MiniSKiiP® 2

3-phase
Converter-Inverter-Brake
(CIB)

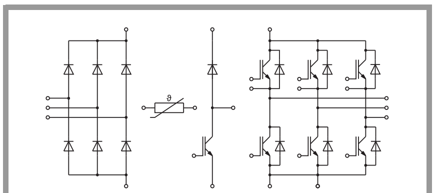
SKiiP 23NAB12T7V1

Features*

- 1200V Generation 7 IGBTs (T7)
- Robust and soft switching freewheeling diodes in CAL technology
- New SKR PEP diode technology for enhanced power and environmental robustness
- Highly reliable spring contacts for electrical connections
- UL recognized: File no. E63532

Remarks

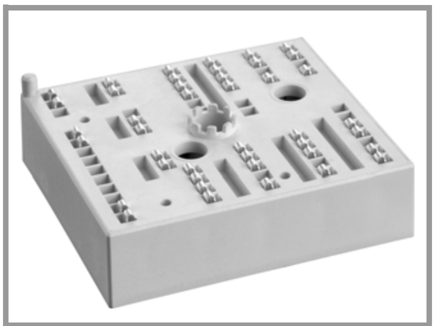
- Max. case temperature limited to TC=TS=125 °C
- Product reliability results valid for Tj≤150 °C; Tj,op >150°C during overload (Details see AN19-002)
- MiniSKiiP ″Technical Explanations″ and ″Mounting Instructions″ are part of the data sheet Please refer to both documents for further information
- For storage and case temperature with TIM see document ″Technical Explanations Thermal Interface Materials″
- Inverter IGBT: T1 – T6
- Chopper IGBT: T14
- Inverse Diode: D1 – D6
- Freewheeling Diode: D13
- Rectifier Diode: D7 – D12



NAB

Absolute Maximum Ratings

Symbol	Conditions		Values	Unit
Inverter - IGBT				
V_{CES}	T_j = 25 °C		1200	V
I_C	λ_{paste}=0.8 W/(mK)	T_s = 70 °C	33	A
	T_j = 175 °C	T_s = 100 °C	27	A
I_C	λ_{paste}=2.5 W/(mK)	T_s = 70 °C	37	A
	T_j = 175 °C	T_s = 100 °C	30	A
I_{Cnom}			25	A
I_{CRM}			50	A
V_{GES}			-20 ... 20	V
t_{psc}	V_{CC} = 800 V V_{GE} ≤ 15 V V_{CES} ≤ 1200 V	T_j = 175 °C	7	µs
T_j			-40 ... 175	°C
Chopper - IGBT				
V_{CES}	T_j = 25 °C		1200	V
I_C	λ_{paste}=0.8 W/(mK)	T_s = 70 °C	33	A
	T_j = 175 °C	T_s = 100 °C	27	A
I_C	λ_{paste}=2.5 W/(mK)	T_s = 70 °C	37	A
	T_j = 175 °C	T_s = 100 °C	30	A
I_{Cnom}			25	A
I_{CRM}			50	A
V_{GES}			-20 ... 20	V
t_{psc}	V_{CC} = 800 V V_{GE} ≤ 15 V V_{CES} ≤ 1200 V	T_j = 175 °C	7	µs
T_j			-40 ... 175	°C
Inverse - Diode				
V_{RRM}	T_j = 25 °C		1200	V
I_F	λ_{paste}=0.8 W/(mK)	T_s = 70 °C	24	A
	T_j = 175 °C	T_s = 100 °C	20	A
I_F	λ_{paste}=2.5 W/(mK)	T_s = 70 °C	27	A
	T_j = 175 °C	T_s = 100 °C	22	A
I_{FRM}			50	A
I_{FSM}	t_p = 10 ms, sin 180°, T_j = 150 °C		100	A
T_j			-40 ... 175	°C
Freewheeling - Diode				
V_{RRM}	T_j = 25 °C		1200	V
I_F	λ_{paste}=0.8 W/(mK)	T_s = 70 °C	24	A
	T_j = 175 °C	T_s = 100 °C	20	A
I_F	λ_{paste}=2.5 W/(mK)	T_s = 70 °C	27	A
	T_j = 175 °C	T_s = 100 °C	22	A
I_{FRM}			50	A
I_{FSM}	t_p = 10 ms, sin 180°, T_j = 150 °C		100	A
T_j			-40 ... 175	°C



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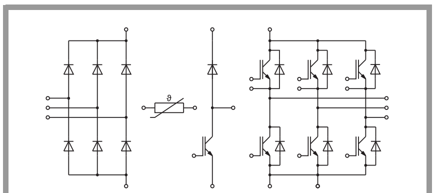

