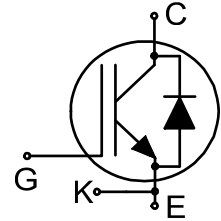


Sixth generation, high speed soft switching series

High speed soft switching TRENCHSTOP™ IGBT 6 in Trench and Fieldstop technology copacked with soft and fast recovery anti-parallel diode

#### Features:

- 1200V TRENCHSTOP™ IGBT6 technology offering:
- High efficiency in hard switching and resonant topologies
  - Easy paralleling capability due to positive temperature coefficient in  $V_{CEsat}$
  - Low EMI
  - Low Gate Charge  $Q_g$
  - Very soft, fast recovery full current anti-parallel diode
  - Maximum junction temperature 175°C
  - Pb-free lead plating; RoHS compliant
  - Complete product spectrum and PSpice Models:  
<http://www.infineon.com/igbt/>



#### Applications:

- Industrial UPS
- Charger
- Energy storage
- Three-level Solar String Inverter
- Welding

#### Product Validation:

Qualified for industrial applications according to the relevant tests of JEDEC47/20/22



#### Key Performance and Package Parameters

| Type         | $V_{CE}$ | $I_C$ | $V_{CEsat}$ , $T_{vj}=25^\circ\text{C}$ | $T_{vjmax}$ | Marking | Package      |
|--------------|----------|-------|-----------------------------------------|-------------|---------|--------------|
| IKY40N120CS6 | 1200V    | 40A   | 1.85V                                   | 175°C       | K40MCS6 | PG-TO247-4-2 |

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## Sixth generation, high speed soft switching series

**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, $T_{vj} \geq 25^{\circ}\text{C}$                                                | $V_{CE}$    | 1200           | V                  |
| DC collector current, limited by $T_{vjmax}$<br>$T_c = 25^{\circ}\text{C}$<br>$T_c = 100^{\circ}\text{C}$  | $I_C$       | 80.0<br>40.0   | A                  |
| Pulsed collector current, $t_p$ limited by $T_{vjmax}$                                                     | $I_{Cpuls}$ | 160.0          | A                  |
| Turn off safe operating area $V_{CE} \leq 1200\text{V}$ , $T_{vj} \leq 175^{\circ}\text{C}$                | -           | 160.0          | A                  |
| Diode forward current, limited by $T_{vjmax}$<br>$T_c = 25^{\circ}\text{C}$<br>$T_c = 100^{\circ}\text{C}$ | $I_F$       | 80.0<br>40.0   | A                  |
| Diode pulsed current, $t_p$ limited by $T_{vjmax}$                                                         | $I_{Fpuls}$ | 160.0          | A                  |
| Gate-emitter voltage<br>Transient Gate-emitter voltage ( $t_p \leq 0.5\mu\text{s}$ , $D < 0.001$ )         | $V_{GE}$    | $\pm 20$<br>25 | V                  |
| Power dissipation $T_c = 25^{\circ}\text{C}$<br>Power dissipation $T_c = 100^{\circ}\text{C}$              | $P_{tot}$   | 500.0<br>250.0 | W                  |
| Operating junction temperature                                                                             | $T_{vj}$    | -40...+175     | $^{\circ}\text{C}$ |
| Storage temperature                                                                                        | $T_{stg}$   | -55...+150     | $^{\circ}\text{C}$ |
| Soldering temperature,<br>wave soldering 1.6mm (0.063in.) from case for 10s                                |             | 260            | $^{\circ}\text{C}$ |

**Thermal Resistance**

| Parameter | Symbol | Conditions | Value |      |      | Unit |
|-----------|--------|------------|-------|------|------|------|
|           |        |            | min.  | typ. | max. |      |

**R<sub>th</sub> Characteristics**

|                                              |               |  |   |   |      |     |
|----------------------------------------------|---------------|--|---|---|------|-----|
| IGBT thermal resistance,<br>junction - case  | $R_{th(j-c)}$ |  | - | - | 0.30 | K/W |
| Diode thermal resistance,<br>junction - case | $R_{th(j-c)}$ |  | - | - | 0.78 | K/W |
| Thermal resistance<br>junction - ambient     | $R_{th(j-a)}$ |  | - | - | 40   | K/W |

Sixth generation, high speed soft switching series

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

| Parameter                            | Symbol              | Conditions                                                                                                                                                                               | Value       |                      |                | Unit          |
|--------------------------------------|---------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|----------------------|----------------|---------------|
|                                      |                     |                                                                                                                                                                                          | min.        | typ.                 | max.           |               |
| Static Characteristic                |                     |                                                                                                                                                                                          |             |                      |                |               |
| Collector-emitter saturation voltage | $V_{\text{CEsat}}$  | $V_{\text{GE}} = 15.0\text{V}$ , $I_{\text{C}} = 40.0\text{A}$<br>$T_{\text{vj}} = 25^{\circ}\text{C}$<br>$T_{\text{vj}} = 125^{\circ}\text{C}$<br>$T_{\text{vj}} = 175^{\circ}\text{C}$ | -<br>-<br>- | 1.85<br>2.15<br>2.25 | 2.15<br>-<br>- | V             |
| Diode forward voltage                | $V_{\text{F}}$      | $V_{\text{GE}} = 0\text{V}$ , $I_{\text{F}} = 40.0\text{A}$<br>$T_{\text{vj}} = 25^{\circ}\text{C}$<br>$T_{\text{vj}} = 175^{\circ}\text{C}$                                             | -<br>-      | 2.20<br>2.25         | 2.55<br>-      | V             |
| Gate-emitter threshold voltage       | $V_{\text{GE(th)}}$ | $I_{\text{C}} = 1.90\text{mA}$ , $V_{\text{CE}} = V_{\text{GE}}$                                                                                                                         | 5.1         | 5.7                  | 6.3            | V             |
| Zero gate voltage collector current  | $I_{\text{CES}}$    | $V_{\text{CE}} = 1200\text{V}$ , $V_{\text{GE}} = 0\text{V}$<br>$T_{\text{vj}} = 25^{\circ}\text{C}$<br>$T_{\text{vj}} = 175^{\circ}\text{C}$                                            | -<br>-      | -<br>1600            | 850<br>-       | $\mu\text{A}$ |
| Gate-emitter leakage current         | $I_{\text{GES}}$    | $V_{\text{CE}} = 0\text{V}$ , $V_{\text{GE}} = 20\text{V}$                                                                                                                               | -           | -                    | 600            | nA            |
| Transconductance                     | $g_{\text{fs}}$     | $V_{\text{CE}} = 20\text{V}$ , $I_{\text{C}} = 40.0\text{A}$                                                                                                                             | -           | 32.0                 | -              | 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                                                    | $C_{ies}$ | $V_{CE} = 25V, V_{GE} = 0V, f = 1MHz$      | -     | 2700  | -    | pF   |
| Output capacitance                                                   | $C_{oes}$ |                                            | -     | 185   | -    |      |
| Reverse transfer capacitance                                         | $C_{res}$ |                                            | -     | 120   | -    |      |
| Gate charge                                                          | $Q_G$     | $V_{CC} = 960V, I_C = 40.0A, V_{GE} = 15V$ | -     | 285.0 | -    | nC   |
| Internal emitter inductance<br>measured 5mm (0.197 in.) from<br>case | $L_E$     |                                            | -     | 13.0  | -    | nH   |

