

## Prospective Data

# Insulated Gate Bi-Polar Transistor

## Type T0600AF65G

### Absolute Maximum Ratings

|                | VOLTAGE RATINGS                                | MAXIMUM LIMITS | UNITS |
|----------------|------------------------------------------------|----------------|-------|
| $V_{CES}$      | Collector – emitter voltage                    | 6500           | V     |
| $V_{CES}$      | Collector – emitter voltage ( $T_j$ 25°C)      | 6500           | V     |
| $V_{CES}$      | Collector – emitter voltage ( $T_j$ -40°C)     | 6000           | V     |
| $V_{DC\ link}$ | Permanent DC voltage for 100 FIT failure rate. | 3600           | V     |
| $V_{GES}$      | Peak gate – emitter voltage                    | ±20            | V     |

|                | RATINGS                                                                      | MAXIMUM LIMITS | UNITS      |
|----------------|------------------------------------------------------------------------------|----------------|------------|
| $I_C$          | DC collector current, IGBT                                                   | 600            | A          |
| $I_{CRM}$      | Repetitive peak collector current, $t_p=1ms$ , IGBT                          | 1200           | A          |
| $I_{F(DC)}$    | Continuous DC forward current, Diode                                         | 600            | A          |
| $I_{FRM}$      | Repetitive peak forward current, $t_p=1ms$ , Diode                           | 1200           | A          |
| $I_{FSM}$      | Peak non-repetitive surge $t_p=10ms$ , $V_{RM}=60\%V_{RRM}$ , Diode (Note 4) | 4910           | A          |
| $I_{FSM2}$     | Peak non-repetitive surge $t_p=10ms$ , $V_{RM}\leq 10V$ , Diode (Note 4)     | 5400           | A          |
| $P_{MAX}$      | Maximum power dissipation, IGBT (Note 2)                                     | 7.1            | KW         |
| $(di/dt)_{cr}$ | Critical diode $di/dt$ (note 3)                                              | 2000           | A/ $\mu s$ |
| $T_j$          | Operating temperature range.                                                 | -40 to +125    | °C         |
| $T_{stg}$      | Storage temperature range.                                                   | -40 to +125    | °C         |

## Notes: -

- 1) Unless otherwise indicated  $T_j = 125^\circ C$ .
- 2)  $T_{sink} = 25^\circ C$ , double side cooled.
- 3) Maximum commutation loop inductance 430nH.
- 4) Half-sinewave, 125°C  $T_j$  initial.

## Characteristics

### IGBT Characteristics

|               | PARAMETER                              | MIN | TYP  | MAX  | TEST CONDITIONS                                                           | UNITS      |
|---------------|----------------------------------------|-----|------|------|---------------------------------------------------------------------------|------------|
| $V_{CE(sat)}$ | Collector – emitter saturation voltage | -   | 3.6  | -    | $I_C = 600A, V_{GE} = 15V, T_j = 25^\circ C$                              | V          |
|               |                                        | 4.4 | 4.8  | 5.2  | $I_C = 600A, V_{GE} = 15V$                                                | V          |
| $V_{T0}$      | Threshold voltage                      | -   |      | 2.49 | Current range: 200A – 600A                                                | V          |
| $r_T$         | Slope resistance                       | -   |      | 4.52 |                                                                           | m $\Omega$ |
| $V_{GE(TH)}$  | Gate threshold voltage                 | -   | 5.2  | -    | $V_{CE} = V_{GE}, I_C = 600mA$                                            | V          |
| $I_{CES}$     | Collector – emitter cut-off current    | -   | 6    | 25   | $V_{CE} = V_{CES}, V_{GE} = 0V$                                           | mA         |
| $I_{GES}$     | Gate leakage current                   | -   | -    | 30   | $V_{GE} = \pm 20V$                                                        | $\mu A$    |
| $C_{ies}$     | Input capacitance                      | -   | 105  | -    | $V_{CE} = 10V, V_{GE} = 0V, f = 100kHz, T_j = 25^\circ C$                 | nF         |
| $t_{d(on)}$   | Turn-on delay time                     | -   | 1.6  | -    | $I_C = 600A, V_{CE} = 3600V, di/dt = 1500A/\mu s$                         | $\mu s$    |
| $t_r(V)$      | Rise time                              | -   | 3.4  | -    |                                                                           | $\mu s$    |
| $Q_{g(on)}$   | Turn-on gate charge                    | -   | 3.5  | -    | $V_{GE} = \pm 15V, L_s = 430nH$                                           | $\mu C$    |
| $E_{on}$      | Turn-on energy                         | -   | 4.2  | -    | $R_{g(ON)} = 5.1\Omega, R_{g(OFF)} = 16\Omega, C_{GE} = 56nF$             | J          |
| $t_{d(off)}$  | Turn-off delay time                    | -   | 4.8  | -    | Integral diode used as freewheel diode<br>(Note 3 & 4)                    | $\mu s$    |
| $t_f(l)$      | Fall time                              | -   | 2.1  | -    |                                                                           | $\mu s$    |
| $Q_{g(off)}$  | Turn-off gate charge                   | -   | 5.8  | -    |                                                                           | $\mu C$    |
| $E_{off}$     | Turn-off energy                        | -   | 3.4  | -    |                                                                           | J          |
| $I_{SC}$      | Short circuit current                  | -   | 3250 | -    | $V_{GE} = +15V, V_{CC} = 3600V, V_{CEmax} \leq V_{CES}, t_p \leq 10\mu s$ | A          |

