Vincotech

10-PG12NAB008MR02-LC59F36T
10-PG12NAC008MR02-LC69F36T
datasheet

***flow*ANPC 1 split**	**1500 V / 8 mΩ**

Features

- Split Advanced NPC topology
- Ultra-high switching frequency with SiC MOSFETs
- Split topology for better thermal performance
- No x-conduction at high frequencies

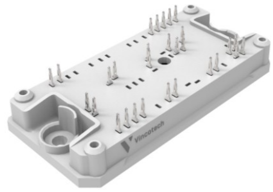
Target applications

- Solar Inverters

Types

- 10-PG12NAB008MR02-LC59F36T
- 10-PG12NAC008MR02-LC69F36T

flow 1 12 mm housing



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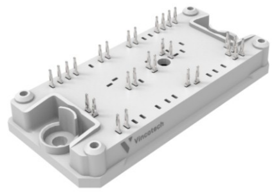
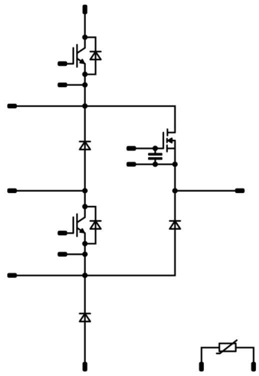


LC69F36T

Schematic



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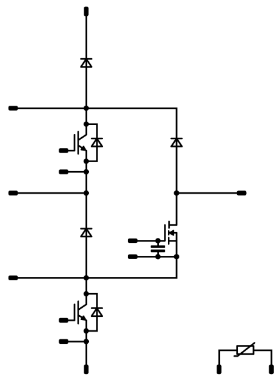


LC69F36T

Maximum Ratings

T_j = 25 °C, unless otherwise specified

Parameter	Symbol	Condition		Value	Unit
AC Switch					
Drain-source voltage	V_{DSS}			1200	V
Drain current	I_D	$T_j = T_{jmax}$	T_s = 80 °C	147	A
Peak drain current	I_{DM}	t_p limited by T_{jmax}		685	A
Total power dissipation	P_{tot}	$T_j = T_{jmax}$	T_s = 80 °C	279	W
Gate-source voltage	V_{GSS}			-4/22	V
Maximum Junction Temperature	T_{jmax}			175	°C

Maximum Ratings

T_j = 25 °C, unless otherwise specified

Parameter	Symbol	Condition		Value	Unit
AC Diode					
Peak repetitive reverse voltage	V_{RRM}			1200	V
Continuous (direct) forward current	I_F	$T_j = T_{jmax}$	T_s = 80 °C	72	A
Repetitive peak forward current	I_{FRM}			252	A
Surge (non-repetitive) forward current	I_{FSM}	Single Half Sine Wave, t_p = 8,3 ms	T_j = 150 °C	196	A
Total power dissipation	P_{tot}	$T_j = T_{jmax}$	T_s = 80 °C	183	W
Maximum junction temperature	T_{jmax}			175	°C
Neutral Point Switch					
Collector-emitter voltage	V_{CES}			1200	V
Collector current	I_C	$T_j = T_{jmax}$	T_s = 80 °C	130	A
Repetitive peak collector current	I_{CRM}	t_p limited by T_{jmax}		300	A
Total power dissipation	P_{tot}	$T_j = T_{jmax}$	T_s = 80 °C	232	W
Gate-emitter voltage	V_{GES}			±20	V
Short circuit ratings	t_{SC}	V_{GE} = 15 V, V_{CC} = 800 V	T_j = 150 °C	9,5	μs
Maximum junction temperature	T_{jmax}			175	°C
Neutral Point Diode					
Peak repetitive reverse voltage	V_{RRM}			1200	V
Continuous (direct) forward current	I_F	$T_j = T_{jmax}$	T_s = 80 °C	95	A
Repetitive peak forward current	I_{FRM}			300	A
Total power dissipation	P_{tot}	$T_j = T_{jmax}$	T_s = 80 °C	151	W
Maximum junction temperature	T_{jmax}			175	°C
Neutral Point Switch Prot. Diode					
Peak repetitive reverse voltage	V_{RRM}			1200	V
Continuous (direct) forward current	I_F	$T_j = T_{jmax}$	T_s = 80 °C	21	A
Surge (non-repetitive) forward current	I_{FSM}	50 Hz Single Half Sine Wave t_p = 10 ms	T_j = 150 °C	65	A
Surge current capability	I^2t			21	A^2s
Maximum junction temperature Total power dissipation	P_{tot}	$T_j = T_{jmax}$	T_s = 80 °C	64	W
	T_{jmax}			175	°C

Maximum Ratings

T_j = 25 °C, unless otherwise specified

Parameter	Symbol	Condition		Value	Unit
DC-Link Switch					
Collector-emitter voltage	V_{CES}			1200	V
Collector current	I_C	$T_j = T_{jmax}$	T_s = 80 °C	130	A
Repetitive peak collector current	I_{CRM}	t_p limited by T_{jmax}		300	A
Total power dissipation	P_{tot}	$T_j = T_{jmax}$	T_s = 80 °C	232	W
Gate-emitter voltage	V_{GES}			±20	V
Short circuit ratings	t_{SC}	V_{GE} = 15 V, V_{CC} = 800 V	T_j = 150 °C	9,5	μs
Maximum junction temperature	T_{jmax}			175	°C
DC-Link Diode					
Peak repetitive reverse voltage	V_{RRM}			1200	V
Continuous (direct) forward current	I_F	$T_j = T_{jmax}$	T_s = 80 °C	71	A
Repetitive peak forward current	I_{FRM}			200	A
Total power dissipation	P_{tot}	$T_j = T_{jmax}$	T_s = 80 °C	122	W
Maximum junction temperature	T_{jmax}			175	°C
DC-Link Switch Prot. Diode					
Peak repetitive reverse voltage	V_{RRM}			1200	V
Continuous (direct) forward current	I_F	$T_j = T_{jmax}$	T_s = 80 °C	71	A
Repetitive peak forward current	I_{FRM}			200	A
Total power dissipation	P_{tot}	$T_j = T_{jmax}$	T_s = 80 °C	122	W
Maximum junction temperature	T_{jmax}			175	°C
Capacitor (GS)					
Maximum DC voltage	V_{MAX}			25	V
Operation Temperature	T_{op}			0 … 125	°C

Maximum Ratings

T_j = 25 °C, unless otherwise specified

Parameter	Symbol	Condition		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	6000	V
Creepage distance				>12,7	mm
Clearance				8,33	mm
Comparative Tracking Index	CTI			≥ 600	

*100 % tested in production

Characteristic Values

Parameter	Symbol	Conditions					Value			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	
AC Switch										
Static										
Drain-source on-state resistance	$r_{DS(on)}$		18		100	25 125 150		8 11 12	10(1)	mΩ
Gate-source threshold voltage	$V_{GS(th)}$			10	0,05	25	2,7	3,9	5,6	V
Gate to Source Leakage Current	I_{GSS}		22	0		25			500	nA
Zero Gate Voltage Drain Current	I_{DSS}		0	1200		25		5	50	µA
Internal gate resistance	r_g							1,4		Ω
Gate charge	Q_g	V_{DD} = 600 V	18		100	25		535		nC
Short-circuit input capacitance	C_{iss}	f = 1 MHz	0	800	0	25		6685		pF
Short-circuit output capacitance	C_{oss}							380		
Reverse transfer capacitance	C_{rss}							135		
Reverse Diode Static										
Diode forward voltage	V_{SD}		0		100	25		3,2		V
Thermal										
Thermal resistance junction to sink	$R_{th(j-s)}$	λ_{paste} = 3,4 W/mK (PSX)						0,34		K/W
AC Diode										
Static										
Forward voltage	V_F				60	25 125		1,63 2,04	1,6(1)	V
Reverse leakage current	I_R	V_r = 1200 V				25 150		60 480	1200	µA
Thermal										
Thermal resistance junction to sink	$R_{th(j-s)}$	λ_{paste} = 3,4 W/mK (PSX)						0,52		K/W

Characteristic Values

Parameter	Symbol	Conditions	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	Unit
AC Real Open configuration										
Switch Dynamic										
Turn-on delay time	$t_{d(on)}$	R_{gon} = 2 Ω R_{goff} = 2 Ω	-2 / 18	600	100	25 125 150		49 41 39		ns
Rise time	t_r					25 125 150		18 15 17		ns
Turn-off delay time	$t_{d(off)}$					25 125 150		133 145 146		ns
Fall time	t_f					25 125 150		16 12 13		ns
Turn-on energy (per pulse)	E_{on}	Q_{rFWD} = 0,8 µC Q_{rFWD} = 0,7 µC Q_{rFWD} = 0,7 µC				25 125 150		2,18 2,02 2,05		mWs
Turn-off energy (per pulse)	E_{off}					25 125 150		0,929 1,28 1,29		mWs
Diode Dynamic										
Peak recovery current	I_{RRM}	di/dt = 5202 A/µs di/dt = 7639 A/µs di/dt = 7755 A/µs	-2 / 18	600	100	25 125 150		24 55 55		A
Reverse recovery time	t_{rr}					25 125 150		22 16 17		ns
Recovered charge	Q_r					25 125 150		0,759 0,729 0,713		µC
Reverse recovered energy	E_{rec}					25 125 150		0,156 0,165 0,177		mWs
Peak rate of fall of recovery current	$(di_{rf}/dt)_{max}$					25 125 150		2264 9943 9635		A/µs

Characteristic Values

Parameter	Symbol	Conditions	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	Unit
AC Reactive Open configuration										
Switch Dynamic										
Turn-on delay time	$t_{d(on)}$	R_{gon} = 2 Ω R_{goff} = 2 Ω	-2 / 18	600	100	25 125 150		51 55 54		ns
Rise time	t_r					25 125 150		18 20 21		ns
Turn-off delay time	$t_{d(off)}$					25 125 150		132 143 146		ns
Fall time	t_f					25 125 150		18 23 23		ns
Turn-on energy (per pulse)	E_{on}	Q_{rFWD} = 1,2 µC Q_{rFWD} = 1,2 µC Q_{rFWD} = 1,2 µC				25 125 150		1,92 1,91 2,07		mWs
Turn-off energy (per pulse)	E_{off}					25 125 150		1,65 1,75 1,74		mWs
Diode Dynamic										
Peak recovery current	I_{RRM}	di/dt = 6506 A/µs di/dt = 4757 A/µs di/dt = 4833 A/µs	-2 / 18	600	100	25 125 150		45 43 45		A
Reverse recovery time	t_{rr}					25 125 150		32 37 37		ns
Recovered charge	Q_r					25 125 150		1,22 1,21 1,20		µC
Reverse recovered energy	E_{rec}					25 125 150		0,455 0,598 0,592		mWs
Peak rate of fall of recovery current	$(di_{rf}/dt)_{max}$					25 125 150		4067 2444 2741		A/µs

Characteristic Values

Parameter	Symbol	Conditions					Value			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	
AC Real Short configuration										
Switch Dynamic										
Turn-on delay time	$t_{d(on)}$	R_{gon} = 2 Ω R_{goff} = 2 Ω	-2 / 18	600	100	25 125 150		54 53 53		ns
Rise time	t_r					25 125 150		20 22 22		
Turn-off delay time	$t_{d(off)}$					25 125 150		134 146 147		
Fall time	t_f					25 125 150		22 24 25		
Turn-on energy (per pulse)	E_{on}	Q_{rFWD} = 1,2 µC Q_{rFWD} = 1,2 µC Q_{rFWD} = 1,1 µC				25 125 150		1,89 1,64 1,62		mWs
Turn-off energy (per pulse)	E_{off}					25 125 150		1,13 1,38 1,45		
Diode Dynamic										
Peak recovery current	I_{RRM}	di/dt = 4768 A/µs di/dt = 4373 A/µs di/dt = 4246 A/µs	-2 / 18	600	100	25 125 150		53 48 49		A
Reverse recovery time	t_{rr}					25 125 150		33 34 34		ns
Recovered charge	Q_r					25 125 150		1,15 1,19 1,12		µC
Reverse recovered energy	E_{rec}					25 125 150		0,563 0,671 0,636		mWs
Peak rate of fall of recovery current	$(di_{rf}/dt)_{max}$					25 125 150		4288 3726 3800		A/µs

Characteristic Values

Parameter	Symbol	Conditions	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	Unit
AC Reactive Short configuration										
Switch Dynamic										
Turn-on delay time	$t_{d(on)}$	R_{gon} = 2 Ω R_{goff} = 2 Ω	-2 / 18	600	100	25 125 150		57 55 53		ns
Rise time	t_r					25 125 150		25 25 25		
Turn-off delay time	$t_{d(off)}$					25 125 150		132 144 145		
Fall time	t_f					25 125 150		24 25 26		
Turn-on energy (per pulse)	E_{on}	Q_{rFWD} = 1,8 µC Q_{rFWD} = 1,6 µC Q_{rFWD} = 1,8 µC				25 125 150		1,69 1,64 1,69		mWs
Turn-off energy (per pulse)	E_{off}					25 125 150		1,41 1,55 1,57		
Diode Dynamic										
Peak recovery current	I_{RRM}	di/dt = 4238 A/µs di/dt = 4105 A/µs di/dt = 4164 A/µs	-2 / 18	600	100	25 125 150		65 61 63		A
Reverse recovery time	t_{rr}					25 125 150		45 44 45		ns
Recovered charge	Q_r					25 125 150		1,84 1,63 1,77		µC
Reverse recovered energy	E_{rec}					25 125 150		1,021 0,891 0,964		mWs
Peak rate of fall of recovery current	$(di_{rf}/dt)_{max}$					25 125 150		3747 3368 3440		A/µs

Characteristic Values

Parameter	Symbol	Conditions					Value			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	
Neutral Point Switch										
Static										
Gate-emitter threshold voltage	$V_{GE(th)}$	$V_{GE} = V_{CE}$			0,015	25	5,4	6	6,6	V
Collector-emitter saturation voltage	V_{CEsat}		15		150	25 125 150		1,58 1,80 1,86	1,85(1)	V
Collector-emitter cut-off current	I_{CES}		0	1200		25			100	µA
Gate-emitter leakage current	I_{GES}		20	0		25			500	nA
Internal gate resistance	r_{g}							3		Ω
Input capacitance	C_{ies}		0	10		25		30000		pF
Output capacitance	C_{oes}							880		
Reverse transfer capacitance	C_{res}							320		
Gate charge	Q_{g}	V_{CC} = 600 V	15		150	25		1000		nC
Thermal										
Thermal resistance junction to sink	$R_{th(j-s)}$	λ_{paste} = 3,4 W/mK (PSX)						0,41		K/W
Dynamic										
Turn-on delay time	$t_{d(on)}$	R_{gon} = 2 Ω R_{goff} = 2 Ω	±15	600	100	25 125 150		335 349 351		ns
Rise time	t_{r}					25 125 150		38 47 49		
Turn-off delay time	$t_{d(off)}$					25 125 150		304 351 363		
Fall time	t_{f}					25 125 150		101 139 142		
Turn-on energy (per pulse)	E_{on}	Q_{rFWD} = 10,4 µC Q_{rFWD} = 15 µC Q_{rFWD} = 16,2 µC				25 125 150		8,92 11,15 11,85		mWs
Turn-off energy (per pulse)	E_{off}					25 125 150		7,89 10,42 10,95		

Characteristic Values

Parameter	Symbol	Conditions					Value			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	
Neutral Point Diode										
Static										
Forward voltage	V_F				150	25 125 150		1,80 1,90 1,90	2,1(1)	V
Reverse leakage current	I_R	V_r = 1200 V				25			40	µA
Thermal										
Thermal resistance junction to sink	$R_{th(j-s)}$	λ_{paste} = 3,4 W/mK (PSX)						0,63		K/W
Dynamic										
Peak recovery current	I_{RRM}	di/dt = 2578 A/µs di/dt = 2565 A/µs di/dt = 2545 A/µs	±15	600	100	25 125 150		117 120 118		A
Reverse recovery time	t_{rr}					25 125 150		268 406 454		ns
Recovered charge	Q_r					25 125 150		12,79 20,79 22,27		µC
Reverse recovered energy	E_{rec}					25 125 150		4,36 7,63 8,66		mWs
Peak rate of fall of recovery current	$(di_{rf}/dt)_{max}$					25 125 150		865 626 632		A/µs
Neutral Point Switch Prot. Diode										
Static										
Forward voltage	V_F				15	25 125		2,37 2,47	2,71(1)	V
Reverse leakage current	I_R	V_r = 1200 V				25 150		900	60 1800	µA
Thermal										
Thermal resistance junction to sink	$R_{th(j-s)}$	λ_{paste} = 3,4 W/mK (PSX)						1,48		K/W

Characteristic Values

Parameter	Symbol	Conditions					Value			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	
DC-Link Switch										
Static										
Gate-emitter threshold voltage	$V_{GE(th)}$	$V_{GE} = V_{CE}$			0,015	25	5,4	6	6,6	V
Collector-emitter saturation voltage	V_{CEsat}		15		150	25 125 150		1,58 1,80 1,86	1,85(1)	V
Collector-emitter cut-off current	I_{CES}		0	1200		25			100	µA
Gate-emitter leakage current	I_{GES}		20	0		25			500	nA
Internal gate resistance	r_g							3		Ω
Input capacitance	C_{ies}		0	10		25		30000		pF
Output capacitance	C_{oes}							880		
Reverse transfer capacitance	C_{res}							320		
Gate charge	Q_g	V_{CC} = 600 V	15	600	150	25		1000		nC
Thermal										
Thermal resistance junction to sink	$R_{th(j-s)}$	λ_{paste} = 3,4 W/mK (PSX)						0,41		K/W
Dynamic										
Turn-on delay time	$t_{d(on)}$	R_{gon} = 2 Ω R_{goff} = 2 Ω	±15	600	100	25 125 150		317 335 350		ns
Rise time	t_r					25 125 150		36 41 45		
Turn-off delay time	$t_{d(off)}$					25 125 150		306 351 368		
Fall time	t_f					25 125 150		97 136 146		
Turn-on energy (per pulse)	E_{on}	Q_{rFWD} = 12,8 µC Q_{rFWD} = 20,8 µC Q_{rFWD} = 22,3 µC				25 125 150		9,56 13,18 13,42		mWs
Turn-off energy (per pulse)	E_{off}					25 125 150		7,12 9,90 11,12		

Characteristic Values

Parameter	Symbol	Conditions					Value			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	
DC-Link Diode										
Static										
Forward voltage	V_F				100	25 125 150		1,82 1,96 1,97	2,1(1)	V
Reverse leakage current	I_R	Vr = 1200 V		1200		25			40	µA
Thermal										
Thermal resistance junction to sink	$R_{th(j-s)}$	λ_{paste} = 3,4 W/mK (PSX)						0,78		K/W
Dynamic										
Peak recovery current	I_{RRM}	di/dt = 2662 A/µs di/dt = 2286 A/µs di/dt = 2159 A/µs	±15	600	100	25 125 150		83 86 88		A
Reverse recovery time	t_{rr}					25 125 150		310 419 453		ns
Recovered charge	Q_r					25 125 150		10,40 15,02 16,24		µC
Reverse recovered energy	E_{rec}					25 125 150		3,99 5,95 6,43		mWs
Peak rate of fall of recovery current	$(di_{rf}/dt)_{max}$					25 125 150		507 513 504		A/µs
DC-Link Switch Prot. Diode										
Static										
Forward voltage	V_F				100	25 125 150		1,82 1,96 1,97	2,1(1)	V
Reverse leakage current	I_R	Vr = 1200 V		1200		25			40	µA
Thermal										
Thermal resistance junction to sink	$R_{th(j-s)}$	λ_{paste} = 3,4 W/mK (PSX)						0,78		K/W
Capacitor (GS)										
Capacitance	C	DC bias voltage = 0 V						10		nF
Tolerance							-10		+10	%

Characteristic Values

Parameter	Symbol	Conditions					Value			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										
Rated resistance	R					25		22		kΩ
Deviation of R_{100}	$\Delta_{R/R}$	R_{100} = 1484 Ω				100	-5		5	%
Power dissipation	P					25		5		mW
Power dissipation constant						25		1,5		mW/K
B-value	$B_{(25/50)}$	Tol. ±1 %				25		3962		K
B-value	$B_{(25/100)}$	Tol. ±1 %				25		4000		K
Vincotech NTC Reference									I	

(1) Value at chip level

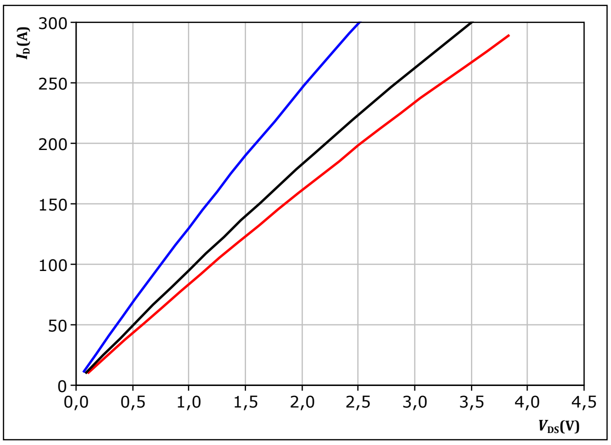
(2) Only valid with pre-applied Vincotech thermal interface material

AC Switch Characteristics

figure 1. **MOSFET**

Typical output characteristics

I_D = f(V_{DS})

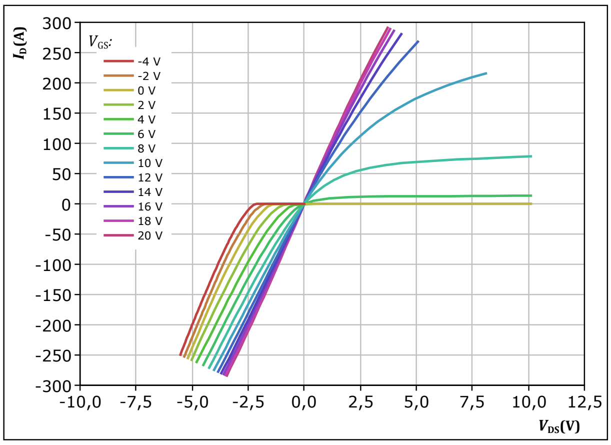


t_p =	250	µs		25 °C
V_{GS} =	18	V	T_j:	125 °C
				150 °C

figure 2. **MOSFET**

Typical output characteristics

I_D = f(V_{DS})



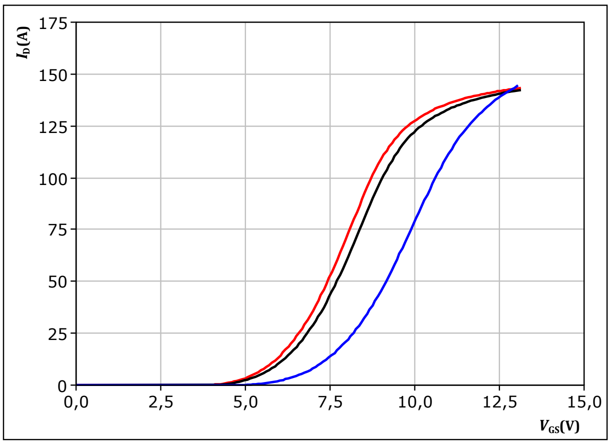
t_p =	250	µs
T_j =	150	°C

V_{GS} from -4 V to 20 V in steps of 2 V

figure 3. **MOSFET**

Typical transfer characteristics

I_D = f(V_{GS})

