

## IGBT

High speed DuoPack: IGBT in Trench and Fieldstop technology with soft, fast recovery anti-parallel diode

### IKW25N120H3

1200V high speed switching series third generation

Data sheet

High speed DuoPack: IGBT in Trench and Fieldstop technology with soft, fast recovery anti-parallel diode

#### Features:

TRENCHSTOP™ technology offering

- very low  $V_{CEsat}$
- low EMI
- Very soft, fast recovery anti-parallel diode
- maximum junction temperature 175°C
- qualified according to JEDEC for target applications
- Pb-free lead plating; RoHS compliant
- complete product spectrum and PSpice Models:  
<http://www.infineon.com/igbt/>

#### Applications:

- uninterruptible power supplies
- welding converters
- converters with high switching frequency



#### Key Performance and Package Parameters

| Type        | $V_{CE}$ | $I_C$ | $V_{CEsat}$ , $T_{vj}=25^{\circ}C$ | $T_{vjmax}$ | Marking  | Package    |
|-------------|----------|-------|------------------------------------|-------------|----------|------------|
| IKW25N120H3 | 1200V    | 25A   | 2.05V                              | 175°C       | K25H1203 | PG-TO247-3 |

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## Maximum Ratings

For optimum lifetime and reliability, Infineon recommends operating conditions that do not exceed 80% of the maximum ratings stated in this datasheet.

| Parameter                                                                                                                                                                                                         | Symbol      | Value            | Unit             |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|------------------|------------------|
| Collector-emitter voltage                                                                                                                                                                                         | $V_{CE}$    | 1200             | V                |
| DC collector current, limited by $T_{vjmax}$<br>$T_C = 25^\circ\text{C}$<br>$T_C = 100^\circ\text{C}$                                                                                                             | $I_C$       | 50.0<br>25.0     | A                |
| Pulsed collector current, $t_p$ limited by $T_{vjmax}$                                                                                                                                                            | $I_{Cpuls}$ | 100.0            | A                |
| Turn off safe operating area $V_{CE} \leq 1200\text{V}$ , $T_{vj} \leq 175^\circ\text{C}$                                                                                                                         | -           | 100.0            | A                |
| Diode forward current, limited by $T_{vjmax}$<br>$T_C = 25^\circ\text{C}$<br>$T_C = 100^\circ\text{C}$                                                                                                            | $I_F$       | 25.0<br>12.5     | A                |
| Diode pulsed current, $t_p$ limited by $T_{vjmax}$                                                                                                                                                                | $I_{Fpuls}$ | 100.0            | A                |
| Gate-emitter voltage                                                                                                                                                                                              | $V_{GE}$    | $\pm 20$         | V                |
| Short circuit withstand time<br>$V_{GE} = 15.0\text{V}$ , $V_{CC} \leq 600\text{V}$<br>Allowed number of short circuits < 1000<br>Time between short circuits: $\geq 1.0\text{s}$<br>$T_{vj} = 175^\circ\text{C}$ | $t_{SC}$    | 10               | $\mu\text{s}$    |
| Power dissipation $T_C = 25^\circ\text{C}$<br>Power dissipation $T_C = 100^\circ\text{C}$                                                                                                                         | $P_{tot}$   | 326.0<br>156.0   | W                |
| Operating junction temperature                                                                                                                                                                                    | $T_{vj}$    | $-40 \dots +175$ | $^\circ\text{C}$ |
| Storage temperature                                                                                                                                                                                               | $T_{stg}$   | $-55 \dots +150$ | $^\circ\text{C}$ |
| Soldering temperature,<br>wave soldering 1.6mm (0.063in.) from case for 10s                                                                                                                                       |             | 260              | $^\circ\text{C}$ |
| Mounting torque, M3 screw<br>Maximum of mounting processes: 3                                                                                                                                                     | $M$         | 0.6              | Nm               |

## Thermal Resistance

| Parameter                                    | Symbol        | Conditions | Max. Value | Unit |
|----------------------------------------------|---------------|------------|------------|------|
| <b>Characteristic</b>                        |               |            |            |      |
| IGBT thermal resistance,<br>junction - case  | $R_{th(j-c)}$ |            | 0.46       | K/W  |
| Diode thermal resistance,<br>junction - case | $R_{th(j-c)}$ |            | 1.49       | K/W  |
| Thermal resistance<br>junction - ambient     | $R_{th(j-a)}$ |            | 40         | K/W  |

**Electrical Characteristic, at  $T_{vj} = 25^{\circ}\text{C}$ , unless otherwise specified**

| Parameter                            | Symbol        | Conditions                                                                                                    | Value       |                      |                 | Unit    |
|--------------------------------------|---------------|---------------------------------------------------------------------------------------------------------------|-------------|----------------------|-----------------|---------|
|                                      |               |                                                                                                               | min.        | typ.                 | max.            |         |
| Static Characteristic                |               |                                                                                                               |             |                      |                 |         |
| Collector-emitter breakdown voltage  | $V_{(BR)CES}$ | $V_{GE} = 0V, I_C = 0.50mA$                                                                                   | 1200        | -                    | -               | V       |
| Collector-emitter saturation voltage | $V_{CEsat}$   | $V_{GE} = 15.0V, I_C = 25.0A$<br>$T_{vj} = 25^{\circ}C$<br>$T_{vj} = 125^{\circ}C$<br>$T_{vj} = 175^{\circ}C$ | -<br>-<br>- | 2.05<br>2.50<br>2.70 | 2.40<br>-<br>-  | V       |
| Diode forward voltage                | $V_F$         | $V_{GE} = 0V, I_F = 12.5A$<br>$T_{vj} = 25^{\circ}C$<br>$T_{vj} = 175^{\circ}C$                               | -<br>-      | 1.80<br>1.85         | 2.35<br>-       | V       |
| Diode forward voltage                | $V_F$         | $V_{GE} = 0V, I_F = 25.0A$<br>$T_{vj} = 25^{\circ}C$<br>$T_{vj} = 125^{\circ}C$<br>$T_{vj} = 175^{\circ}C$    | -<br>-<br>- | 2.40<br>2.60<br>2.60 | 3.05<br>-<br>-  | V       |
| Gate-emitter threshold voltage       | $V_{GE(th)}$  | $I_C = 0.85mA, V_{CE} = V_{GE}$                                                                               | 5.0         | 5.8                  | 6.5             | V       |
| Zero gate voltage collector current  | $I_{CES}$     | $V_{CE} = 1200V, V_{GE} = 0V$<br>$T_{vj} = 25^{\circ}C$<br>$T_{vj} = 175^{\circ}C$                            | -<br>-      | -<br>-               | 250.0<br>2500.0 | $\mu A$ |
| Gate-emitter leakage current         | $I_{GES}$     | $V_{CE} = 0V, V_{GE} = 20V$                                                                                   | -           | -                    | 600             | nA      |
| Transconductance                     | $g_{fs}$      | $V_{CE} = 20V, I_C = 25.0A$                                                                                   | -           | 13.0                 | -               | S       |

**Electrical Characteristic, at  $T_{vj} = 25^{\circ}\text{C}$ , unless otherwise specified**

| Parameter                                                                                               | Symbol      | Conditions                                                                              | Value |       |      | Unit |
|---------------------------------------------------------------------------------------------------------|-------------|-----------------------------------------------------------------------------------------|-------|-------|------|------|
|                                                                                                         |             |                                                                                         | min.  | typ.  | max. |      |
| Dynamic Characteristic                                                                                  |             |                                                                                         |       |       |      |      |
| Input capacitance                                                                                       | $C_{ies}$   | $V_{CE} = 25V, V_{GE} = 0V, f = 1MHz$                                                   | -     | 1430  | -    | pF   |
| Output capacitance                                                                                      | $C_{oes}$   |                                                                                         | -     | 115   | -    |      |
| Reverse transfer capacitance                                                                            | $C_{res}$   |                                                                                         | -     | 75    | -    |      |
| Gate charge                                                                                             | $Q_G$       | $V_{CC} = 960V, I_C = 25.0A,$<br>$V_{GE} = 15V$                                         | -     | 115.0 | -    | nC   |
| Internal emitter inductance<br>measured 5mm (0.197 in.) from<br>case                                    | $L_E$       |                                                                                         | -     | 13.0  | -    | nH   |
| Short circuit collector current<br>Max. 1000 short circuits<br>Time between short circuits: $\geq 1.0s$ | $I_{C(SC)}$ | $V_{GE} = 15.0V, V_{CC} \leq 600V,$<br>$t_{SC} \leq 10\mu s$<br>$T_{vj} = 175^{\circ}C$ | -     | 87    | -    | A    |