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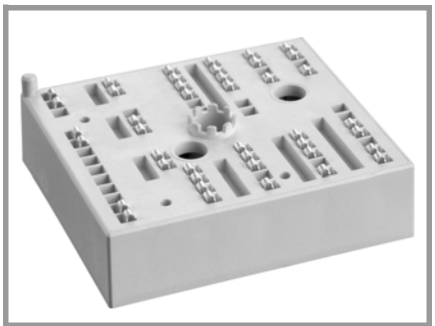
Absolute Maximum Ratings

Symbol	Conditions		Values	Unit
Rectifier - Diode				
V_{RRM}	T_j = 25 °C		1600	V
I_F	λ_{paste}=0.8 W/(mK)	T_s = 70 °C	49	A
	T_j = 175 °C	T_s = 100 °C	39	A
I_F	λ_{paste}=2.5 W/(mK)	T_s = 70 °C	55	A
	T_j = 175 °C	T_s = 100 °C	43	A
I_{FSM}	t_p = 10 ms	T_j = 25 °C	370	A
	sin 180°	T_j = 150 °C	270	A
i^2t	t_p = 10 ms	T_j = 25 °C	685	A^2s
	sin 180°	T_j = 150 °C	365	A^2s
T_j			-40 ... 175	°C
Module				
$I_{t(RMS)}$	$T_{terminal}$ = 80 °C, 20 A per spring		40	A
T_{stg}	module without TIM		-40 ... 125	°C
V_{isol}	AC sinus 50 Hz, 1 min		2500	V

Characteristics

Symbol	Conditions		min.	typ.	max.	Unit
Inverter - IGBT						
$V_{CE(sat)}$	I_C = 25 A	T_j = 25 °C		1.60	1.75	V
	V_{GE} = 15 V	T_j = 150 °C		1.78	1.93	V
	chiplevel	T_j = 175 °C		1.82	1.97	V
V_{CE0}		T_j = 25 °C		1.00	1.05	V
	chiplevel	T_j = 150 °C		0.80	0.85	V
		T_j = 175 °C		0.75	0.80	V
r_{CE}		T_j = 25 °C		24	28	mΩ
	V_{GE} = 15 V chiplevel	T_j = 150 °C		39	43	mΩ
		T_j = 175 °C		43	47	mΩ
$V_{GE(th)}$	V_{GE} = V_{CE}, I_C = 0.53 mA		5.15	5.8	6.45	V
I_{CES}	V_{GE} = 0 V, V_{CE} = 1200 V, T_j = 25 °C				1	mA
C_{ies}		f = 1 MHz		4.80		nF
C_{oes}	V_{CE} = 25 V V_{GE} = 0 V	f = 1 MHz		0.06		nF
C_{res}		f = 1 MHz		0.02		nF
Q_G	V_{GE} = - 8V ... + 15 V			350		nC
R_{Gint}	T_j = 25 °C			0		Ω
$t_{d(on)}$	V_{CC} = 600 V	T_j = 25 °C		40		ns
	I_C = 25 A	T_j = 150 °C		42		ns
	$R_{G\,on}$ = 12.8 Ω $R_{G\,off}$ = 12.8 Ω	T_j = 175 °C		43		ns
t_r	V_{GE} = +15/-15 V	T_j = 25 °C		38		ns
		T_j = 150 °C		44		ns
		T_j = 175 °C		47		ns
E_{on}	@ T_j = 150 °C:	T_j = 25 °C		2		mJ
	di/dt_{on} = 590 A/µs di/dt_{off} = 280 A/µs	T_j = 150 °C		2.8		mJ
	dv/dt = 3600 V/µs	T_j = 175 °C		3		mJ



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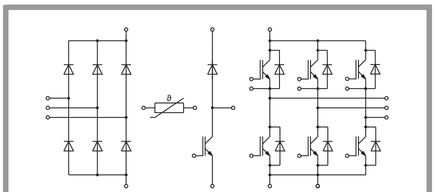

