Vincotech

| MiniSKiiP PIM 2 | 600 V / 30 A |

Topology features

- Kelvin Emitter for improved switching performance
- Single-phase Converter+Brake+Inverter
- Temperature sensor

Component features

- Easy paralleling
- Low turn-off losses
- Low collector emitter saturation voltage
- Positive temperature coefficient
- Short tail current

Housing features

- Base isolation: Al_2O_3
- Easy assembly in one mounting step
- Flexible PCB design w/o pin holes
- Rugged solderless spring contacts
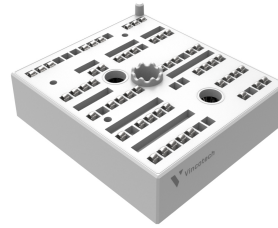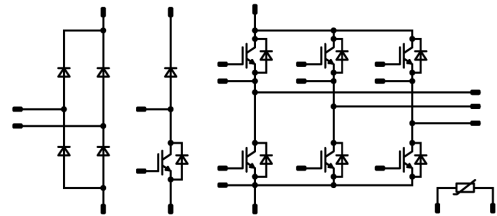
Target applications

- Industrial Drives

Types

- V23990-K222-B10

MiniSKiiP® 2 16 mm housing

Schematic

Vincotech

Maximum Ratings

T_j = 25 °C, unless otherwise specified

Parameter	Symbol	Conditions		Value	Unit
Inverter Switch					
Collector-emitter voltage	V_{CES}			600	V
Collector current (DC current)	I_C	$T_j = T_{jmax}$	$T_s = 80$ °C	36	A
Repetitive peak collector current	I_{CRM}	t_p limited by T_{jmax}		90	A
Total power dissipation	P_{tot}	$T_j = T_{jmax}$	$T_s = 80$ °C	79	W
Gate-emitter voltage	V_{GES}			±20	V
Short circuit ratings	t_{SC}	$V_{GE} = 15$ V, $V_{CC} = 360$ V	$T_j = 150$ °C	6	µs
Maximum junction temperature	T_{jmax}			175	°C
Inverter Diode					
Peak repetitive reverse voltage	V_{RRM}			600	V
Forward current (DC current)	I_F	$T_j = T_{jmax}$	$T_s = 80$ °C	29	A
Repetitive peak forward current	I_{FRM}	t_p limited by T_{jmax}		60	A
Total power dissipation	P_{tot}	$T_j = T_{jmax}$	$T_s = 80$ °C	53	W
Maximum junction temperature	T_{jmax}			175	°C
Brake Switch					
Collector-emitter voltage	V_{CES}			650	V
Collector current (DC current)	I_C	$T_j = T_{jmax}$	$T_s = 80$ °C	50	A
Repetitive peak collector current	I_{CRM}	t_p limited by T_{jmax}		150	A
Total power dissipation	P_{tot}	$T_j = T_{jmax}$	$T_s = 80$ °C	114	W
Gate-emitter voltage	V_{GES}			±20	V
Short circuit ratings	t_{SC}	$V_{GE} = 15$ V, $V_{CC} = 400$ V	$T_j = 150$ °C	5	µs
Maximum junction temperature	T_{jmax}			175	°C

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Maximum Ratings

T_j = 25 °C, unless otherwise specified

Parameter	Symbol	Conditions		Value	Unit
Brake Diode					
Peak repetitive reverse voltage	V_{RRM}			600	V
Forward current (DC current)	I_F	$T_j = T_{jmax}$	$T_s = 80$ °C	67	A
Surge (non-repetitive) forward current	I_{FSM}	Single Half Sine Wave, t_p = 10 ms	$T_j = 25$ °C	480	A
Total power dissipation	P_{tot}	$T_j = T_{jmax}$	$T_s = 80$ °C	99	W
Maximum junction temperature	T_{jmax}			175	°C
Brake Sw. Protection Diode					
Peak repetitive reverse voltage	V_{RRM}			650	V
Forward current (DC current)	I_F	$T_j = T_{jmax}$	$T_s = 80$ °C	20	A
Repetitive peak forward current	I_{FRM}	t_p limited by T_{jmax}		30	A
Total power dissipation	P_{tot}	$T_j = T_{jmax}$	$T_s = 80$ °C	38	W
Maximum junction temperature	T_{jmax}			175	°C
Rectifier Diode					
Peak repetitive reverse voltage	V_{RRM}			1600	V
Forward current (DC current)	I_F	$T_j = T_{jmax}$	$T_s = 80$ °C	81	A
Surge (non-repetitive) forward current	I_{FSM}	Single Half Sine Wave, t_p = 10 ms	$T_j = 150$ °C	270	A
Surge current capability	I^2t			365	A²s
Total power dissipation	P_{tot}	$T_j = T_{jmax}$	$T_s = 80$ °C	89	W
Maximum junction temperature	T_{jmax}			175	°C

Maximum Ratings

T_j = 25 °C, unless otherwise specified

Parameter	Symbol	Conditions	Value	Unit
Module Properties				
Thermal Properties				
Storage temperature	T_{stg}		-40...+125	°C
Operation temperature under switching condition	T_{jop}		-40...+(T_{jmax} - 25)	°C
Isolation Properties				
Isolation voltage	V_{isol}	DC Test Voltage* t_p = 2 s	5500	V
Creepage distance		With std lid For more informations see handling instructions	6,3	mm
Clearance		With std lid For more informations see handling instructions	6,3	mm
Comparative Tracking Index	CTI		≥ 600	

*100 % tested in production

Characteristic Values

Parameter	Symbol	Conditions				Values			Unit
		V_{GE} **[V]** V_{GS} **[V]**	V_{CE} **[V]** V_{DS} **[V]** V_{F} **[V]**	I_{C} **[A]** I_{D} **[A]** I_{F} **[A]**	T_{j} **[°C]**	**Min**	**Typ**	**Max**	

Inverter Switch

Static

Gate-emitter threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}$		0,00043	25	5	5,8	6,5	V
Collector-emitter saturation voltage	V_{CEsat}	15		30	25 125 150	1,1	1,76 1,88 1,95	1,9[1]	V
Collector-emitter cut-off current	I_{CES}	0	600		25			1,6	µA
Gate-emitter leakage current	I_{GES}	20	0		25			300	nA
Internal gate resistance	r_{g}						None		Ω
Input capacitance	C_{ies}						1630		pF
Output capacitance	C_{oes}	f = 1 Mhz	0 25		25		108		pF
Reverse transfer capacitance	C_{res}						50		pF

Thermal

Thermal resistance junction to sink[2]	$R_{th(j-s)}$	λ_{paste} = 2,5 W/mK (HPTP)					1,2		K/W

Dynamic

Turn-on delay time	$t_{d(on)}$				25 125 150		110,32 109,92 109,75		ns
Rise time	t_{r}	R_{gon} = 16 Ω R_{goff} = 16 Ω	±15	350	30	25 125 150		26,72 28,85 29,75		ns
Turn-off delay time	$t_{d(off)}$				25 125 150		147,75 168,27 172,74		ns
Fall time	t_{f}				25 125 150		63,53 88,5 97,95		ns
Turn-on energy (per pulse)	E_{on}	Q_{rFWD}=0,725 µC Q_{rFWD}=1,74 µC Q_{rFWD}=2,03 µC				25 125 150		0,669 0,933 1,02		mWs
Turn-off energy (per pulse)	E_{off}				25 125 150		0,794 1,08 1,14		mWs

Characteristic Values

Parameter	Symbol	Conditions				Values			Unit
		V_{GE} [V] V_{GS} [V]	V_{CE} [V] V_{DS} [V] V_{F} [V]	I_{C} [A] I_{D} [A] I_{F} [A]	T_{j} [°C]	Min	Typ	Max	

Inverter Diode

Static

Parameter	Symbol	Conditions				Values			Unit
Forward voltage	V_{F}			30	25 125 150	1,25	1,95 1,89 1,89	1,95[1]	V
Reverse leakage current	I_{R}	V_{r} = 600 V			25			27	µA

Thermal

Parameter	Symbol	Conditions				Values			Unit
Thermal resistance junction to sink[2]	$R_{th(j-s)}$	λ_{paste} = 2,5 W/mK (HPTP)					1,78		K/W

Dynamic

Parameter	Symbol	Conditions				Values			Unit
Peak recovery current	I_{RM}				25 125 150		17,56 22,38 23,79		A
Reverse recovery time	t_{rr}				25 125 150		145,16 228,36 249,11		ns
Recovered charge	Q_{r}	di/dt=1250 A/µs di/dt=1330 A/µs di/dt=1209 A/µs	±15	350	30 25 125 150		0,725 1,74 2,03		µC
Reverse recovered energy	E_{rec}				25 125 150		0,15 0,38 0,45		mWs
Peak rate of fall of recovery current	$(di_{rr}/dt)_{max}$				25 125 150		1131,35 437,42 411,36		A/µs

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Characteristic Values

Parameter	Symbol	Conditions				Values			Unit
		V_{GE} [V] V_{GS} [V]	V_{CE} [V] V_{DS} [V] V_{F} [V]	I_{C} [A] I_{D} [A] I_{F} [A]	T_{j} [°C]	Min	Typ	Max	

Brake Switch

Static

Parameter	Symbol	V_{GE}/V_{GS}	$V_{CE}/V_{DS}/V_F$	$I_C/I_D/I_F$	T_j	Min	Typ	Max	Unit
Gate-emitter threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}$		0,0008	25	4,2	5,1	5,6	V
Collector-emitter saturation voltage	V_{CEsat}	15		50	25 125	1,38	1,89 2,17	2,22[1]	V
Collector-emitter cut-off current	I_{CES}	0	650		25			2,8	µA
Gate-emitter leakage current	I_{GES}	20	0		25			150	nA
Internal gate resistance	r_g						None		Ω
Input capacitance	C_{ies}	f = 1 Mhz	0	20	25		3100		pF
Reverse transfer capacitance	C_{res}						90		pF

Thermal

Parameter	Symbol	Conditions				Min	Typ	Max	Unit
Thermal resistance junction to sink[2]	$R_{th(j-s)}$	λ_{paste} = 2,5 W/mK (HPTP)					0,83		K/W