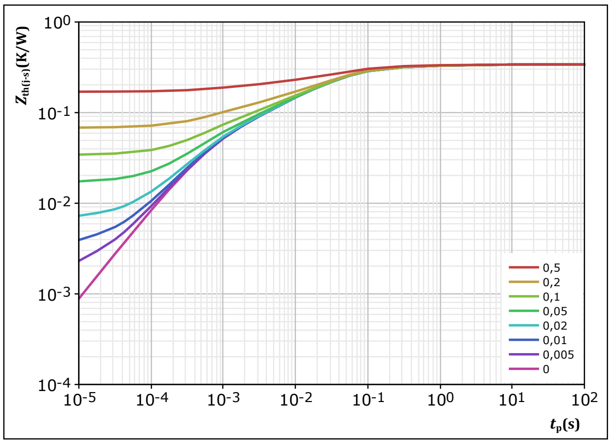


t_p =	250	µs		25 °C
V_{DS} =	10	V	T_j:	125 °C
				150 °C

figure 4. **MOSFET**

Transient thermal impedance as a function of pulse width

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



D =	t_p / T	
$R_{th(j-s)}$ =	0,34	K/W

MOSFET thermal model values

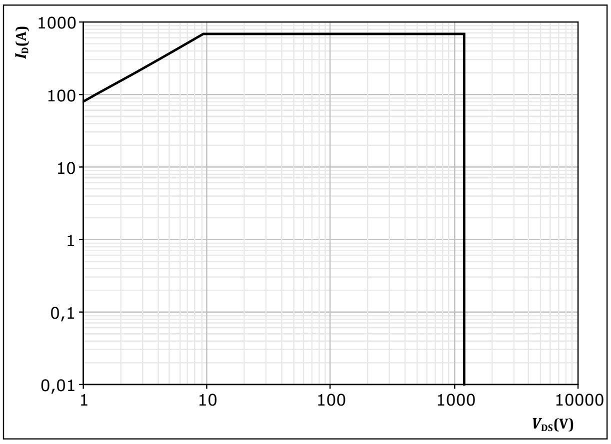
R (K/W)	τ (s)
1,23E-02	3,61E+00
3,10E-02	3,07E-01
1,44E-01	4,87E-02
6,59E-02	1,36E-02
4,97E-02	3,22E-03
3,74E-02	5,68E-04

AC Switch Characteristics

figure 5.	**MOSFET**

Safe operating area

$I_D = f(V_{DS})$



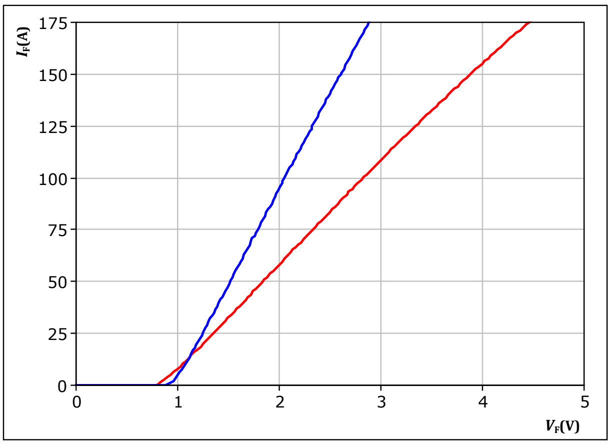
D =	single pulse	
T_s =	80	°C
V_{GS} =	18	V
T_j =	T_{jmax}	

AC Diode Characteristics

figure 6. **FWD**

Typical forward characteristics

I_F = f(V_F)



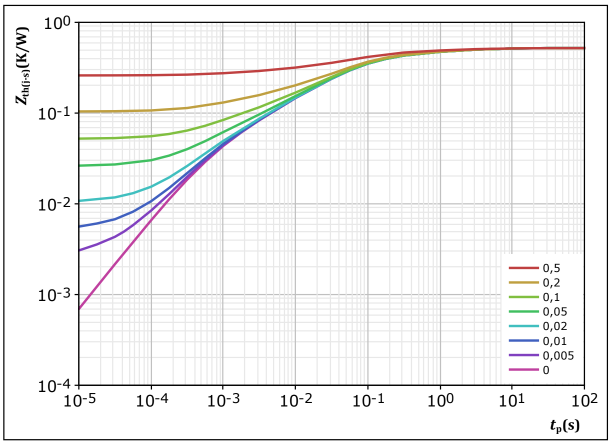
t_p = 250 µs

T_j: 25 °C, 125 °C

figure 7. **FWD**

Transient thermal impedance as a function of pulse width

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



D = t_p / T

$R_{th(j-s)}$ = 0,52 K/W

FWD thermal model values

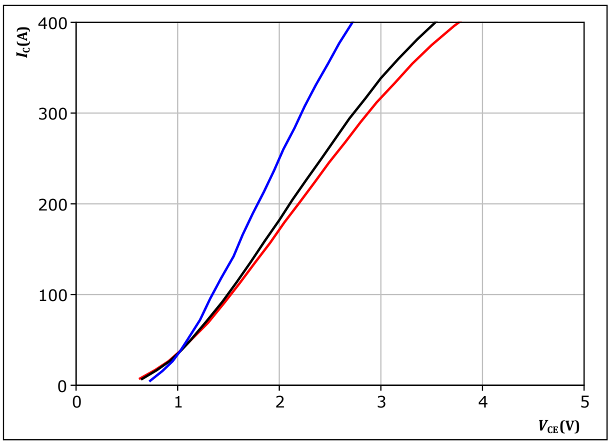
R (K/W)	τ (s)
2,95E-02	5,33E+00
5,99E-02	9,85E-01
1,02E-01	1,79E-01
1,92E-01	5,14E-02
7,16E-02	1,10E-02
3,93E-02	2,74E-03
2,53E-02	5,68E-04

Neutral Point Switch Characteristics

figure 8. **IGBT**

Typical output characteristics

$I_C = f(V_{CE})$

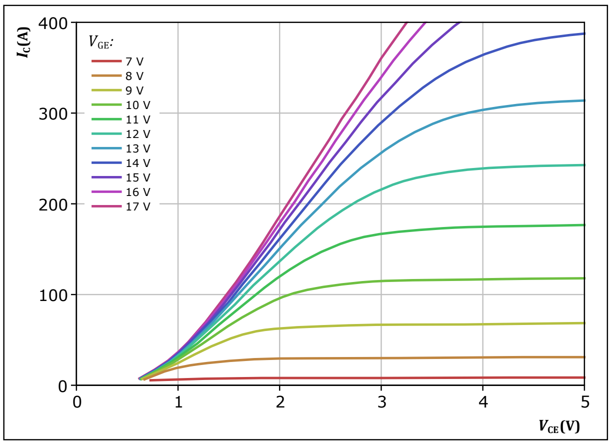


t_p =	250	µs		25 °C
V_{GE} =	15	V	T_j:	125 °C
				150 °C

figure 9. **IGBT**

Typical output characteristics

$I_C = f(V_{CE})$



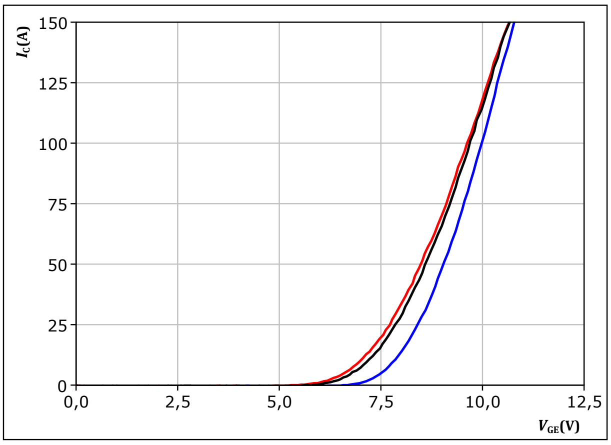
t_p =	250	µs
T_j =	150	°C

V_{GE} from 7 V to 17 V in steps of 1 V

figure 10. **IGBT**

Typical transfer characteristics

$I_C = f(V_{GE})$

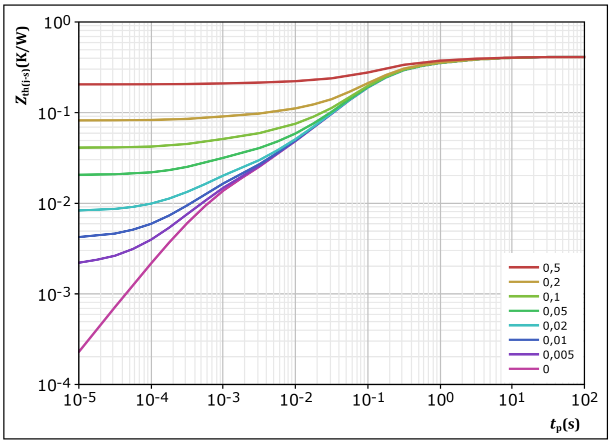


t_p =	250	µs		25 °C
V_{CE} =	10	V	T_j:	125 °C
				150 °C

figure 11. **IGBT**

Transient thermal impedance as a function of pulse width

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



D =	t_p / T	
$R_{th(j\text{-}s)}$ =	0,41	K/W

IGBT thermal model values

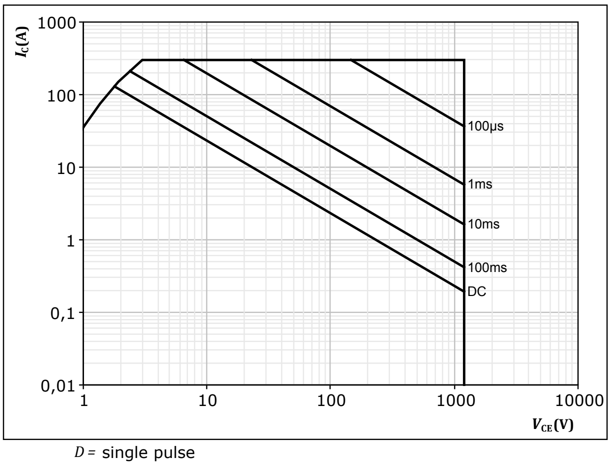
R (K/W)	τ (s)
3,37E-02	5,83E+00
6,56E-02	1,16E+00
1,87E-01	1,81E-01
9,56E-02	6,35E-02
1,67E-02	6,71E-03
1,10E-02	6,14E-04

Neutral Point Switch Characteristics

figure 12.	IGBT

Safe operating area

I_C = f(V_{CE})



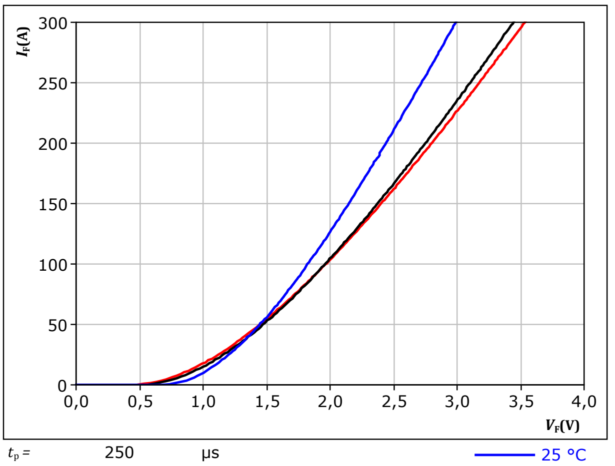
D =	single pulse	
T_s =	80	°C
V_{GE} =	15	V
T_j =	T_{jmax}	

DC-Link Diode Characteristics

figure 13. **FWD**

Typical forward characteristics

$I_F = f(V_F)$



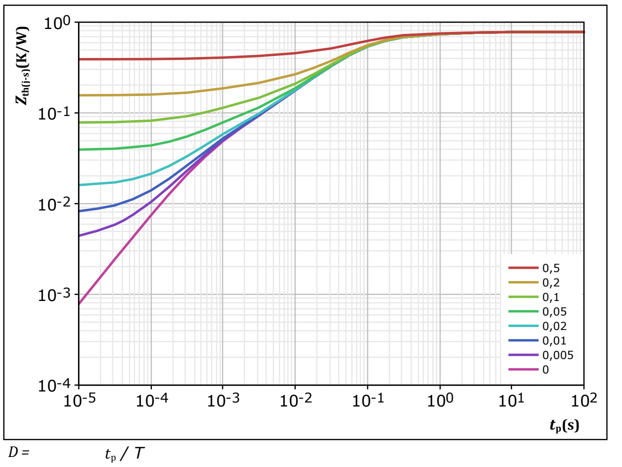
t_p = 250 µs

T_j: 25 °C, 125 °C, 150 °C

figure 14. **FWD**

Transient thermal impedance as a function of pulse width

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



$D = t_p / T$

$R_{th(j-s)}$ = 0,78 K/W

FWD thermal model values

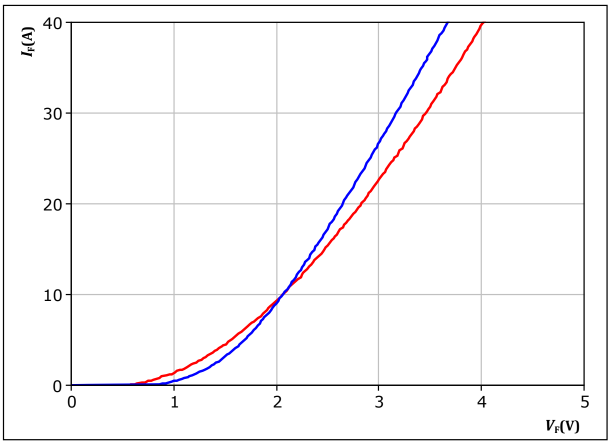
R (K/W)	τ (s)
4,02E-02	3,25E+00
8,95E-02	5,38E-01
3,67E-01	8,95E-02
1,96E-01	3,04E-02
5,18E-02	4,59E-03
3,55E-02	6,26E-04

Neutral Point Switch Prot. Diode Characteristics

figure 15. **FWD**

Typical forward characteristics

I_F = f(V_F)



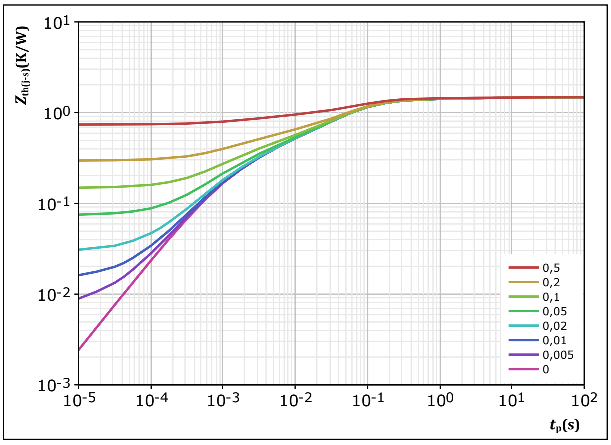
t_p = 250 µs

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

$R_{th(j-s)}$ = 1,479 K/W

FWD thermal model values

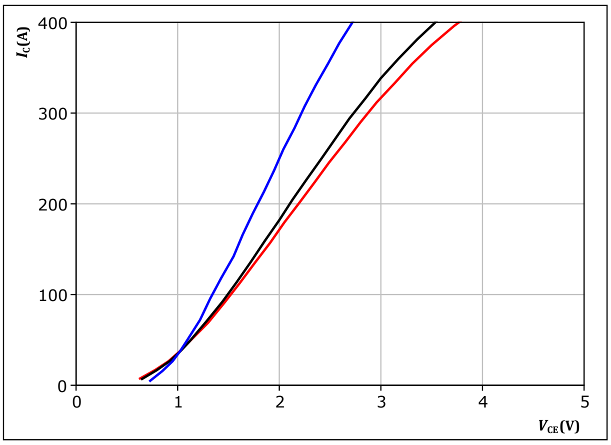
R (K/W)	τ (s)
4,85E-02	9,59E+00
1,03E-01	5,73E-01
6,61E-01	7,81E-02
3,02E-01	2,68E-02
2,12E-01	4,22E-03
1,52E-01	8,77E-04

DC-Link Switch Characteristics

figure 17. IGBT

Typical output characteristics

$I_C = f(V_{CE})$

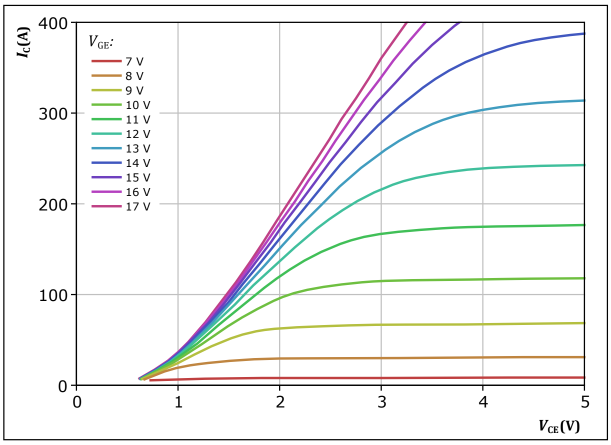


t_p = 250 µs
V_{GE} = 15 V
T_j: 25 °C, 125 °C, 150 °C

figure 18. IGBT

Typical output characteristics

$I_C = f(V_{CE})$

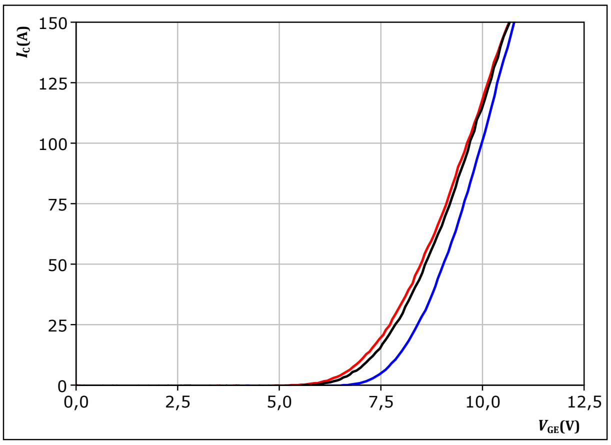


t_p = 250 µs
T_j = 150 °C
V_{GE} from 7 V to 17 V in steps of 1 V

figure 19. IGBT

Typical transfer characteristics

$I_C = f(V_{GE})$

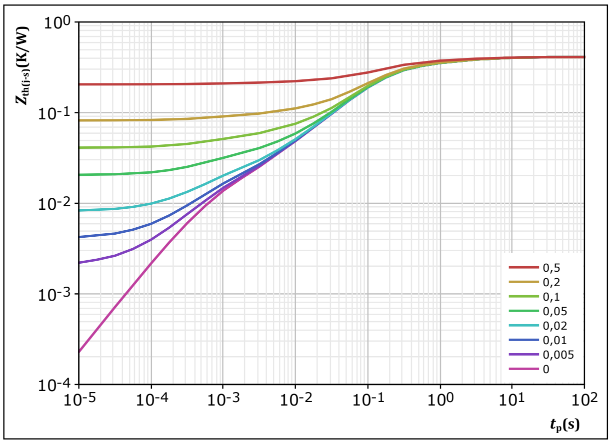


t_p = 250 µs
V_{CE} = 10 V
T_j: 25 °C, 125 °C, 150 °C

figure 20. IGBT

Transient thermal impedance as a function of pulse width

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



D = t_p / T
$R_{th(j-s)}$ = 0,41 K/W

IGBT thermal model values

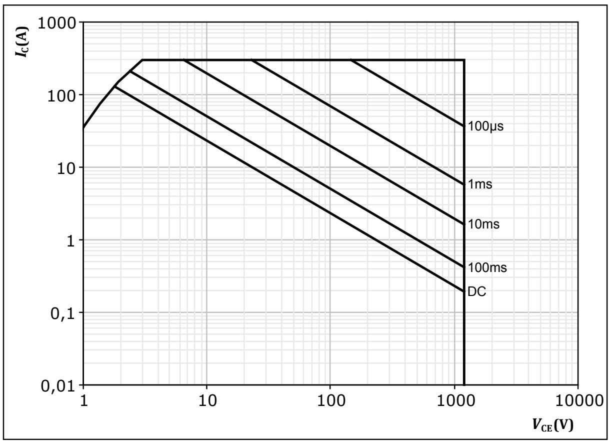
R (K/W)	τ (s)
3,37E-02	5,83E+00
6,56E-02	1,16E+00
1,87E-01	1,81E-01
9,56E-02	6,35E-02
1,67E-02	6,71E-03
1,10E-02	6,14E-04

DC-Link Switch Characteristics

figure 21.	IGBT

Safe operating area

I_C = f(V_{CE})



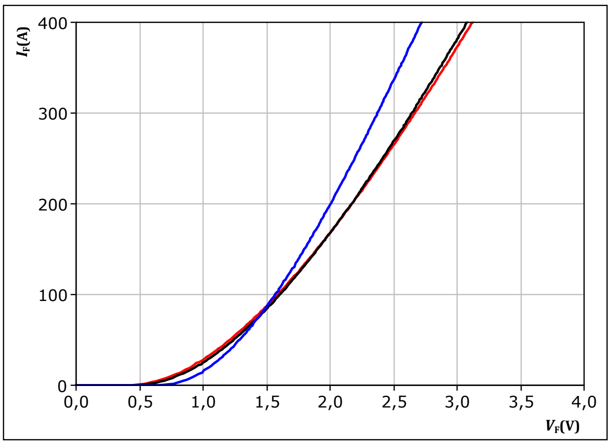
D =	single pulse	
T_s =	80	°C
V_{GE} =	15	V
T_j =	T_{jmax}	

Neutral Point Diode Characteristics

figure 22. **FWD**

Typical forward characteristics

$I_F = f(V_F)$



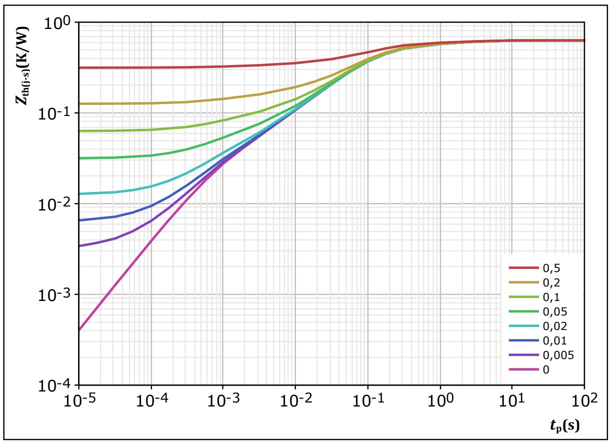
t_p = 250 µs

T_j: 25 °C, 125 °C, 150 °C

figure 23. **FWD**

Transient thermal impedance as a function of pulse width

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



$D = t_p / T$

$R_{th(j-s)}$ = 0,63 K/W

FWD thermal model values

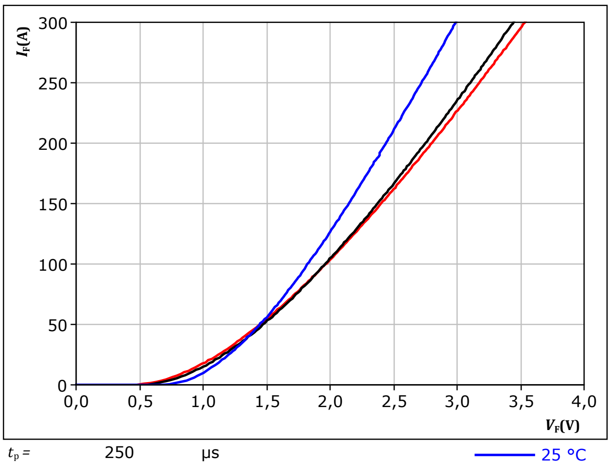
R (K/W)	τ (s)
5,76E-02	2,80E+00
9,23E-02	5,30E-01
3,12E-01	1,04E-01
1,04E-01	3,96E-02
4,08E-02	6,94E-03
2,30E-02	8,04E-04

DC-Link Switch Prot. Diode Characteristics

figure 24. **FWD**

Typical forward characteristics

$I_F = f(V_F)$



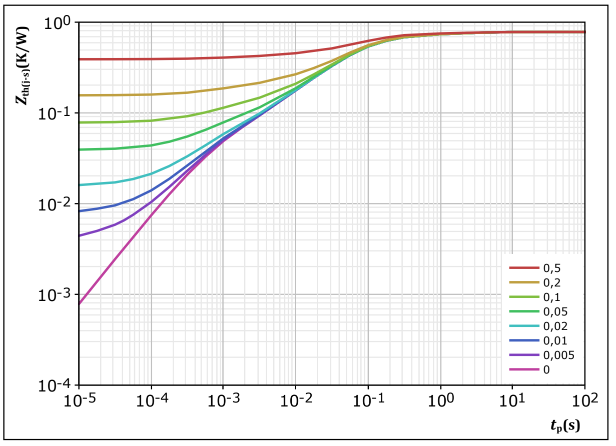
t_p = 250 µs

T_j: 25 °C, 125 °C, 150 °C

figure 25. **FWD**

Transient thermal impedance as a function of pulse width

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



$D = t_p / T$

$R_{th(j-s)}$ = 0,78 K/W

FWD thermal model values

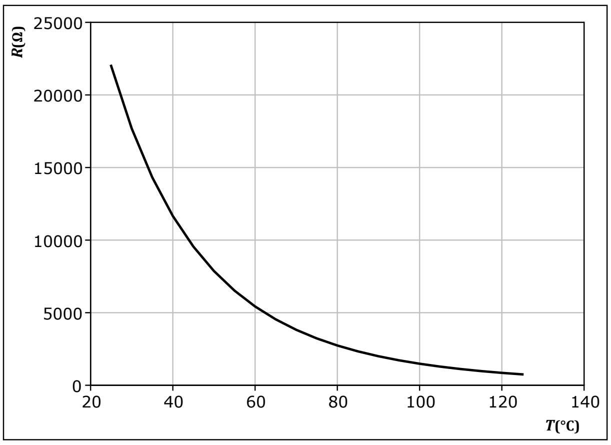
R (K/W)	τ (s)
4,02E-02	3,25E+00
8,95E-02	5,38E-01
3,67E-01	8,95E-02
1,96E-01	3,04E-02
5,18E-02	4,59E-03
3,55E-02	6,26E-04