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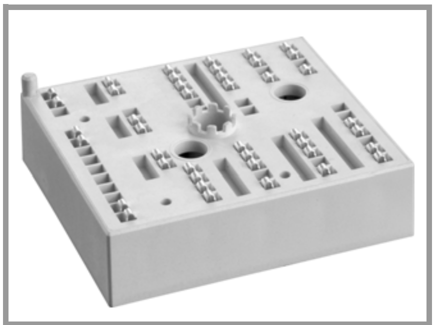
Characteristics						
Symbol	**Conditions**		**min.**	**typ.**	**max.**	**Unit**
Inverter - IGBT						
$t_{d(off)}$	V_{CC} = 600 V	T_j = 25 °C		218		ns
	I_C = 25 A	T_j = 150 °C		308		ns
	$R_{G\,on}$ = 12.8 Ω	T_j = 175 °C		333		ns
t_f	$R_{G\,off}$ = 12.8 Ω	T_j = 25 °C		46		ns
	V_{GE} = +15/-15 V	T_j = 150 °C		71		ns
		T_j = 175 °C		87		ns
E_{off}	@ T_j = 150 °C:	T_j = 25 °C		1.6		mJ
	di/dt_{on} = 590 A/µs di/dt_{off} = 280 A/µs	T_j = 150 °C		2.8		mJ
	dv/dt = 3600 V/µs	T_j = 175 °C		3		mJ
$R_{th(j-s)}$	per IGBT, λ_{paste}=0.8 W/(mK)			1.32		K/W
$R_{th(j-s)}$	per IGBT, λ_{paste}=2.5 W/(mK)			1.11		K/W
Chopper - IGBT						
$V_{CE(sat)}$	I_C = 25 A	T_j = 25 °C		1.60	1.75	V
	V_{GE} = 15 V	T_j = 150 °C		1.78	1.93	V
	chiplevel	T_j = 175 °C		1.82	1.97	V
V_{CE0}		T_j = 25 °C		1.00	1.05	V
	chiplevel	T_j = 150 °C		0.80	0.85	V
		T_j = 175 °C		0.75	0.80	V
r_{CE}		T_j = 25 °C		24	28	mΩ
	V_{GE} = 15 V chiplevel	T_j = 150 °C		39	43	mΩ
		T_j = 175 °C		43	47	mΩ
$V_{GE(th)}$	V_{GE} = V_{CE}, I_C = 0.53 mA		5.15	5.8	6.45	V
I_{CES}	V_{GE} = 0 V, V_{CE} = 1200 V, T_j = 25 °C				1	mA
C_{ies}		f = 1 MHz		4.80		nF
C_{oes}	V_{CE} = 25 V V_{GE} = 0 V	f = 1 MHz		0.06		nF
C_{res}		f = 1 MHz		0.02		nF
Q_G	V_{GE} = - 8V ... + 15 V			350		nC
R_{Gint}	T_j = 25 °C			0		Ω
$t_{d(on)}$		T_j = 25 °C		40		ns
		T_j = 150 °C		42		ns
		T_j = 175 °C		43		ns
t_r		T_j = 25 °C		38		ns
	V_{CC} = 600 V	T_j = 150 °C		44		ns
	I_C = 25 A	T_j = 175 °C		47		ns
E_{on}	$R_{G\,on}$ = 12.8 Ω	T_j = 25 °C		2		mJ
	$R_{G\,off}$ = 12.8 Ω	T_j = 150 °C		2.8		mJ
	V_{GE} = +15/-15 V	T_j = 175 °C		3		mJ
$t_{d(off)}$		T_j = 25 °C		218		ns
	@ T_j = 150 °C:	T_j = 150 °C		308		ns
	di/dt_{on} = 590 A/µs	T_j = 175 °C		333		ns
t_f	di/dt_{off} = 280 A/µs	T_j = 25 °C		46		ns
	dv/dt = 3600 V/µs	T_j = 150 °C		71		ns
		T_j = 175 °C		87		ns
E_{off}		T_j = 25 °C		1.6		mJ
		T_j = 150 °C		2.8		mJ
		T_j = 175 °C		3		mJ
$R_{th(j-s)}$	per IGBT, λ_{paste}=0.8 W/(mK)			1.32		K/W
$R_{th(j-s)}$	per IGBT, λ_{paste}=2.5 W/(mK)			1.11		K/W



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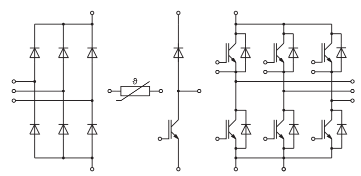