**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>$V_{CC} = 600\text{V}$ , $I_C = 40.0\text{A}$ ,<br>$V_{GE} = 0.0/15.0\text{V}$ ,<br>$R_{G(\text{on})} = 9.0\Omega$ , $R_{G(\text{off})} = 9.0\Omega$ ,<br>$L_{\sigma} = 70\text{nH}$ , $C_{\sigma} = 67\text{pF}$<br>$L_{\sigma}$ , $C_{\sigma}$ from Fig. E<br>Energy losses include “tail” and<br>diode reverse recovery. | -     | 27   | -    | ns   |
| Rise time                                             | $t_r$               |                                                                                                                                                                                                                                                                                                                                                                | -     | 27   | -    | ns   |
| Turn-off delay time                                   | $t_{d(\text{off})}$ |                                                                                                                                                                                                                                                                                                                                                                | -     | 315  | -    | ns   |
| Fall time                                             | $t_f$               |                                                                                                                                                                                                                                                                                                                                                                | -     | 27   | -    | ns   |
| Turn-on energy                                        | $E_{\text{on}}$     |                                                                                                                                                                                                                                                                                                                                                                | -     | 1.45 | -    | mJ   |
| Turn-off energy                                       | $E_{\text{off}}$    |                                                                                                                                                                                                                                                                                                                                                                | -     | 1.55 | -    | mJ   |
| Total switching energy                                | $E_{\text{ts}}$     |                                                                                                                                                                                                                                                                                                                                                                | -     | 3.00 | -    | mJ   |

Sixth generation, high speed soft switching series

#### 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>$I_F = 40.0\text{A}$ ,<br>$di_F/dt = 1650\text{A}/\mu\text{s}$ ,<br>$L\sigma = 70\text{nH}$ ,<br>$C\sigma = 67\text{pF}$ | - | 255  | - | ns                     |
| Diode reverse recovery charge                                    | $Q_{rr}$     |                                                                                                                                                                                      | - | 2.60 | - | $\mu\text{C}$          |
| Diode peak reverse recovery current                              | $I_{rrm}$    |                                                                                                                                                                                      | - | 39.0 | - | A                      |
| Diode peak rate of fall of reverse recovery current during $t_b$ | $di_{rr}/dt$ |                                                                                                                                                                                      | - | -450 | - | $\text{A}/\mu\text{s}$ |

#### 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     | $t_{d(on)}$  | $T_{vj} = 175^{\circ}\text{C}$ ,<br>$V_{CC} = 600\text{V}$ , $I_C = 40.0\text{A}$ ,<br>$V_{GE} = 0.0/15.0\text{V}$ ,<br>$R_{G(on)} = 9.0\Omega$ , $R_{G(off)} = 9.0\Omega$ ,<br>$L\sigma = 70\text{nH}$ , $C\sigma = 67\text{pF}$<br>Energy losses include "tail" and diode reverse recovery. | - | 27   | - | ns |
| Rise time              | $t_r$        |                                                                                                                                                                                                                                                                                               | - | 29   | - | ns |
| Turn-off delay time    | $t_{d(off)}$ |                                                                                                                                                                                                                                                                                               | - | 390  | - | ns |
| Fall time              | $t_f$        |                                                                                                                                                                                                                                                                                               | - | 55   | - | ns |
| Turn-on energy         | $E_{on}$     |                                                                                                                                                                                                                                                                                               | - | 2.05 | - | mJ |
| Turn-off energy        | $E_{off}$    |                                                                                                                                                                                                                                                                                               | - | 2.95 | - | mJ |
| Total switching energy | $E_{ts}$     |                                                                                                                                                                                                                                                                                               | - | 5.00 | - | 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>$I_F = 40.0\text{A}$ ,<br>$di_F/dt = 1650\text{A}/\mu\text{s}$ ,<br>$L\sigma = 70\text{nH}$ ,<br>$C\sigma = 67\text{pF}$ | - | 360  | - | ns                     |
| Diode reverse recovery charge                                    | $Q_{rr}$     |                                                                                                                                                                                       | - | 5.30 | - | $\mu\text{C}$          |
| Diode peak reverse recovery current                              | $I_{rrm}$    |                                                                                                                                                                                       | - | 53.0 | - | A                      |
| Diode peak rate of fall of reverse recovery current during $t_b$ | $di_{rr}/dt$ |                                                                                                                                                                                       | - | -580 | - | $\text{A}/\mu\text{s}$ |

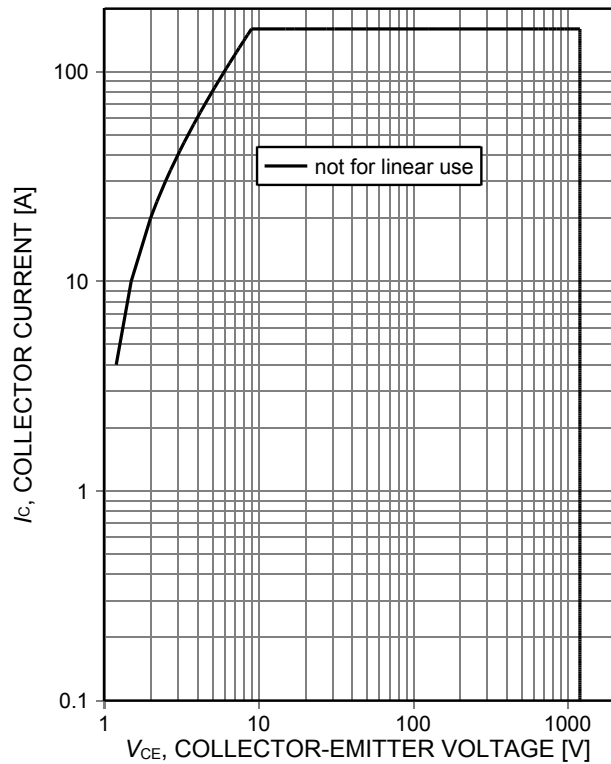


Figure 1. **Forward bias safe operating area**  
( $D=0$ ,  $T_{vj} \leq 175^\circ\text{C}$ ;  $V_{GE}=15\text{V}$ , pulse width limited by  $T_{vjmax}$ )

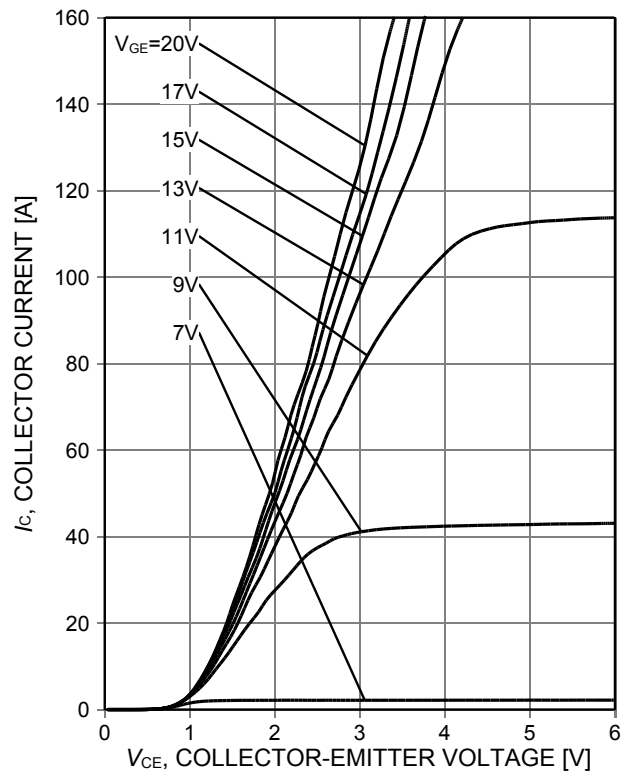


Figure 2. **Typical output characteristic**  
( $T_{vj}=25^\circ\text{C}$ )

