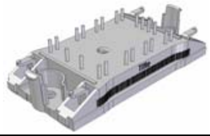
**flowmNPC0** — **1200V/80A & 600V/50A**

### Features

- mixed voltage component topology
- neutral point clamped inverter
- reactive power capability
- low inductance layout

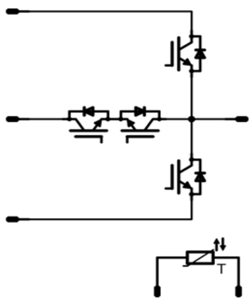
### flow0 12mm housing



### Target Applications

- solar inverter
- UPS

### Schematic




### Types

- FZ12NMA080SH

# Maximum Ratings

Tj=25°C, unless otherwise specified

| Parameter | Symbol | Condition | Value | Unit |
|---|---|---|---|---|
| **half bridge IGBT** | | | | |
| Collector-emitter break down voltage | $V_{CE}$ | | 1200 | V |
| DC collector current | $I_C$ | $T_j=T_j$max   $T_h=80°C$<br>$T_c=80°C$ | 66<br>84 | A |
| Repetitive peak collector current | $I_{Cpulse}$ | $t_p$ limited by $T_j$max | 320 | A |
| Power dissipation per IGBT | $P_{tot}$ | $T_j=T_j$max   $T_h=80°C$<br>$T_c=80°C$ | 158<br>240 | W |
| Gate-emitter peak voltage | $V_{GE}$ | | ±20 | V |
| Short circuit ratings | $t_{SC}$<br>$V_{CC}$ | $T_j≤150°C$<br>$V_{GE}=15V$ | 6<br>360 | µs<br>V |
| Maximum Junction Temperature | $T_j$max | | 175 | °C |
| **neutral point DIODE** | | | | |
| Peak Repetitive Reverse Voltage | $V_{RRM}$ | $T_j=25°C$ | 600 | V |
| DC forward current | $I_F$ | $T_j=T_j$max   $T_h=80°C$<br>$T_c=80°C$ | 26<br>36 | A |
| Repetitive peak forward current | $I_{FRM}$ | $t_p$ limited by $T_j$max   $T_c=100°C$ | 120 | A |
| Power dissipation per Diode | $P_{tot}$ | $T_j=T_j$max   $T_h=80°C$<br>$T_c=80°C$ | 44<br>66 | W |
| Maximum Junction Temperature | $T_j$max | | 150 | °C |

# Maximum Ratings

Tj=25°C, unless otherwise specified

| Parameter | Symbol | Condition | | Value | Unit |
|---|---|---|---|---|---|
| **neutral point IGBT** | | | | | |
| Collector-emitter break down voltage | $V_{CE}$ | | | 600 | V |
| DC collector current | $I_C$ | $T_j=T_j$max | $T_h$=80°C<br>$T_c$=80°C | 36<br>46 | A |
| Repetitive peak collector current | $I_{Cpuls}$ | $t_p$ limited by $T_j$max | | 150 | A |
| Power dissipation per IGBT | $P_{tot}$ | $T_j=T_j$max | $T_h$=80°C<br>$T_c$=80°C | 56<br>85 | W |
| Gate-emitter peak voltage | $V_{GE}$ | | | ±20 | V |
| Short circuit ratings | $t_{SC}$<br>$V_{CC}$ | $T_j$≤150°C<br>$V_{GE}$=15V | | 6<br>360 | μs<br>V |
| Maximum Junction Temperature | $T_j$max | | | 175 | °C |
| **half bridge DIODE** | | | | | |
| Peak Repetitive Reverse Voltage | $V_{RRM}$ | $T_j$=25°C | | 1200 | V |
| DC forward current | $I_F$ | $T_j=T_j$max | $T_h$=80°C<br>$T_c$=80°C | 25<br>35 | A |
| Repetitive peak forward current | $I_{FRM}$ | $t_p$ limited by $T_j$max | | 70 | A |
| Power dissipation per Diode | $P_{tot}$ | $T_j=T_j$max | $T_h$=80°C<br>$T_c$=80°C | 45<br>68 | W |
| Maximum Junction Temperature | $T_j$max | | | 150 | °C |
| **Thermal Properties** | | | | | |
| Storage temperature | $T_{stg}$ | | | -40…+125 | °C |
| Operation temperature under switching condition | $T_{op}$ | | | -40…+(Tjmax - 25) | °C |
| **Insulation Properties** | | | | | |
| Insulation voltage | $V_{is}$ | t=2s | DC voltage | 4000 | V |
| Creepage distance | | | | min 12,7 | mm |
| Clearance | | | | min 12,7 | mm |

## Characteristic Values

| Parameter | Symbol | Conditions | | | | | Value | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | $V_{GE}$ [V] or $V_{GS}$ [V] | $V_r$ [V] or $V_{CE}$ [V] or $V_{DS}$ [V] | $I_C$ [A] or $I_F$ [A] or $I_D$ [A] | $T_j$ | Min | Typ | Max | |
| **half bridge IGBT** | | | | | | | | | | |
| Gate emitter threshold voltage | $V_{GE(th)}$ | VCE=VGE | | | 0,002 | Tj=25°C<br>Tj=150°C | 5 | 5,80 | 6,5 | V |
| Collector-emitter saturation voltage | $V_{CE(sat)}$ | | 15 | | 100 | Tj=25°C<br>Tj=150°C | 1 | 2,10<br>2,43 | 2,5 | V |
| Collector-emitter cut-off current incl. Diode | $I_{CES}$ | | 0 | 1200 | | Tj=25°C<br>Tj=150°C | | | 500 | uA |
| Gate-emitter leakage current | $I_{GES}$ | | 20 | 0 | | Tj=25°C<br>Tj=150°C | | | 1,2 | uA |
| Integrated Gate resistor | $R_{gint}$ | | | | | | | none | | Ω |
| Turn-on delay time | $t_{d(on)}$ | Rgon=8 Ω<br>Rgoff=8 Ω | ±15 | 350 | 40 | Tj=25°C<br>Tj=150°C | | 125<br>126 | | ns |
| Rise time | $t_r$ | | | | | Tj=25°C<br>Tj=150°C | | 20<br>23 | | ns |
| Turn-off delay time | $t_{d(off)}$ | | | | | Tj=25°C<br>Tj=150°C | | 219<br>282 | | ns |
| Fall time | $t_f$ | | | | | Tj=25°C<br>Tj=150°C | | 43<br>73 | | ns |
| Turn-on energy loss per pulse | $E_{on}$ | | | | | Tj=25°C<br>Tj=150°C | | 0,47<br>0,70 | | mWs |
| Turn-off energy loss per pulse | $E_{off}$ | | | | | Tj=25°C<br>Tj=150°C | | 0,98<br>1,65 | | mWs |
| Input capacitance | $C_{ies}$ | f=1MHz | 0 | 25 | | Tj=25°C | | 4660 | | pF |
| Output capacitance | $C_{oss}$ | | | | | | | 300 | | pF |
| Reverse transfer capacitance | $C_{rss}$ | | | | | | | 130 | | pF |
| Gate charge | $Q_{Gate}$ | | 15 | 960 | 40 | Tj=25°C | | 370 | | nC |
| Thermal resistance chip to heatsink per chip | $R_{thJH}$ | Thermal grease thickness≤50um λ = 1 W/mK | | | | | | 0,60 | | K/W |
| **neutral point DIODE** | | | | | | | | | | |
| Diode forward voltage | $V_F$ | | | | 30 | Tj=25°C<br>Tj=125°C | 1 | 2,46<br>1,86 | 2,8 | V |
| Peak reverse recovery current | $I_{RRM}$ | Rgon=8 Ω | ±15 | 350 | 40 | Tj=25°C<br>Tj=125°C | | 31<br>43 | | A |
| Reverse recovery time | $t_{rr}$ | | | | | Tj=25°C<br>Tj=125°C | | 18<br>38 | | ns |
| Reverse recovered charge | $Q_{rr}$ | | | | | Tj=25°C<br>Tj=125°C | | 0,30<br>0,95 | | µC |
| Peak rate of fall of recovery current | di(rec)max /dt | | | | | Tj=25°C<br>Tj=125°C | | 7783<br>4120 | | A/µs |
| Reverse recovered energy | Erec | | | | | Tj=25°C<br>Tj=125°C | | 0,02<br>0,12 | | mWs |
| Thermal resistance chip to heatsink per chip | $R_{thJH}$ | Thermal grease thickness≤50um λ = 1 W/mK | | | | | | 1,61 | | K/W |

## Characteristic Values

| Parameter | Symbol | Conditions | | | | | Value | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | $V_{GE}$ [V] or $V_{GS}$ [V] | $V_r$ [V] or $V_{CE}$ [V] or $V_{DS}$ [V] | $I_C$ [A] or $I_F$ [A] or $I_D$ [A] | $T_j$ | Min | Typ | Max | |
| **neutral point IGBT** | | | | | | | | | | |
| Gate emitter threshold voltage | $V_{GE(th)}$ | $V_{CE}=V_{GE}$ | | | 0,0008 | Tj=25°C<br>Tj=125°C | 5 | 5,8 | 6,5 | V |
| Collector-emitter saturation voltage | $V_{CE(sat)}$ | | 15 | | 50 | Tj=25°C<br>Tj=125°C | 1,1 | 1,54<br>1,75 | 2 | V |
| Collector-emitter cut-off incl diode | $I_{CES}$ | | 0 | 600 | | Tj=25°C<br>Tj=125°C | | | 100 | uA |
| Gate-emitter leakage current | $I_{GES}$ | | 20 | 0 | | Tj=25°C<br>Tj=125°C | | | 650 | nA |
| Integrated Gate resistor | $R_{gint}$ | | | | | | | none | | Ω |
| Turn-on delay time | $t_{d(on)}$ | Rgon=8 Ω<br>Rgoff=8 Ω | ±15 | 350 | 41 | Tj=25°C<br>Tj=125°C | | 99<br>102 | | ns |
| Rise time | $t_r$ | | | | | Tj=25°C<br>Tj=125°C | | 10<br>13 | | |
| Turn-off delay time | $t_{d(off)}$ | | | | | Tj=25°C<br>Tj=125°C | | 183<br>206 | | |
| Fall time | $t_f$ | | | | | Tj=25°C<br>Tj=125°C | | 80<br>99 | | |
| Turn-on energy loss per pulse | $E_{on}$ | | | | | Tj=25°C<br>Tj=125°C | | 0,49<br>0,72 | | mWs |
| Turn-off energy loss per pulse | $E_{off}$ | | | | | Tj=25°C<br>Tj=125°C | | 1,16<br>1,50 | | |
| Input capacitance | $C_{ies}$ | f=1MHz | 0 | 25 | | Tj=25°C | | 3140 | | pF |
| Output capacitance | $C_{oss}$ | | | | | | | 200 | | |
| Reverse transfer capacitance | $C_{rss}$ | | | | | | | 93 | | |
| Gate charge | $Q_{Gate}$ | | 15 | 480 | 50 | Tj=25°C | | 310 | | nC |
| Thermal resistance chip to heatsink per chip | $R_{thJH}$ | Thermal grease thickness≤50um λ = 1 W/mK | | | | | | 1,70 | | K/W |
| **half bridge DIODE** | | | | | | | | | | |
| Diode forward voltage | $V_F$ | | | | 30 | Tj=25°C<br>Tj=125°C | 1,5 | 2,23<br>1,91 | 3,4 | V |
| Reverse leakage current | $I_r$ | | | 1200 | | Tj=25°C<br>Tj=125°C | | | 100 | μA |
| Peak reverse recovery current | $I_{RRM}$ | Rgon=8 Ω | ±15 | 350 | 41 | Tj=25°C<br>Tj=125°C | | 64<br>79 | | A |
| Reverse recovery time | $t_{rr}$ | | | | | Tj=25°C<br>Tj=125°C | | 29<br>172 | | ns |
| Reverse recovered charge | $Q_{rr}$ | | | | | Tj=25°C<br>Tj=125°C | | 2,7<br>6,1 | | μC |
| Peak rate of fall of recovery current | di(rec)max /dt | | | | | Tj=25°C<br>Tj=125°C | | 8246<br>4626 | | A/μs |
| Reverse recovery energy | $E_{rec}$ | | | | | Tj=25°C<br>Tj=125°C | | 0,74<br>1,79 | | mWs |
| Thermal resistance chip to heatsink per chip | $R_{thJH}$ | Thermal grease thickness≤50um λ = 1 W/mK | | | | | | 1,55 | | K/W |
| **Thermistor** | | | | | | | | | | |
| Rated resistance | R | | | | | T=25°C | | 22000 | | Ω |
| Deviation of R100 | ΔR/R | R100=1486 Ω | | | | T=100°C | -5 | | 5 | % |
| Power dissipation | P | | | | | T=25°C | | 200 | | mW |
| Power dissipation constant | | | | | | T=25°C | | 2 | | mW/K |
| B-value | B(25/50) | Tol. ±3% | | | | T=25°C | | 3950 | | K |
| B-value | B(25/100) | Tol. ±3% | | | | T=25°C | | 3996 | | K |
| Vincotech NTC Reference | | | | | | | | | B | |