Dynamic

Parameter	Symbol	Conditions				Min	Typ	Max	Unit
Turn-on delay time	$t_{d(on)}$	R_{gon} = 4 Ω R_{goff} = 4 Ω	0/15	400	50	25 125 150		21,76 20,73 20,98		ns
Rise time	t_r					25 125 150		33,57 33,12 33,27		ns
Turn-off delay time	$t_{d(off)}$					25 125 150		167,49 190,1 196,1		ns
Fall time	t_f					25 125 150		7,88 12,58 13,57		ns
Turn-on energy (per pulse)	E_{on}	Q_{rFWD}=0,34 µC Q_{rFWD}=1,38 µC Q_{rFWD}=1,81 µC				25 125 150		1,33 2,08 2,32		mWs
Turn-off energy (per pulse)	E_{off}					25 125 150		0,581 0,839 0,918		mWs

Characteristic Values

Parameter	Symbol	Conditions				Values			Unit
		V_{GE} [V] V_{GS} [V]	V_{CE} [V] V_{DS} [V] V_{F} [V]	I_{C} [A] I_{D} [A] I_{F} [A]	T_{j} [°C]	Min	Typ	Max	

Brake Diode

Static

Parameter	Symbol	Conditions				Values			Unit
Forward voltage	V_{F}			60	25 125 150		1,89 1,57 1,5	2,5[1]	V
Reverse leakage current	I_{R}	V_{r} = 600 V			25			25	µA

Thermal

Parameter	Symbol	Conditions				Values			Unit
Thermal resistance junction to sink[2]	$R_{th(j-s)}$	λ_{paste} = 2,5 W/mK (HPTP)					0,96		K/W

Dynamic

Parameter	Symbol	Conditions				Values			Unit
Peak recovery current	I_{RM}				25 125 150		15,52 29,16 33,42		A
Reverse recovery time	t_{rr}				25 125 150		52,42 74,66 83,45		ns
Recovered charge	Q_{r}	di/dt=1007 A/µs di/dt=1049 A/µs di/dt=961 A/µs	0/15 400	50	25 125 150		0,34 1,38 1,81		µC
Reverse recovered energy	E_{rec}				25 125 150		0,031 0,125 0,167		mWs
Peak rate of fall of recovery current	$(di_{rr}/dt)_{max}$				25 125 150		1387,51 1119,05 1324,09		A/µs

Characteristic Values

Parameter	Symbol	Conditions				Values			Unit
		V_{GE} [V] V_{GS} [V]	V_{CE} [V] V_{DS} [V] V_{F} [V]	I_{C} [A] I_{D} [A] I_{F} [A]	T_{j} [°C]	Min	Typ	Max	

Brake Sw. Protection Diode

Static

Parameter	Symbol					Min	Typ	Max	Unit
Forward voltage	V_{F}			15	25 125	1,23	1,79 1,67	1,87[1]	V
Reverse leakage current	I_{R}	V_{r} = 650 V			25			0,18	µA

Thermal

Parameter	Symbol					Min	Typ	Max	Unit
Thermal resistance junction to sink[2]	$R_{th(j\text{-}s)}$	λ_{paste} = 2,5 W/mK (HPTP)					2,53		K/W

Rectifier Diode

Static

Parameter	Symbol					Min	Typ	Max	Unit
Forward voltage	V_{F}			28	25 125 150		0,191 0,307 0,354	1,5[1]	V
Reverse leakage current	I_{R}	V_{r} = 1600 V			25 150			50 1000	µA

Thermal

Parameter	Symbol					Min	Typ	Max	Unit
Thermal resistance junction to sink[2]	$R_{th(j\text{-}s)}$	λ_{paste} = 2,5 W/mK (HPTP)					1,06		K/W

Characteristic Values

Parameter	Symbol	Conditions				Values			Unit
		V_{GE} **[V]** V_{GS} **[V]**	V_{CE} **[V]** V_{DS} **[V]** V_{F} **[V]**	I_{C} **[A]** I_{D} **[A]** I_{F} **[A]**	T_{j} **[°C]**	**Min**	**Typ**	**Max**	

Thermistor

Static

Parameter	Symbol	Conditions				Min	Typ	Max	Unit
Rated resistance	R				25		1		kΩ
Deviation of R100	$\Delta_{R/R}$	R_{100} = 1670 Ω			100	-2		2	%
Maximum Current	I_{max}						3		mA
Power dissipation constant	d				25		0,76		mW/K
A-value	A						$7{,}635 \times 10^{-3}$		1/K
B-value	B						$1{,}73 \times 10^{-5}$		$1/K^2$
Vincotech Thermistor Reference								E	

[1] Value at chip level

[2] Only valid with pre-applied Vincotech thermal interface material.

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Inverter Switch Characteristics

figure 1. IGBT

Typical output characteristics

$I_C = f(V_{CE})$

$t_p =$	250	µs		25 °C	
$V_{GE} =$	15	V	T_j:	125 °C	
				150 °C	
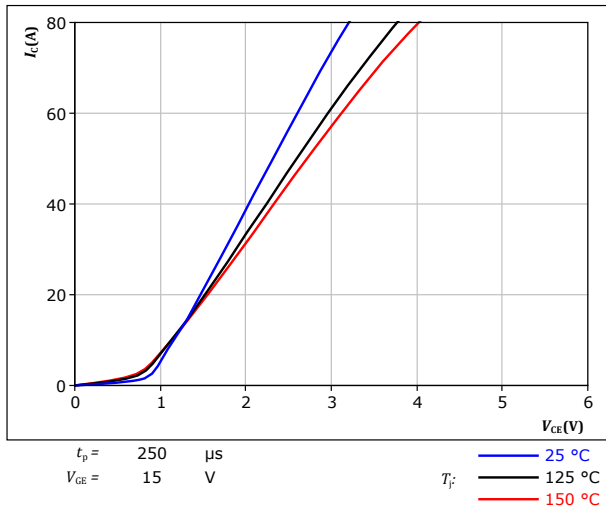
figure 2. IGBT

Typical output characteristics

$I_C = f(V_{CE})$

V_{GE}:
7 V, 8 V, 9 V, 10 V, 11 V, 12 V, 13 V, 14 V, 15 V, 16 V, 17 V

$t_p =$	250	µs
$T_j =$	150	°C

V_{GE} from 7 V to 17 V in steps of 1 V
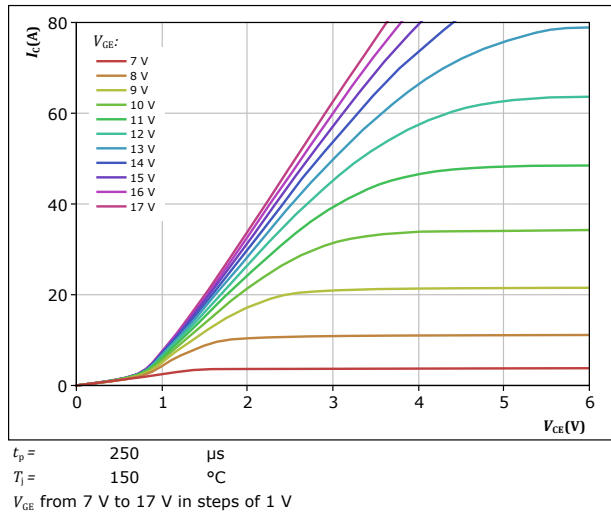
figure 3. IGBT

Typical transfer characteristics

$I_C = f(V_{GE})$

$t_p =$	250	µs		25 °C	
$V_{CE} =$	14	V	T_j:	125 °C	
				150 °C	
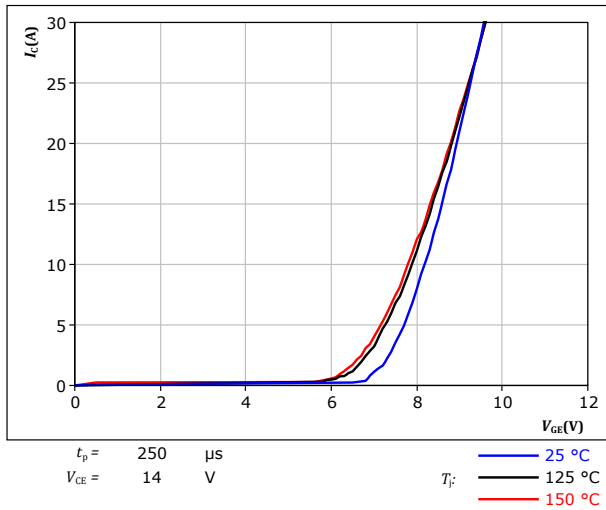
figure 4. IGBT

Transient thermal impedance as a function of pulse width

$Z_{th(j-s)} = f(t_p)$

0,5; 0,2; 0,1; 0,05; 0,02; 0,01; 0,005; 0

$D = t_p / T$

$R_{th(j-s)} =$ 1,199 K/W
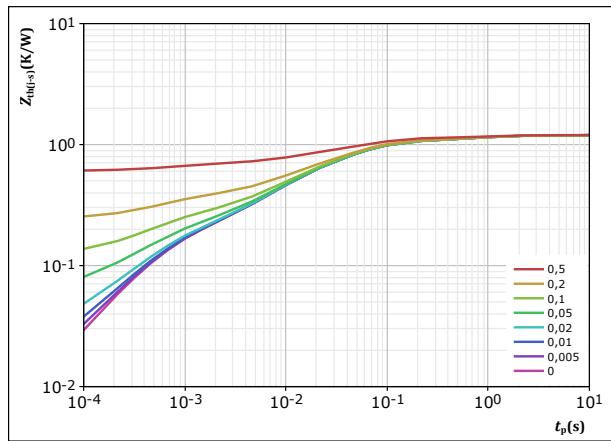
IGBT thermal model values

