

CooliRIGBT™

Features

- Designed And Qualified for Automotive Applications
- Ultra Fast Switching IGBT:70-200kHz
- Extremely Low Switching Losses
- Maximum Junction Temperature 175 °C
- Square RBSOA
- Positive $V_{CE(on)}$ Temperature Coefficient

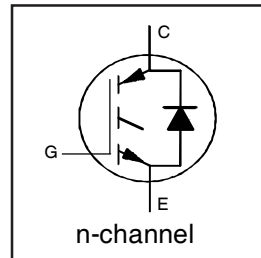
Benefits

- Optimized High Frequency Switching Applications
- Rugged Transient Performance for Increased Reliability
- Excellent Current Sharing in Parallel Operation

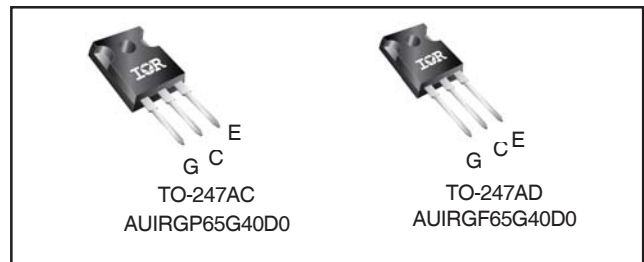
Applications

- DC-DC Converter
- PFC

ULTRAFAST IGBT WITH ULTRAFAST SOFT RECOVERY DIODE



| |
|----------------------------------|
| $V_{CES} = 600V$ |
| $V_{CE(on)} \text{ typ.} = 1.8V$ |
| $I_C @ T_C = 100^\circ C = 41A$ |
| $T_J \text{ max} = 175^\circ C$ |



| | | |
|----------|-----------|----------|
| G | C | E |
| Gate | Collector | Emitter |

| Base part number | Package Type | Standard Pack | | Orderable Part Number |
|------------------|--------------|---------------|----------|-----------------------|
| | | Form | Quantity | |
| AUIRGP65G40D0 | TO-247AC | Tube | 25 | AUIRGP65G40D0 |
| AUIRGF65G40D0 | TO-247AD | Tube | 25 | AUIRGF65G40D0 |

Absolute Maximum Ratings

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only; and functional operation of the device at these or any other condition beyond those indicated in the specifications is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability. The thermal resistance and power dissipation ratings are measured under board mounted and still air conditions. Ambient temperature (T_A) is 25°C, unless otherwise specified.

| | Parameter | Max. | Units |
|---------------------------|---|-----------------------------------|-------|
| V_{CES} | Collector-to-Emitter Voltage | 600 | V |
| $I_C @ T_C = 25^\circ C$ | Continuous Collector Current ⑥ | 62 | A |
| $I_C @ T_C = 100^\circ C$ | Continuous Collector Current ⑥ | 41 | |
| $I_{NOMINAL}$ | Nominal Current @ 200kHz ⑦ | 20 | |
| I_{CM} | Pulse Collector Current | 84 | |
| I_{LM} | Clamped Inductive Load Current ① | 112 | |
| $I_F @ T_C = 25^\circ C$ | Diode Continuous Forward Current | 46.1 | |
| $I_F @ T_C = 100^\circ C$ | Diode Continuous Forward Current | 30 | |
| I_{FRM} | Maximum Repetitive Forward Current ② | 112 | V |
| V_{GE} | Gate-to-Emitter Voltage | ±20 | |
| $P_D @ T_C = 25^\circ C$ | Maximum Power Dissipation | 625 | W |
| $P_D @ T_C = 100^\circ C$ | Maximum Power Dissipation | 313 | |
| T_J T_{STG} | Operating Junction and Storage Temperature Range | -55 to +175 | °C |
| | Soldering Temperature for 10 sec. | 300 (0.063 in. (1.6mm) from case) | |
| | Mounting Torque, 6-32 or M3 Screw | 10 lbf·in (1.1 N·m) | |

Thermal Resistance

| | Parameter | Min. | Typ. | Max. | Units |
|-------------------------|--|------|------------|------|--------|
| $R_{\theta JC}$ (IGBT) | Junction-to-Case-(each IGBT) ④ | — | — | 0.24 | °C/W |
| $R_{\theta JC}$ (Diode) | Junction-to-Case-(each Diode) ④ | — | — | 1.78 | |
| $R_{\theta CS}$ | Case-to-Sink (flat, greased surface) | — | 0.24 | — | |
| $R_{\theta JA}$ | Junction-to-Ambient (typical socket mount) | — | — | 40 | |
| | | — | 6.0 (0.21) | — | g (oz) |

*Qualification standards can be found at <http://www.irf.com/>

Electrical Characteristics @ T_J = 25°C (unless otherwise specified)

| | Parameter | Min. | Typ. | Max. | Units | Conditions |
|--|---|------|------|------|-------|---|
| V _{(BR)CES} | Collector-to-Emitter Breakdown Voltage | 600 | — | — | V | V _{GE} = 0V, I _C = 500μA ③ |
| ΔV _{(BR)CES} /ΔT _J | Temperature Coeff. of Breakdown Voltage | — | 0.18 | — | V/°C | V _{GE} = 0V, I _C = 1.0mA (25°C-175°C) |
| V _{CE(on)} | Collector-to-Emitter Saturation Voltage | — | 1.4 | — | V | I _C = 12A, V _{GE} = 15V, T _J = 25°C |
| | | — | 1.8 | 2.2 | | I _C = 20A, V _{GE} = 15V, T _J = 25°C |
| | | — | 1.9 | — | | I _C = 12A, V _{GE} = 15V, T _J = 150°C |
| | | — | 2.6 | — | | I _C = 20A, V _{GE} = 15V, T _J = 150°C |
| | | — | 2.2 | — | | I _C = 12A, V _{GE} = 15V, T _J = 175°C |
| | | — | 3.0 | — | | I _C = 20A, V _{GE} = 15V, T _J = 175°C |
| V _{GE(th)} | Gate Threshold Voltage | 3.0 | — | 5.5 | V | V _{CE} = V _{GE} , I _C = 250μA |
| ΔV _{GE(th)} /ΔT _J | Threshold Voltage temp. coefficient | — | -12 | — | mV/°C | V _{CE} = V _{GE} , I _C = 1.0mA (25°C - 175°C) |
| g _{fe} | Forward Transconductance | — | 36 | — | S | V _{CE} = 50V, I _C = 20A |
| I _{CES} | Collector-to-Emitter Leakage Current | — | 3.2 | 25 | μA | V _{GE} = 0V, V _{CE} = 600V |
| | | — | 0.81 | — | mA | V _{GE} = 0V, V _{CE} = 600V, T _J = 175°C |
| V _{FM} | Diode Forward Voltage Drop | — | 1.7 | 2.45 | V | I _F = 20A |
| | | — | 1.4 | — | | I _F = 20A, T _J = 175°C |
| I _{GES} | Gate-to-Emitter Leakage Current | — | — | ±100 | nA | V _{GE} = ±20V |

Switching Characteristics @ T_J = 25°C (unless otherwise specified)