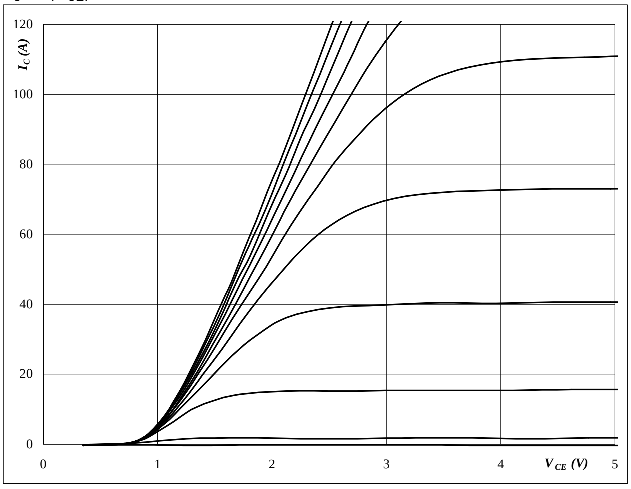
# Buck

**half bridge IGBT and neutral point FRED**

**Figure 1** IGBT

**Typical output characteristics**

$I_C = f(V_{CE})$




**At**

$t_p$ = 250 µs

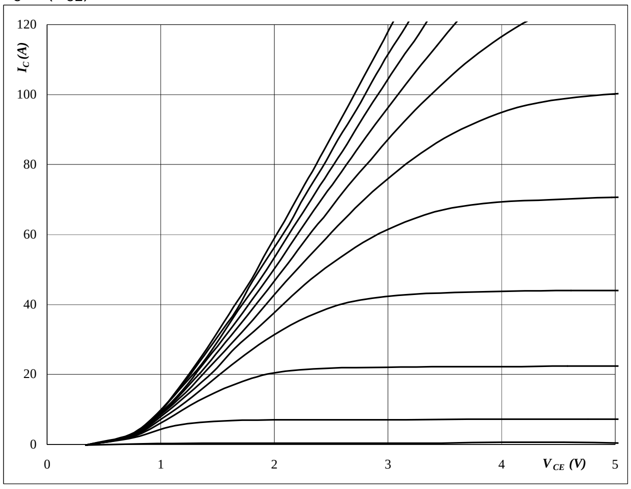
$T_j$ = 25 °C

$V_{GE}$ from 6 V to 16 V in steps of 1 V

**Figure 2** IGBT

**Typical output characteristics**

$I_C = f(V_{CE})$




**At**

$t_p$ = 250 µs

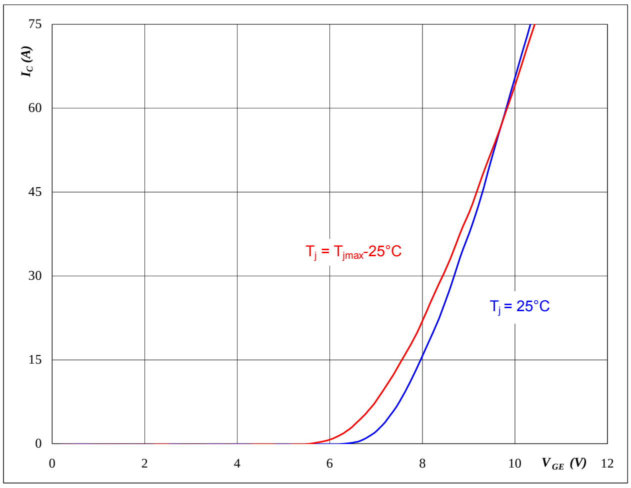
$T_j$ = 125 °C

$V_{GE}$ from 6 V to 16 V in steps of 1 V

**Figure 3** IGBT

**Typical transfer characteristics**

$I_C = f(V_{GE})$




**At**

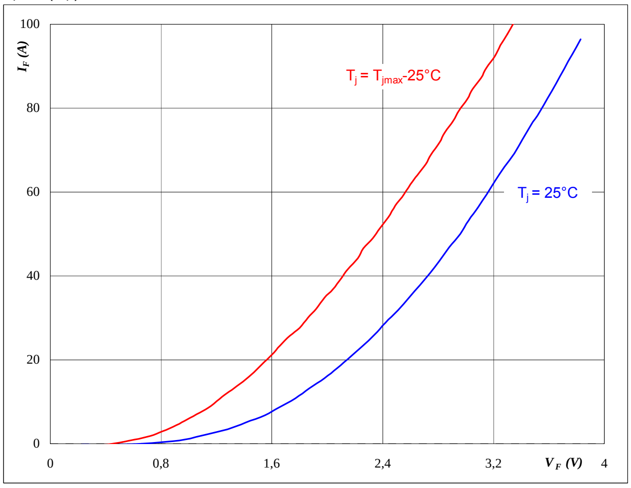
$t_p$ = 250 µs

$V_{CE}$ = 10 V

**Figure 4** FRED

**Typical diode forward current as a function of forward voltage**

$I_F = f(V_F)$




**At**

$t_p$ = 250 µs

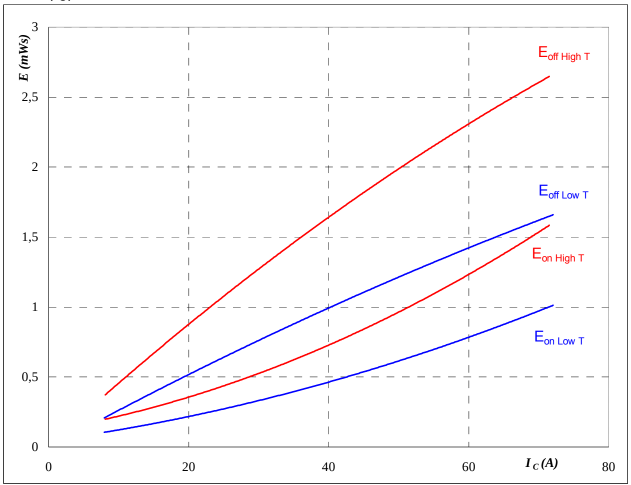
# Buck

**half bridge IGBT** and **neutral point FRED**

**Figure 5** IGBT

**Typical switching energy losses**
**as a function of collector current**

E = f($I_C$)



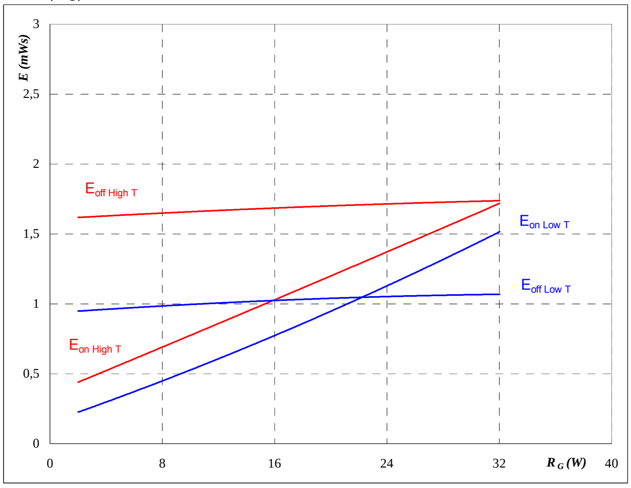

With an inductive load at

| | | |
|---|---|---|
| $T_j$ = | 25/125 | °C |
| $V_{CE}$ = | 350 | V |
| $V_{GE}$ = | ±15 | V |
| $R_{gon}$ = | 8 | Ω |
| $R_{goff}$ = | 8 | Ω |

**Figure 6** IGBT

**Typical switching energy losses**
**as a function of gate resistor**

E = f($R_G$)



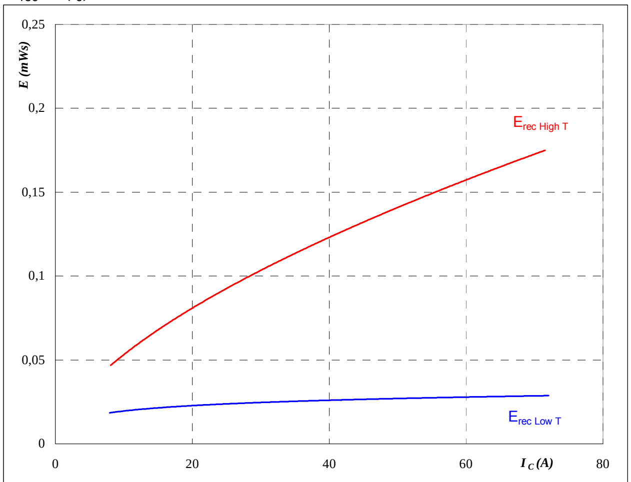

With an inductive load at

| | | |
|---|---|---|
| $T_j$ = | 25/125 | °C |
| $V_{CE}$ = | 350 | V |
| $V_{GE}$ = | ±15 | V |
| $I_C$ = | 40 | A |

**Figure 7** FRED

**Typical reverse recovery energy loss**
**as a function of collector current**

$E_{rec}$ = f($I_c$)



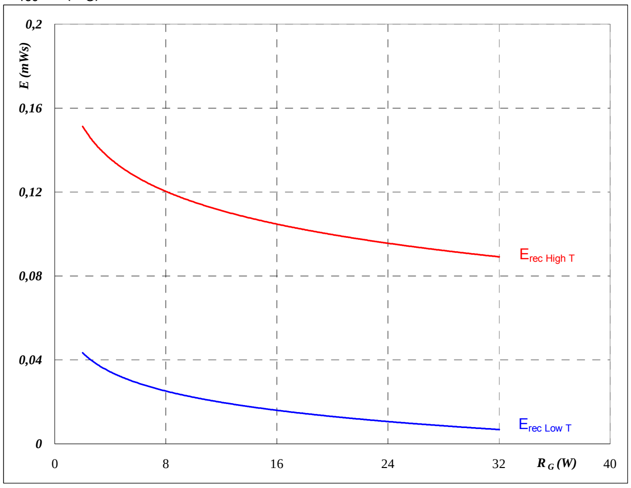

With an inductive load at

| | | |
|---|---|---|
| $T_j$ = | 25/125 | °C |
| $V_{CE}$ = | 350 | V |
| $V_{GE}$ = | ±15 | V |
| $R_{gon}$ = | 8 | Ω |

**Figure 8** FRED

**Typical reverse recovery energy loss**
**as a function of gate resistor**

$E_{rec}$ = f($R_G$)




With an inductive load at

| | | |
|---|---|---|
| $T_j$ = | 25/125 | °C |
| $V_{CE}$ = | 350 | V |
| $V_{GE}$ = | ±15 | V |
| $I_C$ = | 40 | A |

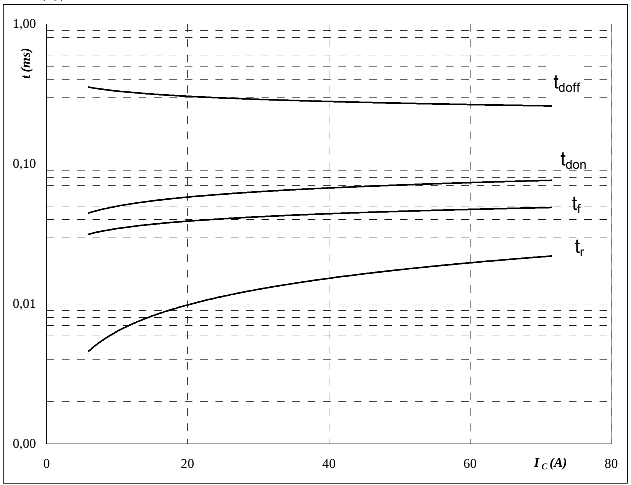
# Buck

**half bridge IGBT** and **neutral point FRED**

**Figure 9** IGBT

**Typical switching times as a function of collector current**

t = f($I_C$)



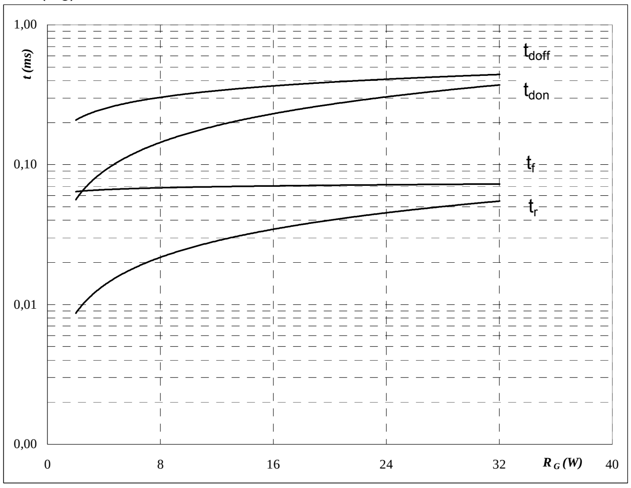

With an inductive load at

| | | |
|---|---|---|
| $T_j$ = | 125 | °C |
| $V_{CE}$ = | 350 | V |
| $V_{GE}$ = | ±15 | V |
| $R_{gon}$ = | 8 | Ω |
| $R_{goff}$ = | 8 | Ω |

**Figure 10** IGBT

**Typical switching times as a function of gate resistor**

t = f($R_G$)



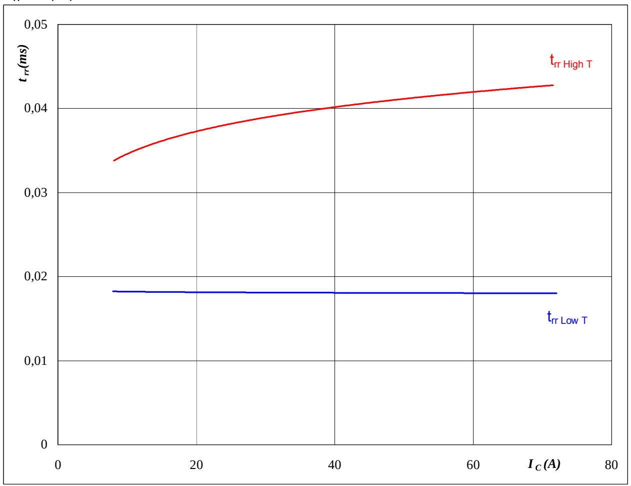

With an inductive load at

| | | |
|---|---|---|
| $T_j$ = | 125 | °C |
| $V_{CE}$ = | 350 | V |
| $V_{GE}$ = | ±15 | V |
| $I_C$ = | 40 | A |

**Figure 11** FRED

**Typical reverse recovery time as a function of collector current**

$t_{rr}$ = f(Ic)



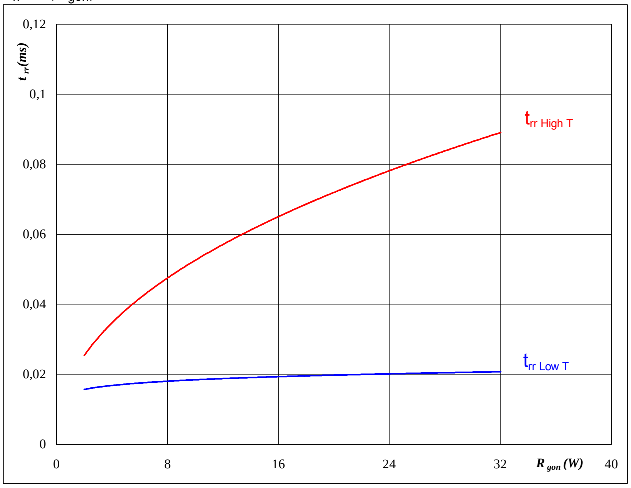

**At**

| | | |
|---|---|---|
| $T_j$ = | 25/125 | °C |
| $V_{CE}$ = | 350 | V |
| $V_{GE}$ = | ±15 | V |
| $R_{gon}$ = | 8 | Ω |

**Figure 12** FRED

**Typical reverse recovery time as a function of IGBT turn on gate resistor**

$t_{rr}$ = f($R_{gon}$)




