



1200V 100A High-speed IGBT

(Integrated FRD)

Preliminary

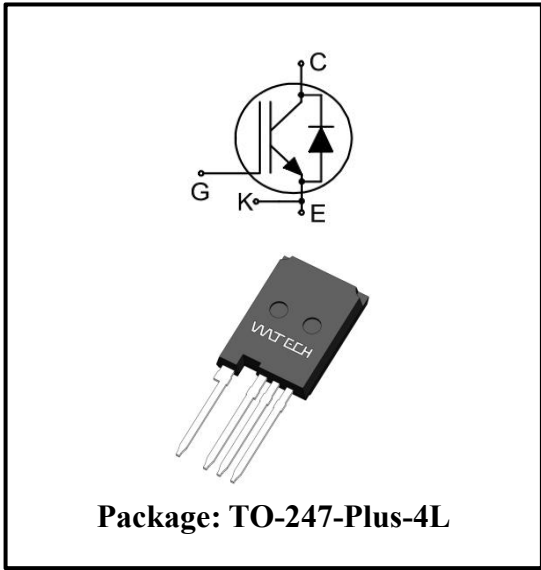
HKY100N120SHEM

1. Product Features:

- Ultra-low switching losses
- Internal integrated fast&soft recovery anti-parallel FRD
- Maximum junction temperature 175°C
- Qualified according to JEDEC
- RoHS compliant

2. Product Applications

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



3. Typical Performance Parameters

Tab.1. Typical Performance Parameters

| Type | V_{CE} | I_C | V_{CEsat} $T_{vj} = 25^\circ\text{C}$ | T_{vjmax} | Marking | Package |
|----------------|----------|-------|--|-------------|----------------|-------------|
| HKY100N120SHEM | 1200V | 100A | 1.55V | 175°C | HKY100N120SHEM | TO-247-Plus |

4. Maximum Ratings

Tab.2. Maximum Ratings

| Parameters | Symbol | Value | Unit |
|--|-------------|---|------------------|
| Collector-emitter voltage | V_{CE} | 1200 | V |
| DC collector current (limited by T_{vjmax} and bond wire) | I_C | 170 ($T_c = 25^\circ\text{C}$) 130 ($T_c = 100^\circ\text{C}$) | A |
| Pulsed collector current (t_p limited by T_{vjmax} .) | I_{Cpuls} | 400 | A |
| Turn off safe operating area ($V_{CE} \leq 1200\text{V}$, $T_{vj} \leq 175^\circ\text{C}$) | - | 400 | A |
| Diode forward current (limited by T_{vjmax}) | I_F | 100 ($T_c = 100^\circ\text{C}$) | A |
| Diode pulse current (t_p limited by T_{vjmax} .) | I_{Fpuls} | 400 ($T_c = 25^\circ\text{C}$) | A |
| Gate-emitter voltage | V_{GE} | ± 20 | V |
| Power dissipation | P_{tot} | 789.0 ($T_c = 25^\circ\text{C}$) 394.0 ($T_c = 100^\circ\text{C}$) | W |
| Operating junction temperature | T_{vj} | -40 to +175 | $^\circ\text{C}$ |
| Storage temperature | T_{stg} | -55 to +150 | $^\circ\text{C}$ |
| Soldering temperature, (wave soldering 1.6mm from case for 10s) | | 260 | $^\circ\text{C}$ |

5. Thermal Properties

Tab.3. Thermal Properties

| Parameters | Symbol | Max. value | Unit |
|---|---------------|------------|--------------------|
| IGBT thermal resistance (junction - case) | $R_{th(j-c)}$ | 0.19 | $^\circ\text{C/W}$ |
| Diode thermal resistance (junction - case) | $R_{th(j-c)}$ | 0.26 | $^\circ\text{C/W}$ |
| Thermal resistance (junction – ambient) | $R_{th(j-a)}$ | 40 | $^\circ\text{C/W}$ |

6. Electrical Characteristics

Tab.4. Static Characteristic ($T_{vj} = 25^{\circ}\text{C}$, unless otherwise specified)

| Parameters | Symbol | Conditions | Min. value | Typ. value | Max. value | Unit |
|--------------------------------------|---------------|---|------------|--------------|------------|---------------|
| Collector-emitter breakdown voltage | $V_{(BR)CES}$ | $V_{GE} = 0\text{V}$ | 1200 | - | - | V |
| Collector-emitter saturation voltage | V_{CEsat} | $V_{GE} = 15\text{V}, I_C = 100\text{A}$ $T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 175^{\circ}\text{C}$ | - - | 1.55 2.05 | 1.95 - | V |
| Diode forward voltage | V_F | $V_{GE} = 0\text{V}, I_F = 100\text{A}$ $T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 175^{\circ}\text{C}$ | - - | 2.64 2.14 | 3.1 - | V |
| Gate-emitter threshold voltage | $V_{GE(th)}$ | $I_C = 1.60\text{mA}, V_{CE} = V_{GE}$ | 4.7 | 5.5 | 6.2 | V |
| Zero gate voltage collector current | I_{CES} | $V_{CE} = 1200\text{V}, V_{GE} = 0\text{V}$ $T_{vj} = 25^{\circ}\text{C}$ | - | - | 100 | μA |
| Gate-emitter leakage current | I_{GES} | $V_{CE} = 0\text{V}, V_{GE} = 20\text{V}$ | - | - | 200 | nA |
| Internal Gate Resistance | $R_{G(int)}$ | $f = 1\text{MHz}, V_{ac} = 10\text{mV}$ | - | 8.3 | - | Ω |

