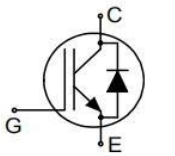
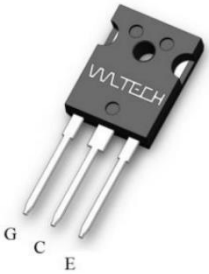
# High-speed IGBT Power Transistor

**(Integrated SiC SBD)**

HKW75N65SHRA




**Package: TO-247-3**

## 1. Product Features:

- Ultra-low switching losses
- Benchmark efficiency in hard switching topologies
- Plug-and-play replacement of pure Si-based IGBT
- Internal integrated SiC Schottky Diode (SBD)
- Maximum junction temperature 175℃
- Qualified according to JEDEC
- RoHS compliant

## 2. Product Applications

- Industrial Power Supplies
- Solar String Inverter
- Energy Storage Inverter
- UPS
- DC Charger for Electric Vehicles
- Welding Machines

## 3. Typical Performance Parameters

**Tab.1. Typical Performance Parameters**

| Type | $V_{CE}$ | $I_C$ | $V_{CEsat}$ | $T_{vjmax}$ | Marking | Package |
|---|---|---|---|---|---|---|
| HKW75N65SHRA | 650V | 75A | 1.66V ($T_{vj}$ = 25℃) | 175℃ | HKW75N65SHRA | TO-247-3 |

# 4. Maximum Ratings

**Tab.2. Maximum Ratings**

| Parameters | Symbol | Value | Unit |
|---|---|---|---|
| Collector-emitter voltage | $V_{CE}$ | 650 | V |
| DC collector current (limited by $T_{vjmax}$) | $I_C$ | 90($T_c$ = 25℃)<br>75($T_c$ = 100℃) | A |
| Pulsed collector current ($t_p$ limited by $T_{vjmax.}$) | $I_{Cpuls}$ | 300 | A |
| Diode forward current (limited by $T_{vjmax}$) | $I_F$ | 52($T_c$ = 100℃) | A |
| Diode pulse current<br>($t_p$ limited by $T_{vjmax.}$) | $I_{Fpuls}$ | 200($T_c$ = 25℃) | A |
| Gate-emitter voltage | $V_{GE}$ | ±20 | V |
| Transient Gate-emitter voltage<br>($t_p \leq 10\mu s$, $D < 0.0100$) | | ±30 | V |
| Power dissipation | $P_{tot}$ | 395($T_c$ = 25℃)<br>197($T_c$ = 100℃) | W |
| Operating junction temperature | $T_{vj}$ | -40 to +175 | ℃ |
| Storage temperature | $T_{stg}$ | -55 to +150 | ℃ |
| Soldering temperature,<br>(wave soldering 1.6mm from case for 10s) | | 260 | ℃ |
| Mounting torque (M3 screw)<br>(Maximum of mounting processes: 3) | $M$ | 0.6 | Nm |

# 5. Thermal Properties

**Tab.3. Thermal Properties**

| Parameters | Symbol | Conditions | Max. value | Unit |
|---|---|---|---|---|
| IGBT thermal resistance<br>(junction - case) | $R_{th(j-c)}$ | | 0.38 | ℃/W |
| Diode thermal resistance<br>(junction - case) | $R_{th(j-c)}$ | | 0.57 | ℃/W |
| Thermal resistance<br>(junction – ambient ) | $R_{th(j-a)}$ | | 40 | ℃/W |

# 6. Electrical Characteristics

**Tab.4. Static Characteristic ($T_{vj}$ = 25℃, unless otherwise specified)**

| Parameters | Symbol | Conditions | Min. value | Typ. value | Max. value | Unit |
|---|---|---|---|---|---|---|
| Collector-emitter breakdown voltage | $V_{(BR)CES}$ | $V_{GE}$= 0V | 650 | - | - | V |
| Collector-emitter saturation voltage | $V_{CEsat}$ | $V_{GE}$= 15V, $I_C$= 75A<br>$T_{vj}$= 25℃<br>$T_{vj}$= 175℃ | <br>-<br>- | <br>1.66<br>2.12 | <br>2.3<br>- | V |
| Diode forward voltage | $V_F$ | $V_{GE}$= 0V, $I_F$= 30A<br>$T_{vj}$ = 25℃<br>$T_{vj}$= 175℃ | <br>-<br>- | <br>1.41<br>1.84 | <br>1.8<br>- | V |
| Gate-emitter threshold voltage | $V_{GE(th)}$ | $I_C$= 0.75mA, $V_{CE}$= $V_{GE}$ | 4.2 | 5.2 | 6.2 | V |
| Zero gate voltage collector current | $I_{CES}$ | $V_{CE}$= 650V, $V_{GE}$= 0V<br>$T_{vj}$= 25℃<br>$T_{vj}$= 175℃ | <br>-<br>- | <br>1<br>800 | <br>75<br>- | μA |
| Gate-emitter leakage current | $I_{GES}$ | $V_{CE}$= 0V, $V_{GE}$= 20V | - | - | 100 | nA |
| Transconductance | $g_{fs}$ | $V_{CE}$= 20V, $I_C$= 75.0A | - | 41.0 | - | S |

