# COOLiR*IGBT*™

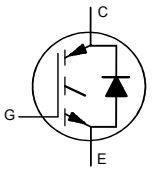
***INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE***

$V_{CES}$ = 600V

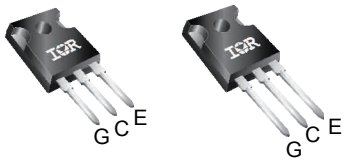
$I_{NOMINAL}$ = 24A

Tsc ≥ 6µs, $T_{J(MAX)}$ = 175°C

$V_{CE(ON)}$ typ. = 1.60V



n-channel



TO-247AC
AUIRGP66524D0

TO-247AD
AUIRGF66524D0

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

**Applications**
- Air Conditioning Compressor
- Auxiliary Motor Drive

| Features | → | Benefits |
|---|---|---|
| Low $V_{CE(on)}$ Trench IGBT Technology | | High Efficiency in a Wide Range of Applications |
| Low Switching Losses | | Suitable for a Wide Range of Switching Frequencies |
| 6µs SCSOA Guaranteed | | Enables Short Circuit Protection Scheme |
| Square RBSOA and 100% Clamp IL Tested | | Rugged Hard Switching Operation |
| Positive $V_{CE(on)}$ Temperature Coefficient | | Enables Easy Paralleling of Devices |
| Ultra Fast Soft Recovery Co-pak Diode | | Better Efficiency and Improved EMI Performance |
| Lead-Free, RoHS Compliant, Automotive Qualified * | | Environmentally Friendly |

| Base Part Number | Package Type | Standard Pack | | Orderable Part Number |
|---|---|---|---|---|
| | | Form | Quantity | |
| AUIRGP66524D0 | TO-247AC | Tube | 25 | AUIRGP66524D0 |
| AUIRGF66524D0 | TO-247AD | Tube | 25 | AUIRGF66524D0 |

**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 |
| $I_{Nominal}$ | Nominal Collector Current | 24 | A |
| $I_C$ @ $T_C$ = 25°C | Continuous Collector Current | 60 | |
| $I_C$ @ $T_C$ = 100°C | Continuous Collector Current | 40 | |
| $I_{CM}$ | Pulse Collector Current, $V_{GE}$ = 15V | 72 | |
| $I_{LM}$ | Clamped Inductive Load Current, $V_{GE}$ = 20V ① | 96 | |
| $I_F$ @ $T_C$ = 25°C | Diode Continous Forward Current | 55 | |
| $I_F$ @ $T_C$ = 100°C | Diode Continous Forward Current | 35 | |
| $I_{FM}$ | Diode Maximum Forward Current ② | 72 | |
| $V_{GE}$ | Continuous Gate-to-Emitter Voltage | ±20 | V |
| | Transient Gate-to-Emitter Voltage | ±30 | |
| dV/dt | Maximum Voltage Transient | 15 | V/ns |
| $P_D$ @ $T_C$ = 25°C | Maximum Power Dissipation | 214 | W |
| $P_D$ @ $T_C$ = 100°C | Maximum Power Dissipation | 107 | |
| $T_J$<br>$T_{STG}$ | Operating Junction and<br>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) | |

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

**Thermal Resistance**

| | Parameter | Typ. | Max. | Units |
|---|---|---|---|---|
| $R_{\theta JC}$ (IGBT) | Thermal Resistance Junction-to-Case (each IGBT) ④ | —— | 0.7 | °C/W |
| $R_{\theta JC}$ (Diode) | Thermal Resistance Junction-to-Case (each Diode) ④ | —— | 1.1 | |
| $R_{\theta CS}$ | Thermal Resistance, Case-to-Sink (flat, greased surface) | 0.24 | —— | |
| $R_{\theta JA}$ | Thermal Resistance, Junction-to-Ambient (typical socket mount) | —— | 40 | |

**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, $I_C$ = 100µA ③ |
| $\Delta V_{(BR)CES}/\Delta T_J$ | Temperature Coeff. of Breakdown Voltage | — | 0.21 | — | V/°C | $V_{GE}$=0V, $I_C$=20mA (25°C-175°C) |
| $V_{CE(on)}$ | Collector-to-Emitter Saturation Voltage | — | 1.60 | 1.90 | V | $I_C$ = 24A, $V_{GE}$ = 15V, $T_J$ = 25°C |
| | | — | 1.95 | — | | $I_C$ = 24A, $V_{GE}$ = 15V, $T_J$ = 150°C |
| | | — | 2.0 | — | | $I_C$ = 24A, $V_{GE}$ = 15V, $T_J$ = 175°C |
| $V_{GE(th)}$ | Gate Threshold Voltage | 5.5 | 6.5 | 7.5 | V | $V_{CE}$ = $V_{GE}$, $I_C$ = 250µA |
| $\Delta V_{GE(th)}/\Delta TJ$ | Threshold Voltage temp. coefficient | — | -28 | — | mV/°C | $V_{CE}$=$V_{GE}$, $I_C$=1mA(25°C-175°C) |
| gfe | Forward Transconductance | — | 21 | — | S | $V_{CE}$ = 50V, $I_C$ = 24A, PW = 20µs |
| $I_{CES}$ | Collector-to-Emitter Leakage Current | — | 1.1 | 50 | µA | $V_{GE}$ = 0V, $V_{CE}$ = 600V |
| $V_{FM}$ | Diode Forward Voltage Drop | — | 1.50 | 1.90 | V | $I_F$ = 24A |
| | | — | 1.40 | — | | $I_F$ = 24A, $T_J$ = 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) | — | 50 | 80 | nC | $I_C$ = 24A |
| $Q_{ge}$ | Gate-to-Emitter Charge (turn-on) | — | 16 | 24 | | $V_{GE}$ = 15V |
| $Q_{gc}$ | Gate-to-Collector Charge (turn-on) | — | 26 | 39 | | $V_{CC}$ = 400V |
| $E_{on}$ | Turn-On Switching Loss | — | 915 | 1045 | µJ | |
| $E_{off}$ | Turn-Off Switching Loss | — | 280 | 395 | | |
| $E_{total}$ | Total Switching Loss | — | 1195 | 1440 | | $I_C$ = 24A, $V_{CC}$ = 400V, $V_{GE}$ = 15V |
| $t_{d(on)}$ | Turn-On delay time | — | 30 | 50 | ns | $R_G$ = 10Ω, L = 740µH, $T_J$ = 25°C |
| $t_r$ | Rise time | — | 25 | 45 | | Energy losses include tail & diode |
| $t_{d(off)}$ | Turn-Off delay time | — | 75 | 95 | | reverse recovery |
| $t_f$ | Fall time | — | 25 | 45 | | |
| $E_{on}$ | Turn-On Switching Loss | — | 1280 | — | µJ | |
| $E_{off}$ | Turn-Off Switching Loss | — | 550 | — | | |
| $E_{total}$ | Total Switching Loss | — | 1830 | — | | $I_C$ = 24A, $V_{CC}$ = 400V, $V_{GE}$ = 15V |
| $t_{d(on)}$ | Turn-On delay time | — | 30 | — | ns | $R_G$ = 10Ω, L = 740µH, $T_J$ = 175°C |
| $t_r$ | Rise time | — | 25 | — | | Energy losses include tail & diode |
| $t_{d(off)}$ | Turn-Off delay time | — | 100 | — | | reverse recovery |
| $t_f$ | Fall time | — | 95 | — | | |
| $C_{ies}$ | Input Capacitance | — | 1460 | — | pF | $V_{GE}$ = 0V |
| $C_{oes}$ | Output Capacitance | — | 120 | — | | $V_{CC}$ = 30V |
| $C_{res}$ | Reverse Transfer Capacitance | — | 50 | — | | f = 1.0Mhz |
| RBSOA | Reverse Bias Safe Operating Area | FULL SQUARE | | | | $T_J$ = 175°C, $I_C$ = 96A<br>$V_{CC}$ = 480V, Vp ≤ 600V<br>Rg = 10Ω, $V_{GE}$ = +20V to 0V |
| SCSOA | Short Circuit Safe Operating Area | 6 | — | — | µs | $T_J$ = 150°C, $V_{CC}$ = 400V, Vp ≤600V<br>Rg = 50Ω, $V_{GE}$ = +15V to 0V |
| Erec | Reverse Recovery Energy of the Diode | — | 570 | — | µJ | $T_J$ = 175°C |
| $t_{rr}$ | Diode Reverse Recovery Time | — | 176 | — | ns | $V_{CC}$ = 400V, $I_F$ = 24A |
| $I_{rr}$ | Peak Reverse Recovery Current | — | 19 | — | A | $V_{GE}$ = 15V, Rg = 10Ω, L = 740µH |