R (K/W)	τ (s)
2,10E-02	1,09E+01
1,46E-01	6,95E-01
5,84E-01	4,74E-02
3,09E-01	9,24E-03
1,45E-01	5,37E-04

Inverter Switch Characteristics

figure 5.	IGBT

Safe operating area

I_C = f(V_{CE})
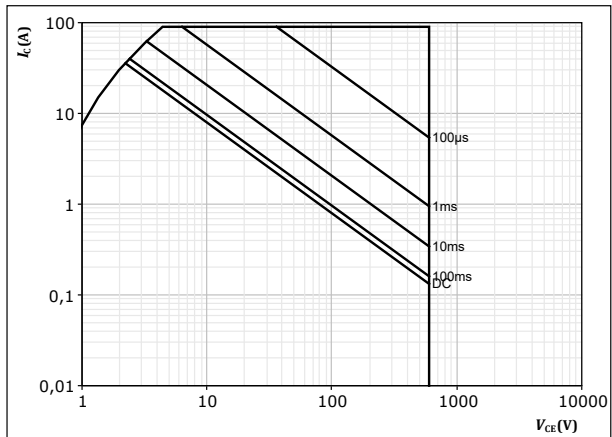
D = single pulse

T_s =	80	°C
V_{GE} =	15	V
T_j =	T_{jmax}	

Inverter Diode Characteristics

figure 6.	FWD

Typical forward characteristics

$I_F = f(V_F)$

$t_p =$ 250 µs

		25 °C
$T_j:$		125 °C
		150 °C
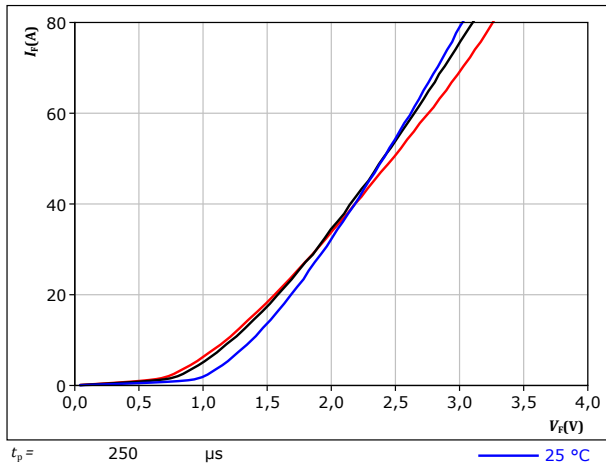
figure 7.	FWD

Transient thermal impedance as a function of pulse width

$Z_{th(j-s)} = f(t_p)$

		0,5
		0,2
		0,1
		0,05
		0,02
		0,01
		0,005
		0
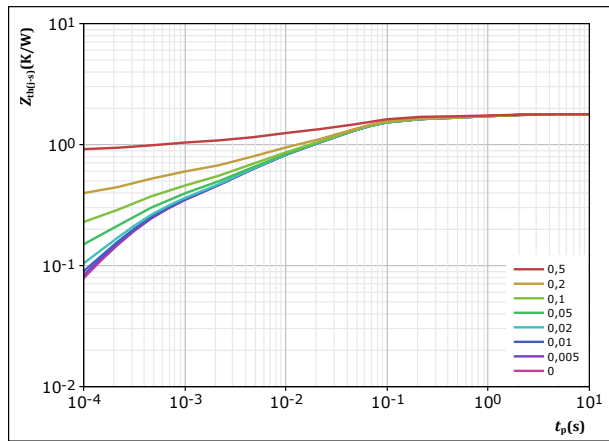
$D =$ t_p / T

$R_{th(j-s)} =$ 1,783 K/W

FWD thermal model values

R (K/W)	τ (s)
1,57E-02	6,87E+01
1,88E-01	8,17E-01
9,27E-01	4,08E-02
4,07E-01	4,21E-03
2,51E-01	3,23E-04

Brake Switch Characteristics

figure 8.	IGBT

Typical output characteristics

$I_C = f(V_{CE})$

$t_p =$	250	µs
$V_{GE} =$	15	V

T_j: — 25 °C — 125 °C
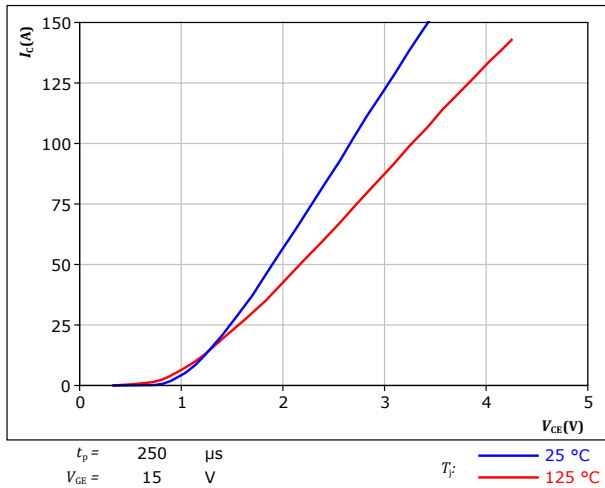
figure 9.	IGBT

Typical output characteristics

$I_C = f(V_{CE})$

V_{GE}:
7 V, 8 V, 9 V, 10 V, 11 V, 12 V, 13 V, 14 V, 15 V, 16 V, 17 V

$t_p =$	250	µs
$T_j =$	125	°C

V_{GE} from 7 V to 17 V in steps of 1 V
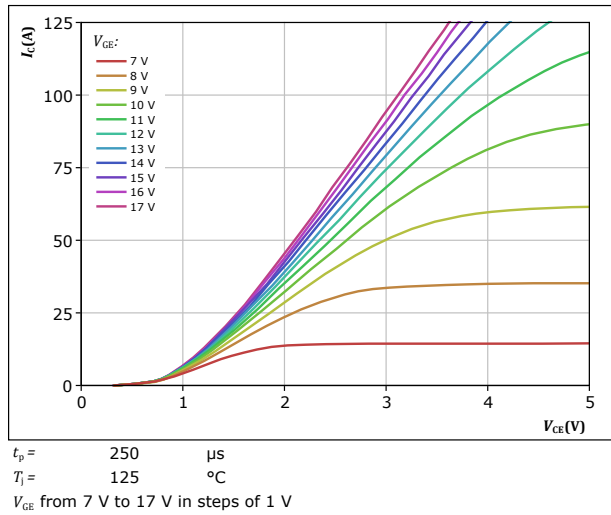
figure 10.	IGBT

Typical transfer characteristics

$I_C = f(V_{GE})$

$t_p =$	250	µs
$V_{CE} =$	10	V

T_j: — 25 °C — 125 °C
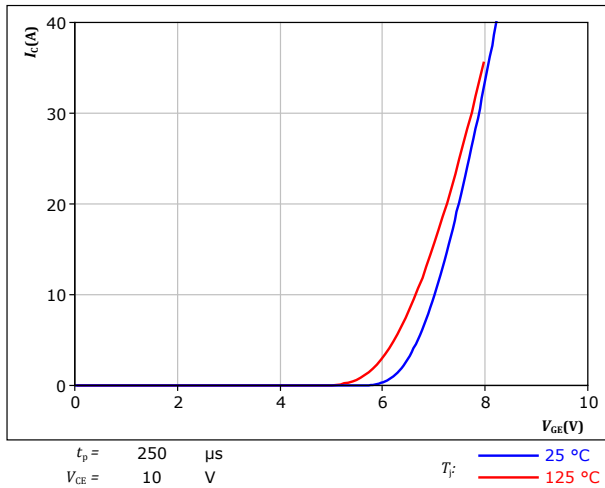
figure 11.	IGBT

Transient thermal impedance as a function of pulse width

$Z_{th(j-s)} = f(t_p)$

0,5 / 0,2 / 0,1 / 0,05 / 0,02 / 0,01 / 0,005 / 0

$D =$	t_p / T	
$R_{th(j-s)} =$	0,833	K/W
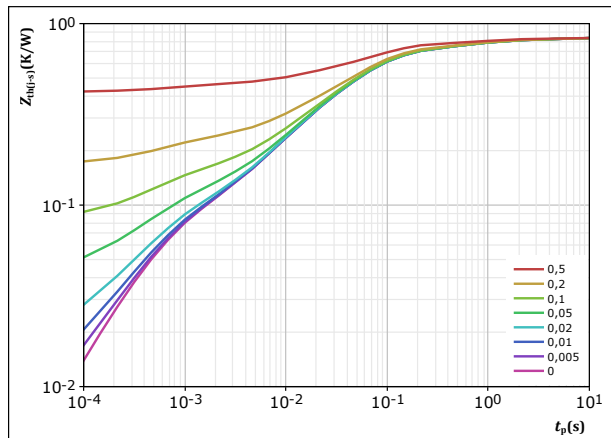
IGBT thermal model values

R (K/W)	τ (s)
3,60E-02	5,39E+00
1,23E-01	5,70E-01
4,68E-01	5,74E-02
1,41E-01	1,02E-02
6,93E-02	5,40E-04

Brake Switch Characteristics

figure 12.   **IGBT**

Safe operating area

I_C = f(V_{CE})
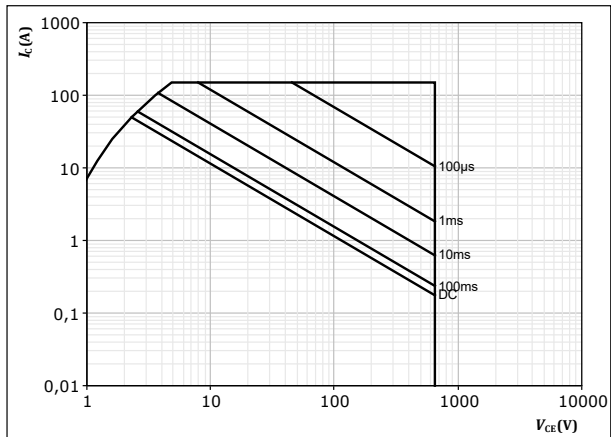
D = single pulse

T_s =	80	°C
V_{GE} =	15	V
T_j =	T_{jmax}	

Brake Diode Characteristics

figure 13.	FWD

Typical forward characteristics

I_F = f(V_F)

t_p = 250 µs

T_j: — 25 °C
— 125 °C
— 150 °C
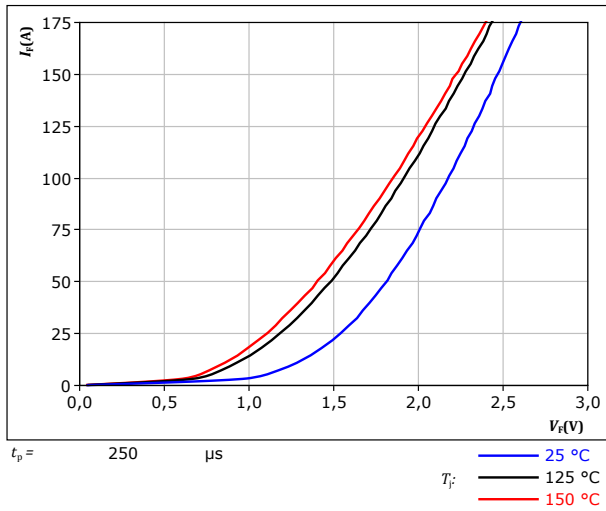
figure 14.	FWD

Transient thermal impedance as a function of pulse width

$Z_{th(j-s)}$ = f(t_p)

