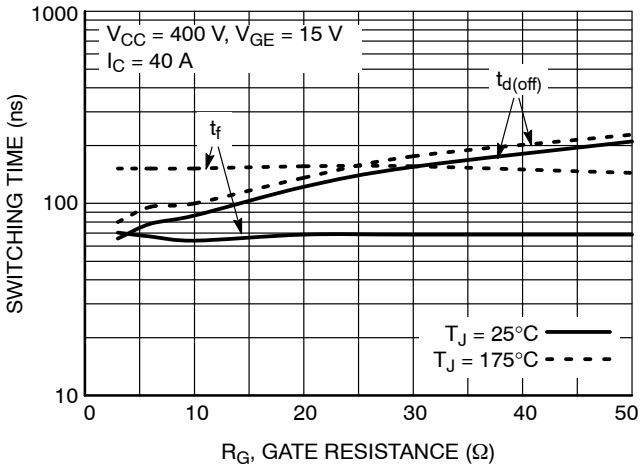


Figure 10. Turn−Off Characteristics vs. Gate Resistance

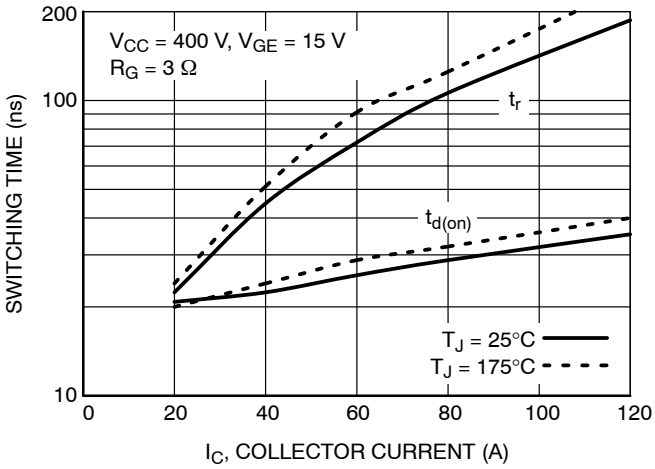


Figure 11. Turn−On Characteristics vs. Collector Current

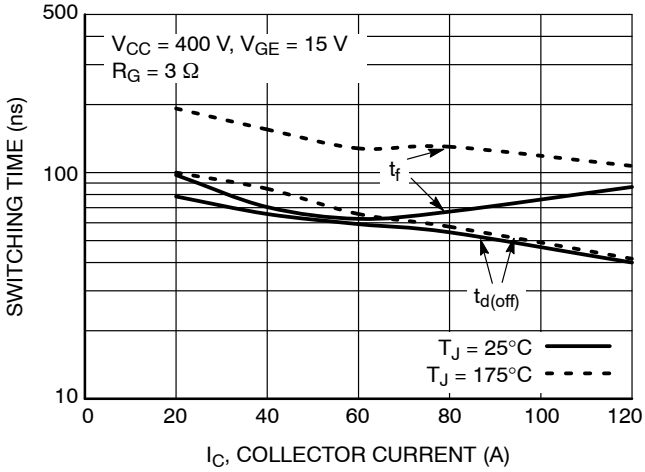


Figure 12. Turn−Off Characteristics vs. Collector Current

TYPICAL CHARACTERISTICS (Continued)