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Characteristics						
Symbol	**Conditions**		**min.**	**typ.**	**max.**	**Unit**
Inverse - Diode						
$V_F = V_{EC}$	I_F = 25 A	T_j = 25 °C		2.41	2.74	V
	V_{GE} = 0 V	T_j = 150 °C		2.45	2.79	V
	chiplevel	T_j = 175 °C		2.30	2.62	V
V_{F0}		T_j = 25 °C		1.30	1.50	V
	chiplevel	T_j = 150 °C		0.90	1.10	V
		T_j = 175 °C		0.82	0.98	V
r_F		T_j = 25 °C		44	50	mΩ
	chiplevel	T_j = 150 °C		62	68	mΩ
		T_j = 175 °C		59	66	mΩ
I_{RRM}		T_j = 25 °C		15		A
		T_j = 150 °C		20		A
	V_{CC} = 600 V	T_j = 175 °C		23		A
Q_{rr}	I_F = 25 A	T_j = 25 °C		1.5		µC
	V_{GE} = -15 V	T_j = 150 °C		3.7		µC
	@ T_j = 150 °C:	T_j = 175 °C		4.1		µC
E_{rr}	di/dt_{off} = 610 A/µs	T_j = 25 °C		0.48		mJ
		T_j = 150 °C		1.4		mJ
		T_j = 175 °C		1.9		mJ
$R_{th(j-s)}$	per Diode, λ_{paste}=0.8 W/(mK)			1.68		K/W
$R_{th(j-s)}$	per Diode, λ_{paste}=2.5 W/(mK)			1.44		K/W
Freewheeling - Diode						
$V_F = V_{EC}$	I_F = 25 A	T_j = 25 °C		2.41	2.74	V
	V_{GE} = 0 V	T_j = 150 °C		2.45	2.79	V
	chiplevel	T_j = 175 °C		2.30	2.62	V
V_{F0}		T_j = 25 °C		1.30	1.50	V
	chiplevel	T_j = 150 °C		0.90	1.10	V
		T_j = 175 °C		0.82	0.98	V
r_F		T_j = 25 °C		44	50	mΩ
	chiplevel	T_j = 150 °C		62	68	mΩ
		T_j = 175 °C		59	66	mΩ
I_{RRM}		T_j = 25 °C		15		A
		T_j = 150 °C		20		A
	V_{CC} = 600 V	T_j = 175 °C		23		A
Q_{rr}	I_F = 25 A	T_j = 25 °C		1.5		µC
	V_{GE} = -15 V	T_j = 150 °C		3.7		µC
	@ T_j = 150 °C:	T_j = 175 °C		4.1		µC
E_{rr}	di/dt_{off} = 610 A/µs	T_j = 25 °C		0.48		mJ
		T_j = 150 °C		1.4		mJ
		T_j = 175 °C		1.9		mJ
$R_{th(j-s)}$	per Diode, λ_{paste}=0.8 W/(mK)			1.68		K/W
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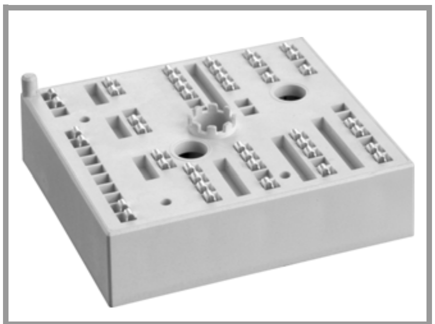

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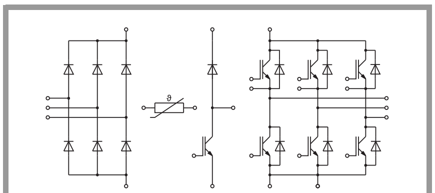

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Characteristics						
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Rectifier - Diode						
V_F	I_F = 13 A chiplevel	T_j = 25 °C		0.97	1.20	V
		T_j = 150 °C		0.84	1.07	V
		T_j = 175 °C		0.82	1.05	V
V_{F0}	chiplevel	T_j = 25 °C		0.89	1.09	V
		T_j = 150 °C		0.73	0.92	V
		T_j = 175 °C		0.69	0.88	V
r_F	chiplevel	T_j = 25 °C		6.2	8.5	mΩ
		T_j = 150 °C		8.8	12	mΩ
		T_j = 175 °C		10.0	13	mΩ
I_R	T_j = 150 °C, V_{RRM}				1.7	mA
$R_{th(j-s)}$	per Diode, λ_{paste}=0.8 W/(mK)			1.39		K/W
$R_{th(j-s)}$	per Diode, λ_{paste}=2.5 W/(mK)			1.2		K/W
Module						
M_s	to heat sink		2		2.5	Nm
w				55		g
L_{CE}				-		nH
Temperature Sensor						
R_{100}	T_r=100°C (R_{25}=1000Ω)			1670 ± 3%		Ω
$R_{(T)}$	$R_{(T)}=1000\Omega[1+A(T-25°C)+B(T-25°C)^2]$, $A = 7.635 \cdot 10^{-3} °C^{-1}$, $B = 1.731 \cdot 10^{-5} °C^{-2}$					