Tab.5. Dynamic Characteristic ($T_{vj} = 25^{\circ}\text{C}$, unless otherwise specified)

| Parameters | Symbol | Conditions | Min. value | Typ. value | Max. value | Unit |
|------------------------------|-----------|---|------------|------------|------------|------|
| Input capacitance | C_{ies} | $V_{CE} = 25\text{V}, V_{GE} = 0\text{V}$ $f = 100\text{kHz}$ | - | 8736 | - | pF |
| Output capacitance | C_{oes} | | - | 331 | - | |
| Reverse transfer capacitance | C_{res} | | - | 45 | - | |
| Gate-charge | Q_g | $V_{CE} = 960\text{V}, I_C = 100\text{A},$ $V_{GE} = 15\text{V}$ | - | 335 | - | nC |

Tab.6. Switching Characteristic (Inductive load)

| Parameters | Symbol | Conditions | Min. value | Typ. value | Max. value | Unit |
|---|--------------|---|------------|------------|------------|------------------|
| IGBT Characteristic, at $T_{vj} = 25^{\circ}\text{C}$ | | | | | | |
| Turn-on delay time | $t_{d(on)}$ | $T_{vj} = 25^{\circ}\text{C}$, $V_{CC} = 600\text{V}$, $I_C = 100\text{A}$, $V_{GE} = 0.0/15.0\text{V}$, $R_{G(on)} = 4.0\Omega$ $R_{G(off)} = 4.0\Omega$ Inductive load | - | 66 | - | ns |
| Rise time | t_r | | - | 20 | - | |
| Turn-off delay time | $t_{d(off)}$ | | - | 485 | - | |
| Fall time | t_f | | - | 24 | - | |
| Turn-on energy | E_{on} | Energy losses include "tail" and diode reverse recovery. | - | 2.66 | - | mJ |
| Turn-off energy | E_{off} | | - | 3.03 | - | |
| Total switching energy | E_{ts} | | - | 5.69 | - | |
| IGBT Characteristic, at $T_{vj} = 25^{\circ}\text{C}$ | | | | | | |
| Turn-on delay time | $t_{d(on)}$ | $T_{vj} = 25^{\circ}\text{C}$, $V_{CC} = 600\text{V}$, $I_C = 50\text{A}$, $V_{GE} = 0.0/15.0\text{V}$, $R_{G(on)} = 4.0\Omega$ $R_{G(off)} = 4.0\Omega$ Inductive load | - | 62 | - | ns |
| Rise time | t_r | | - | 17 | - | |
| Turn-off delay time | $t_{d(off)}$ | | - | 504 | - | |
| Fall time | t_f | | - | 38 | - | |
| Turn-on energy | E_{on} | Energy losses include "tail" and diode reverse recovery. | - | 1.22 | - | mJ |
| Turn-off energy | E_{off} | | - | 1.46 | - | |
| Total switching energy | E_{ts} | | - | 2.68 | - | |
| Diode Characteristic, at $T_{vj} = 25^{\circ}\text{C}$ | | | | | | |
| Diode reverse recovery time | t_{rr} | $T_{vj} = 25^{\circ}\text{C}$, $V_R = 600\text{V}$, $I_F = 100\text{A}$, $R_{G(on)} = 4.0\Omega$ | - | 37.76 | - | ns |
| Diode reverse recovery charge | Q_{rr} | | - | 3.1 | - | μC |
| Diode peak reverse recovery current | I_{rrm} | | - | 147.2 | - | A |
| Diode peak rate of fall of reverse Recovery current during tb | di_{rr}/dt | | - | -7850 | - | A/ μs |

| | | | | | | |
|---|--------------|--|---|-------|---|------------------|
| Diode reverse recovery time | t_{rr} | $T_{vj} = 25^{\circ}\text{C},$ $V_R = 600\text{V},$ $I_F = 50\text{A},$ $R_{G(on)} = 4.0\Omega$ | - | 31.6 | - | ns |
| Diode reverse recovery charge | Q_{rr} | | - | 1.99 | - | μC |
| Diode peak reverse recovery current | I_{rrm} | | - | 120.5 | - | A |
| Diode peak rate of fall of reverse Recovery current during tb | di_{rr}/dt | | - | -8700 | - | A/ μs |

Tab.7. Switching Characteristic (Inductive load)