**At**

| | | |
|---|---|---|
| $T_j$ = | 25/125 | °C |
| $V_R$ = | 350 | V |
| $I_F$ = | 40 | A |
| $V_{GE}$ = | ±15 | V |

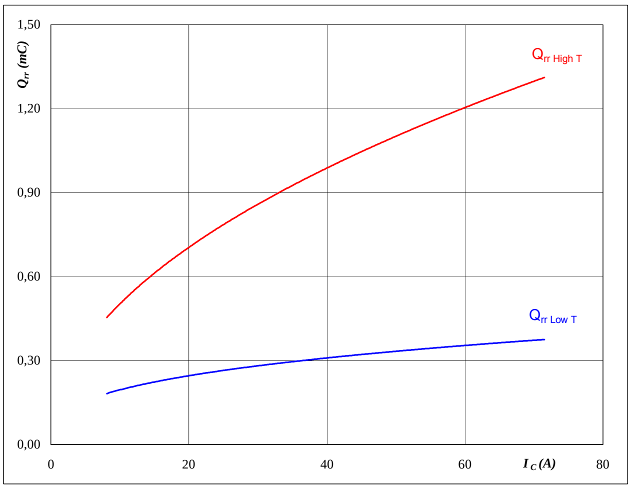
# Buck

**half bridge IGBT** and **neutral point FRED**

**Figure 13** FRED

**Typical reverse recovery charge as a function of collector current**

$Q_{rr} = f(I_C)$



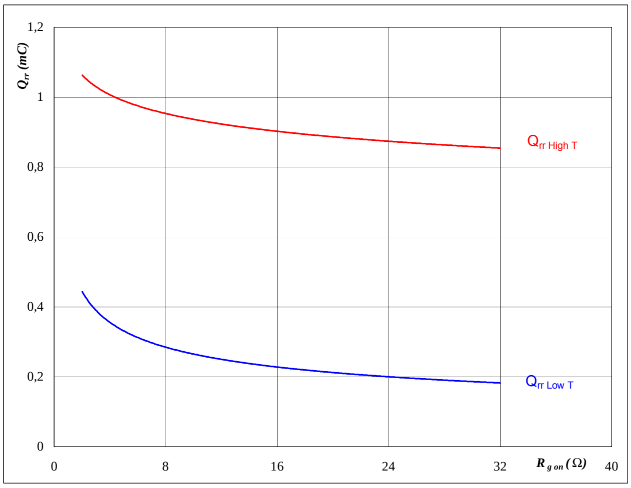

At

| | | |
|---|---|---|
| $T_j$ = | 25/125 | °C |
| $V_{CE}$ = | 350 | V |
| $V_{GE}$ = | ±15 | V |
| $R_{gon}$ = | 8 | Ω |

**Figure 14** FRED

**Typical reverse recovery charge as a function of IGBT turn on gate resistor**

$Q_{rr} = f(R_{gon})$



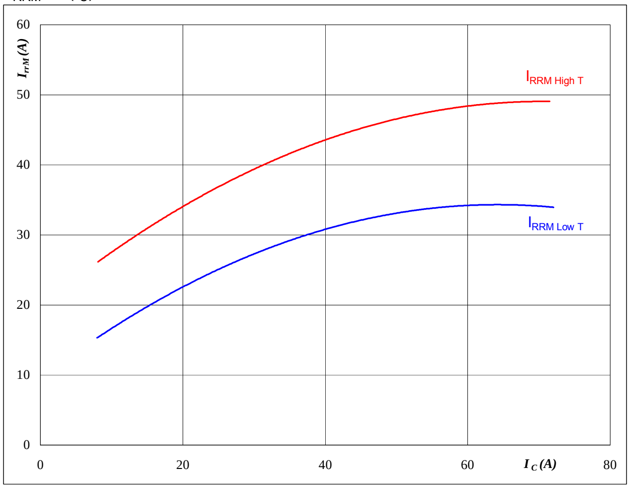

At

| | | |
|---|---|---|
| $T_j$ = | 25/125 | °C |
| $V_R$ = | 350 | V |
| $I_F$ = | 40 | A |
| $V_{GE}$ = | ±15 | V |

**Figure 15** FRED

**Typical reverse recovery current as a function of collector current**

$I_{RRM} = f(I_C)$



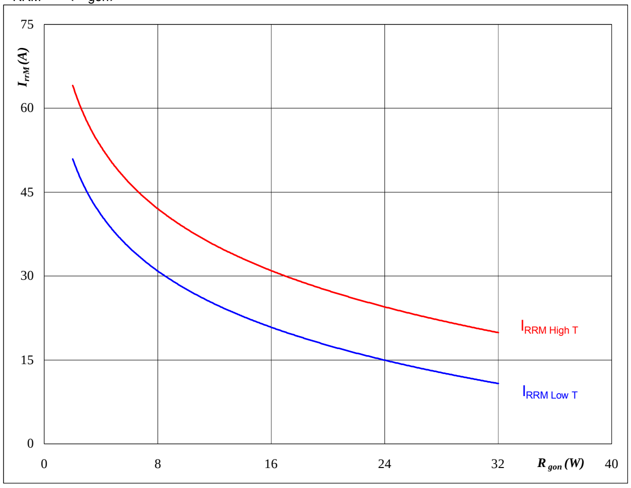

At

| | | |
|---|---|---|
| $T_j$ = | 25/125 | °C |
| $V_{CE}$ = | 350 | V |
| $V_{GE}$ = | ±15 | V |
| $R_{gon}$ = | 8 | Ω |

**Figure 16** FRED

**Typical reverse recovery current as a function of IGBT turn on gate resistor**

$I_{RRM} = f(R_{gon})$




At

| | | |
|---|---|---|
| $T_j$ = | 25/125 | °C |
| $V_R$ = | 350 | V |
| $I_F$ = | 40 | A |
| $V_{GE}$ = | ±15 | V |

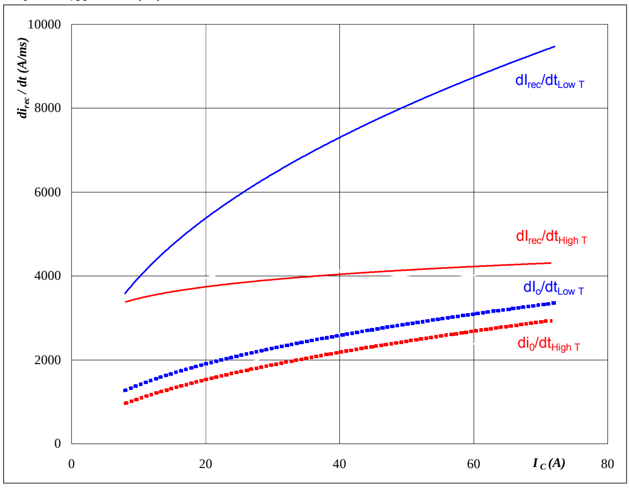
# Buck

**half bridge IGBT and neutral point FRED**

**Figure 17** FRED

**Typical rate of fall of forward and reverse recovery current as a function of collector current**

$dI_0/dt, dI_{rec}/dt = f(Ic)$



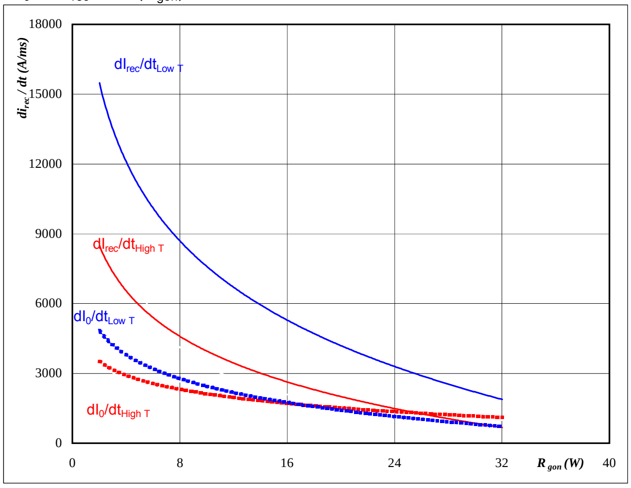

At

| | | |
|---|---|---|
| $T_j$ = | 25/125 | °C |
| $V_{CE}$ = | 350 | V |
| $V_{GE}$ = | ±15 | V |
| $R_{gon}$ = | 8 | Ω |

**Figure 18** FRED

**Typical rate of fall of forward and reverse recovery current as a function of IGBT turn on gate resistor**

$dI_0/dt, dI_{rec}/dt = f(R_{gon})$



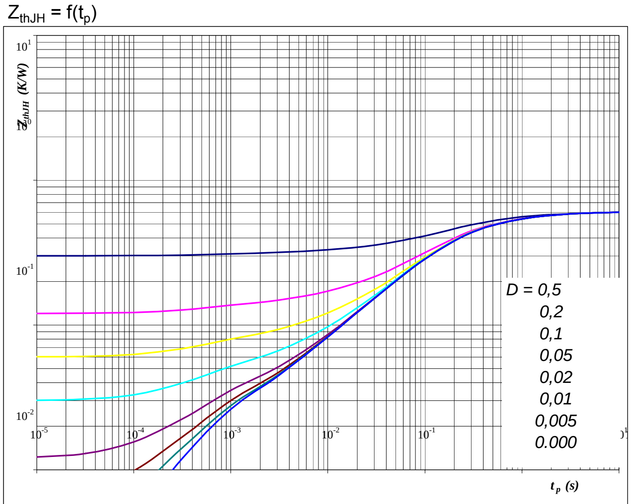

At

| | | |
|---|---|---|
| $T_j$ = | 25/125 | °C |
| $V_R$ = | 350 | V |
| $I_F$ = | 40 | A |
| $V_{GE}$ = | ±15 | V |

**Figure 19** IGBT

**IGBT transient thermal impedance as a function of pulse width**

$Z_{thJH} = f(t_p)$




At

| | | |
|---|---|---|
| D = | $t_p$ / T | |
| $R_{thJH}$ = | 0,60 | K/W |

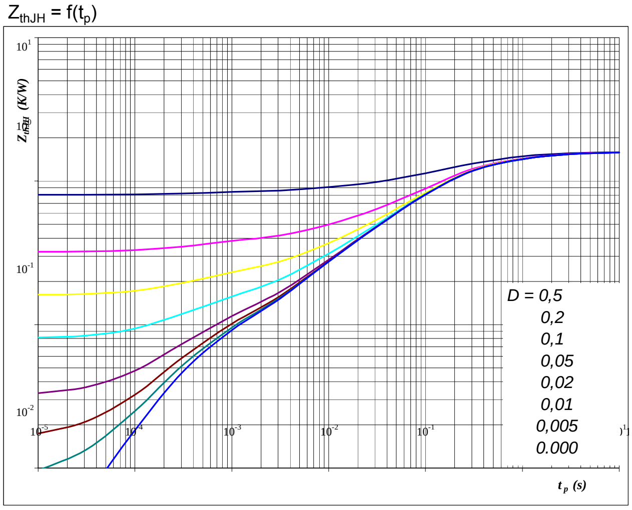
IGBT thermal model values

| R (C/W) | Tau (s) |
|---|---|
| 0,10 | 1,7E+00 |
| 0,28 | 2,4E-01 |
| 0,16 | 6,7E-02 |
| 0,04 | 8,5E-03 |
| 0,02 | 5,6E-04 |

**Figure 20** FRED

**FRED transient thermal impedance as a function of pulse width**

$Z_{thJH} = f(t_p)$




At

| | | |
|---|---|---|
| D = | $t_p$ / T | |
| $R_{thJH}$ = | 1,61 | K/W |

FRED thermal model values

| R (C/W) | Tau (s) |
|---|---|
| 0,06 | 9,8E+00 |
| 0,30 | 1,1E+00 |
| 0,80 | 1,8E-01 |
| 0,28 | 3,3E-02 |
| 0,11 | 5,6E-03 |
| 0,07 | 3,8E-04 |