		0,5
		0,2
		0,1
		0,05
		0,02
		0,01
		0,005
		0
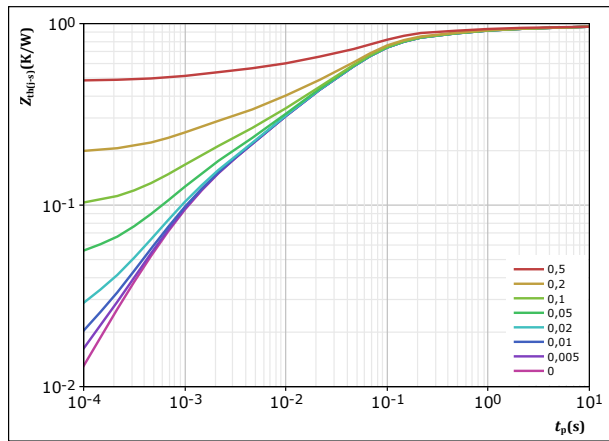
D = t_p / T

$R_{th(j-s)}$ = 0,962 K/W

FWD thermal model values

R (K/W)	τ (s)
4,74E-02	4,48E+00
1,20E-01	4,39E-01
5,41E-01	5,45E-02
1,59E-01	7,47E-03
9,87E-02	9,49E-04

Brake Sw. Protection Diode Characteristics

figure 15.	FWD

Typical forward characteristics

$I_F = f(V_F)$

$t_p =$ 250 µs

T_j: — 25 °C — 125 °C
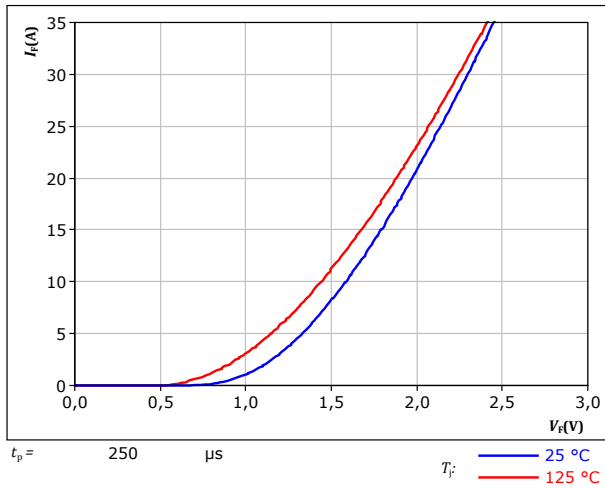
figure 16.	FWD

Transient thermal impedance as a function of pulse width

$Z_{th(j-s)} = f(t_p)$

$D = t_p / T$

$R_{th(j-s)} =$ 2,527 K/W

FWD thermal model values

R (K/W)	τ (s)
9,88E-02	4,82E+00
3,90E-01	1,35E-01
1,00E+00	1,93E-02
6,01E-01	2,48E-03
4,45E-01	3,49E-04
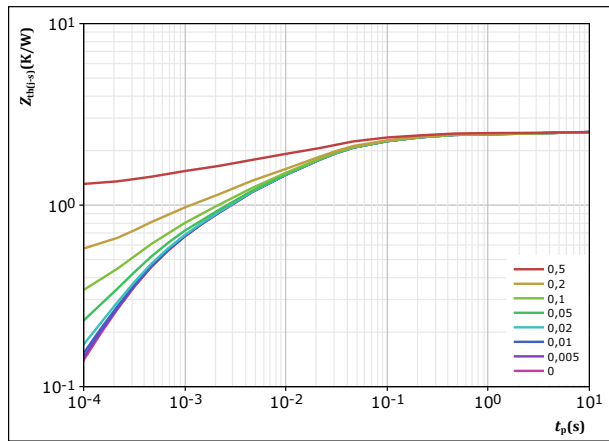
Rectifier Diode Characteristics

figure 17.	Rectifier

Typical forward characteristics

$I_F = f(V_F)$

$t_p = $ 250 µs

$T_j:$
- 25 °C
- 125 °C
- 150 °C
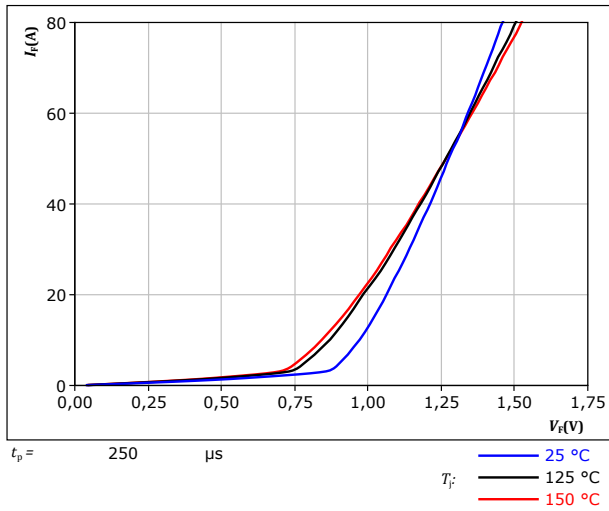
figure 18.	Rectifier

Transient thermal impedance as a function of pulse width

$Z_{th(j-s)} = f(t_p)$
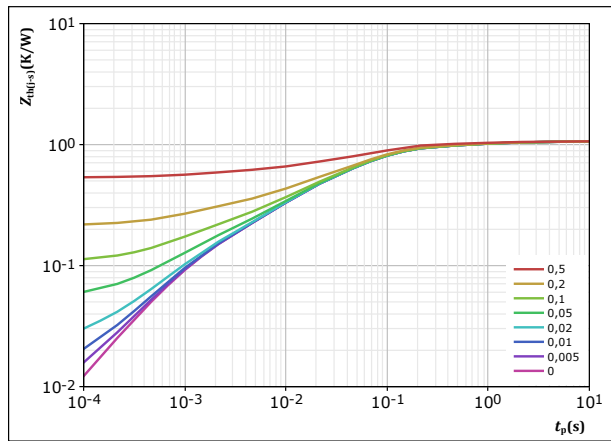
$D = $ t_p / T

$R_{th(j-s)} = $ 1,064 K/W

Rectifier thermal model values

R (K/W)	τ (s)
3,59E-02	4,94E+00
1,20E-01	5,58E-01
5,78E-01	6,45E-02
2,37E-01	1,02E-02
9,84E-02	1,05E-03

Thermistor Characteristics

figure 19.	Thermistor

Typical PTC characteristic as function of temperature
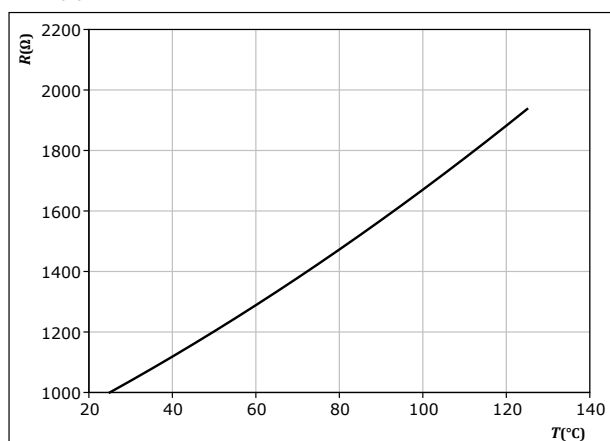
$R_T = f(T)$

Inverter Switching Characteristics

figure 20.	IGBT

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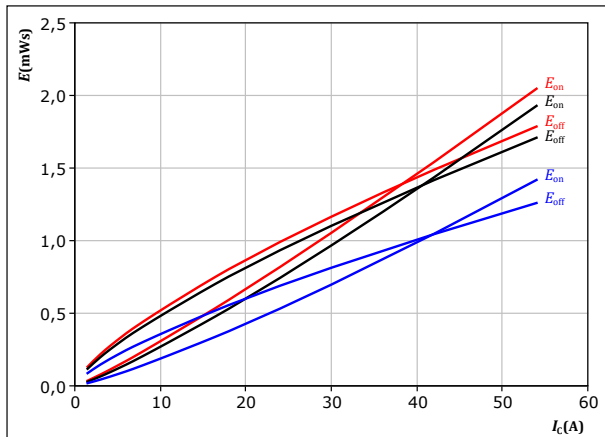
$E = f(I_C)$

With an inductive load at

				T_j:	25 °C
V_{CE} =	350	V			125 °C
V_{GE} =	±15	V			150 °C
R_{gon} =	16	Ω			
R_{goff} =	16	Ω			

figure 21.	IGBT

Typical switching energy losses as a function of IGBT turn on gate resistor
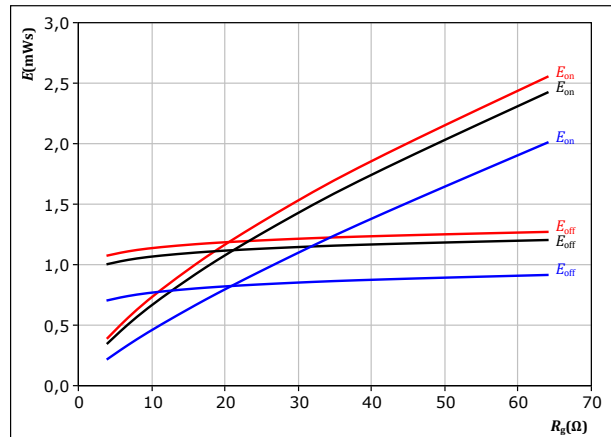
$E = f(R_g)$

With an inductive load at

				T_j:	25 °C
V_{CE} =	350	V			125 °C
V_{GE} =	±15	V			150 °C
I_C =	30	A			

figure 22.	FWD

Typical reverse recovered energy loss as a function of collector current
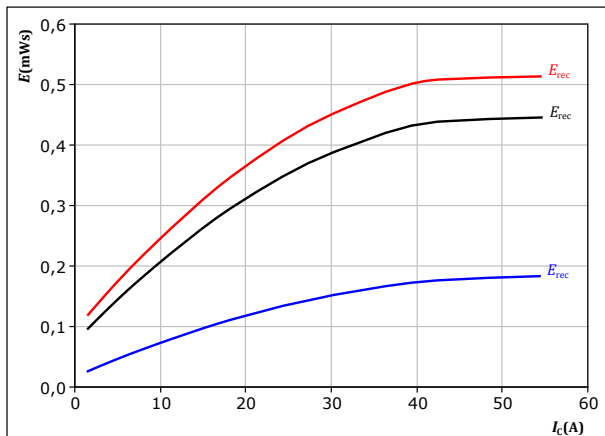
$E_{rec} = f(I_C)$