### Diode Characteristics

|          | PARAMETER                        | MIN | TYP  | MAX  | TEST CONDITIONS                                               | UNITS      |
|----------|----------------------------------|-----|------|------|---------------------------------------------------------------|------------|
| $V_F$    | Forward voltage                  | -   | 3.1  | -    | $I_F = 600A, T_j = 25^\circ C$                                | V          |
|          |                                  | -   | 3.45 | 3.85 | $I_F = 600A$                                                  | V          |
| $V_{T0}$ | Threshold voltage                | -   | -    | 1.89 | Current range 200A – 600A                                     | V          |
| $r_T$    | Slope resistance                 | -   | -    | 3.27 |                                                               | m $\Omega$ |
| $I_{rm}$ | Peak reverse recovery current    | -   | 700  | -    | $V_i = 3600V, I_F = 600A, V_{GE} = -15V, di/dt = 1500A/\mu s$ | A          |
| $Q_{rr}$ | Recovered charge                 | -   | 960  | -    |                                                               | $\mu C$    |
| $t_{rr}$ | Reverse recovery time, 50% chord | -   | 1.1  | -    |                                                               | $\mu s$    |
| $E_r$    | Reverse recovery energy          | -   | 1.4  | -    |                                                               | J          |

### Thermal Characteristics

|            | PARAMETER                                  | MIN | TYP | MAX  | TEST CONDITIONS       | UNITS |
|------------|--------------------------------------------|-----|-----|------|-----------------------|-------|
| $R_{thJK}$ | Thermal resistance junction to sink, IGBT  | -   | -   | 14.1 | Double side cooled    | K/kW  |
|            |                                            | -   | -   | 21.4 | Collector side cooled | K/kW  |
|            |                                            | -   | -   | 41.3 | Emitter side cooled   | K/kW  |
| $R_{thJK}$ | Thermal resistance junction to sink, Diode | -   | -   | 24.3 | Double side cooled    | K/kW  |
|            |                                            | -   | -   | 35.1 | Cathode side cooled   | K/kW  |
|            |                                            | -   | -   | 78.4 | Anode side cooled     | K/kW  |
| F          | Mounting force                             | 25  | -   | 35   | Note 2                | kN    |
| $W_t$      | Weight                                     | -   | 1.7 | -    |                       | kg    |

Notes:-

- 1) Unless otherwise indicated  $T_j = 125^\circ C$ .
- 2) Consult application note 2008AN01 for detailed mounting requirements
- 3)  $C_{GE}$  is additional gate – emitter capacitance added to output of gate drive
- 4) Figures 6 to 9 are obtained using integral diode as freewheeling diode