**Switching Characteristic, Inductive Load**

| Parameter                                             | Symbol              | Conditions                                                                                                                                                                                                                                                                                                                                        | Value |      |      | Unit |
|-------------------------------------------------------|---------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|------|------|------|
|                                                       |                     |                                                                                                                                                                                                                                                                                                                                                   | min.  | typ. | max. |      |
| IGBT Characteristic, at $T_{vj} = 25^{\circ}\text{C}$ |                     |                                                                                                                                                                                                                                                                                                                                                   |       |      |      |      |
| Turn-on delay time                                    | $t_{d(\text{on})}$  | $T_{vj} = 25^{\circ}\text{C}$ ,<br>$V_{CC} = 600\text{V}$ , $I_C = 25.0\text{A}$ ,<br>$V_{GE} = 0.0/15.0\text{V}$ ,<br>$R_{G(\text{on})} = 23.0\Omega$ , $R_{G(\text{off})} = 23.0\Omega$ ,<br>$L\sigma = 80\text{nH}$ , $C\sigma = 67\text{pF}$<br>$L\sigma$ , $C\sigma$ from Fig. E<br>Energy losses include “tail” and diode reverse recovery. | -     | 27   | -    | ns   |
| Rise time                                             | $t_r$               |                                                                                                                                                                                                                                                                                                                                                   | -     | 41   | -    | ns   |
| Turn-off delay time                                   | $t_{d(\text{off})}$ |                                                                                                                                                                                                                                                                                                                                                   | -     | 277  | -    | ns   |
| Fall time                                             | $t_f$               |                                                                                                                                                                                                                                                                                                                                                   | -     | 17   | -    | ns   |
| Turn-on energy                                        | $E_{\text{on}}$     |                                                                                                                                                                                                                                                                                                                                                   | -     | 1.80 | -    | mJ   |
| Turn-off energy                                       | $E_{\text{off}}$    |                                                                                                                                                                                                                                                                                                                                                   | -     | 0.85 | -    | mJ   |
| Total switching energy                                | $E_{\text{ts}}$     | -                                                                                                                                                                                                                                                                                                                                                 | 2.65  | -    | mJ   |      |

**Diode Characteristic, at  $T_{vj} = 25^{\circ}\text{C}$** 

|                                                                  |              |                                                                                                                           |   |      |   |                  |
|------------------------------------------------------------------|--------------|---------------------------------------------------------------------------------------------------------------------------|---|------|---|------------------|
| Diode reverse recovery time                                      | $t_{rr}$     | $T_{vj} = 25^{\circ}\text{C}$ ,<br>$V_R = 600\text{V}$ ,<br>$I_F = 25.0\text{A}$ ,<br>$di_F/dt = 500\text{A}/\mu\text{s}$ | - | 290  | - | ns               |
| Diode reverse recovery charge                                    | $Q_{rr}$     |                                                                                                                           | - | 1.20 | - | $\mu\text{C}$    |
| Diode peak reverse recovery current                              | $I_{rrm}$    |                                                                                                                           | - | 10.4 | - | A                |
| Diode peak rate of fall of reverse recovery current during $t_b$ | $di_{rr}/dt$ |                                                                                                                           | - | -150 | - | A/ $\mu\text{s}$ |

**Switching Characteristic, Inductive Load**

| Parameter                                              | Symbol              | Conditions                                                                                                                                                                                                                                                                                                                                         | Value |      |      | Unit |
|--------------------------------------------------------|---------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|------|------|------|
|                                                        |                     |                                                                                                                                                                                                                                                                                                                                                    | min.  | typ. | max. |      |
| IGBT Characteristic, at $T_{vj} = 175^{\circ}\text{C}$ |                     |                                                                                                                                                                                                                                                                                                                                                    |       |      |      |      |
| Turn-on delay time                                     | $t_{d(\text{on})}$  | $T_{vj} = 175^{\circ}\text{C}$ ,<br>$V_{CC} = 600\text{V}$ , $I_C = 25.0\text{A}$ ,<br>$V_{GE} = 0.0/15.0\text{V}$ ,<br>$R_{G(\text{on})} = 23.0\Omega$ , $R_{G(\text{off})} = 23.0\Omega$ ,<br>$L\sigma = 80\text{nH}$ , $C\sigma = 67\text{pF}$<br>$L\sigma$ , $C\sigma$ from Fig. E<br>Energy losses include “tail” and diode reverse recovery. | -     | 26   | -    | ns   |
| Rise time                                              | $t_r$               |                                                                                                                                                                                                                                                                                                                                                    | -     | 35   | -    | ns   |
| Turn-off delay time                                    | $t_{d(\text{off})}$ |                                                                                                                                                                                                                                                                                                                                                    | -     | 347  | -    | ns   |
| Fall time                                              | $t_f$               |                                                                                                                                                                                                                                                                                                                                                    | -     | 50   | -    | ns   |
| Turn-on energy                                         | $E_{\text{on}}$     |                                                                                                                                                                                                                                                                                                                                                    | -     | 2.60 | -    | mJ   |
| Turn-off energy                                        | $E_{\text{off}}$    |                                                                                                                                                                                                                                                                                                                                                    | -     | 1.70 | -    | mJ   |
| Total switching energy                                 | $E_{\text{ts}}$     |                                                                                                                                                                                                                                                                                                                                                    | -     | 4.30 | -    | mJ   |

**Diode Characteristic, at  $T_{vj} = 175^{\circ}\text{C}$** 

|                                                                  |              |                                                                                                                            |   |      |   |                  |
|------------------------------------------------------------------|--------------|----------------------------------------------------------------------------------------------------------------------------|---|------|---|------------------|
| Diode reverse recovery time                                      | $t_{rr}$     | $T_{vj} = 175^{\circ}\text{C}$ ,<br>$V_R = 600\text{V}$ ,<br>$I_F = 25.0\text{A}$ ,<br>$di_F/dt = 500\text{A}/\mu\text{s}$ | - | 505  | - | ns               |
| Diode reverse recovery charge                                    | $Q_{rr}$     |                                                                                                                            | - | 2.75 | - | $\mu\text{C}$    |
| Diode peak reverse recovery current                              | $I_{rrm}$    |                                                                                                                            | - | 12.8 | - | A                |
| Diode peak rate of fall of reverse recovery current during $t_b$ | $di_{rr}/dt$ |                                                                                                                            | - | -85  | - | A/ $\mu\text{s}$ |

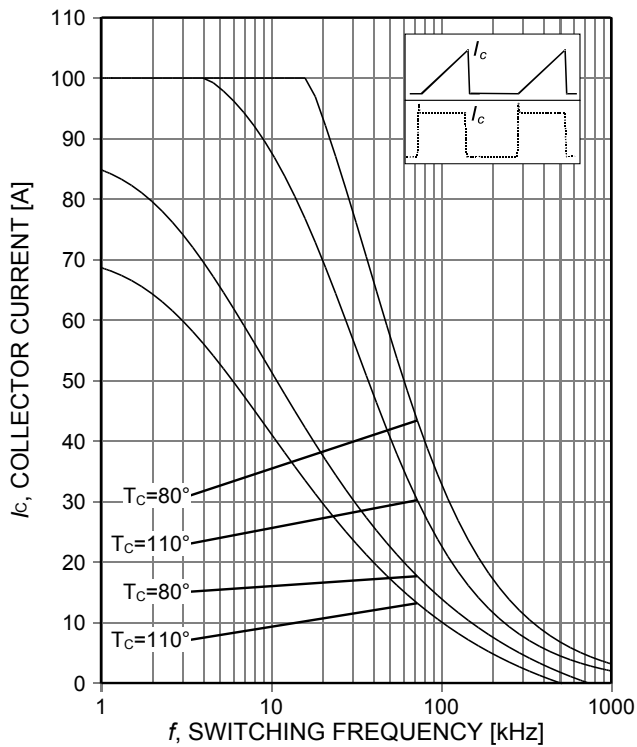


Figure 1. **Collector current as a function of switching frequency**  
( $T_j \leq 175^\circ\text{C}$ ,  $D=0.5$ ,  $V_{CE}=600\text{V}$ ,  $V_{GE}=15/0\text{V}$ ,  $r_G=23\Omega$ )

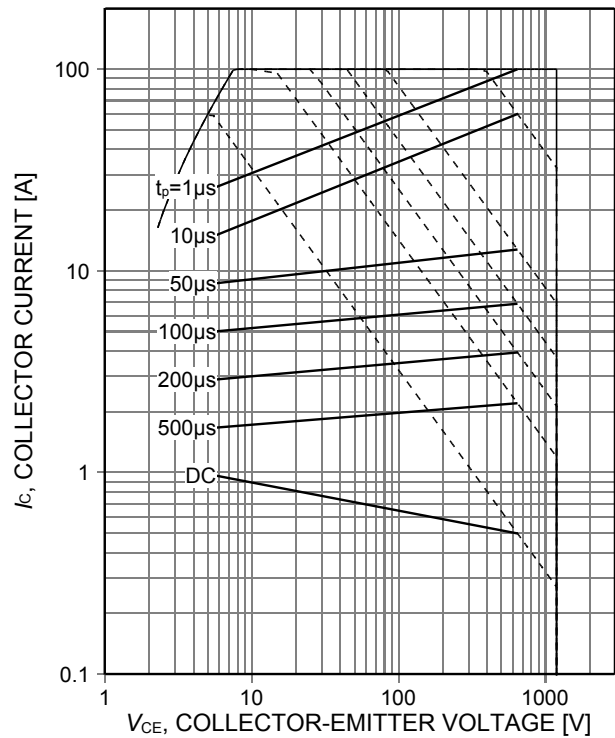


Figure 2. **Forward bias safe operating area**  
( $D=0$ ,  $T_C=25^\circ\text{C}$ ,  $T_j \leq 175^\circ\text{C}$ ;  $V_{GE}=15\text{V}$ )