| Parameters | Symbol | Conditions | Min. value | Typ. value | Max. value | Unit |
|---|--------------|--|------------|------------|------------|------|
| IGBT Characteristic, at $T_{vj} = 175^{\circ}\text{C}$ | | | | | | |
| Turn-on delay time | $t_{d(on)}$ | $T_{vj} = 175^{\circ}\text{C},$ $V_{CC} = 600\text{V}, I_C = 100\text{A},$ $V_{GE} = 0.0/15.0\text{V},$ $R_{G(on)} = 4.0\Omega$ $R_{G(off)} = 4.0\Omega$ Inductive load Energy losses include “tail” and diode reverse recovery. | - | 70 | - | ns |
| Rise time | t_r | | - | 24 | - | |
| Turn-off delay time | $t_{d(off)}$ | | - | 613 | - | |
| Fall time | t_f | | - | 69 | - | |
| Turn-on energy | E_{on} | | - | 7.2 | - | mJ |
| Turn-off energy | E_{off} | | - | 4.44 | - | |
| Total switching energy | E_{ts} | | - | 11.64 | - | |
| IGBT Characteristic, at $T_{vj} = 175^{\circ}\text{C}$ | | | | | | |
| Turn-on delay time | $t_{d(on)}$ | $T_{vj} = 175^{\circ}\text{C},$ $V_{CC} = 600\text{V}, I_C = 50\text{A},$ $V_{GE} = 0.0/15.0\text{V},$ $R_{G(on)} = 4.0\Omega$ $R_{G(off)} = 4.0\Omega$ Inductive load Energy losses include “tail” and diode reverse recovery. | - | 63 | - | ns |
| Rise time | t_r | | - | 19 | - | |
| Turn-off delay time | $t_{d(off)}$ | | - | 630 | - | |
| Fall time | t_f | | - | 68 | - | |
| Turn-on energy | E_{on} | | - | 3.6 | - | mJ |
| Turn-off energy | E_{off} | | - | 2.03 | - | |
| Total switching energy | E_{ts} | | - | 5.63 | - | |
| Diode Characteristic, at $T_{vj} = 175^{\circ}\text{C}$ | | | | | | |

| | | | | | | |
|---|--------------|---|---|--------|---|------------------|
| Diode reverse recovery time | t_{rr} | $T_{vj} = 175^{\circ}\text{C}$, $V_R = 600\text{V}$, $I_F = 100\text{A}$, $R_{G(on)} = 4.0\Omega$ | - | 225.74 | - | ns |
| Diode reverse recovery charge | Q_{rr} | | - | 13.3 | - | μC |
| Diode peak reverse recovery current | I_{rrm} | | - | 190.9 | - | A |
| Diode peak rate of fall of reverse Recovery current during tb | di_{rr}/dt | | - | -4540 | - | A/ μs |
| Diode reverse recovery time | t_{rr} | $T_{vj} = 175^{\circ}\text{C}$, $V_R = 600\text{V}$, $I_F = 50\text{A}$, $R_{G(on)} = 4.0\Omega$ | - | 233.24 | - | ns |
| Diode reverse recovery charge | Q_{rr} | | - | 9.36 | - | μC |
| Diode peak reverse recovery current | I_{rrm} | | - | 148.4 | - | A |
| Diode peak rate of fall of reverse Recovery current during tb | di_{rr}/dt | | - | -3950 | - | A/ μs |

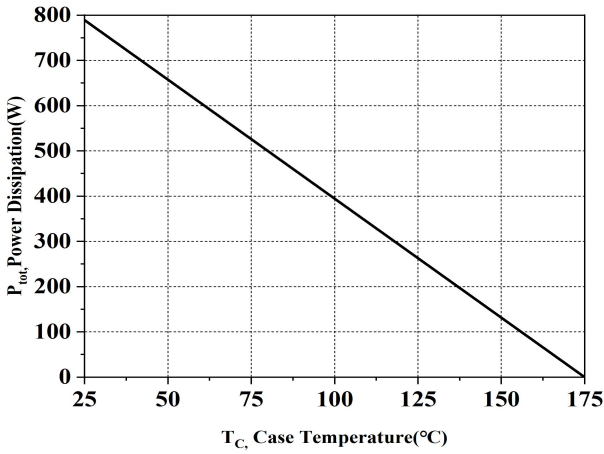


Fig.1. Power dissipation as a function of case temperature ($T_j \leq 175^\circ\text{C}$)

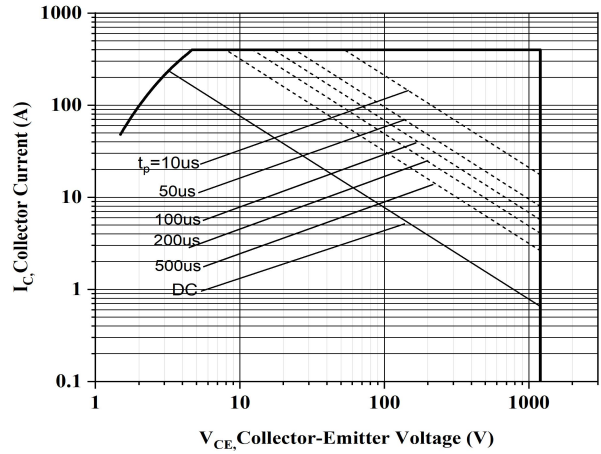


Fig.2. Forward bias safe operating area ($D = 0, T_C = 25^\circ\text{C}, T_j \leq 175^\circ\text{C}, V_{GE} = 15\text{V}$)

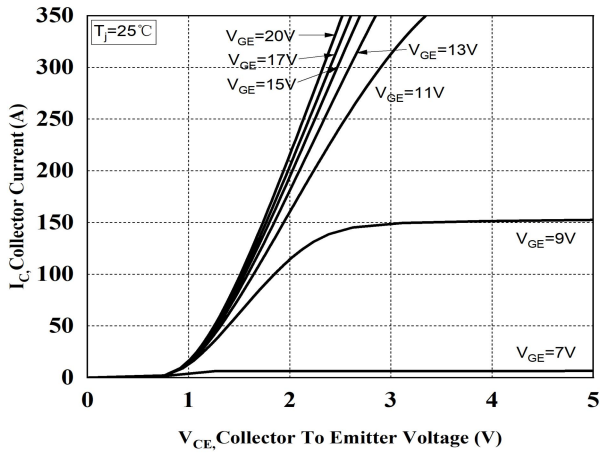


Fig.3. Typical output characteristics ($T_j = 25^\circ\text{C}$)