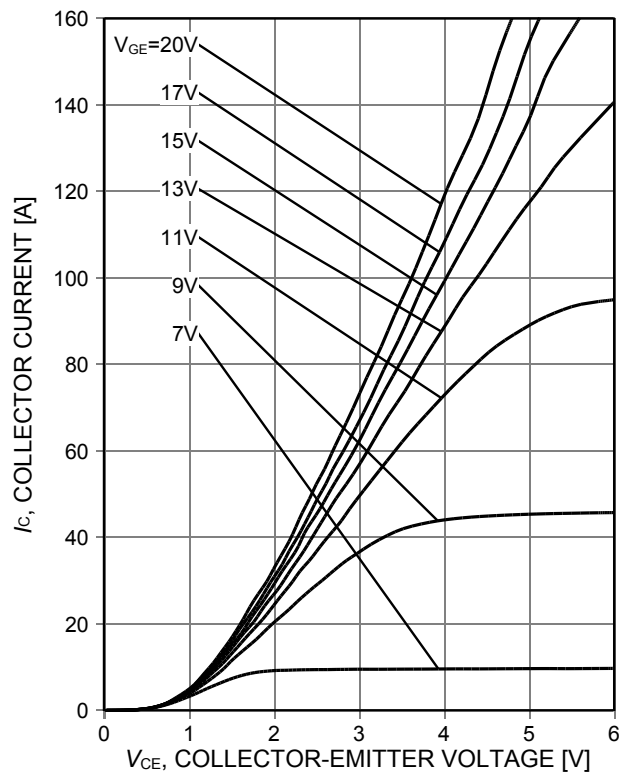


Figure 3. **Typical output characteristic**  
( $T_{vj}=175^\circ\text{C}$ )

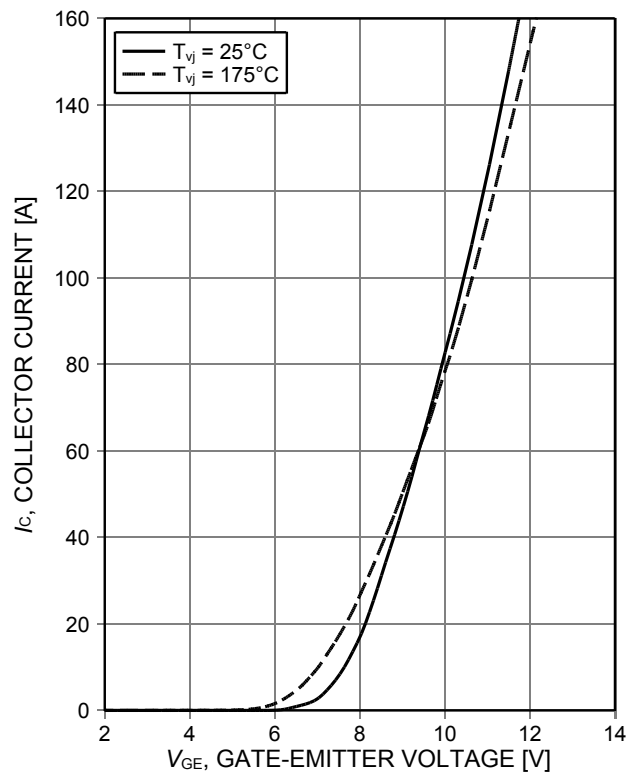


Figure 4. **Typical transfer characteristic**  
( $V_{CE}=20\text{V}$ )

## Sixth generation, high speed soft switching series

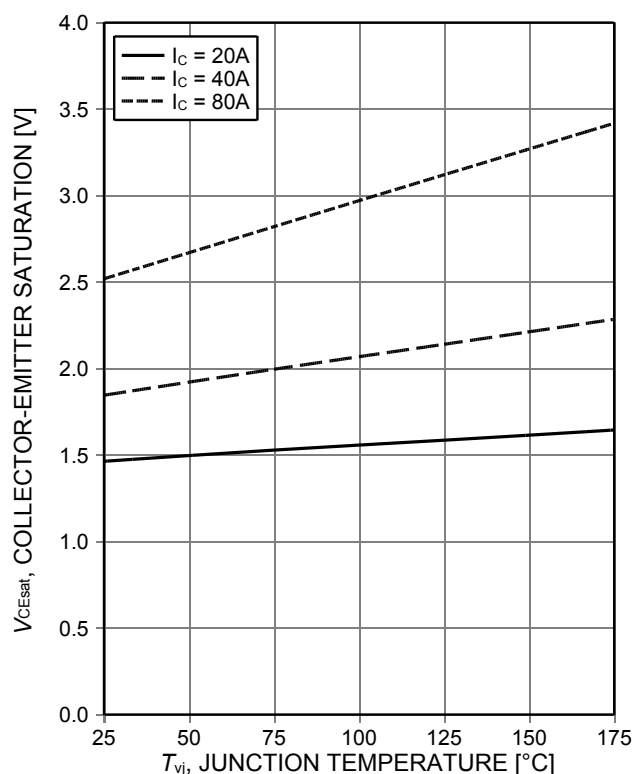


Figure 5. **Typical collector-emitter saturation voltage as a function of junction temperature**  
( $V_{GE}=15V$ )

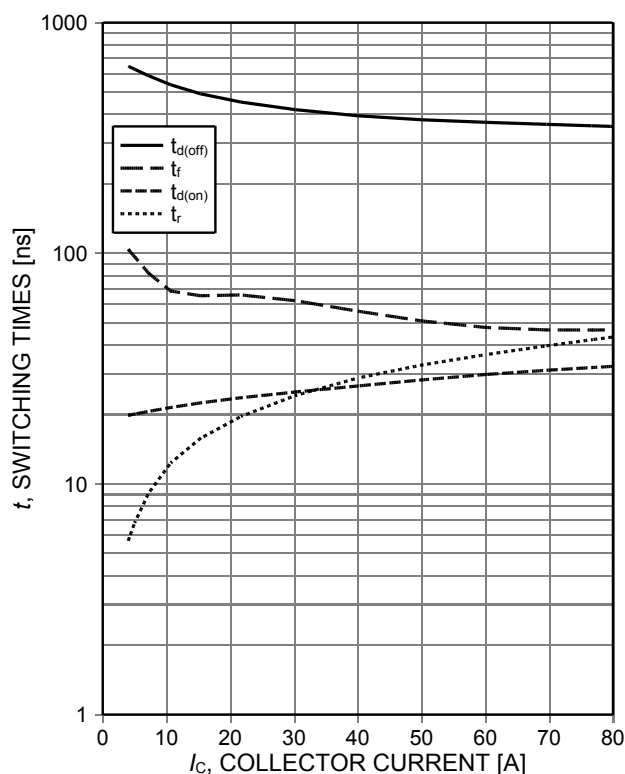


Figure 6. **Typical switching times as a function of collector current**  
(inductive load,  $T_{vj}=175^{\circ}C$ ,  $V_{CE}=600V$ ,  $V_{GE}=0/15V$ ,  $R_G=9\Omega$ , Dynamic test circuit in Figure E)

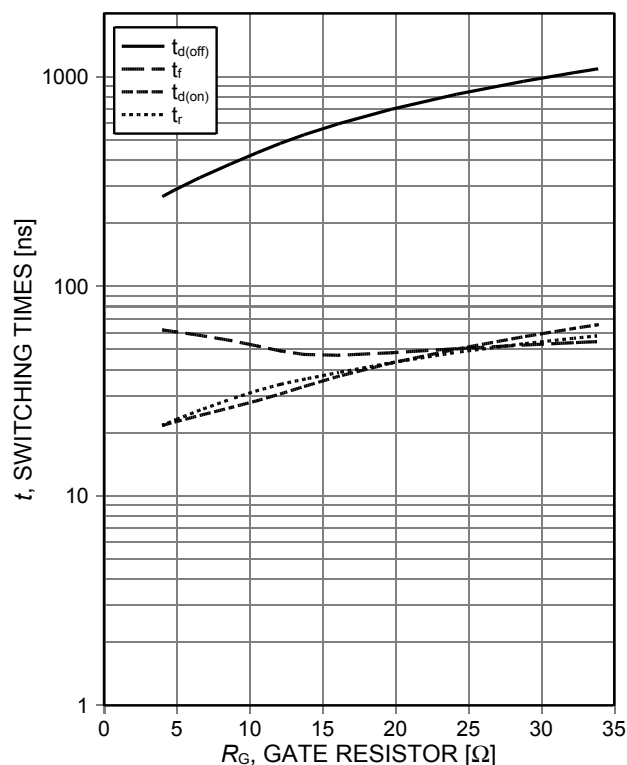


Figure 7. **Typical switching times as a function of gate resistor**  
(inductive load,  $T_{vj}=175^{\circ}C$ ,  $V_{CE}=600V$ ,  $V_{GE}=0/15V$ ,  $I_C=40A$ , Dynamic test circuit in Figure E)