## Curves

Figure 1 – Typical collector-emitter saturation voltage characteristics

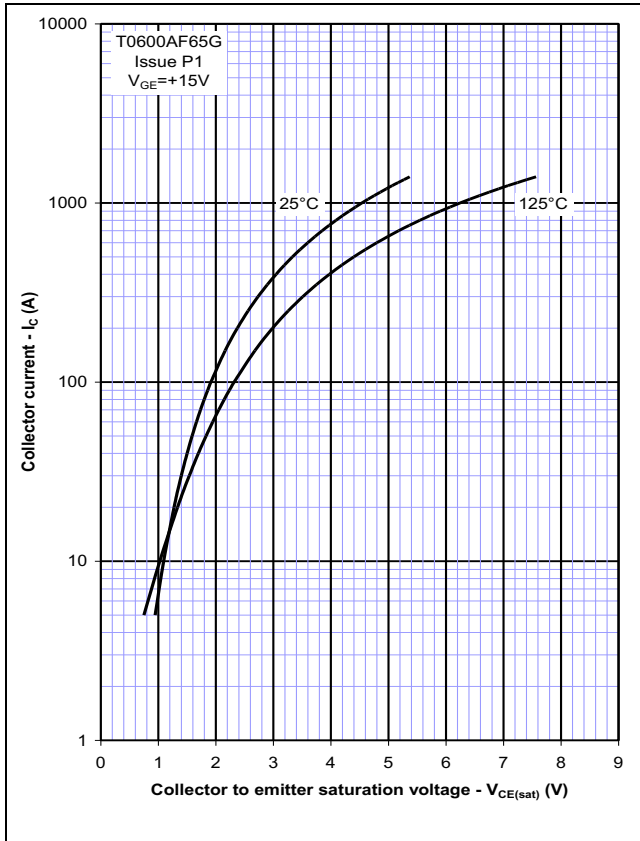


Figure 2 – Typical output characteristic

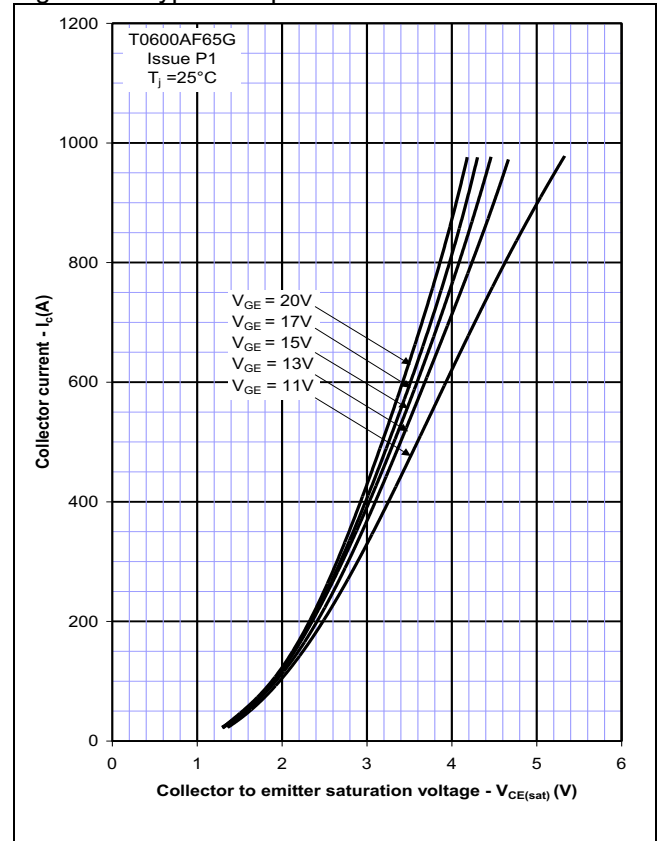


Figure 3 – Typical output characteristic

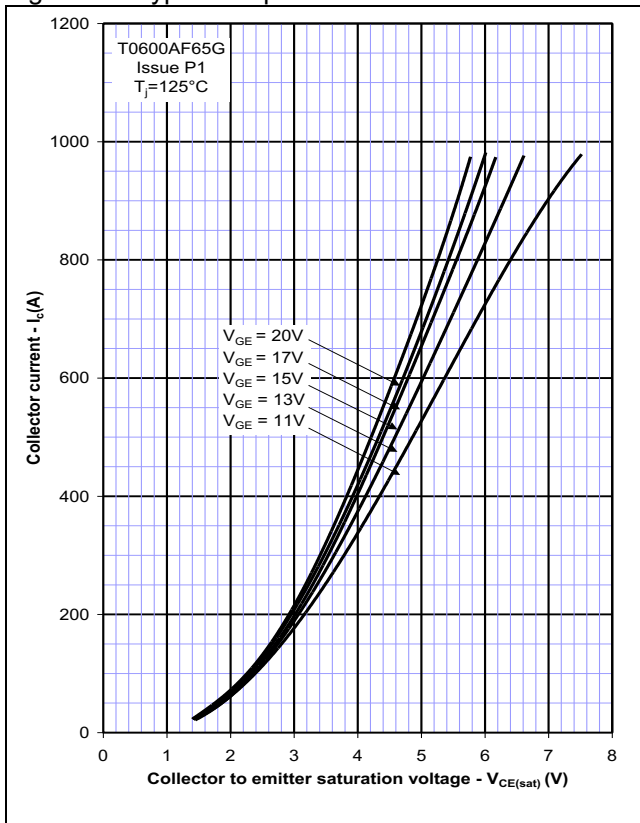