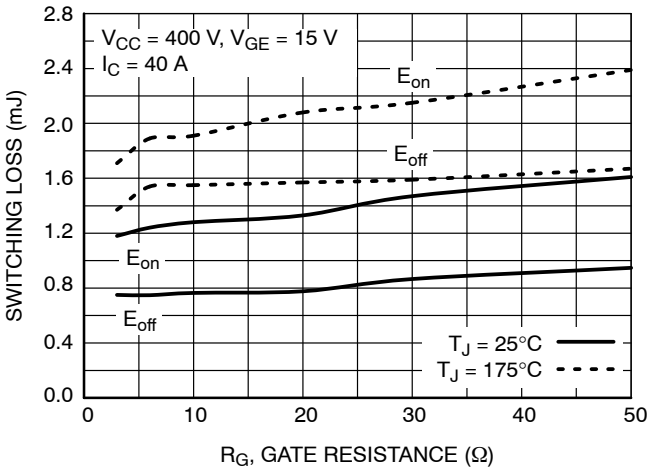


Figure 13. Switching Loss vs. Gate Resistance

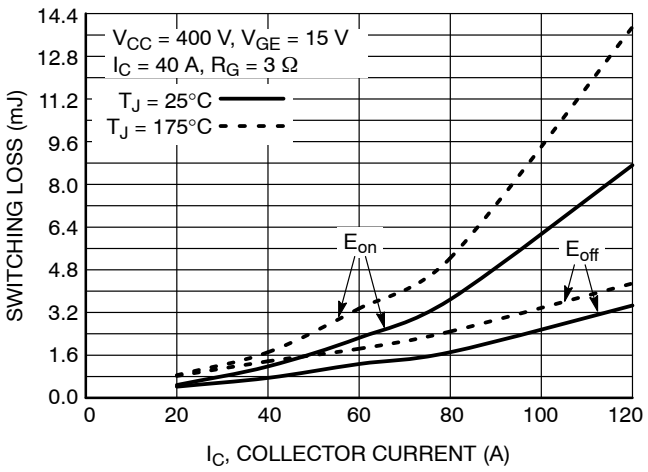


Figure 14. Switching Loss vs. Collector Current

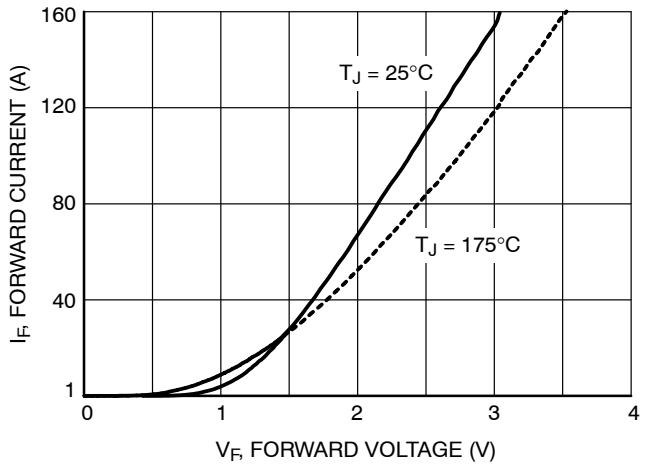


Figure 15. Forward Characteristics

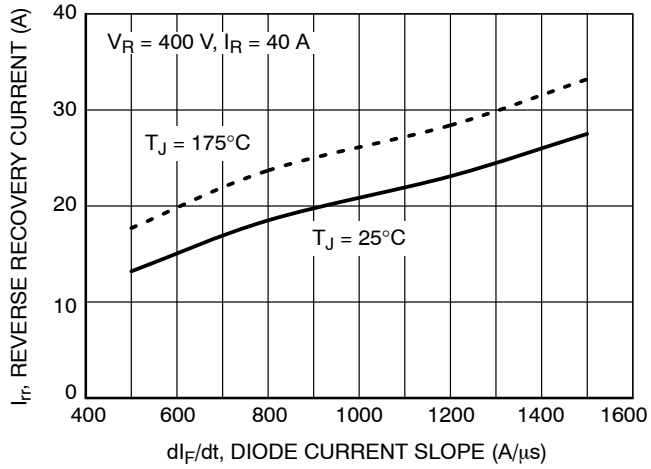


Figure 16. Reverse Recovery Current