**Tab.5. Dynamic Characteristic ($T_{vj}$ = 25℃, unless otherwise specified)**

| Parameters | Symbol | Conditions | Min. value | Typ. value | Max. value | Unit |
|---|---|---|---|---|---|---|
| Input capacitance | $C_{ies}$ | $V_{CE}$= 25V, $V_{GE}$= 0V<br>$f$ = 250kHz | - | 2755 | - | pF |
| Output capacitance | $C_{oes}$ | | - | 527 | - | |
| Reverse transfer capacitance | $C_{res}$ | | - | 52 | - | |
| Gate-charge | $Q_g$ | $V_{CE}$= 520V, $I_C$= 75.0A,<br>$V_{GE}$= 15V | - | 92 | - | nC |

**Tab.6. Switching Characteristic (Inductive load)**

| Parameters | Symbol | Conditions | Min. value | Typ. value | Max. value | Unit |
|---|---|---|---|---|---|---|
| IGBT Characteristic， at $T_{vj}$ = 25°C | | | | | | |
| Turn-on delay time | $t_{d(on)}$ | $T_{vj}$ = 25°C, $V_{CC}$ = 400V, $I_C$ = 75.0A, $V_{GE}$ = 0.0/15.0V, $R_{G(on)}$ =1.5Ω,$R_{G(off)}$ =1.5Ω, $R_{G(int)}$ =7.5 Ω Inductive load | - | 25 | - | ns |
| Rise time | $t_r$ | | - | 52 | - | |
| Turn-off delay time | $t_{d(off)}$ | | - | 106 | - | |
| Fall time | $t_f$ | | - | 41 | - | |
| Turn-on energy | $E_{on}$ | Energy losses include “tail” and diode reverse recovery. | - | 1.3 | - | mJ |
| Turn-off energy | $E_{off}$ | | - | 0.8 | - | |
| Total switching energy | $E_{ts}$ | | - | 2.1 | - | |
| | | | | | | |
| Turn-on delay time | $t_{d(on)}$ | $T_{vj}$ = 25°C, $V_{CC}$ = 400V, $I_C$ = 37.5A, $V_{GE}$ = 0.0/15.0V, $R_{G(on)}$ =1.5Ω,$R_{G(off)}$ =1.5Ω, $R_{G(int)}$ =7.5 Ω Inductive load | - | 19 | - | ns |
| Rise time | $t_r$ | | - | 24 | - | |
| Turn-off delay time | $t_{d(off)}$ | | - | 117 | - | |
| Fall time | $t_f$ | | - | 15 | - | |
| Turn-on energy | $E_{on}$ | Energy losses include “tail” and diode reverse recovery. | - | 0.36 | - | mJ |
| Turn-off energy | $E_{off}$ | | - | 0.17 | - | |
| Total switching energy | $E_{ts}$ | | - | 0.53 | - | |
| | | | | | | |

**Tab.7. Switching Characteristic (Inductive load)**

| Parameters | Symbol | Conditions | Min. value | Typ. value | Max. value | Unit |
|---|---|---|---|---|---|---|
| IGBT Characteristic， at $T_{vj}$ = 150°C | | | | | | |
| Turn-on delay time | $t_{d(on)}$ | $T_{vj}$ = 150°C, $V_{CC}$ = 400V, $I_C$ = 75.0A, $V_{GE}$ = 0.0/15.0V, $R_{G(on)}$ =1.5Ω,$R_{G(off)}$ =1.5Ω, $R_{G(int)}$ =7.5 Ω Inductive load Energy losses include “tail” and diode reverse recovery. | - | 27 | - | ns |
| Rise time | $t_r$ | | - | 50 | - | |
| Turn-off delay time | $t_{d(off)}$ | | - | 139 | - | |
| Fall time | $t_f$ | | - | 42 | - | |
| Turn-on energy | $E_{on}$ | | - | 1.4 | - | mJ |
| Turn-off energy | $E_{off}$ | | - | 1.1 | - | |
| Total switching energy | $E_{ts}$ | | - | 2.5 | - | |
| | | | | | | |
| Turn-on delay time | $t_{d(on)}$ | $T_{vj}$ = 150°C, $V_{CC}$ = 400V, $I_C$ = 37.5A, $V_{GE}$ = 0.0/15.0V, $R_{G(on)}$ =1.5Ω,$R_{G(off)}$ =1.5Ω, $R_{G(int)}$ =7.5 Ω Inductive load Energy losses include “tail” and diode reverse recovery. | - | 21 | - | ns |
| Rise time | $t_r$ | | - | 26 | - | |
| Turn-off delay time | $t_{d(off)}$ | | - | 154 | - | |
| Fall time | $t_f$ | | - | 51 | - | |
| Turn-on energy | $E_{on}$ | | - | 0.41 | - | mJ |
| Turn-off energy | $E_{off}$ | | - | 0.42 | - | |
| Total switching energy | $E_{ts}$ | | - | 0.83 | - | |