Figure 4 – Typical turn-on delay time vs gate resistance

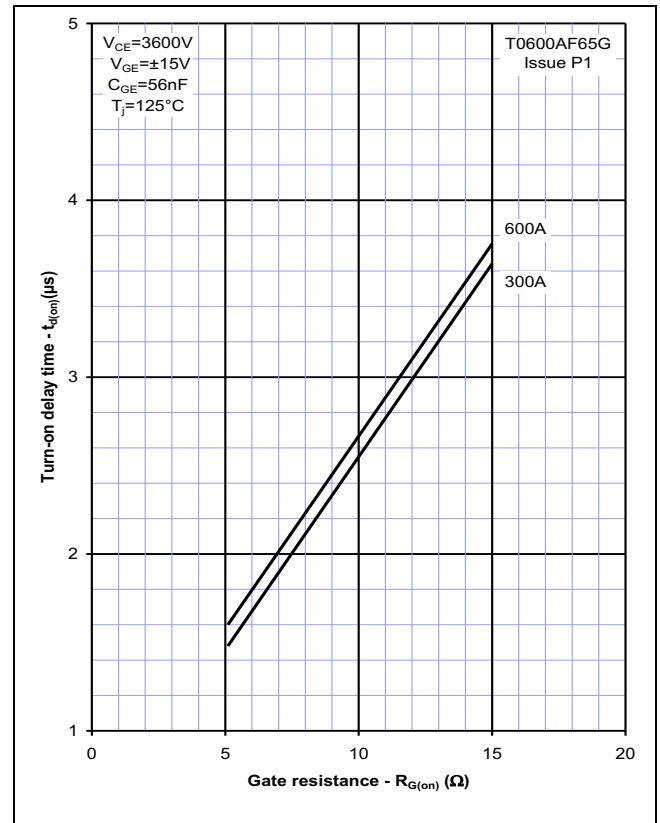


Figure 5 – Typical turn-off delay time vs. gate resistance

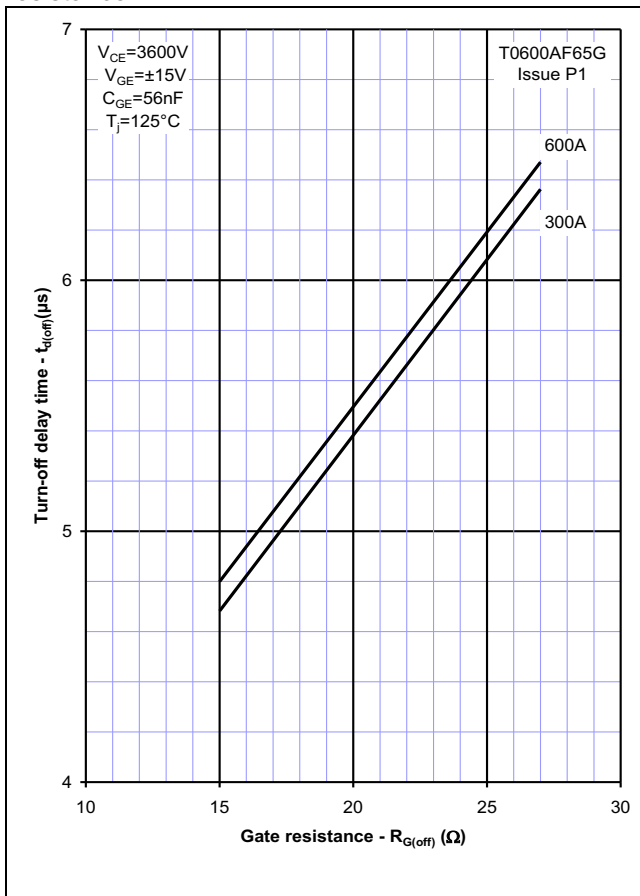


Figure 6 – Typical turn-on energy vs. collector current

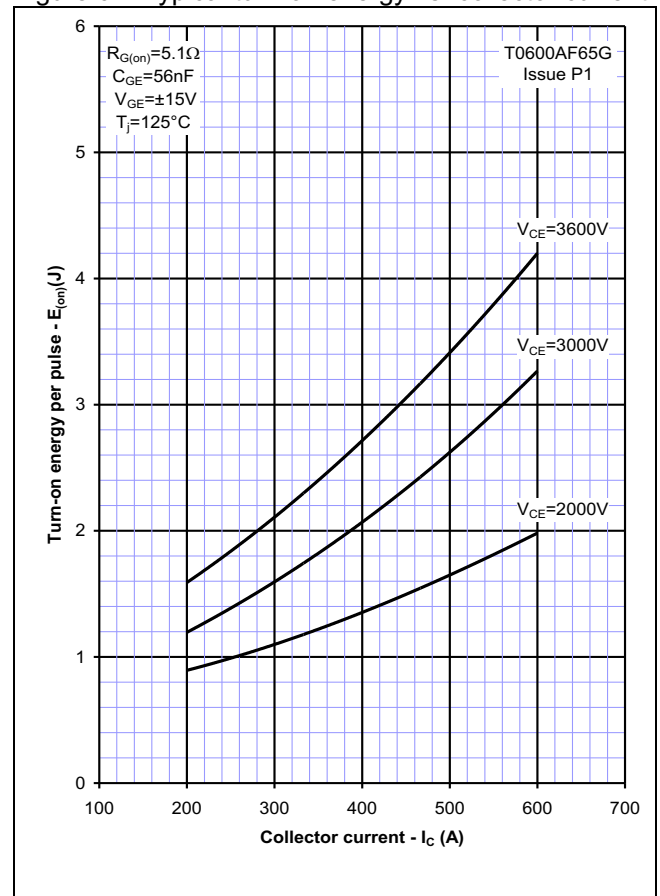