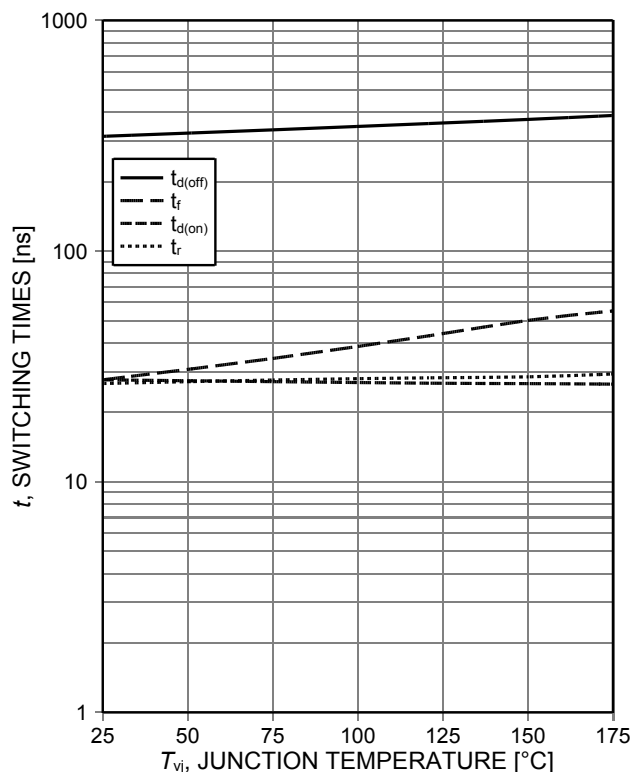


Figure 8. **Typical switching times as a function of junction temperature**  
(inductive load,  $V_{CE}=600V$ ,  $V_{GE}=0/15V$ ,  $I_C=40A$ ,  $R_G=9\Omega$ , Dynamic test circuit in Figure E)

## Sixth generation, high speed soft switching series

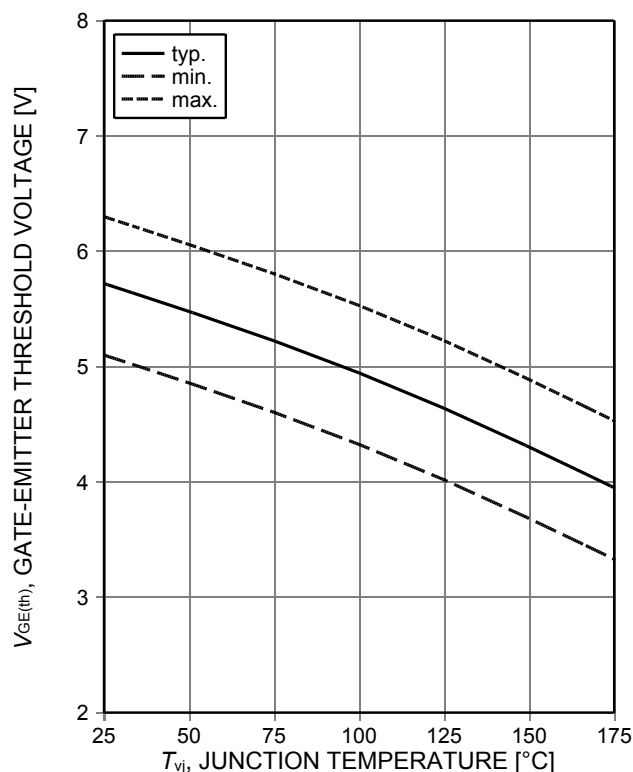


Figure 9. Gate-emitter threshold voltage as a function of junction temperature ( $I_C=1.9\text{mA}$ )

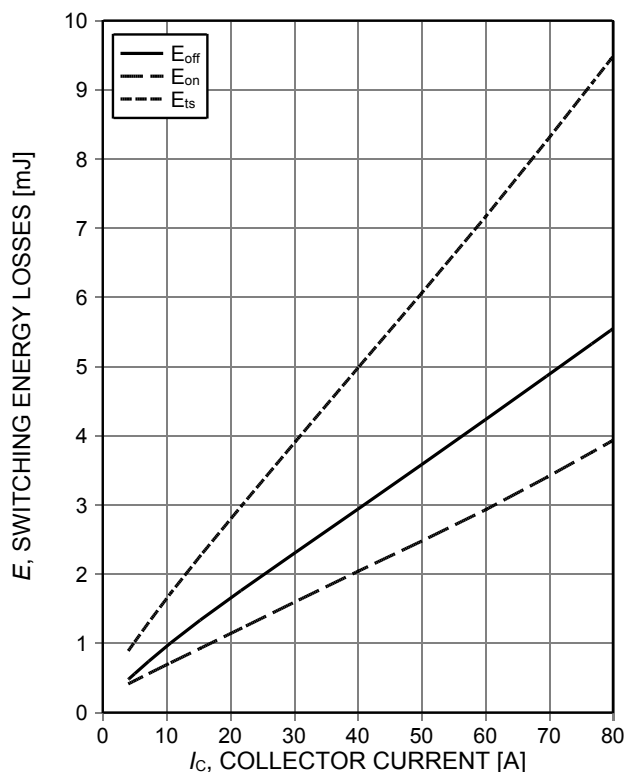


Figure 10. Typical switching energy losses as a function of collector current (inductive load,  $T_{vj}=175^\circ\text{C}$ ,  $V_{CE}=600\text{V}$ ,  $V_{GE}=0/15\text{V}$ ,  $R_G=9\Omega$ , Dynamic test circuit in Figure E)

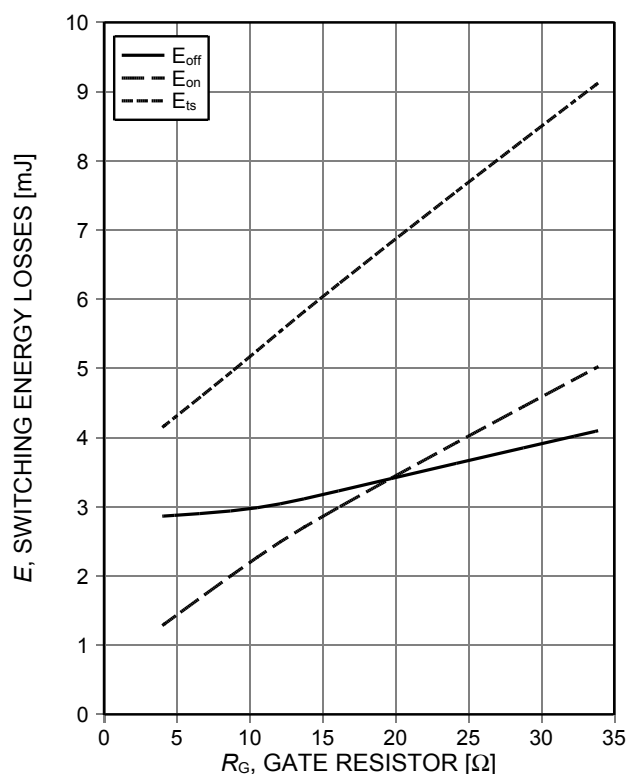


Figure 11. Typical switching energy losses as a function of gate resistor (inductive load,  $T_{vj}=175^\circ\text{C}$ ,  $V_{CE}=600\text{V}$ ,  $V_{GE}=0/15\text{V}$ ,  $I_C=40\text{A}$ , Dynamic test circuit in Figure E)