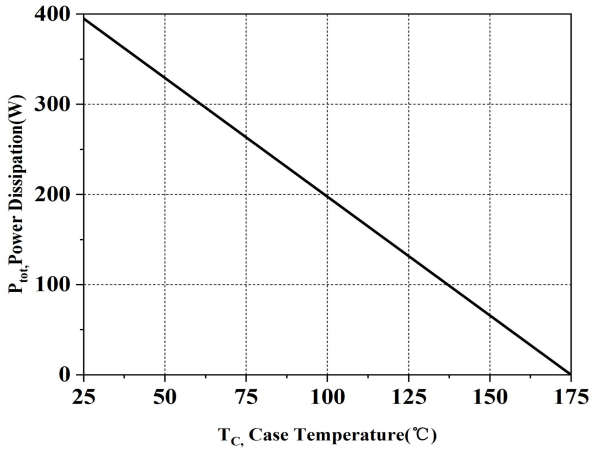



**Fig.1. Power dissipation as a function of case temperature** ($T_j \leq 175°C$)

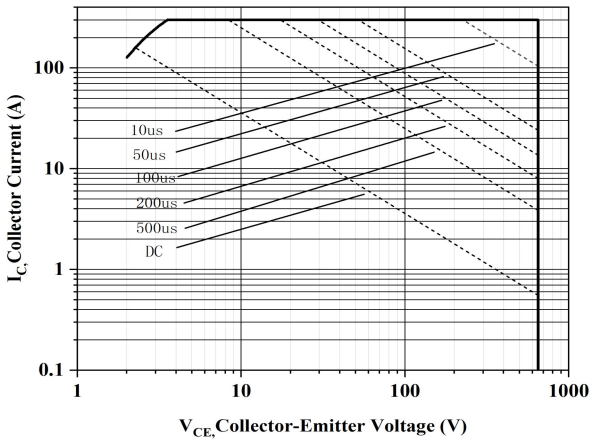



**Fig.2. Forward bias safe operating area**
($D = 0$, $T_C = 25°C$, $T_j \leq 175°C$, $V_{GE} = 15V$)

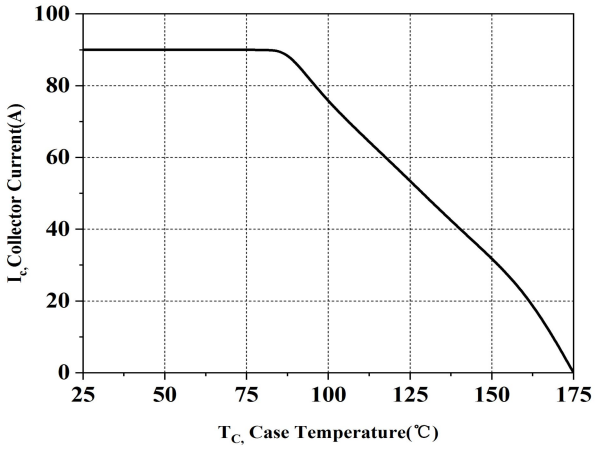



**Fig.3. Collector current as a function of case temperature** ($V_{GE} \geq 15V, T_j \leq 175°C$)

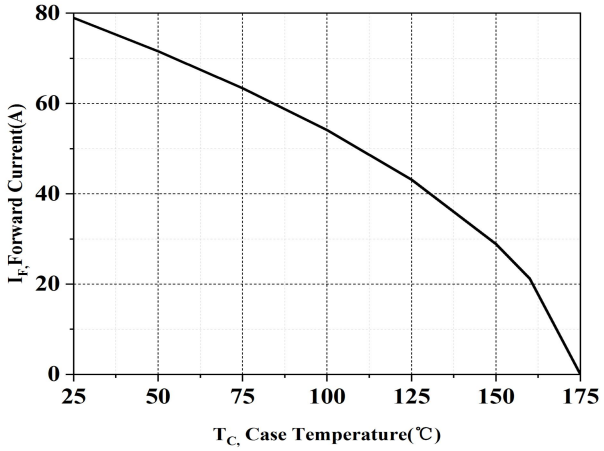



**Fig.4. Diode Forward current as a function of case temperature**

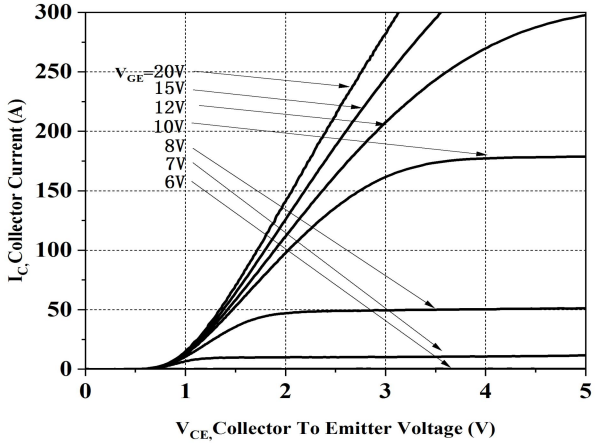