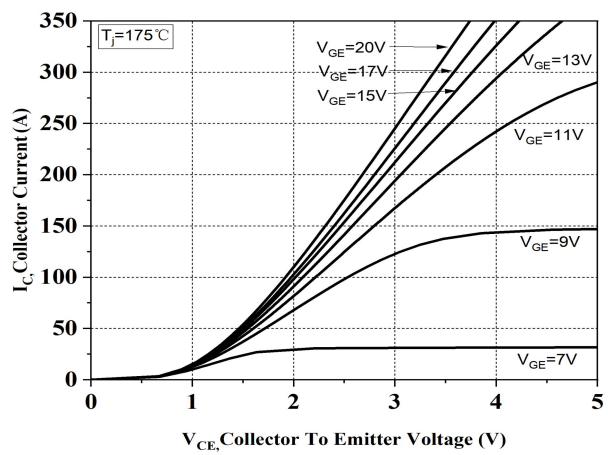


Fig.4. Typical output characteristics ($T_j = 175^\circ\text{C}$)

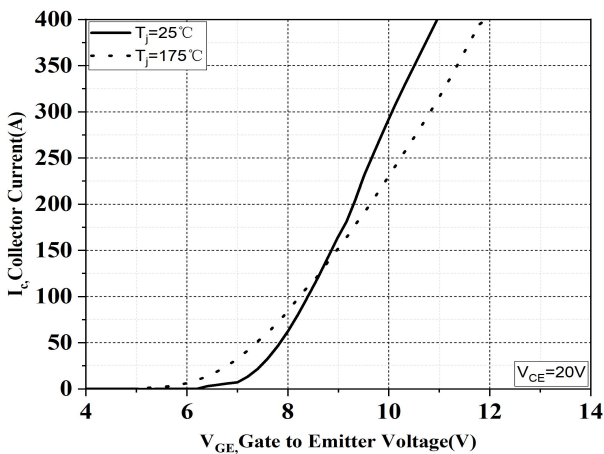


Fig.5. Typical transfer characteristic

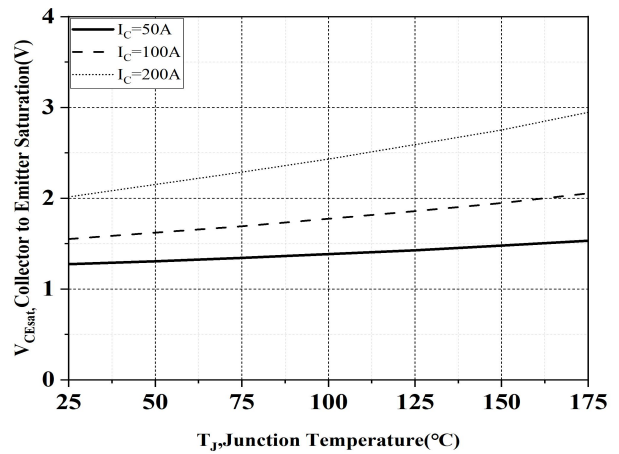


Fig.6. Typical collector-emitter saturation voltage vs. junction temperature ($V_{GE} = 15\text{V}$)

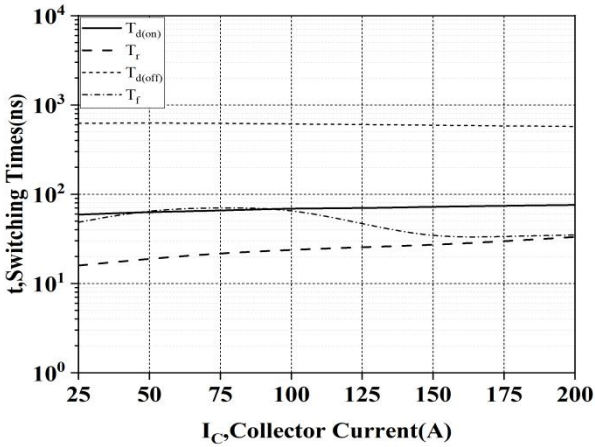


Fig.7. Typical switching times vs. collector current
($T_j = 175^\circ\text{C}$, $V_{CE} = 600\text{V}$, $V_{GE} = 15/0\text{V}$)

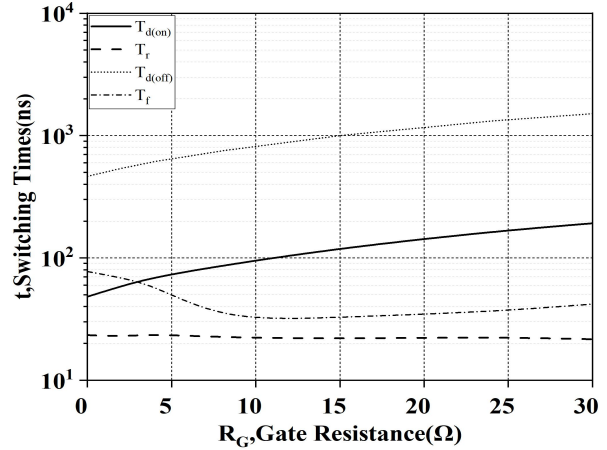


Fig.8. Typical switching times vs. gate Resistor

($T_j = 175^\circ\text{C}$, $V_{CE} = 600\text{V}$, $V_{GE} = 15/0\text{V}$, $I_C = 100\text{A}$)