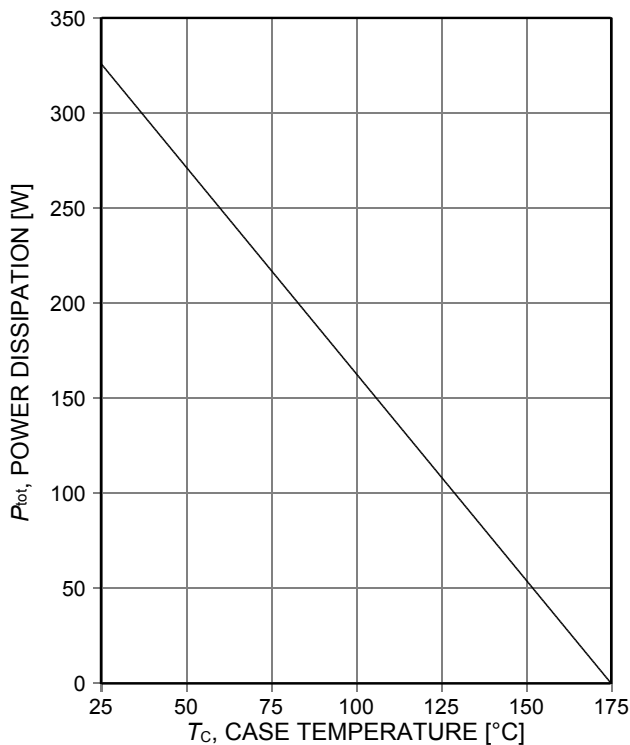


Figure 3. **Power dissipation as a function of case temperature**  
( $T_j \leq 175^\circ\text{C}$ )

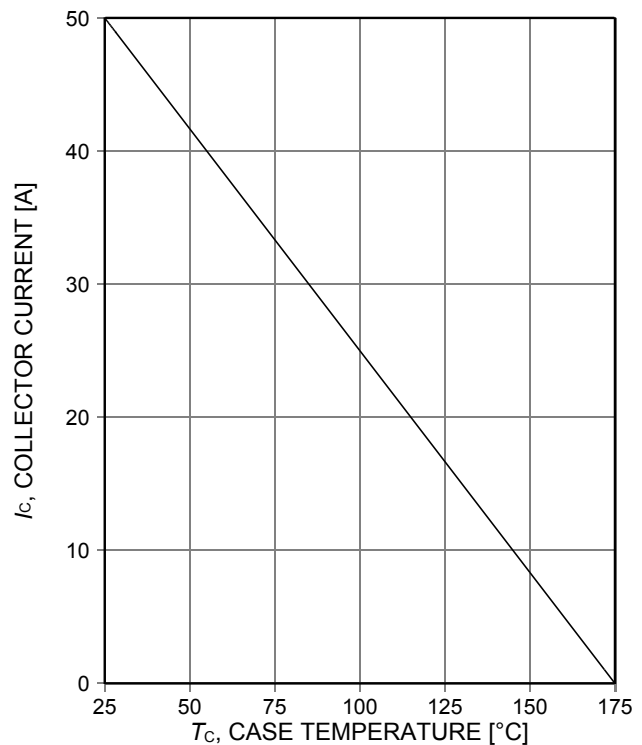


Figure 4. **Collector current as a function of case temperature**  
( $V_{GE} \geq 15\text{V}$ ,  $T_j \leq 175^\circ\text{C}$ )

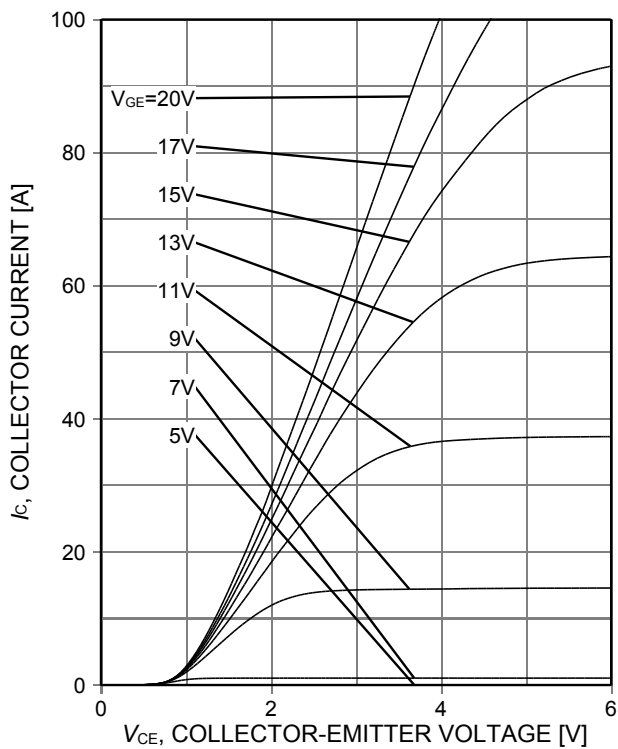


Figure 5. **Typical output characteristic**  
( $T_j=25^\circ\text{C}$ )

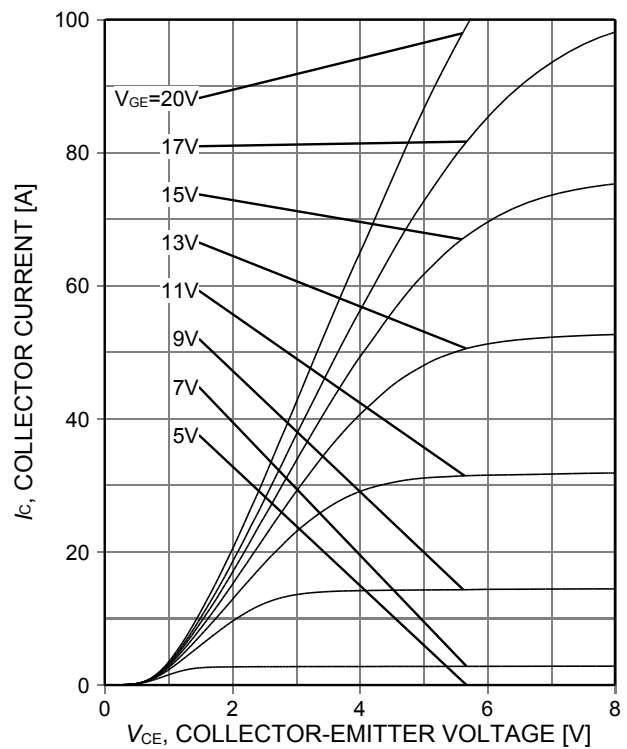


Figure 6. **Typical output characteristic**  
( $T_j=175^\circ\text{C}$ )

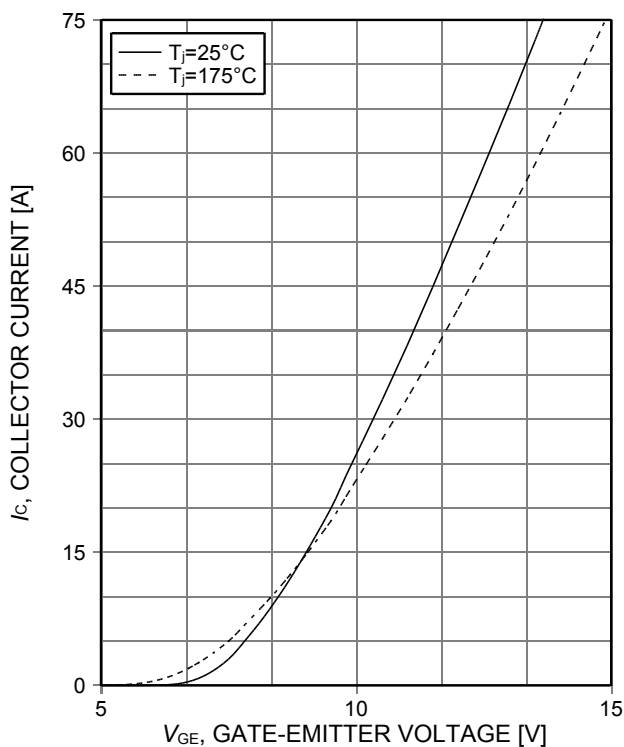


Figure 7. **Typical transfer characteristic**  
( $V_{CE}=20\text{V}$ )