| | Parameter | Min. | Typ. | Max. | Units | Conditions |
|----------------------------|---|-------------|------|------|--|---|
| Q _g | Total Gate Charge (turn-on) | — | 180 | 270 | nC | I _C = 20A |
| Q _{ge} | Gate-to-Emitter Charge (turn-on) | — | 28 | 42 | | V _{GE} = 15V |
| Q _{gc} | Gate-to-Collector Charge (turn-on) | — | 64 | 96 | | V _{CC} = 400V |
| E _{on} | Turn-On Switching Loss | — | 298 | 389 | μJ | I _C = 20A, V _{CC} = 400V, V _{GE} = 15V |
| E _{off} | Turn-Off Switching Loss | — | 147 | 234 | | R _G = 4.7Ω, L = 485μH, T _J = 25°C |
| E _{total} | Total Switching Loss | — | 445 | 623 | | Energy losses include tail & diode reverse recovery |
| t _{d(on)} | Turn-On delay time | — | 35 | 53 | ns | I _C = 20A, V _{CC} = 400V, V _{GE} = 15V |
| t _r | Rise time | — | 12 | 29 | | R _G = 4.7Ω, L = 485μH, T _J = 25°C |
| t _{d(off)} | Turn-Off delay time | — | 142 | 163 | | |
| t _f | Fall time | — | 15 | 32 | | |
| E _{on} | Turn-On Switching Loss | — | 630 | — | | μJ |
| E _{off} | Turn-Off Switching Loss | — | 137 | — | R _G = 4.7Ω, L = 485μH, T _J = 175°C | |
| E _{total} | Total Switching Loss | — | 767 | — | Energy losses include tail & diode reverse recovery | |
| t _{d(on)} | Turn-On delay time | — | 33 | — | ns | I _C = 20A, V _{CC} = 400V, V _{GE} = 15V |
| t _r | Rise time | — | 12 | — | | R _G = 4.7Ω, L = 485μH |
| t _{d(off)} | Turn-Off delay time | — | 165 | — | | T _J = 175°C |
| t _f | Fall time | — | 16 | — | | |
| C _{ies} | Input Capacitance | — | 4673 | — | pF | V _{GE} = 0V |
| C _{oes} | Output Capacitance | — | 337 | — | | V _{CC} = 30V |
| C _{res} | Reverse Transfer Capacitance | — | 58 | — | | f = 1.0Mhz |
| C _{oes eff.} | Effective Output Capacitance (Time Related) ⑤ | — | 406 | — | | V _{GE} = 0V, V _{CE} = 0V to 480V |
| C _{oes eff. (ER)} | Effective Output Capacitance (Energy Related) ⑥ | — | 162 | — | | |
| RBSOA | Reverse Bias Safe Operating Area | FULL SQUARE | | | | |
| t _{rr} | Diode Reverse Recovery Time | — | 41 | — | ns | T _J = 25°C I _F = 20A, V _R = 200V, |
| | | — | 70 | — | | T _J = 125°C di/dt = 200A/μs |
| Q _{rr} | Diode Reverse Recovery Charge | — | 116 | — | nC | T _J = 25°C I _F = 20A, V _R = 200V, |
| | | — | 580 | — | | T _J = 125°C di/dt = 200A/μs |
| I _{rr} | Peak Reverse Recovery Current | — | 4.8 | — | A | T _J = 25°C I _F = 20A, V _R = 200V, |
| | | — | 7.2 | — | | T _J = 125°C di/dt = 200A/μs |

Notes ① through ⑦ are on page 13

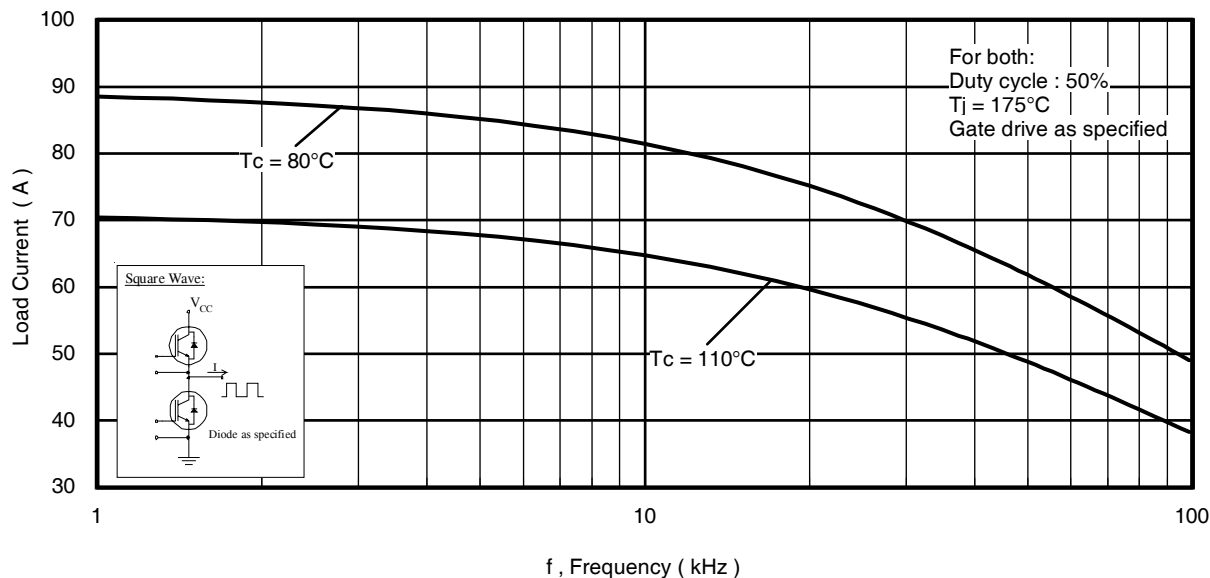


Fig. 1 - Typical Load Current vs. Frequency
(Load Current = IRMS of fundamental)

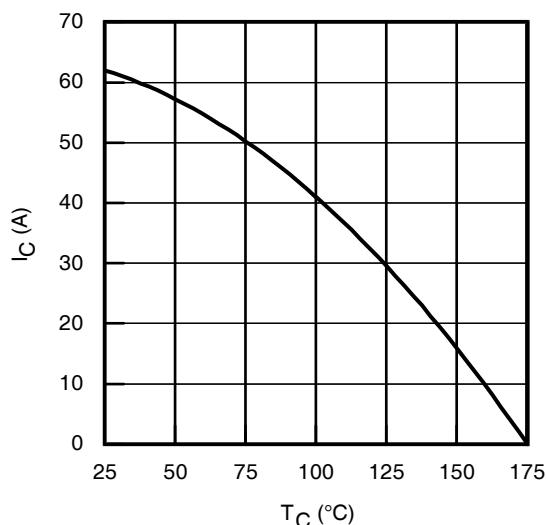


Fig. 2 - Maximum DC Collector Current vs. Case Temperature

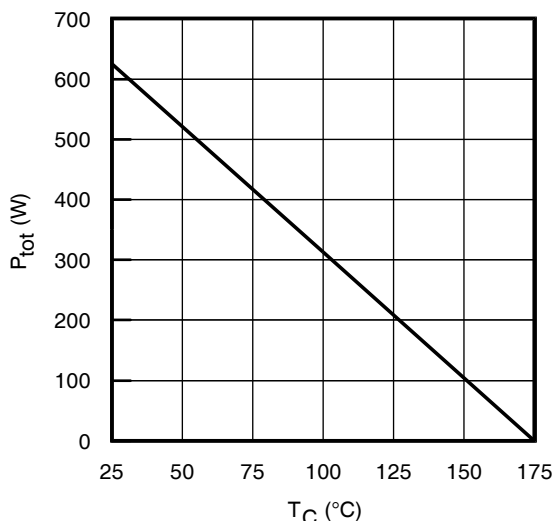


Fig. 3 - Power Dissipation vs. Case Temperature

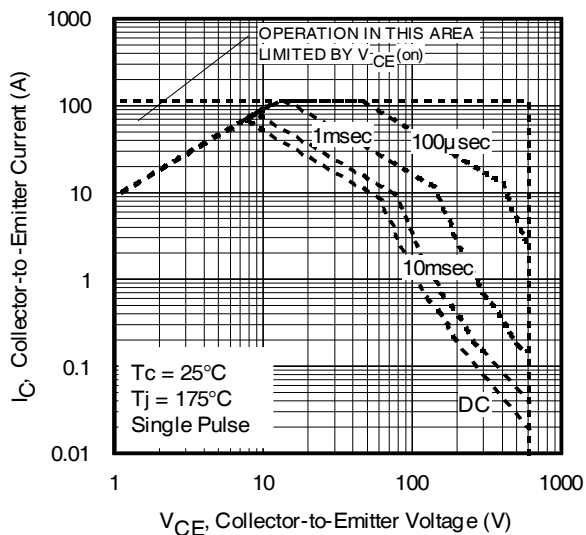


Fig. 4 - Forward SOA
 $T_C = 25^\circ\text{C}; T_J \leq 175^\circ\text{C}; V_{GE} = 15\text{V}$