Creepage distance (spring to spring) between temperature sensor and phase DC- = 3.2mm (CTI 600)

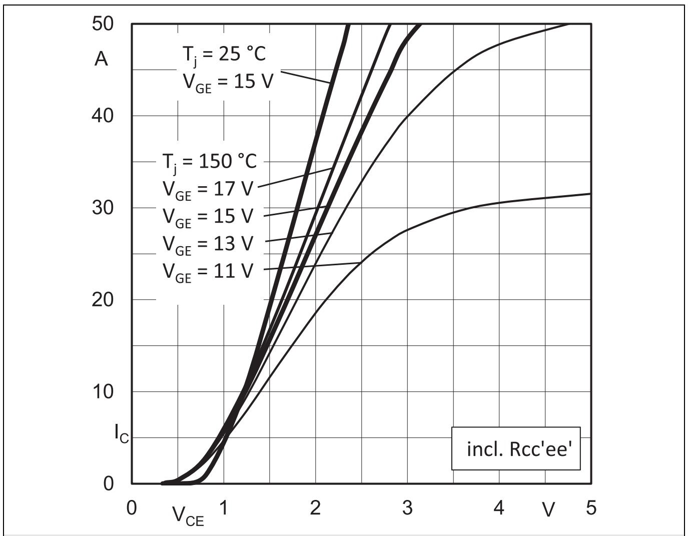


Fig. 1: Typ. output characteristic

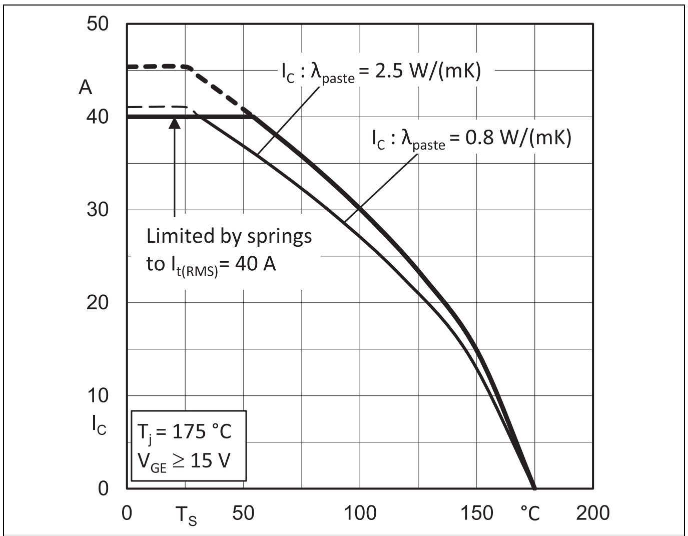


Fig. 2: Typ. rated current vs. temperature $I_C = f(T_S)$

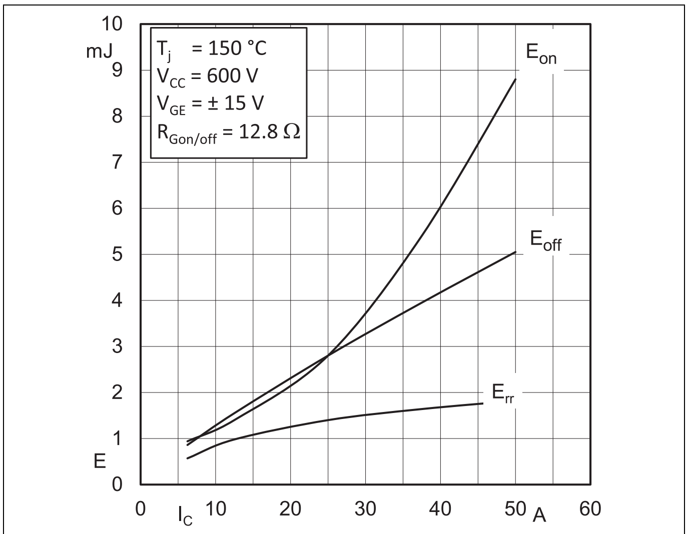


Fig. 3: Typ. turn-on /-off energy = f (I_C)