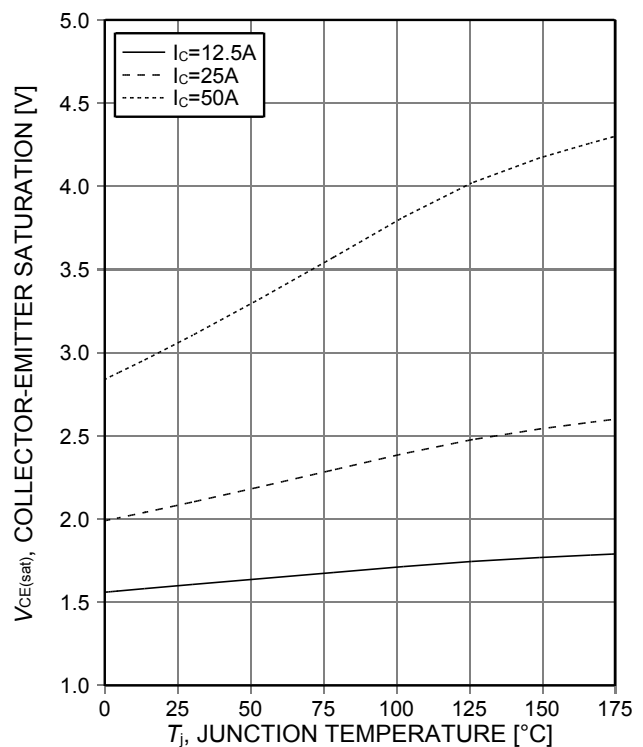


Figure 8. **Typical collector-emitter saturation voltage as a function of junction temperature**  
( $V_{GE}=15\text{V}$ )

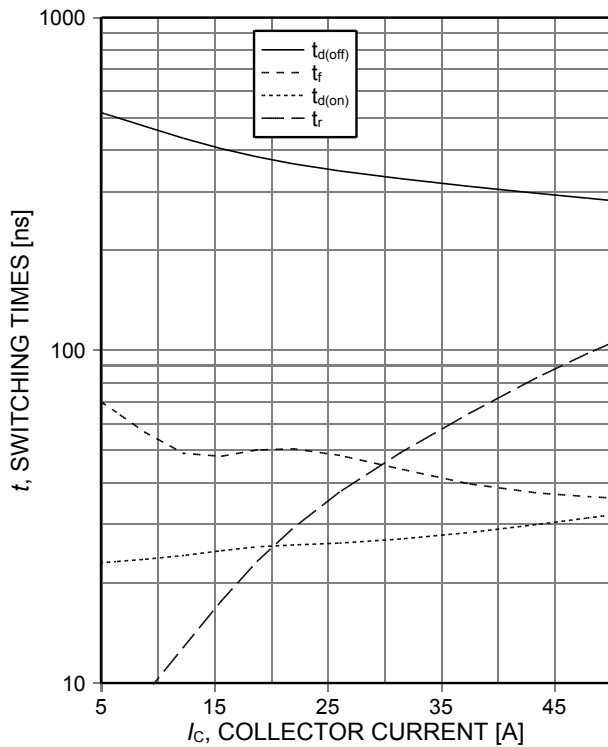


Figure 9. **Typical switching times as a function of collector current**  
(ind. load,  $T_J=175^{\circ}\text{C}$ ,  $V_{CE}=600\text{V}$ ,  $V_{GE}=15/0\text{V}$ ,  $r_G=23\Omega$ , test circuit in Fig. E)

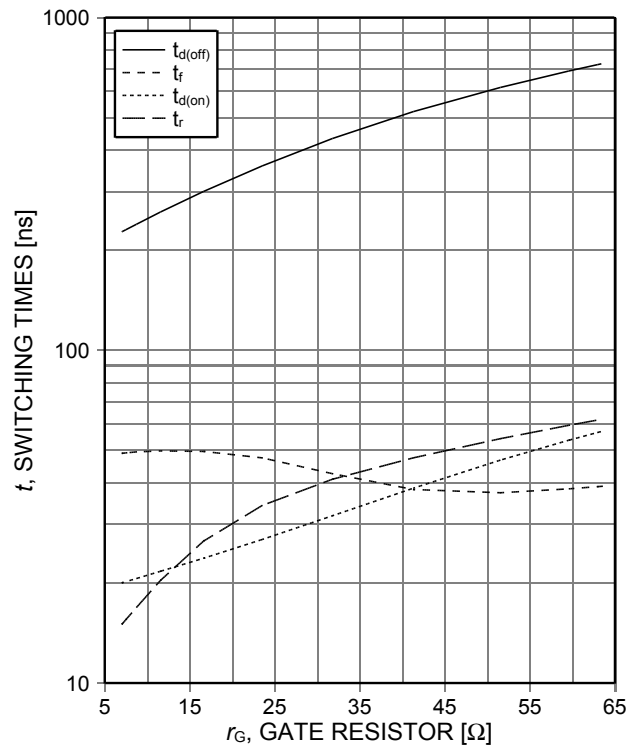


Figure 10. **Typical switching times as a function of gate resistor**  
(ind. load,  $T_J=175^{\circ}\text{C}$ ,  $V_{CE}=600\text{V}$ ,  $V_{GE}=15/0\text{V}$ ,  $I_C=25\text{A}$ , test circuit in Fig. E)

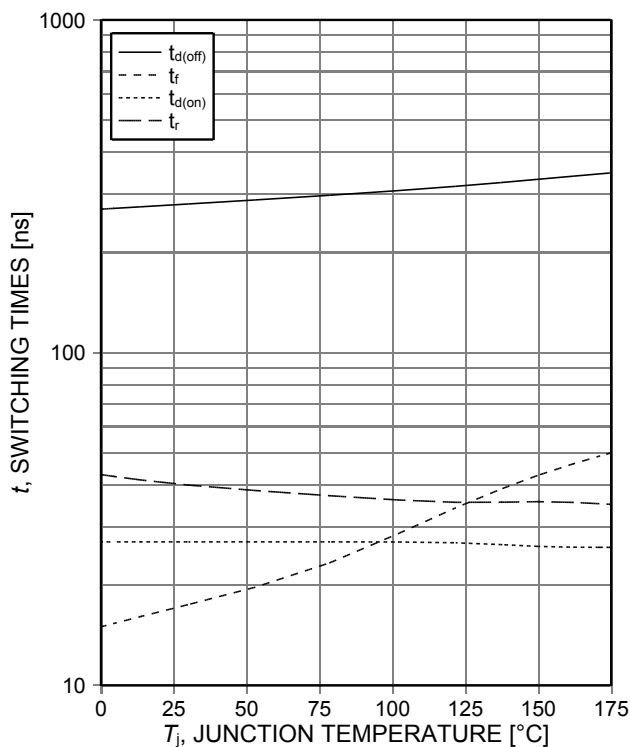


Figure 11. **Typical switching times as a function of junction temperature**  
(ind. load,  $V_{CE}=600\text{V}$ ,  $V_{GE}=15/0\text{V}$ ,  $I_C=25\text{A}$ ,  $r_G=23\Omega$ , test circuit in Fig. E)

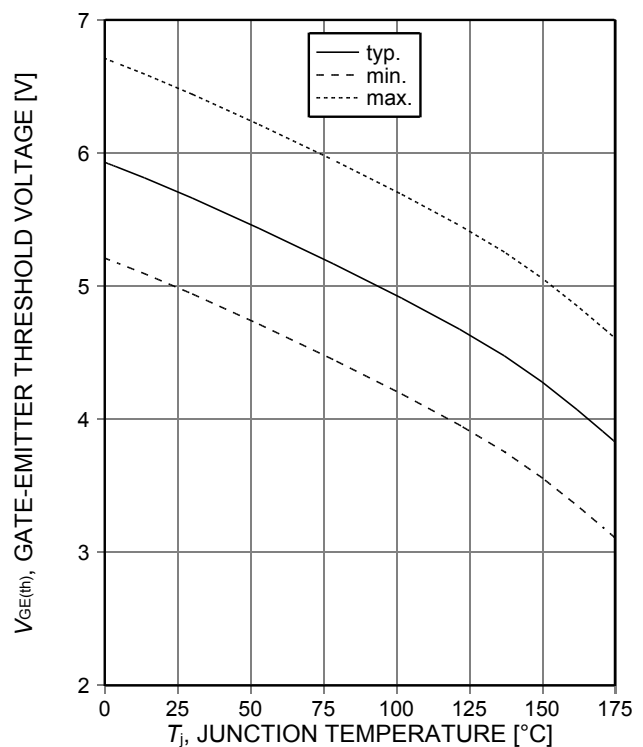


Figure 12. **Gate-emitter threshold voltage as a function of junction temperature**  
( $I_C=0.85\text{mA}$ )