Thermistor Characteristics

figure 26. **Thermistor**

Typical NTC characteristic as function of temperature

R_T = f(T)

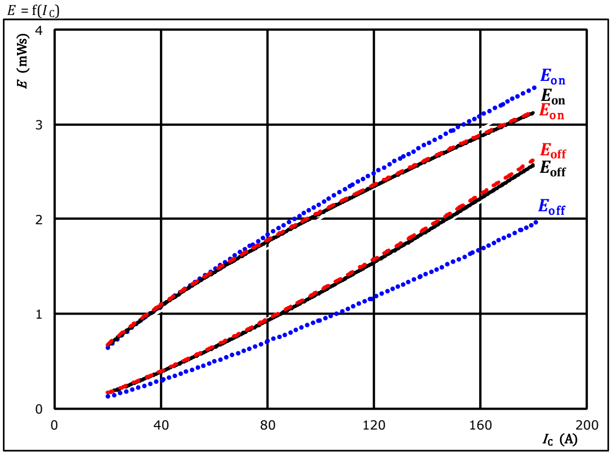


AC Real Open Switching Characteristics

figure 1. IGBT

Typical switching energy losses as a function of collector current

$E = f(I_C)$



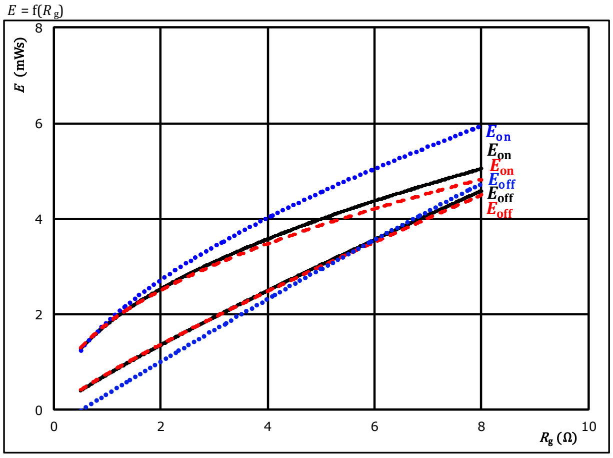
With an inductive load at

V_{CE} =	600	V	T_j:	25 °C	dotted
V_{GE} =	-2 / 18	V		125 °C	solid
R_{gon} =	2	Ω		150 °C	dashed
R_{goff} =	2	Ω			

figure 2. IGBT

Typical switching energy losses as a function of gate resistor

$E = f(R_g)$



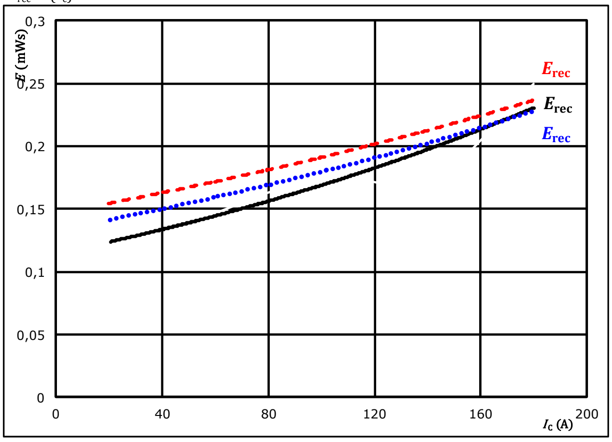
With an inductive load at

V_{CE} =	600	V	T_j:	25 °C	dotted
V_{GE} =	-2 / 18	V		125 °C	solid
I_C =	100	A		150 °C	dashed

figure 3. FWD

Typical reverse recovered energy loss as a function of collector current

$E_{rec} = f(I_c)$



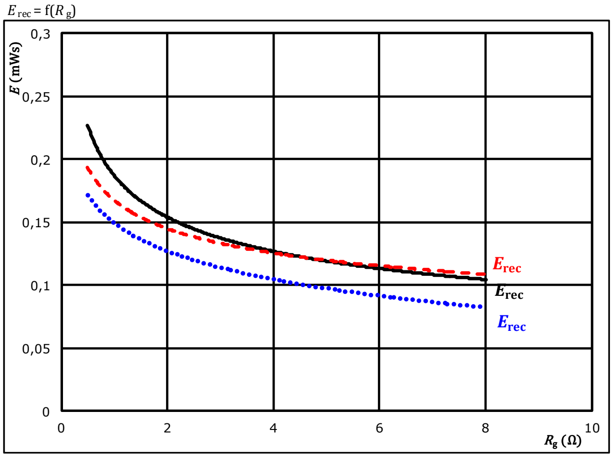
With an inductive load at

V_{CE} =	600	V	T_j:	25 °C	dotted
V_{GE} =	-2 / 18	V		125 °C	solid
R_{gon} =	2	Ω		150 °C	dashed

figure 4. FWD

Typical reverse recovered energy loss as a function of gate resistor

$E_{rec} = f(R_g)$



With an inductive load at

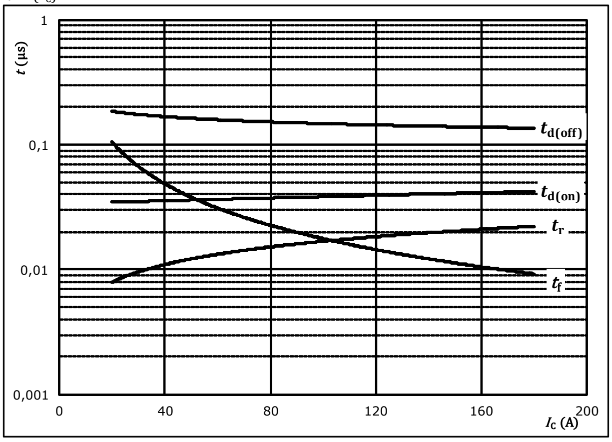
V_{CE} =	600	V	T_j:	25 °C	dotted
V_{GE} =	-2 / 18	V		125 °C	solid
I_C =	100	A		150 °C	dashed

AC Real Open Switching Characteristics

figure 5. **IGBT**

Typical switching times as a function of collector current

$t = f(I_C)$



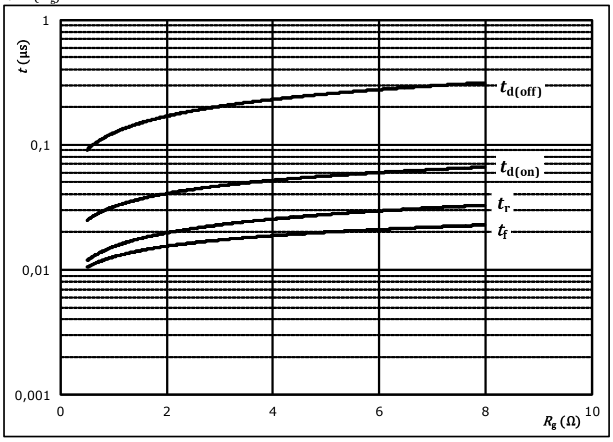
With an inductive load at

T_j =	150	°C
V_{CE} =	600	V
V_{GE} =	-2 / 18	V
R_{gon} =	2	Ω
R_{goff} =	2	Ω

figure 6. **IGBT**

Typical switching times as a function of gate resistor

$t = f(R_g)$



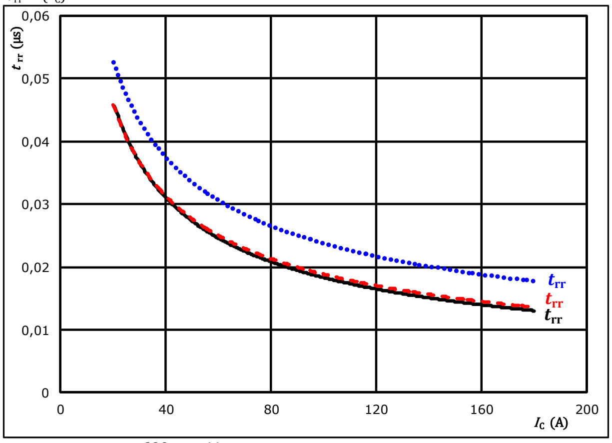
With an inductive load at

T_j =	150	°C
V_{CE} =	600	V
V_{GE} =	-2 / 18	V
I_C =	100	A

figure 7. **FWD**

Typical reverse recovery time as a function of collector current

$t_{rr} = f(I_C)$

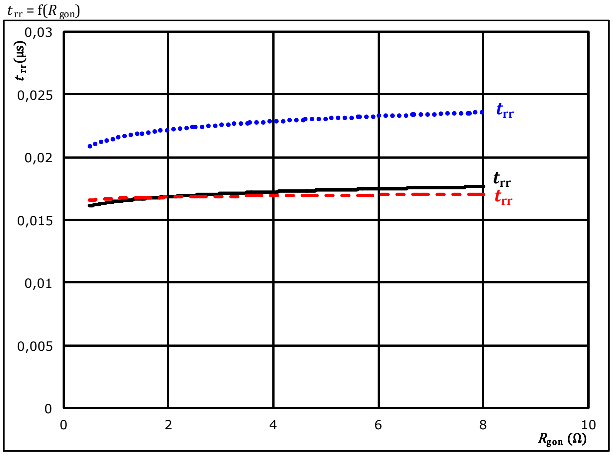


At						
V_{CE}=	600	V			25 °C	···········
V_{GE} =	-2 / 18	V	T_j:		125 °C	———
R_{gon} =	2	Ω			150 °C	– – –

figure 8. **FWD**

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

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



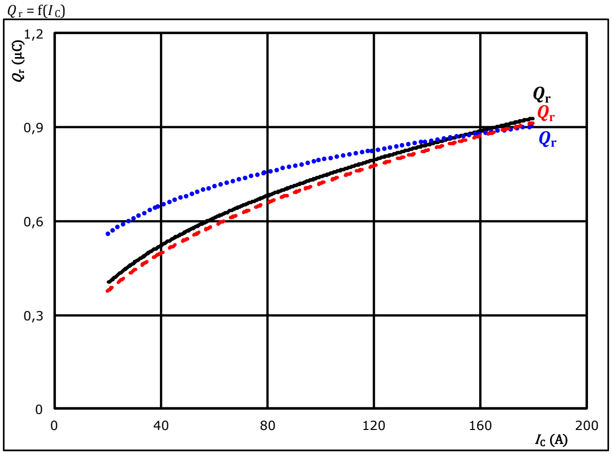
At						
V_{CE}=	600	V			25 °C	···········
V_{GE} =	-2 / 18	V	T_j:		125 °C	———
I_C =	100	A			150 °C	– – –

AC Real Open Switching Characteristics

figure 9. **FWD**

Typical recovered charge as a function of collector current

$Q_r = f(I_C)$

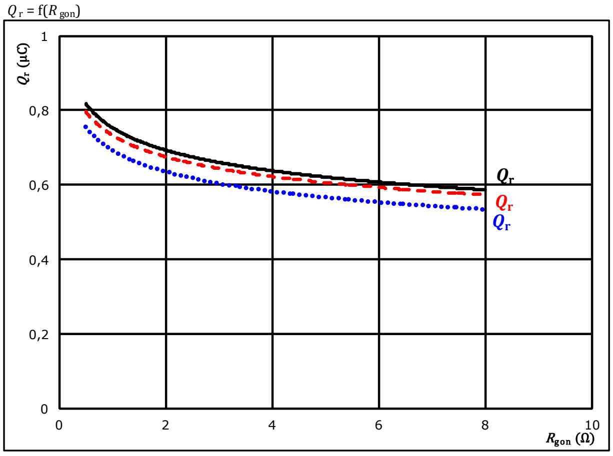


At					
V_{CE} =	600	V	T_j:	25 °C	············
V_{GE} =	-2 / 18	V		125 °C	———
R_{gon} =	2	Ω		150 °C	– – –

figure 10. **FWD**

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

$Q_r = f(R_{gon})$

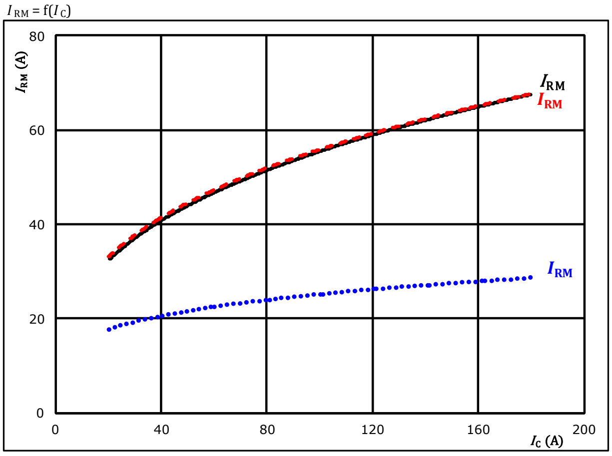


At					
V_{CE} =	600	V	T_j:	25 °C	············
V_{GE} =	-2 / 18	V		125 °C	———
I_C =	100	A		150 °C	– – –

figure 11. **FWD**

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

$I_{RM} = f(I_C)$

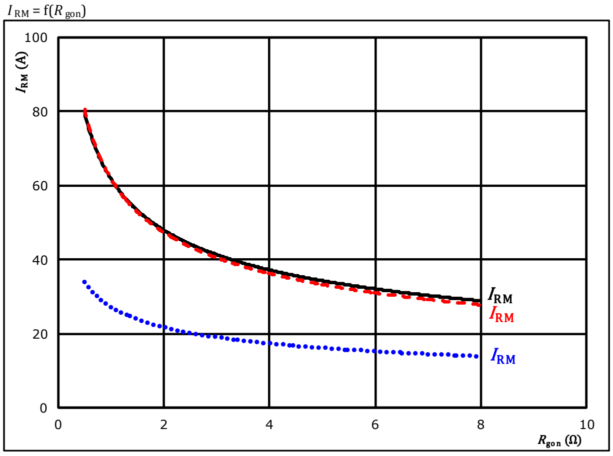


At					
V_{CE} :	600	V	T_j:	25 °C	············
V_{GE} =	-2 / 18	V		125 °C	———
R_{gon} =	2	Ω		150 °C	– – –

figure 12. **FWD**

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

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



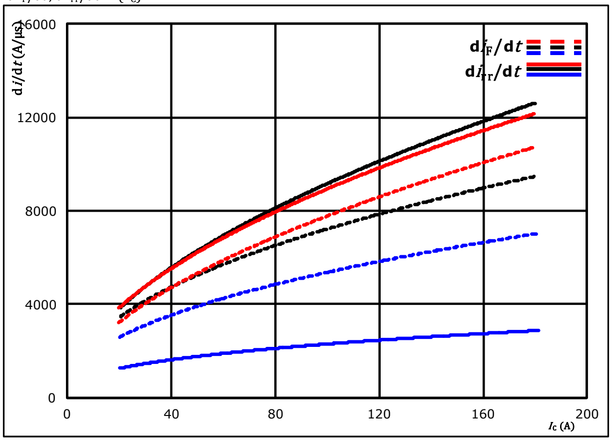
At					
V_{CE} =	600	V	T_j:	25 °C	············
V_{GE} =	-2 / 18	V		125 °C	———
I_C =	100	A		150 °C	– – –

AC Real Open Switching Characteristics

figure 13. **FWD**

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

$di_F/dt, di_{rr}/dt = f(I_C)$

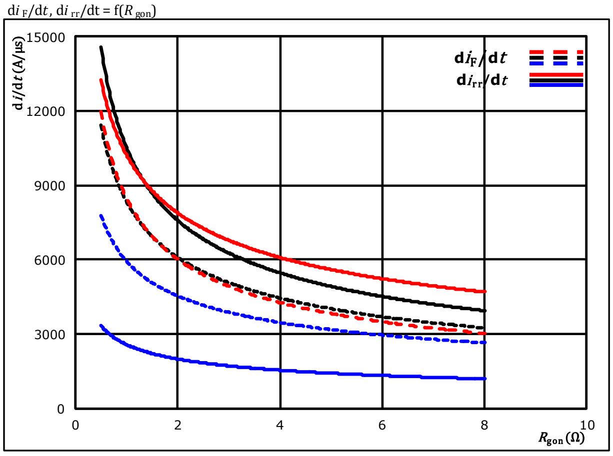


At					
V_{CE} =	600	V		25	°C
V_{GE} =	-2 / 18	V	T_j:	125	°C
R_{gon} =	2	Ω		150	°C

figure 14. **FWD**

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

$di_F/dt, di_{rr}/dt = f(R_{gon})$

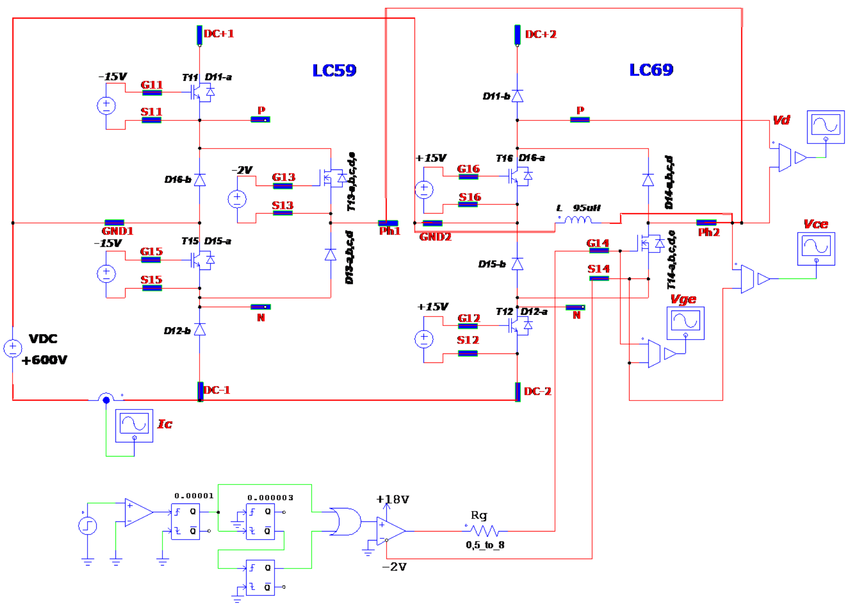


At					
V_{CE} =	600	V		25	°C
V_{GE} =	-2 / 18	V	T_j:	125	°C
I_C =	100	A		150	°C

AC Real Open measurement circuit

figure 1.

AC Real PN Open Configuration

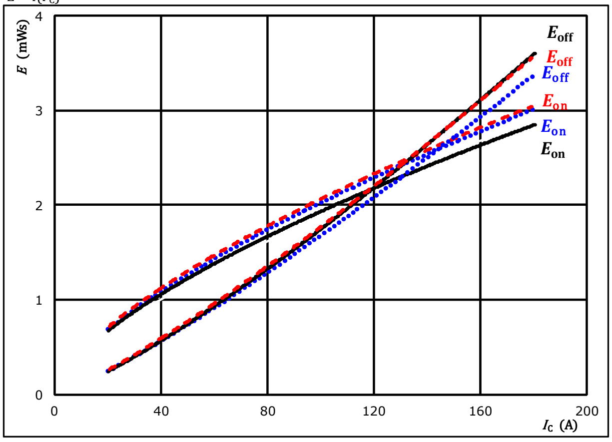


AC Reactive Open Switching Characteristics

figure 1. IGBT

Typical switching energy losses as a function of collector current

$E = f(I_C)$



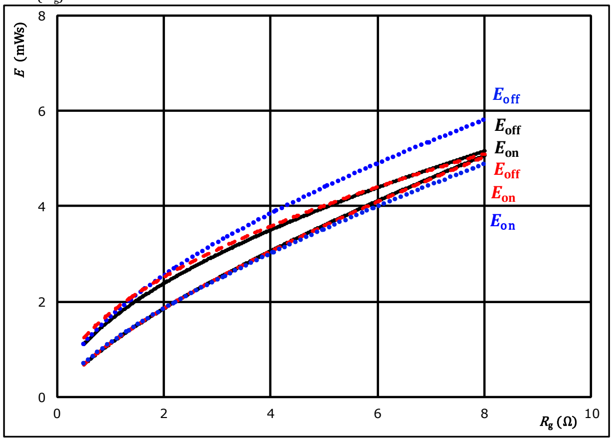
With an inductive load at

V_{CE} =	600	V	T_j:	25 °C	dotted
V_{GE} =	-2 / 18	V		125 °C	solid
R_{gon} =	2	Ω		150 °C	dashed
R_{goff} =	2	Ω			

figure 2. IGBT

Typical switching energy losses as a function of gate resistor

$E = f(R_g)$



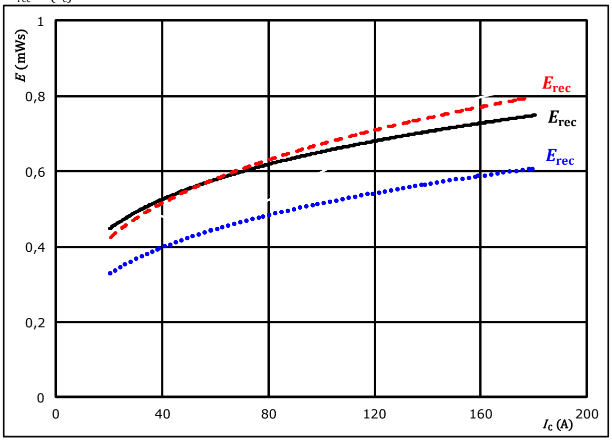
With an inductive load at

V_{CE} =	600	V	T_j:	25 °C	dotted
V_{GE} =	-2 / 18	V		125 °C	solid
I_C =	100	A		150 °C	dashed

figure 3. FWD

Typical reverse recovered energy loss as a function of collector current

$E_{rec} = f(I_c)$



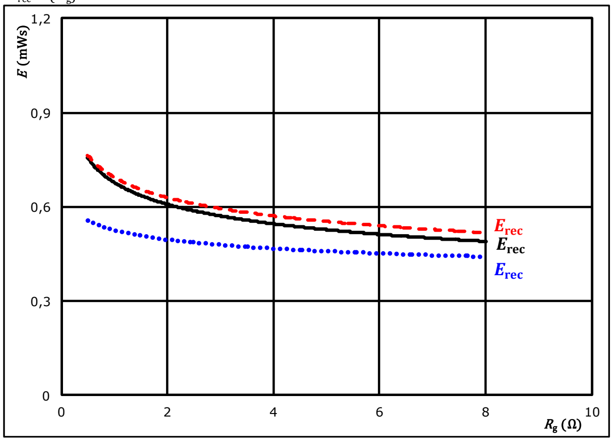
With an inductive load at

V_{CE} =	600	V	T_j:	25 °C	dotted
V_{GE} =	-2 / 18	V		125 °C	solid
R_{gon} =	2	Ω		150 °C	dashed

figure 4. FWD

Typical reverse recovered energy loss as a function of gate resistor

$E_{rec} = f(R_g)$



With an inductive load at

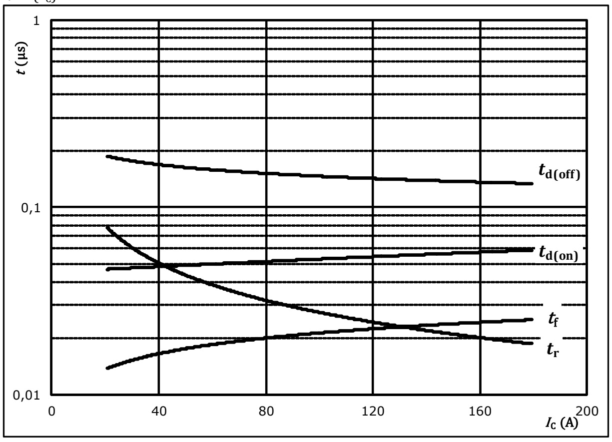
V_{CE} =	600	V	T_j:	25 °C	dotted
V_{GE} =	-2 / 18	V		125 °C	solid
I_C =	100	A		150 °C	dashed