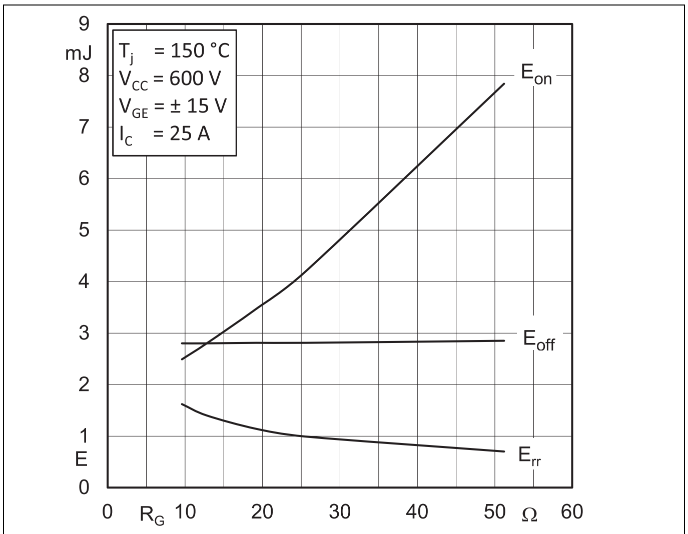


Fig. 4: Typ. turn-on /-off energy = f (R_G)