**Notes:**

① $V_{CC}$ = 80% ($V_{CES}$), $V_{GE}$ = 20V, L = 740µH, $R_G$ = 10Ω.

② Pulse width limited by max. junction temperature.

③ Refer to AN-1086 for guidelines for measuring $V_{(BR)CES}$ safely.

④ $R_\theta$ is measured at $T_J$ approximately 90°C.

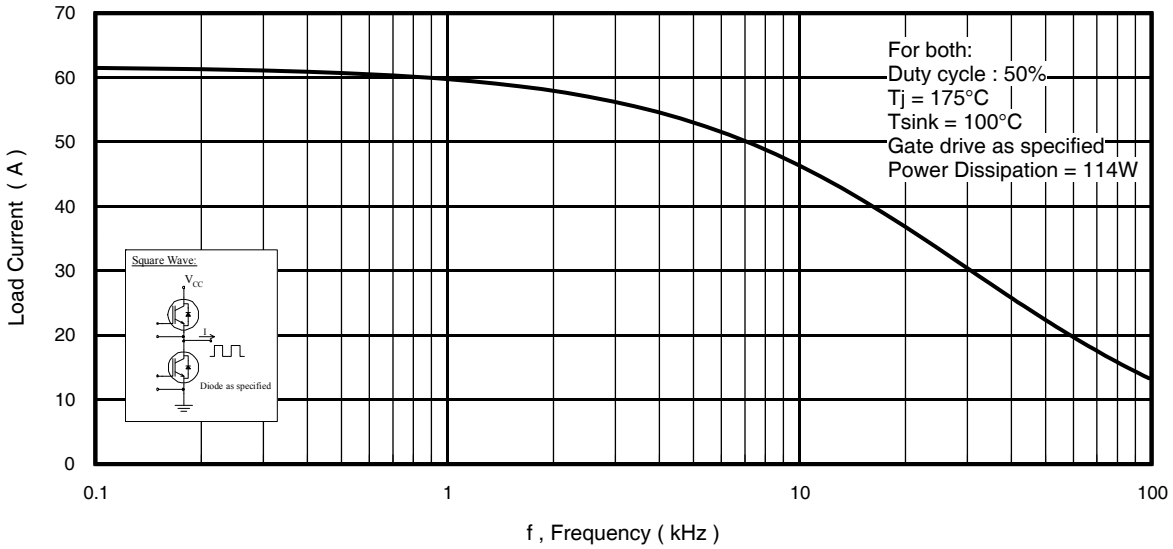



**Fig. 1** - Typical Load Current vs. Frequency

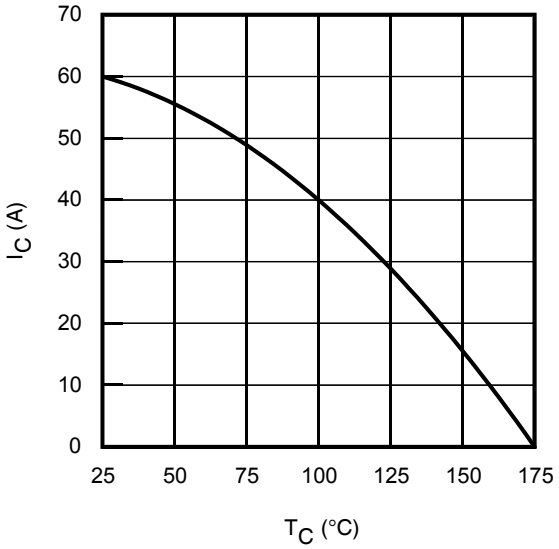



**Fig. 2** - Maximum DC Collector Current vs. Case Temperature

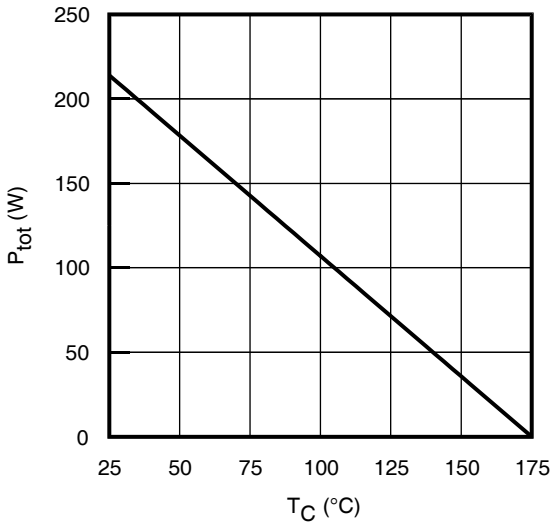



**Fig. 3** - Power Dissipation vs. Case Temperature

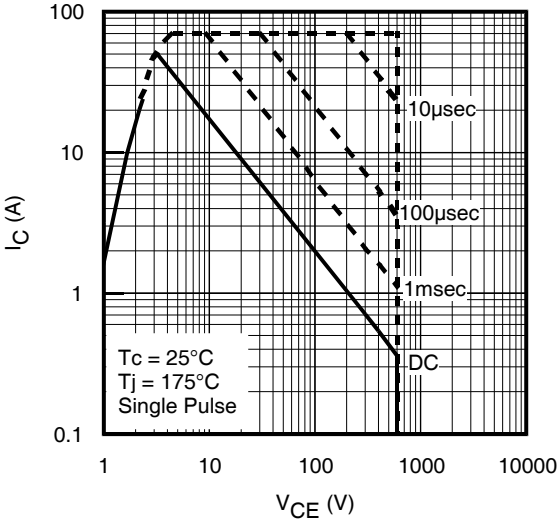



**Fig. 4** - Forward SOA
$T_C$ = 25°C, $T_J$ @ 175°C; $V_{GE}$ =15V

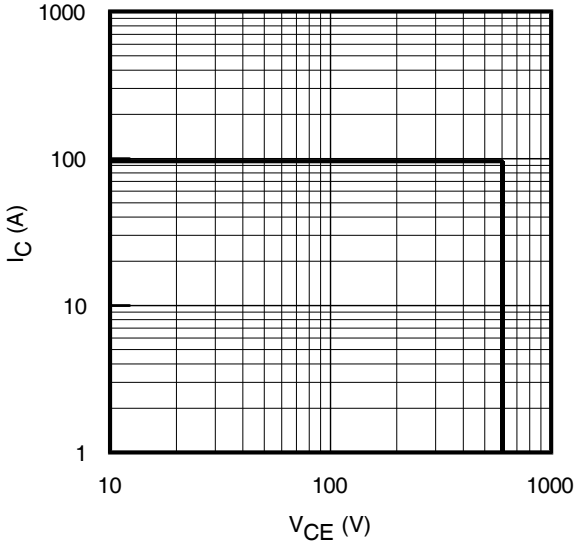



**Fig. 5** - Reverse Bias SOA
$T_J$ = 175°C; $V_{GE}$ = 20V