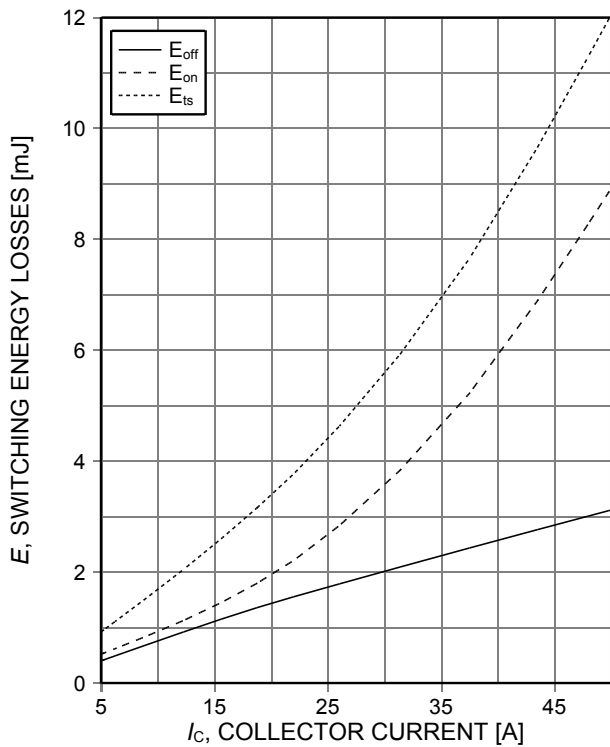


Figure 13. **Typical switching energy losses as a function of collector current**  
(ind. load,  $T_J=175^\circ\text{C}$ ,  $V_{CE}=600\text{V}$ ,  $V_{GE}=15/0\text{V}$ ,  $r_G=23\Omega$ , test circuit in Fig. E)

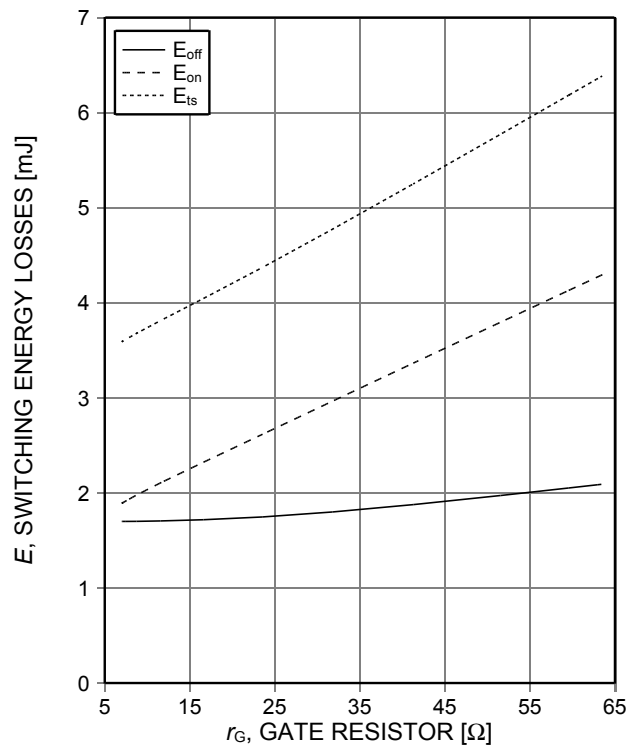


Figure 14. **Typical switching energy losses as a function of gate resistor**  
(ind. load,  $T_J=175^\circ\text{C}$ ,  $V_{CE}=600\text{V}$ ,  $V_{GE}=15/0\text{V}$ ,  $I_C=25\text{A}$ , test circuit in Fig. E)

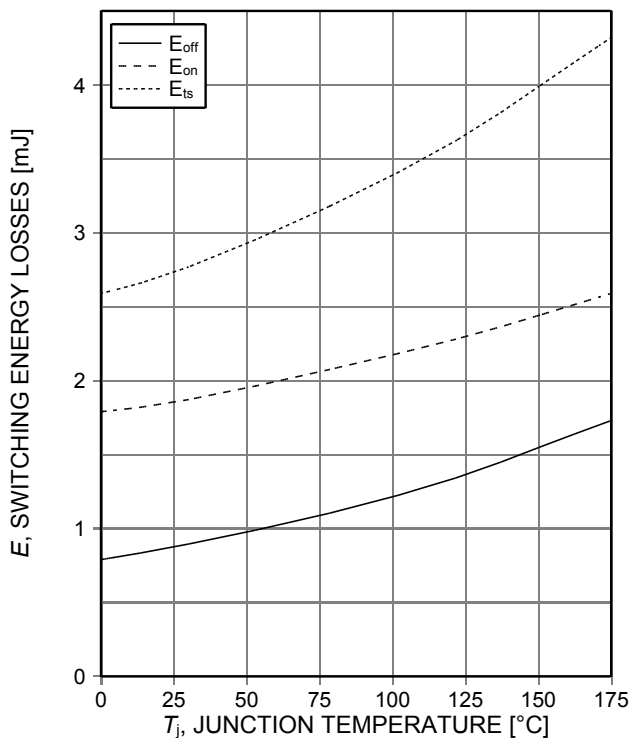


Figure 15. **Typical switching energy losses as a function of junction temperature**  
(ind load,  $V_{CE}=600\text{V}$ ,  $V_{GE}=15/0\text{V}$ ,  $I_C=25\text{A}$ ,  $r_G=23\Omega$ , test circuit in Fig. E)

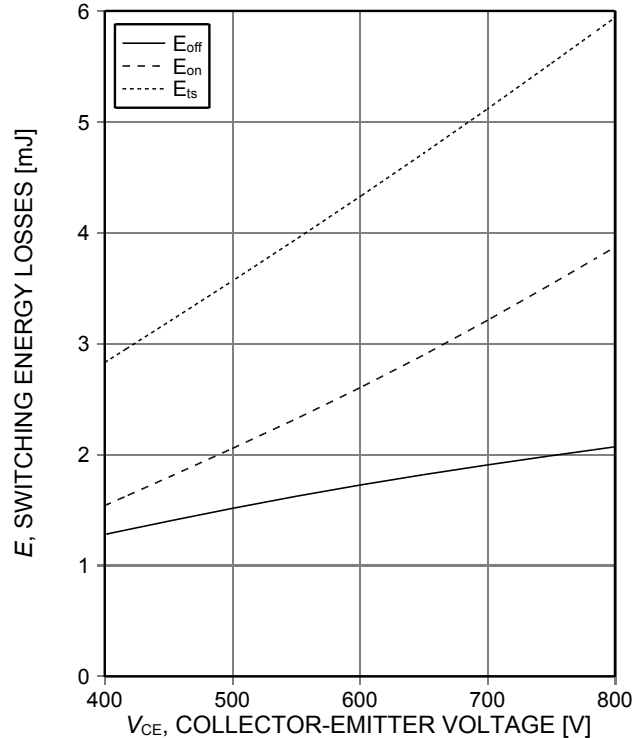


Figure 16. **Typical switching energy losses as a function of collector emitter voltage**  
(ind. load,  $T_J=175^\circ\text{C}$ ,  $V_{GE}=15/0\text{V}$ ,  $I_C=25\text{A}$ ,  $r_G=23\Omega$ , test circuit in Fig. E)

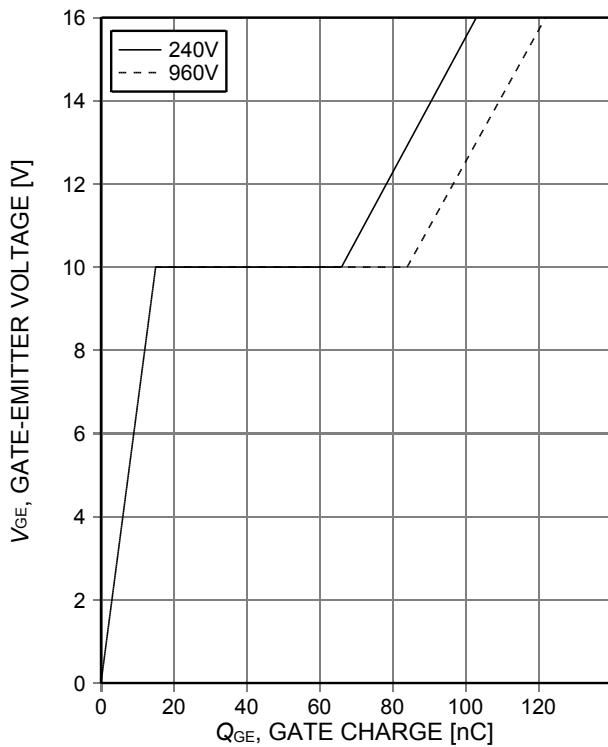


Figure 17. **Typical gate charge**  
( $I_C=25A$ )