**Fig.5. Typical output characteristics**
($T_j = 25°C$)

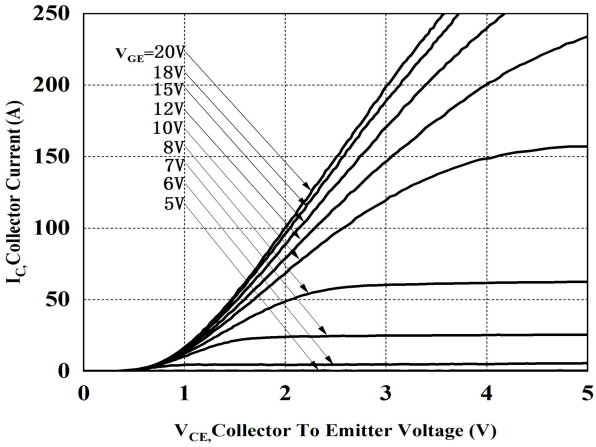



**Fig.6. Typical output characteristics**
($T_j = 150°C$)

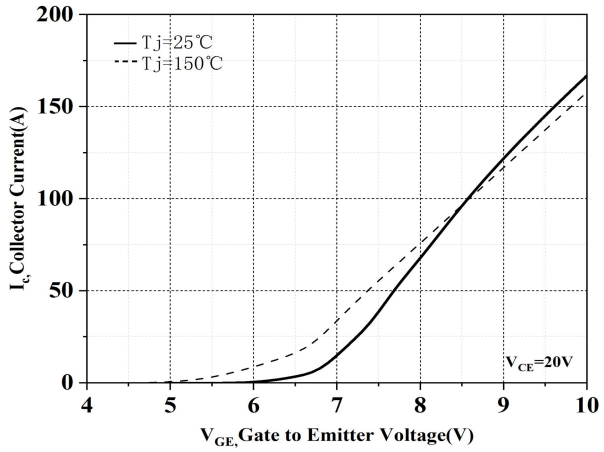



**Fig.7. Typical transfer characteristic**

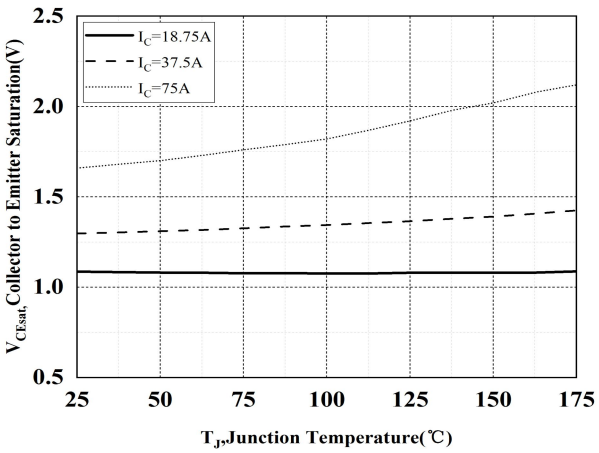



**Fig.8. Typical collector-emitter saturation voltage as junction temperature ($V_{GE}$=15V)**

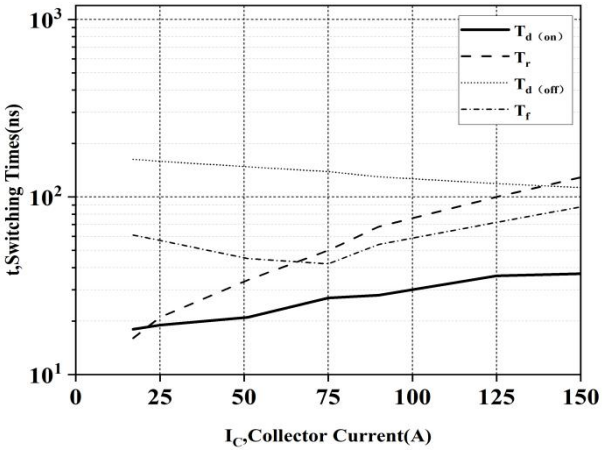



**Fig.9. Typical switching times as collector current** ($T_j$= 150°C, $V_{CE}$= 400V, $V_{GE}$= 15/0V)

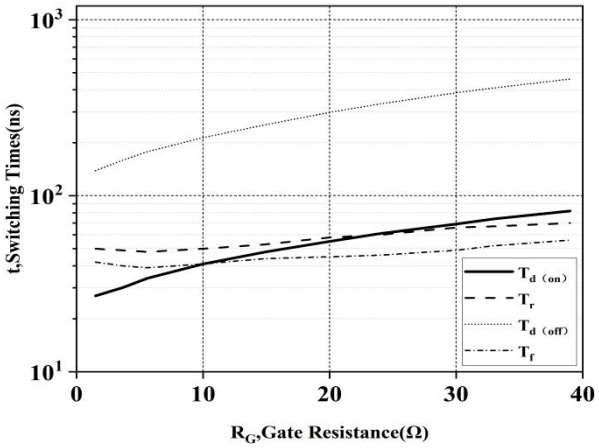