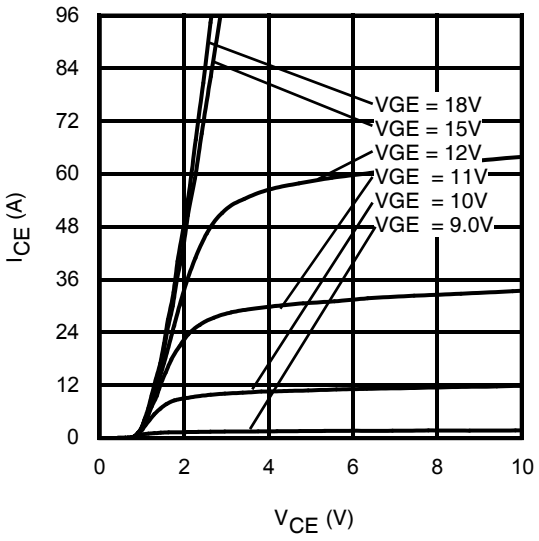



**Fig. 6** - - Typ. IGBT Output Characteristics
$T_J$ = -40°C; tp = 20µs

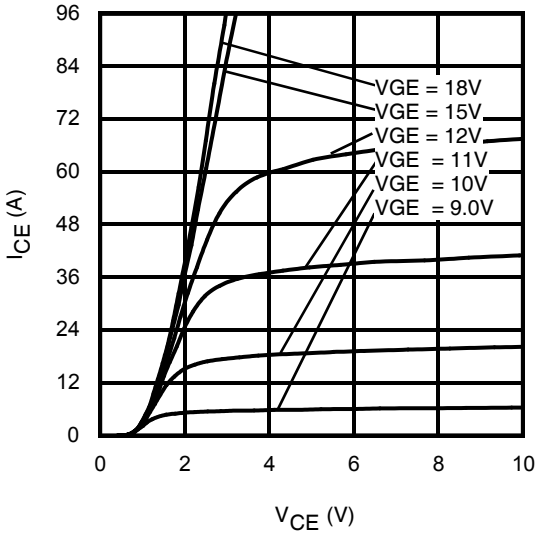



**Fig. 7** - Typ. IGBT Output Characteristics
TJ = 25°C; tp = 20µs

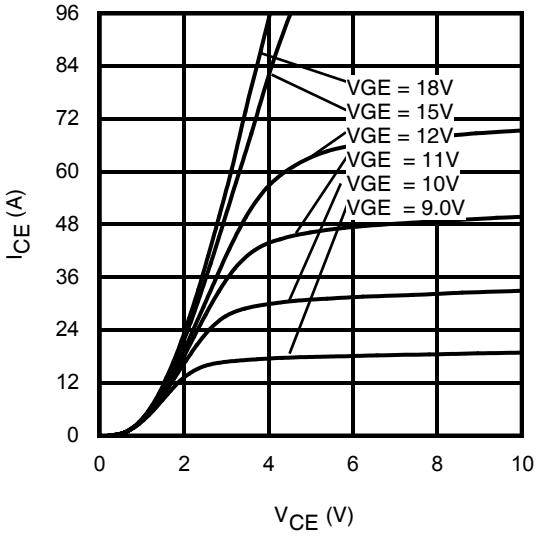



**Fig. 8** - Typ. IGBT Output Characteristics
$T_J$ = 175°C; tp = 20µs

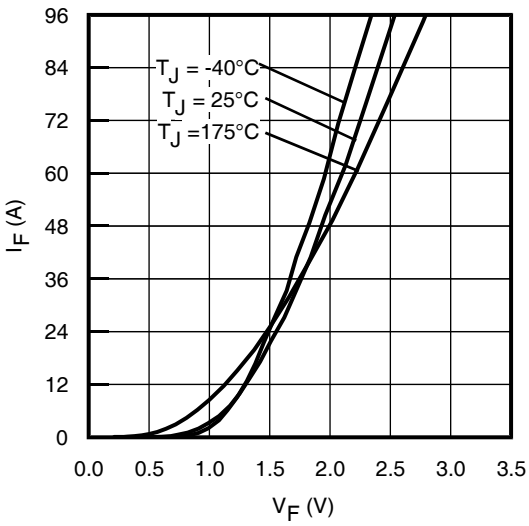



**Fig. 9** - Typ. Diode Forward Characteristics
tp = 20µs

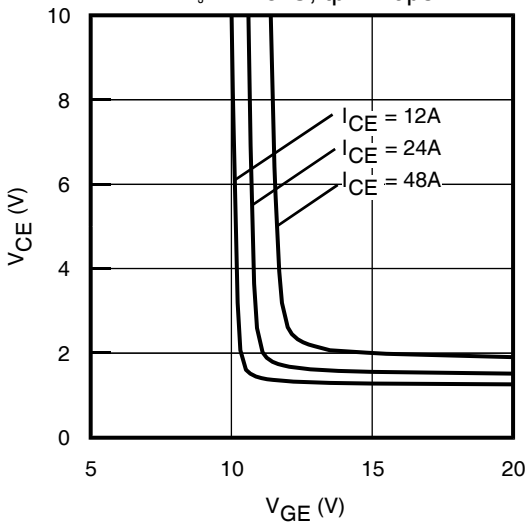



**Fig. 10** - Typical $V_{CE}$ vs. $V_{GE}$
$T_J$ = -40°C

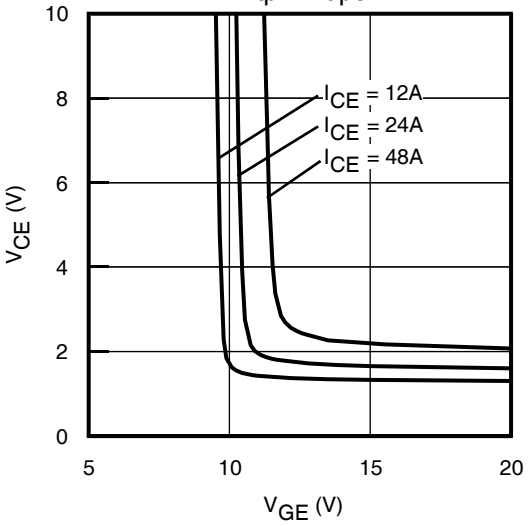



**Fig. 11** - Typical $V_{CE}$ vs. $V_{GE}$
$T_J$ = 25°C

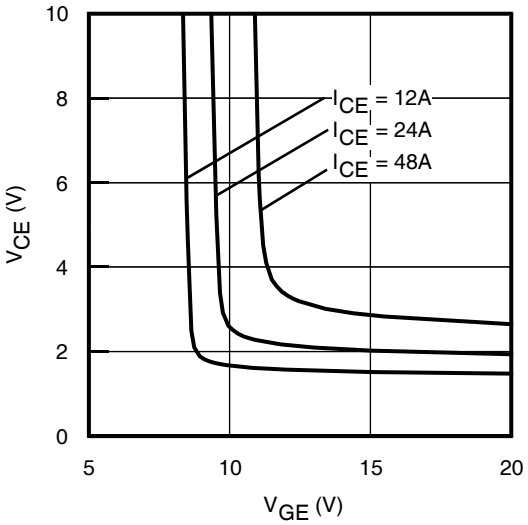