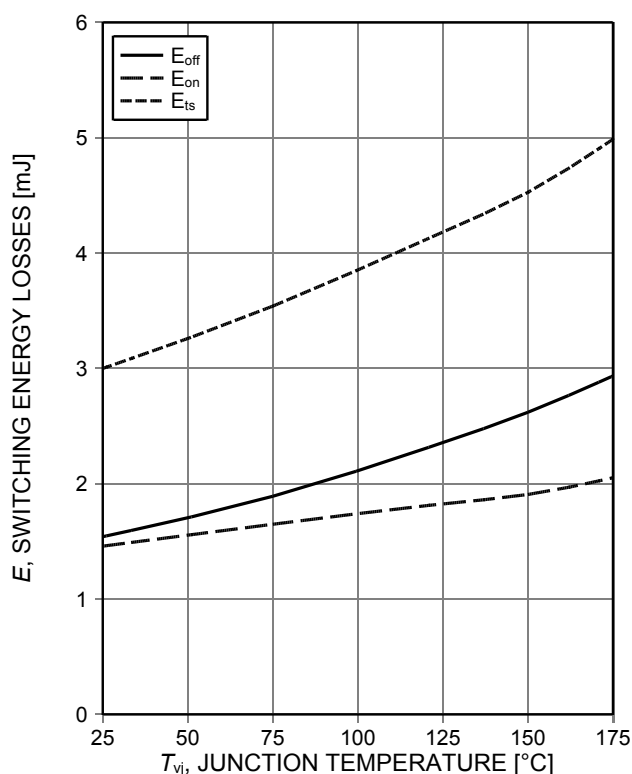


Figure 12. Typical switching energy losses as a function of junction temperature (inductive load,  $V_{CE}=600\text{V}$ ,  $V_{GE}=0/15\text{V}$ ,  $I_C=40\text{A}$ ,  $R_G=9\Omega$ , Dynamic test circuit in Figure E)

## Sixth generation, high speed soft switching series

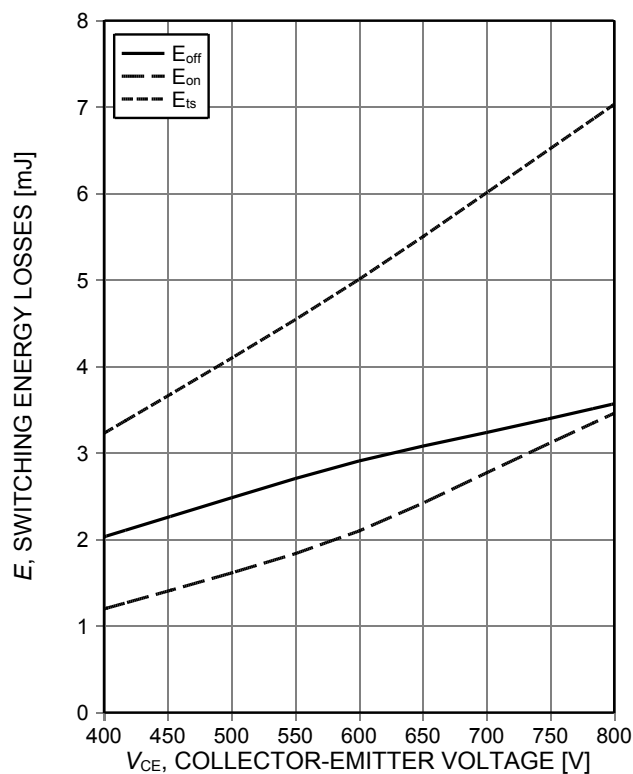


Figure 13. **Typical switching energy losses as a function of collector emitter voltage**  
(inductive load,  $T_{vj}=175^{\circ}\text{C}$ ,  $V_{GE}=0/15\text{V}$ ,  $I_C=40\text{A}$ ,  $R_G=9\Omega$ , Dynamic test circuit in Figure E)

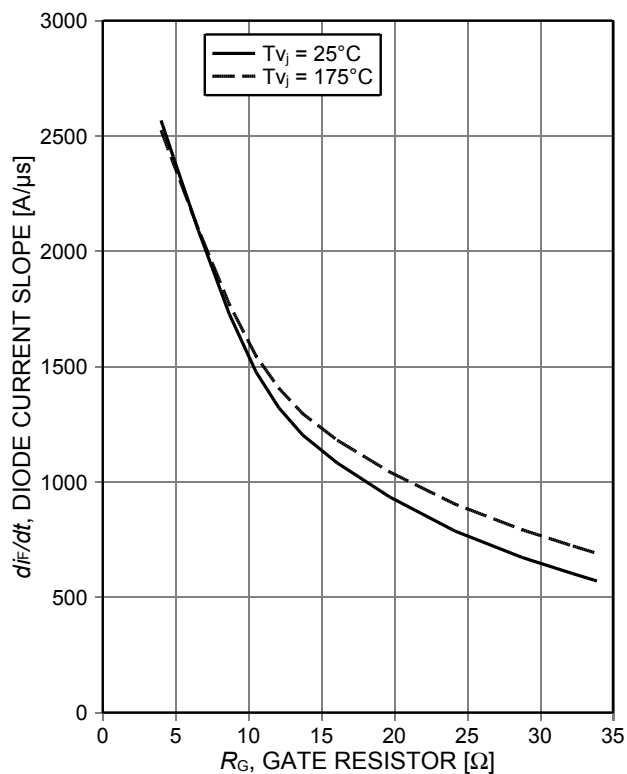


Figure 14. **Typical diode current slope as a function of gate resistor**  
(inductive load,  $V_{CE}=600\text{V}$ ,  $V_{GE}=0/15\text{V}$ ,  $I_C=40\text{A}$ , Dynamic test circuit in Figure E)

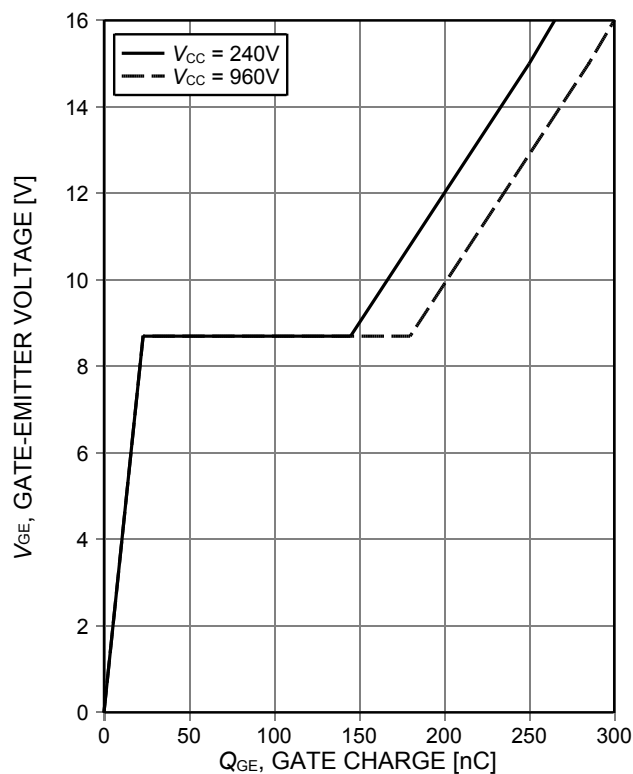


Figure 15. **Typical gate charge**  
( $I_C=40\text{A}$ )