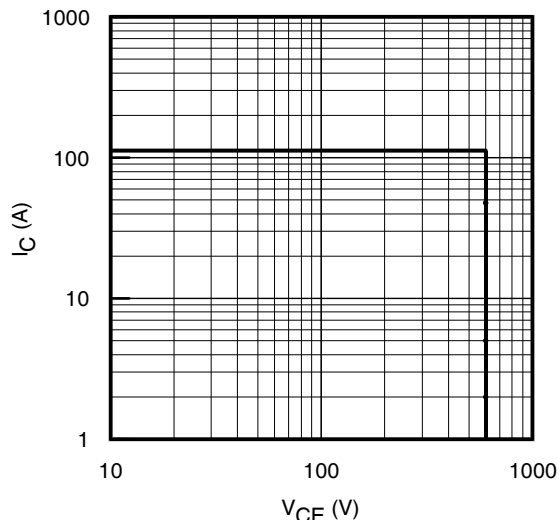


Fig. 5 - Reverse Bias SOA
 $T_J = 175^\circ\text{C}; V_{GE} = 20\text{V}$

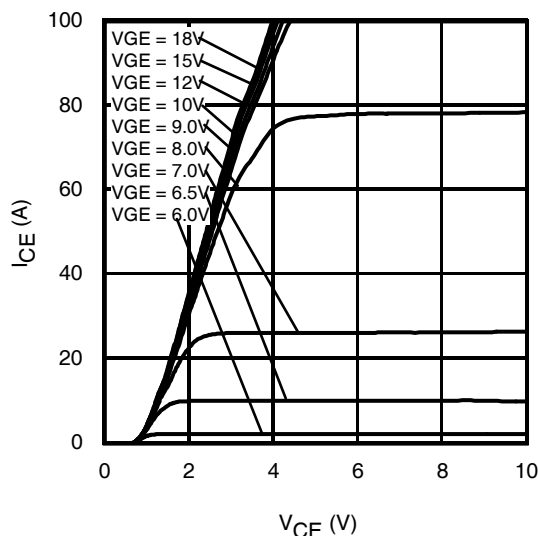


Fig. 6 - Typ. IGBT Output Characteristics
 $T_J = -40^\circ\text{C}$; $t_p = 30\mu\text{s}$

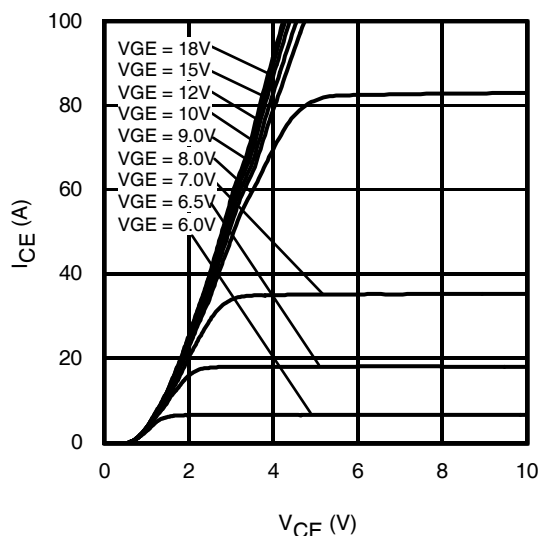


Fig. 7 - Typ. IGBT Output Characteristics
 $T_J = 25^\circ\text{C}$; $t_p = 30\mu\text{s}$

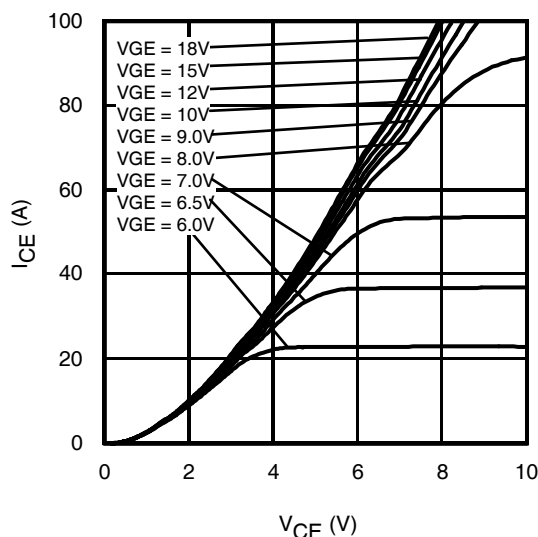


Fig. 8 - Typ. IGBT Output Characteristics
 $T_J = 175^\circ\text{C}$; $t_p = 30\mu\text{s}$

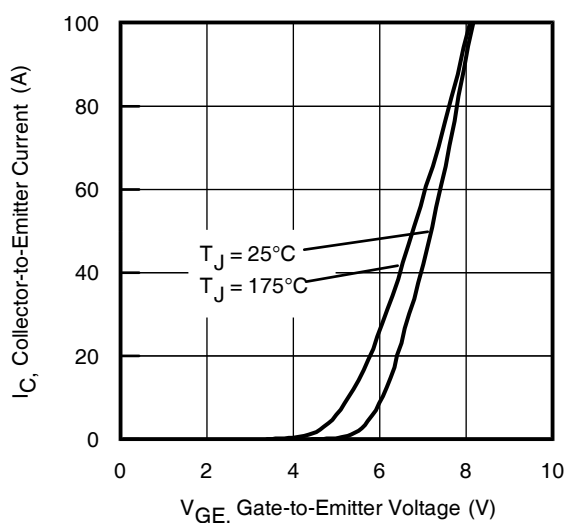


Fig. 9 - Typ. Transfer Characteristics
 $V_{CE} = 50\text{V}$; $t_p = 30\mu\text{s}$

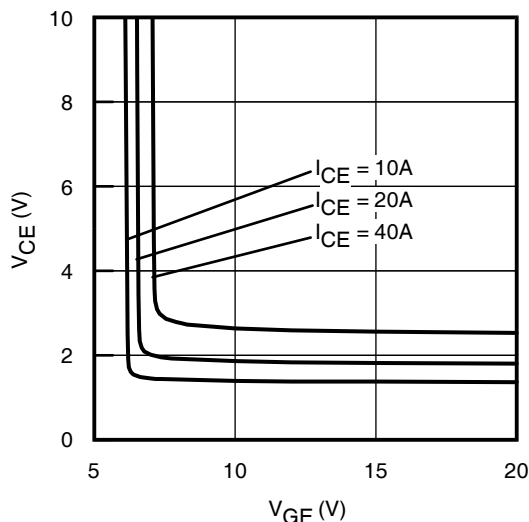


Fig. 10 - Typical V_{CE} vs. V_{GE}
 $T_J = 25^\circ\text{C}$

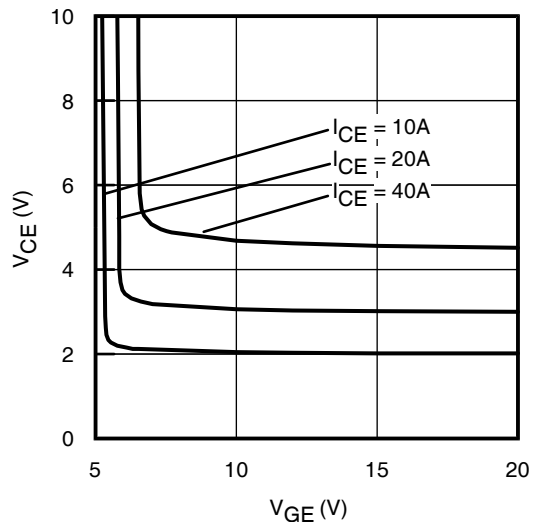


Fig. 11 - Typical V_{CE} vs. V_{GE}
 $T_J = 175^\circ\text{C}$

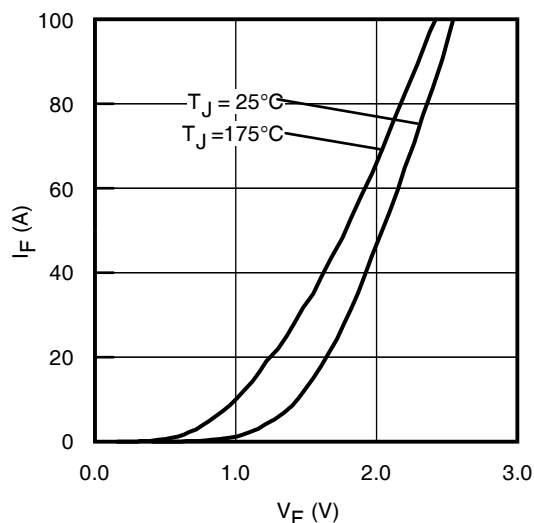


Fig. 12 - Typ. Diode Forward Characteristics
 $t_p = 30\mu s$

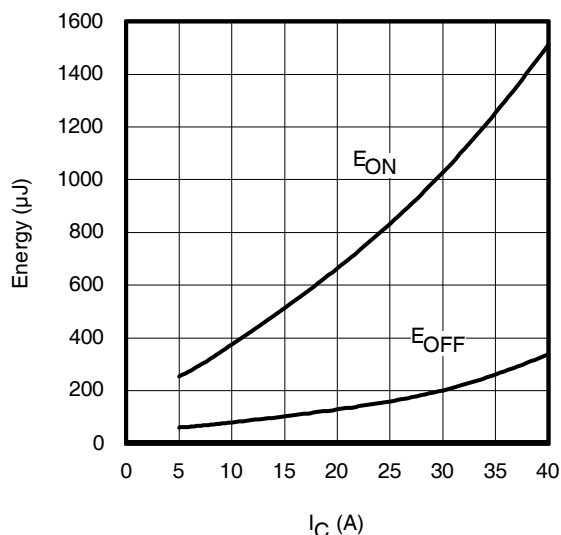


Fig. 13 - Typ. Energy Loss vs. I_C
 $T_J = 175^\circ C$; $L = 0.49mH$; $V_{CE} = 400V$; $R_G = 4.7\Omega$; $V_{GE} = 15V$