**Fig. 12** - Typical $V_{CE}$ vs. $V_{GE}$
$T_J$ = 175°C

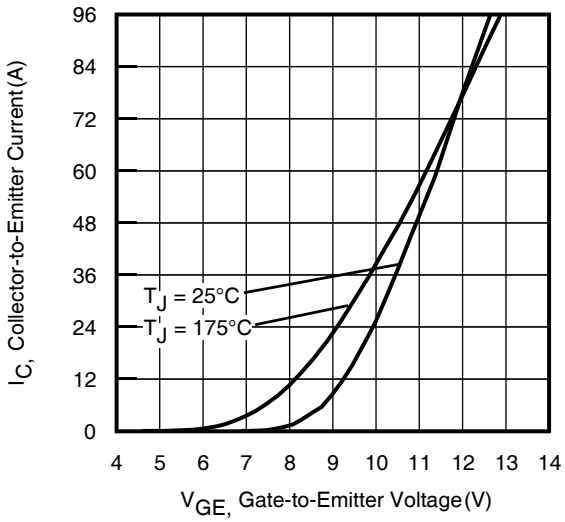



**Fig. 13** - Typ. Transfer Characteristics
$V_{CE}$ = 50V; tp = 20µs

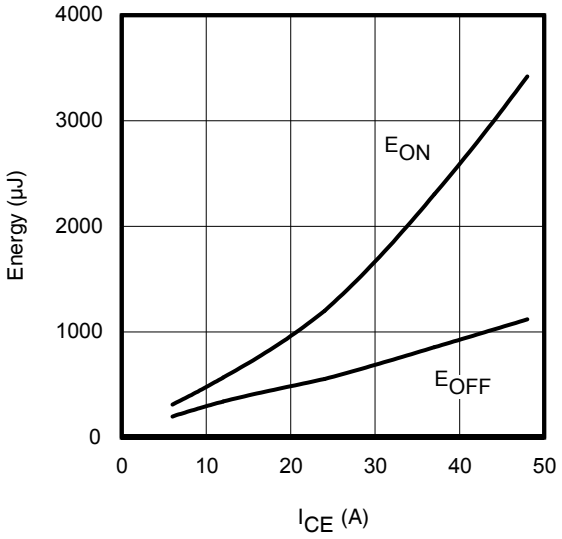



**Fig. 14** - Typ. Energy Loss vs. $I_C$
$T_J$ = 175°C; L = 740µH; $V_{CE}$ = 400V, $R_G$ = 10Ω; $V_{GE}$ = 15V

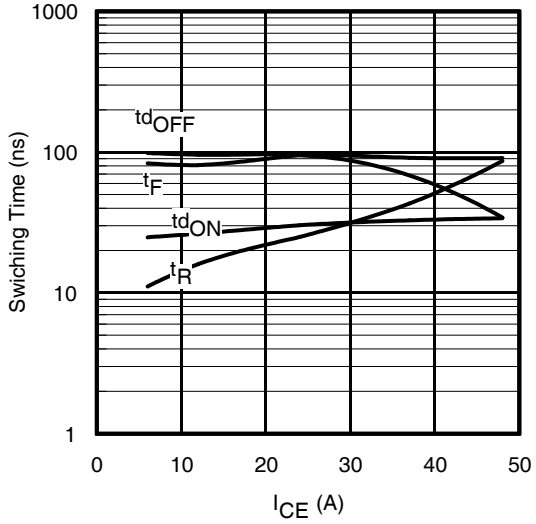



**Fig. 15** - Typ. Switching Time vs. IC
TJ = 175°C; L = 740µH; $V_{CE}$ = 400V, $R_G$ = 10Ω; $V_{GE}$ = 15V

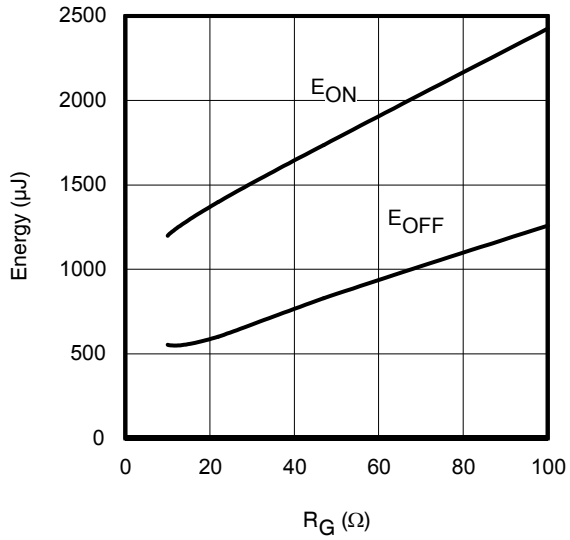



**Fig. 16** - Typ. Energy Loss vs. $R_G$
$T_J$ = 175°C; L = 740µH; $V_{CE}$ = 400V, $I_{CE}$ = 24A; $V_{GE}$ = 15V

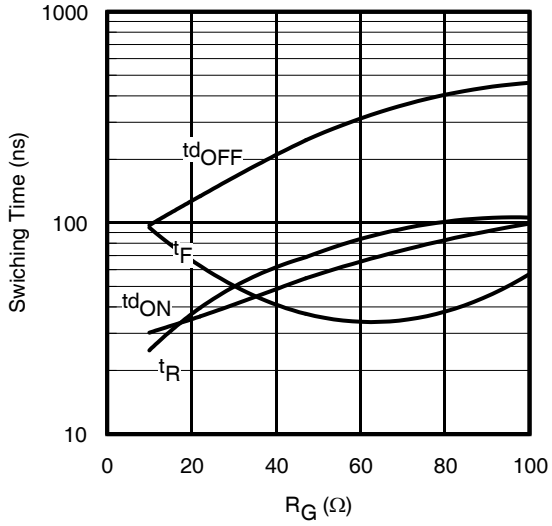



**Fig. 17** - Typ. Switching Time vs. $R_G$
$T_J$ = 175°C; L = 740µH; $V_{CE}$ = 400V, $I_{CE}$ = 24A; $V_{GE}$ = 15V