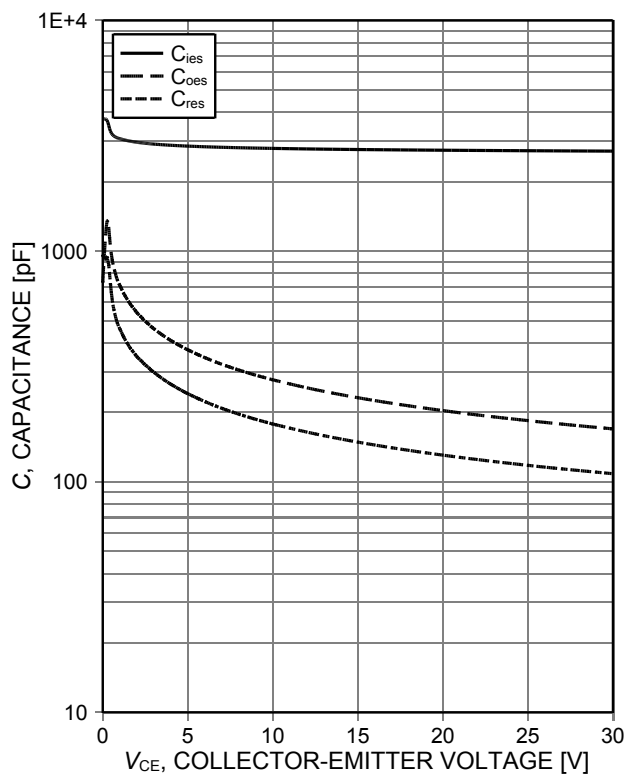
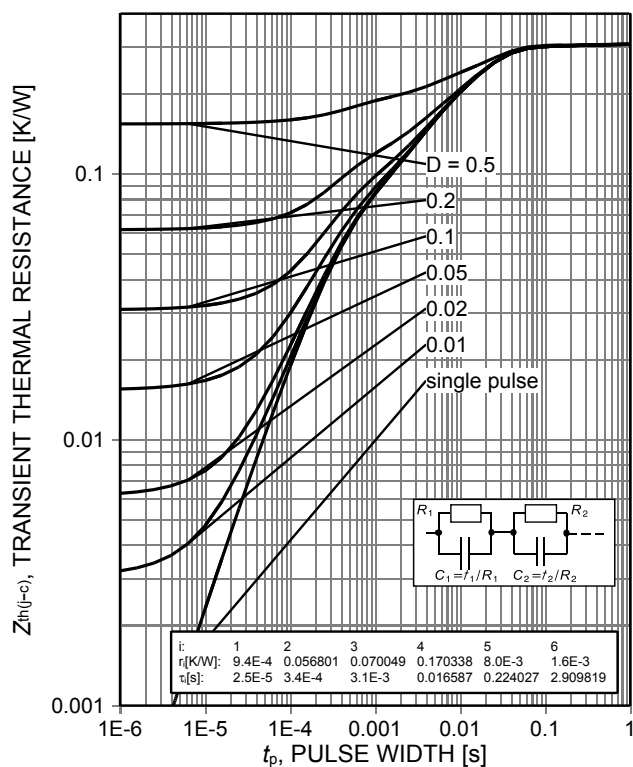
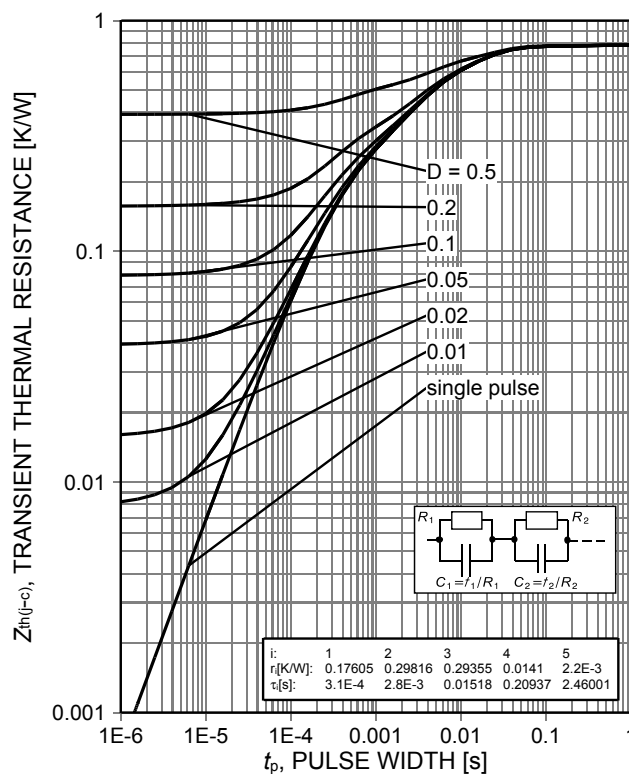
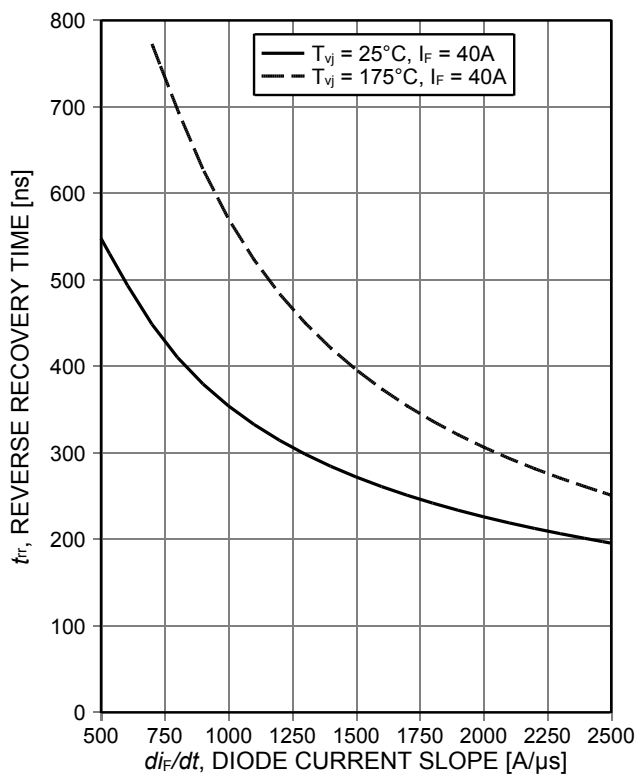
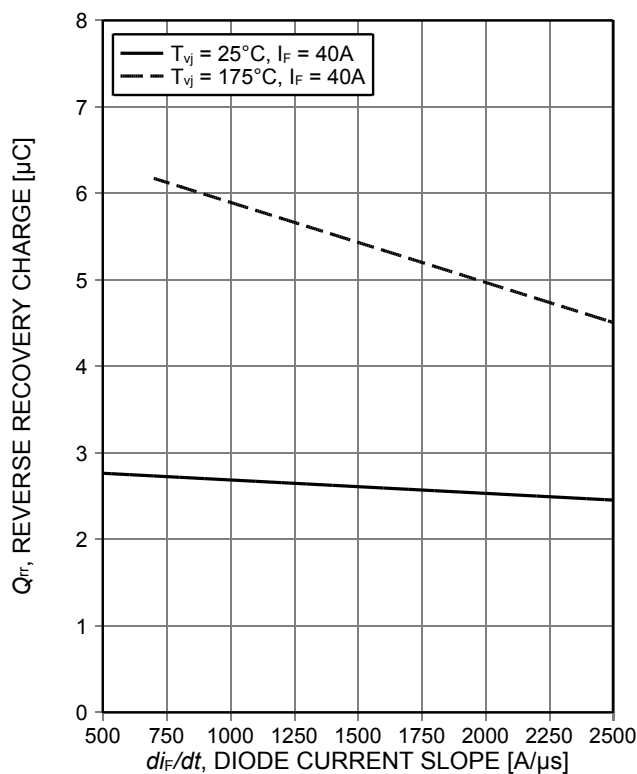