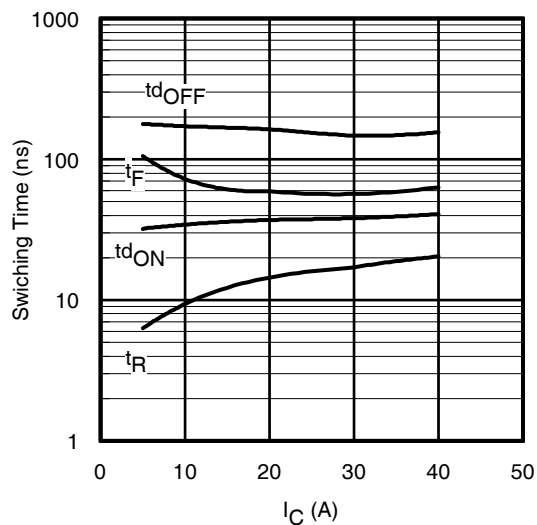


Fig. 14 - Typ. Switching Time vs. I_C
 $T_J = 175^\circ C$; $L = 0.49mH$; $V_{CE} = 400V$; $R_G = 4.7\Omega$; $V_{GE} = 15V$

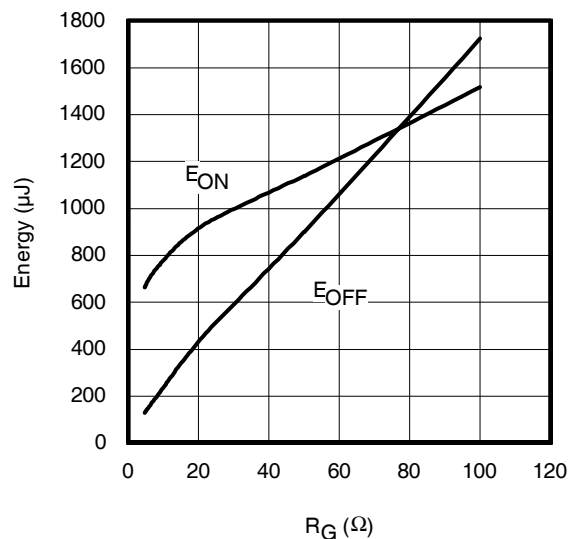


Fig. 15 - Typ. Energy Loss vs. R_G
 $T_J = 175^\circ C$; $L = 0.49mH$; $V_{CE} = 400V$; $I_{CE} = 20A$; $V_{GE} = 15V$

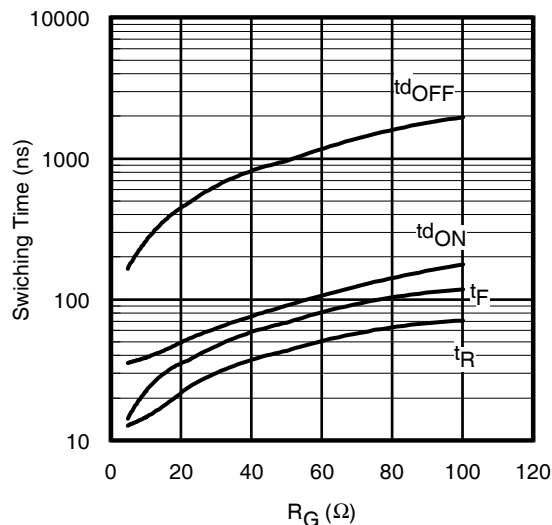


Fig. 16 - Typ. Switching Time vs. R_G
 $T_J = 175^\circ C$; $L = 0.49mH$; $V_{CE} = 400V$; $I_{CE} = 20A$; $V_{GE} = 15V$