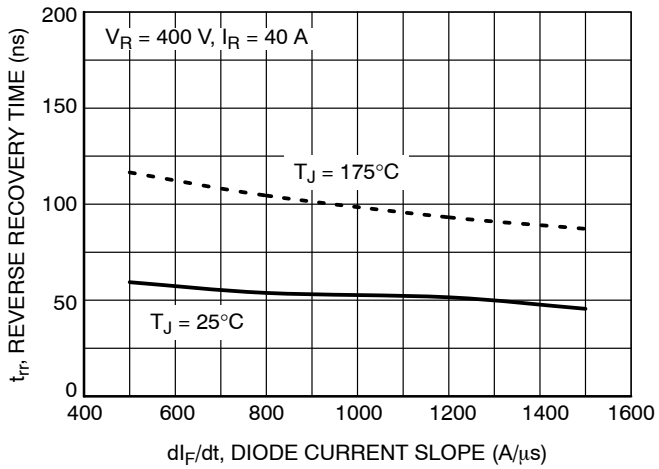


Figure 17. Reverse Recovery Time

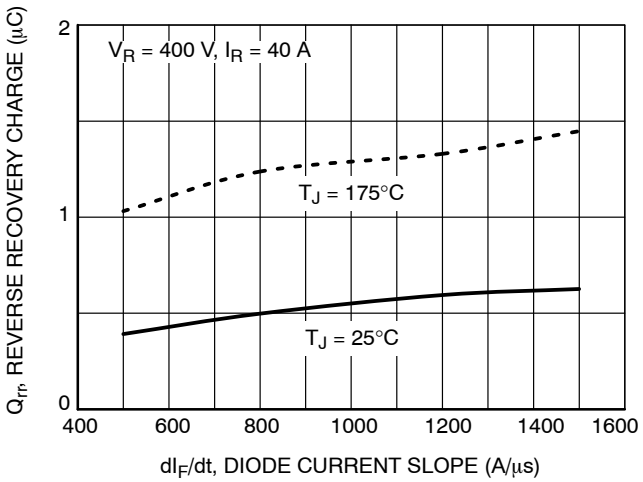


Figure 18. Stored Charge

TYPICAL CHARACTERISTICS (Continued)

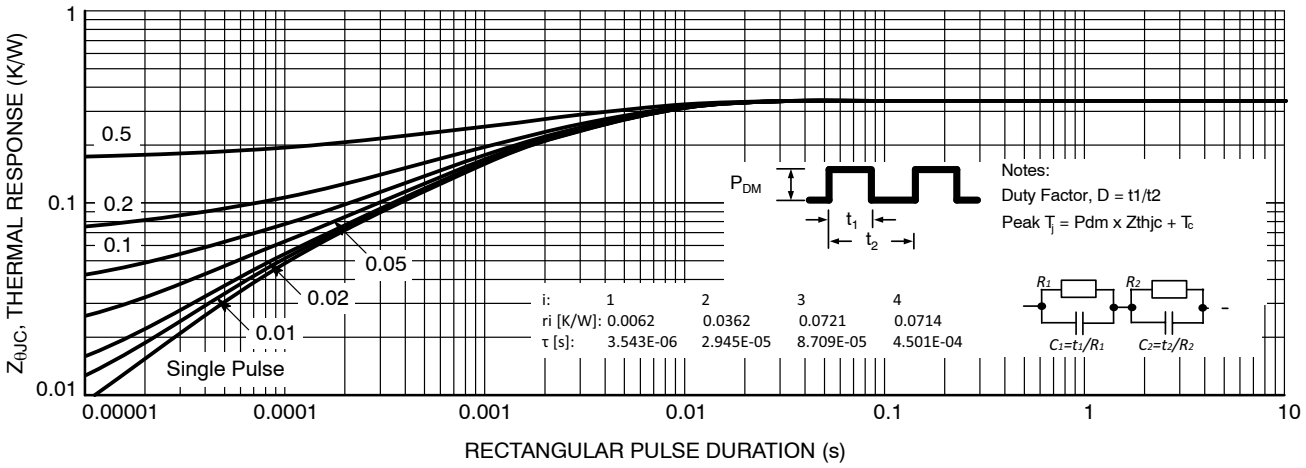


Figure 19. Transient Thermal Impedance of IGBT

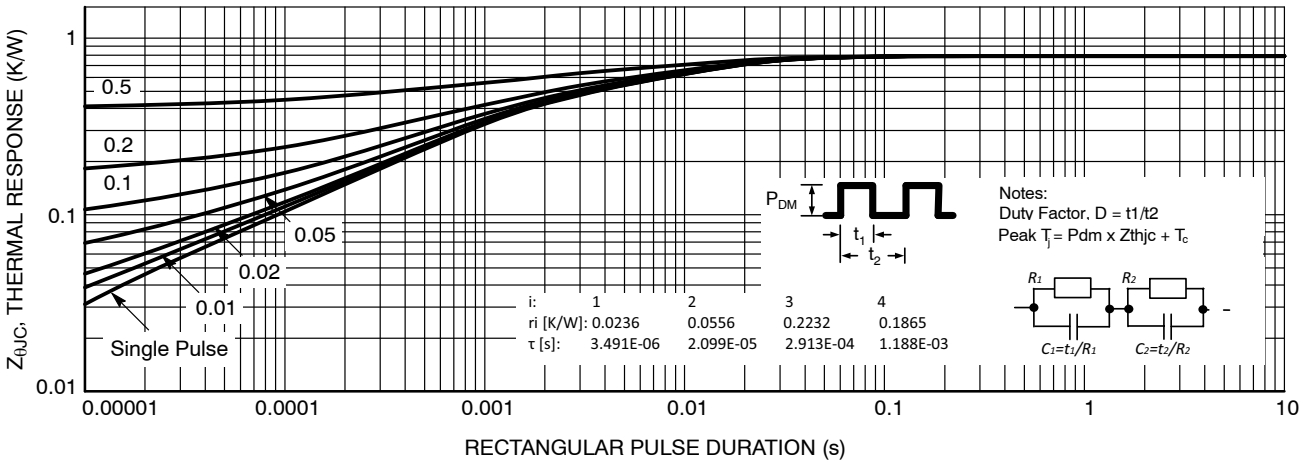
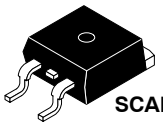