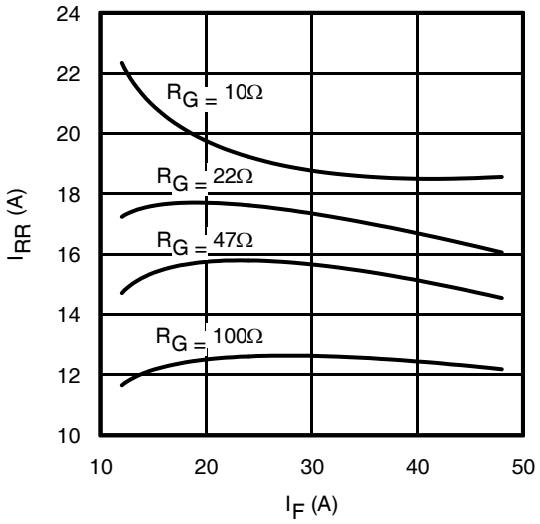



**Fig. 18** - Typ. Diode $I_{RR}$ vs. $I_F$
$T_J$ = 175°C

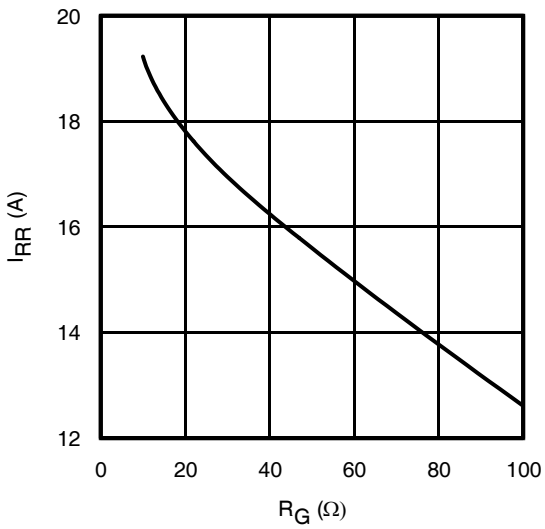



**Fig. 19** - Typ. Diode $I_{RR}$ vs. $R_G$
$T_J$ = 175°C

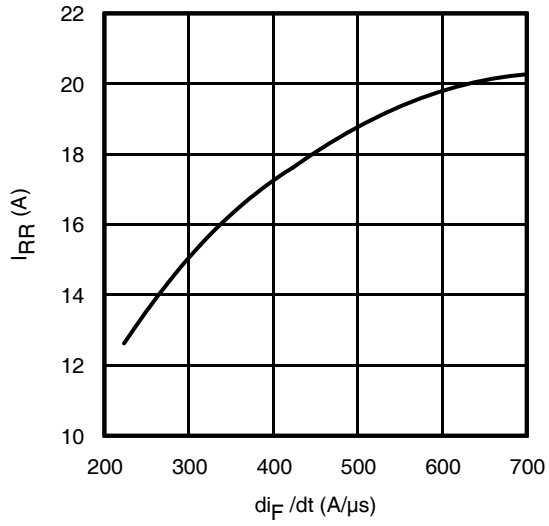



**Fig. 20** - Typ. Diode $I_{RR}$ vs. diF/dt
$V_{CC}$ = 400V; $V_{GE}$ = 15V; $I_F$ = 24A; $T_J$ = 175°C

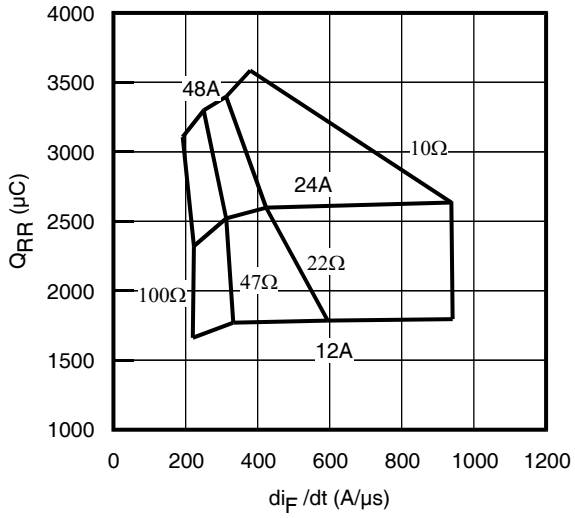



**Fig. 21** - Typ. Diode $Q_{RR}$ vs. diF/dt
$V_{CC}$ = 400V; $V_{GE}$ = 15V; $T_J$ = 175°C

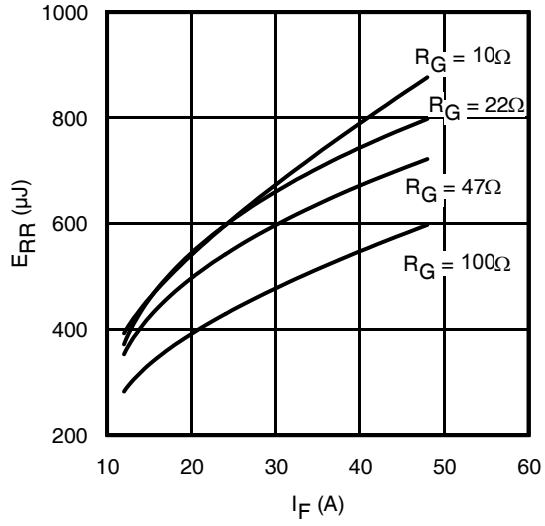



**Fig. 22** - Typ. Diode $E_{RR}$ vs. $I_F$
$T_J$ = 175°C

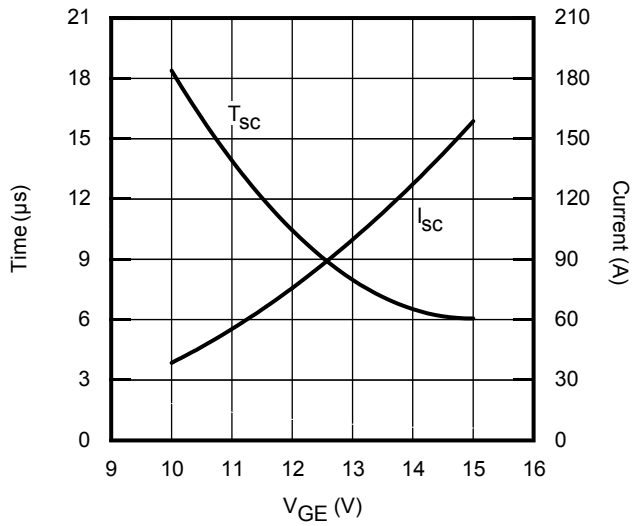



**Fig. 23** - $V_{GE}$ vs. Short Circuit Time
$V_{CC}$ = 400V; $T_C$ = 150°C