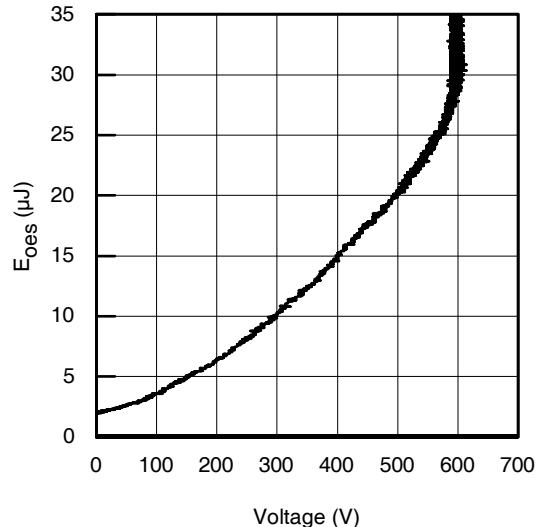


Fig. 17 - Typ. Output Capacitance
 Stored Energy vs. V_{CE}

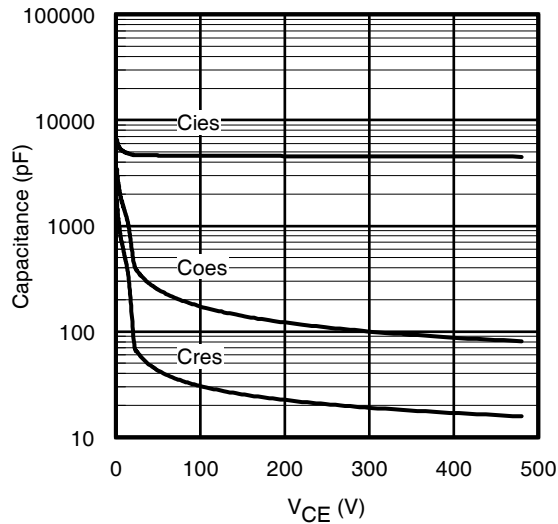


Fig. 18 - Typ. Capacitance vs. V_{CE}
 $V_{GE} = 0V$; $f = 1MHz$

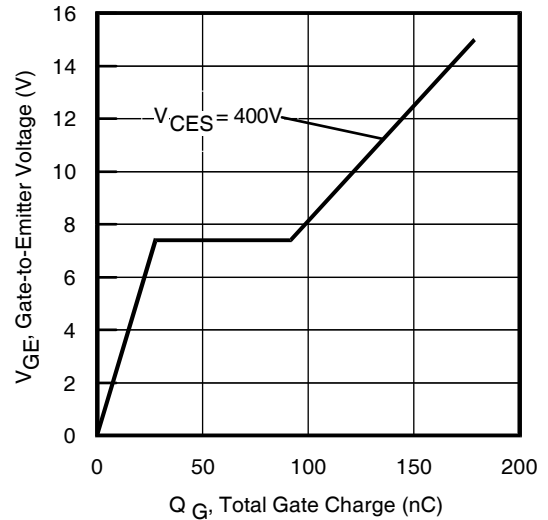


Fig. 19 - Typical Gate Charge vs. V_{GE}
 $I_{CE} = 20A$; $L = 200\mu H$

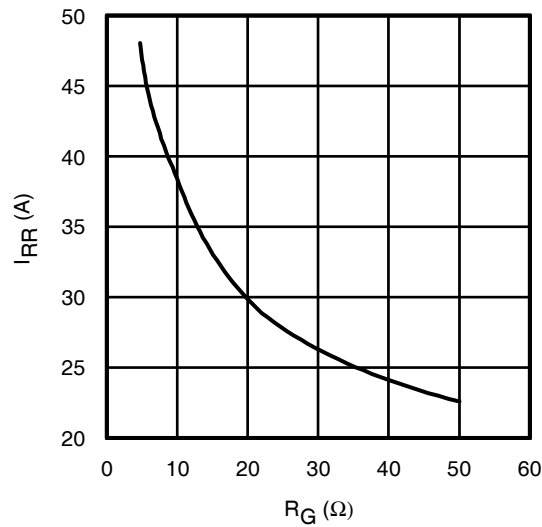
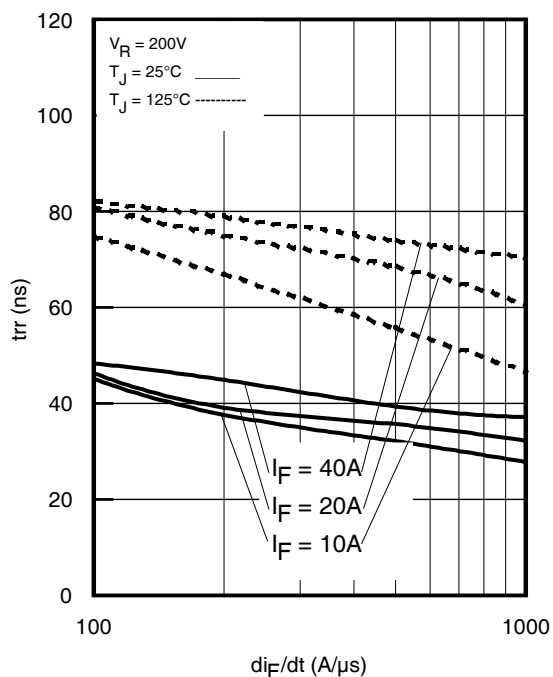
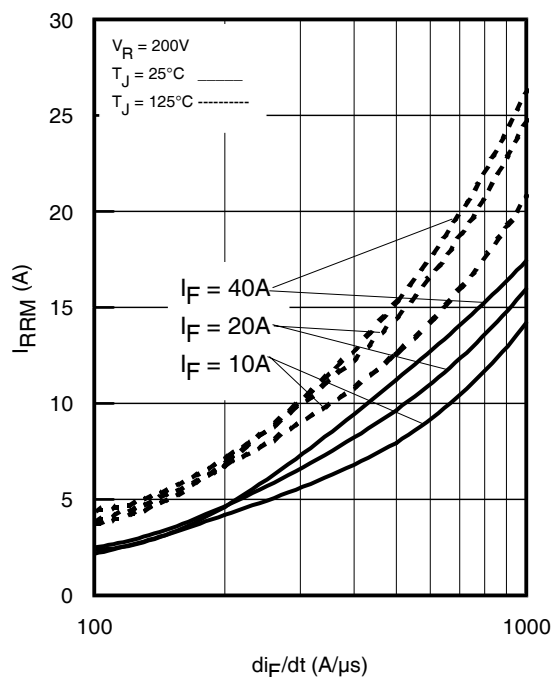
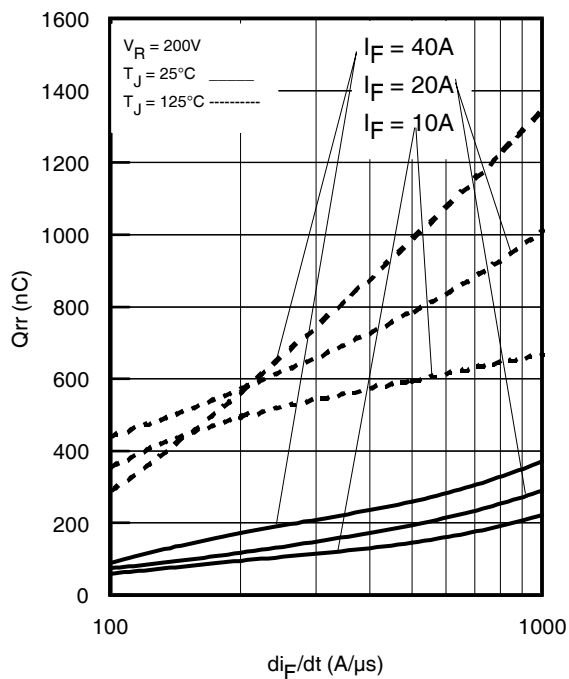
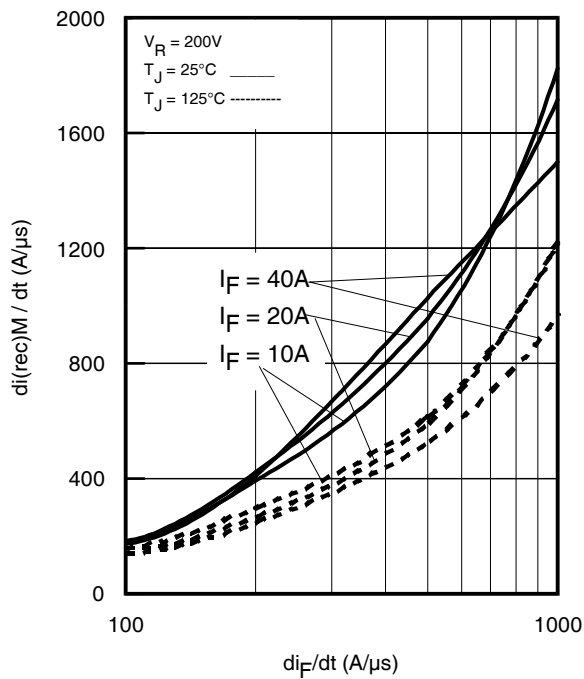
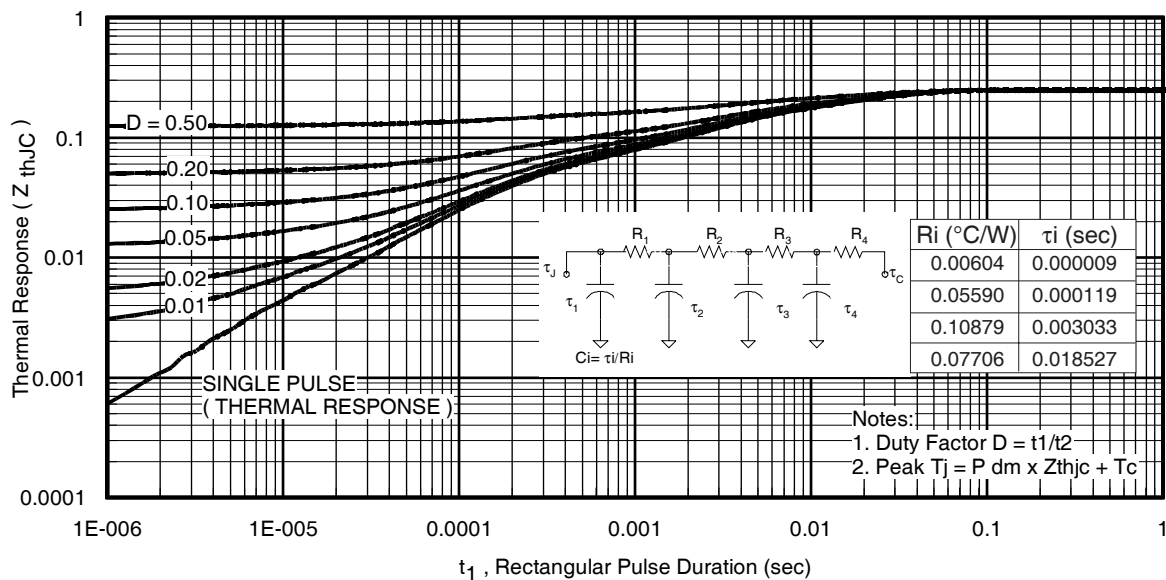
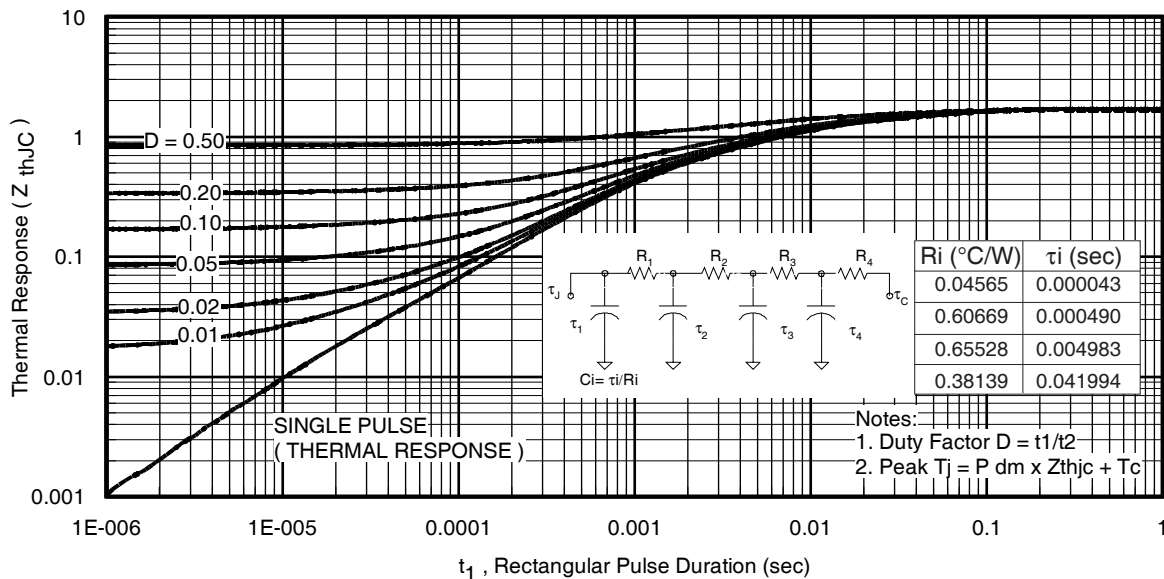
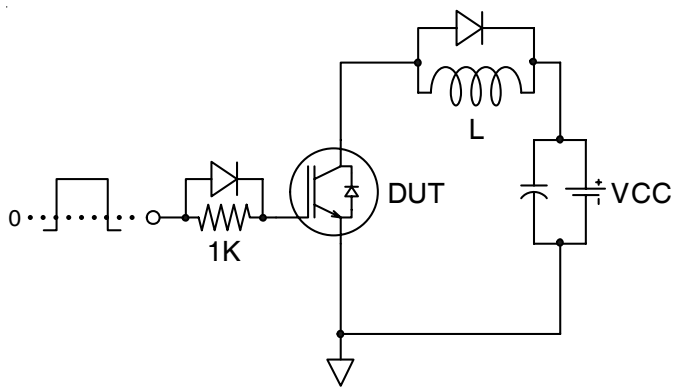
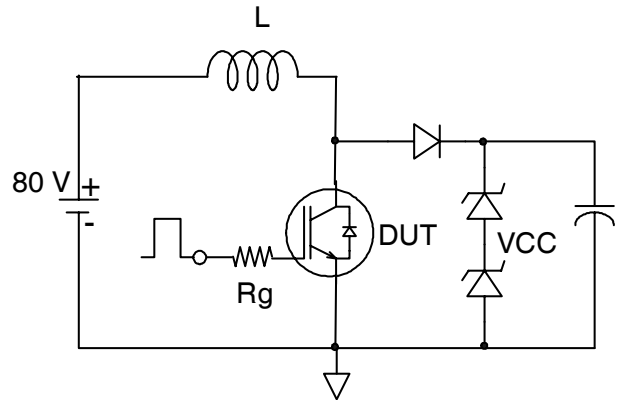
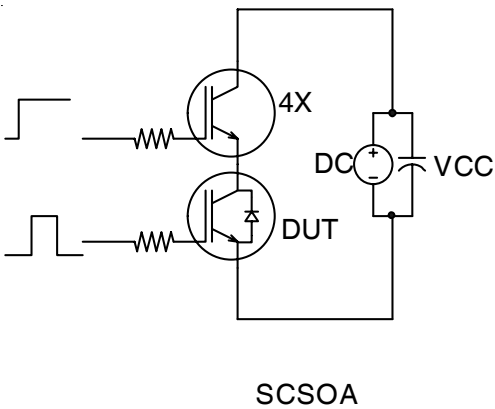
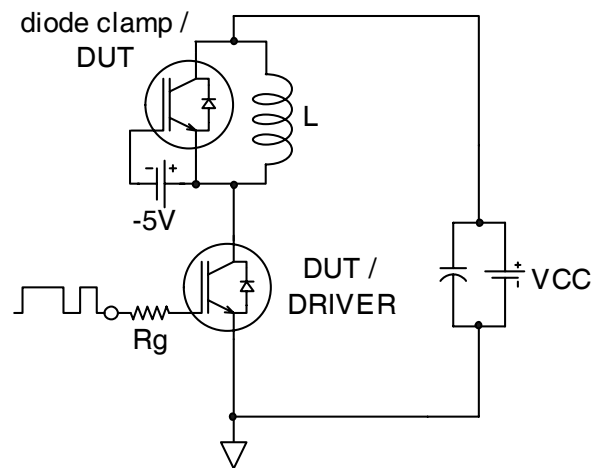
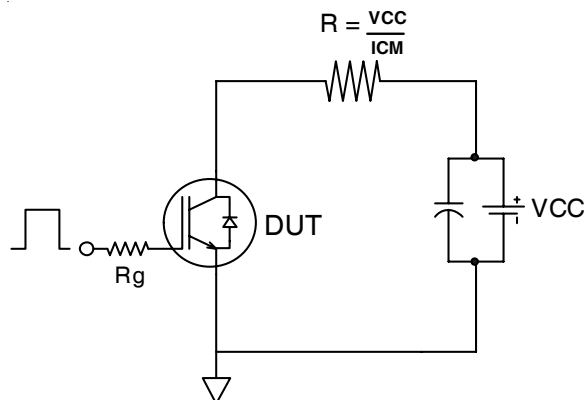