Figure 7 – Typical turn-on energy vs. di/dt

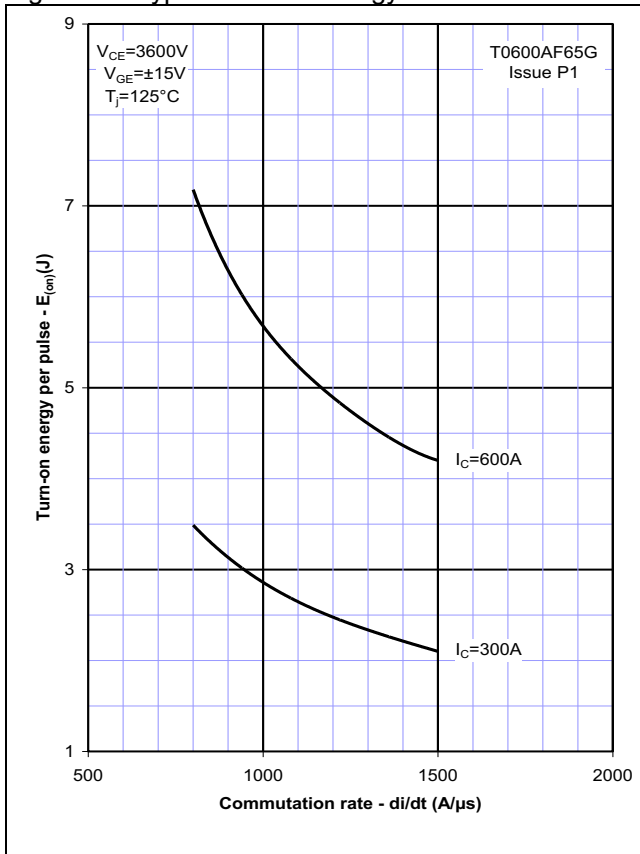


Figure 8 – Typical turn-off energy vs. collector current

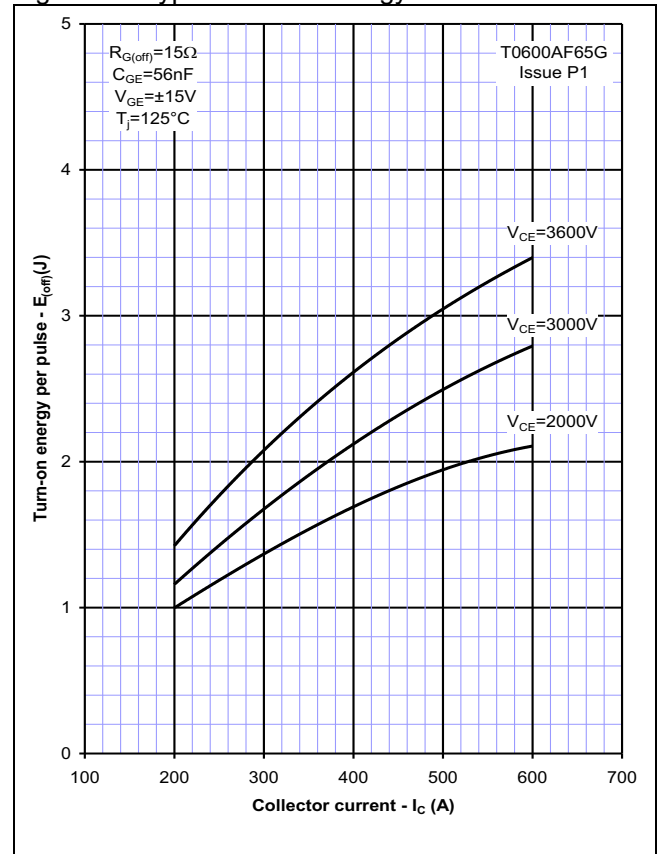


Figure 9 – Turn-off energy vs voltage

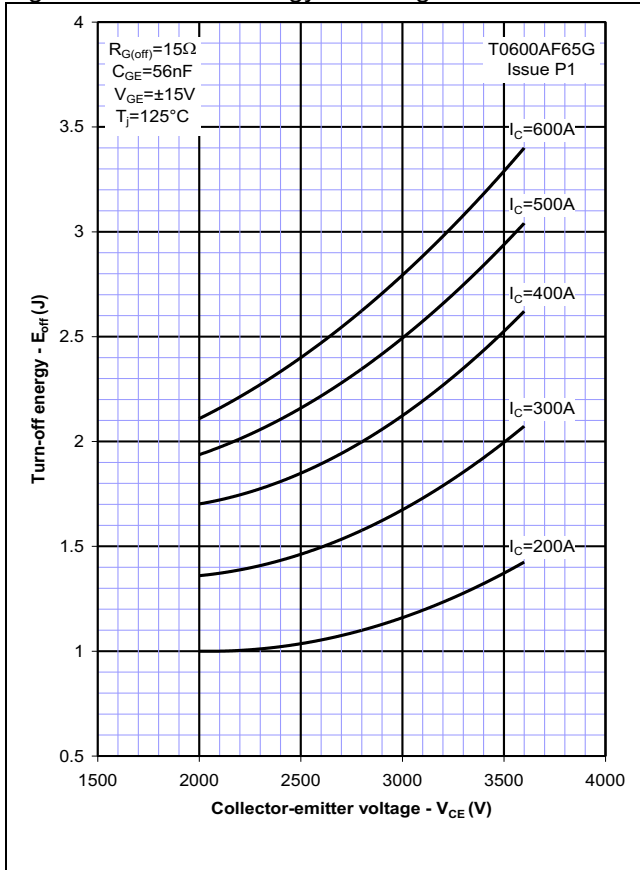


Figure 10 – Safe operating area (IGBT)