Figure 16. **Typical capacitance as a function of collector-emitter voltage**  
( $V_{GE}=0\text{V}$ ,  $f=1\text{MHz}$ )

## Sixth generation, high speed soft switching series

Figure 17. IGBT transient thermal resistance ( $D=t_p/T$ )Figure 18. Diode transient thermal impedance as a function of pulse width ( $D=t_p/T$ )Figure 19. Typical reverse recovery time as a function of diode current slope ( $V_R=600V$ )Figure 20. Typical reverse recovery charge as a function of diode current slope ( $V_R=600V$ )

## Sixth generation, high speed soft switching series

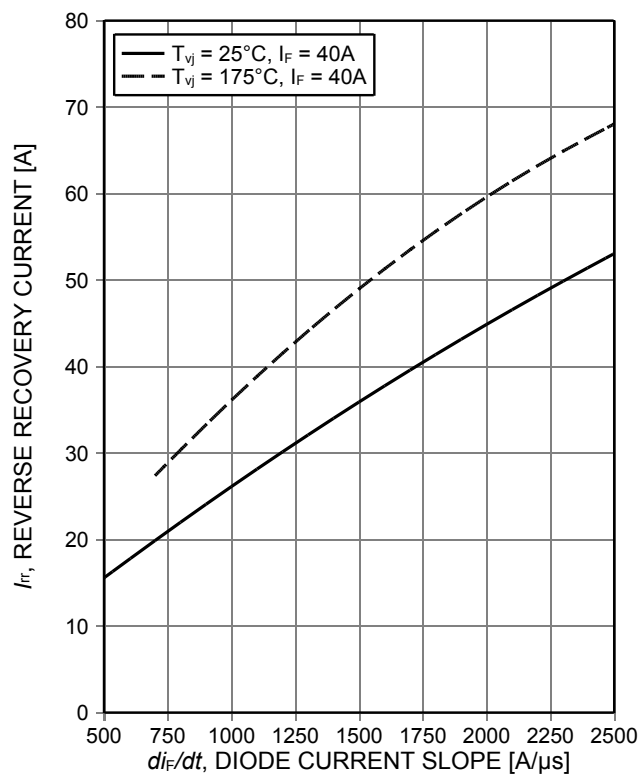


Figure 21. **Typical reverse recovery current as a function of diode current slope**  
( $V_R=600V$ )

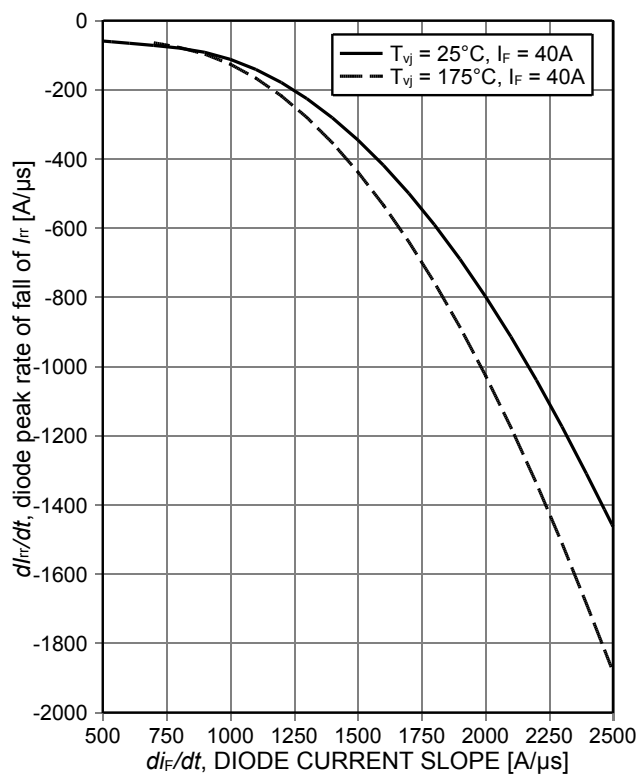


Figure 22. **Typical diode peak rate of fall of reverse recovery current as a function of diode current slope**  
( $V_R=600V$ )

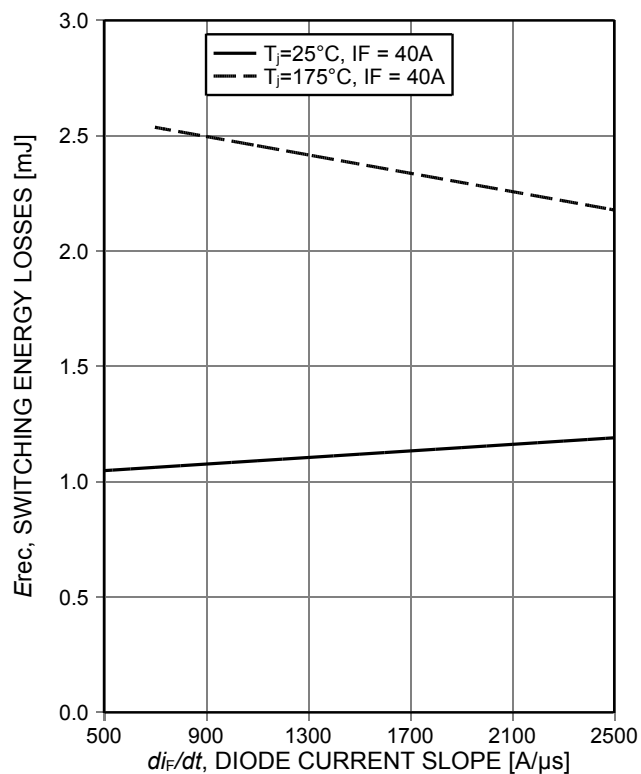


Figure 23. **Typical reverse energy losses as a function of diode current slope**  
( $V_R=600V$ )