With an inductive load at

				T_j:	25 °C
V_{CE} =	350	V			125 °C
V_{GE} =	±15	V			150 °C
R_{gon} =	16	Ω			

figure 23.	FWD

Typical reverse recovered energy loss as a function of IGBT turn on gate resistor

$E_{rec} = f(R_g)$
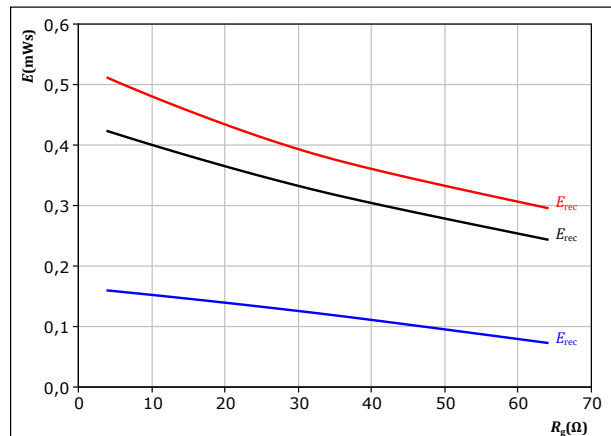
With an inductive load at

				T_j:	25 °C
V_{CE} =	350	V			125 °C
V_{GE} =	±15	V			150 °C
I_C =	30	A			

Inverter Switching Characteristics

figure 24. IGBT

Typical switching times as a function of collector current

$t = f(I_C)$
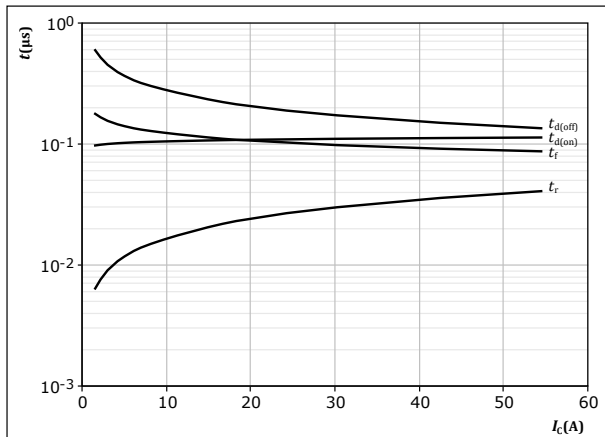
With an inductive load at

T_j =	150	°C
V_{CE} =	350	V
V_{GE} =	±15	V
R_{gon} =	16	Ω
R_{goff} =	16	Ω

figure 25. IGBT

Typical switching times as a function of IGBT turn on gate resistor

$t = f(R_g)$
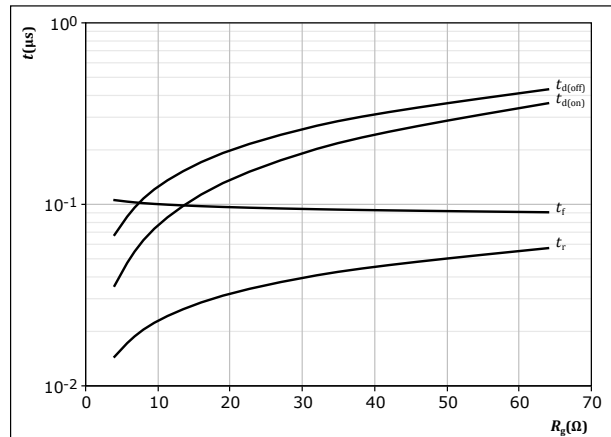
With an inductive load at

T_j =	150	°C
V_{CE} =	350	V
V_{GE} =	±15	V
I_C =	30	A

figure 26. FWD

Typical reverse recovery time as a function of collector current

$t_{rr} = f(I_C)$
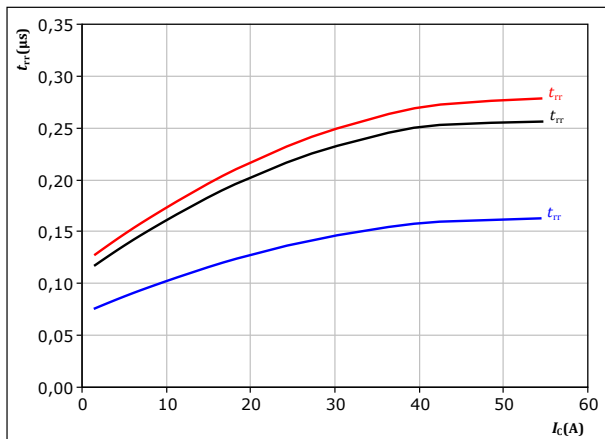
With an inductive load at

V_{CE} =	350	V
V_{GE} =	±15	V
R_{gon} =	16	Ω

T_j: — 25 °C — 125 °C — 150 °C

figure 27. FWD

Typical reverse recovery time as a function of IGBT turn on gate resistor
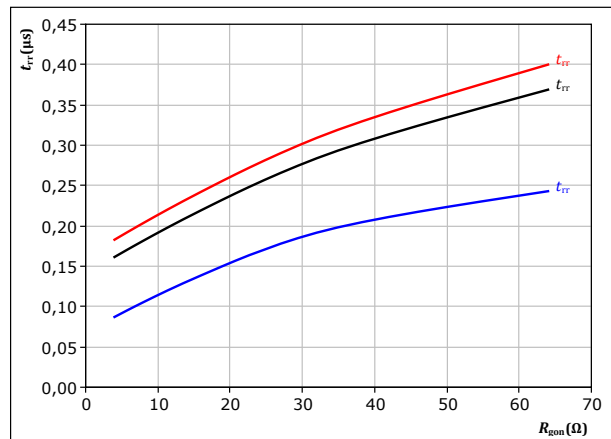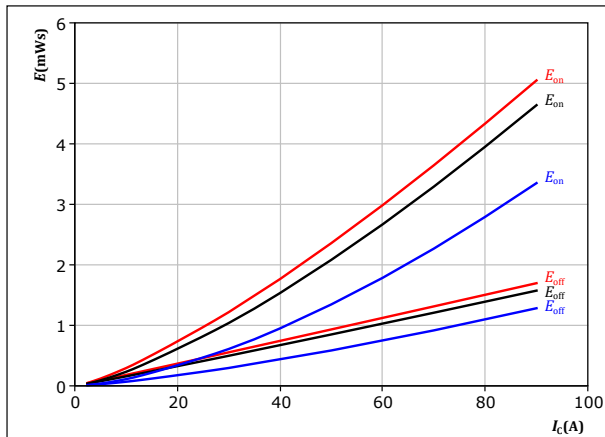
$t_{rr} = f(R_{gon})$

With an inductive load at

V_{CE} =	350	V
V_{GE} =	±15	V
I_C =	30	A

T_j: — 25 °C — 125 °C — 150 °C

Inverter Switching Characteristics

figure 28. FWD

Typical recovered charge as a function of collector current

Q_r = f(I_C)

With an inductive load at

V_{CE} =	350	V
V_{GE} =	±15	V
R_{gon} =	16	Ω

T_j:
- 25 °C
- 125 °C
- 150 °C

figure 29. FWD

Typical recovered charge as a function of IGBT turn on gate resistor

Q_r = f(R_{gon})
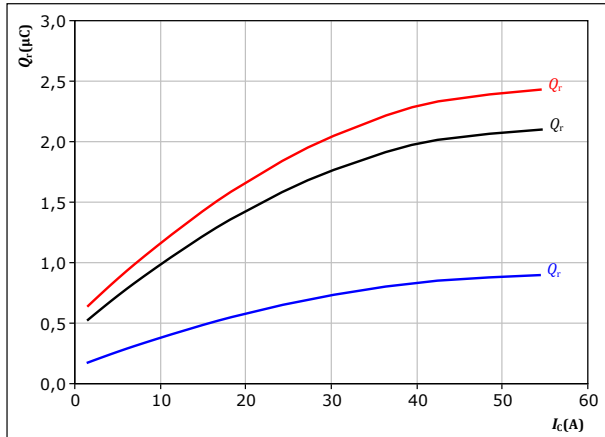
With an inductive load at

V_{CE} =	350	V
V_{GE} =	±15	V
I_C =	30	A

T_j:
- 25 °C
- 125 °C
- 150 °C

figure 30. FWD

Typical peak reverse recovery current as a function of collector current

I_{RM} = f(I_C)
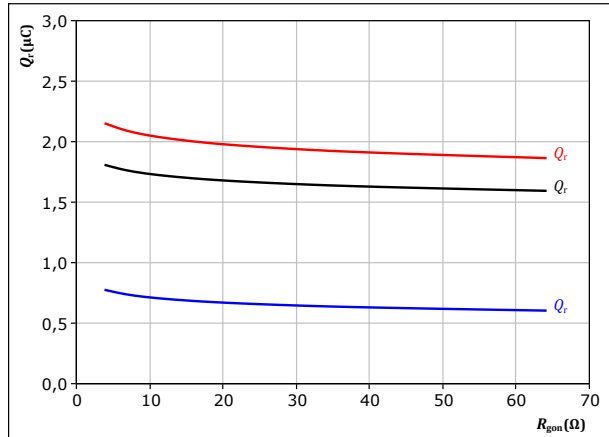
With an inductive load at

V_{CE} =	350	V
V_{GE} =	±15	V
R_{gon} =	16	Ω

T_j:
- 25 °C
- 125 °C
- 150 °C

figure 31. FWD

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

I_{RM} = f(R_{gon})