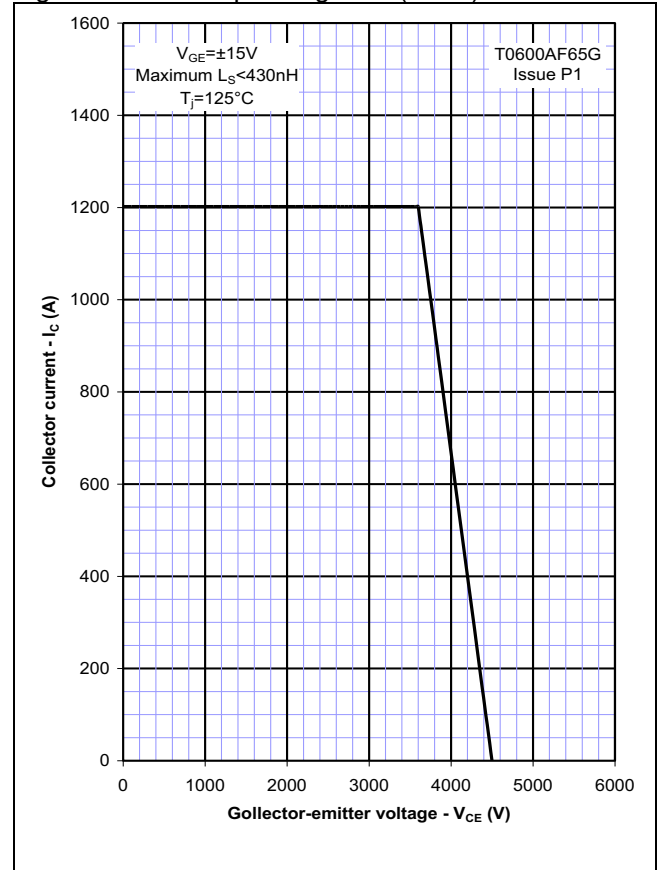


Figure 11 – Typical diode forward characteristics

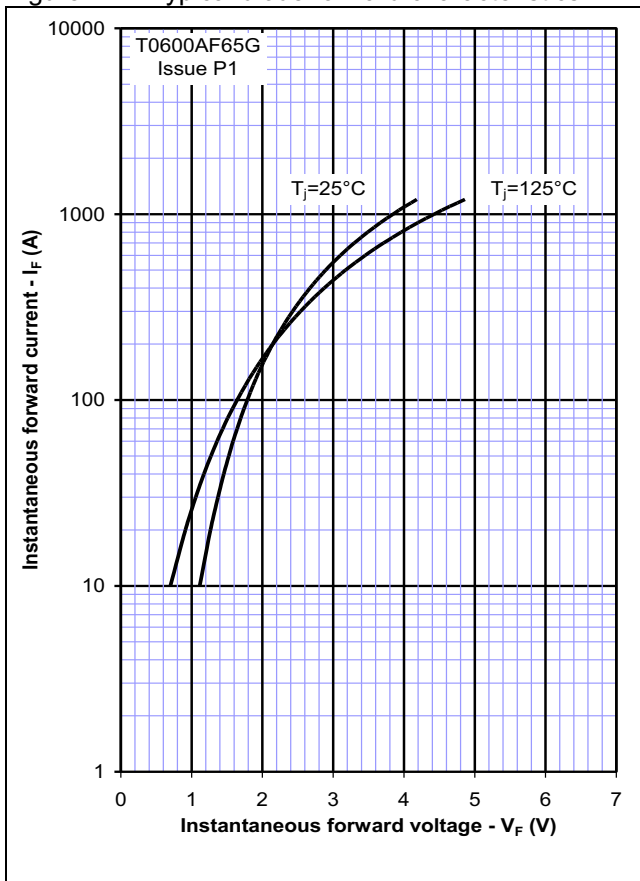


Figure 12 – Typical recovered charge

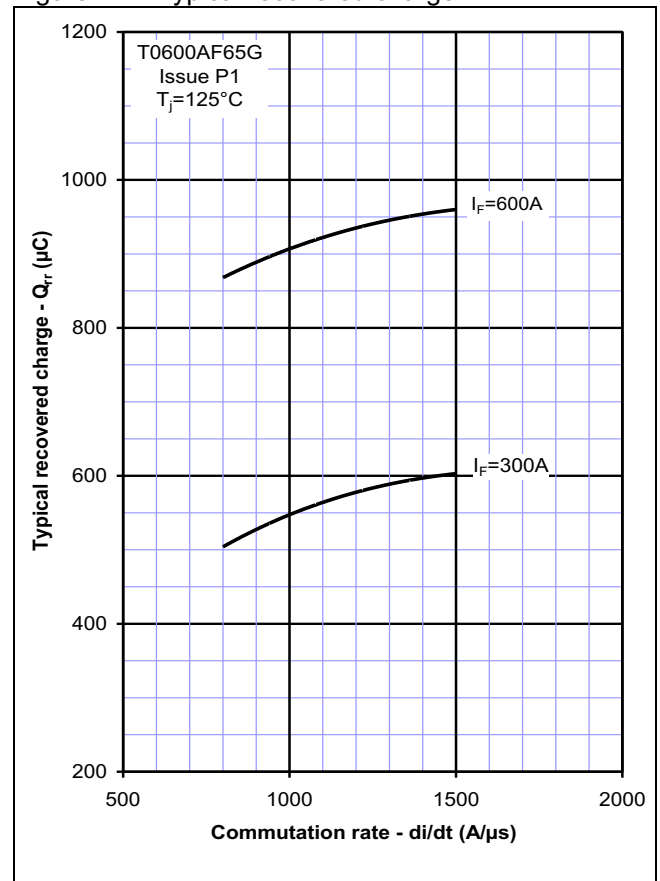


Figure 13 – Typical reverse recovery current

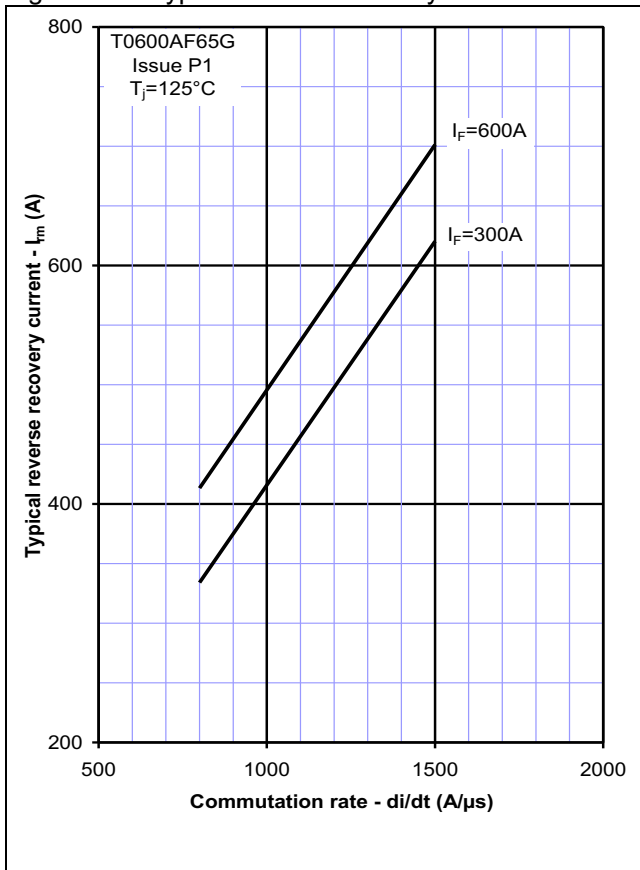