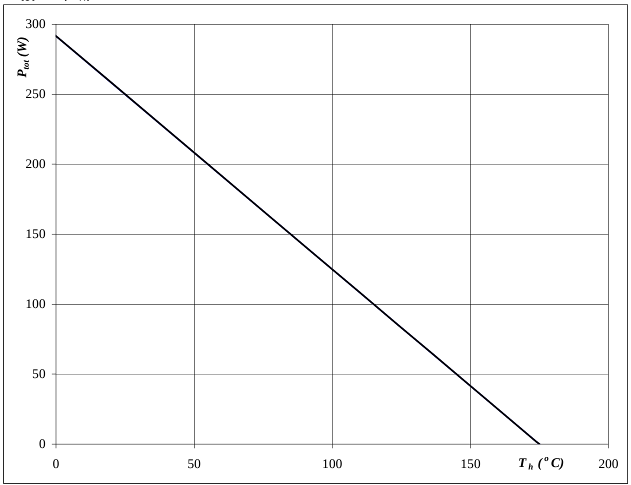
# Buck

**half bridge IGBT** and **neutral point FRED**

**Figure 21** IGBT

**Power dissipation as a function of heatsink temperature**

$P_{tot} = f(T_h)$



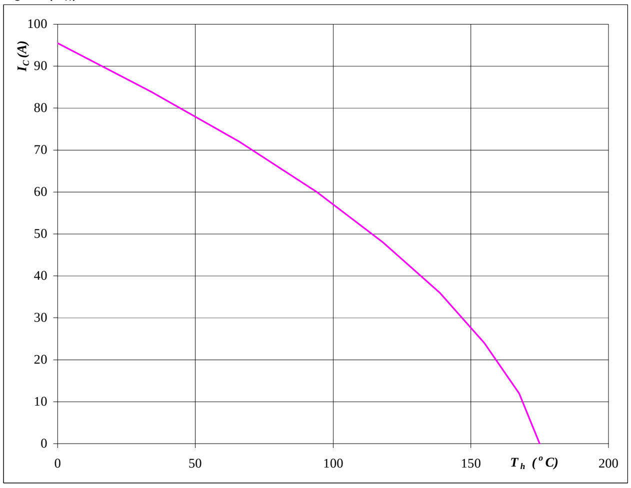

**At**

$T_j$ = 175 °C

**Figure 22** IGBT

**Collector current as a function of heatsink temperature**

$I_C = f(T_h)$




**At**

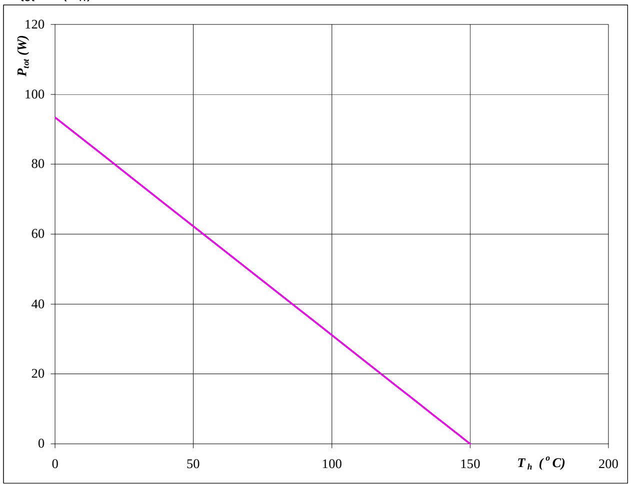
$T_j$ = 175 °C

$V_{GE}$ = 15 V

**Figure 23** FRED

**Power dissipation as a function of heatsink temperature**

$P_{tot} = f(T_h)$



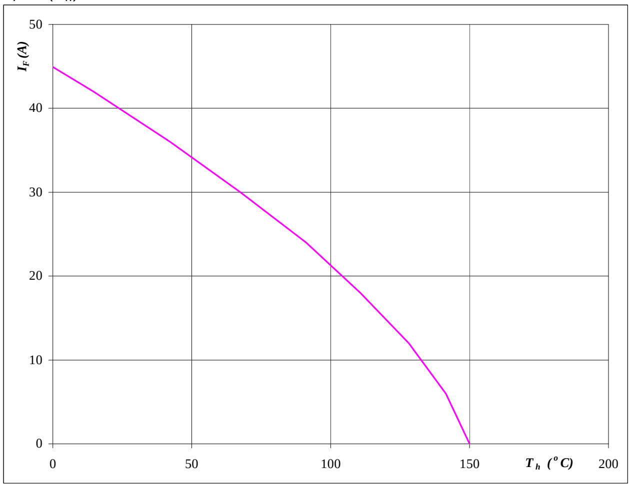

**At**

$T_j$ = 150 °C

**Figure 24** FRED

**Forward current as a function of heatsink temperature**

$I_F = f(T_h)$




**At**

$T_j$ = 150 °C

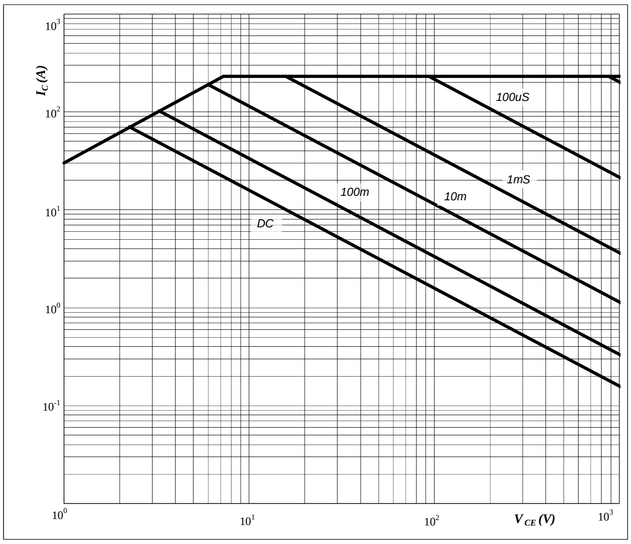
# Buck

**half bridge IGBT** and **neutral point FRED**

**Figure 25** IGBT

**Safe operating area as a function of collector-emitter voltage**

$I_C = f(V_{CE})$



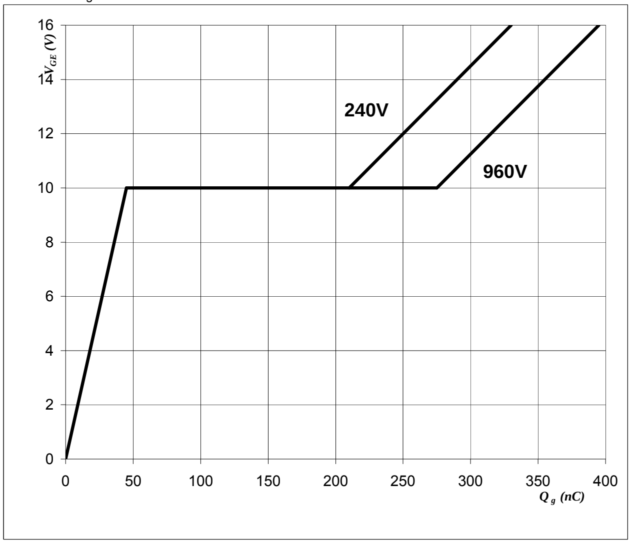

**At**

| | | |
|---|---|---|
| D = | single pulse | |
| Th = | 80 | ºC |
| $V_{GE}$ = | ±15 | V |
| $T_j$ = | $T_{jmax}$ | ºC |

**Figure 26** IGBT

**Gate voltage vs Gate charge**

$V_{GE} = f(Q_g)$




**At**

| | | |
|---|---|---|
| $I_C$ = | 40 | A |

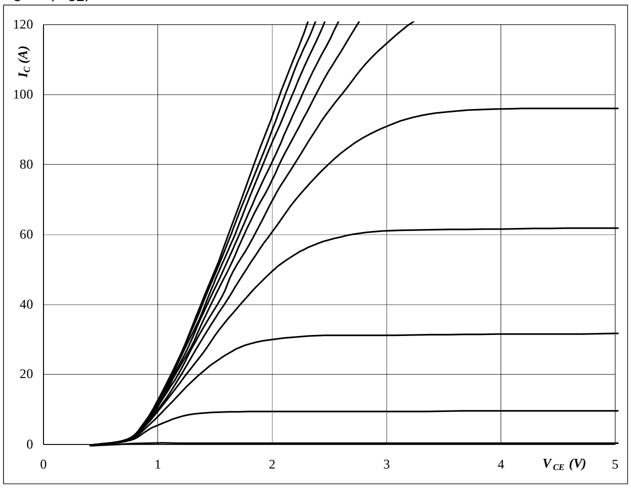
# Boost

**neutral point IGBT** and **half bridge FRED**

**Figure 1** IGBT

**Typical output characteristics**

$I_C = f(V_{CE})$



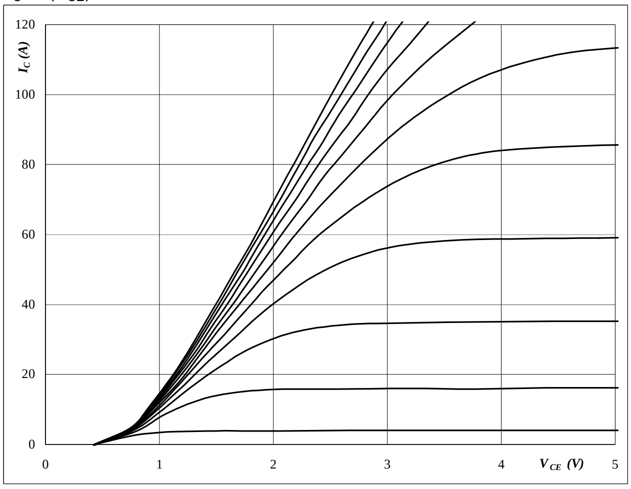

**At**

| | | |
|---|---|---|
| $t_p$ = | 250 | µs |
| $T_j$ = | 25 | °C |
| $V_{GE}$ from | 7 V to 17 V in steps of 1 V | |

**Figure 2** IGBT

**Typical output characteristics**

$I_C = f(V_{CE})$



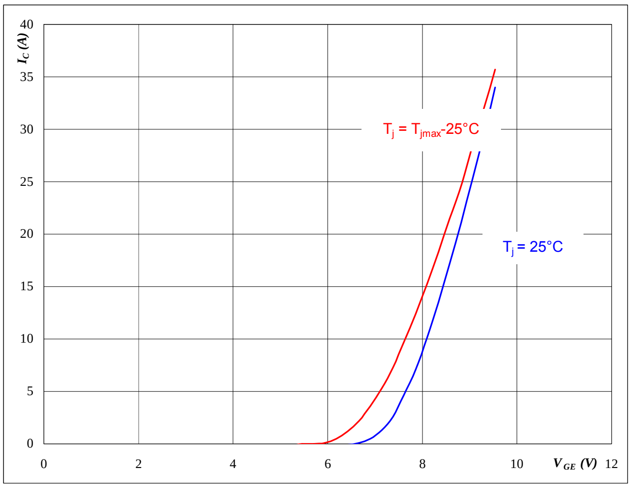

**At**

| | | |
|---|---|---|
| $t_p$ = | 250 | µs |
| $T_j$ = | 125 | °C |
| $V_{GE}$ from | 7 V to 17 V in steps of 1 V | |

**Figure 3** IGBT

**Typical transfer characteristics**

$I_C = f(V_{GE})$



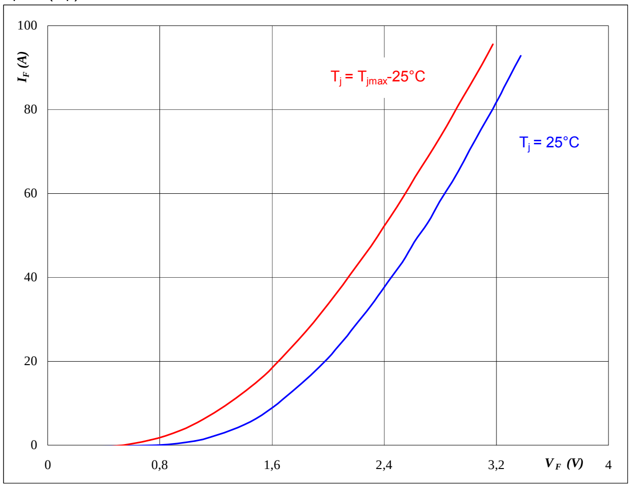

**At**

| | | |
|---|---|---|
| $t_p$ = | 250 | µs |
| $V_{CE}$ = | 10 | V |

**Figure 4** FRED

**Typical diode forward current as a function of forward voltage**

$I_F = f(V_F)$




**At**

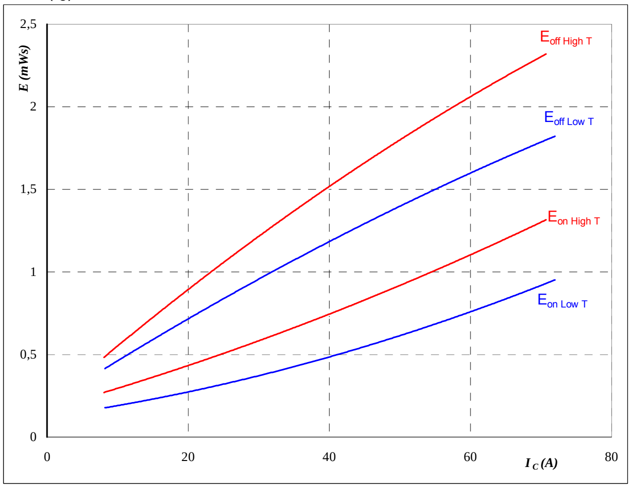
| | | |
|---|---|---|
| $t_p$ = | 250 | µs |

# Boost

**neutral point IGBT** and **half bridge FRED**

| **Figure 5** | IGBT |
|---|---|

**Typical switching energy losses**
**as a function of collector current**
$E = f(I_C)$

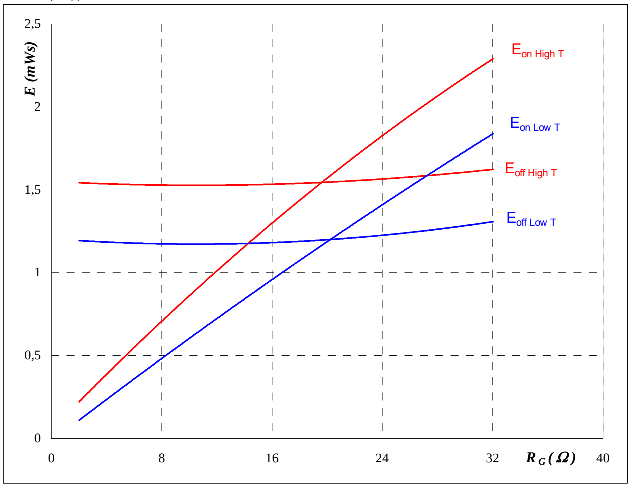



With an inductive load at

| | | |
|---|---|---|
| $T_j$ = | 25/125 | °C |
| $V_{CE}$ = | 350 | V |
| $V_{GE}$ = | ±15 | V |
| $R_{gon}$ = | 8 | Ω |
| $R_{goff}$ = | 8 | Ω |

| **Figure 6** | IGBT |
|---|---|

**Typical switching energy losses**
**as a function of gate resistor**
$E = f(R_G)$

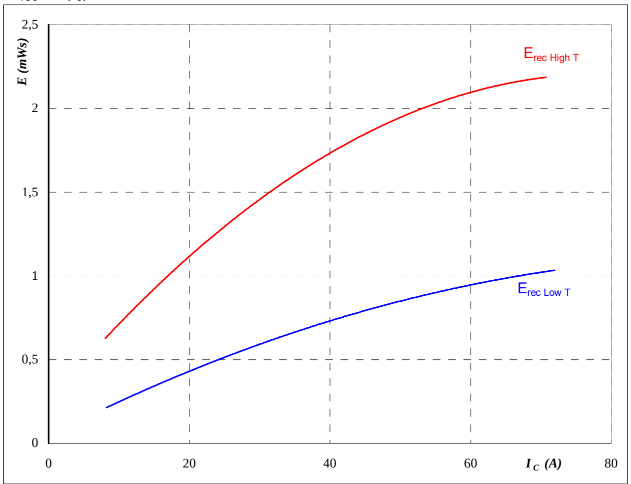



With an inductive load at

| | | |
|---|---|---|
| $T_j$ = | 25/125 | °C |
| $V_{CE}$ = | 350 | V |
| $V_{GE}$ = | ±15 | V |
| $I_C$ = | 41 | A |

| **Figure 7** | IGBT |
|---|---|

**Typical reverse recovery energy loss**
**as a function of collector current**
$E_{rec} = f(I_c)$

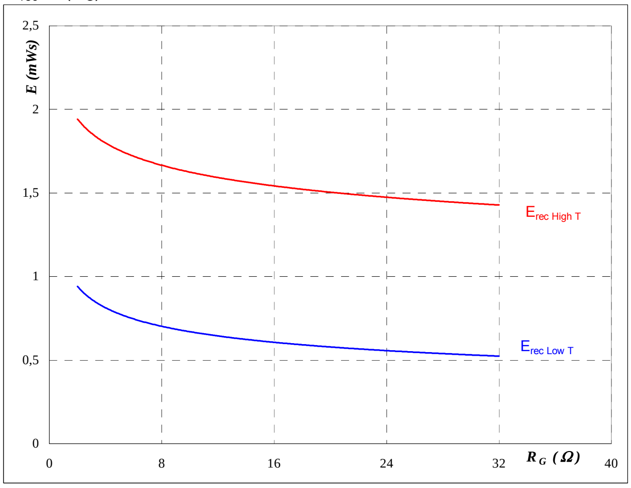



With an inductive load at

| | | |
|---|---|---|
| $T_j$ = | 25/125 | °C |
| $V_{CE}$ = | 350 | V |
| $V_{GE}$ = | ±15 | V |
| $R_{gon}$ = | 8 | Ω |

| **Figure 8** | IGBT |
|---|---|

**Typical reverse recovery energy loss**
**as a function of gate resistor**
$E_{rec} = f(R_G)$




With an inductive load at

| | | |
|---|---|---|
| $T_j$ = | 25/125 | °C |
| $V_{CE}$ = | 350 | V |
| $V_{GE}$ = | ±15 | V |
| $I_C$ = | 41 | A |

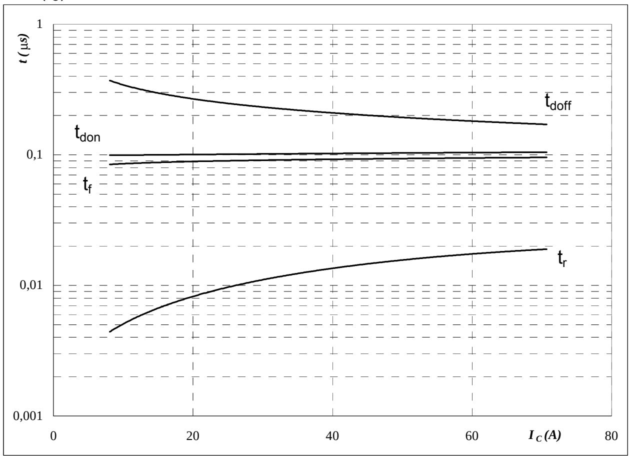
# Boost

**neutral point IGBT** and **half bridge FRED**

**Figure 9** IGBT

**Typical switching times as a function of collector current**

t = f($I_C$)