AC Reactive Open Switching Characteristics

figure 5. IGBT

Typical switching times as a function of collector current

$t = f(I_C)$



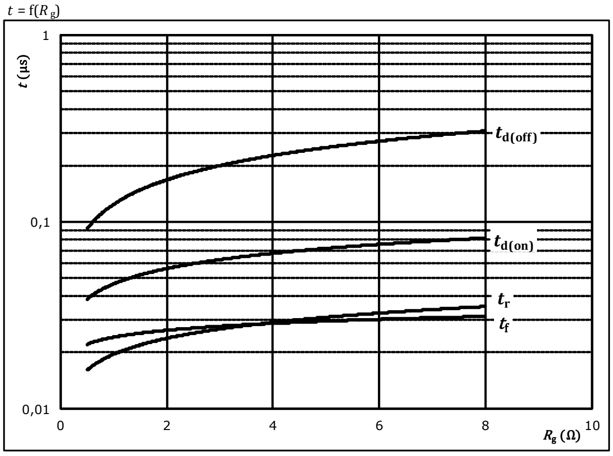
With an inductive load at

T_j =	150	°C
V_{CE} =	600	V
V_{GE} =	-2 / 18	V
R_{gon} =	2	Ω
R_{goff} =	2	Ω

figure 6. IGBT

Typical switching times as a function of gate resistor

$t = f(R_g)$



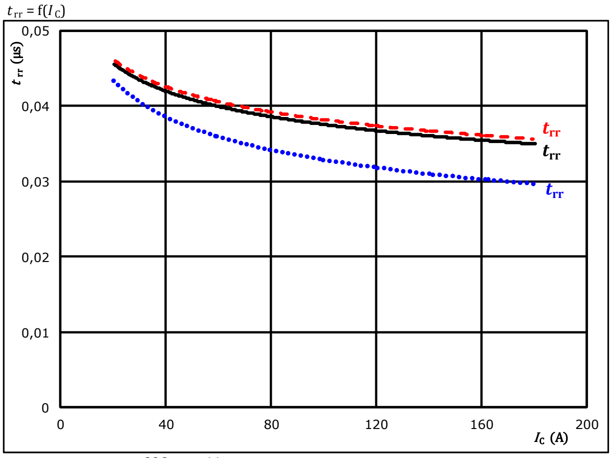
With an inductive load at

T_j =	150	°C
V_{CE} =	600	V
V_{GE} =	-2 / 18	V
I_C =	100	A

figure 7. FWD

Typical reverse recovery time as a function of collector current

$t_{rr} = f(I_C)$



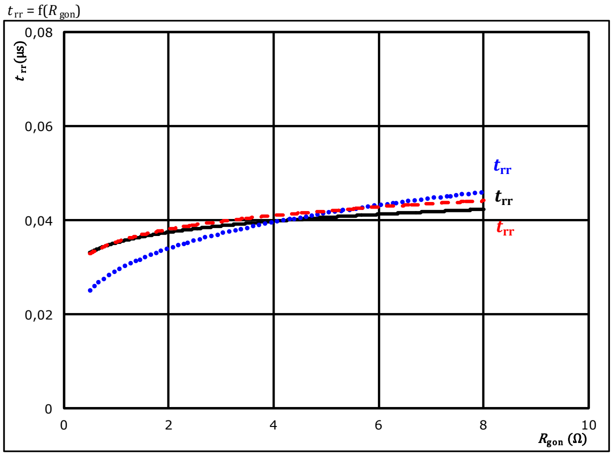
At

V_{CE} =	600	V		25 °C	dotted blue
V_{GE} =	-2 / 18	V	T_j:	125 °C	solid black
R_{gon} =	2	Ω		150 °C	dashed red

figure 8. FWD

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

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



At

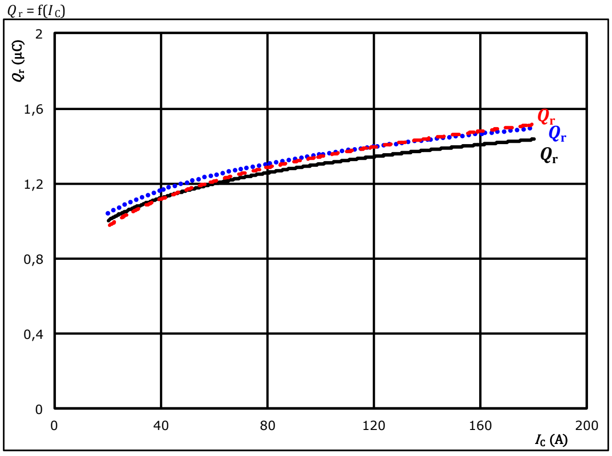
V_{CE} =	600	V		25 °C	dotted blue
V_{GE} =	-2 / 18	V	T_j:	125 °C	solid black
I_C =	100	A		150 °C	dashed red

AC Reactive Open Switching Characteristics

figure 9. **FWD**

Typical recovered charge as a function of collector current

$Q_r = f(I_C)$

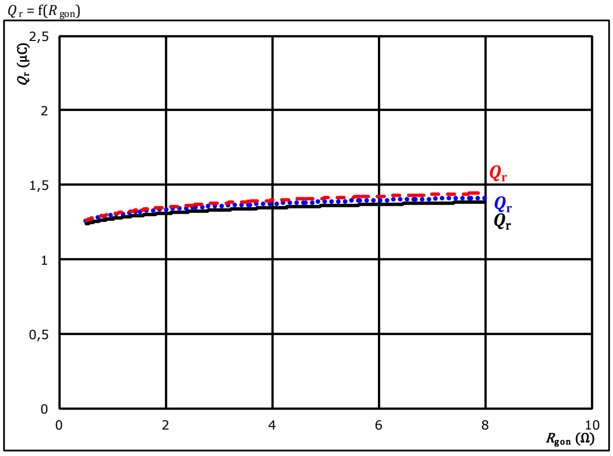


At					
V_{CE} =	600	V	T_j:	25 °C	dotted
V_{GE} =	-2 / 18	V		125 °C	solid
R_{gon} =	2	Ω		150 °C	dashed

figure 10. **FWD**

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

$Q_r = f(R_{gon})$

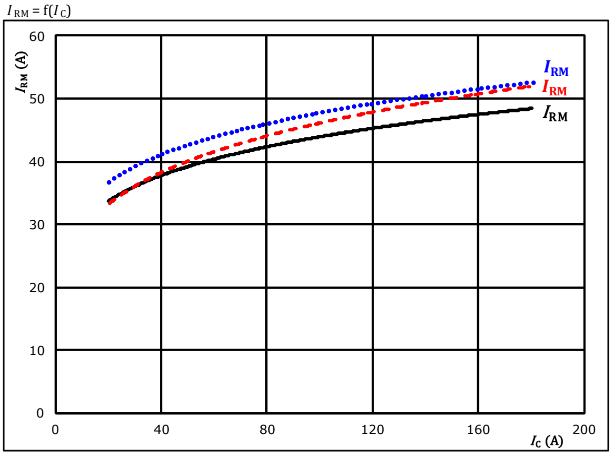


At					
V_{CE} =	600	V	T_j:	25 °C	dotted
V_{GE} =	-2 / 18	V		125 °C	solid
I_C =	100	A		150 °C	dashed

figure 11. **FWD**

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

$I_{RM} = f(I_C)$

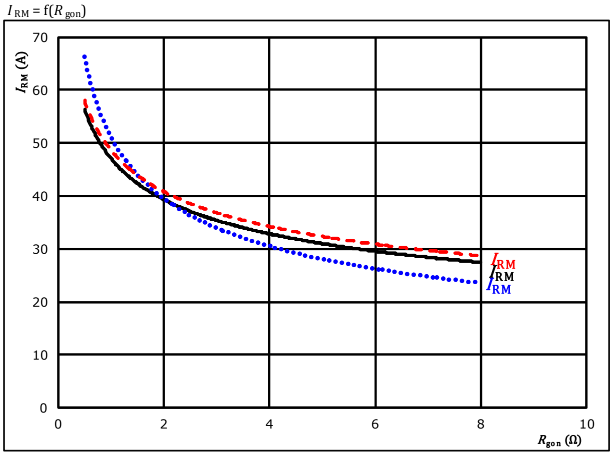


At					
V_{CE} =	600	V	T_j:	25 °C	dotted
V_{GE} =	-2 / 18	V		125 °C	solid
R_{gon} =	2	Ω		150 °C	dashed

figure 12. **FWD**

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

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



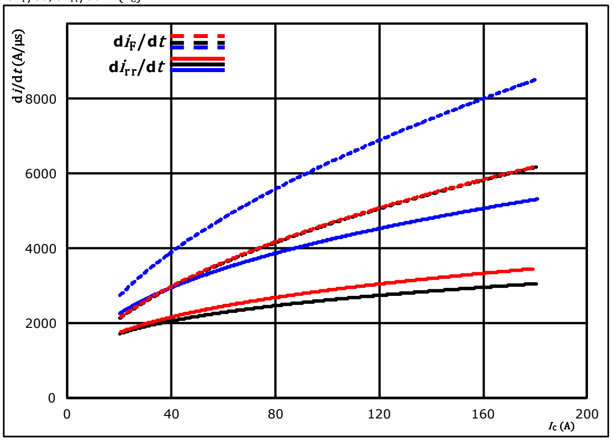
At					
V_{CE} =	600	V	T_j:	25 °C	dotted
V_{GE} =	-2 / 18	V		125 °C	solid
I_C =	100	A		150 °C	dashed

AC Reactive Open Switching Characteristics

figure 13. 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)

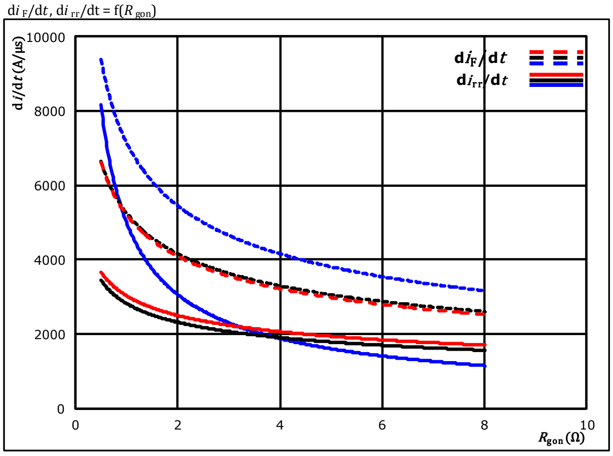


At					
V_{CE} =	600	V		25	°C
V_{GE} =	-2 / 18	V	T_j:	125	°C
R_{gon} =	2	Ω		150	°C

figure 14. FWD

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

di_F/dt, di_{rr}/dt = f(R_{gon})

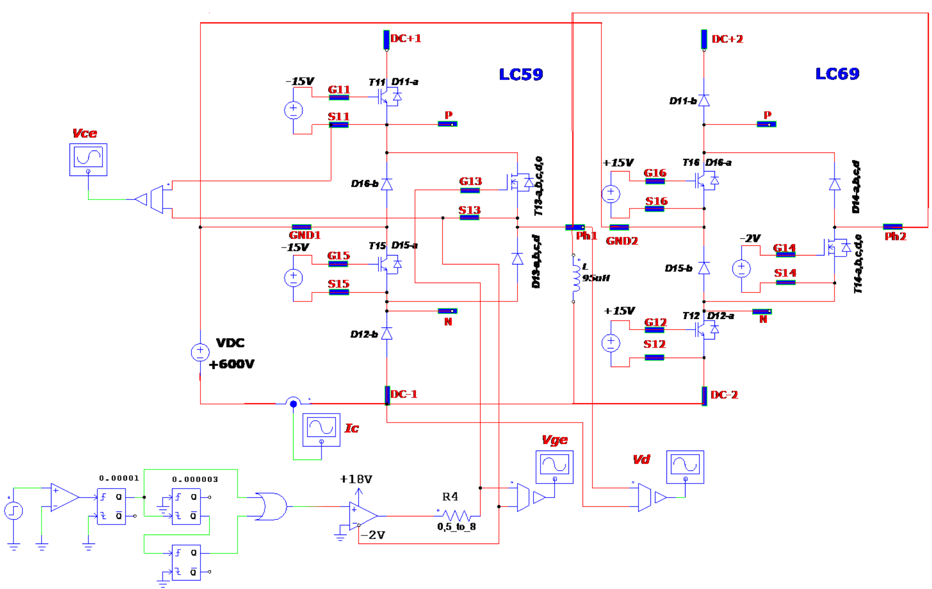


At					
V_{CE} =	600	V		25	°C
V_{GE} =	-2 / 18	V	T_j:	125	°C
I_C =	100	A		150	°C

AC Reactive Open measurement circuit

figure 1.

AC Reactive PN Open Configuration



Vincotech

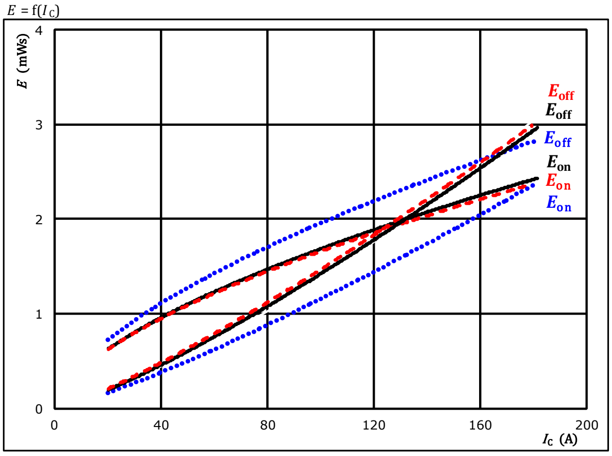
10-PG12NAB008MR02-LC59F36T
10-PG12NAC008MR02-LC69F36T
datasheet

AC Real Short Switching Characteristics

figure 1. **IGBT**

Typical switching energy losses as a function of collector current

$E = f(I_C)$



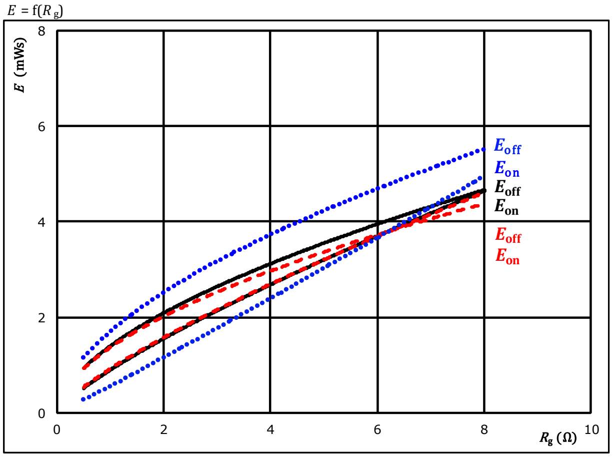
With an inductive load at

V_{CE} =	600	V	T_j:	25 °C	dotted
V_{GE} =	-2 / 18	V		125 °C	solid
R_{gon} =	2	Ω		150 °C	dashed
R_{goff} =	2	Ω			

figure 2. **IGBT**

Typical switching energy losses as a function of gate resistor

$E = f(R_g)$



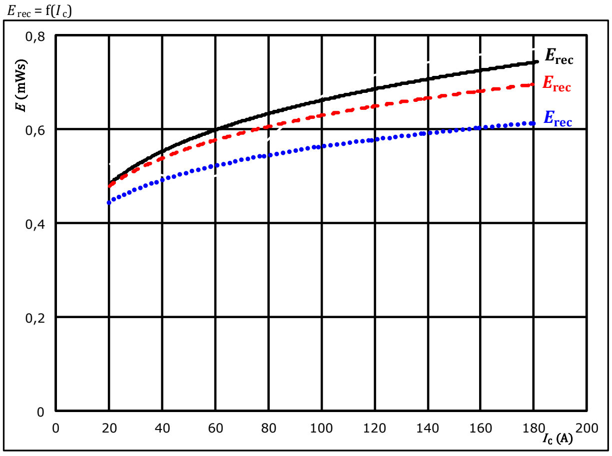
With an inductive load at

V_{CE} =	600	V	T_j:	25 °C	dotted
V_{GE} =	-2 / 18	V		125 °C	solid
I_C =	100	A		150 °C	dashed

figure 3. **FWD**

Typical reverse recovered energy loss as a function of collector current

$E_{rec} = f(I_c)$



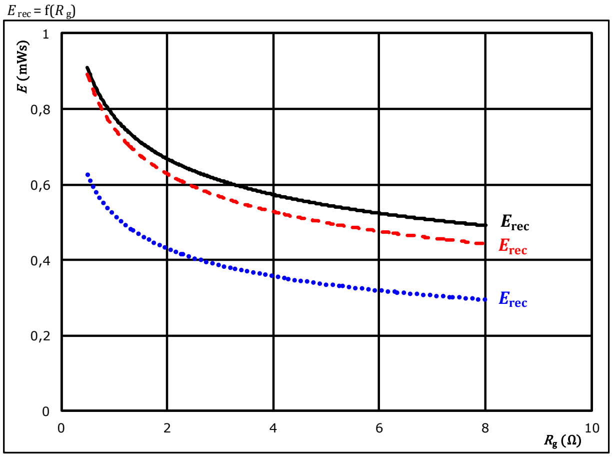
With an inductive load at

V_{CE} =	600	V	T_j:	25 °C	dotted
V_{GE} =	-2 / 18	V		125 °C	solid
R_{gon} =	2	Ω		150 °C	dashed

figure 4. **FWD**

Typical reverse recovered energy loss as a function of gate resistor

$E_{rec} = f(R_g)$



With an inductive load at

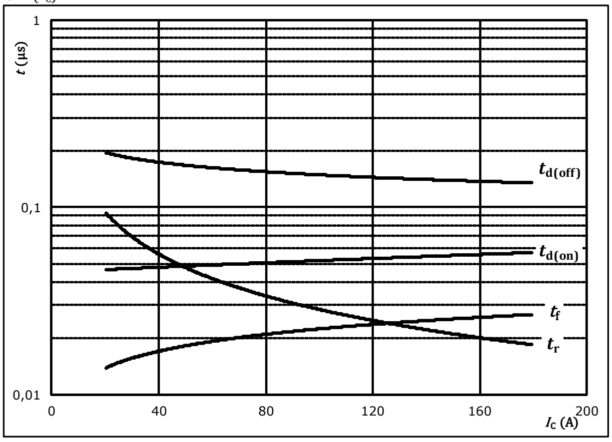
V_{CE} =	600	V	T_j:	25 °C	dotted
V_{GE} =	-2 / 18	V		125 °C	solid
I_C =	100	A		150 °C	dashed

AC Real Short Switching Characteristics

figure 5. **IGBT**

Typical switching times as a function of collector current

$t = f(I_C)$



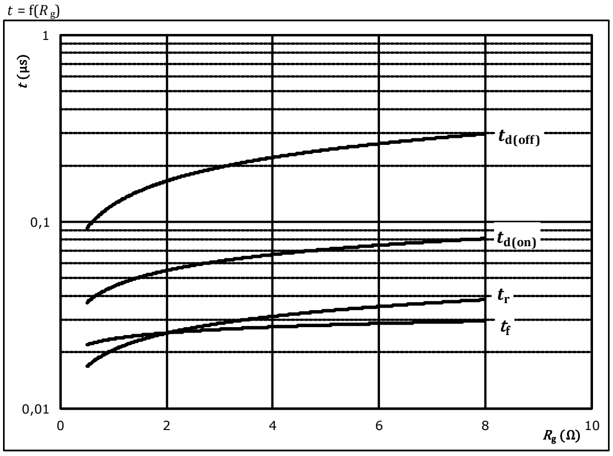
With an inductive load at

T_j =	150	°C
V_{CE} =	600	V
V_{GE} =	-2 / 18	V
R_{gon} =	2	Ω
R_{goff} =	2	Ω

figure 6. **IGBT**

Typical switching times as a function of gate resistor

$t = f(R_g)$



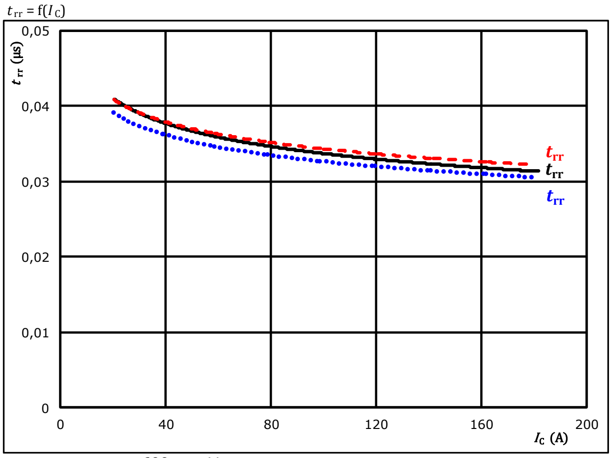
With an inductive load at

T_j =	150	°C
V_{CE} =	600	V
V_{GE} =	-2 / 18	V
I_C =	100	A

figure 7. **FWD**

Typical reverse recovery time as a function of collector current

$t_{rr} = f(I_C)$

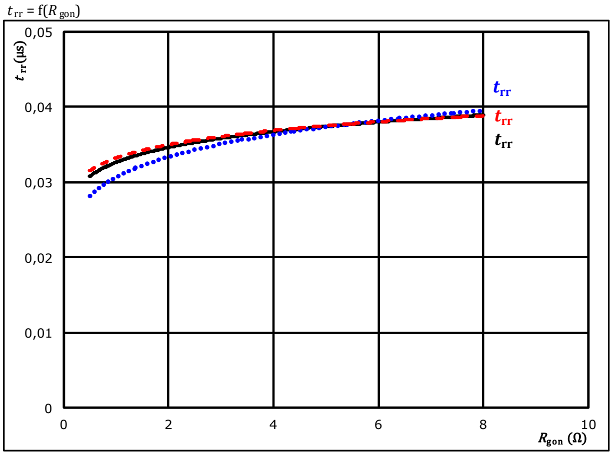


At	V_{CE} =	600	V		25 °C	···········
	V_{GE} =	-2 / 18	V	T_j:	125 °C	———
	R_{gon} =	2	Ω		150 °C	– – –

figure 8. **FWD**

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

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



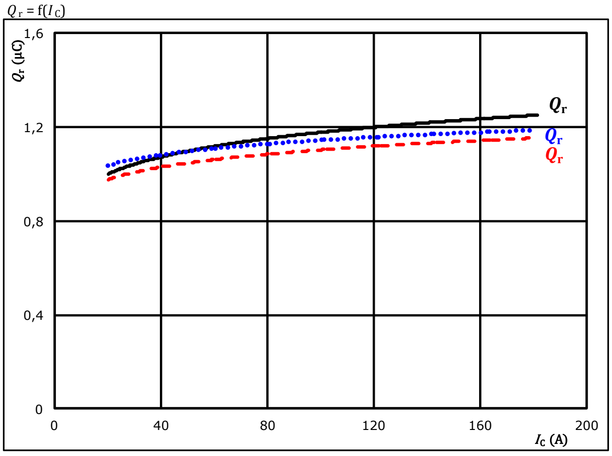
At	V_{CE} =	600	V		25 °C	···········
	V_{GE} =	-2 / 18	V	T_j:	125 °C	———
	I_C =	100	A		150 °C	– – –