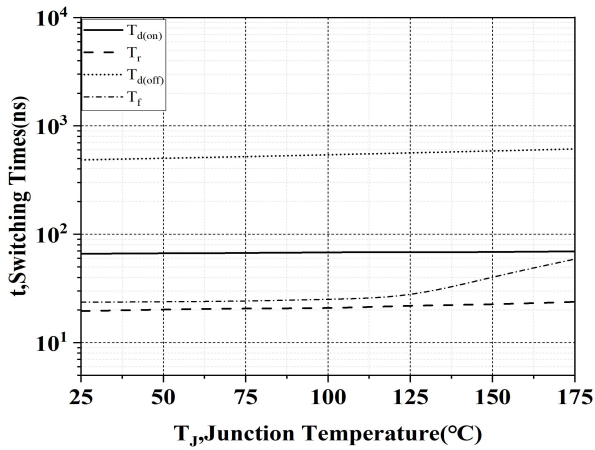


Fig.9. Typical switching times vs. junction temperature

($V_{CE} = 600\text{V}$, $V_{GE} = 15/0\text{V}$, $I_C = 100\text{A}$)

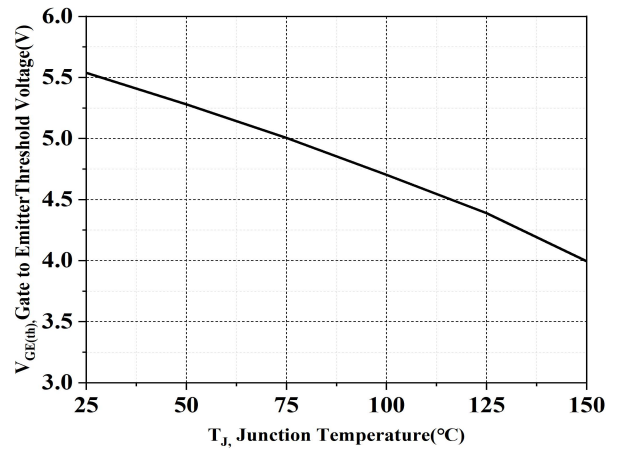


Fig.10. Gate-emitter threshold voltage vs. junction temperature

($I_C = 1.6\text{mA}$)

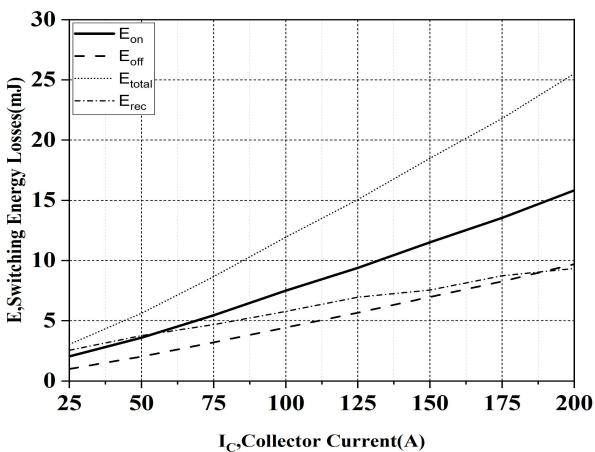


Fig.11. Typical switching energy losses as a function of collector current

($T_j = 175^\circ\text{C}$, $V_{CE} = 600\text{V}$, $V_{GE} = 15/0\text{V}$)

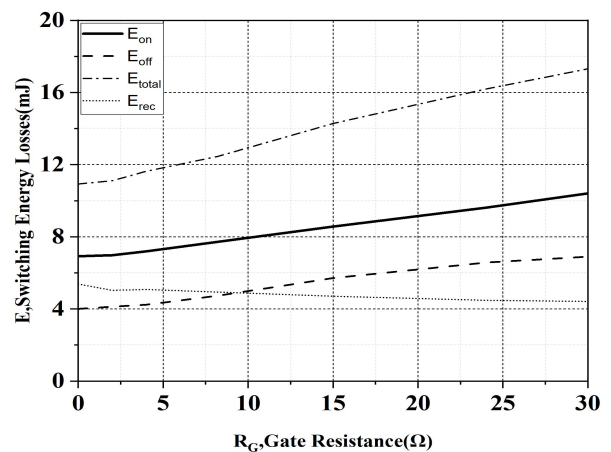


Fig.12. Typical switching energy losses as a function of gate resistor

($T_j = 175^\circ\text{C}$, $V_{CE} = 600\text{V}$, $V_{GE} = 15/0\text{V}$, $I_C = 100\text{A}$)

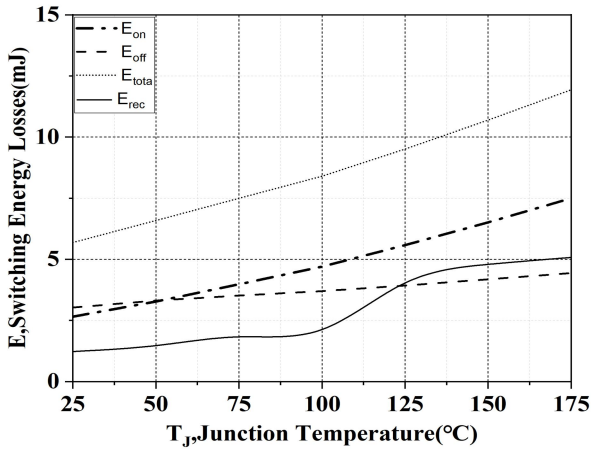


Fig.13. Typical switching energy losses as a function of junction temperature

(Inductive load, $V_{CE} = 600V$, $V_{GE} = 15/0V$, $I_C = 100A$)