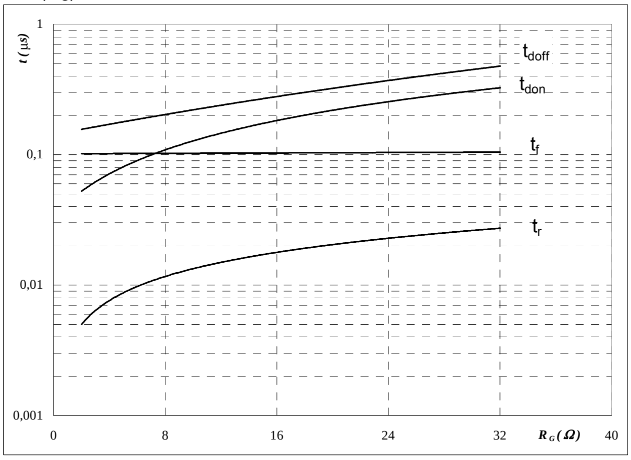

With an inductive load at

| | | |
|---|---|---|
| $T_j$ = | 125 | °C |
| $V_{CE}$ = | 350 | V |
| $V_{GE}$ = | ±15 | V |
| $R_{gon}$ = | 8 | Ω |
| $R_{goff}$ = | 8 | Ω |

**Figure 10** IGBT

**Typical switching times as a function of gate resistor**

t = f($R_G$)



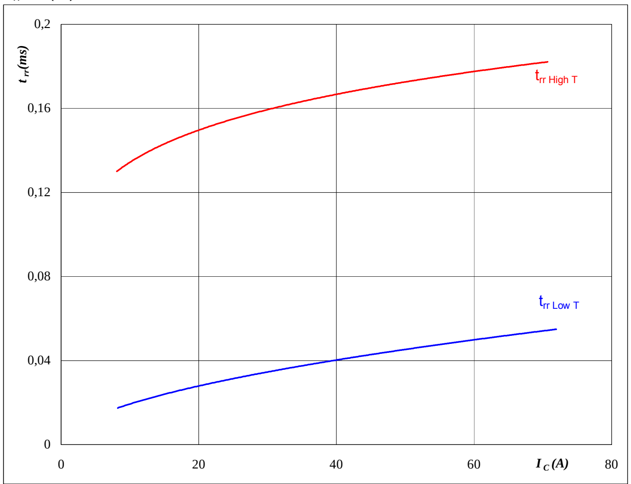

With an inductive load at

| | | |
|---|---|---|
| $T_j$ = | 125 | °C |
| $V_{CE}$ = | 350 | V |
| $V_{GE}$ = | ±15 | V |
| $I_C$ = | 41 | A |

**Figure 11** FRED

**Typical reverse recovery time as a function of collector current**

$t_{rr}$ = f(Ic)



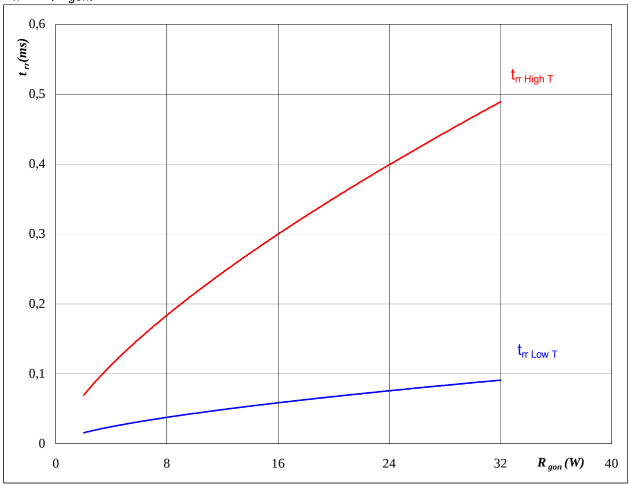

**At**

| | | |
|---|---|---|
| $T_j$ = | 25/125 | °C |
| $V_{CE}$ = | 350 | V |
| $V_{GE}$ = | ±15 | V |
| $R_{gon}$ = | 8 | Ω |

**Figure 12** FRED

**Typical reverse recovery time as a function of IGBT turn on gate resistor**

$t_{rr}$ = f($R_{gon}$)




**At**

| | | |
|---|---|---|
| $T_j$ = | 25/125 | °C |
| $V_R$ = | 350 | V |
| $I_F$ = | 41 | A |
| $V_{GE}$ = | ±15 | V |

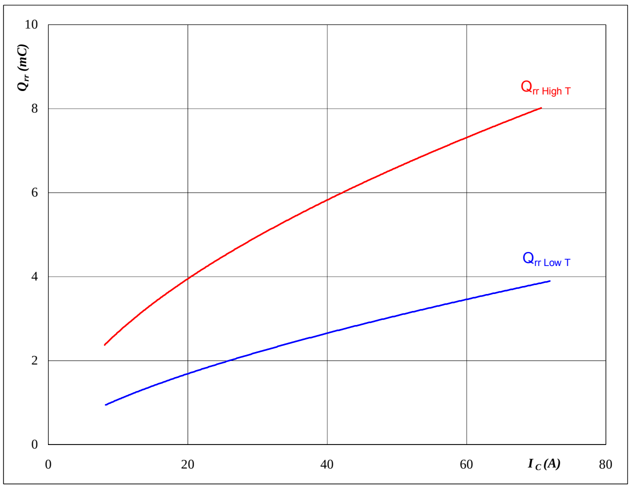
# Boost

**neutral point IGBT** and **half bridge FRED**

**Figure 13** FRED

**Typical reverse recovery charge as a function of collector current**

$Q_{rr} = f(I_C)$

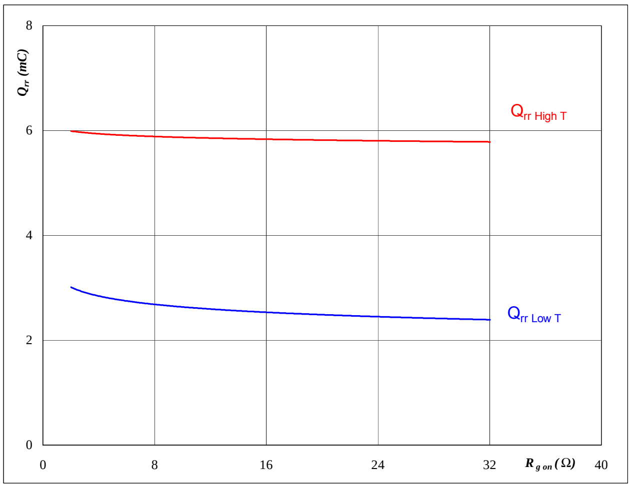



| At | | |
|---|---|---|
| $T_j$ = | 25/125 | °C |
| $V_{CE}$ = | 350 | V |
| $V_{GE}$ = | ±15 | V |
| $R_{gon}$ = | 8 | Ω |

**Figure 14** FRED

**Typical reverse recovery charge as a function of IGBT turn on gate resistor**

$Q_{rr} = f(R_{gon})$

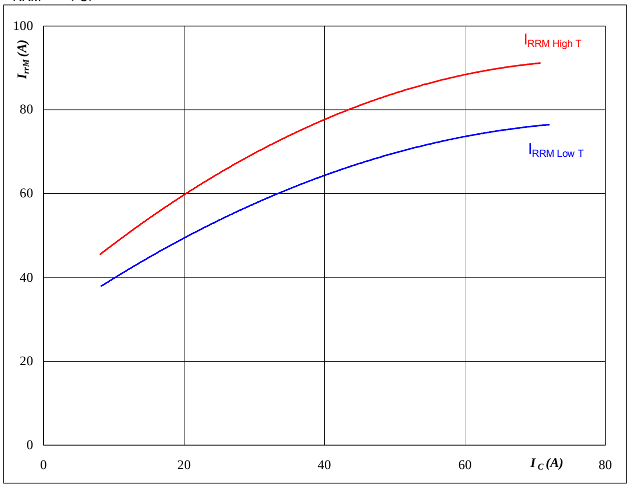



| At | | |
|---|---|---|
| $T_j$ = | 25/125 | °C |
| $V_R$ = | 350 | V |
| $I_F$ = | 41 | A |
| $V_{GE}$ = | ±15 | V |

**Figure 15** FRED

**Typical reverse recovery current as a function of collector current**

$I_{RRM} = f(I_C)$

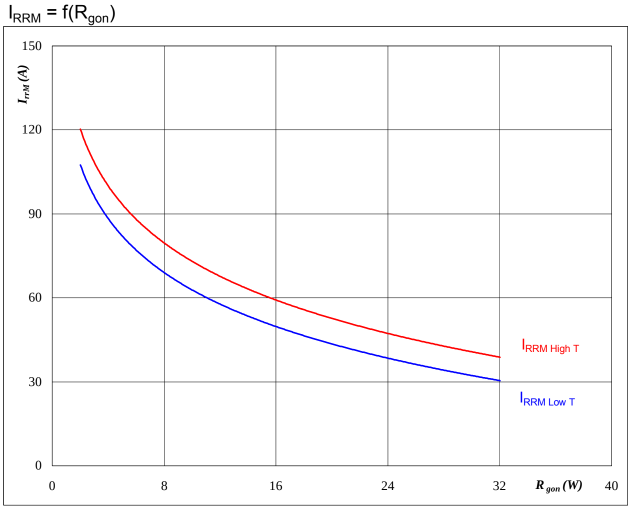



| At | | |
|---|---|---|
| $T_j$ = | 25/125 | °C |
| $V_{CE}$ = | 350 | V |
| $V_{GE}$ = | ±15 | V |
| $R_{gon}$ = | 8 | Ω |

**Figure 16** FRED

**Typical reverse recovery current as a function of IGBT turn on gate resistor**

$I_{RRM} = f(R_{gon})$




| At | | |
|---|---|---|
| $T_j$ = | 25/125 | °C |
| $V_R$ = | 350 | V |
| $I_F$ = | 41 | A |
| $V_{GE}$ = | ±15 | V |

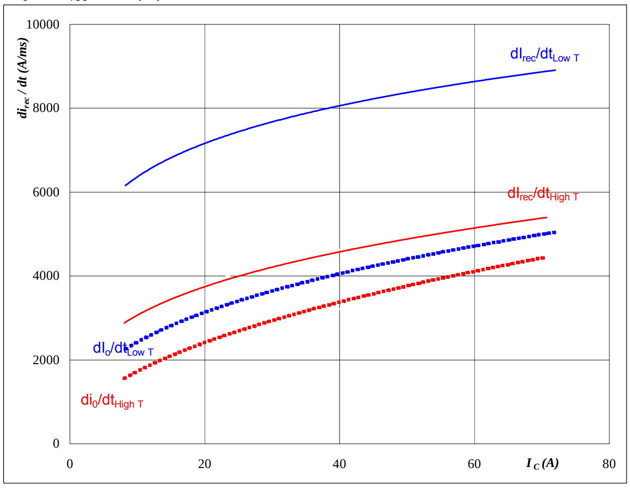
# Boost

**neutral point IGBT** and **half bridge FRED**

**Figure 17** FRED

**Typical rate of fall of forward and reverse recovery current as a function of collector current**

$dI_0/dt, dI_{rec}/dt = f(I_c)$



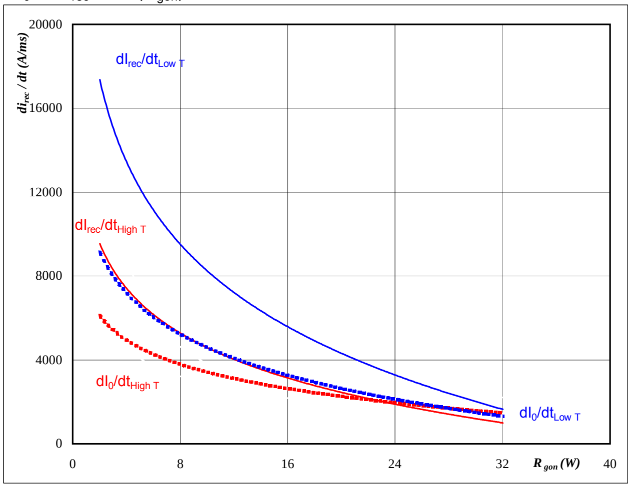

At

| | | |
|---|---|---|
| $T_j$ = | 25/125 | °C |
| $V_{CE}$ = | 350 | V |
| $V_{GE}$ = | ±15 | V |
| $R_{gon}$ = | 8 | Ω |

**Figure 18** FRED

**Typical rate of fall of forward and reverse recovery current as a function of IGBT turn on gate resistor**

$dI_0/dt, dI_{rec}/dt = f(R_{gon})$



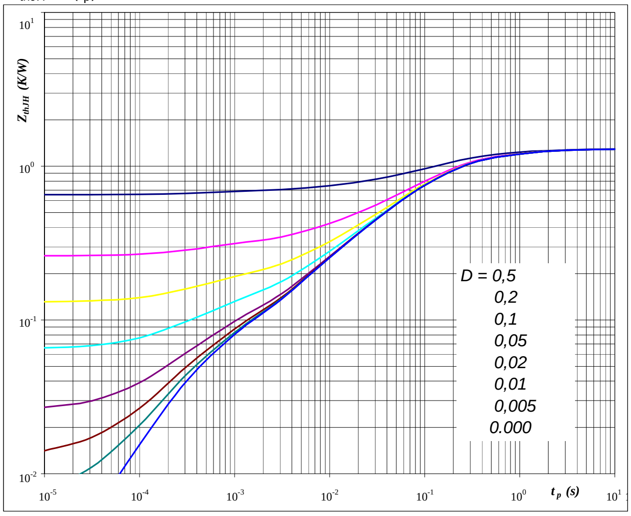

At

| | | |
|---|---|---|
| $T_j$ = | 25/125 | °C |
| $V_R$ = | 350 | V |
| $I_F$ = | 41 | A |
| $V_{GE}$ = | ±15 | V |

**Figure 19** IGBT

**IGBT transient thermal impedance as a function of pulse width**

$Z_{thJH} = f(t_p)$




At

| | | |
|---|---|---|
| D = | tp / T | |
| $R_{thJH}$ = | 1,30 | K/W |

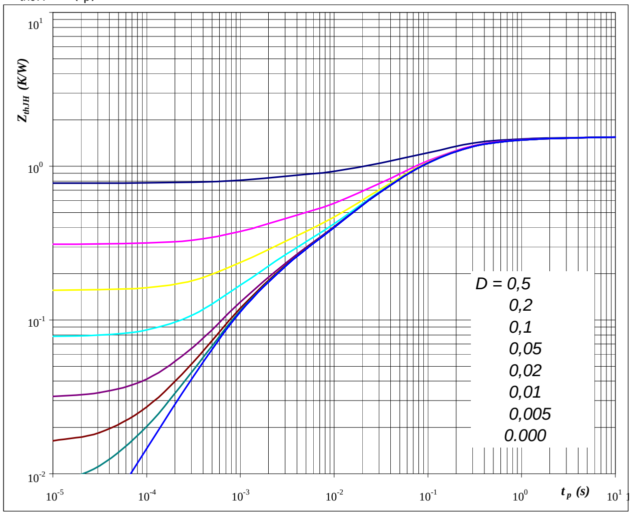
IGBT thermal model values

| R (C/W) | Tau (s) |
|---|---|
| 0,04 | 9,0E+00 |
| 0,17 | 1,1E+00 |
| 0,62 | 1,7E-01 |
| 0,31 | 3,9E-02 |
| 0,12 | 6,7E-03 |
| 0,06 | 4,1E-04 |