AC Real Short Switching Characteristics

figure 9. **FWD**

Typical recovered charge as a function of collector current

$Q_r = f(I_C)$

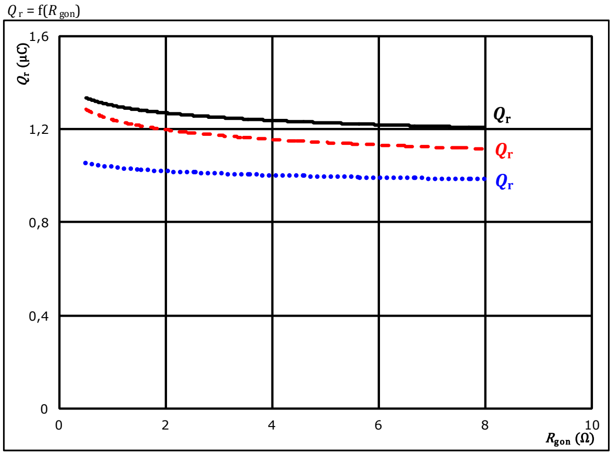


At					
V_{CE} =	600	V	T_j:	25 °C	dotted
V_{GE} =	-2 / 18	V		125 °C	solid
R_{gon} =	2	Ω		150 °C	dashed

figure 10. **FWD**

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

$Q_r = f(R_{gon})$

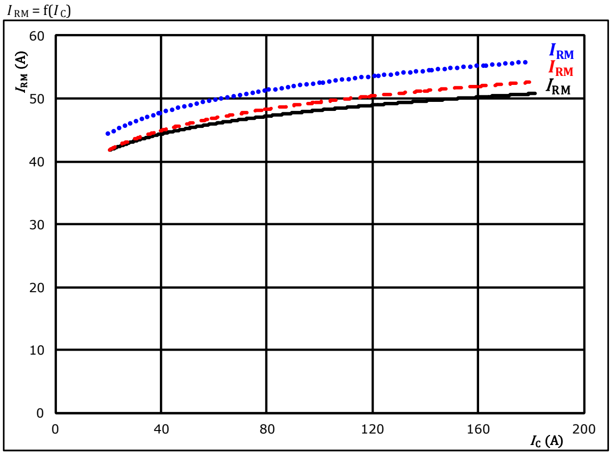


At					
V_{CE} =	600	V	T_j:	25 °C	dotted
V_{GE} =	-2 / 18	V		125 °C	solid
I_C =	100	A		150 °C	dashed

figure 11. **FWD**

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

$I_{RM} = f(I_C)$

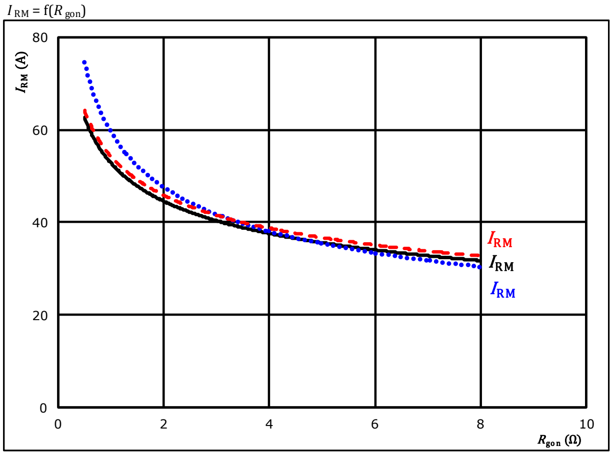


At					
V_{CE} =	600	V	T_j:	25 °C	dotted
V_{GE} =	-2 / 18	V		125 °C	solid
R_{gon} =	2	Ω		150 °C	dashed

figure 12. **FWD**

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

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



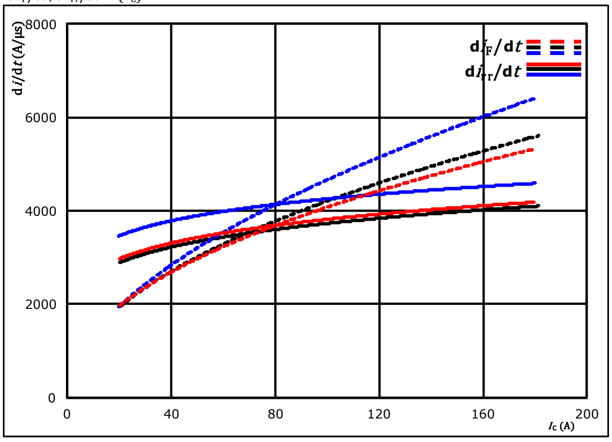
At					
V_{CE} =	600	V	T_j:	25 °C	dotted
V_{GE} =	-2 / 18	V		125 °C	solid
I_C =	100	A		150 °C	dashed

AC Real Short Switching Characteristics

figure 13. FWD

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

$di_F/dt, di_{rr}/dt = f(I_C)$

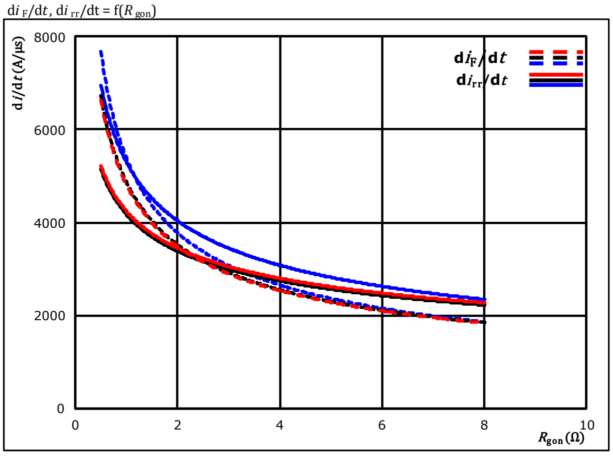


At					
V_{CE} =	600	V	T_j:	25	°C
V_{GE} =	-2 / 18	V		125	°C
R_{gon} =	2	Ω		150	°C

figure 14. FWD

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

$di_F/dt, di_{rr}/dt = f(R_{gon})$

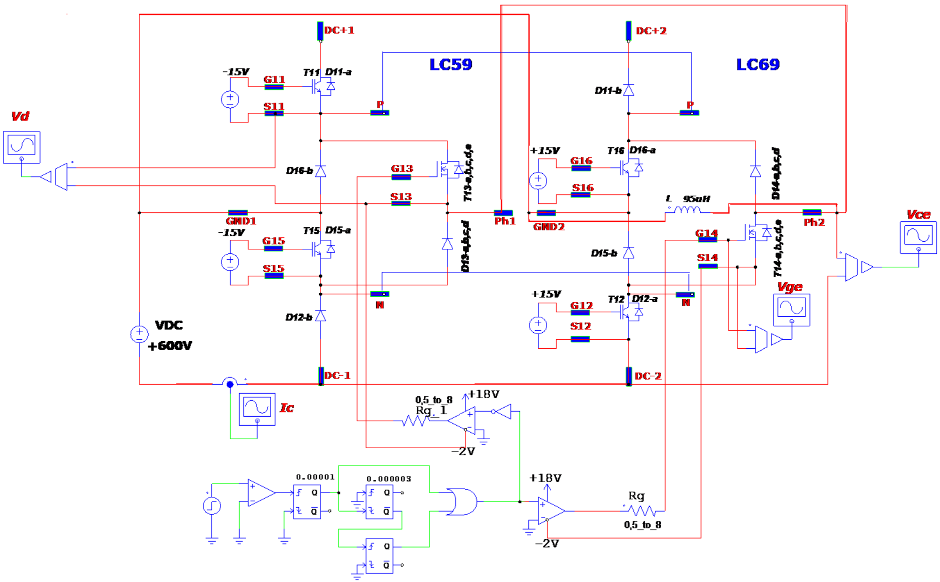


At					
V_{CE} =	600	V	T_j:	25	°C
V_{GE} =	-2 / 18	V		125	°C
I_C =	100	A		150	°C

AC Real Short measurement circuit

figure 1.

AC Real PN Short Configuration

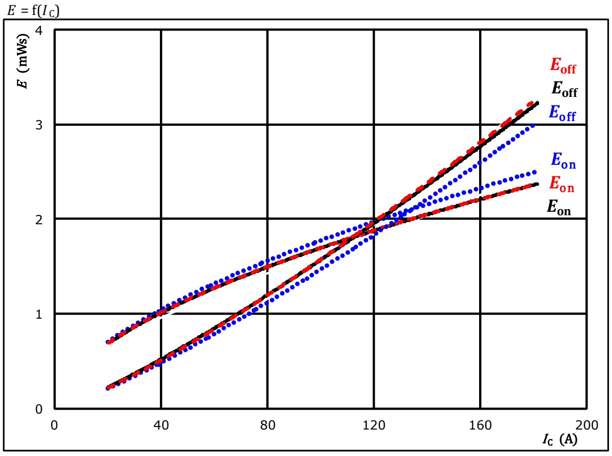


AC Reactive Short Switching Characteristics

figure 1. **IGBT**

Typical switching energy losses as a function of collector current

$E = f(I_C)$



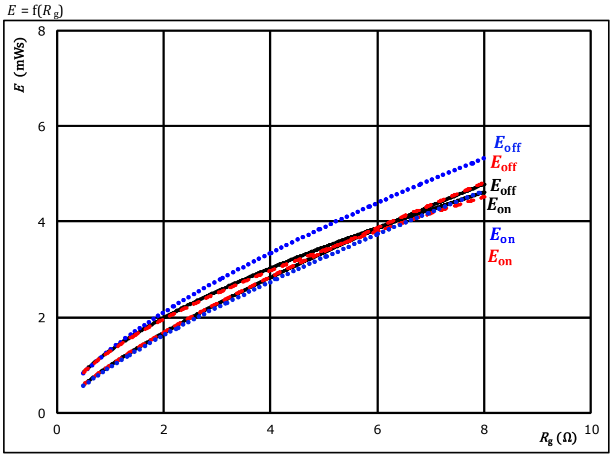
With an inductive load at

V_{CE} =	600	V	T_j:	25 °C	dotted
V_{GE} =	-2 / 18	V		125 °C	solid
R_{gon} =	2	Ω		150 °C	dashed
R_{goff} =	2	Ω			

figure 2. **IGBT**

Typical switching energy losses as a function of gate resistor

$E = f(R_g)$



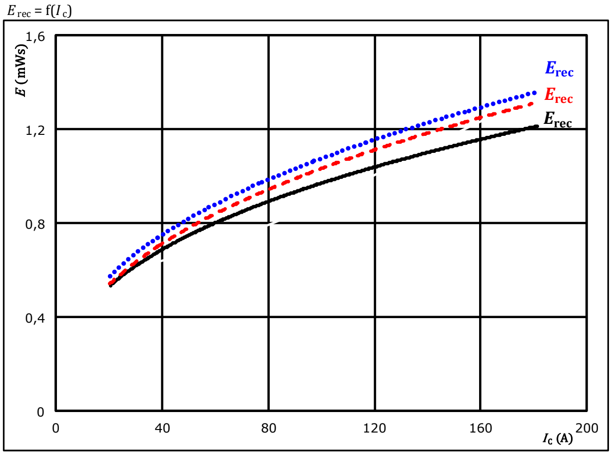
With an inductive load at

V_{CE} =	600	V	T_j:	25 °C	dotted
V_{GE} =	-2 / 18	V		125 °C	solid
I_C =	100	A		150 °C	dashed

figure 3. **FWD**

Typical reverse recovered energy loss as a function of collector current

$E_{rec} = f(I_c)$



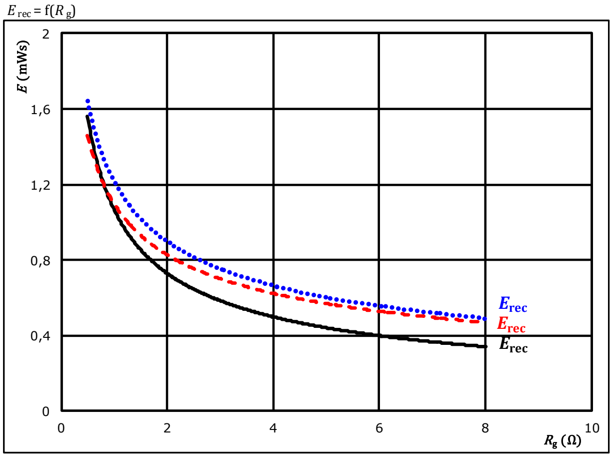
With an inductive load at

V_{CE} =	600	V	T_j:	25 °C	dotted
V_{GE} =	-2 / 18	V		125 °C	solid
R_{gon} =	2	Ω		150 °C	dashed

figure 4. **FWD**

Typical reverse recovered energy loss as a function of gate resistor

$E_{rec} = f(R_g)$



With an inductive load at

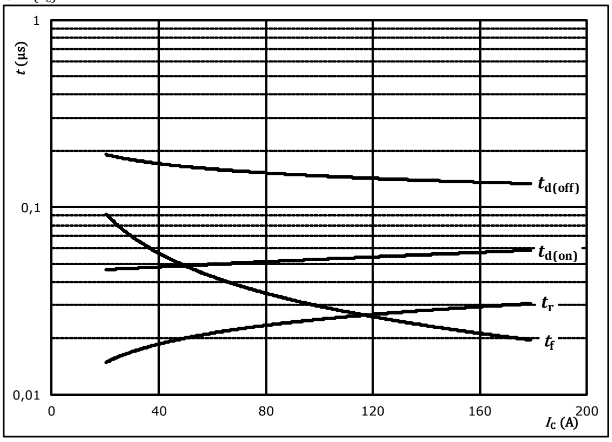
V_{CE} =	600	V	T_j:	25 °C	dotted
V_{GE} =	-2 / 18	V		125 °C	solid
I_C =	100	A		150 °C	dashed

AC Reactive Short Switching Characteristics

figure 5. **IGBT**

Typical switching times as a function of collector current

$t = f(I_C)$



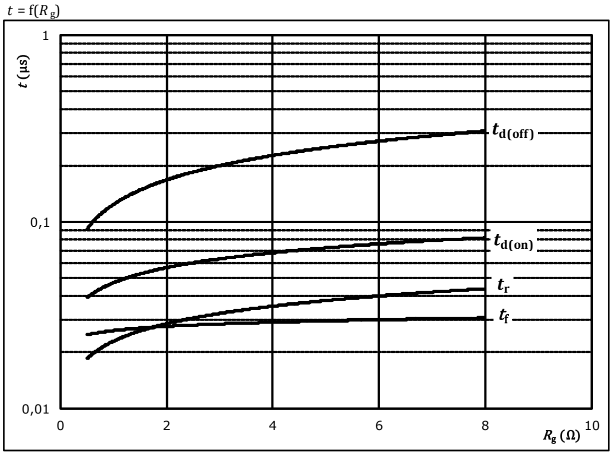
With an inductive load at

T_j =	150	°C
V_{CE} =	600	V
V_{GE} =	-2 / 18	V
R_{gon} =	2	Ω
R_{goff} =	2	Ω

figure 6. **IGBT**

Typical switching times as a function of gate resistor

$t = f(R_g)$



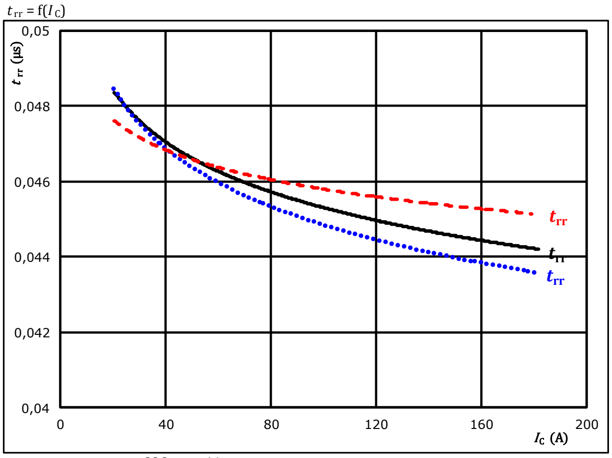
With an inductive load at

T_j =	150	°C
V_{CE} =	600	V
V_{GE} =	-2 / 18	V
I_C =	100	A

figure 7. **FWD**

Typical reverse recovery time as a function of collector current

$t_{rr} = f(I_C)$

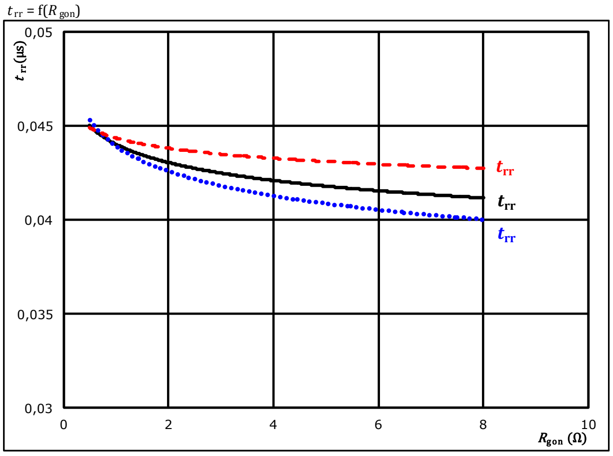


At						
V_{CE} =	600	V		25 °C	············
V_{GE} =	-2 / 18	V	T_j:	125 °C	———
R_{gon} =	2	Ω		150 °C	– – –

figure 8. **FWD**

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

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



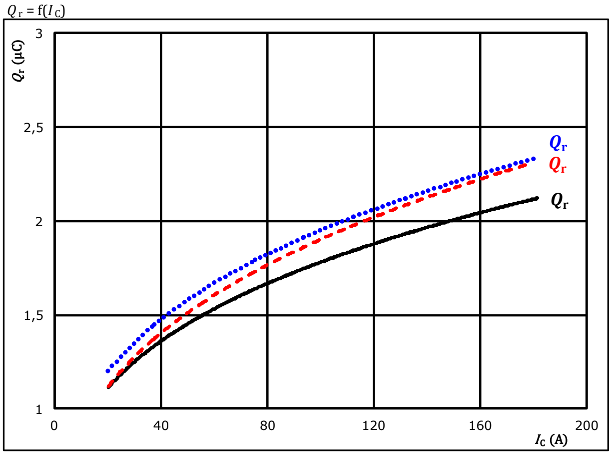
At					
V_{CE} =	600	V		25 °C	············
V_{GE} =	-2 / 18	V	T_j:	125 °C	———
I_C =	100	A		150 °C	– – –

AC Reactive Short Switching Characteristics

figure 9. FWD

Typical recovered charge as a function of collector current

$Q_r = f(I_C)$

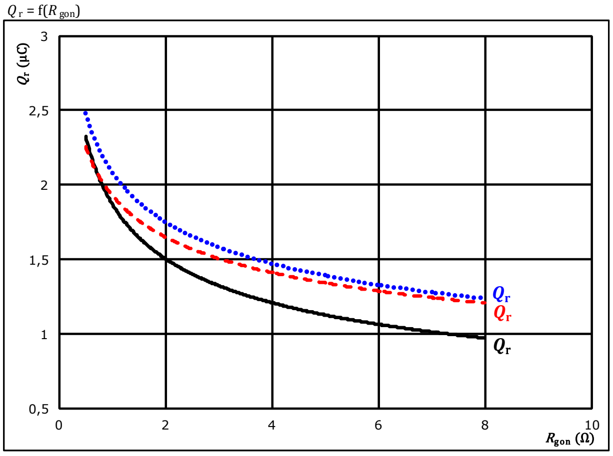


At						
	V_{CE} =	600	V	T_j:	25 °C	············
	V_{GE} =	-2 / 18	V		125 °C	————
	R_{gon} =	2	Ω		150 °C	– – – –

figure 10. FWD

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

$Q_r = f(R_{gon})$

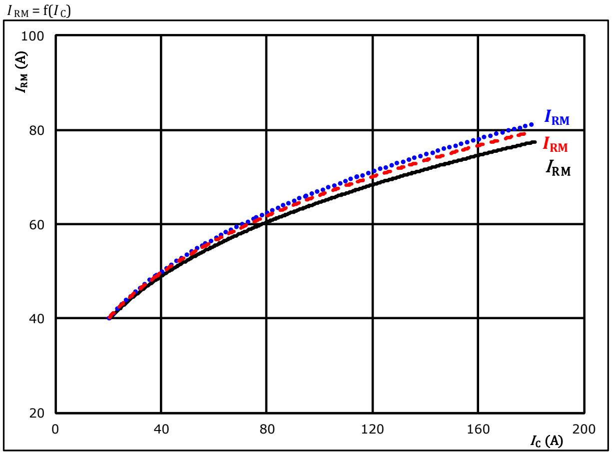


At						
	V_{CE} =	600	V	T_j:	25 °C	············
	V_{GE} =	-2 / 18	V		125 °C	————
	I_C =	100	A		150 °C	– – – –

figure 11. FWD

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

$I_{RM} = f(I_C)$

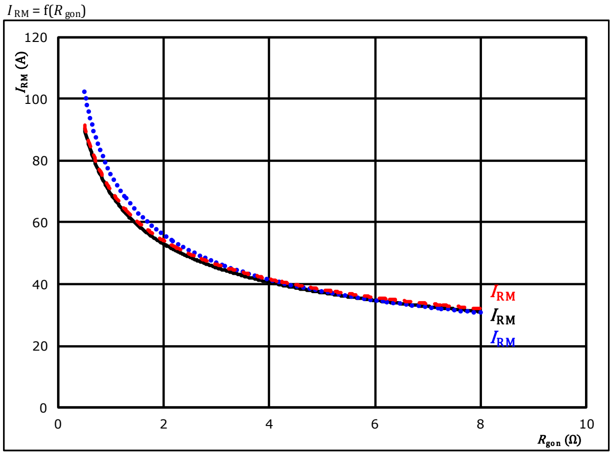


At						
	V_{CE} =	600	V	T_j:	25 °C	············
	V_{GE} =	-2 / 18	V		125 °C	————
	R_{gon} =	2	Ω		150 °C	– – – –

figure 12. FWD

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

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



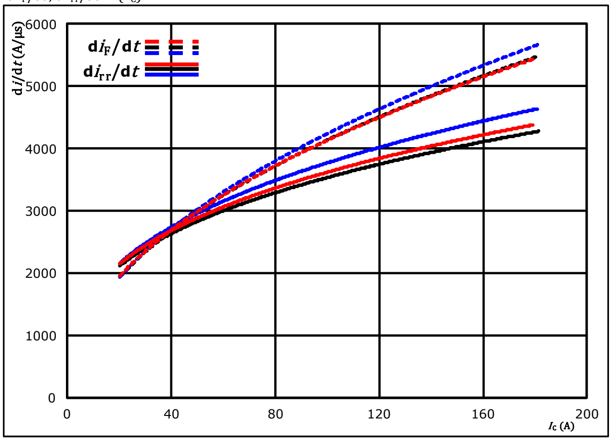
At						
	V_{CE} =	600	V	T_j:	25 °C	············
	V_{GE} =	-2 / 18	V		125 °C	————
	I_C =	100	A		150 °C	– – – –

AC Reactive Short Switching Characteristics

figure 13. FWD

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

di_F/dt, $di_{rr}/dt = f(I_C)$



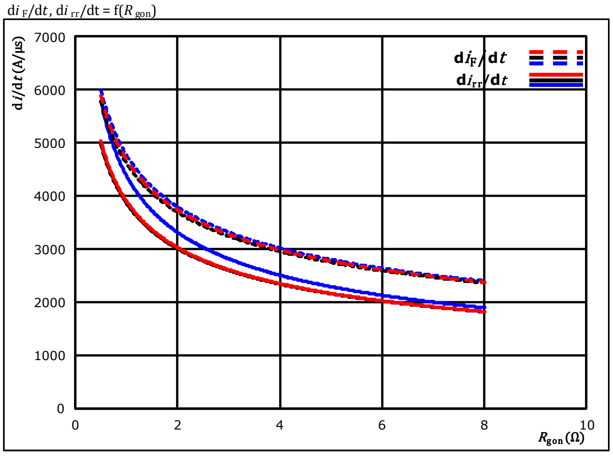
At

V_{CE} =	600	V	T_j:	25 °C
V_{GE} =	-2 / 18	V		125 °C
R_{gon} =	2	Ω		150 °C

figure 14. FWD

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

di_F/dt, $di_{rr}/dt = f(R_{gon})$



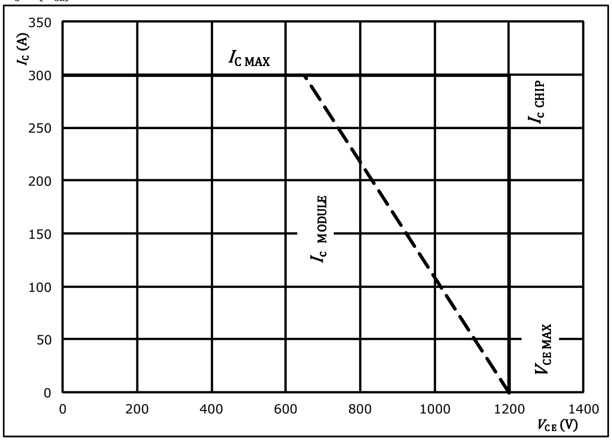
At

V_{CE} =	600	V	T_j:	25 °C
V_{GE} =	-2 / 18	V		125 °C
I_C =	100	A		150 °C

figure 15. IGBT

Reverse bias safe operating area

$I_C = f(V_{CE})$



At

T_j =	125	°C
R_{gon} =	2	Ω
R_{goff} =	2	Ω

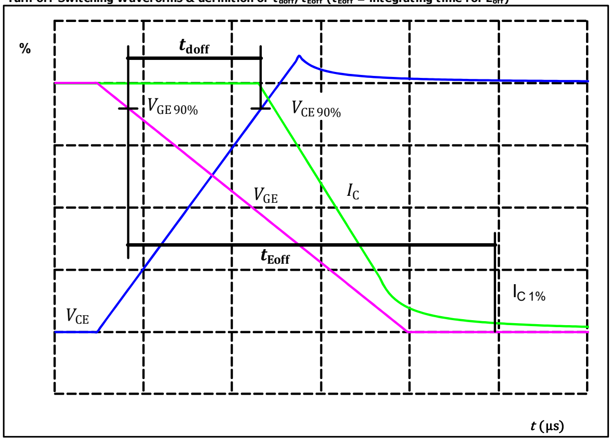
AC Switching Definitions

General conditions

T_j	=	125 °C
R_{gon}	=	2 Ω
R_{goff}	=	2 Ω

figure 1. IGBT

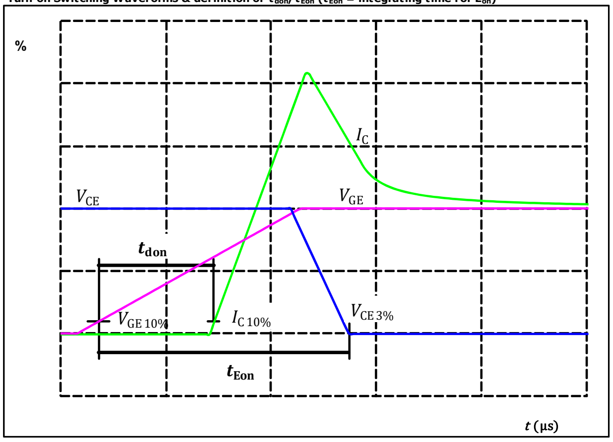
Turn-off Switching Waveforms & definition of t_{doff}, t_{Eoff} (t_{Eoff} = integrating time for E_{off})