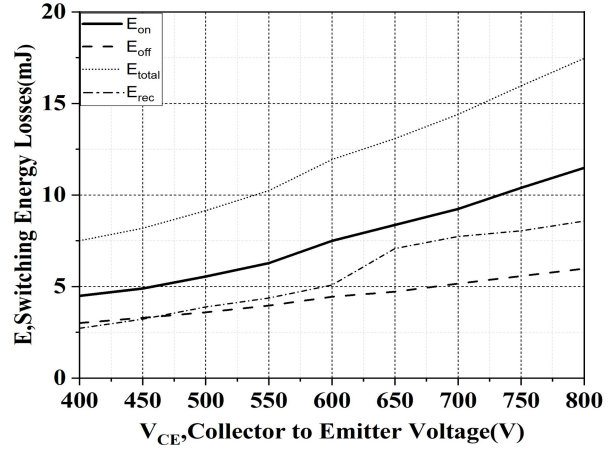


Fig.14. Typical switching energy losses as a function of collector emitter voltage

(Inductive load, $T_j = 175^\circ C$, $V_{GE} = 15/0V$, $I_C = 100A$)

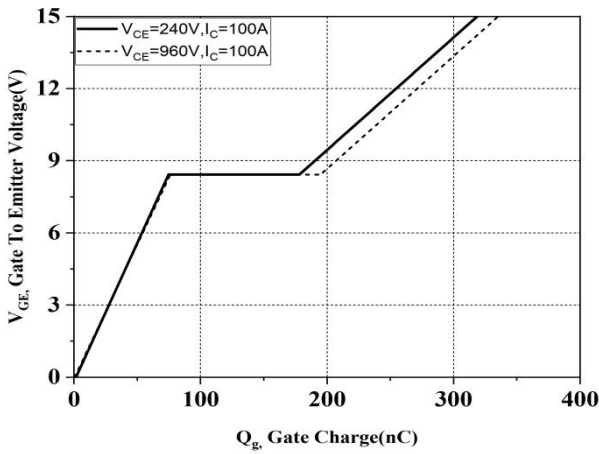


Fig.15. Typical gate charge

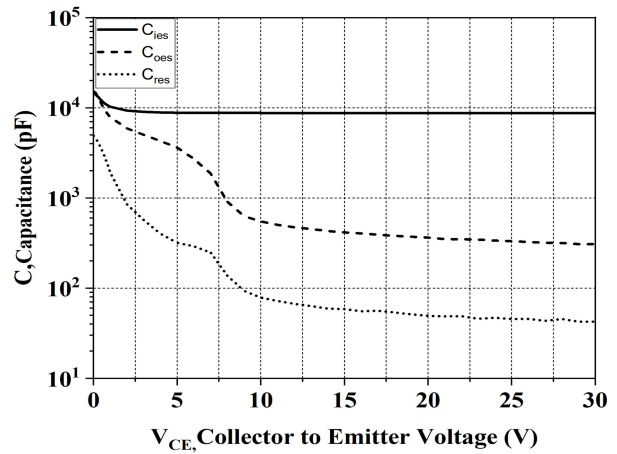


Fig.16. Typical capacitance as a function of collector-emitter voltage
($V_{GE} = 0V, f = 100KHz$)

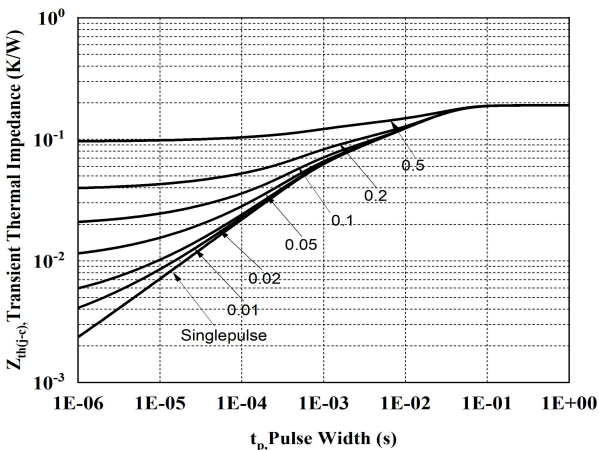


Fig.17. IGBT transient thermal impedance
($D = t_p/T$)

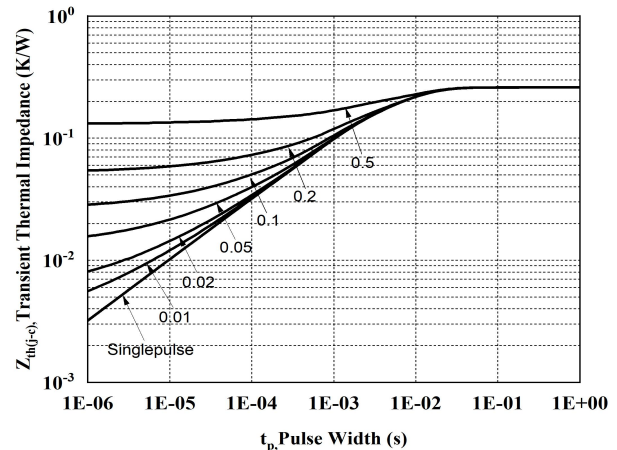


Fig.18. Transient thermal impedance of diode
($D = t_p/T$)