**Figure 20** FRED

**FRED transient thermal impedance as a function of pulse width**

$Z_{thJH} = f(t_p)$




At

| | | |
|---|---|---|
| D = | tp / T | |
| $R_{thJH}$ = | 1,55 | K/W |

FRED thermal model values

| R (C/W) | Tau (s) |
|---|---|
| 0,06 | 3,9E+00 |
| 0,30 | 3,8E-01 |
| 0,77 | 7,8E-02 |
| 0,28 | 1,2E-02 |
| 0,14 | 1,2E-03 |

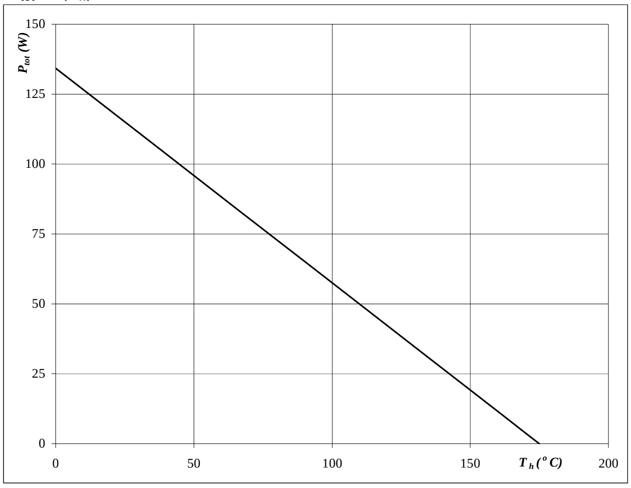
# Boost

**neutral point IGBT** and **half bridge FRED**

**Figure 21** IGBT

**Power dissipation as a function of heatsink temperature**

$P_{tot} = f(T_h)$



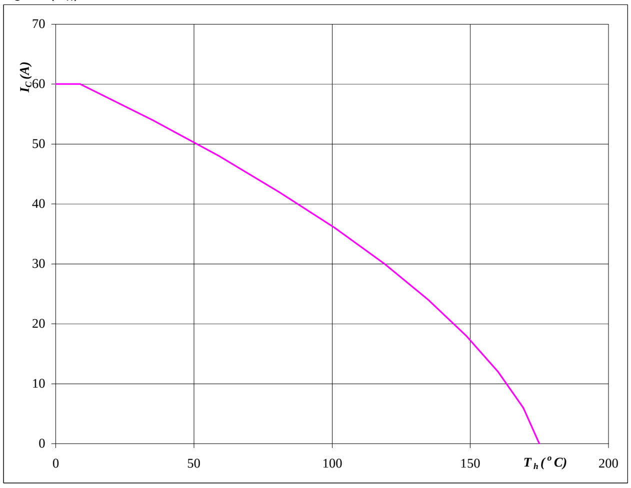

**At**

$T_j$ = 175 ºC

**Figure 22** IGBT

**Collector current as a function of heatsink temperature**

$I_C = f(T_h)$




**At**

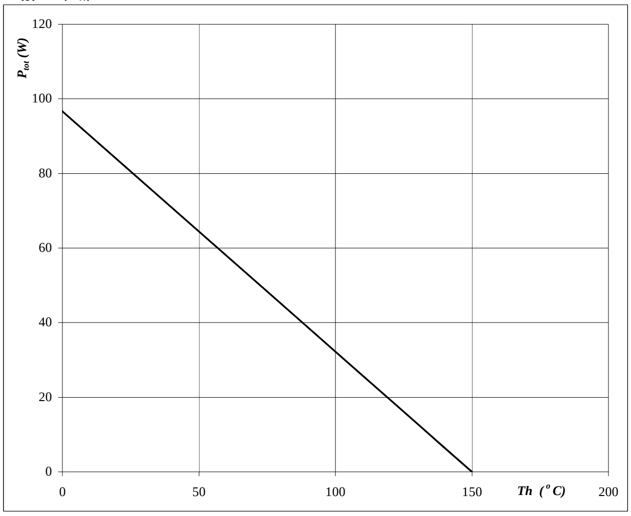
$T_j$ = 175 ºC

$V_{GE}$ = 15 V

**Figure 23** FRED

**Power dissipation as a function of heatsink temperature**

$P_{tot} = f(T_h)$



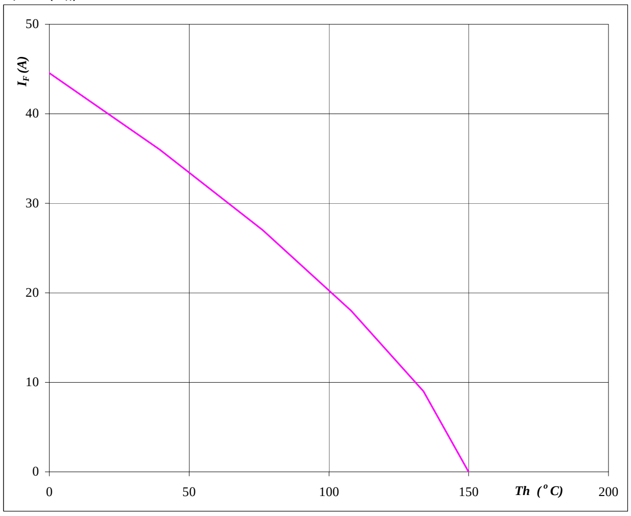

**At**

$T_j$ = 150 ºC

**Figure 24** FRED

**Forward current as a function of heatsink temperature**

$I_F = f(T_h)$




**At**

$T_j$ = 150 ºC

# Thermistor

**Figure 1** Thermistor

**Typical NTC characteristic**
**as a function of temperature**

$R_T = f(T)$

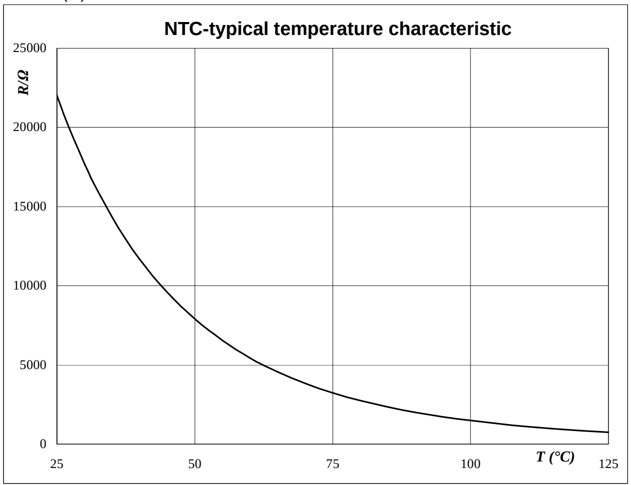



**Figure 2** Thermistor

**Typical NTC resistance values**

$$R(T) = R_{25} \cdot e^{\left(B_{25/100} \cdot \left(\frac{1}{T} - \frac{1}{T_{25}}\right)\right)} \quad [\Omega]$$

| T [°C] | R [Ω] | | T [°C] | R [Ω] |
|---|---|---|---|---|
| -55 | 3006477 | | 30 | 17635 |
| -50 | 1993973 | | 40 | 11574 |
| -45 | 1346473 | | 50 | 7796 |
| -40 | 924676 | | 55 | 6457 |
| -35 | 645112 | | 60 | 5378 |
| -30 | 456784 | | 65 | 4503 |
| -25 | 327965 | | 70 | 3791 |
| -20 | 238577 | | 75 | 3207 |
| -15 | 175705 | | 80 | 2726 |
| -10 | 130914 | | 85 | 2327 |
| -5 | 98618 | | 90 | 1996 |
| 0 | 75063 | | 95 | 1718 |
| 5 | 57698 | | 100 | 1486 |
| 10 | 44764 | | 105 | 1289 |
| 15 | 35037 | | 110 | 1123 |
| 20 | 27654 | | 115 | 982 |
| 25 | 22000 | | 120 | 861 |
| 30 | 17635 | | 125 | 758 |

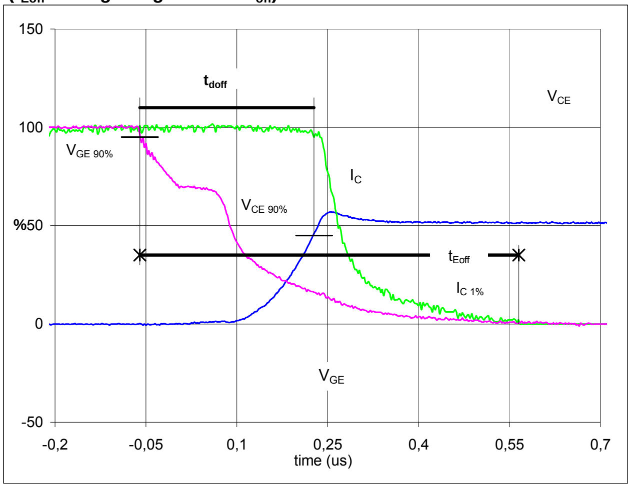
# Switching Definitions BUCK IGBT

**General conditions**

| | | |
|---|---|---|
| $T_j$ | = | 125 °C |
| $R_{gon}$ | = | 8 Ω |
| $R_{goff}$ | = | 8 Ω |

**Figure 1** half bridge IGBT

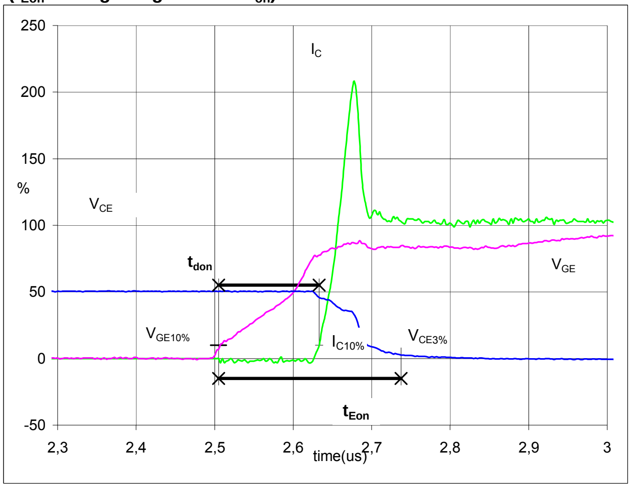
**Turn-off Switching Waveforms & definition of $t_{doff}$, $t_{Eoff}$**
**($t_{Eoff}$ = integrating time for $E_{off}$)**




| | | |
|---|---|---|
| $V_{GE}$ (0%) = | -15 | V |
| $V_{GE}$ (100%) = | 15 | V |
| $V_C$ (100%) = | 700 | V |
| $I_C$ (100%) = | 40 | A |
| $t_{doff}$ = | 0,28 | μs |
| $t_{Eoff}$ = | 0,63 | μs |

**Figure 2** half bridge IGBT

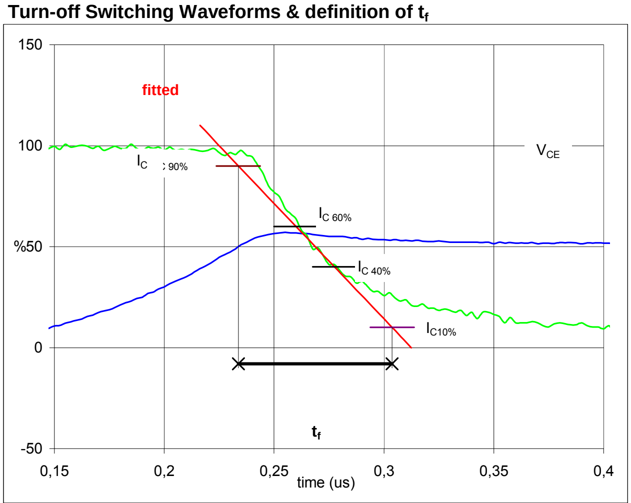
**Turn-on Switching Waveforms & definition of $t_{don}$, $t_{Eon}$**
**($t_{Eon}$ = integrating time for $E_{on}$)**




| | | |
|---|---|---|
| $V_{GE}$ (0%) = | -15 | V |
| $V_{GE}$ (100%) = | 15 | V |
| $V_C$ (100%) = | 700 | V |
| $I_C$ (100%) = | 40 | A |
| $t_{don}$ = | 0,13 | μs |
| $t_{Eon}$ = | 0,23 | μs |

**Figure 3** half bridge IGBT

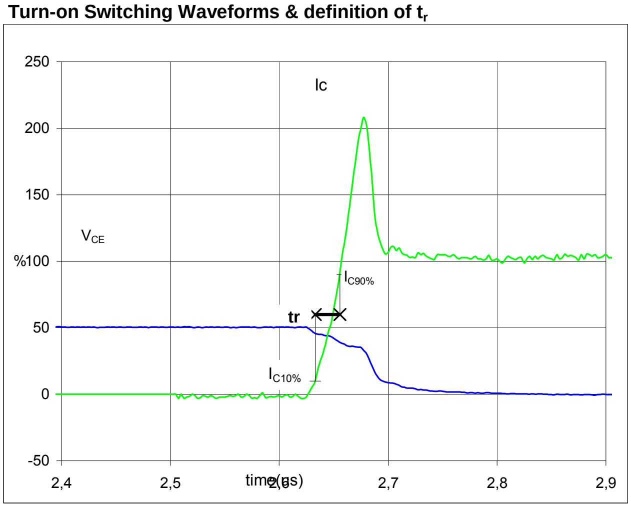
**Turn-off Switching Waveforms & definition of $t_f$**




| | | |
|---|---|---|
| $V_C$ (100%) = | 700 | V |
| $I_C$ (100%) = | 40 | A |
| $t_f$ = | 0,07 | μs |

**Figure 4** half bridge IGBT

**Turn-on Switching Waveforms & definition of $t_r$**

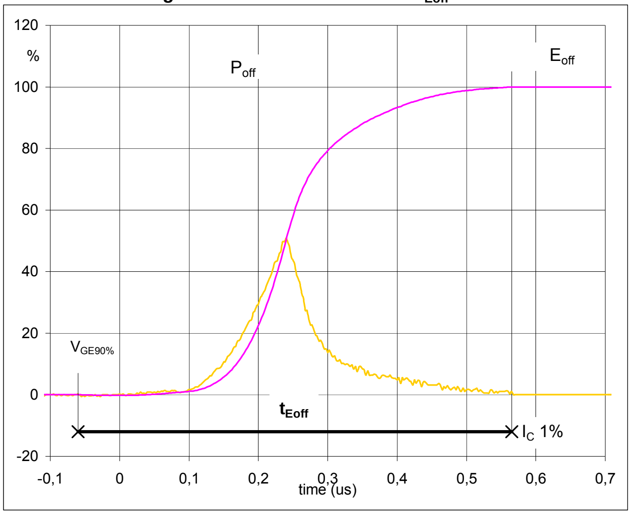



| | | |
|---|---|---|
| $V_C$ (100%) = | 700 | V |
| $I_C$ (100%) = | 40 | A |
| $t_r$ = | 0,02 | μs |