Figure 14 – Typical reverse recovery time

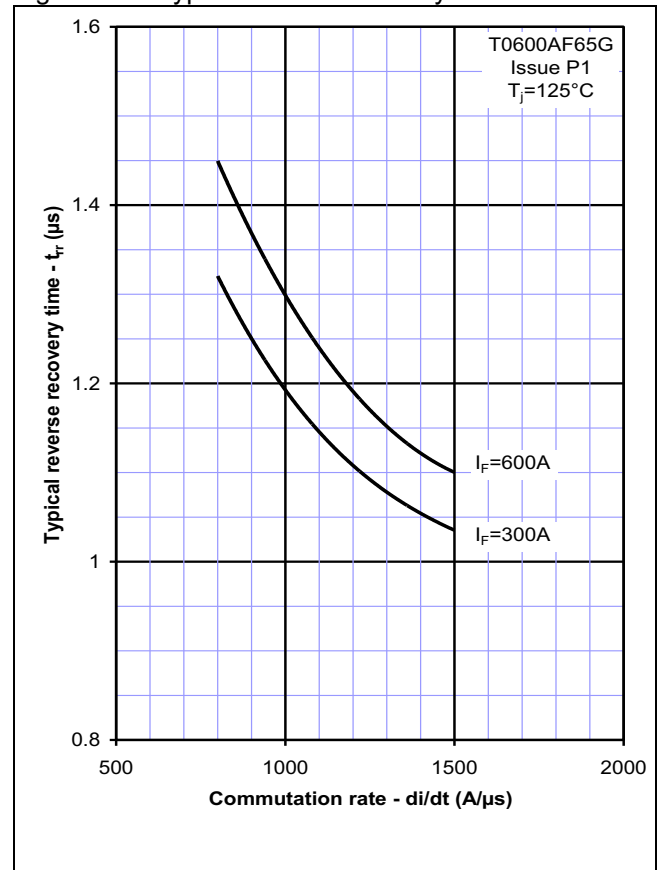


Figure 15 – Typical reverse recovery energy

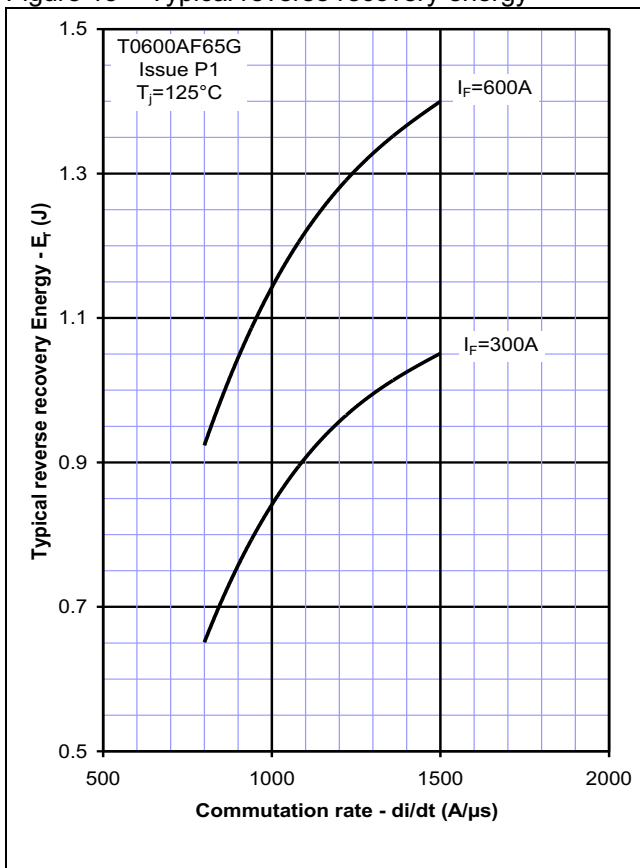


Figure 16 – Safe operating area (Diode)

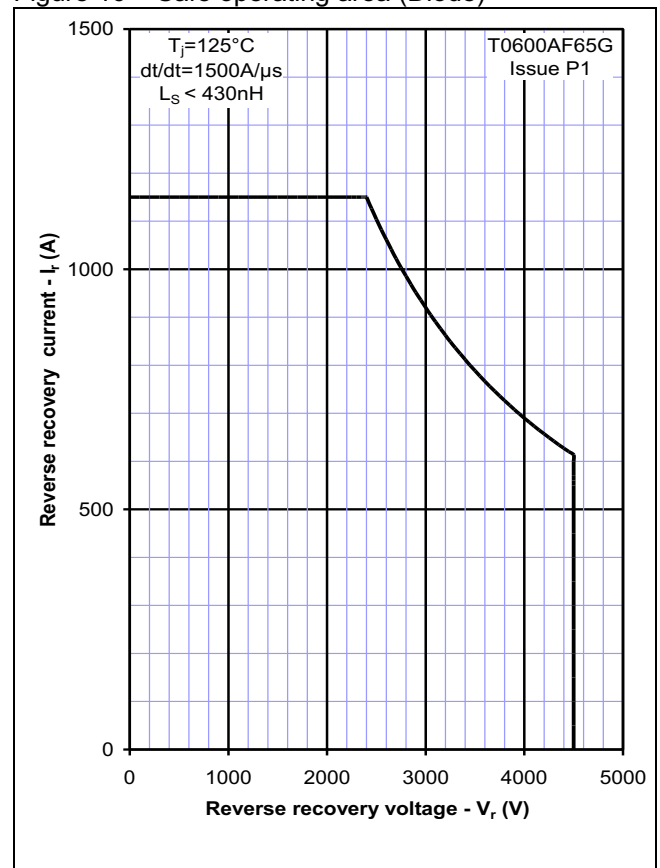


Figure 17 – Transient thermal impedance (IGBT)