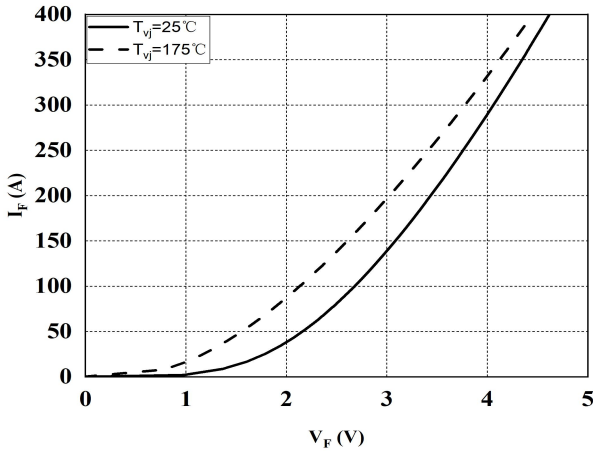


Fig.19. Typical diode forward current as a function of forward voltage

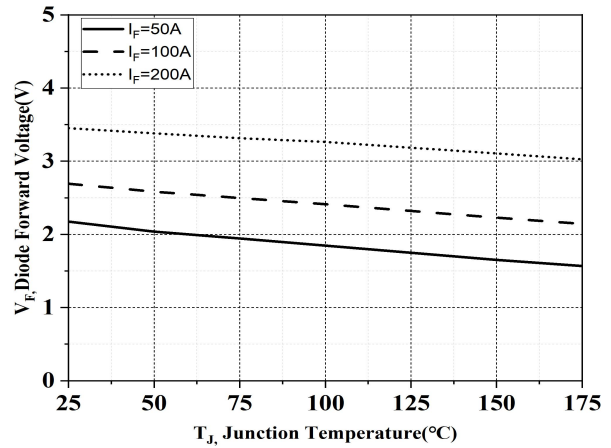


Fig.20. Typical diode forward voltage as a function of junction temperature

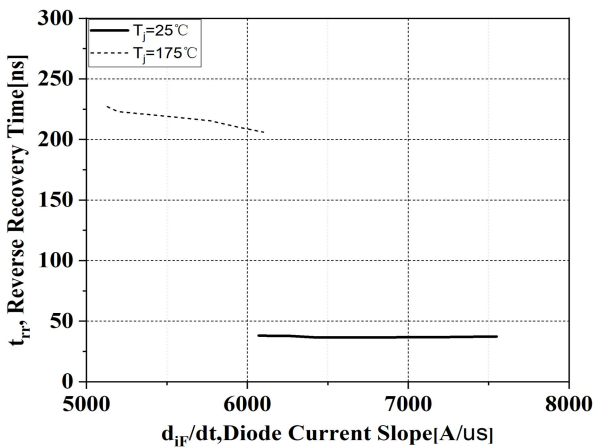


Fig.21. Typical reverse recovery time as a function of diode current slope (VR=600V IF=100A)

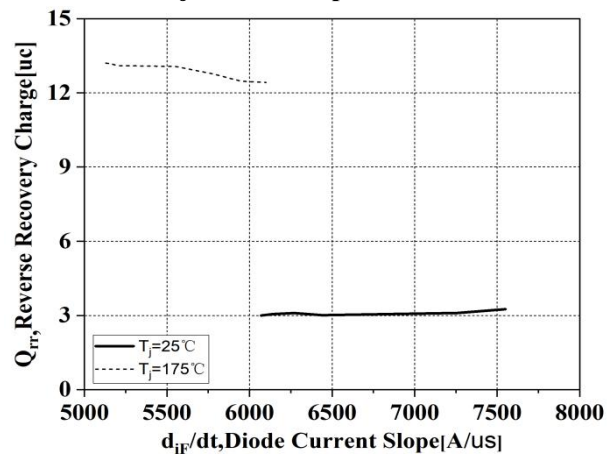


Fig.22. Typical reverse recovery charge as a function of diode current slope (VR=600V IF=100A)

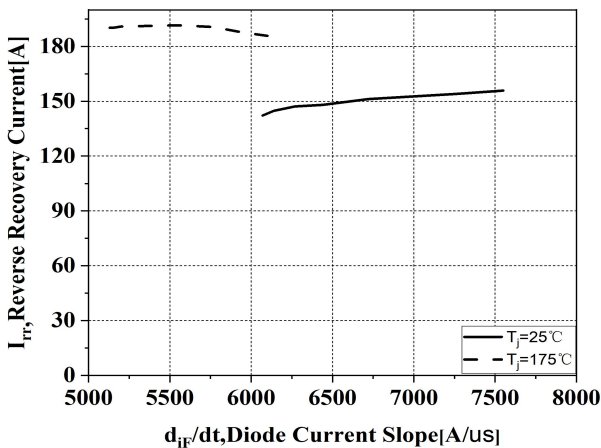


Fig.23. Typical reverse recovery current as a function of diode current slope (VR=600V IF=100A)