# Switching Definitions BUCK IGBT

**Figure 5** half bridge IGBT

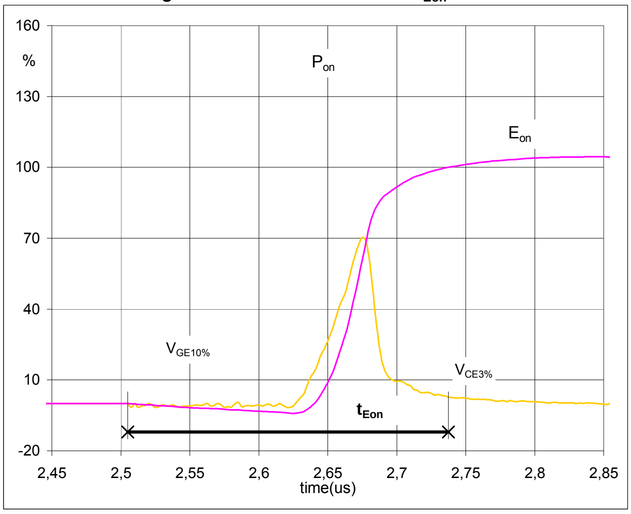
**Turn-off Switching Waveforms & definition of $t_{Eoff}$**




| | | |
|---|---|---|
| $P_{off}$ (100%) = | 28,05 | kW |
| $E_{off}$ (100%) = | 1,65 | mJ |
| $t_{Eoff}$ = | 0,63 | µs |

**Figure 6** half bridge IGBT

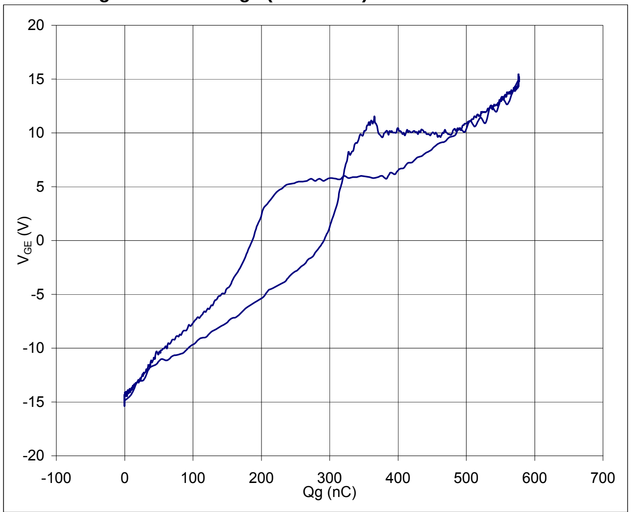
**Turn-on Switching Waveforms & definition of $t_{Eon}$**




| | | |
|---|---|---|
| $P_{on}$ (100%) = | 28,05 | kW |
| $E_{on}$ (100%) = | 0,70 | mJ |
| $t_{Eon}$ = | 0,23 | µs |

**Figure 7** half bridge IGBT

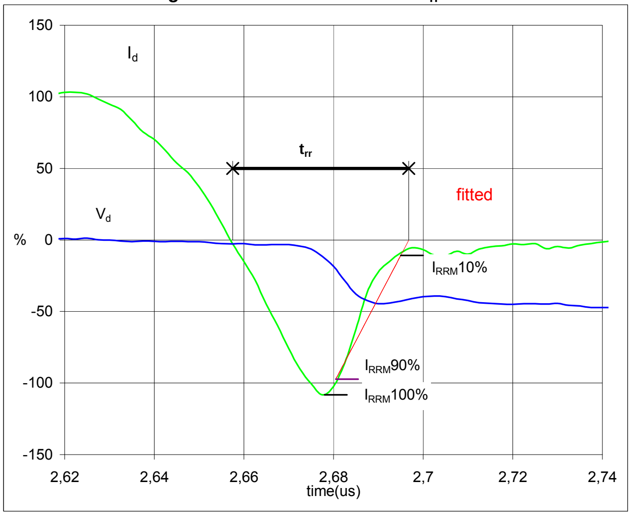
**Gate voltage vs Gate charge (measured)**




| | | |
|---|---|---|
| $V_{GEoff}$ = | -15 | V |
| $V_{GEon}$ = | 15 | V |
| $V_C$ (100%) = | 700 | V |
| $I_C$ (100%) = | 40 | A |
| $Q_g$ = | 1556,37 | nC |

**Figure 8** half bridge IGBT

**Turn-off Switching Waveforms & definition of $t_{rr}$**

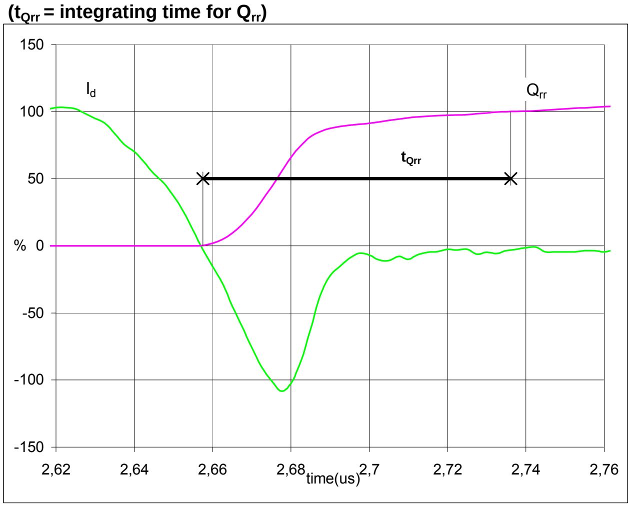



| | | |
|---|---|---|
| $V_d$ (100%) = | 700 | V |
| $I_d$ (100%) = | 40 | A |
| $I_{RRM}$ (100%) = | -43 | A |
| $t_{rr}$ = | 0,04 | µs |

# Switching Definitions BUCK IGBT

**Figure 9** neutral point FRED

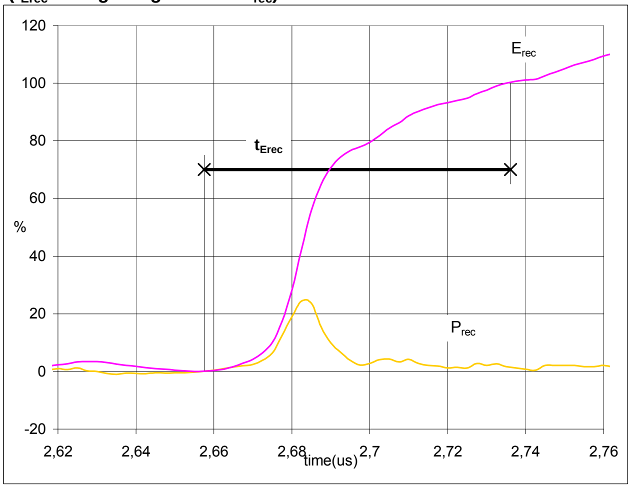
**Turn-on Switching Waveforms & definition of $t_{Qrr}$**
**($t_{Qrr}$ = integrating time for $Q_{rr}$)**




| | | |
|---|---|---|
| $I_d$ (100%) = | 40 | A |
| $Q_{rr}$ (100%) = | 0,95 | µC |
| $t_{Qrr}$ = | 0,08 | µs |

**Figure 10** neutral point FRED

**Turn-on Switching Waveforms & definition of $t_{Erec}$**
**($t_{Erec}$= integrating time for $E_{rec}$)**

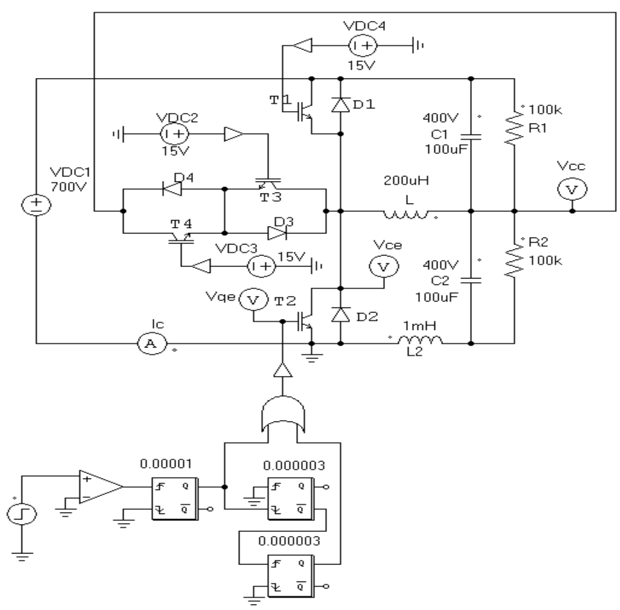



| | | |
|---|---|---|
| $P_{rec}$ (100%) = | 28,05 | kW |
| $E_{rec}$ (100%) = | 0,12 | mJ |
| $t_{Erec}$ = | 0,08 | µs |

# Measurement circuit

**Figure 11**

**BUCK stage switching measurement circuit**



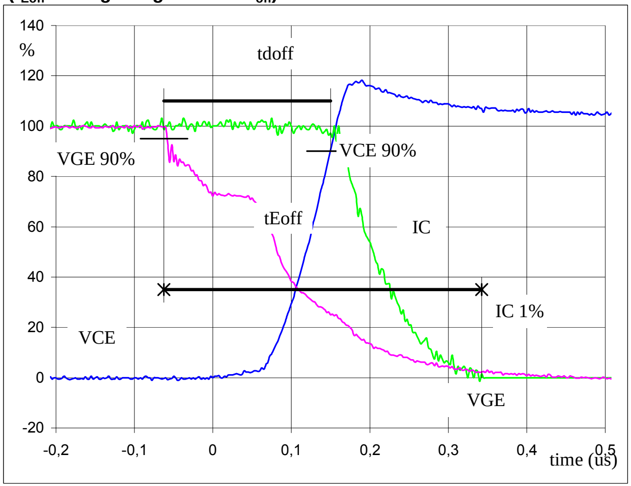
# Switching Definitions BOOST IGBT

**General conditions**

| | | |
|---|---|---|
| $T_j$ | = | 125 °C |
| $R_{gon}$ | = | 8 Ω |
| $R_{goff}$ | = | 8 Ω |

**Figure 1** neutral point IGBT

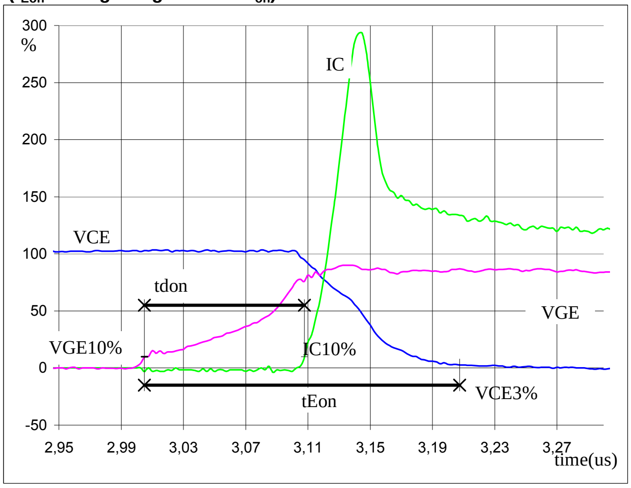
**Turn-off Switching Waveforms & definition of $t_{doff}$, $t_{Eoff}$**
**($t_{Eoff}$ = integrating time for $E_{off}$)**




| | | |
|---|---|---|
| $V_{GE}$ (0%) = | -15 | V |
| $V_{GE}$ (100%) = | 15 | V |
| $V_C$ (100%) = | 350 | V |
| $I_C$ (100%) = | 40 | A |
| $t_{doff}$ = | 0,21 | μs |
| $t_{Eoff}$ = | 0,40 | μs |

**Figure 2** neutral point IGBT

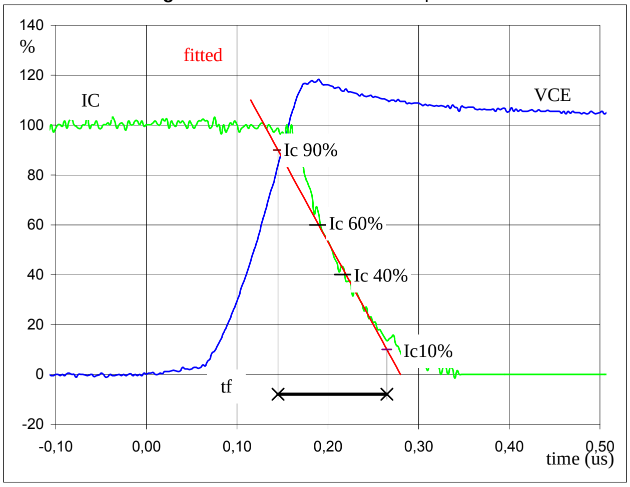
**Turn-on Switching Waveforms & definition of $t_{don}$, $t_{Eon}$**
**($t_{Eon}$ = integrating time for $E_{on}$)**




| | | |
|---|---|---|
| $V_{GE}$ (0%) = | -15 | V |
| $V_{GE}$ (100%) = | 15 | V |
| $V_C$ (100%) = | 350 | V |
| $I_C$ (100%) = | 40 | A |
| $t_{don}$ = | 0,10 | μs |
| $t_{Eon}$ = | 0,20 | μs |

**Figure 3** neutral point IGBT

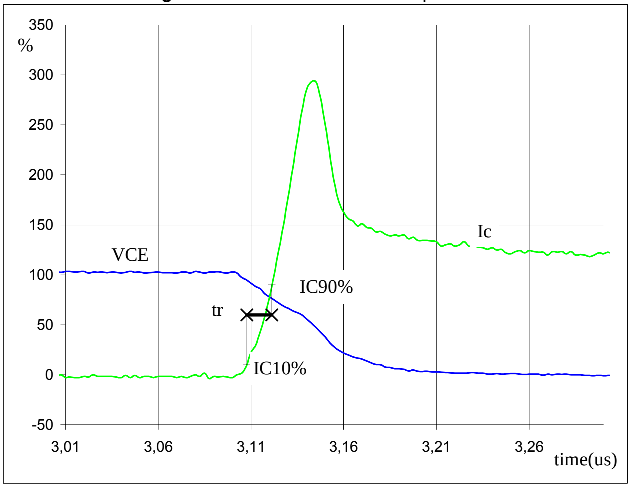
**Turn-off Switching Waveforms & definition of $t_f$**




| | | |
|---|---|---|
| $V_C$ (100%) = | 350 | V |
| $I_C$ (100%) = | 40 | A |
| $t_f$ = | 0,099 | μs |