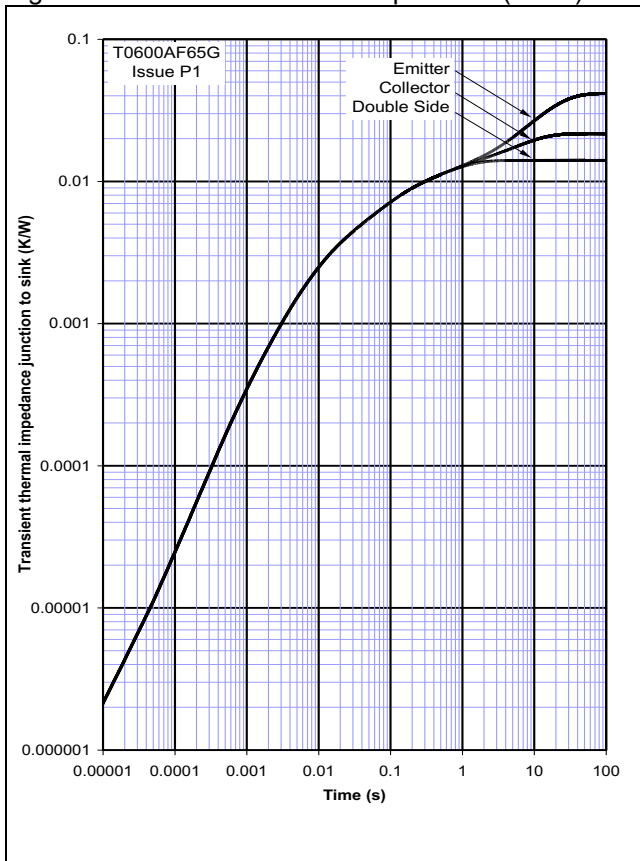
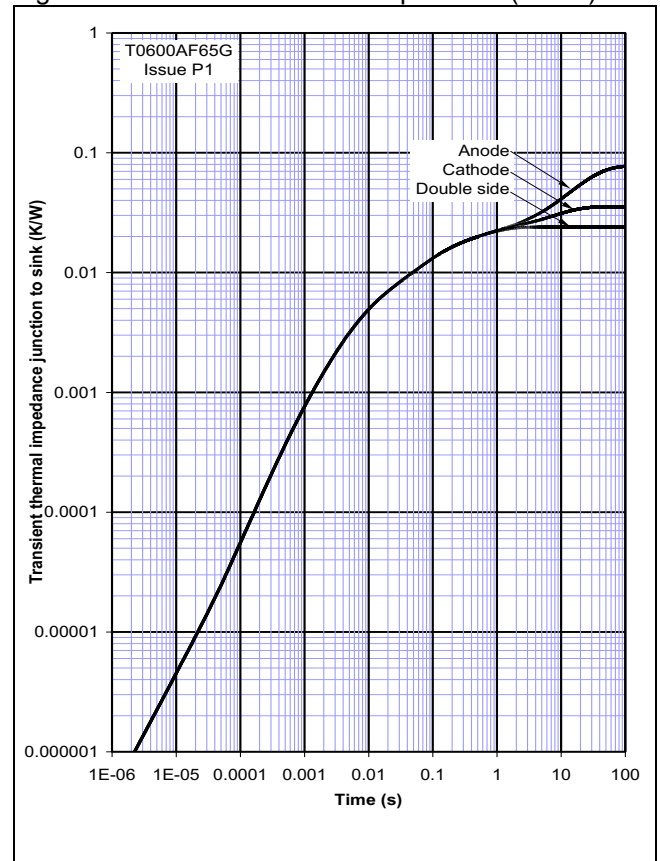
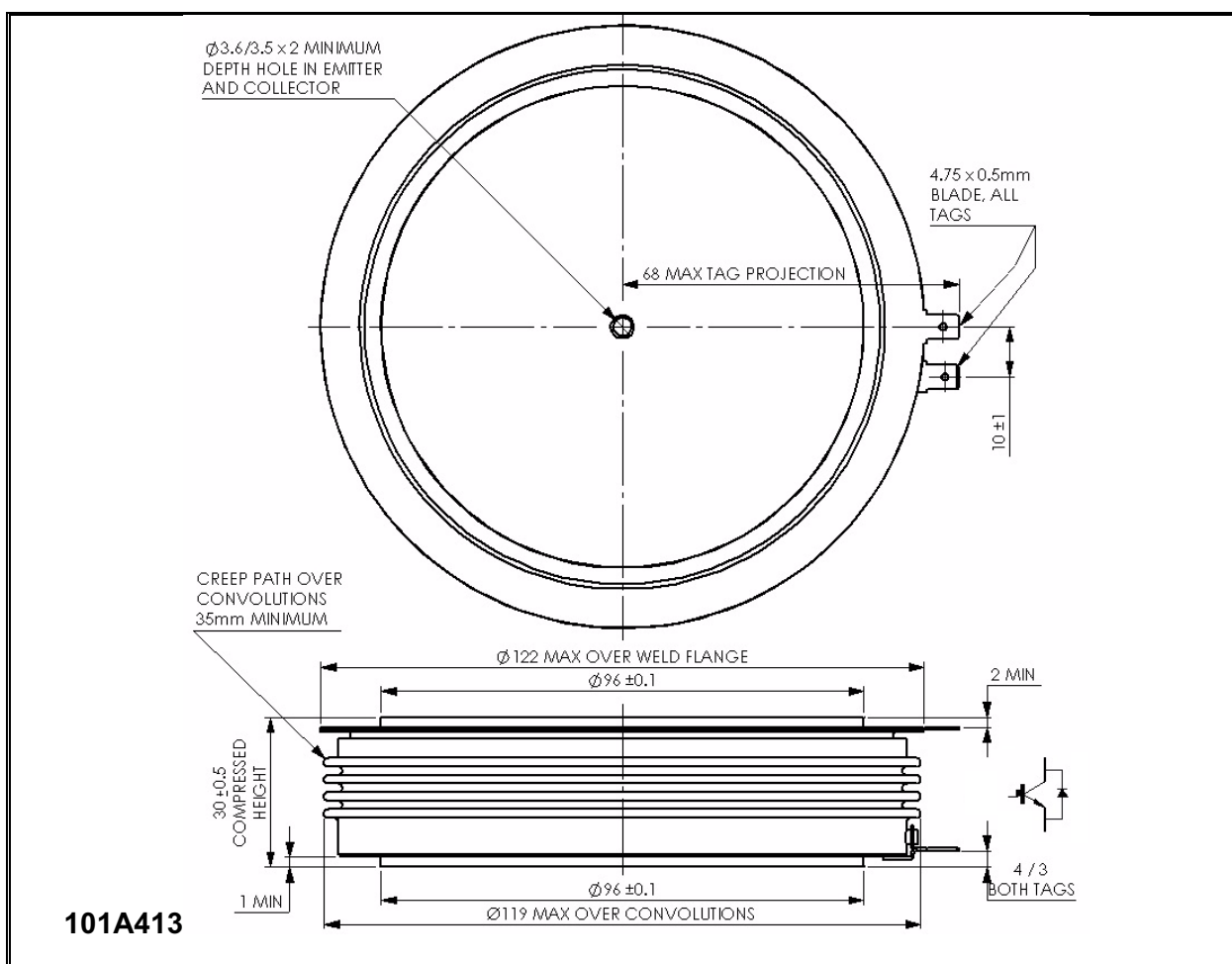


Figure 18 – Transient thermal impedance (Diode)



### Outline Drawing & Ordering Information



## ORDERING INFORMATION

(Please quote 10 digit code as below)

| <b>T0600</b>       | <b>AF</b>             | <b>65</b>                            | <b>G</b>          |
|--------------------|-----------------------|--------------------------------------|-------------------|
| Fixed type<br>Code | Fixed Outline<br>Code | Voltage Grade<br>$V_{CES}/100$<br>65 | Fixed format code |

Typical order code: T0600AF65G ( $V_{CES} = 6500V$ )

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