Fig. 20 - Typ. Diode I_{RR} vs. R_G
 $T_J = 175^\circ C$


Fig. 21 - Typical Reverse Recovery vs. di_F/dt

Fig. 22 - Typical Recovery Current vs. di_F/dt

Fig. 23 - Typical Stored Charge vs. di_F/dt

Fig. 24 - Typical $di_{(rec)M}/dt$ vs. di_F/dt ,


Fig 25. Maximum Transient Thermal Impedance, Junction-to-Case (IGBT)

Fig. 26. Maximum Transient Thermal Impedance, Junction-to-Case (DIODE)


Fig.C.T.1 - Gate Charge Circuit (turn-off)

Fig.C.T.2 - RBSOA Circuit

Fig.C.T.3 - S.C. SOA Circuit

Fig.C.T.4 - Switching Loss Circuit

Fig.C.T.5 - Resistive Load Circuit

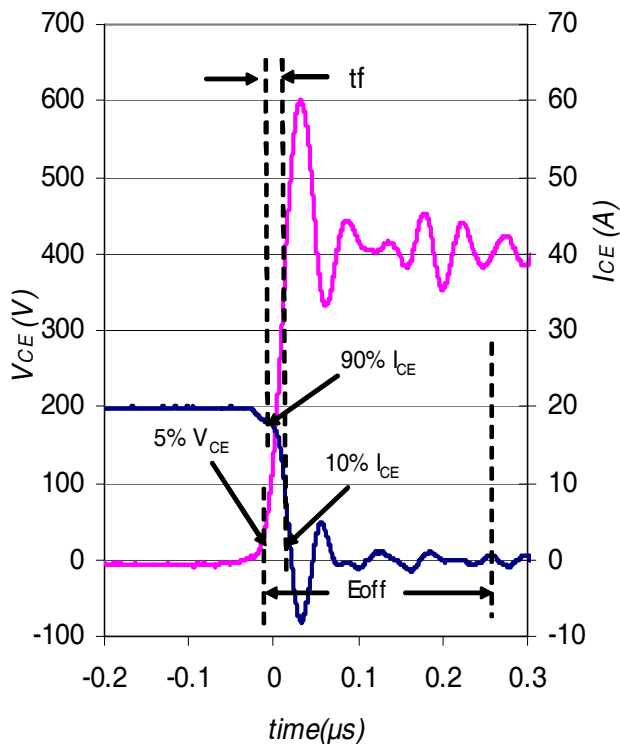


Fig. WF1 - Typ. Turn-off Loss Waveform
@ $T_J = 175^\circ\text{C}$ using Fig. CT.4