**Fig.10. Typical switching times as gate Resistor** (Tj= 150°C, VCE=400V, VGE= 15/0V, IC = 75A)

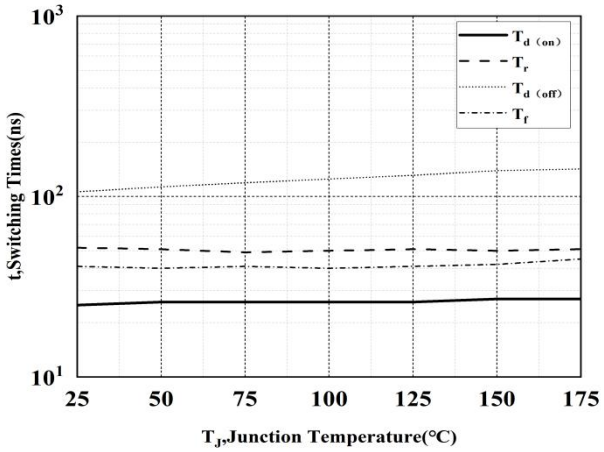



**Fig.11. Typical switching times as junction temperature**

($V_{CE}$= 400V, $V_{GE}$= 15/0V, $I_C$ = 75A）

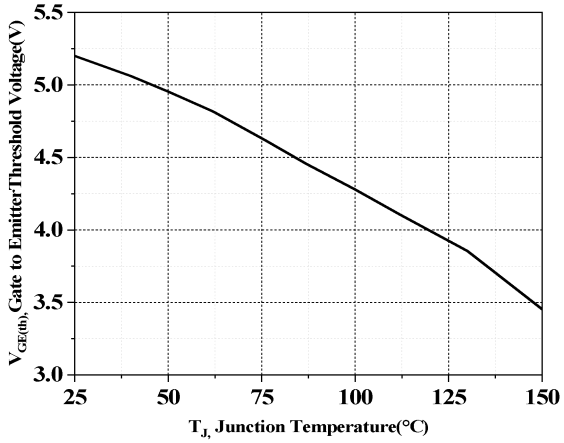



**Fig.12. Gate-emitter threshold voltage as junction temperature** ($I_C$=0.75mA)

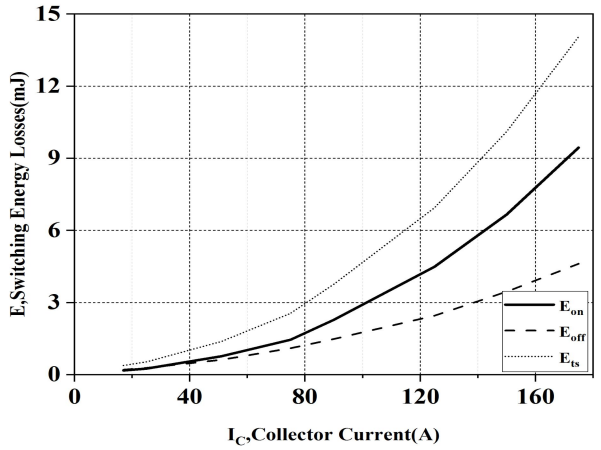