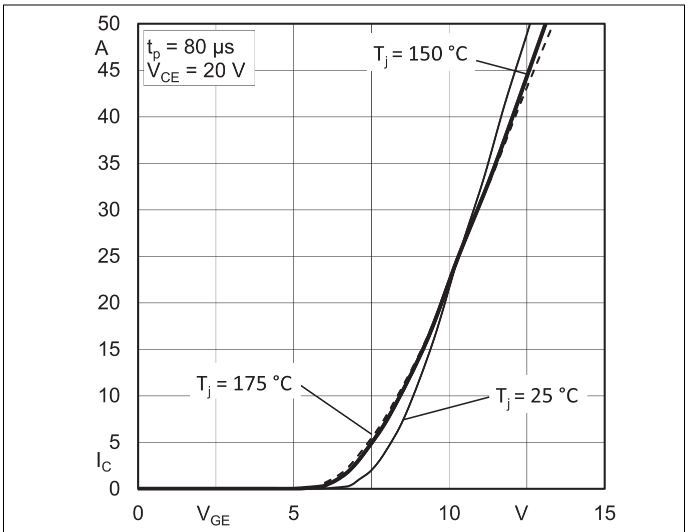


Fig. 5: Typ. transfer characteristic

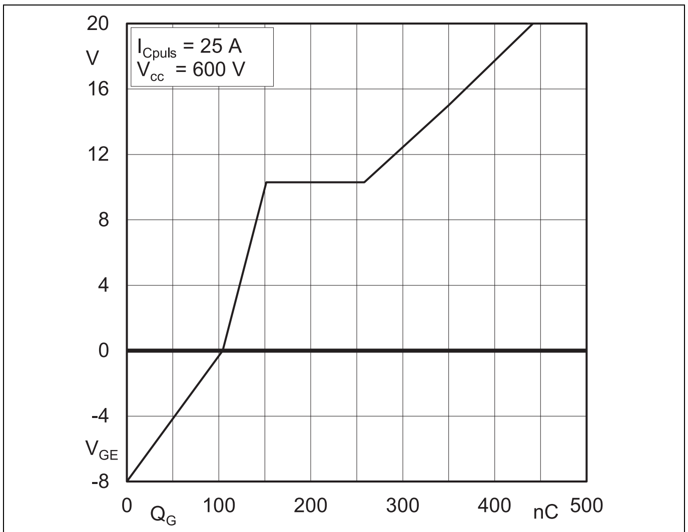


Fig. 6: Typ. gate charge characteristic

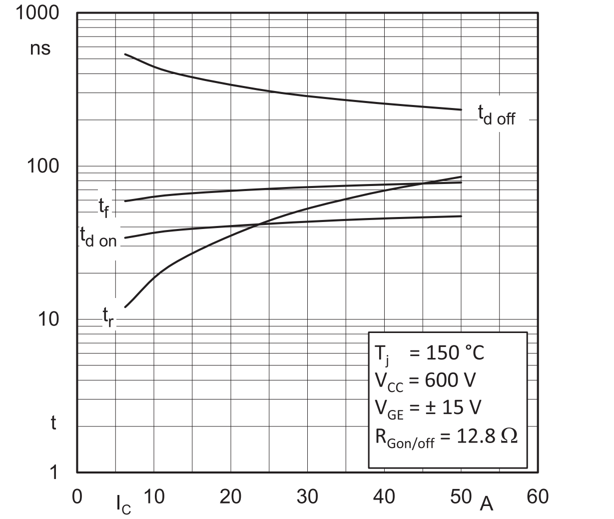


Fig. 7: Typ. switching times vs. I_C

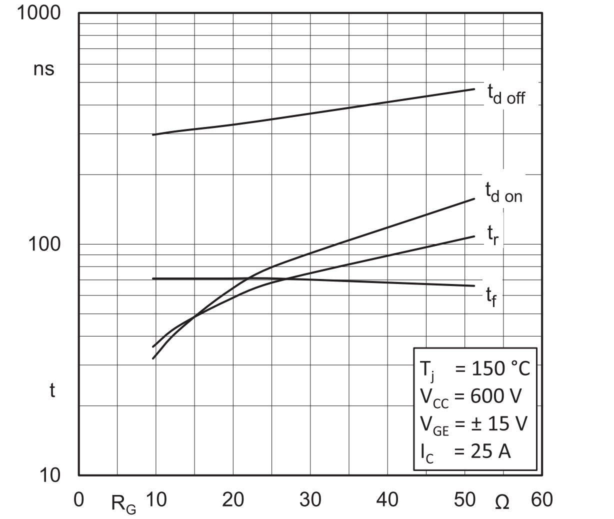


Fig. 8: Typ. switching times vs. gate resistor R_G

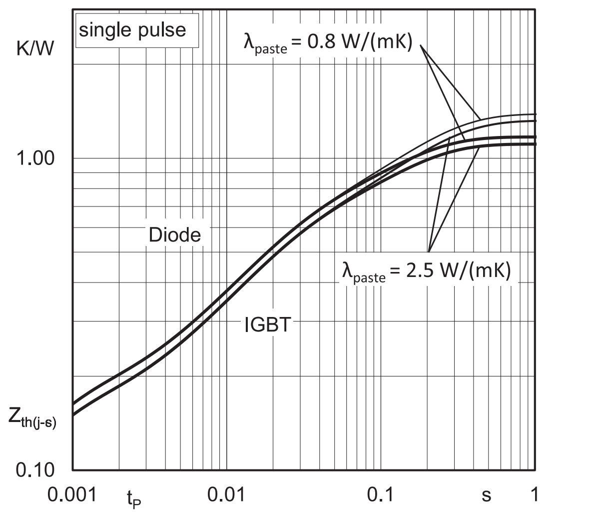


Fig. 9: Typ. transient thermal impedance

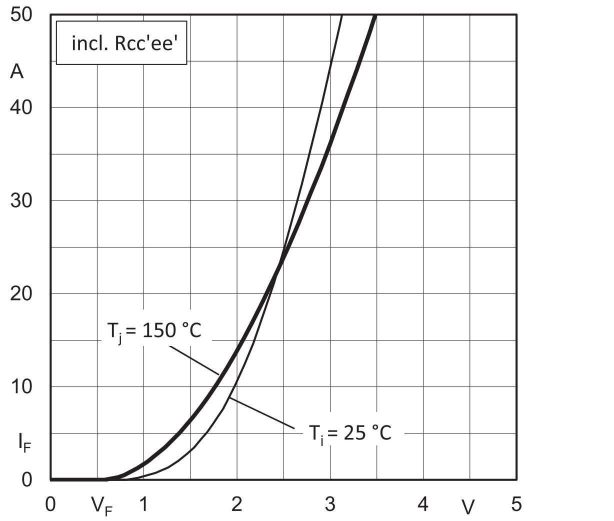


Fig. 10: Typ. CAL diode forward characteristic