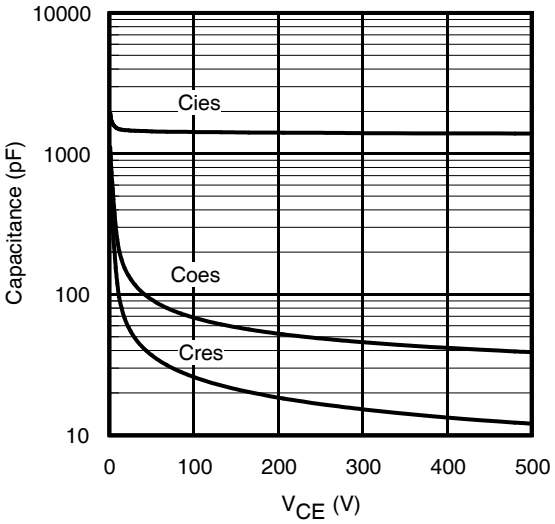



**Fig. 24** - Typ. Capacitance vs. $V_{CE}$
$V_{GE}$= 0V; f = 1MHz

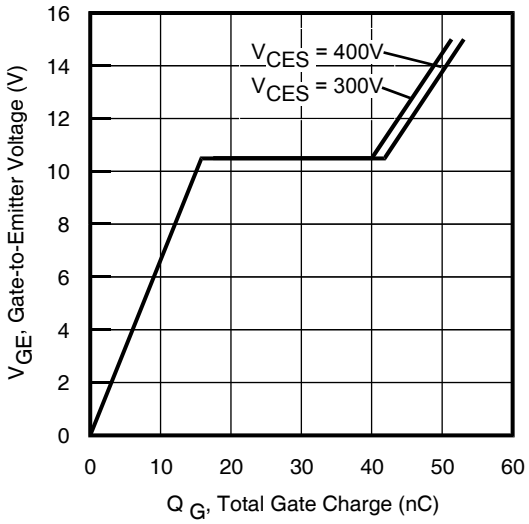



**Fig. 25** - Typical Gate Charge vs. $V_{GE}$
$I_{CE}$ = 24A; L= 485µH

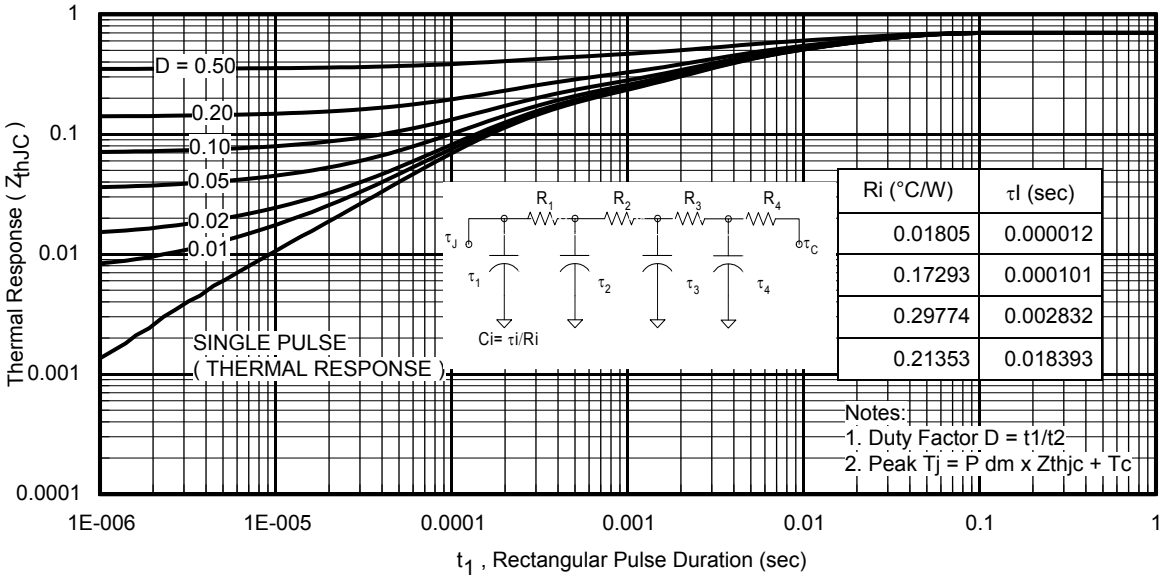



**Fig 26.** Maximum Transient Thermal Impedance, Junction-to-Case (IGBT)

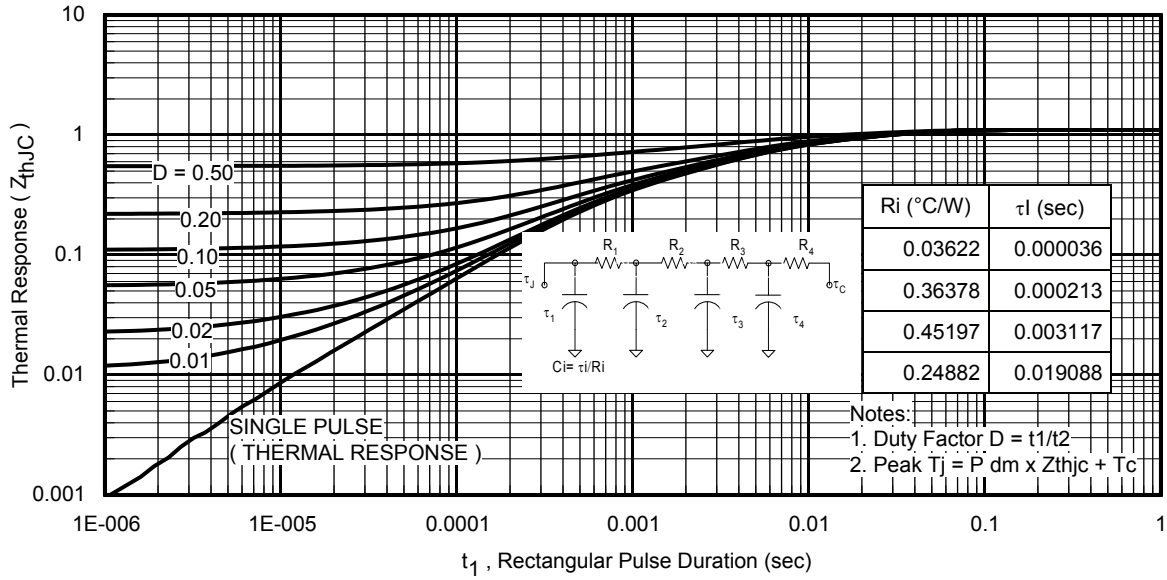
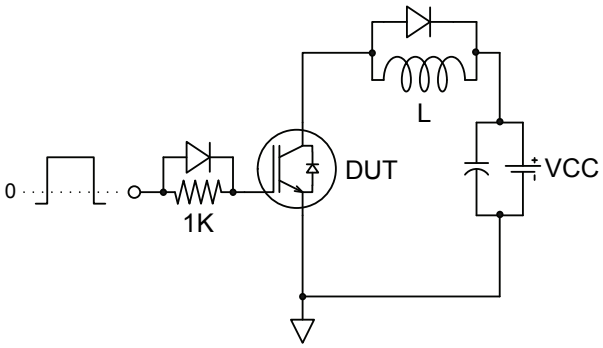


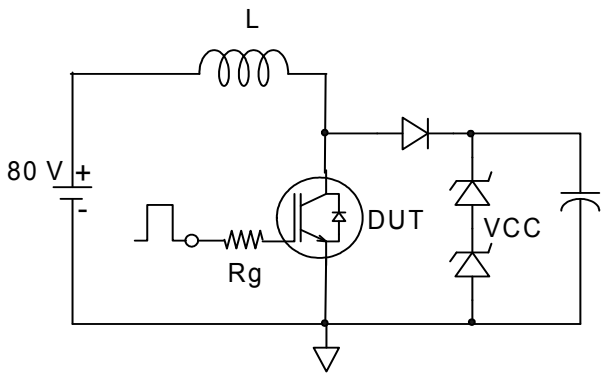

**Fig 27.** Maximum Transient Thermal Impedance, Junction-to-Case (DIODE)




Gate Charge Circuit

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




RBSOA Circuit

**Fig.C.T.2** - RBSOA Circuit

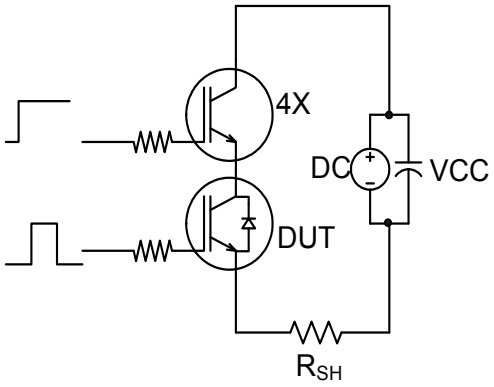
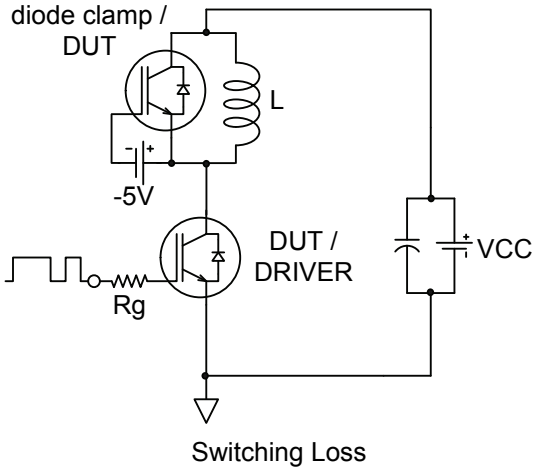