**Fig.13. Typical switching energy losses as a function of collector current**

($T_j$= 150°C, $V_{CE}$= 400V, $V_{GE}$= 15/0V）

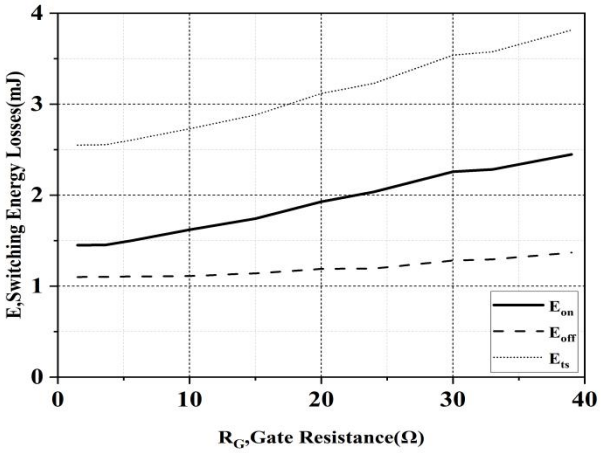



**Fig.14. Typical switching energy losses as a function of gate resistor**

( $T_j$= 150°C, $V_{CE}$= 400V, $V_{GE}$= 15/0V, $I_C$ = 75A）

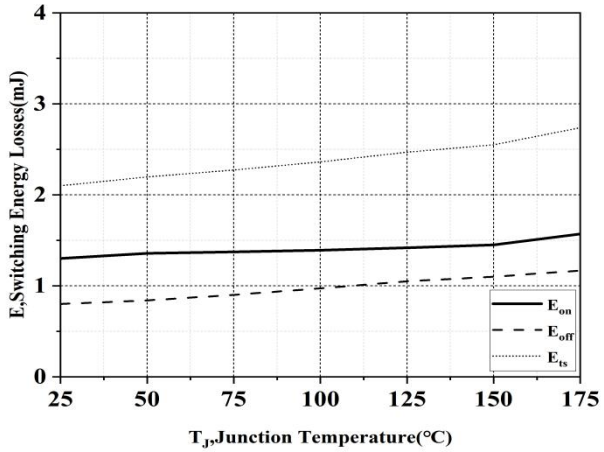



**Fig.15. Typical switching energy losses as a function of junction temperature**

(Inductive load, $V_{CE}$= 400V, $V_{GE}$= 15/0V, $I_C$ = 75A）

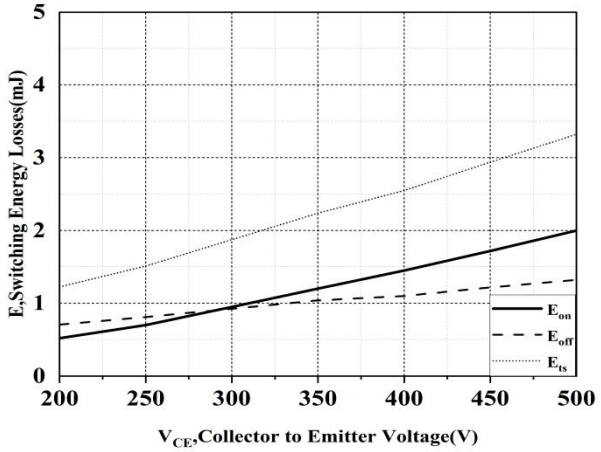