With an inductive load at

V_{CE} =	350	V
V_{GE} =	±15	V
I_C =	30	A

T_j:
- 25 °C
- 125 °C
- 150 °C
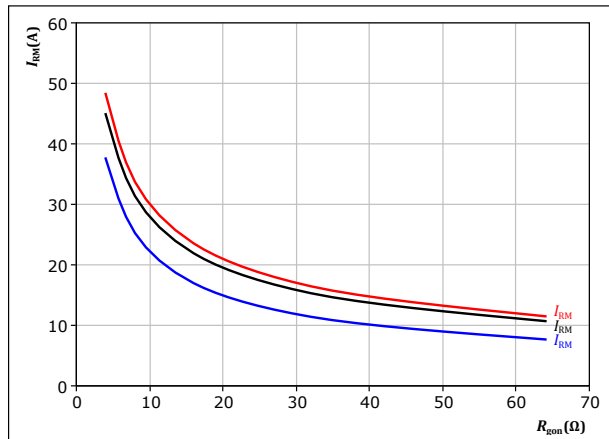
Inverter Switching Characteristics

figure 32.	FWD

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

di_F/dt, $di_{rr}/dt = f(I_C)$
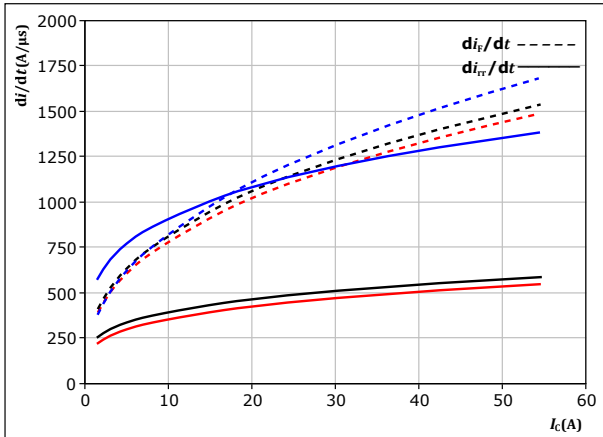
With an inductive load at

				T_j:	25 °C
$V_{CE} =$	350	V			125 °C
$V_{GE} =$	±15	V			150 °C
$R_{gon} =$	16	Ω			

figure 33.	FWD

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

di_F/dt, $di_{rr}/dt = f(R_{gon})$
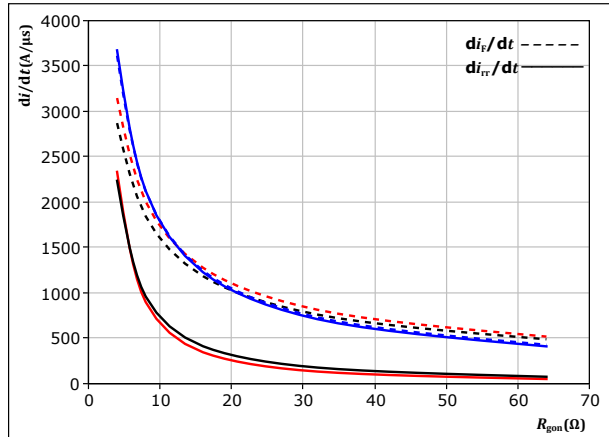
With an inductive load at

				T_j:	25 °C
$V_{CE} =$	350	V			125 °C
$V_{GE} =$	±15	V			150 °C
$I_C =$	30	A			

figure 34.	IGBT

Reverse bias safe operating area
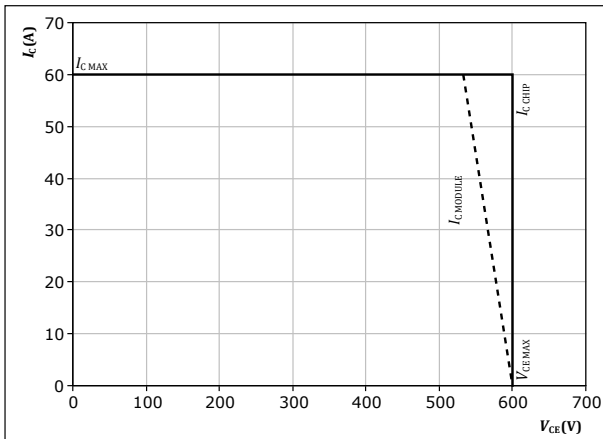
$I_C = f(V_{CE})$

At	$T_j =$	150	°C
	$R_{gon} =$	16	Ω
	$R_{goff} =$	16	Ω

Brake Switching Characteristics

figure 35.	IGBT

Typical switching energy losses as a function of collector current

$E = f(I_C)$

With an inductive load at

				T_j:	25 °C
V_{CE} =	400	V			125 °C
V_{GE} =	0/15	V			150 °C
R_{gon} =	4	Ω			
R_{goff} =	4	Ω			

figure 36.	IGBT

Typical switching energy losses as a function of IGBT turn on gate resistor

$E = f(R_g)$

With an inductive load at

				T_j:	25 °C
V_{CE} =	400	V			125 °C
V_{GE} =	0/15	V			150 °C
I_C =	50	A			

figure 37.	FWD

Typical reverse recovered energy loss as a function of collector current

$E_{rec} = f(I_C)$
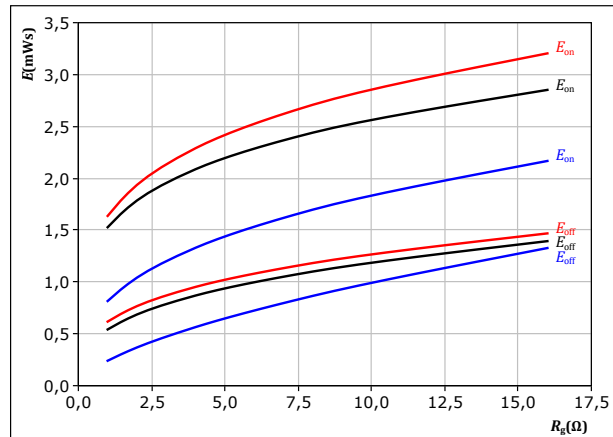
With an inductive load at

				T_j:	25 °C
V_{CE} =	400	V			125 °C
V_{GE} =	0/15	V			150 °C
R_{gon} =	4	Ω			

figure 38.	FWD

Typical reverse recovered energy loss as a function of IGBT turn on gate resistor

$E_{rec} = f(R_g)$
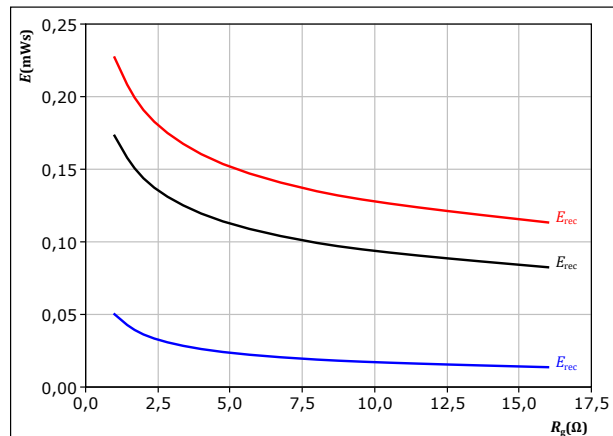
With an inductive load at

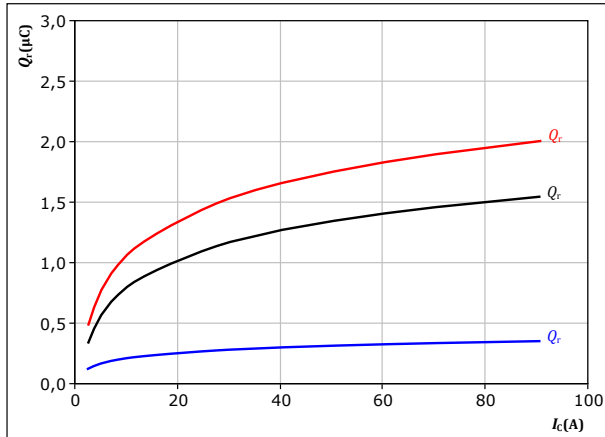|				T_j:	25 °C
V_{CE} =	400	V			125 °C
V_{GE} =	0/15	V			150 °C
I_C =	50	A			

Brake Switching Characteristics

figure 39. IGBT

Typical switching times as a function of collector current

$t = f(I_c)$
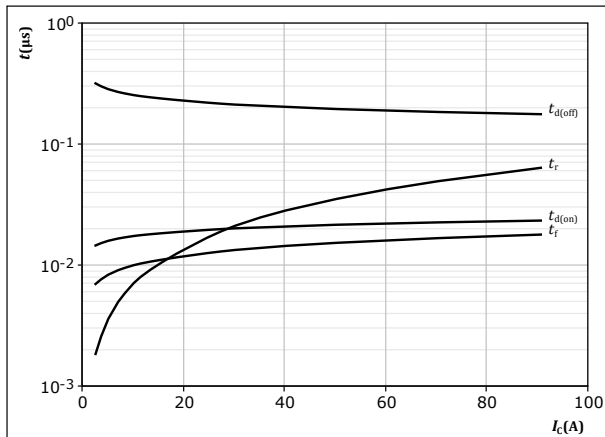
With an inductive load at

T_j =	150	°C
V_{CE} =	400	V
V_{GE} =	0/15	V
R_{gon} =	4	Ω
R_{goff} =	4	Ω

figure 40. IGBT

Typical switching times as a function of IGBT turn on gate resistor

$t = f(R_g)$
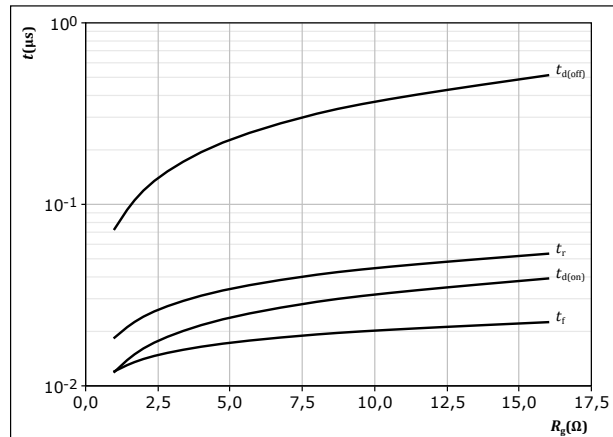
With an inductive load at

T_j =	150	°C
V_{CE} =	400	V
V_{GE} =	0/15	V
I_C =	50	A

figure 41. FWD

Typical reverse recovery time as a function of collector current
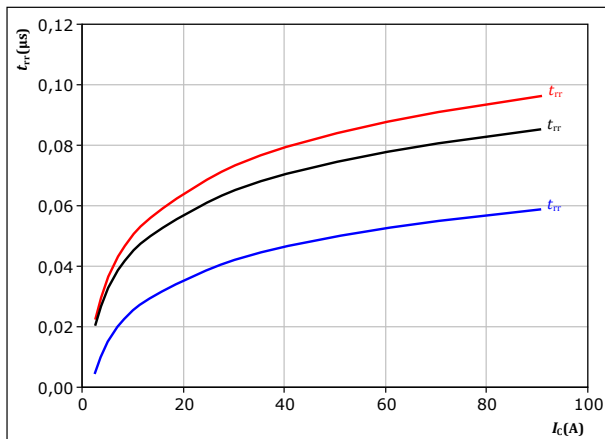
$t_{rr} = f(I_c)$