**Fig.C.T.3** - S.C. SOA Circuit




Switching Loss

**Fig.C.T.4** - Switching Loss Circuit

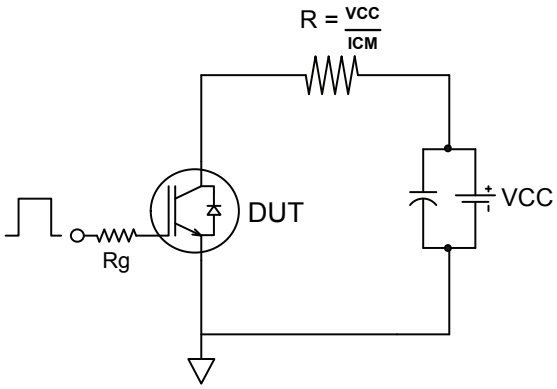



**Fig.C.T.5** - Resistive Load Circuit

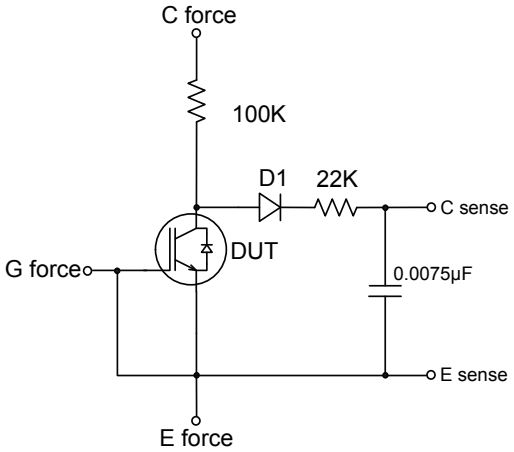



**Fig.C.T.6** - BVCES Filter Circuit

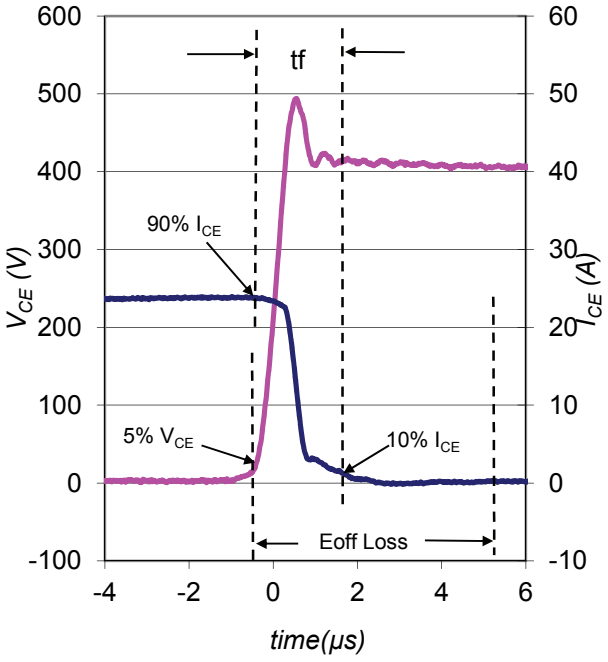



**Fig. WF1** - Typ. Turn-off Loss Waveform
@ $T_J$ = 175°C using Fig. CT.4

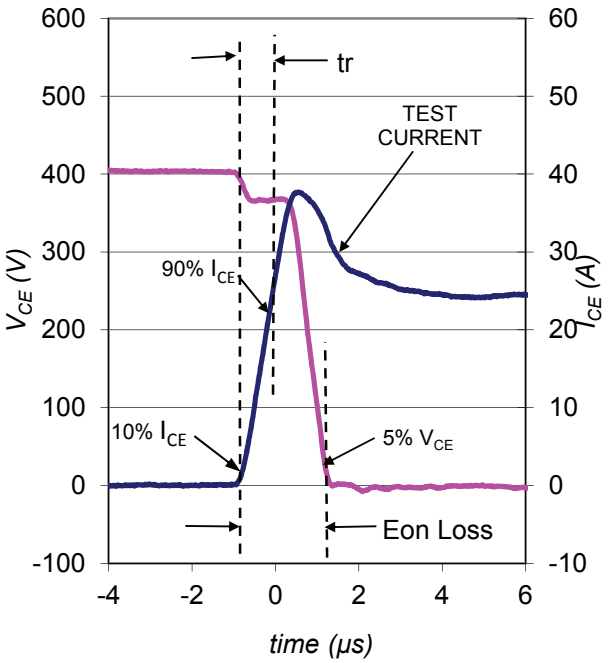



**Fig. WF2** - Typ. Turn-on Loss Waveform
@ $T_J$ = 175°C using Fig. CT.4

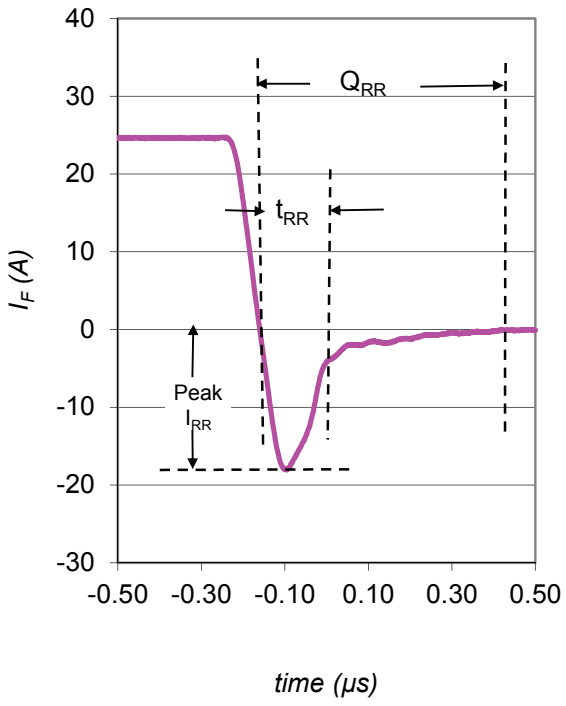



**Fig. WF3** - Typ. Diode Recovery Waveform
@ $T_J$ = 175°C using Fig. CT.4

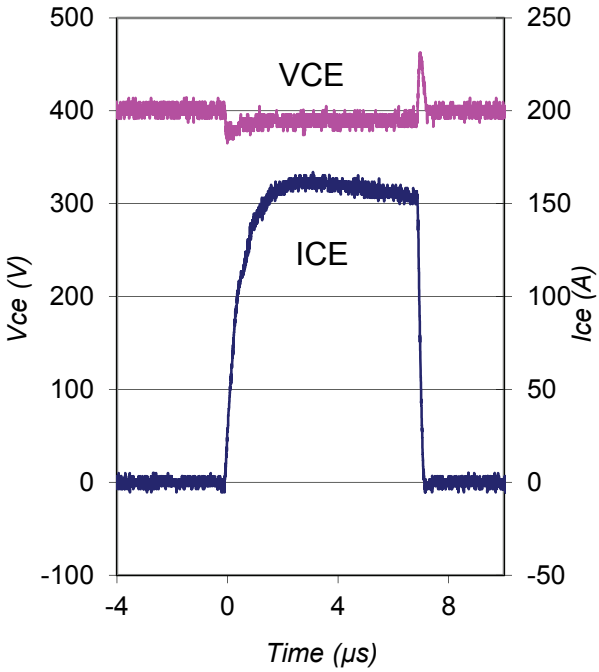
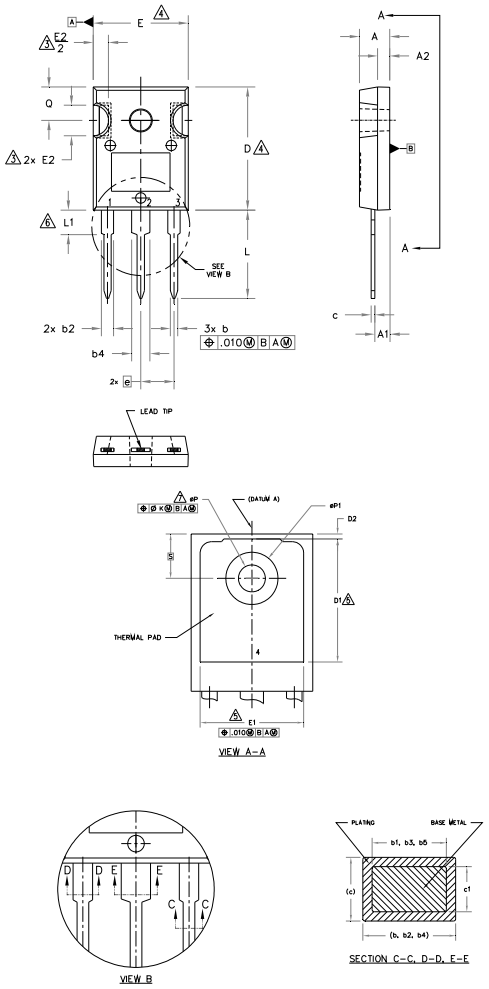