**Fig.16. Typical switching energy losses as a function of collector emitter voltage**

(Inductive load, $T_j$= 150°C, $V_{GE}$= 15/0V, $I_C$ = 75A）

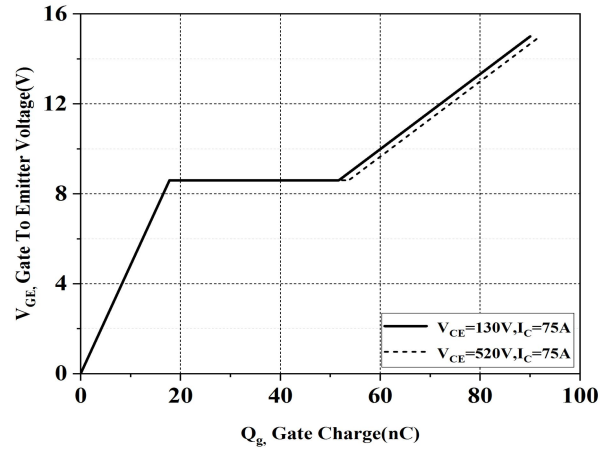



**Fig.17. Typical gate charge**

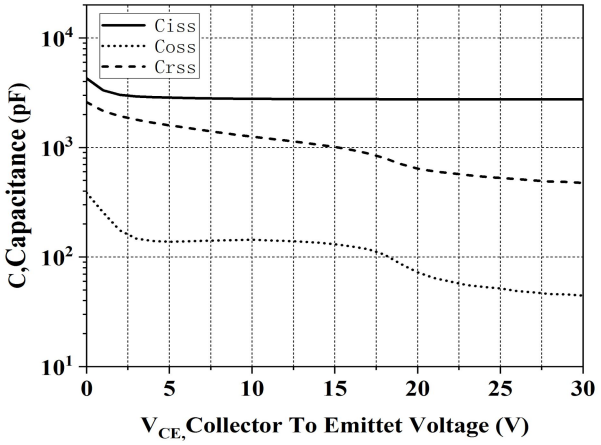



**Fig.18. Typical capacitance as a function of collector-emitter voltage**

($V_{GE}$ = 0V,$f$ = 250KHz)

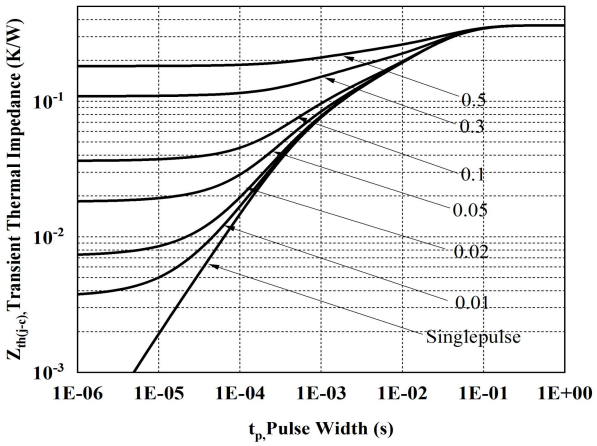



**Fig.19. IGBT transient thermal impedance**

(D = $t_p$/T)

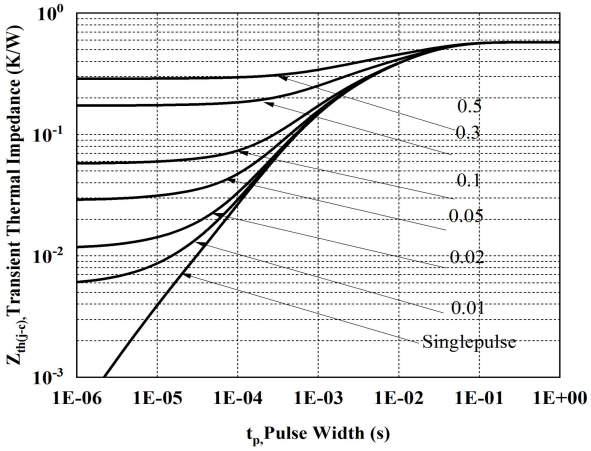



**Fig.20. Transient thermal impedance of diode**

(D = $t_p$/T)