$V_{GE}(0\%)$ =	-2	V
$V_{GE}(100\%)$ =	18	V
$V_C(100\%)$ =	600	V
$I_C(100\%)$ =	100	A
t_{doff} =	144	ns

figure 2. IGBT

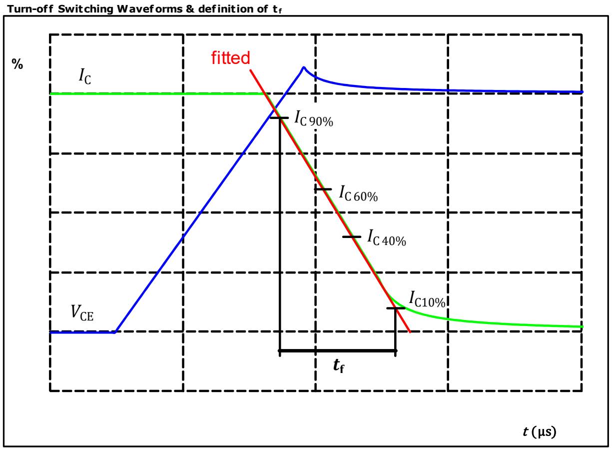
Turn-on Switching Waveforms & definition of t_{don}, t_{Eon} (t_{Eon} = integrating time for E_{on})



$V_{GE}(0\%)$ =	-2	V
$V_{GE}(100\%)$ =	18	V
$V_C(100\%)$ =	600	V
$I_C(100\%)$ =	100	A
t_{don} =	55	ns

figure 3. IGBT

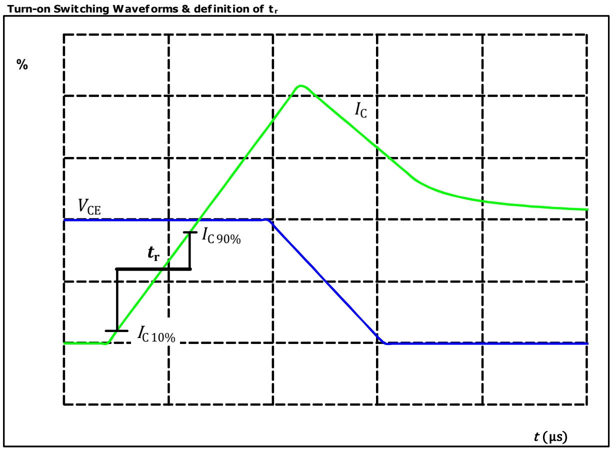
Turn-off Switching Waveforms & definition of t_f



$V_C(100\%)$ =	600	V
$I_C(100\%)$ =	100	A
t_f =	25	ns

figure 4. IGBT

Turn-on Switching Waveforms & definition of t_r

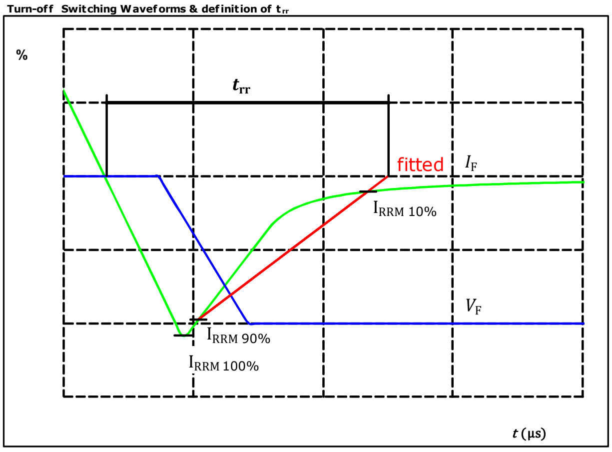


$V_C(100\%)$ =	600	V
$I_C(100\%)$ =	100	A
t_r =	25	ns

AC Switching Characteristics

figure 5. **FWD**

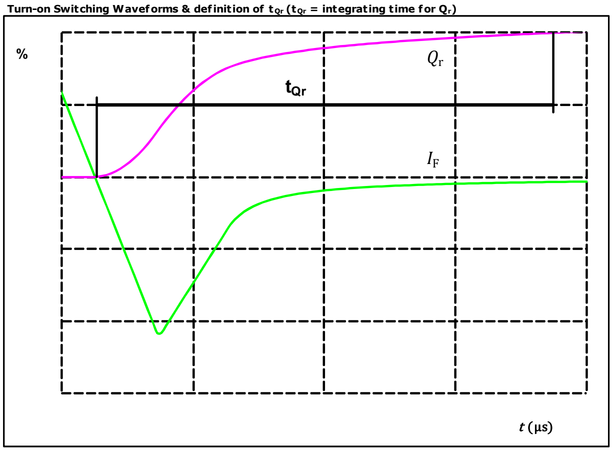
Turn-off Switching Waveforms & definition of t_{rr}



V_F (100%) =	600	V
I_F (100%) =	100	A
I_{RRM} (100%) =	61	A
t_{rr} =	44	ns

figure 6. **FWD**

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

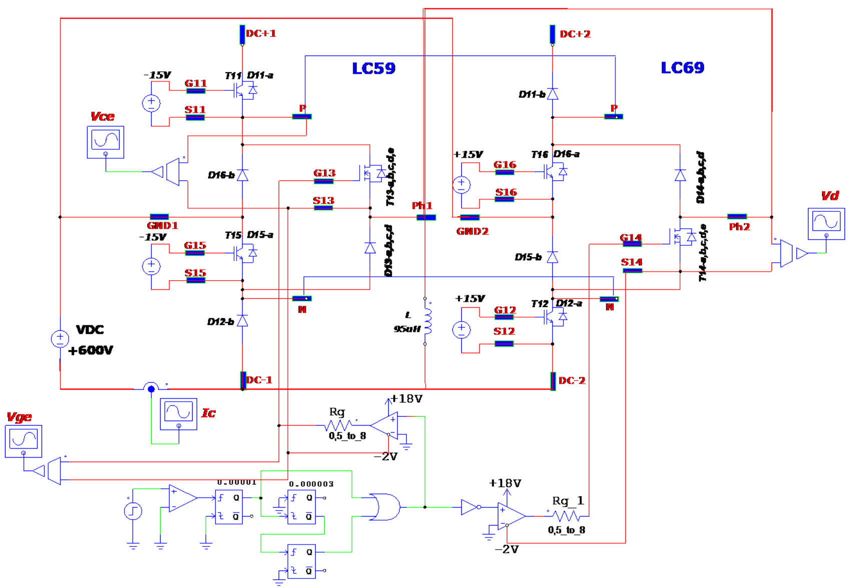


I_F (100%) =	100	A
Q_r (100%) =	1,63	µC

AC Reactive Short measurement circuit

figure 1.

AC Reactive PN Short Configuration

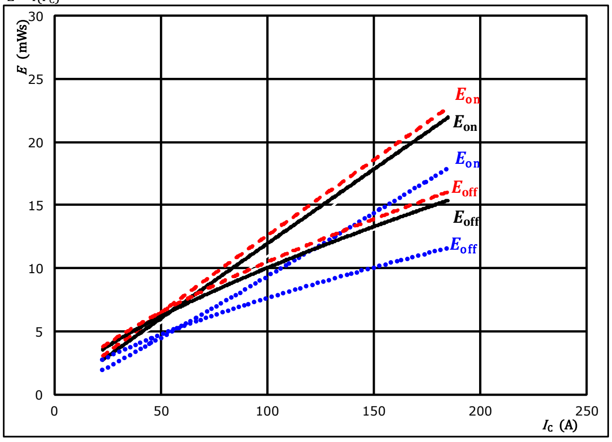


Neutral Point Switching Characteristics

figure 1. **IGBT**

Typical switching energy losses as a function of collector current

$E = f(I_C)$



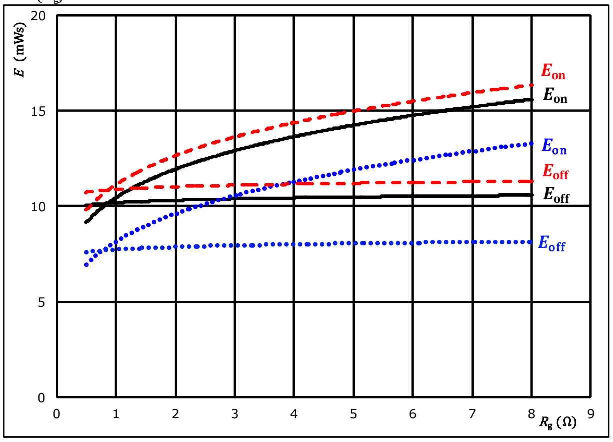
With an inductive load at

V_{CE} =	600	V	T_j:	25 °C
V_{GE} =	±15	V		125 °C
R_{gon} =	2	Ω		150 °C
R_{goff} =	2	Ω		

figure 2. **IGBT**

Typical switching energy losses as a function of gate resistor

$E = f(R_g)$



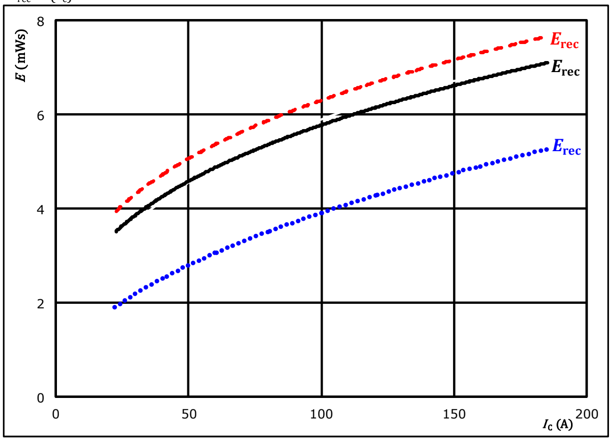
With an inductive load at

V_{CE} =	600	V	T_j:	25 °C
V_{GE} =	±15	V		125 °C
I_C =	100	A		150 °C

figure 3. **FWD**

Typical reverse recovered energy loss as a function of collector current

$E_{rec} = f(I_c)$



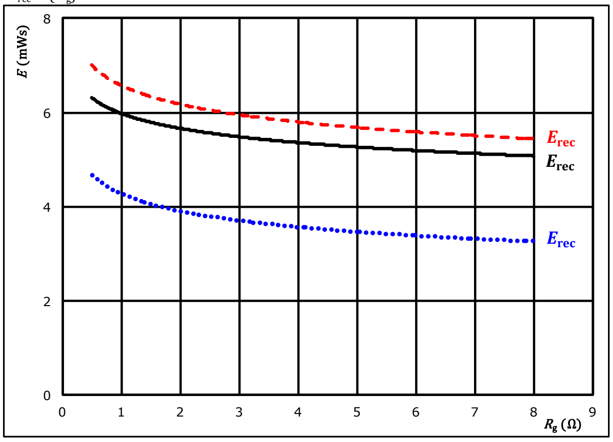
With an inductive load at

V_{CE} =	600	V	T_j:	25 °C
V_{GE} =	±15	V		125 °C
R_{gon} =	2	Ω		150 °C

figure 4. **FWD**

Typical reverse recovered energy loss as a function of gate resistor

$E_{rec} = f(R_g)$



With an inductive load at

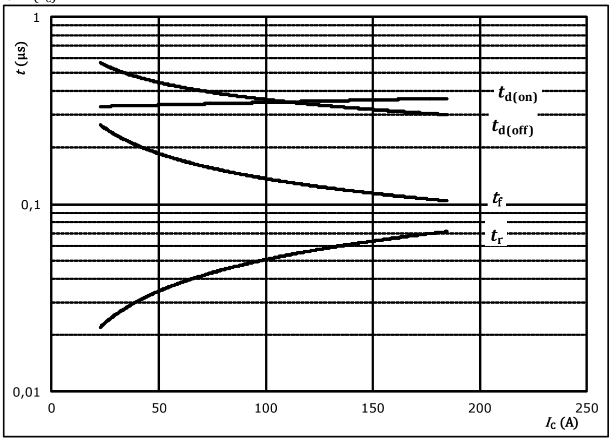
V_{CE} =	600	V	T_j:	25 °C
V_{GE} =	±15	V		125 °C
I_C =	100	A		150 °C

Neutral Point Switching Characteristics

figure 5. **IGBT**

Typical switching times as a function of collector current

$t = f(I_C)$



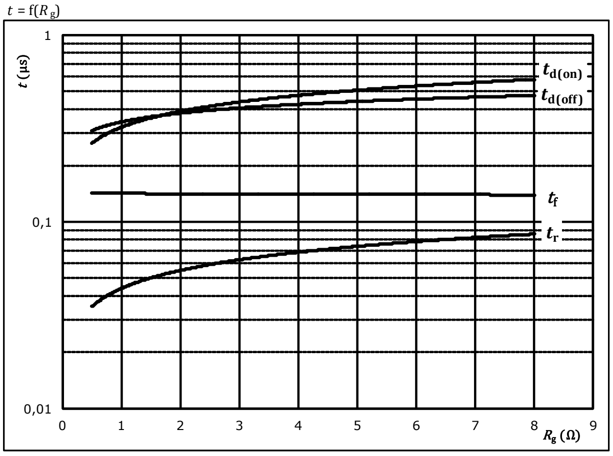
With an inductive load at

T_j =	150	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	2	Ω
R_{goff} =	2	Ω

figure 6. **IGBT**

Typical switching times as a function of gate resistor

$t = f(R_g)$



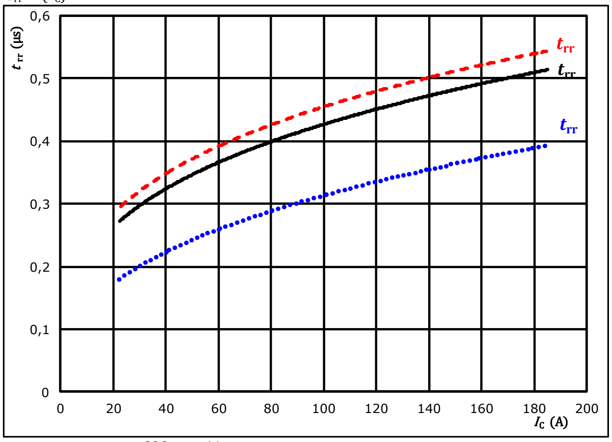
With an inductive load at

T_j =	150	°C
V_{CE} =	600	V
V_{GE} =	±15	V
I_C =	100	A

figure 7. **FWD**

Typical reverse recovery time as a function of collector current

$t_{rr} = f(I_C)$

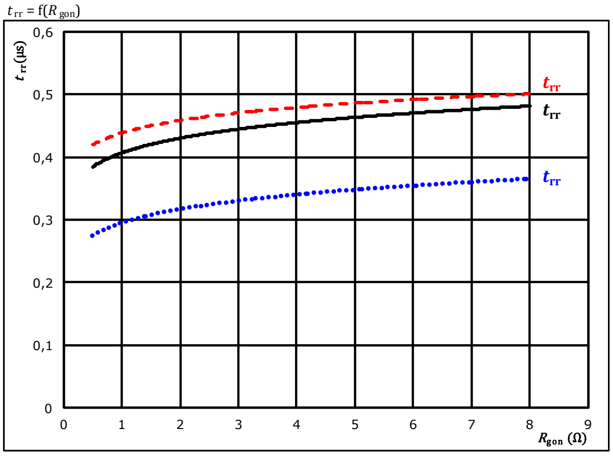


At				
V_{CE} =	600	V	T_j:	25 °C
V_{GE} =	±15	V		125 °C
R_{gon} =	2	Ω		150 °C

figure 8. **FWD**

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

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



At				
V_{CE} =	600	V	T_j:	25 °C
V_{GE} =	±15	V		125 °C
I_C =	100	A		150 °C

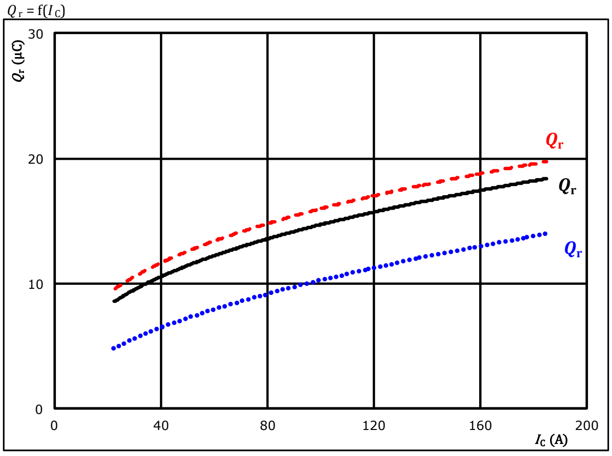
Vincotech

Neutral Point Switching Characteristics

figure 9. **FWD**

Typical recovered charge as a function of collector current

$Q_r = f(I_C)$

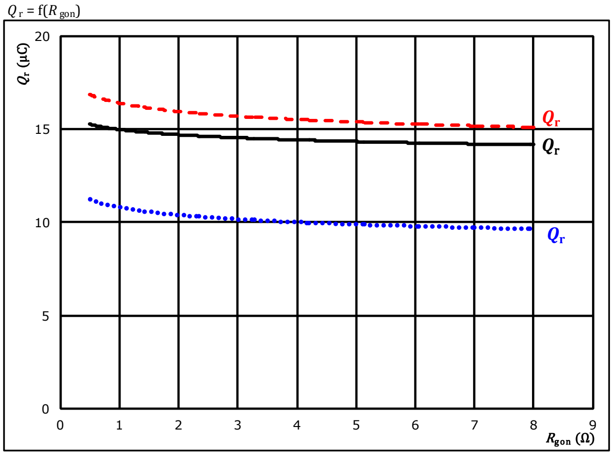


At	V_{CE} =	600	V		25 °C	dotted (blue)
	V_{GE} =	±15	V	T_j:	125 °C	solid (black)
	R_{gon} =	2	Ω		150 °C	dashed (red)

figure 10. **FWD**

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

$Q_r = f(R_{gon})$

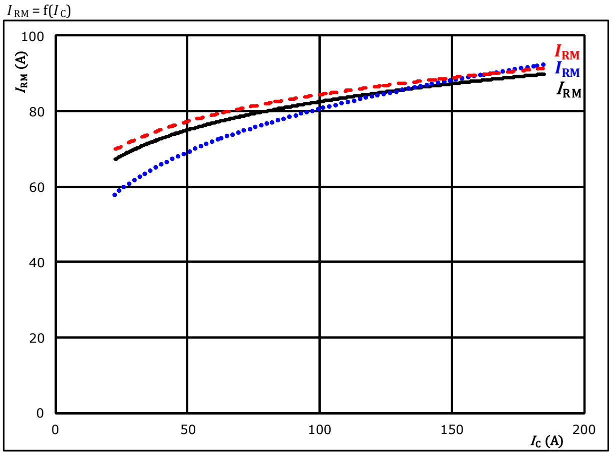


At	V_{CE} =	600	V		25 °C	dotted (blue)
	V_{GE} =	±15	V	T_j:	125 °C	solid (black)
	I_C =	100	A		150 °C	dashed (red)

figure 11. **FWD**

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

$I_{RM} = f(I_C)$

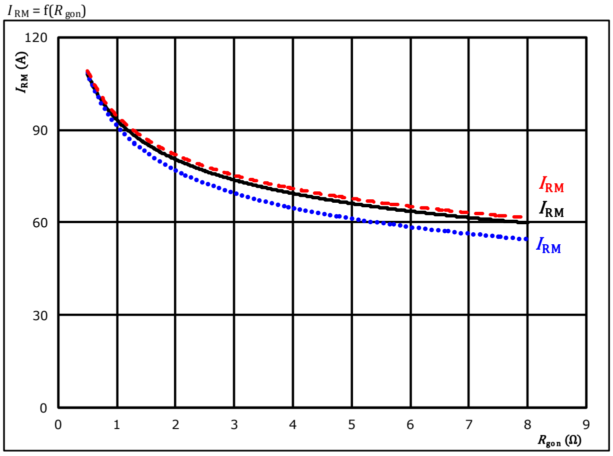


At	V_{CE} =	600	V		25 °C	dotted (blue)
	V_{GE} =	±15	V	T_j:	125 °C	solid (black)
	R_{gon} =	2	Ω		150 °C	dashed (red)

figure 12. **FWD**

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

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



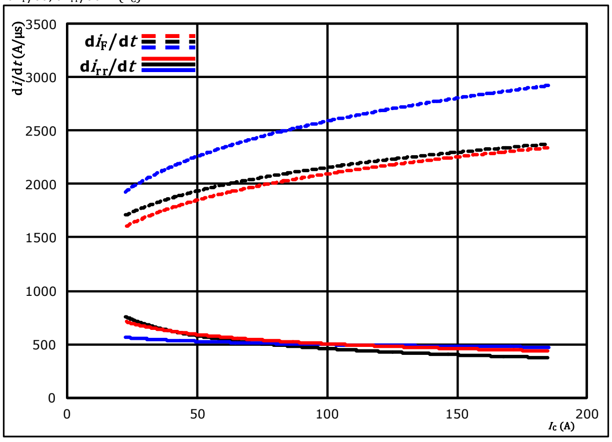
At	V_{CE} =	600	V		25 °C	dotted (blue)
	V_{GE} =	±15	V	T_j:	125 °C	solid (black)
	I_C =	100	A		150 °C	dashed (red)

