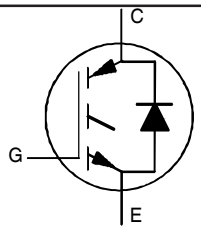
International
IOR Rectifier

PD - 95616

# IRGB4B60KD1PbF
# IRGS4B60KD1
# IRGSL4B60KD1

## INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE



n-channel

$V_{CES}$ = 600V

$I_C$ = 7.6A, $T_C$=100°C

$t_{sc}$ > 10µs, $T_J$=150°C

$V_{CE(on)}$ typ. = 2.1V

### Features

- Low VCE (on) Non Punch Through IGBT Technology.
- 10µs Short Circuit Capability.
- Square RBSOA.
- Positive VCE (on) Temperature Coefficient.
- Maximum Junction Temperature rated at 175°C.
- TO-220 is available in PbF as Lead-Free

### Benefits

- Benchmark Efficiency for Motor Control.
- Rugged Transient Performance.
- Low EMI.
- Excellent Current Sharing in Parallel Operation.

TO-220 IRGB4B60KD1PbF | $D^2$Pak IRGS4B60KD1 | TO-262 IRGSL4B60KD1

### Absolute Maximum Ratings

| | Parameter | Max. | Units |
|---|---|---|---|
| $V_{CES}$ | Collector-to-Emitter Voltage | 600 | V |
| $I_C$ @ $T_C$ = 25°C | Continuous Collector Current | 11 | A |
| $I_C$ @ $T_C$ = 100°C | Continuous Collector Current | 7.6 | |
| $I_{CM}$ | Pulse Collector Current (Ref.Fig.C.T.5) | 22 | |
| $I_{LM}$ | Clamped Inductive Load current ① | 22 | |
| $I_F$ @ $T_C$ = 25°C | Diode Continuous Forward Current | 11 | |
| $I_F$ @ $T_C$ = 100°C | Diode Continuous Forward Current | 6.7 | |
| $I_{FM}$ | Diode Maximum Forward Current | 22 | |
| $V_{GE}$ | Gate-to-Emitter Voltage | ±20 | V |
| $P_D$ @ $T_C$ = 25°C | Maximum Power Dissipation | 63 | W |
| $P_D$ @ $T_C$ = 100°C | Maximum Power Dissipation | 31 | |
| $T_J$ | Operating Junction and | -55 to +175 | °C |
| $T_{STG}$ | Storage Temperature Range | | |
| | Storage Temperature Range, for 10 sec. | 300 (0.063 in. (1.6mm) from case) | |

### Thermal / Mechanical Characteristics

| | Parameter | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|
| $R_{\theta JC}$ | Junction-to-Case- IGBT | — | — | 2.4 | °C/W |
| $R_{\theta JC}$ | Junction-to-Case- Diode | — | — | 6.1 | |
| $R_{\theta CS}$ | Case-to-Sink, flat, greased surface | — | 0.50 | — | |
| $R_{\theta JA}$ | Junction-to-Ambient | — | — | 62 | |
| $R_{\theta JA}$ | Junction-to-Ambient (PCB Mount, steady state)② | — | — | 40 | |
| Wt | Weight | — | 1.44 | — | g |