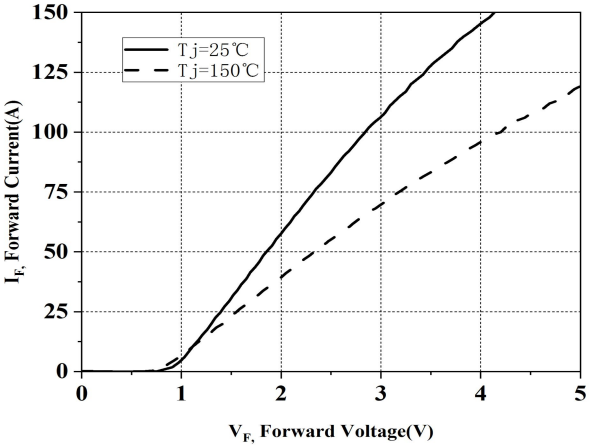



**Fig.21. Typical diode forward current as a function of forward voltage**

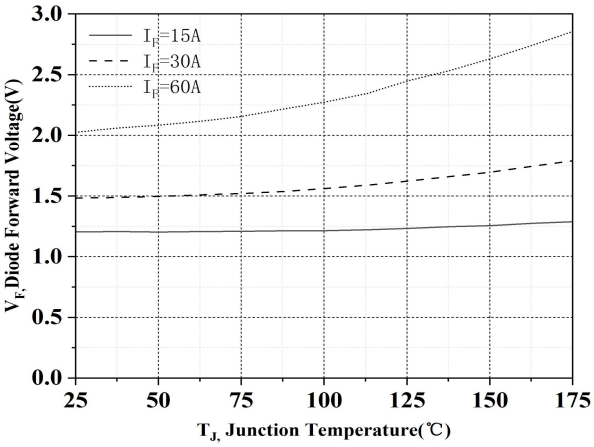
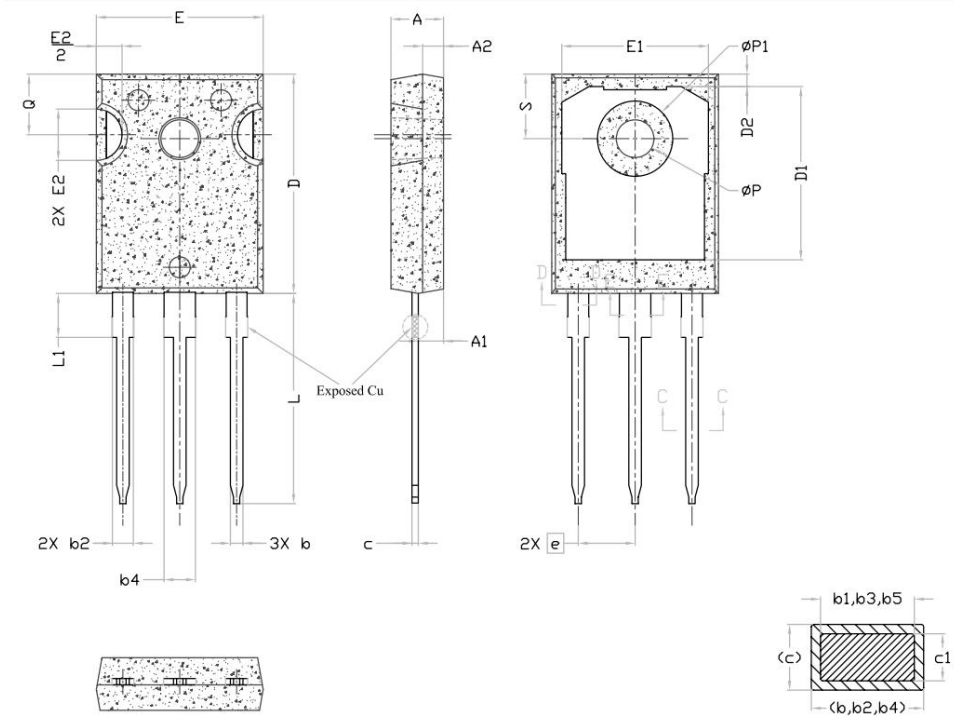



**Fig.22. Typical diode forward voltage as a function of junction temperature**

# 7. Package Dimensions




| SYMBOL | DIMENSIONS | | | NOTES |
|---|---|---|---|---|
| | MIN. | NOM. | MAX. | |
| A | 4.83 | 5.02 | 5.21 | |
| A1 | 2.29 | 2.41 | 2.55 | |
| A2 | 1.50 | 2.00 | 2.49 | |
| b | 1.12 | 1.20 | 1.33 | |
| b1 | 1.12 | 1.20 | 1.28 | |
| b2 | 1.91 | 2.00 | 2.39 | 6 |
| b3 | 1.91 | 2.00 | 2.34 | |
| b4 | 2.87 | 3.00 | 3.22 | 6, 8 |
| b5 | 2.87 | 3.00 | 3.18 | |
| c | 0.55 | 0.60 | 0.69 | 6 |
| c1 | 0.55 | 0.60 | 0.65 | |
| D | 20.80 | 20.95 | 21.10 | 4 |
| D1 | 16.25 | 16.55 | 17.65 | 5 |
| D2 | 0.51 | 1.19 | 1.35 | |
| E | 15.75 | 15.94 | 16.13 | 4 |
| E1 | 13.46 | 14.02 | 14.16 | 5 |
| E2 | 4.32 | 4.91 | 5.49 | 3 |
| e | 5.44BSC | | | |
| L | 19.81 | 20.07 | 20.32 | |
| L1 | 4.10 | 4.19 | 4.40 | 6 |
| øP | 3.56 | 3.61 | 3.65 | 7 |
| øP1 | 7.19REF. | | | |
| Q | 5.39 | 5.79 | 6.20 | |
| S | 6.04 | 6.17 | 6.30 | |

# 8. Version Information

| Version No. | Status | Date changed | Version revision record |
|---|---|---|---|
| V1.0 | Initial release | 2023/02 | |