Neutral Point Switching Characteristics

figure 13. **FWD**

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

$di_F/dt, di_{rr}/dt = f(I_C)$

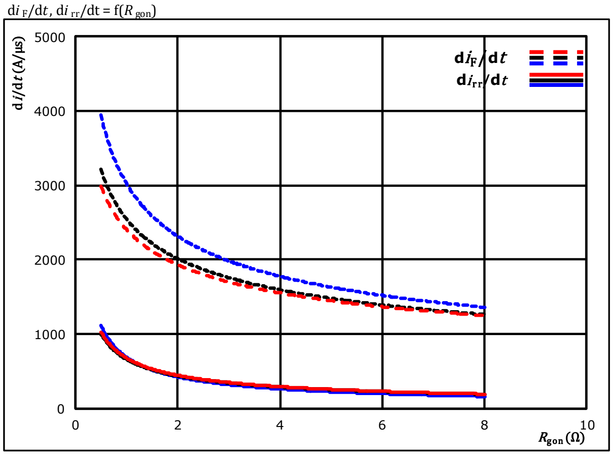


At					
V_{CE} =	600	V		25	°C
V_{GE} =	±15	V	T_j:	125	°C
R_{gon} =	2	Ω		150	°C

figure 14. **FWD**

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

$di_F/dt, di_{rr}/dt = f(R_{gon})$

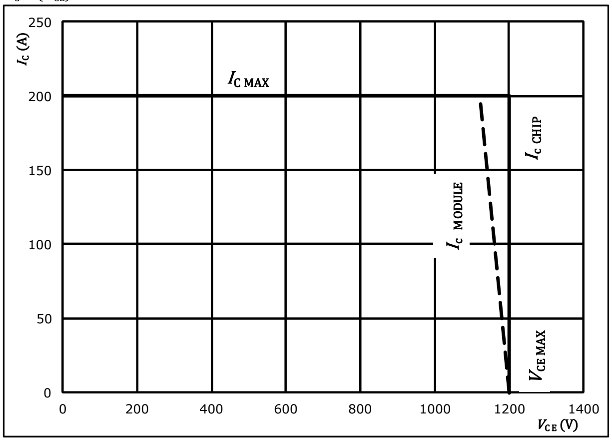


At					
V_{CE} =	600	V		25	°C
V_{GE} =	±15	V	T_j:	125	°C
I_C=	100	A		150	°C

figure 15. **IGBT**

Reverse bias safe operating area

$I_C = f(V_{CE})$



At		
T_j =	125	°C
R_{gon} =	2	Ω
R_{goff} =	2	Ω

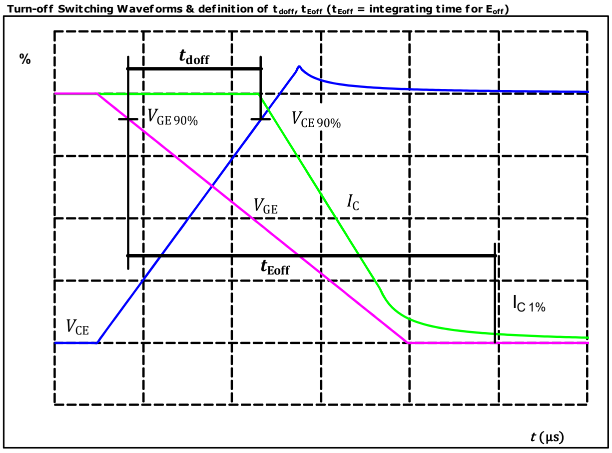
Neutral Point Switching Definitions

General conditions

T_j	=	125 °C
R_{gon}	=	2 Ω
R_{goff}	=	2 Ω

figure 1. IGBT

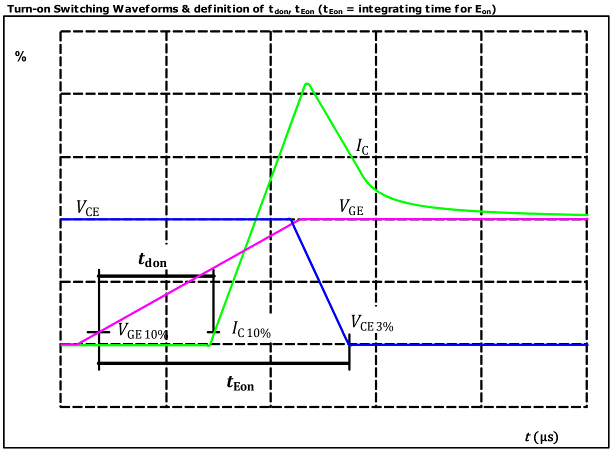
Turn-off Switching Waveforms & definition of t_{doff}, t_{Eoff} (t_{Eoff} = integrating time for E_{off})



$V_{GE}(0\%)$ =	-15	V
$V_{GE}(100\%)$ =	15	V
$V_C(100\%)$ =	600	V
$I_C(100\%)$ =	100	A
t_{doff} =	351	ns

figure 2. IGBT

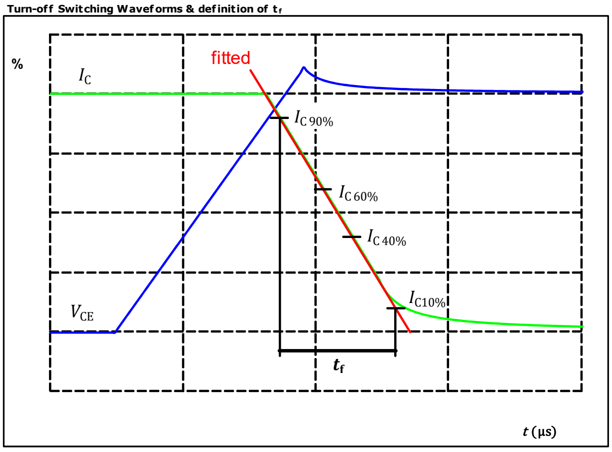
Turn-on Switching Waveforms & definition of t_{don}, t_{Eon} (t_{Eon} = integrating time for E_{on})



$V_{GE}(0\%)$ =	-15	V
$V_{GE}(100\%)$ =	15	V
$V_C(100\%)$ =	600	V
$I_C(100\%)$ =	100	A
t_{don} =	349	ns

figure 3. IGBT

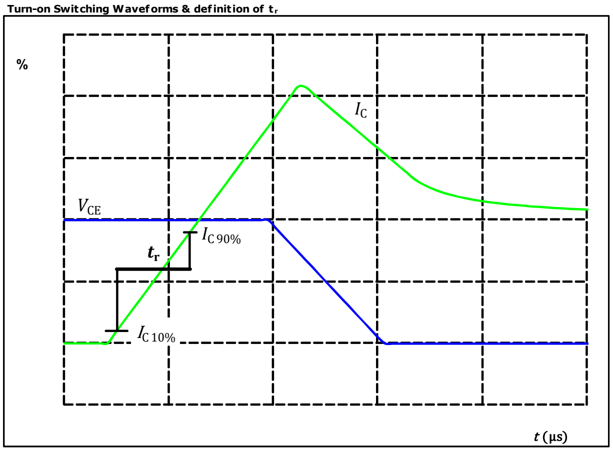
Turn-off Switching Waveforms & definition of t_f



$V_C(100\%)$ =	600	V
$I_C(100\%)$ =	100	A
t_f =	139	ns

figure 4. IGBT

Turn-on Switching Waveforms & definition of t_r

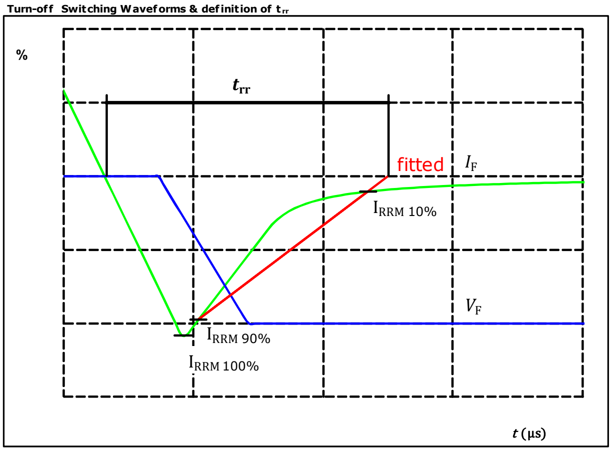


$V_C(100\%)$ =	600	V
$I_C(100\%)$ =	100	A
t_r =	47	ns

Neutral Point Switching Characteristics

figure 5. FWD

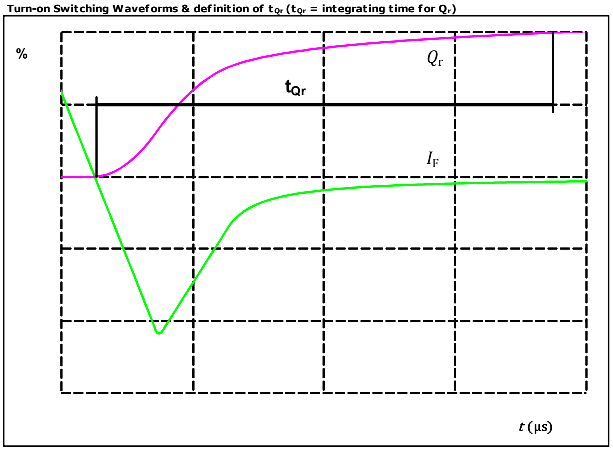
Turn-off Switching Waveforms & definition of t_{rr}



V_F (100%) =	600	V
I_F (100%) =	100	A
I_{RRM} (100%) =	86	A
t_{rr} =	419	ns

figure 6. FWD

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

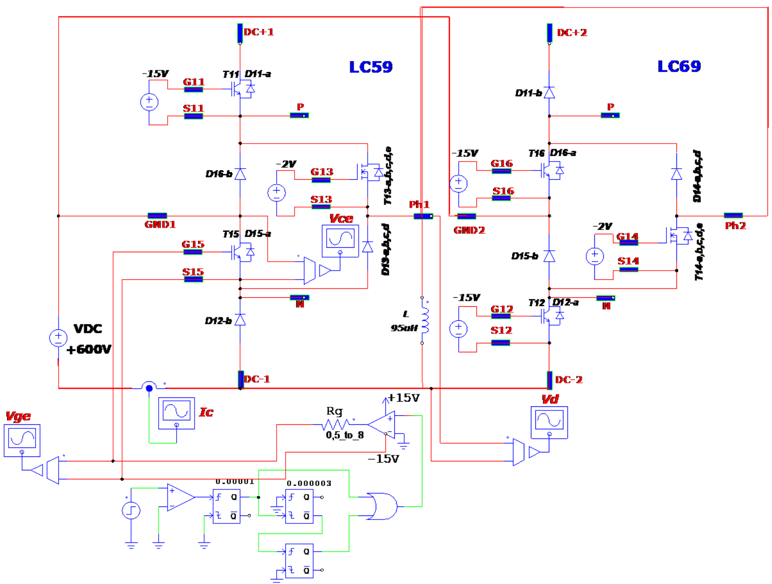


I_F (100%) =	100	A
Q_r (100%) =	15,02	µC

Neutral Point Switching measurement circuit

figure 1.

NEUTRAL POINT SWITCH

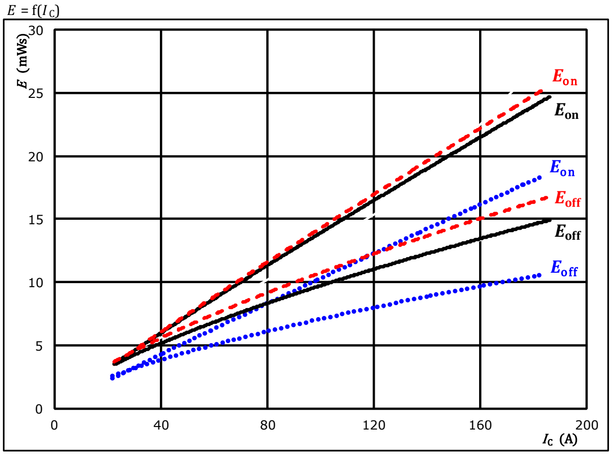


DC Open Switching Characteristics

figure 1. **IGBT**

Typical switching energy losses as a function of collector current

$E = f(I_C)$



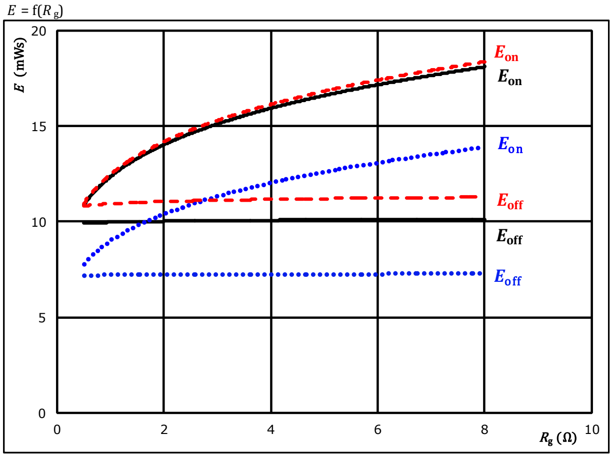
With an inductive load at

V_{CE} =	600	V	T_j:	25 °C	dotted
V_{GE} =	±15	V		125 °C	solid
R_{gon} =	2	Ω		150 °C	dashed
R_{goff} =	2	Ω			

figure 2. **IGBT**

Typical switching energy losses as a function of gate resistor

$E = f(R_g)$



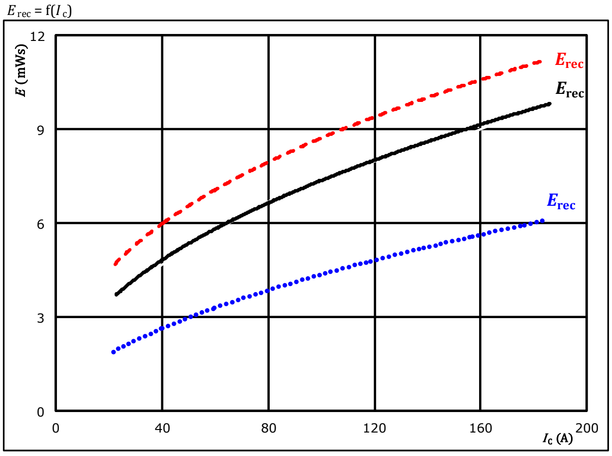
With an inductive load at

V_{CE} =	600	V	T_j:	25 °C	dotted
V_{GE} =	±15	V		125 °C	solid
I_C =	100	A		150 °C	dashed

figure 3. **FWD**

Typical reverse recovered energy loss as a function of collector current

$E_{rec} = f(I_c)$



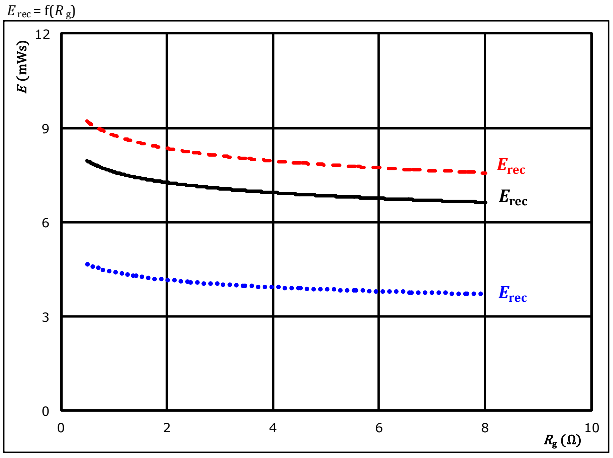
With an inductive load at

V_{CE} =	600	V	T_j:	25 °C	dotted
V_{GE} =	±15	V		125 °C	solid
R_{gon} =	2	Ω		150 °C	dashed

figure 4. **FWD**

Typical reverse recovered energy loss as a function of gate resistor

$E_{rec} = f(R_g)$



With an inductive load at

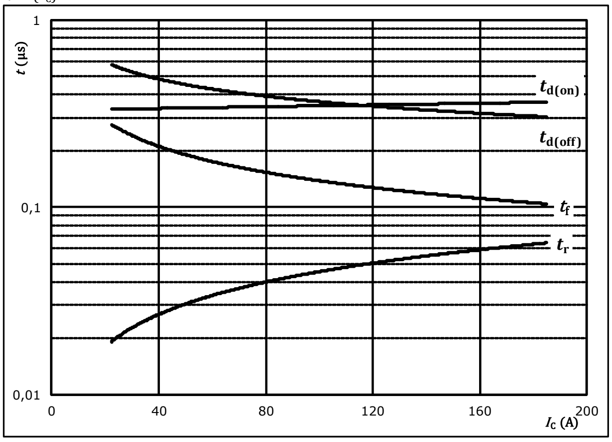
V_{CE} =	600	V	T_j:	25 °C	dotted
V_{GE} =	±15	V		125 °C	solid
I_C =	100	A		150 °C	dashed

DC Open Switching Characteristics

figure 5. **IGBT**

Typical switching times as a function of collector current

$t = f(I_C)$



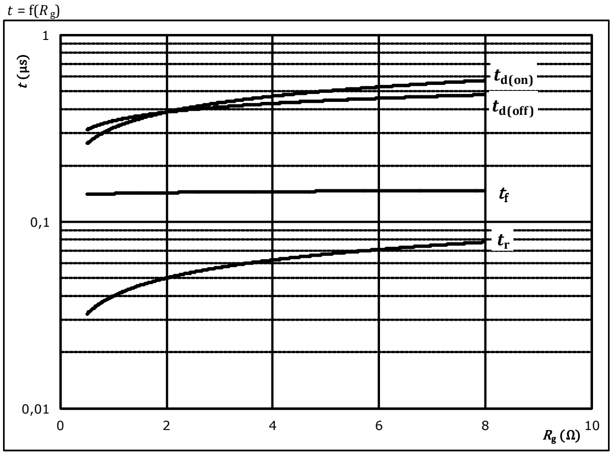
With an inductive load at

T_j =	150	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	2	Ω
R_{goff} =	2	Ω

figure 6. **IGBT**

Typical switching times as a function of gate resistor

$t = f(R_g)$



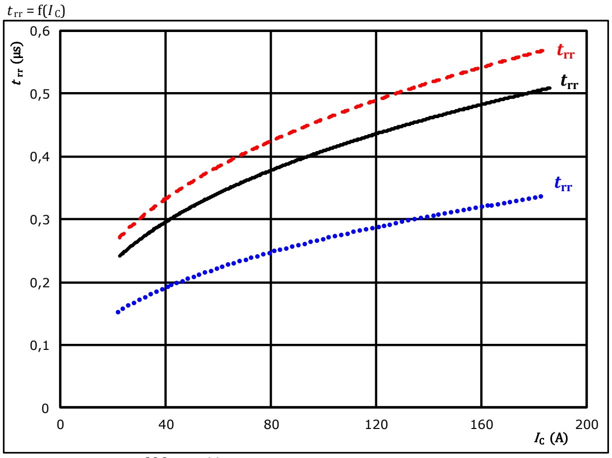
With an inductive load at

T_j =	150	°C
V_{CE} =	600	V
V_{GE} =	±15	V
I_C =	100	A

figure 7. **FWD**

Typical reverse recovery time as a function of collector current

$t_{rr} = f(I_C)$

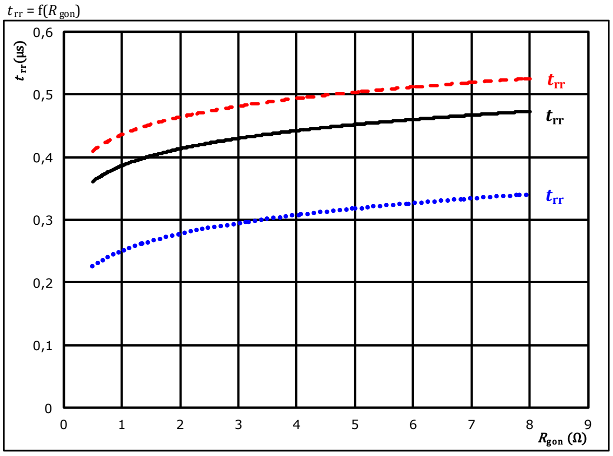


At					
V_{CE} =	600	V	T_j:	25 °C	dotted blue
V_{GE} =	±15	V		125 °C	solid black
R_{gon} =	2	Ω		150 °C	dashed red

figure 8. **FWD**

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

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



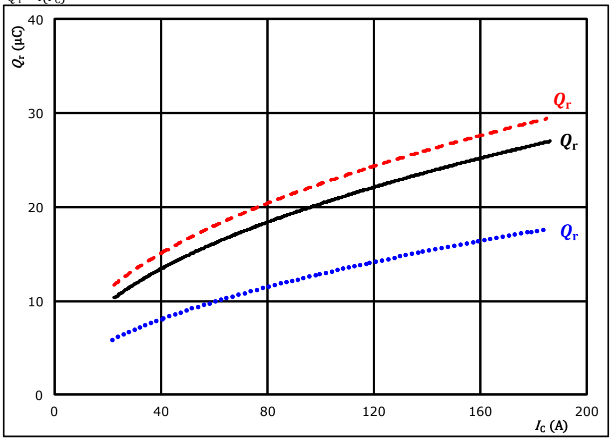
At					
V_{CE} =	600	V	T_j:	25 °C	dotted blue
V_{GE} =	±15	V		125 °C	solid black
I_C =	100	A		150 °C	dashed red

DC Open Switching Characteristics

figure 9. FWD

Typical recovered charge as a function of collector current

$Q_r = f(I_C)$

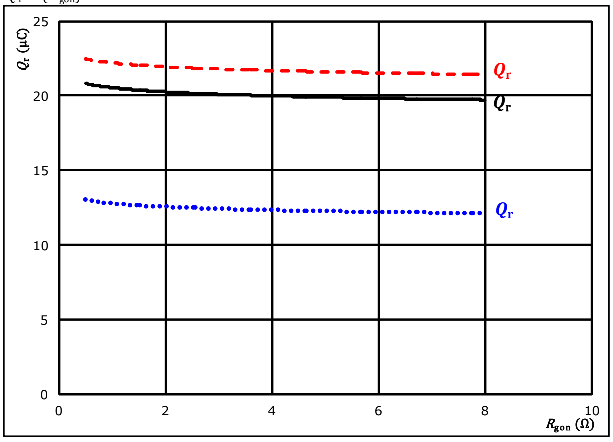


At	V_{CE} =	600	V		25 °C	dotted
	V_{GE} =	±15	V	T_j:	125 °C	solid
	R_{gon} =	2	Ω		150 °C	dashed

figure 10. FWD

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

$Q_r = f(R_{gon})$

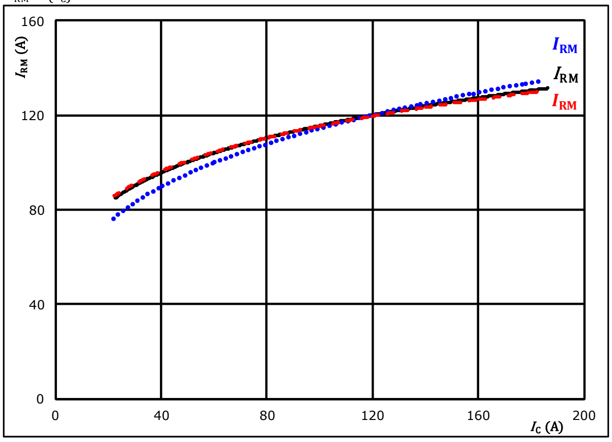


At	V_{CE} =	600	V		25 °C	dotted
	V_{GE} =	±15	V	T_j:	125 °C	solid
	I_C =	100	A		150 °C	dashed

figure 11. FWD

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

$I_{RM} = f(I_C)$

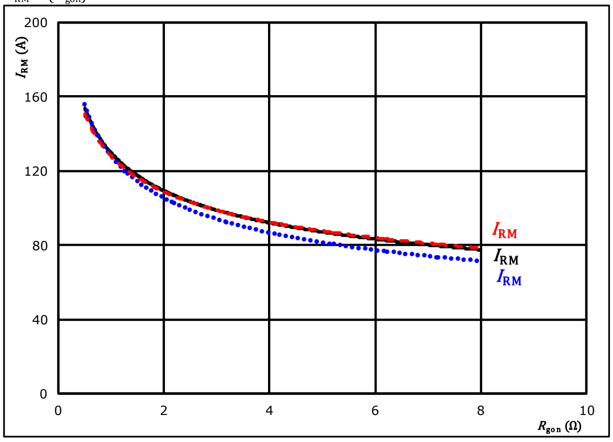


At	V_{CE} =	600	V		25 °C	dotted
	V_{GE} =	±15	V	T_j:	125 °C	solid
	R_{gon} =	2	Ω		150 °C	dashed

figure 12. FWD

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

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



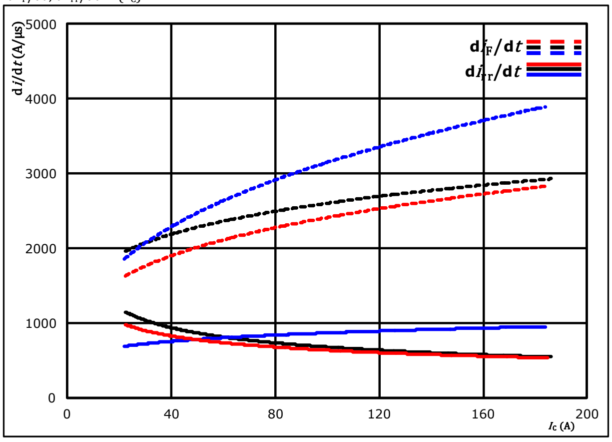
At	V_{CE} =	600	V		25 °C	dotted
	V_{GE} =	±15	V	T_j:	125 °C	solid
	I_C =	100	A		150 °C	dashed