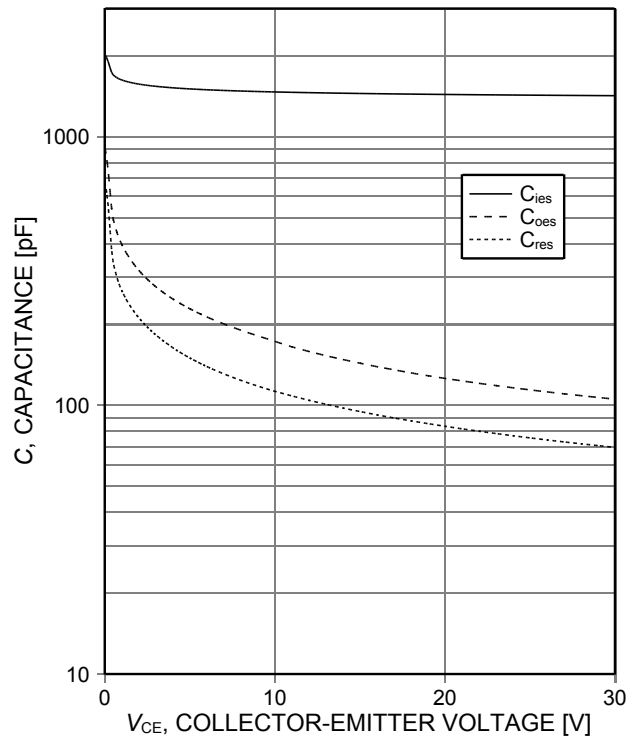


Figure 18. **Typical capacitance as a function of collector-emitter voltage**  
( $V_{GE}=0V$ ,  $f=1MHz$ )

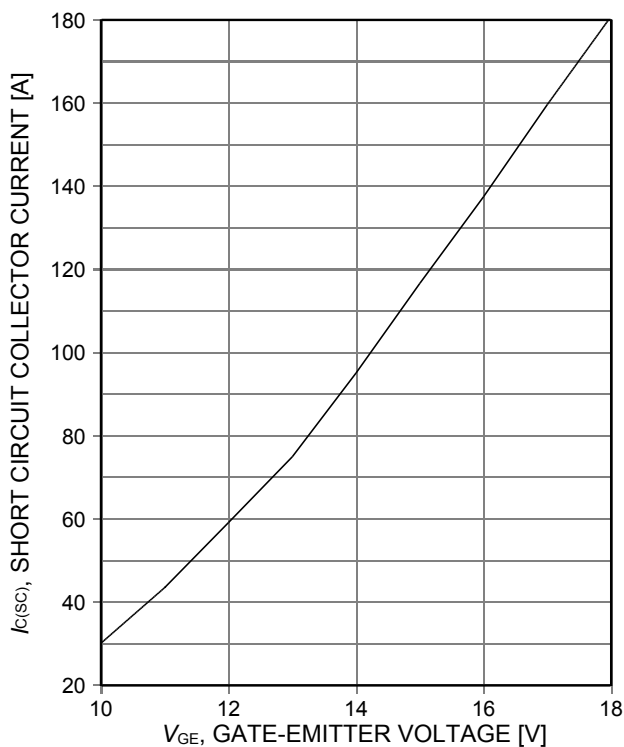


Figure 19. **Typical short circuit collector current as a function of gate-emitter voltage**  
( $V_{CE} \leq 600V$ , start at  $T_j=25^\circ C$ )

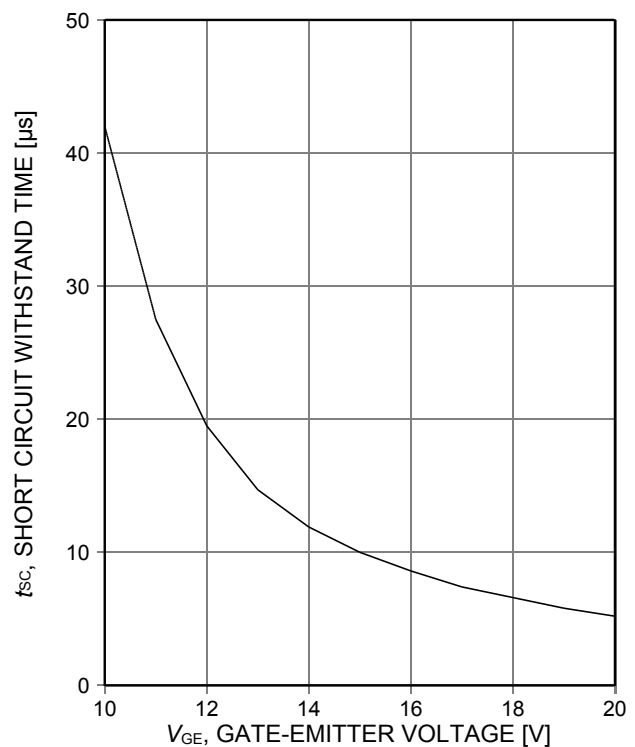


Figure 20. **Short circuit withstand time as a function of gate-emitter voltage**  
( $V_{CE} \leq 600V$ , start at  $T_j \leq 150^\circ C$ )

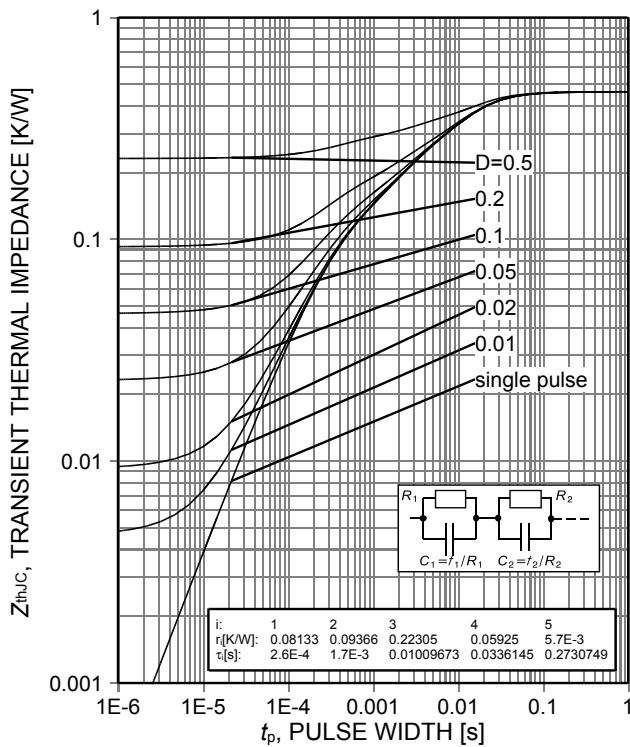


Figure 21. IGBT transient thermal impedance ( $D=t_p/T$ )

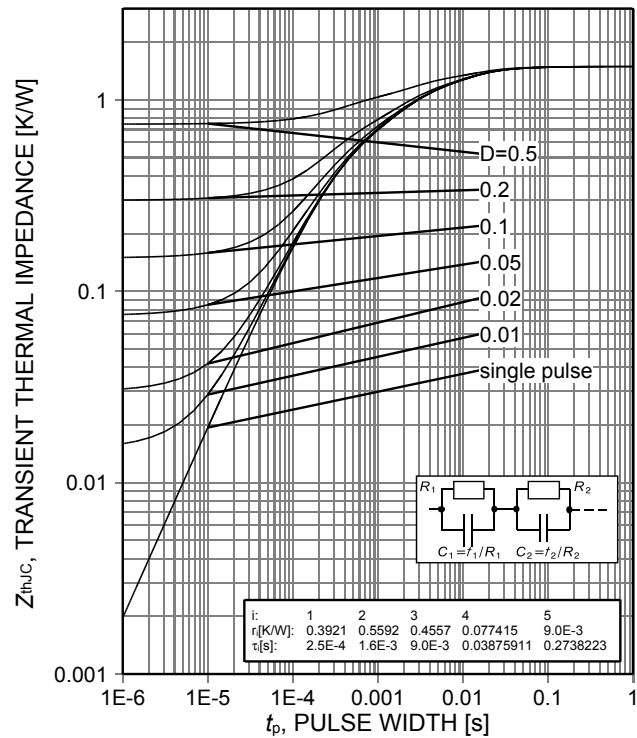


Figure 22. Diode transient thermal impedance as a function of pulse width ( $D=t_p/T$ )