**Figure 4** neutral point IGBT

**Turn-on Switching Waveforms & definition of $t_r$**

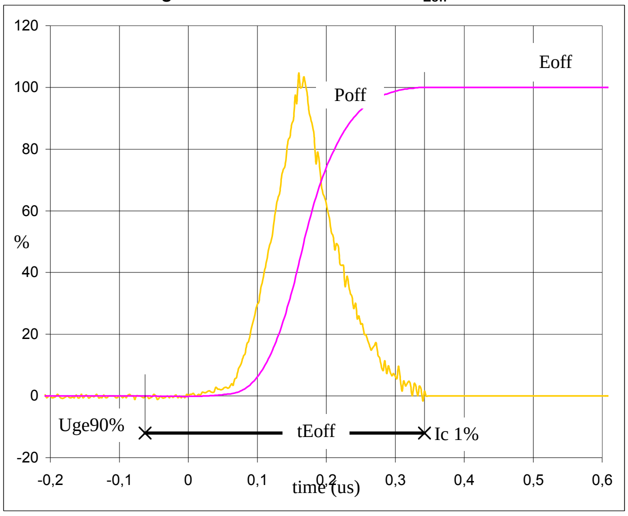



| | | |
|---|---|---|
| $V_C$ (100%) = | 350 | V |
| $I_C$ (100%) = | 40 | A |
| $t_r$ = | 0,013 | μs |

# Switching Definitions BOOST IGBT

**Figure 5** neutral point IGBT

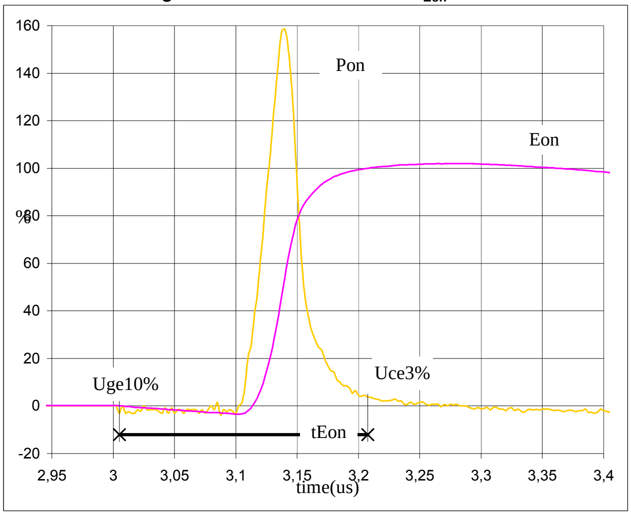
**Turn-off Switching Waveforms & definition of $t_{Eoff}$**




| | | |
|---|---|---|
| $P_{off}$ (100%) = | 13,96 | kW |
| $E_{off}$ (100%) = | 1,50 | mJ |
| $t_{Eoff}$ = | 0,40 | μs |

**Figure 6** neutral point IGBT

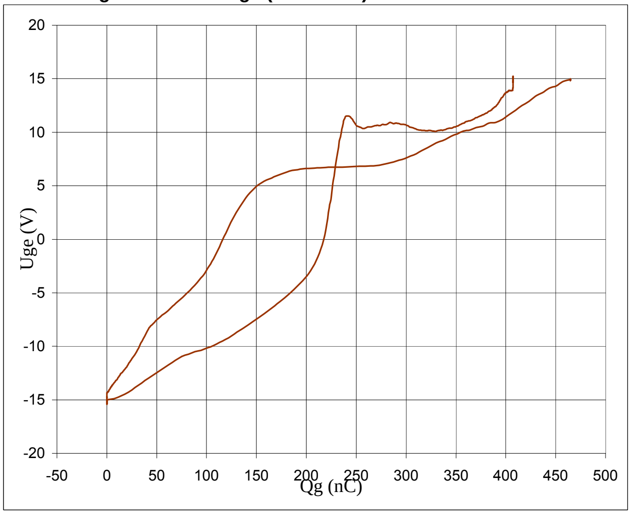
**Turn-on Switching Waveforms & definition of $t_{Eon}$**




| | | |
|---|---|---|
| $P_{on}$ (100%) = | 13,9552 | kW |
| $E_{on}$ (100%) = | 0,72 | mJ |
| $t_{Eon}$ = | 0,2025 | μs |

**Figure 7** neutral point IGBT

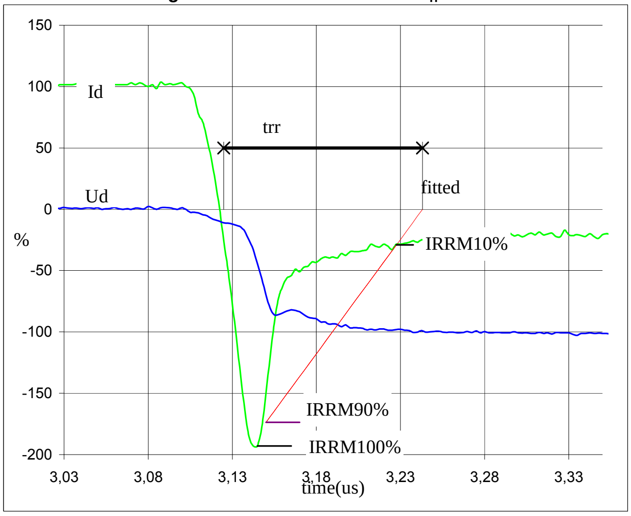
**Gate voltage vs Gate charge (measured)**




| | | |
|---|---|---|
| $V_{GEoff}$ = | -15 | V |
| $V_{GEon}$ = | 15 | V |
| $V_C$ (100%) = | 350 | V |
| $I_C$ (100%) = | 40 | A |
| $Q_g$ = | 464,74 | nC |

**Figure 8** half bridge FRED

**Turn-off Switching Waveforms & definition of $t_{rr}$**

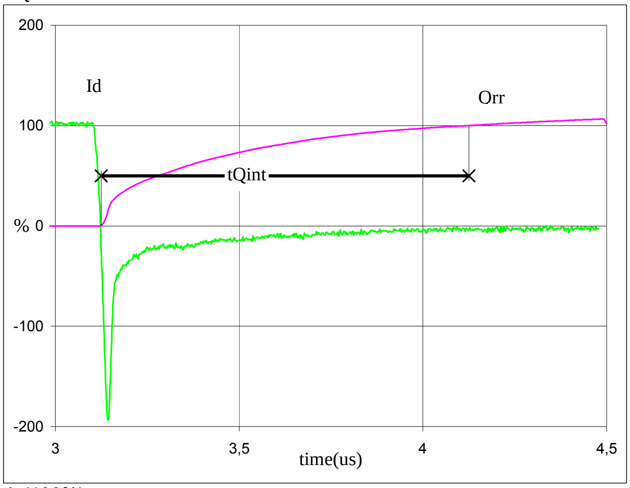



| | | |
|---|---|---|
| $V_d$ (100%) = | 350 | V |
| $I_d$ (100%) = | 40 | A |
| $I_{RRM}$ (100%) = | -79 | A |
| $t_{rr}$ = | 0,17 | μs |

# Switching Definitions BOOST IGBT

**Figure 9** half bridge FRED

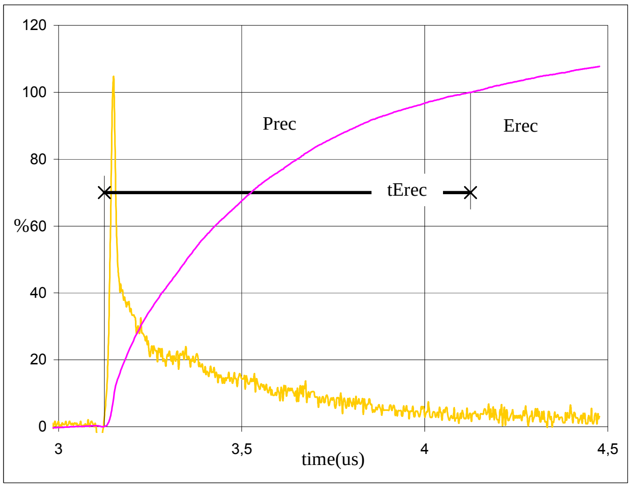
**Turn-on Switching Waveforms & definition of $t_{Qrr}$**
**($t_{Qrr}$= integrating time for $Q_{rr}$)**




| | | |
|---|---|---|
| $I_d$ (100%) = | 40 | A |
| $Q_{rr}$ (100%) = | 6,14 | μC |
| $t_{Qint}$ = | 1,00 | μs |

**Figure 10** half bridge FRED

**Turn-on Switching Waveforms & definition of $t_{Erec}$**
**($t_{Erec}$= integrating time for $E_{rec}$)**

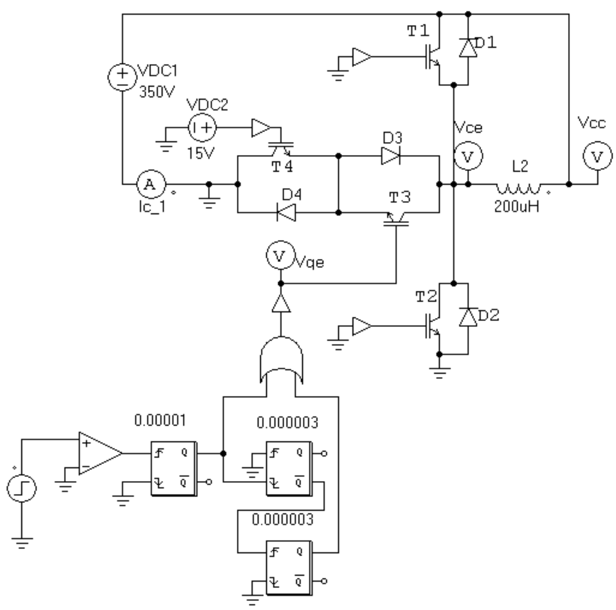



| | | |
|---|---|---|
| $P_{rec}$ (100%) = | 13,96 | kW |
| $E_{rec}$ (100%) = | 1,79 | mJ |
| $t_{Erec}$ = | 1,00 | μs |

# Measurement circuit

**Figure 11**

**BOOST stage switching measurement circuit**



# Ordering Code and Marking - Outline - Pinout

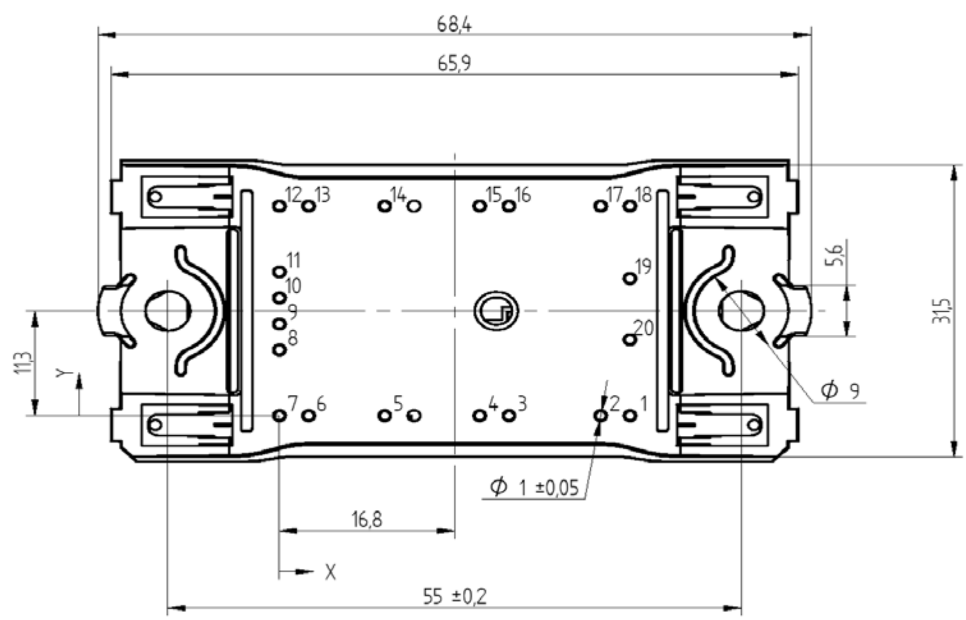
## Ordering Code & Marking

| Version | Ordering Code | in DataMatrix as | in packaging barcode as |
|---|---|---|---|
| without thermal paste 12mm housing | 10-FZ06NMA080SH-M269F | M269F | M269F |

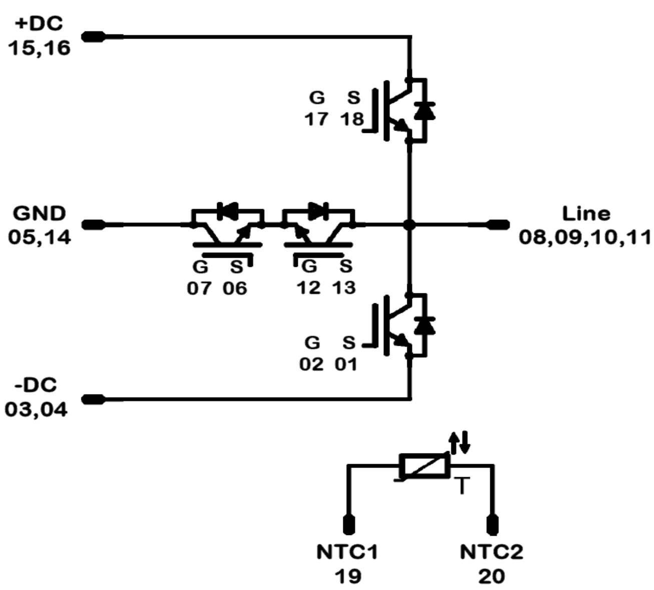
## Outline

Pin table

| Pin | X | Y |
|---|---|---|
| 1 | 33,6 | 0 |
| 2 | 30,8 | 0 |
| 3 | 22 | 0 |
| 4 | 19,2 | 0 |
| 5 | 10,1 | 0 |
| 6 | 2,8 | 0 |
| 7 | 0 | 0 |
| 8 | 0 | 7,1 |
| 9 | 0 | 9,9 |
| 10 | 0 | 12,7 |
| 11 | 0 | 15,5 |
| 12 | 0 | 22,6 |
| 13 | 2,8 | 22,6 |
| 14 | 10,1 | 22,6 |
| 15 | 19,2 | 22,6 |
| 16 | 22 | 22,6 |
| 17 | 30,8 | 22,6 |
| 18 | 33,6 | 22,6 |
| 19 | 33,6 | 14,8 |
| 20 | 33,6 | 8,2 |




## Pinout



## PRODUCT STATUS DEFINITIONS

| Datasheet Status | Product Status | Definition |
|---|---|---|
| Target | Formative or In Design | This datasheet contains the design specifications for product development. Specifications may change in any manner without notice. The data contained is exclusively intended for technically trained staff. |
| Preliminary | First Production | This datasheet contains preliminary data, and supplementary data may be published at a later date. Vincotech reserves the right to make changes at any time without notice in order to improve design. The data contained is exclusively intended for technically trained staff. |
| Final | Full Production | This datasheet contains final specifications. Vincotech reserves the right to make changes at any time without notice in order to improve design. The data contained is exclusively intended for technically trained staff. |



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2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.