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

| | Parameter | Min. | Typ. | Max. | Units | Conditions | Ref.Fig. |
|---|---|---|---|---|---|---|---|
| $V_{(BR)CES}$ | Collector-to-Emitter Breakdown Voltage | 600 | — | — | V | $V_{GE}$ = 0V, $I_C$ = 500µA | |
| $\Delta V_{(BR)CES}/\Delta T_J$ | Temperature Coeff. of Breakdown Voltage | — | 0.28 | — | V/°C | $V_{GE}$ = 0V, $I_C$ = 1mA (25°C-150°C) | |
| $V_{CE(on)}$ | Collector-to-Emitter Voltage | — | 2.1 | 2.5 | V | $I_C$ = 4.0A, $V_{GE}$ = 15V, $T_J$ = 25°C | 5,6,7 |
| | | — | 2.5 | 2.8 | | $I_C$ = 4.0A, $V_{GE}$ = 15V, $T_J$ = 150°C | 9,10,11 |
| | | — | 2.6 | 2.9 | | $I_C$ = 4.0A, $V_{GE}$ = 15V, $T_J$ = 175°C | |
| $V_{GE(th)}$ | Gate Threshold Voltage | 3.5 | 4.5 | 5.5 | V | $V_{CE}$ = $V_{GE}$, $I_C$ = 250µA | 9,10,11 |
| $\Delta V_{GE(th)}/\Delta T_J$ | Threshold Voltage temp. coefficient | — | -8.1 | — | mV/°C | $V_{CE}$ = $V_{GE}$, $I_C$ = 1mA (25°C-150°C) | 12 |
| gfe | Forward Transconductance | — | 1.7 | — | S | $V_{CE}$ = 50V, $I_C$ = 4.0A, PW = 80µs | |
| $I_{CES}$ | Zero Gate Voltage Collector Current | — | 1.0 | 150 | µA | $V_{GE}$ = 0V, $V_{CE}$ = 600V | |
| | | — | 136 | 600 | | $V_{GE}$ = 0V, $V_{CE}$ = 600V, $T_J$ = 150°C | |
| | | — | 722 | 2400 | | $V_{GE}$ = 0V, $V_{CE}$ = 600V, $T_J$ = 175°C | |
| $V_{FM}$ | Diode Forward Voltage Drop | — | 1.4 | 2.0 | V | $I_F$ = 4.0A | 8 |
| | | — | 1.3 | 1.8 | | $I_F$ = 4.0A, $T_J$ = 150°C | |
| | | — | 1.2 | 1.7 | | $I_F$ = 4.0A, $T_J$ = 175°C | |
| $I_{GES}$ | Gate-to-Emitter Leakage Current | — | — | ±100 | nA | $V_{GE}$ = ±20V | |

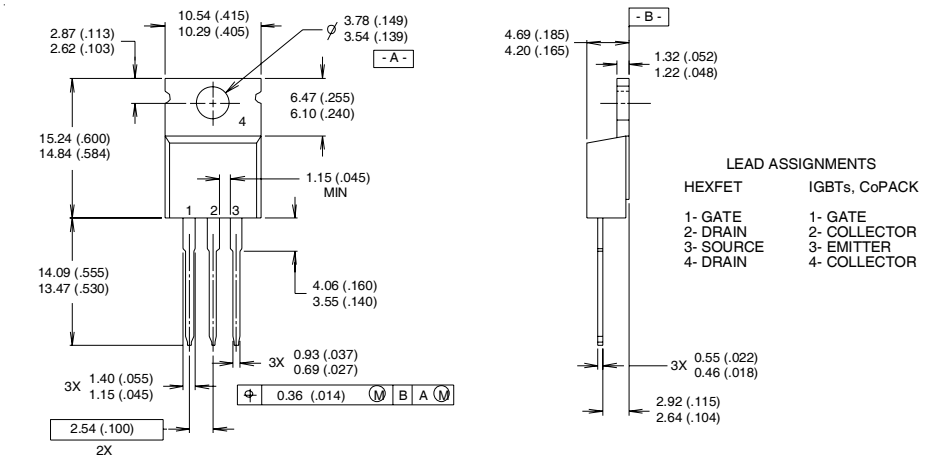
**Switching Characteristics @ $T_J$ = 25°C (unless otherwise specified)**