DC Open Switching Characteristics

figure 13. **FWD**

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

di_F/dt, $di_{rr}/dt = f(I_C)$

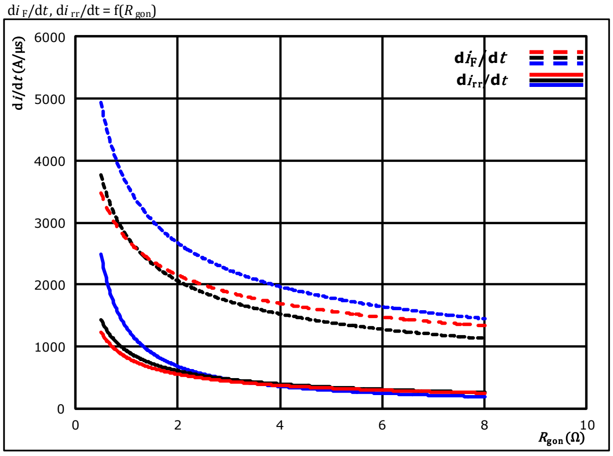


At					
V_{CE} =	600	V		25	°C
V_{GE} =	±15	V	T_j:	125	°C
R_{gon} =	2	Ω		150	°C

figure 14. **FWD**

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

di_F/dt, $di_{rr}/dt = f(R_{gon})$

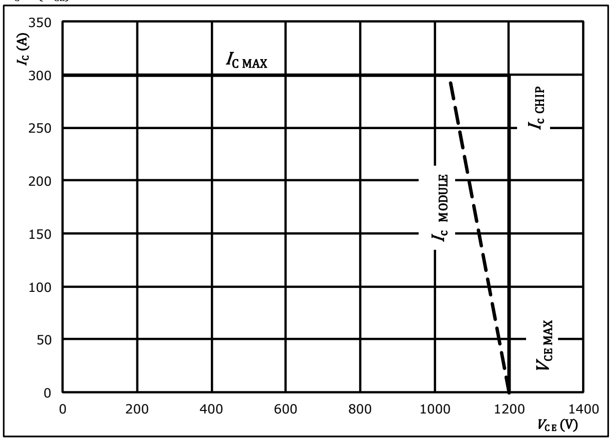


At					
V_{CE} =	600	V		25	°C
V_{GE} =	±15	V	T_j:	125	°C
I_C =	100	A		150	°C

figure 15. **IGBT**

Reverse bias safe operating area

$I_C = f(V_{CE})$



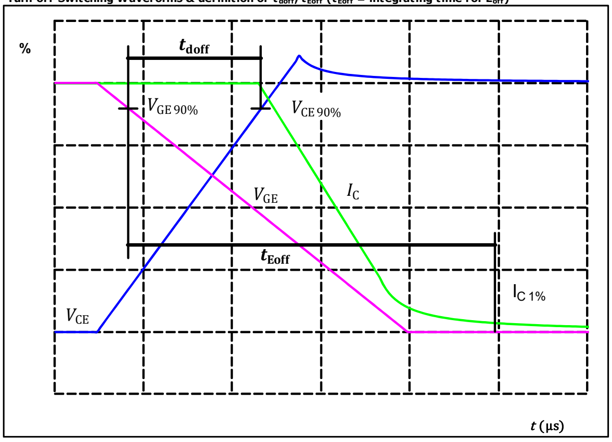
At		
T_j =	125	°C
R_{gon} =	2	Ω
R_{goff} =	2	Ω

DC Open Switching Definitions

General conditions		
T_j	=	125 °C
R_{gon}	=	2 Ω
R_{goff}	=	2 Ω

figure 1. IGBT

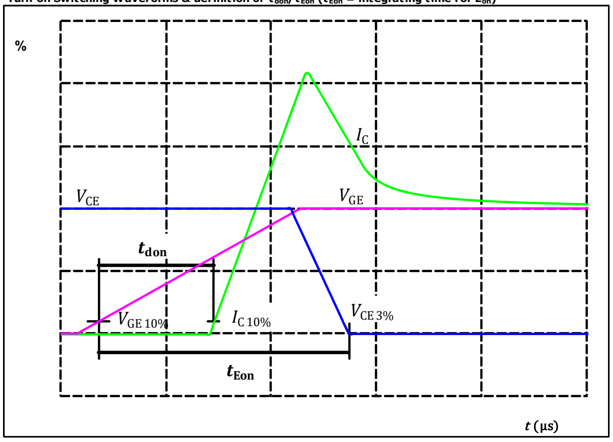
Turn-off Switching Waveforms & definition of t_{doff}, t_{Eoff} (t_{Eoff} = integrating time for E_{off})



$V_{GE}(0\%)$ =	-15	V
$V_{GE}(100\%)$ =	15	V
$V_C(100\%)$ =	600	V
$I_C(100\%)$ =	100	A
t_{doff} =	351	ns

figure 2. IGBT

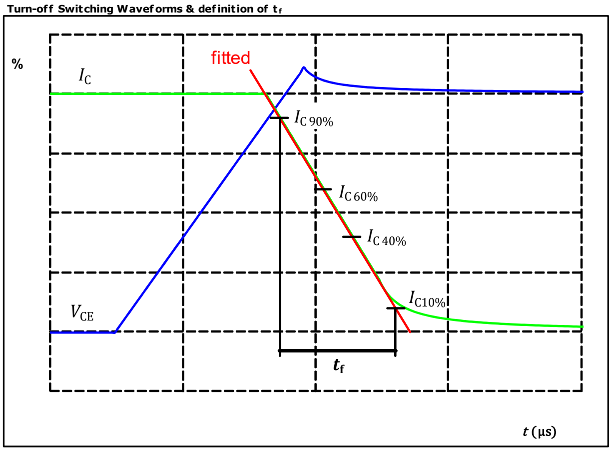
Turn-on Switching Waveforms & definition of t_{don}, t_{Eon} (t_{Eon} = integrating time for E_{on})



$V_{GE}(0\%)$ =	-15	V
$V_{GE}(100\%)$ =	15	V
$V_C(100\%)$ =	600	V
$I_C(100\%)$ =	100	A
t_{don} =	335	ns

figure 3. IGBT

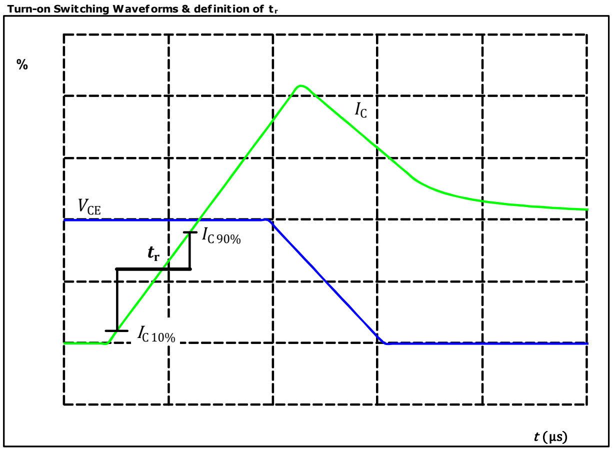
Turn-off Switching Waveforms & definition of t_f



$V_C(100\%)$ =	600	V
$I_C(100\%)$ =	100	A
t_f =	136	ns

figure 4. IGBT

Turn-on Switching Waveforms & definition of t_r

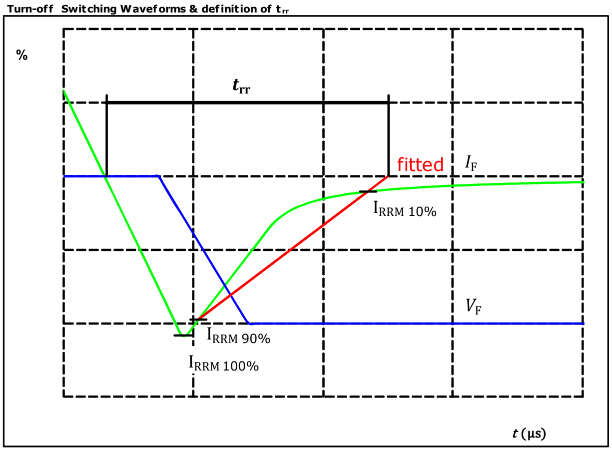


$V_C(100\%)$ =	600	V
$I_C(100\%)$ =	100	A
t_r =	41	ns

DC Open Switching Characteristics

figure 5. **FWD**

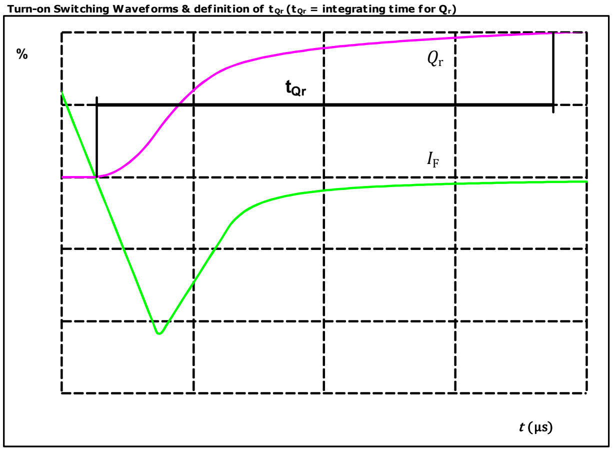
Turn-off Switching Waveforms & definition of t_{rr}



V_F (100%) =	600	V
I_F (100%) =	100	A
I_{RRM} (100%) =	120	A
t_{rr} =	406	ns

figure 6. **FWD**

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

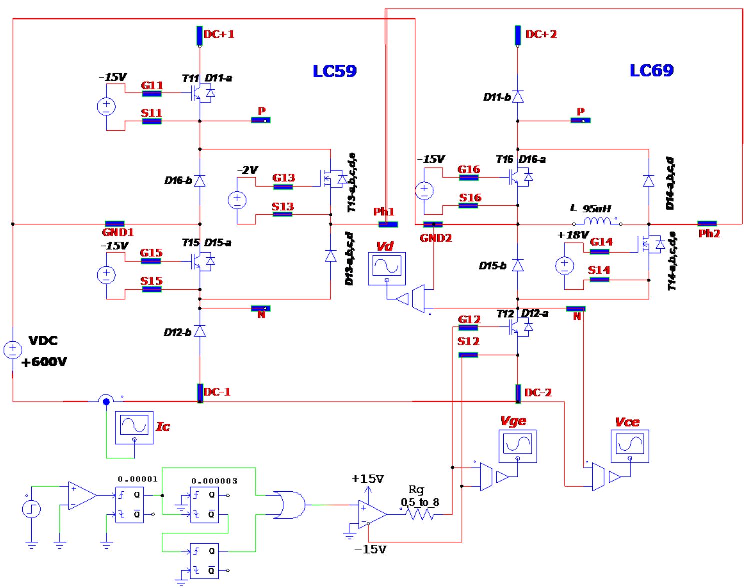


I_F (100%) =	100	A
Q_r (100%) =	20,79	μC

DC Open Switching measurement circuit

figure 1.

DC-LINK SWITCH



Ordering Code & Marking

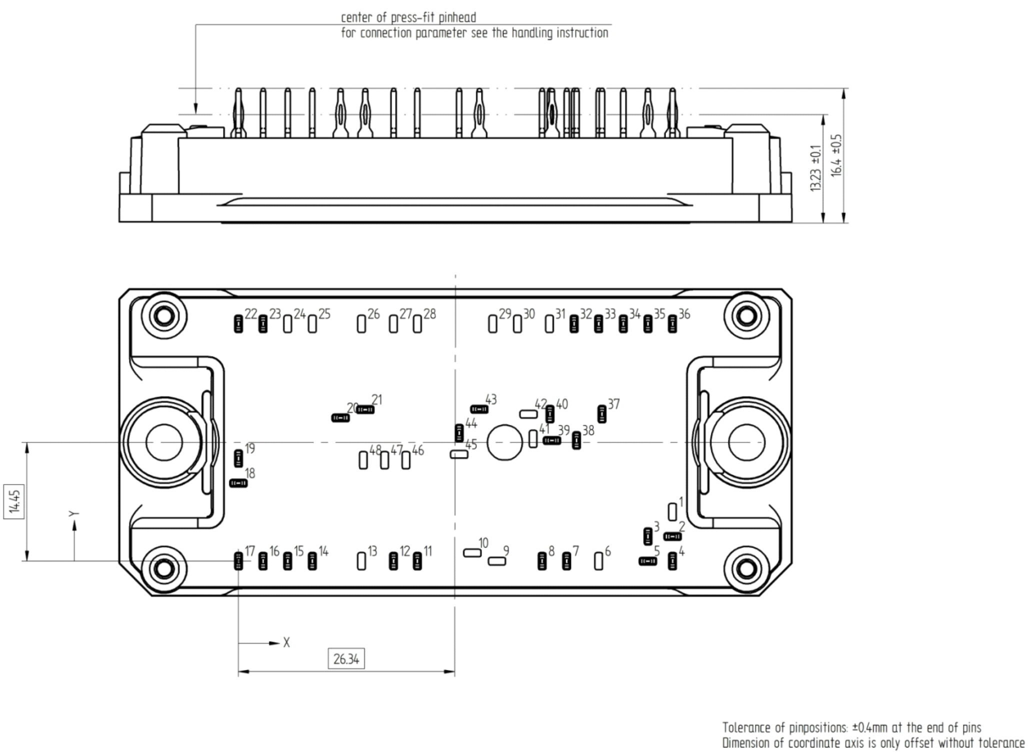
Version	Ordering Code
without thermal paste 12 mm housing with press-fit pins	10-PG12NAB008MR02-LC59F36T
with thermal paste 12 mm housing with press-fit pins	10-PG12NAB008MR02-LC59F36T-/3/

	Name		Date code	UL & VIN	Lot	Serial
Text	NN-NNNNNNNNNNNNNN-TTTTTTVV		WWYY	UL VIN	LLLLL	SSSS
Datamatrix	Type&Ver	Lot number	Serial	Date code		
	TTTTTTTVV	LLLLL	SSSS	WWYY		

High Side Module 10-PG12NAB008MR02-LC59F36T

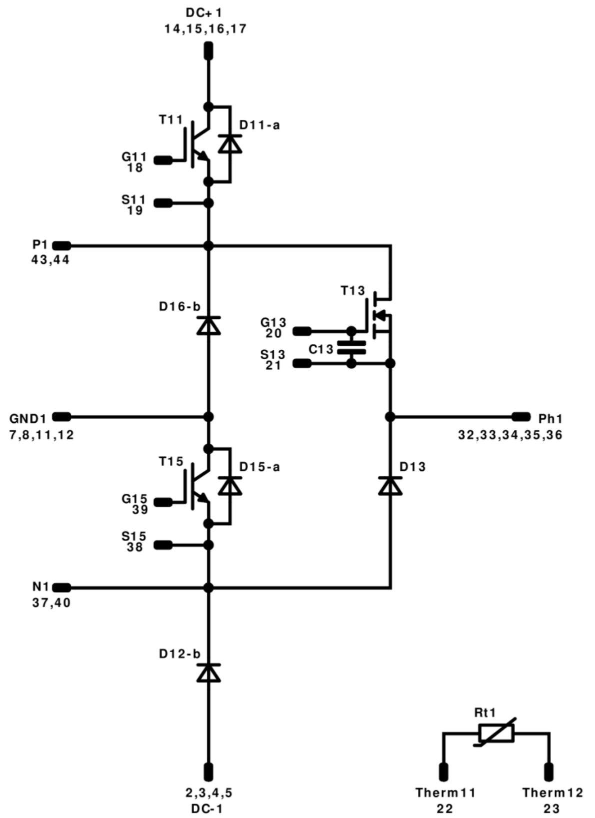
Outline

Pin	X	Y	Function
1	Not assembled		
2	52,9	3	DC-1
3	49,9	3	DC-1
4	52,9	0	DC-1
5	49,9	0	DC-1
6	Not assembled		
7	40	0	GND1
8	37	0	GND1
9	Not assembled		
10	Not assembled		
11	21,8	0	GND1
12	18,9	0	GND1
13	Not assembled		
14	9	0	DC+1
15	6	0	DC+1
16	3	0	DC+1
17	0	0	DC+1
18	0	9,5	G11
19	0	12,5	S11
20	12,45	17,45	G13
21	15,45	18,45	S13
22	0	28,9	Therm11
23	3	28,9	Therm12
24	Not assembled		
25	Not assembled		
26	Not assembled		
27	Not assembled		
28	Not assembled		
29	Not assembled		
30	Not assembled		
31	Not assembled		
32	40,9	28,9	Ph1
33	43,9	28,9	Ph1
34	46,9	28,9	Ph1
35	49,9	28,9	Ph1
36	52,9	28,9	Ph1
37	44,3	17,9	N1
38	41,2	14,7	S15
39	38,2	14,7	G15
40	37,95	17,9	N1
41	Not assembled		
42	Not assembled		
43	29,35	18,5	P1
44	26,9	15,6	P1
45	Not assembled		
46	Not assembled		
47	Not assembled		
48	Not assembled		



High Side Module 10-PG12NAB008MR02-LC59F36T

Pinout



Identification

ID	Component	Voltage	Current	Function	Comment
T13	MOSFET	1200 V	8 mΩ	AC Switch	
D13	FWD	1200 V	60 A	AC Diode	
T15	IGBT	1200 V	150 A	Neutral Point Switch	
D16-b	FWD	1200 V	150 A	Neutral Point Diode	
D15-a	FWD	1200 V	15 A	Neutral Point Switch Prot. Diode	
T11	IGBT	1200 V	150 A	DC-Link Switch	
D12-b	FWD	1200 V	100 A	DC-Link Diode	
D11-a	FWD	1200 V	100 A	DC-Link Switch Prot. Diode	
C13	Capacitor	25 V		Capacitor (GS)	
Rt1	NTC			Thermistor	

Ordering Code & Marking

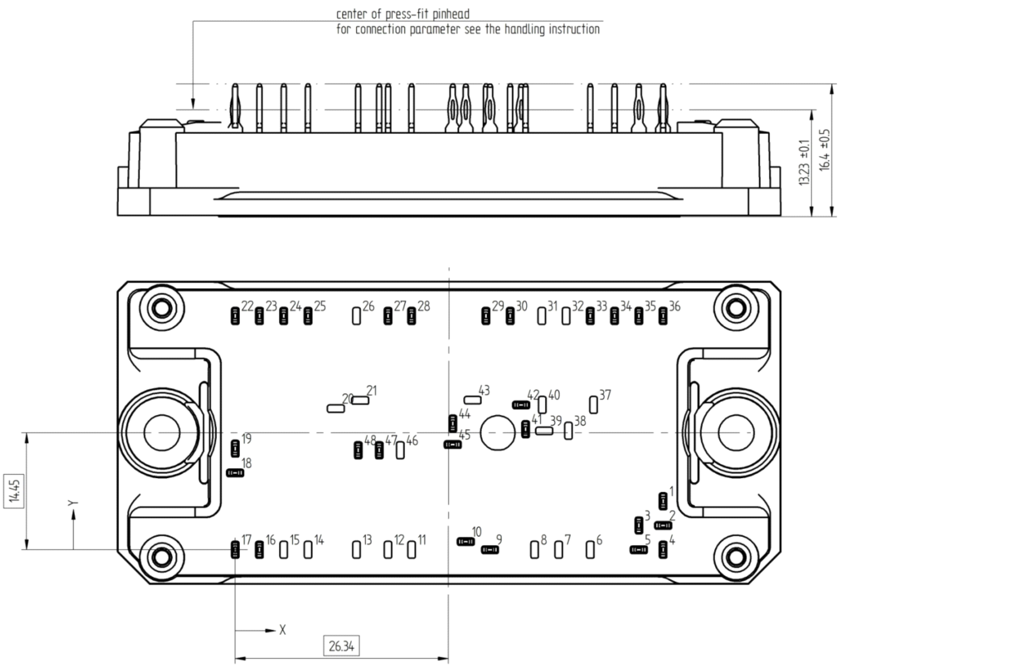
Version	Ordering Code
without thermal paste 12 mm housing with press-fit pins	10-PG12NAC008MR02-LC69F36T
with thermal paste 12 mm housing with press-fit pins	10-PG12NAC008MR02-LC69F36T-/3/

	Name		Date code	UL & VIN	Lot	Serial
Text	NN-NNNNNNNNNNNNNN-TTTTTTVV		WWYY	UL VIN	LLLLL	SSSS
Datamatrix	Type&Ver	Lot number	Serial	Date code		
	TTTTTTTVV	LLLLL	SSSS	WWYY		

Low Side Module 10-PG12NAC008MR02-LC69F36T

Outline

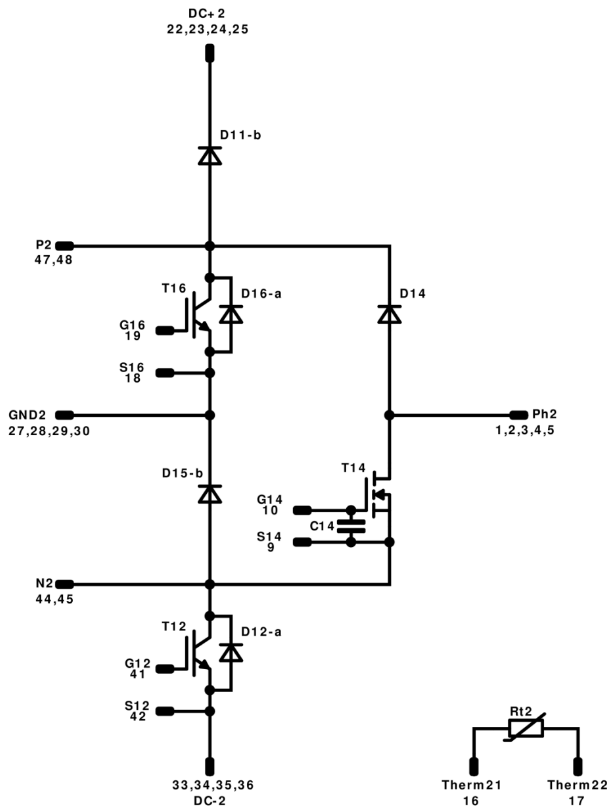
Pin table			
Pin	X	Y	Function
1	52,9	6	Ph2
2	52,9	3	Ph2
3	49,9	3	Ph2
4	52,9	0	Ph2
5	49,9	0	Ph2
6	Not assembled		
7	Not assembled		
8	Not assembled		
9	31,5	0	S14
10	28,5	1	G14
11	Not assembled		
12	Not assembled		
13	Not assembled		
14	Not assembled		
15	Not assembled		
16	3	0	Therm21
17	0	0	Therm22
18	0	9,5	S16
19	0	12,5	G16
20	Not assembled		
21	Not assembled		
22	0	28,9	DC+2
23	3	28,9	DC+2
24	6	28,9	DC+2
25	9	28,9	DC+2
26	Not assembled		
27	18,9	28,9	GND2
28	21,8	28,9	GND2
29	31	28,9	GND2
30	34	28,9	GND2
31	Not assembled		
32	Not assembled		
33	43,9	28,9	DC-2
34	46,9	28,9	DC-2
35	49,9	28,9	DC-2
36	52,9	28,9	DC-2
37	Not assembled		
38	Not assembled		
39	Not assembled		
40	Not assembled		
41	35,9	14,9	G12
42	35,35	17,9	S12
43	Not assembled		
44	26,9	15,6	N2
45	26,9	13	N2
46	Not assembled		
47	17,8	12,3	P2
48	15,2	12,3	P2



Tolerance of pinpositions: ±0.4mm at the end of pins
Dimension of coordinate axis is only offset without tolerance

Low Side Module 10-PG12NAC008MR02-LC69F36T

Pinout



Identification

ID	Component	Voltage	Current	Function	Comment
T14	MOSFET	1200 V	8 mΩ	AC Switch	
D14	FWD	1200 V	60 A	AC Diode	
T16	IGBT	1200 V	150 A	Neutral Point Switch	
D15-b	FWD	1200 V	150 A	Neutral Point Diode	
D16-a	FWD	1200 V	15 A	Neutral Point Switch Prot. Diode	
T12	IGBT	1200 V	150 A	DC-Link Switch	
D11-b	FWD	1200 V	100 A	DC-Link Diode	
D16-a	FWD	1200 V	100 A	DC-Link Switch Prot. Diode	
C14	Capacitor	25 V		Capacitor (GS)	
Rt2	NTC			Thermistor	

Packaging instruction				
Standard packaging quantity (SPQ) 100	>SPQ	Standard	<SPQ	Sample

Handling instruction
Handling instructions for *flow* 1 packages see vincotech.com website.

Package data
Package data for *flow* 1 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 certified according to UL 1557 standard, UL file number E192116. For more information see vincotech.com website.

Document No.:	Date:	Modification:	Pages
10-PG12NAx008MR02-LCx9F36T-D3-14	27 Sep. 2021	Corrected Neutral point diode and DC-link diode characteristics Corrected switching characteristics of DC-link and Neutral point Corrected tau values New datasheet format, module is unchanged	