Figure 20. Transient Thermal Impedance of Diode

MECHANICAL CASE OUTLINE
PACKAGE DIMENSIONS

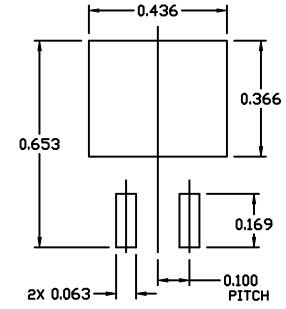
ON Semiconductor®



SCALE 1:1

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

DATE 11 MAR 2021



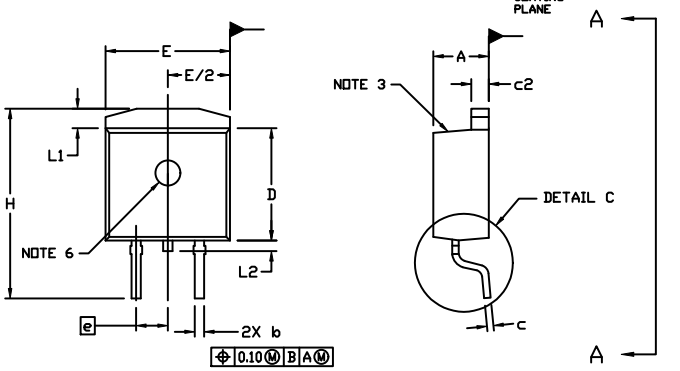
RECOMMENDED
MOUNTING FOOTPRINT

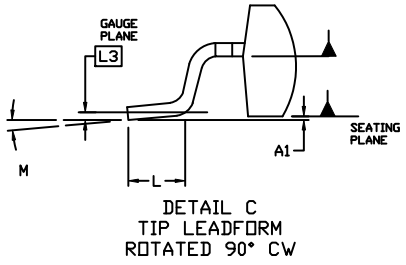
* For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

NOTES:

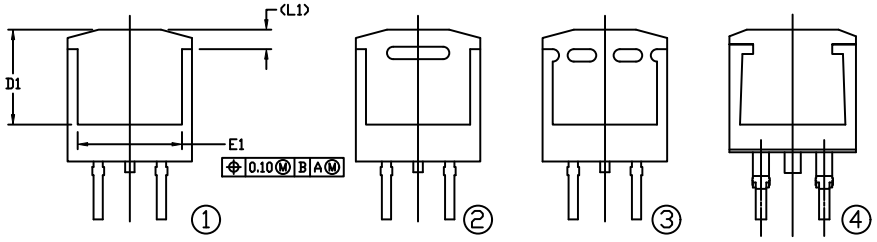
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 2009.
2. CONTROLLING DIMENSION: INCHES
3. CHAMFER OPTIONAL.
4. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.005 PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY AT DATUM H.
5. THERMAL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

	INCHES		MILLIMETERS	
DIM	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°





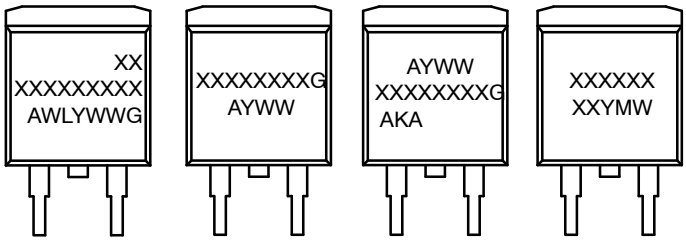
DETAIL C
TIP LEADFORM
ROTATED 90° CW



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.

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DESCRIPTION:	**D²PAK–3 (TO–263, 3–LEAD)**	**PAGE 1 OF 1**

PUBLICATION ORDERING INFORMATION

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onsemi Website: www.onsemi.com

TECHNICAL SUPPORT
North American Technical Support:
Voice Mail: 1 800−282−9855 Toll Free USA/Canada
Phone: 011 421 33 790 2910

Europe, Middle East and Africa Technical Support:
Phone: 00421 33 790 2910
For additional information, please contact your local Sales Representative

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