| | Parameter | Min. | Typ. | Max. | Units | Conditions | Ref.Fig. |
|---|---|---|---|---|---|---|---|
| $Q_g$ | Total Gate Charge (turn-on) | — | 12 | — | nC | $I_C$ = 4.0A | 23 |
| $Q_{ge}$ | Gate-to-Emitter Charge (turn-on) | — | 1.7 | — | | $V_{CC}$ = 400V | CT1 |
| $Q_{gc}$ | Gate-to-Collector Charge (turn-on) | — | 6.5 | — | | $V_{GE}$ = 15V | |
| $E_{on}$ | Turn-On Switching Loss | — | 73 | 80 | µJ | $I_C$ = 4.0A, $V_{CC}$ = 400V | CT4 |
| $E_{off}$ | Turn-Off Switching Loss | — | 47 | 53 | | $V_{GE}$ = 15V, $R_G$ = 100Ω, L = 2.5mH | |
| $E_{tot}$ | Total Switching Loss | — | 120 | 130 | | $T_J$ = 25°C ③ | |
| $t_{d(on)}$ | Turn-On delay time | — | 22 | 28 | ns | $I_C$ = 4.0A, $V_{CC}$ = 400V | |
| $t_r$ | Rise time | — | 18 | 23 | | $V_{GE}$ = 15V, $R_G$ = 100Ω, L = 2.5mH | CT4 |
| $t_{d(off)}$ | Turn-Off delay time | — | 100 | 110 | | $T_J$ = 25°C | |
| $t_f$ | Fall time | — | 66 | 80 | | | |
| $E_{on}$ | Turn-On Switching Loss | — | 130 | 150 | µJ | $I_C$ = 4.0A, $V_{CC}$ = 400V | CT4 |
| $E_{off}$ | Turn-Off Switching Loss | — | 83 | 140 | | $V_{GE}$ = 15V, $R_G$ = 100Ω, L = 2.5mH | 13,15 |
| $E_{tot}$ | Total Switching Loss | — | 220 | 280 | | $T_J$ = 150°C ③ | WF1,WF2 |
| $t_{d(on)}$ | Turn-On delay time | — | 22 | 27 | ns | $I_C$ = 4.0A, $V_{CC}$ = 400V | 14,16 |
| $t_r$ | Rise time | — | 18 | 22 | | $V_{GE}$ = 15V, $R_G$ = 100Ω, L = 2.5mH | CT4 |
| $t_{d(off)}$ | Turn-Off delay time | — | 120 | 130 | | $T_J$ = 150°C | WF1 |
| $t_f$ | Fall time | — | 79 | 89 | | | WF2 |
| $C_{ies}$ | Input Capacitance | — | 190 | — | pF | $V_{GE}$ = 0V | |
| $C_{oes}$ | Output Capacitance | — | 25 | — | | $V_{CC}$ = 30V | 22 |
| $C_{res}$ | Reverse Transfer Capacitance | — | 6.2 | — | | f = 1.0MHz | |
| RBSOA | Reverse Bias Safe Operating Area | FULL SQUARE | | | | $T_J$ = 150°C, $I_C$ = 22A, Vp = 600V | 4 |
| | | | | | | $V_{CC}$=500V,$V_{GE}$ = +15V to 0V,$R_G$ = 100Ω | CT2 |
| SCSOA | Short Circuit Safe Operating Area | 10 | — | — | µs | $T_J$ = 150°C, Vp = 600V, $R_G$ = 100Ω | CT3 |
| | | | | | | $V_{CC}$=360V,$V_{GE}$ = +15V to 0V | WF4 |
| $E_{rec}$ | Reverse Recovery Energy of the Diode | — | 81 | 100 | µJ | $T_J$ = 150°C | 17,18,19 |
| $t_{rr}$ | Diode Reverse Recovery Time | — | 93 | — | ns | $V_{CC}$ = 400V, $I_F$ = 4.0A, L = 2.5mH | 20,21 |
| $I_{rr}$ | Peak Reverse Recovery Current | — | 6.3 | 7.9 | A | $V_{GE}$ = 15V, $R_G$ = 100Ω | CT4,WF3 |

Note ① to ③ are on page 16

## TO-220AB Package Outline

Dimensions are shown in millimeters (inches)




NOTES:

1 DIMENSIONING & TOLERANCING PER ANSI Y14.5M, 1982.
2 CONTROLLING DIMENSION : INCH
3 OUTLINE CONFORMS TO JEDEC OUTLINE TO-220AB.
4 HEATSINK & LEAD MEASUREMENTS DO NOT INCLUDE BURRS.

## TO-220AB Part Marking Information

EXAMPLE: THIS IS AN IRF1010
LOT CODE 1789
ASSEMBLED ON WW 19, 1997
IN THE ASSEMBLY LINE "C"

**Note:** "P" in assembly line position indicates "Lead-Free"