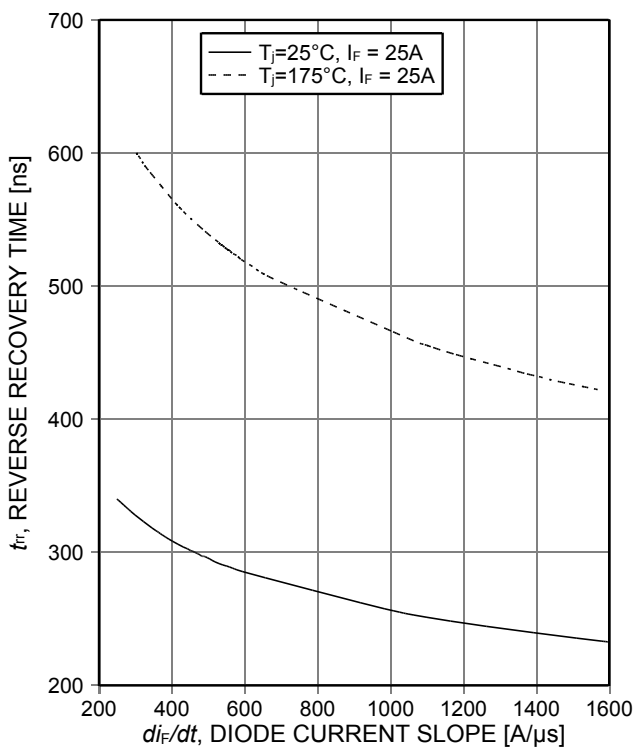


Figure 23. Typical reverse recovery time as a function of diode current slope ( $V_R=600V$ )

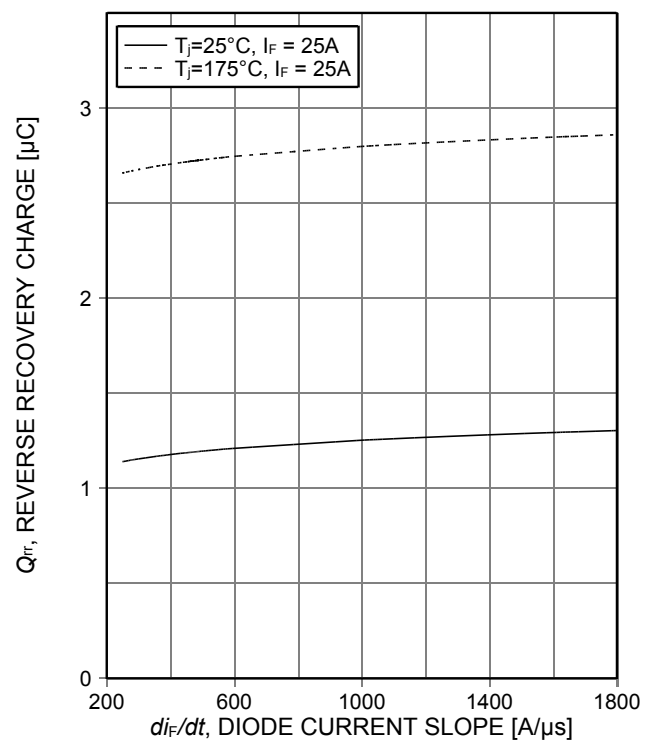


Figure 24. Typical reverse recovery charge as a function of diode current slope ( $V_R=600V$ )

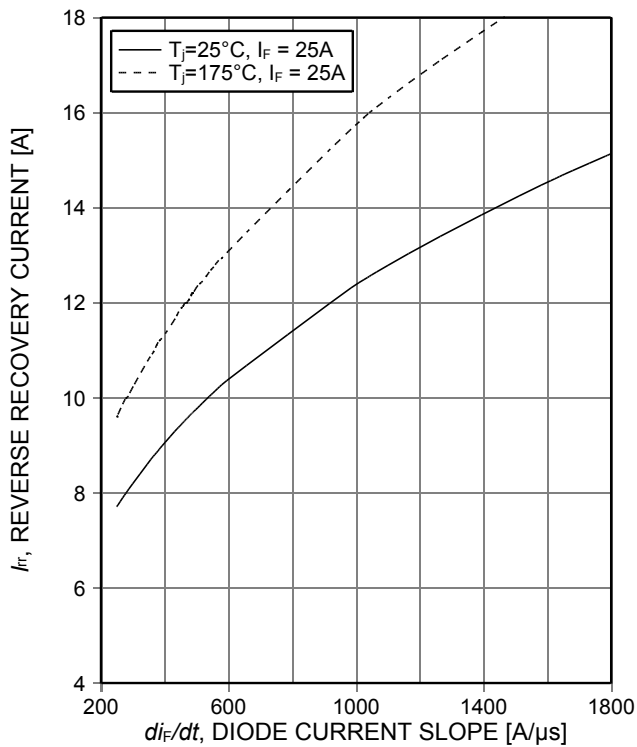


Figure 25. **Typical reverse recovery current as a function of diode current slope**  
( $V_R=600V$ )

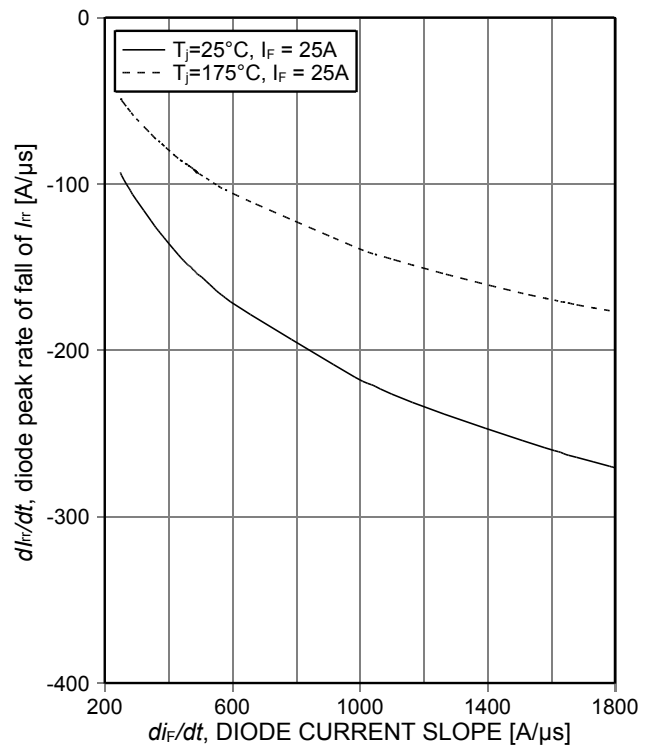


Figure 26. **Typical diode peak rate of fall of reverse recovery current as a function of diode current slope**  
( $V_R=600V$ )

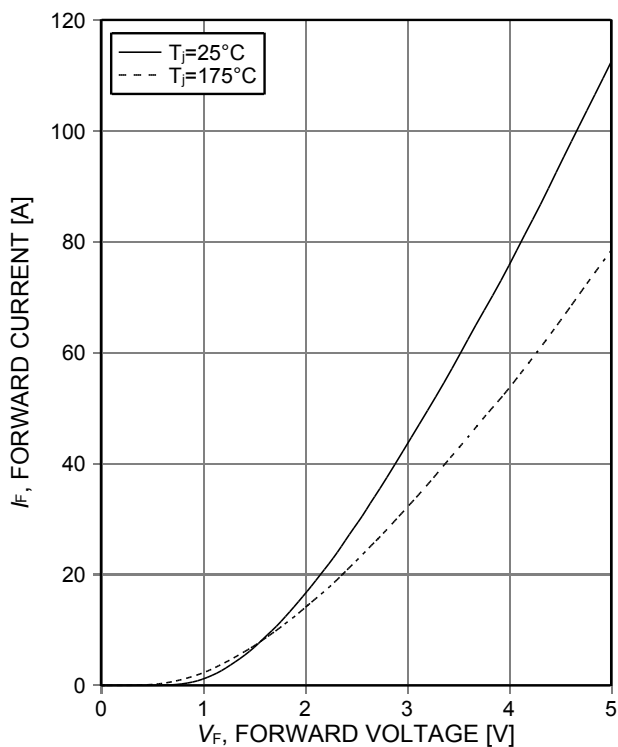


Figure 27. **Typical diode forward current as a function of forward voltage**

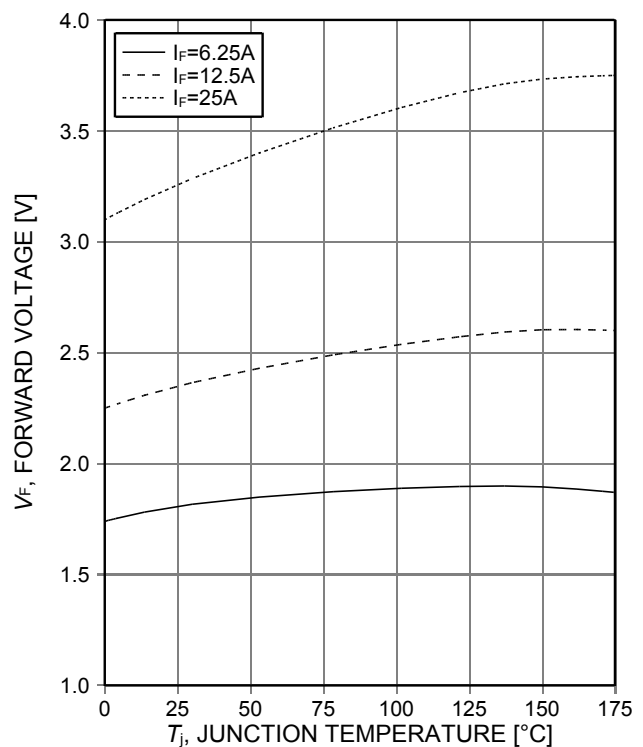


Figure 28. **Typical diode forward voltage as a function of junction temperature**