**Fig. WF4** - Typ. S.C. Waveform
@ $T_J$ = 150°C using Fig. CT.3

# TO-247AC Package Outline

Dimensions are shown in millimeters (inches)

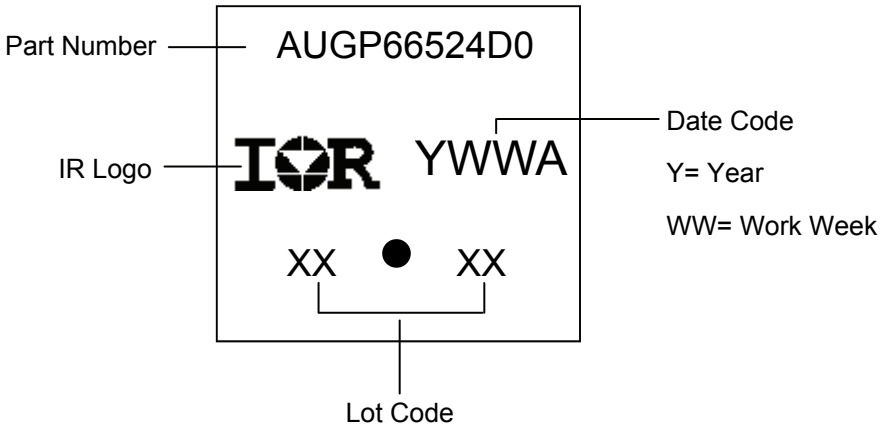



NOTES:

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 .
9. DIMENSION "A" HAS TIGHTER TOLERANCE WITH REFERENCE TO 115-0051 POD

| SYMBOL | DIMENSIONS | | | | NOTES |
|---|---|---|---|---|---|
| | INCHES | | MILLIMETERS | | |
| | MIN. | MAX. | MIN. | MAX. | |
| A | .190 | .203 | 4.83 | 5.13 | |
| 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 | .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 | | |

# TO-247AC Part Marking Information



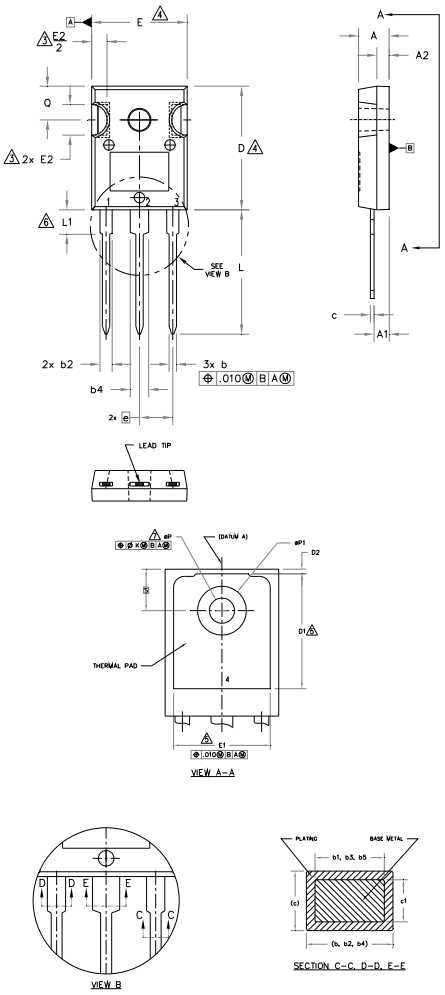

TO-247AC package is not recommended for Surface Mount Application.

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.
9. TIGHTEN DIMENSIONS A, b, b2, b4, c, D, E, E1, L.

| SYMBOL | DIMENSIONS | | | | NOTES |
|---|---|---|---|---|---|
| | INCHES | | MILLIMETERS | | |
| | MIN. | MAX. | MIN. | MAX. | |
| A | .190 | .203 | 4.83 | 5.13 | |
| A1 | .087 | .102 | 2.21 | 2.59 | |
| A2 | .059 | .098 | 1.50 | 2.49 | |
| b | .041 | .051 | 1.04 | 1.30 | |
| b1 | .039 | .053 | 0.99 | 1.35 | |
| b2 | .080 | .094 | 2.02 | 2.38 | |
| b3 | .065 | .092 | 1.65 | 2.34 | |
| b4 | .118 | .134 | 3.00 | 3.40 | |
| b5 | .102 | .133 | 2.59 | 3.38 | |
| c | .017 | .035 | 0.44 | 0.88 | |
| c1 | .015 | .033 | 0.38 | 0.84 | |
| D | .780 | .795 | 19.80 | 20.20 | 4 |
| D1 | .515 | – | 13.08 | – | 5 |
| D2 | .020 | .053 | 0.51 | 1.35 | |
| E | .604 | .624 | 15.35 | 15.85 | 4 |
| E1 | .530 | .544 | 13.46 | 13.82 | |
| E2 | .178 | .216 | 4.52 | 5.49 | |
| e | .215 BSC | | 5.46 BSC | | |
| øk | .010 | | 0.25 | | |
| L | .791 | .823 | 20.10 | 20.90 | |
| 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 | | |

LEAD ASSIGNMENTS

HEXFET

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

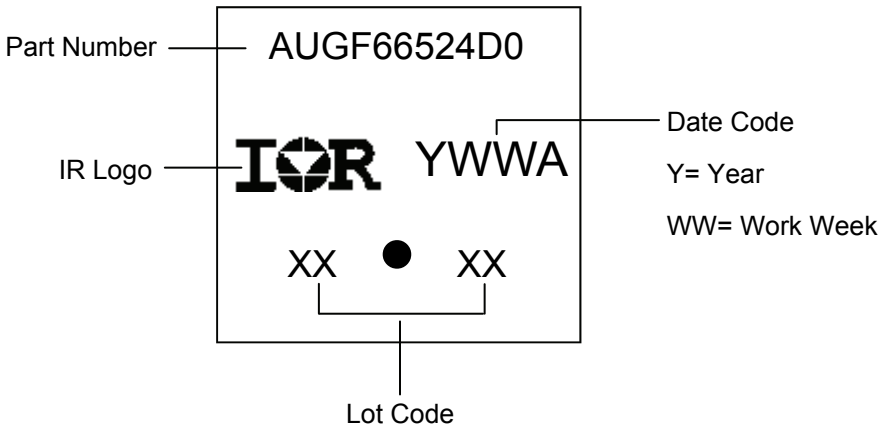
IGBTs, CoPACK

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

DIODES

1.– ANODE/OPEN
2.– CATHODE
3.– ANODE

# TO-247AD Part Marking Information




TO-247AD package is not recommended for Surface Mount Application.

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) † | |
| | | 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 | |
| **ESD** | Human Body Model | Class H1C(+/- 2000)†† AEC-Q101-001 | |
| | Charged Device Model | Class C5 (+/- 1000)†† AEC-Q101-005 | |
| **RoHS Compliant** | | Yes | |

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

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