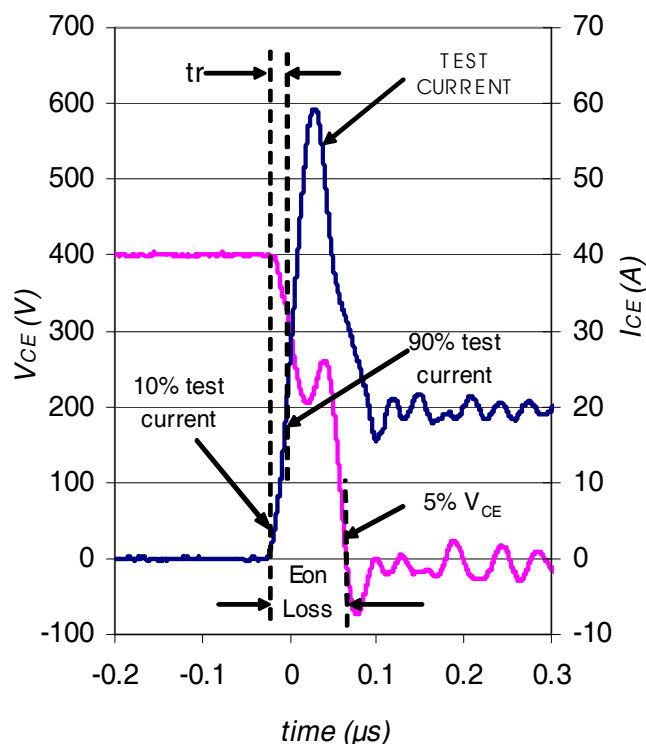
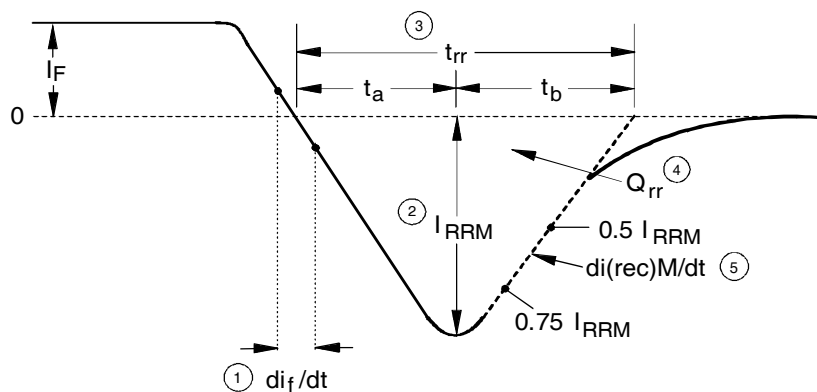


Fig. WF2 - Typ. Turn-on Loss Waveform
@ $T_J = 175^\circ\text{C}$ using Fig. CT.4



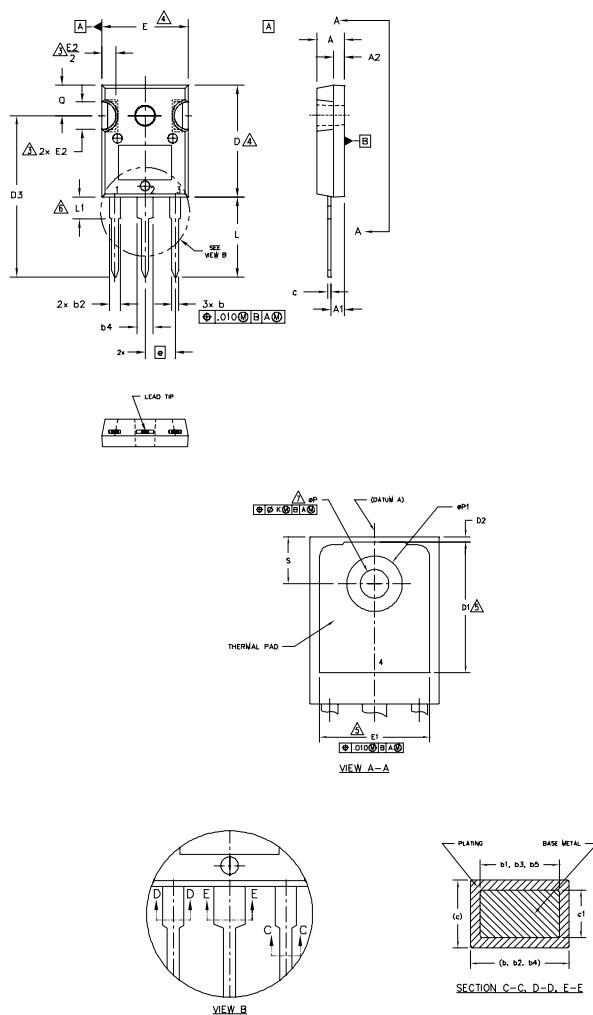
1. di_f/dt - Rate of change of current through zero crossing
2. I_{RRM} - Peak reverse recovery current
3. t_{rr} - Reverse recovery time measured from zero crossing point of negative going I_F to point where a line passing through $0.75 I_{RRM}$ and $0.50 I_{RRM}$ extrapolated to zero current
4. Q_{rr} - Area under curve defined by t_{rr} and I_{RRM}

$$Q_{rr} = \frac{t_{rr} \times I_{RRM}}{2}$$
5. $di_{(rec)M}/dt$ - Peak rate of change of current during t_b portion of t_{rr}

Fig. WF3 - Reverse Recovery Waveform and Definitions

TO-247AC Package Outline

Dimensions are shown in millimeters (inches)



- NOTES:
1. DIMENSIONING AND TOLERANCING AS PER ASME Y14.5M 1994.
 2. DIMENSIONS ARE SHOWN IN INCHES.
 3. CONTOUR OF SLOT OPTIONAL.
 4. DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED .005" (0.127) PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY.
 5. THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSIONS D1 & E1.
 6. LEAD FINISH UNCONTROLLED IN L1.
 7. ØP TO HAVE A MAXIMUM DRAFT ANGLE OF 1.5 ° TO THE TOP OF THE PART WITH A MAXIMUM HOLE DIAMETER OF .154 INCH.
 8. OUTLINE CONFORMS TO JEDEC OUTLINE TO-247AC .

| SYMBOL | DIMENSIONS | | | | NOTES |
|--------|------------|-------|-------------|-------|-------|
| | INCHES | | MILLIMETERS | | |
| | MIN. | MAX. | MIN. | MAX. | |
| A | .183 | .209 | 4.65 | 5.31 | |
| A1 | .087 | .102 | 2.21 | 2.59 | |
| A2 | .059 | .098 | 1.50 | 2.49 | |
| b | .039 | .055 | 0.99 | 1.40 | |
| b1 | .039 | .053 | 0.99 | 1.35 | |
| b2 | .065 | .094 | 1.65 | 2.39 | |
| b3 | .065 | .092 | 1.65 | 2.34 | |
| b4 | .102 | .135 | 2.59 | 3.43 | |
| b5 | .102 | .133 | 2.59 | 3.38 | |
| c | .015 | .035 | 0.38 | 0.89 | |
| c1 | .015 | .033 | 0.38 | 0.84 | |
| D | .776 | .815 | 19.71 | 20.70 | 4 |
| D1 | .515 | - | 13.08 | - | 5 |
| D2 | .020 | .053 | 0.51 | 1.35 | |
| D3 | 1.122 | 1.161 | 28.50 | 29.50 | |
| E | .602 | .625 | 15.29 | 15.87 | 4 |
| E1 | .530 | - | 13.46 | - | |
| E2 | .178 | .216 | 4.52 | 5.49 | |
| e | .215 BSC | | 5.46 BSC | | |
| Øk | .010 | | 0.25 | | |
| L | .559 | .634 | 14.20 | 16.10 | |
| L1 | .146 | .169 | 3.71 | 4.29 | |
| ØP | .140 | .144 | 3.56 | 3.66 | |
| ØP1 | - | .291 | - | 7.39 | |
| Q | .209 | .224 | 5.31 | 5.69 | |
| S | .217 BSC | | 5.51 BSC | | |

PART NUMBERS AFFECTED:

- AUIRGP4PH50S
- AUIRGP4066D1/E
- AUIRGP4063D/E
- AUIRGP50B60PD1/E
- AUIRGP35B60PD/E
- AUIRGP4062D1/E
- AUIRGP65A20D0
- AUIRGP65G20D0
- AUIRGP/F66524D0
- AUIRGP/F76524D0
- AUIRGP/F66548D0
- AUIRGP/F76548D0

LEAD ASSIGNMENTS

HEXFET

- 1.- GATE
- 2.- DRAIN
- 3.- SOURCE
- 4.- DRAIN

IGBTs, CoPACK

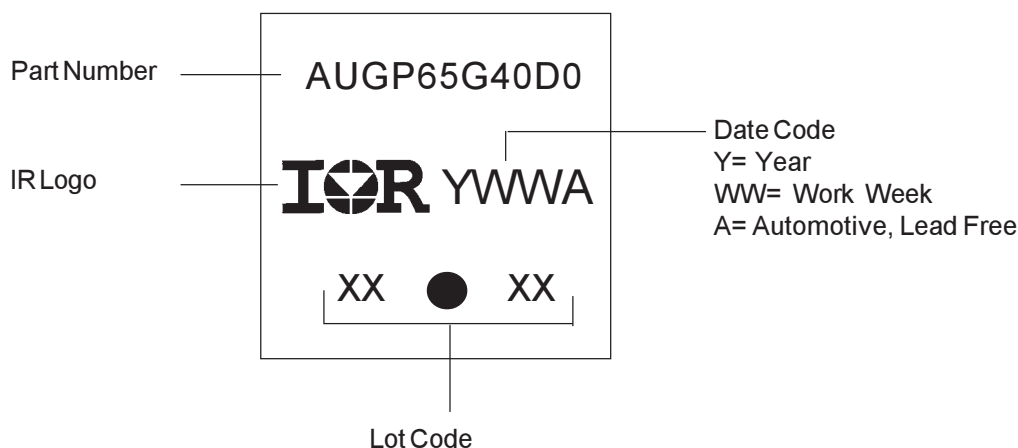
- 1.- GATE
- 2.- COLLECTOR
- 3.- EMITTER
- 4.- COLLECTOR