## PG-TO247-3



| DIM | MILLIMETERS |       | INCHES      |       |
|-----|-------------|-------|-------------|-------|
|     | MIN         | MAX   | MIN         | MAX   |
| A   | 4.83        | 5.21  | 0.190       | 0.205 |
| A1  | 2.27        | 2.54  | 0.089       | 0.100 |
| A2  | 1.85        | 2.16  | 0.073       | 0.085 |
| b   | 1.07        | 1.33  | 0.042       | 0.052 |
| b1  | 1.90        | 2.41  | 0.075       | 0.095 |
| b2  | 1.90        | 2.16  | 0.075       | 0.085 |
| b3  | 2.87        | 3.38  | 0.113       | 0.133 |
| b4  | 2.87        | 3.13  | 0.113       | 0.123 |
| c   | 0.55        | 0.68  | 0.022       | 0.027 |
| D   | 20.80       | 21.10 | 0.819       | 0.831 |
| D1  | 16.25       | 17.65 | 0.640       | 0.695 |
| D2  | 0.95        | 1.35  | 0.037       | 0.053 |
| E   | 15.70       | 16.13 | 0.618       | 0.635 |
| E1  | 13.10       | 14.15 | 0.516       | 0.557 |
| E2  | 3.68        | 5.10  | 0.145       | 0.201 |
| E3  | 1.00        | 2.60  | 0.039       | 0.102 |
| e   | 5.44 (BSC)  |       | 0.214 (BSC) |       |
| N   | 3           |       | 3           |       |
| L   | 19.80       | 20.32 | 0.780       | 0.800 |
| L1  | 4.10        | 4.47  | 0.161       | 0.176 |
| ØP  | 3.50        | 3.70  | 0.138       | 0.146 |
| Q   | 5.49        | 6.00  | 0.216       | 0.236 |
| S   | 6.04        | 6.30  | 0.238       | 0.248 |

|                                                                                                                     |
|---------------------------------------------------------------------------------------------------------------------|
| <b>DOCUMENT NO.</b><br>Z8B00003327                                                                                  |
| <b>SCALE</b><br>0 5 7.5mm                                                                                           |
| <b>EUROPEAN PROJECTION</b><br> |
| <b>ISSUE DATE</b><br>09-07-2010                                                                                     |
| <b>REVISION</b><br>05                                                                                               |

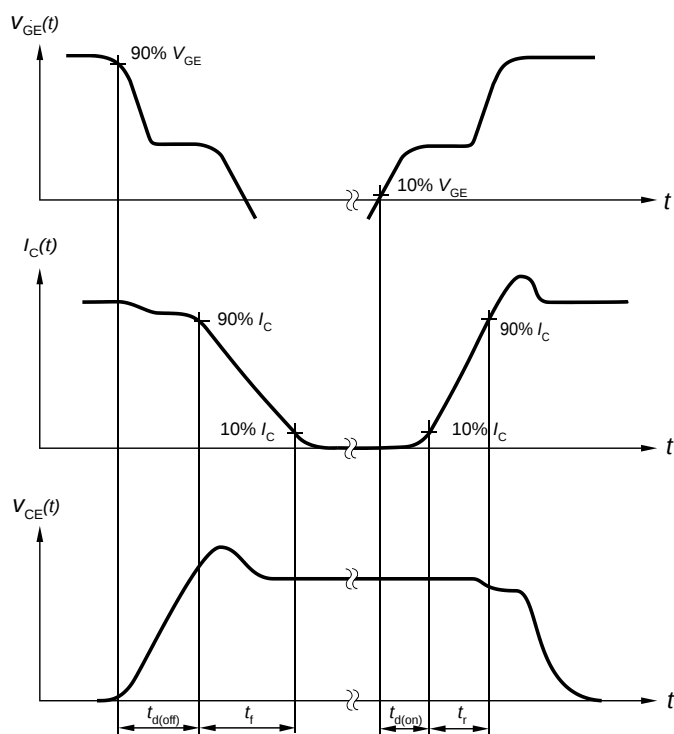


Figure A. Definition of switching times

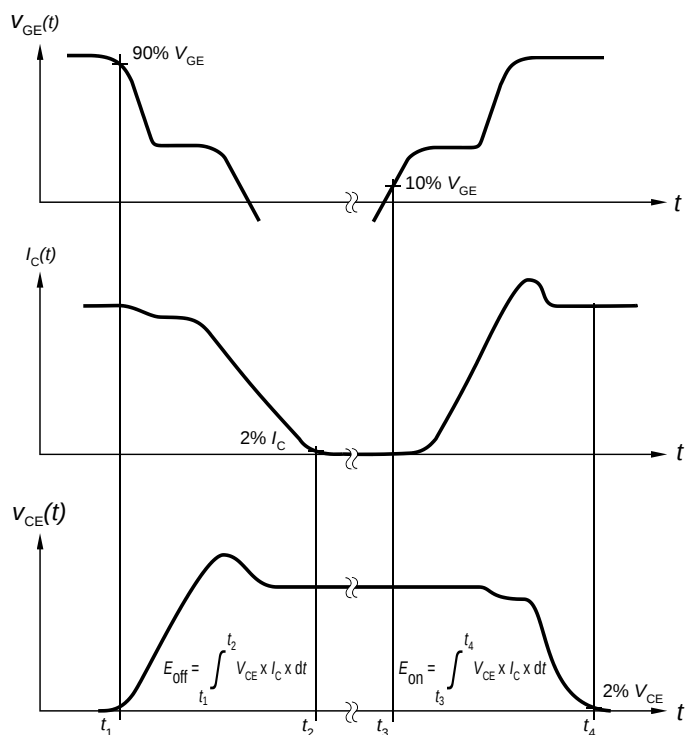
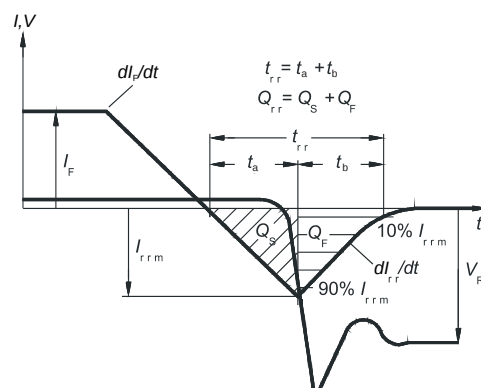


Figure B. Definition of switching losses



**Figure C. Definition of diode switching characteristics**

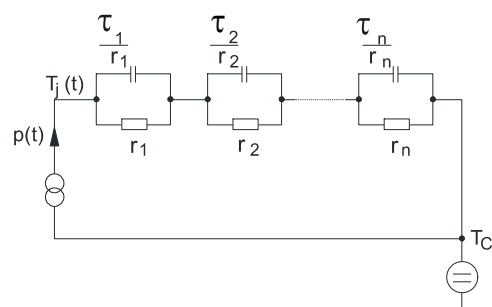


Figure D. Thermal equivalent circuit

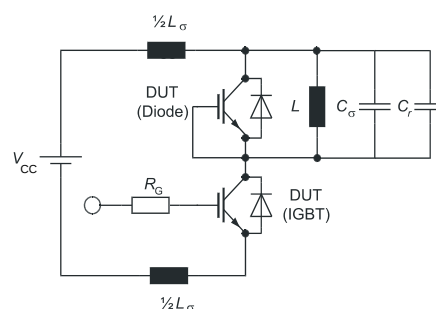


Figure E. **Dynamic test circuit**  
Parasitic inductance  $L_{\sigma}$ ,  
parasitic capacitor  $L_{\sigma}$ ,  
relief capacitor  $C_r$ ,  
(only for ZVT switching)

## Revision History

IKW25N120H3

Revision: 2014-12-01, Rev. 2.1

## Previous Revision

| Revision | Date       | Subjects (major changes since last revision) |
|----------|------------|----------------------------------------------|
| 1.1      | 2009-11-27 | -                                            |
| 1.2      | 2010-02-10 | -                                            |
| 2.1      | 2014-12-01 | Final data sheet                             |

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