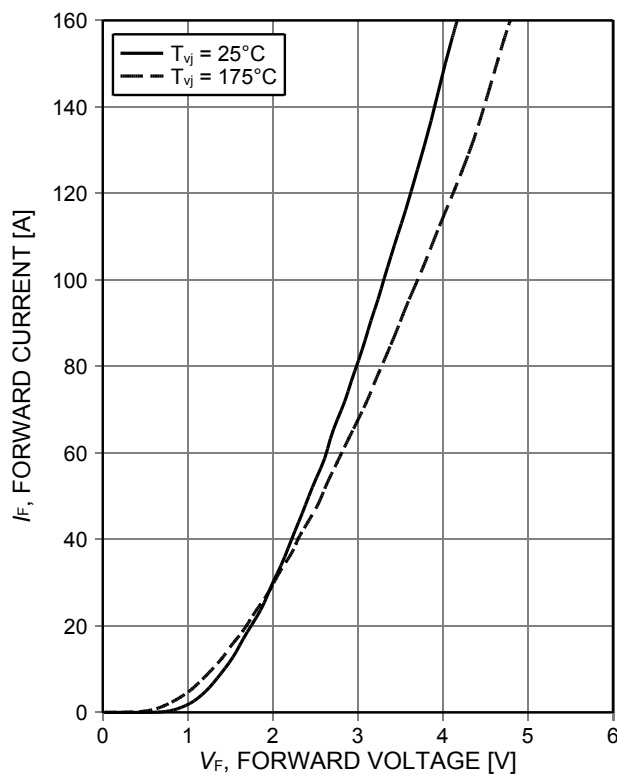


Figure 24. **Typical diode forward current as a function of forward voltage**

Sixth generation, high speed soft switching series

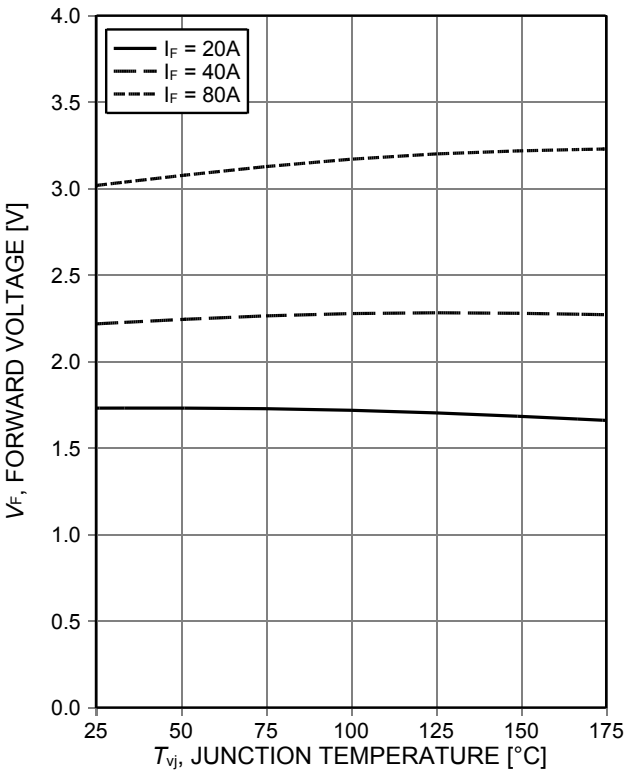
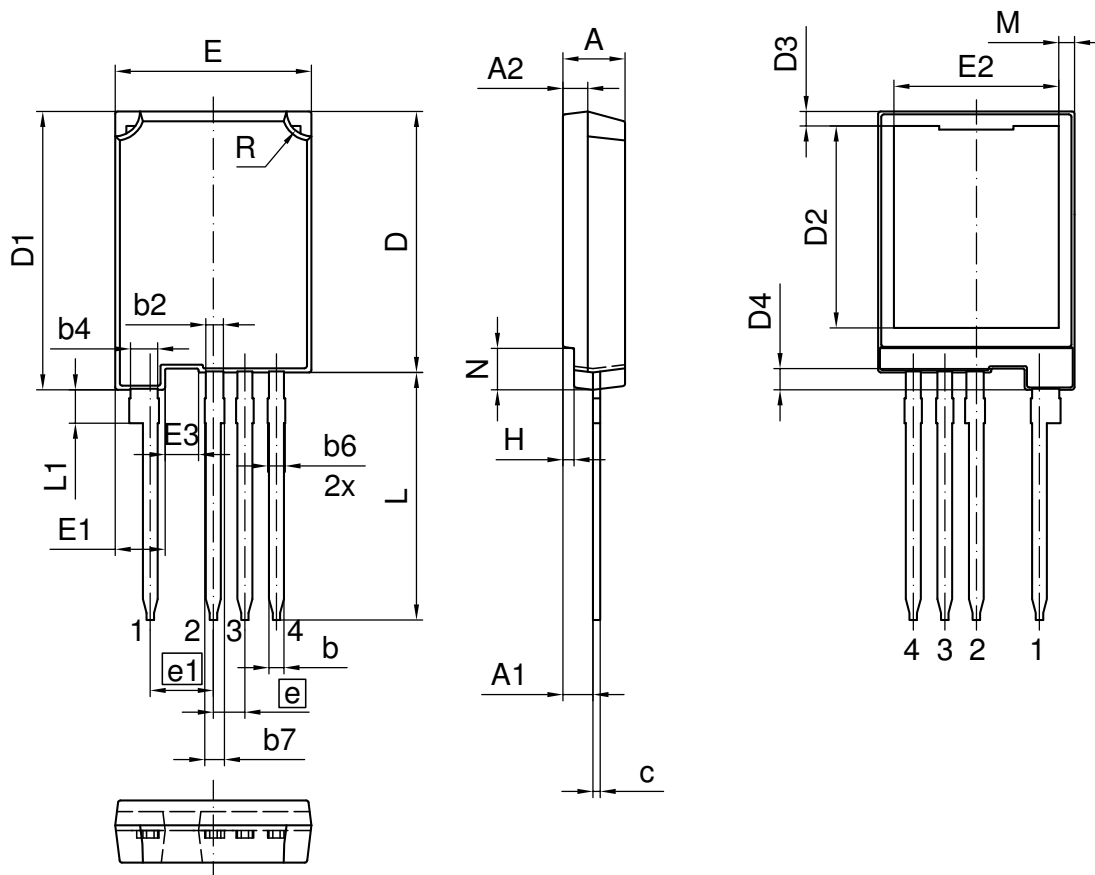


Figure 25. Typical diode forward voltage as a function of junction temperature

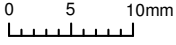
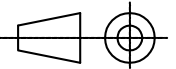
## PG-TO247-4-2

**NOTES:**

PACKAGE SURFACE ROUTE BETWEEN  
PIN 1 & PIN 2 WILL BE 5.1mm MIN.

ALL b... AND c DIMENSIONS INCLUDING  
PLATING EXCEPT AREA OF CUTTING

| DIMENSION | MILLIMETERS |       |
|-----------|-------------|-------|
|           | MIN.        | MAX.  |
| A         | 4.9         | 5.1   |
| A1        | 2.31        | 2.51  |
| A2        | 1.9         | 2.1   |
| b         | 1.16        | 1.29  |
| b2        | 1.36        | 1.49  |
| b4        | 2.16        | 2.29  |
| b6        | 1.16        | 1.45  |
| b7        | 1.16        | 1.65  |
| c         | 0.59        | 0.66  |
| D         | 20.9        | 21.1  |
| D1        | 22.3        | 22.5  |
| D2        | 15.95       | 16.55 |
| D3        | 1           | 1.35  |
| D4        | 1.6         | 1.8   |
| E         | 15.7        | 15.9  |
| E1        | 3.9         | 4.1   |
| E2        | 13.1        | 13.5  |
| E3        | 2.58        | 2.78  |
| e         | 2.54        |       |
| e1        | 5.08        |       |
| H         | 0.8         | 1     |
| L         | 19.8        | 20.1  |
| L1        | 2.55        | 2.85  |
| M         | 0.97        | 1.57  |
| N         | 3.24        | 3.44  |
| R         | 1.9         | 2.1   |

|                                                                                                                     |
|---------------------------------------------------------------------------------------------------------------------|
| <b>DOCUMENT NO.</b><br>Z8B00182798                                                                                  |
| <b>REVISION</b><br>01                                                                                               |
| <b>SCALE</b> 2:1<br>           |
| <b>EUROPEAN PROJECTION</b><br> |
| <b>ISSUE DATE</b><br>23.09.2016                                                                                     |

### Testing Conditions



Figure A. Definition of switching times



Figure B. Definition of switching losses



Figure C. Definition of diode switching characteristics

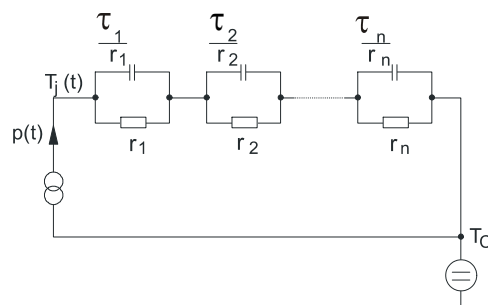


Figure D. Thermal equivalent circuit



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

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Sixth generation, high speed soft switching series

## Revision History

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IKY40N120CS6

**Revision: 2018-05-07, Rev. 2.1**

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Previous Revision

| Revision | Date       | Subjects (major changes since last revision) |
|----------|------------|----------------------------------------------|
| 2.1      | 2018-05-07 | Final data sheet                             |

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