With an inductive load at

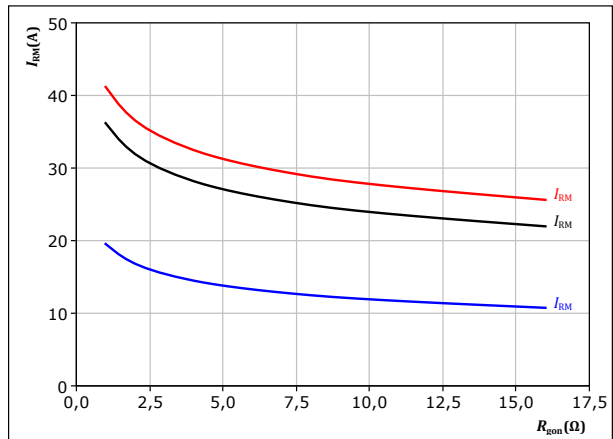|		
V_{CE} =	400	V
V_{GE} =	0/15	V
R_{gon} =	4	Ω

T_j:
- 25 °C
- 125 °C
- 150 °C

figure 42. FWD

Typical reverse recovery time as a function of IGBT turn on gate resistor
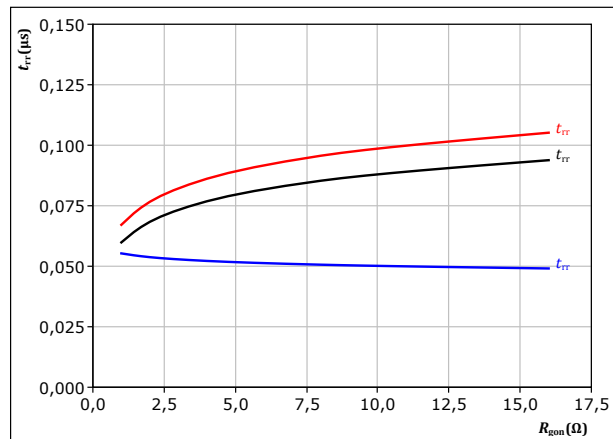
$t_{rr} = f(R_{gon})$

With an inductive load at

V_{CE} =	400	V
V_{GE} =	0/15	V
I_C =	50	A

T_j:
- 25 °C
- 125 °C
- 150 °C

Brake Switching Characteristics

figure 43.	FWD

Typical recovered charge as a function of collector current

Q_r = f(I_c)

With an inductive load at

					25 °C
V_{CE} =	400	V	T_j:		125 °C
V_{GE} =	0/15	V			150 °C
R_{gon} =	4	Ω			

figure 44.	FWD

Typical recovered charge as a function of IGBT turn on gate resistor

Q_r = f(R_{gon})

With an inductive load at

					25 °C
V_{CE} =	400	V	T_j:		125 °C
V_{GE} =	0/15	V			150 °C
I_C =	50	A			

figure 45.	FWD

Typical peak reverse recovery current as a function of collector current

I_{RM} = f(I_c)

With an inductive load at

					25 °C
V_{CE} =	400	V	T_j:		125 °C
V_{GE} =	0/15	V			150 °C
R_{gon} =	4	Ω			
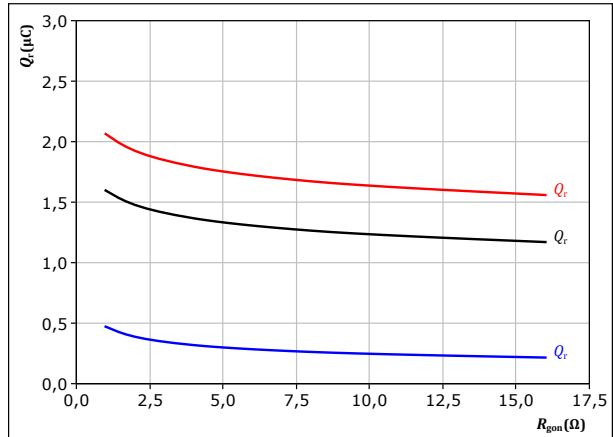
figure 46.	FWD

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

I_{RM} = f(R_{gon})

With an inductive load at

					25 °C
V_{CE} =	400	V	T_j:		125 °C
V_{GE} =	0/15	V			150 °C
I_C =	50	A			

Brake Switching Characteristics

figure 47. **FWD**

Typical rate of fall of forward and reverse recovery current as a function of collector current
di_F/dt, di_{rr}/dt = f(I_C)
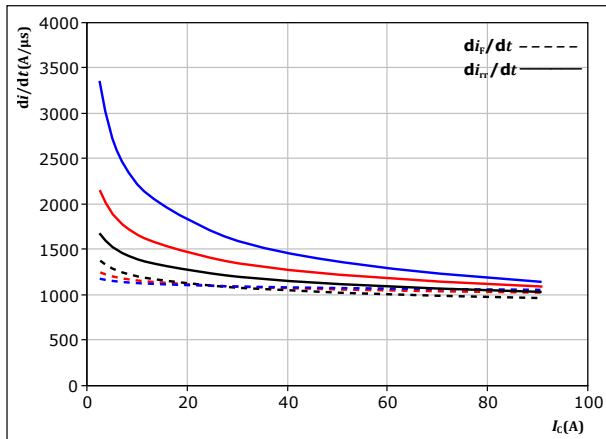
With an inductive load at

V_{CE} =	400	V
V_{GE} =	0/15	V
R_{gon} =	4	Ω

T_j: — 25 °C — 125 °C — 150 °C

figure 48. **FWD**

Typical rate of fall of forward and reverse recovery current as a function of turn on gate resistor
di_F/dt, di_{rr}/dt = f(R_{gon})
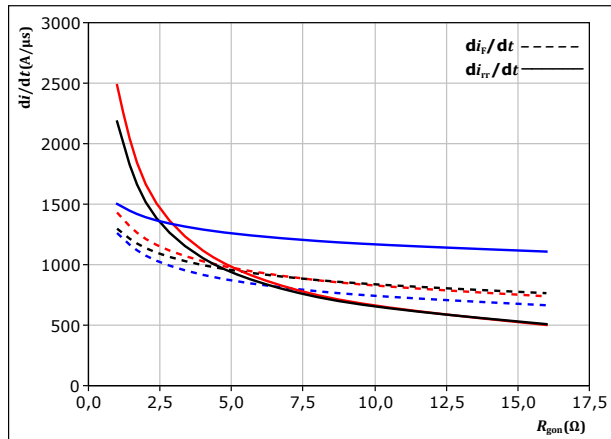
With an inductive load at

V_{CE} =	400	V
V_{GE} =	0/15	V
I_C =	50	A

T_j: — 25 °C — 125 °C — 150 °C

figure 49. **IGBT**

Reverse bias safe operating area
I_C = f(V_{CE})

At
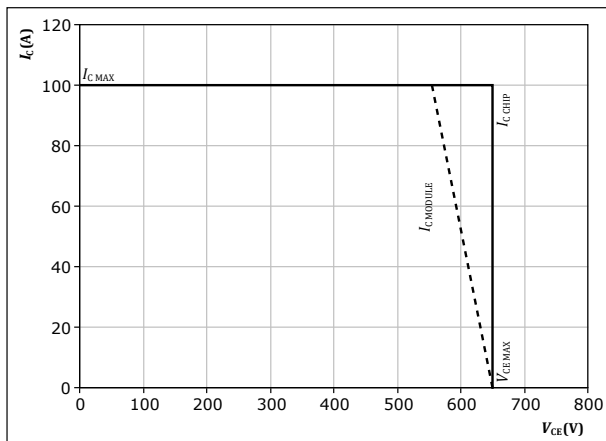
T_j =	150	°C
R_{gon} =	4	Ω
R_{goff} =	4	Ω

Switching Definitions

figure 50. IGBT

Turn-off Switching Waveforms & definition of t_{doff}, t_{Eoff} (t_{tEoff} = integrating time for E_{off})
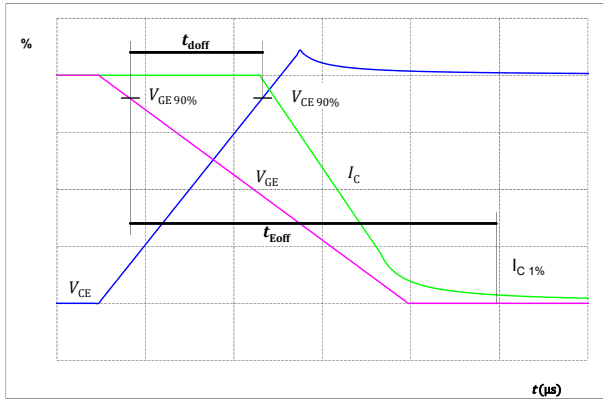
figure 51. IGBT

Turn-on Switching Waveforms & definition of t_{don}, t_{Eon} (t_{Eon} = integrating time for E_{on})
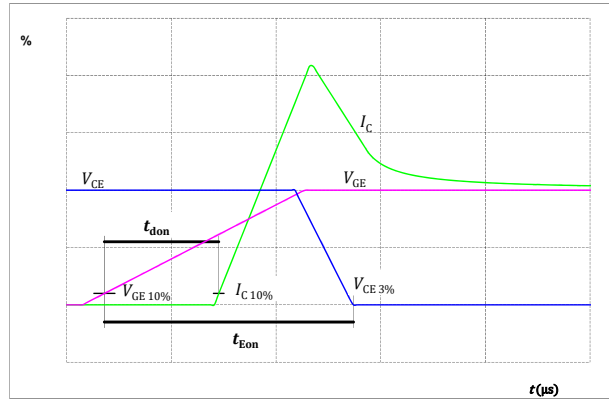
figure 52. IGBT