DIODES

- 1.- ANODE/OPEN
- 2.- CATHODE
- 3.- ANODE

SPECIAL NOTE:
a) ADDED D3 FOR SPECIAL REQUIREMENT

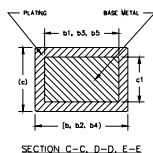
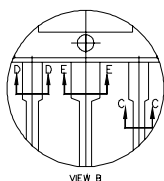
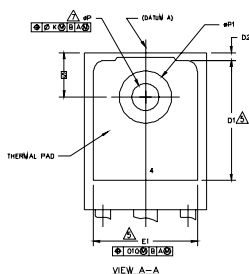
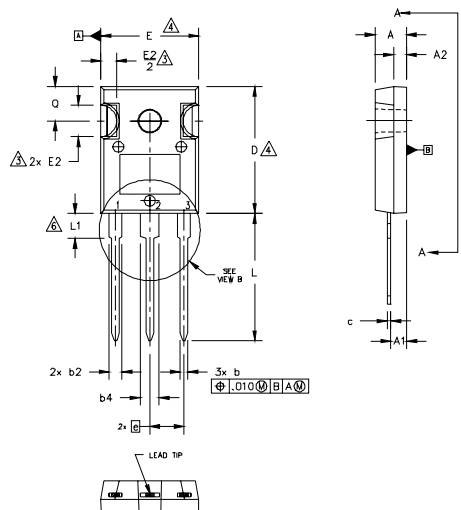
TO-247AC Part Marking Information



Note: For the most current drawing please refer to IR website at <http://www.irf.com/package/>

TO-247AD Package Outline

Dimensions are shown in millimeters (inches)



NOTES:

1. DIMENSIONING AND TOLERANCING AS PER ASME Y14.5M 1994.
2. DIMENSIONS ARE SHOWN IN INCHES.
3. CONTOUR OF SLOT OPTIONAL.
4. DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED .005" (0.127) PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY.
5. THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSIONS D1 & E1.
6. LEAD FINISH UNCONTROLLED IN L1.
7. ØP TO HAVE A MAXIMUM DRAFT ANGLE OF 1.5 ° TO THE TOP OF THE PART WITH A MAXIMUM HOLE DIAMETER OF .154 INCH.
8. OUTLINE CONFORMS TO JEDEC OUTLINE TO-247AD.

| SYMBOL | DIMENSIONS | | | | NOTES |
|--------|------------|------|-------------|-------|-------|
| | INCHES | | MILLIMETERS | | |
| | MIN. | MAX. | MIN. | MAX. | |
| A | .183 | .209 | 4.65 | 5.31 | |
| A1 | .087 | .102 | 2.21 | 2.59 | |
| A2 | .059 | .098 | 1.50 | 2.49 | |
| b | .039 | .055 | 0.99 | 1.40 | |
| b1 | .039 | .053 | 0.99 | 1.35 | |
| b2 | .065 | .094 | 1.65 | 2.39 | |
| b3 | .065 | .092 | 1.65 | 2.34 | |
| b4 | .102 | .135 | 2.59 | 3.43 | |
| b5 | .102 | .133 | 2.59 | 3.38 | |
| c | .015 | .035 | 0.38 | 0.89 | |
| c1 | .015 | .033 | 0.38 | 0.84 | |
| D | .776 | .815 | 19.71 | 20.70 | 4 |
| D1 | .515 | - | 13.08 | - | 5 |
| D2 | .020 | .053 | 0.51 | 1.35 | |
| E | .602 | .625 | 15.29 | 15.87 | 4 |
| E1 | .530 | - | 13.46 | - | |
| E2 | .178 | .216 | 4.52 | 5.49 | |
| e | .215 BSC | | 5.46 BSC | | |
| Øk | .010 | | 0.25 | | |
| L | .780 | .827 | 19.57 | 21.00 | |
| L1 | .146 | .169 | 3.71 | 4.29 | |
| ØP | .140 | .144 | 3.56 | 3.66 | |
| ØP1 | - | .291 | - | 7.39 | |
| Q | .209 | .224 | 5.31 | 5.69 | |
| S | .217 BSC | | 5.51 BSC | | |

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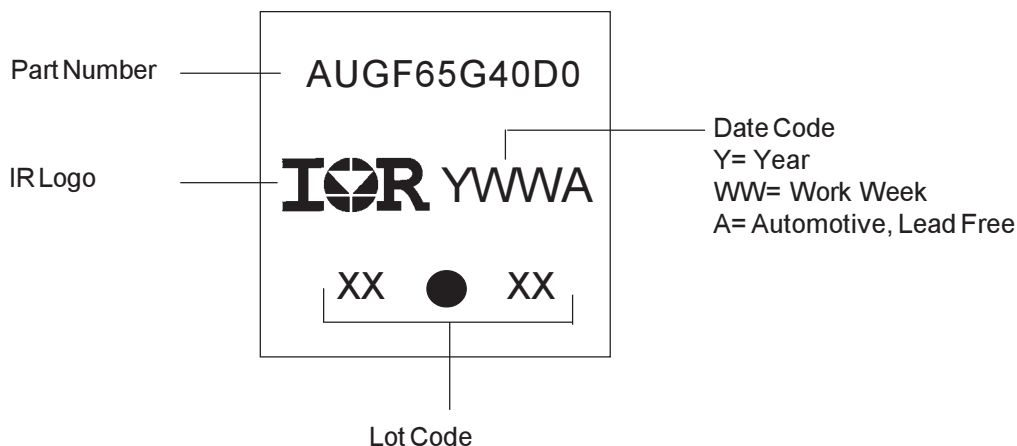
IGBTs, CoPACK

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- 3.- EMITTER
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DIODES

- 1.- ANODE/OPEN
- 2.- CATHODE
- 3.- ANODE

TO-247AD Part Marking Information



Note: For the most current drawing please refer to IR website at <http://www.irf.com/package/>

Qualification Information[†]

| | | | |
|-----------------------------------|----------------------|---|-----|
| Qualification Level | | Automotive (per AEC-Q101) | |
| | | Comments: This part number(s) passed Automotive qualification. IR's Industrial and Consumer qualification level is granted by extension of the higher Automotive level. | |
| Moisture Sensitivity Level | | TO-247AC | N/A |
| | | TO-247AD | N/A |
| ESD | Machine Model | Class M4 (+/- 400V) ^{††} AEC-Q101-002 | |
| | Human Body Model | Class H3B (+/- 8000V) ^{††} AEC-Q101-001 | |
| | Charged Device Model | Class C5 (+/- 1000V) ^{††} AEC-Q101-005 | |
| RoHS Compliant | | Yes | |

† Qualification standards can be found at International Rectifier's web site: <http://www.irf.com>

†† Highest passing voltage.

Notes:

- ① $V_{CC} = 80\% (V_{CES})$, $V_{GE} = 20V$, $L = 485\mu H$, $R_G = 4.7\Omega$, tested in production $I_{LM} \leq 400A$.
- ② Pulse width limited by max. junction temperature.
- ③ Refer to AN-1086 for guidelines for measuring $V_{(BR)CES}$ safely.
- ④ R_{θ} is measured at T_J of approximately $90^{\circ}C$.
- ⑤ $C_{oes\ eff.}$ is a fixed capacitance that gives the same charging time as C_{oes} while V_{CE} is rising from 0 to $80\% V_{CES}$. $C_{oes\ eff.}(ER)$ is a fixed capacitance that stores the same energy as C_{oes} while V_{CE} is rising from 0 to $80\% V_{CES}$.
- ⑥ Calculated continuous current based on maximum allowable junction temperature.
- ⑦ Nominal current limit is suggested for 400V, 200kHz operation. Actual current rating varies with application and is subjected to T_J and SOA limits.

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For technical support, please contact IR's Technical Assistance Center
<http://www.irf.com/technical-info/>

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Tel: (310) 252-7105

Revision History

| Date | Comments |
|-------------|--|
| 9/8/2015 | • Removed "short circuit rating on page 1 & 2. |