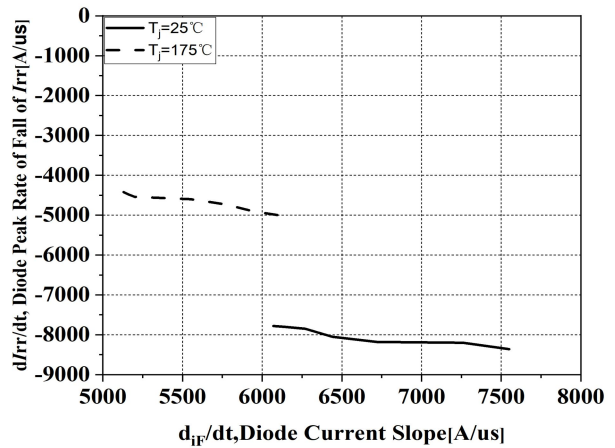


Fig.24. Typical diode peak rate of fall of reverse recovery current as a function of diode current slope (VR=600V IF=100A)

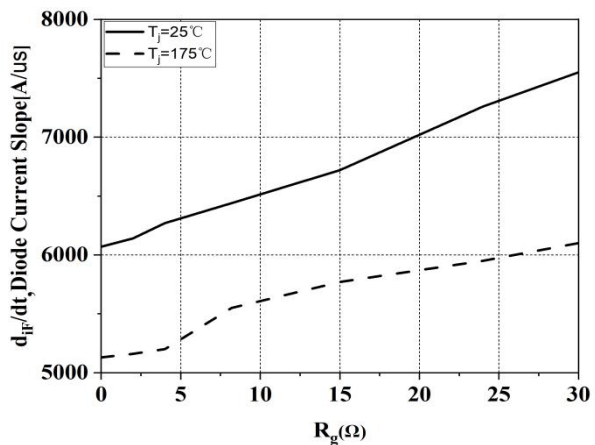
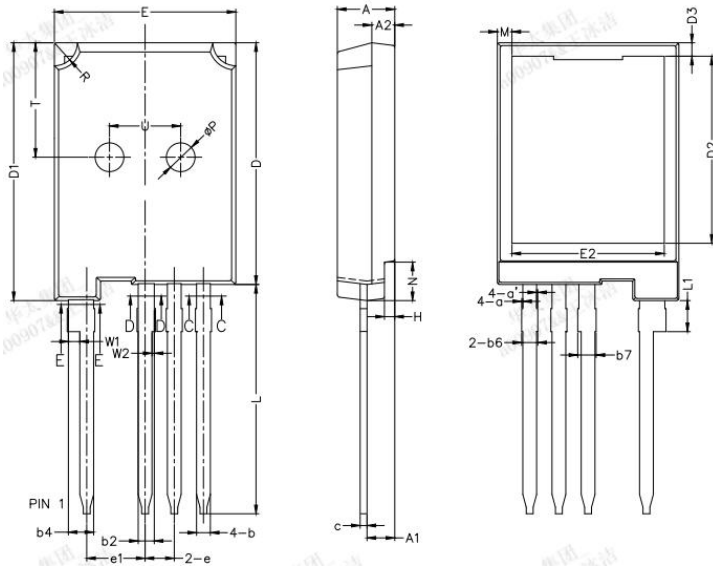


Fig.25. Typical diode current slope as a function of gate resistor
(VR=600V IF=100A)

7. Package Dimensions



| SYMBOL | MIN | NOM | MAX |
|--------|-------|-------|-------|
| A | 4.90 | 5.00 | 5.10 |
| A1 | 2.31 | 2.41 | 2.51 |
| A2 | 1.90 | 2.00 | 2.10 |
| a | 0 | - | 0.15 |
| a' | 0 | - | 0.15 |
| b | 1.16 | - | 1.29 |
| b1 | 1.15 | 1.20 | 1.25 |
| b2 | 1.36 | - | 1.49 |
| b3 | 1.35 | 1.40 | 1.45 |
| b4 | 2.16 | - | 2.29 |
| b5 | 2.15 | 2.20 | 2.25 |
| b6 | - | - | 1.45 |
| b7 | - | - | 1.65 |
| c | 0.59 | - | 0.66 |
| c1 | 0.58 | 0.60 | 0.62 |
| D | 20.90 | 21.00 | 21.10 |
| D1 | 22.30 | 22.40 | 22.50 |
| D2 | 15.95 | 16.25 | 16.55 |
| D3 | 1.00 | 1.17 | 1.35 |
| E | 15.70 | 15.80 | 15.90 |
| E2 | 13.10 | 13.26 | 13.50 |
| e | 2.44 | 2.54 | 2.64 |
| e1 | 4.98 | 5.08 | 5.18 |
| H | 0.80 | 0.90 | 1.00 |
| L | 19.80 | 19.92 | 20.10 |
| L1 | 2.55 | 2.70 | 2.85 |
| M | 0.97 | 1.27 | 1.57 |
| N | 3.24 | 3.34 | 3.44 |
| P | 2.40 | 2.50 | 2.60 |
| R | 1.90 | 2.00 | 2.10 |
| T | 9.80 | 10.00 | 10.20 |
| U | 6.00 | 6.20 | 6.40 |
| W1 | 0.90 | 1.00 | 1.10 |
| W2 | 0.10 | 0.20 | 0.30 |

8. Version Information

| Version No. | Date changed | Version revision record |
|-------------|--------------|-------------------------|
| V1.0 | 2024/05 | Preliminary version |