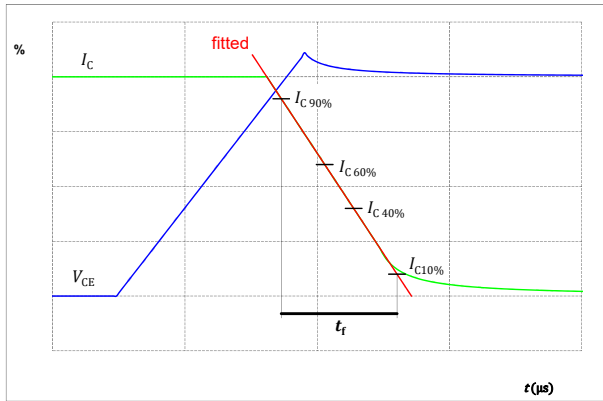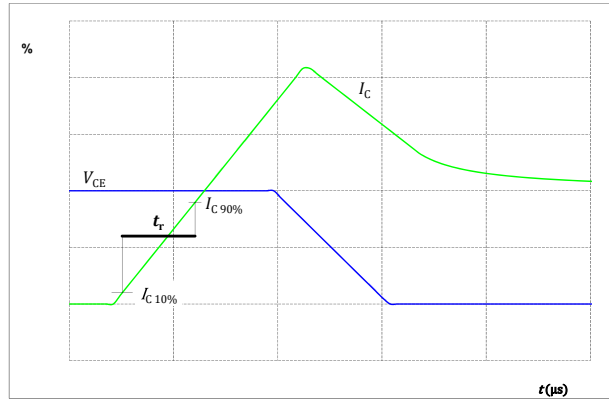Turn-off Switching Waveforms & definition of t_f

figure 53. IGBT

Turn-on Switching Waveforms & definition of t_r

Switching Definitions

figure 54. **FWD**

Turn-off Switching Waveforms & definition of t_{rr}
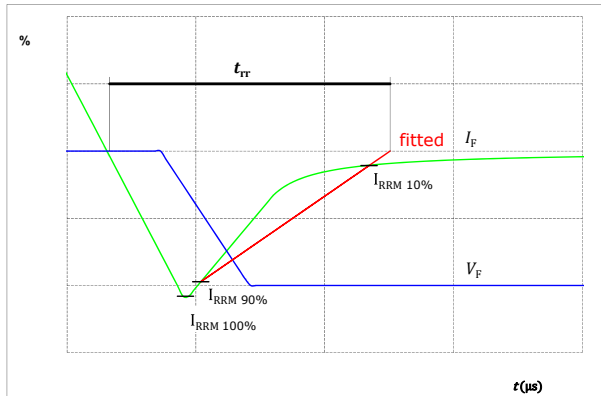
figure 55. **FWD**

Turn-on Switching Waveforms & definition of t_{Qr} (t_{Qr} = integrating time for Q_r)
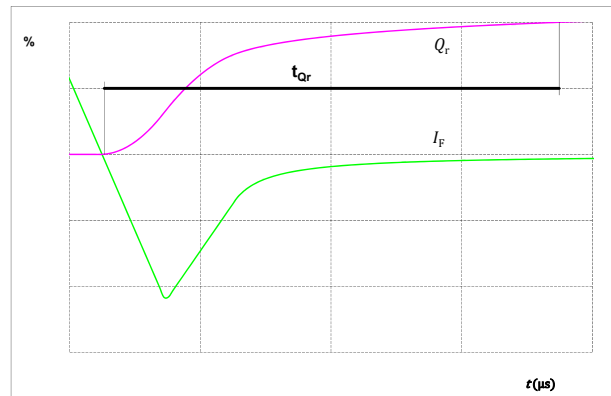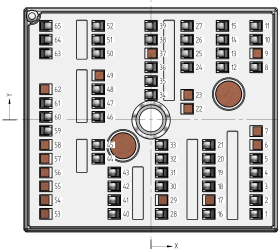
Vincotech

Ordering Code

Version	Ordering Code
With std lid (6.5mm height) + no thermal grease	V23990-K222-B10-/0A/
With thin lid (2.8mm height) + no thermal grease	V23990-K222-B10-/0B/
With std lid (6.5mm height) + thermal grease (0,8 W/mK, P12, silicone-based)	V23990-K222-B10-/1A/
With thin lid (2.8mm height) + thermal grease (0,8 W/mK, P12, silicone-based)	V23990-K222-B10-/1B/
With std lid (6.5mm height) + thermal grease (2,5 W/mK, TG20032, silicone-free)	V23990-K222-B10-/4A/
With thin lid (2.8mm height) + thermal grease (2,5 W/mK, TG20032, silicone-free)	V23990-K222-B10-/4B/
With std lid (6.5mm height) + thermal grease (2,5 W/mK, HPTP, silicone-based)	V23990-K222-B10-/5A/
With thin lid (2.8mm height) + thermal grease (2,5 W/mK, HPTP, silicone-based)	V23990-K222-B10-/5B/

Marking

		VIN	Date code	Type&Ver	UL	Lot	Serial
	Text	VIN	WWYY	TTTTTTTVV	UL	LLLLL	SSSS
		Type&Ver	**Lot number**	**Serial**	**Date code**		
	Datamatrix	TTTTTTTVV	LLLLL	SSSS	WWYY		

VIN WWYY
TTTTTTTVV UL
LLLLL SSSS

Outline

Pin table [mm]

Pin	X	Y	Function	Pin	X	Y	Function
1	24,38	-21,8	G16	34	0,03	5,8	Br
2	24,38	-18,6	S16	35	0,03	9	Br
3	24,38	-15,4	Ph3	36	0,03	12,2	Br
4	24,38	-12,2	Ph3	37	not assembled		
5	24,38	-9	Ph3	38	0,03	18,6	DC-Br
6	not assembled			39	0,03	21,8	G27
7	not assembled			40	-8,5	-21,8	DC+Rect
8	24,38	12,2	G15	41	-8,5	-18,6	DC+Rect
9	not assembled			42	-8,5	-15,4	DC+Rect
10	24,38	18,6	Therm1	43	-8,5	-12,2	DC+Inv
11	24,38	21,8	Therm2	44	-12,22	-9	DC+Inv
12	16,58	12,2	G13	45	-12,22	-5,8	DC+Inv
13	16,58	15,4	DC-Inv	46	-12,22	0,7	DC+Br
14	16,58	18,6	DC-Inv	47	-12,22	3,9	DC+Br
15	16,58	21,8	DC-Inv	48	-12,22	7,1	DC+Br
16	13,42	-21,8	G14	49	not assembled		
17	not assembled			50	-12,22	15,4	DC-Rect
18	13,42	-15,4	S14	51	-12,22	18,6	DC-Rect
19	13,42	-12,2	Ph2	52	-12,22	21,8	DC-Rect
20	13,42	-9	Ph2	53	-24,38	-21,8	ACIn3
21	13,42	-5,8	Ph2	54	-24,38	-18,6	ACIn3
22	not assembled			55	-24,38	-15,4	ACIn3
23	not assembled			56	not assembled		
24	8,38	12,2	G11	57	not assembled		
25	8,38	15,4	Se	58	not assembled		
26	8,38	18,6	DC-Br	59	-24,38	-2,5	ACIn2
27	8,38	21,8	DC-Br	60	-24,38	0,7	ACIn2
28	2,46	-21,8	G12	61	-24,38	3,9	ACIn2
29	not assembled			62	not assembled		
30	2,46	-15,4	S12	63	-24,38	15,4	ACIn2
31	2,46	-12,2	Ph1	64	-24,38	18,6	ACIn2
32	2,46	-9	Ph1	65	-24,38	21,8	ACIn2
33	2,46	-5,8	Ph1				

Pad positions refers to center point. For more informations on pad design please see package data

Pinout
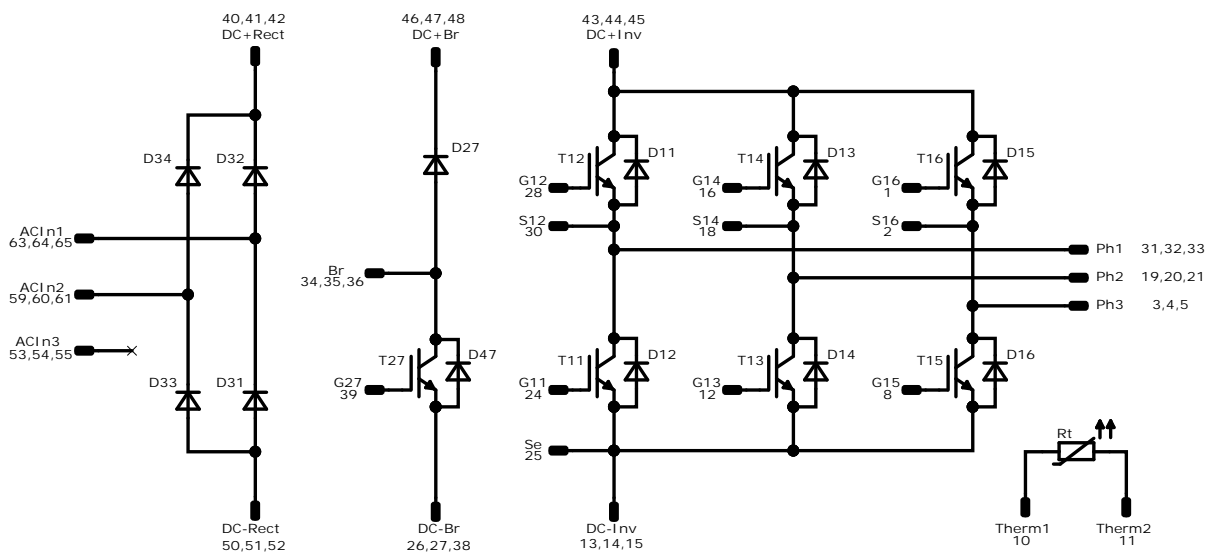
Identification						
ID	**Component**	**Voltage**	**Current**	**Function**	**Comment**
T11, T12, T13, T14, T15, T16	IGBT	600 V	30 A	Inverter Switch	
D11, D12, D13, D14, D15, D16	FWD	600 V	30 A	Inverter Diode	
T27	IGBT	650 V	50 A	Brake Switch	
D27	FWD	600 V	60 A	Brake Diode	
D47	FWD	650 V	15 A	Brake Sw. Protection Diode	
D31, D32, D33, D34	Rectifier	1600 V	28 A	Rectifier Diode	
Rt	Thermistor			Thermistor	

Packaging instruction				
Standard packaging quantity (SPQ) 72	>SPQ	Standard	<SPQ	Sample

Handling instruction
Handling instructions for MiniSKiiP® 2 packages see vincotech.com website.

Package data
Package data for MiniSKiiP® 2 packages see vincotech.com website.

Vincotech thermistor reference
See Vincotech thermistor reference table at vincotech.com website.

UL recognition and file number	
This device is UL 1557 recognized under E192116 up to a junction temperature under switching condition $T_{j,op}$=150°C and up to 2500VAC/1min isolation voltage. For more information see vincotech.com website.	UL

Document No.:	**Date:**	**Modification:**	**Pages**
V23990-K222-B10-D5-14	4 Mar. 2026	Change Diodes according to PCN-2025-032	