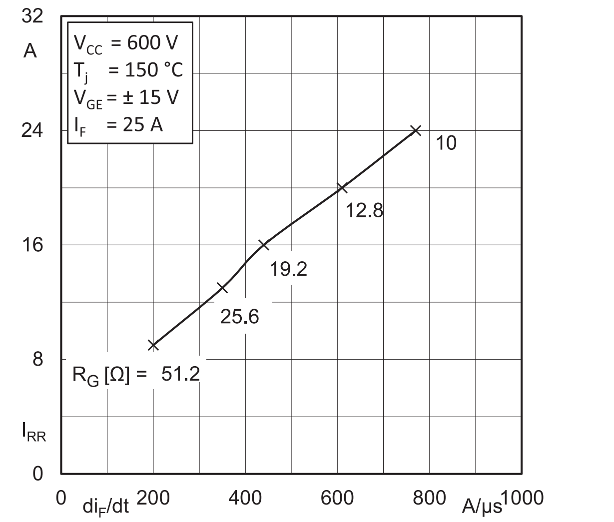


Fig. 11: Typ. CAL diode peak reverse recovery current

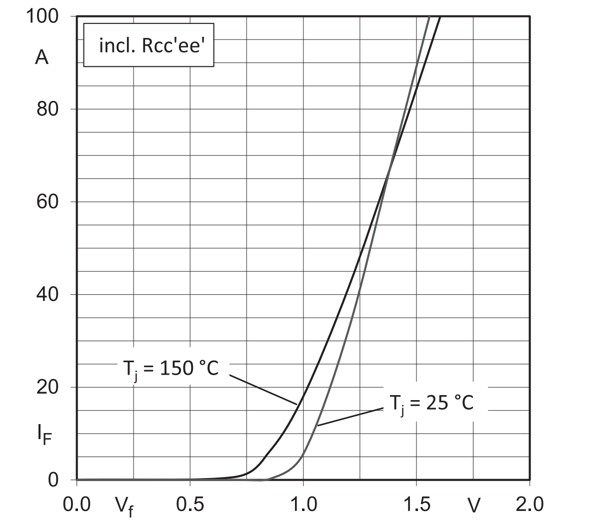
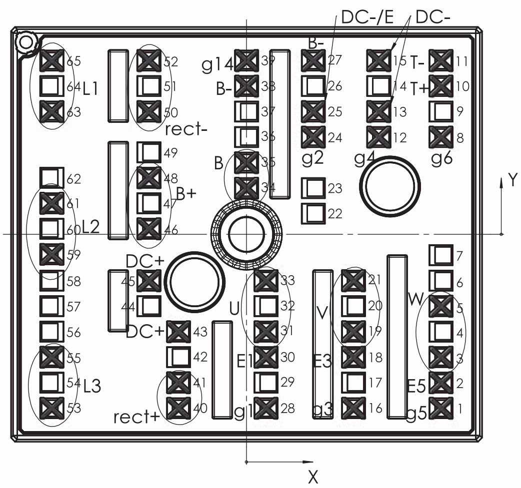


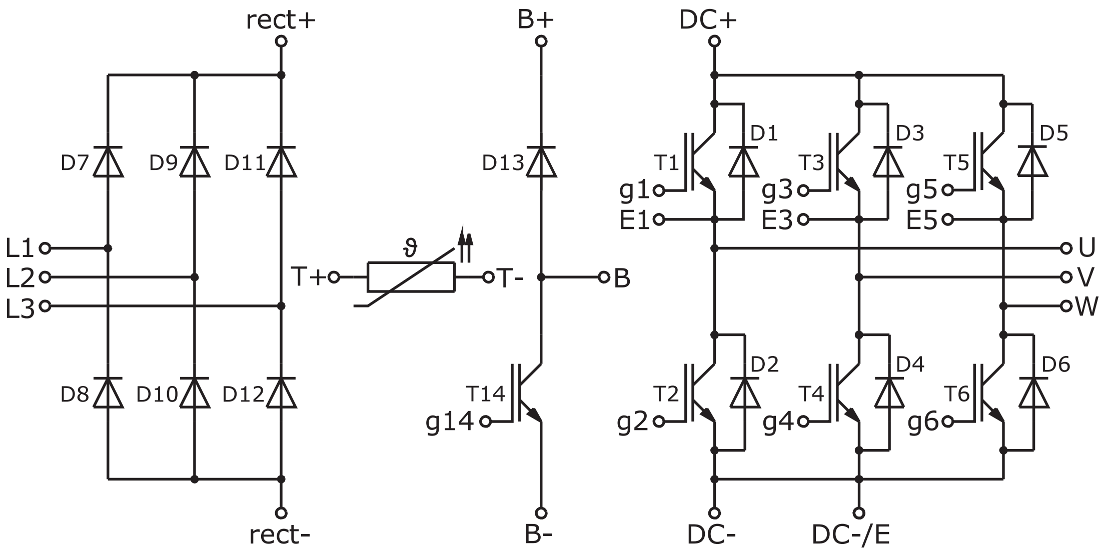
Fig. 12: Typ. input bridge forward characteristic

Pin out											
Pin	X	Y	*Function*	*Pin*	X	Y	*Function*	*Pin*	X	Y	*Function*
1	24,38	-21,8	g5	23				45	-12,23	-5,8	DC+
2	24,38	-18,6	E5	24	8,38	12,2	g2	46	-12,23	0,7	B+
3	24,38	-15,4	W	25	8,38	15,4	DC-/E	47			
4				26				48	-12,23	7,1	B+
5	24,38	-9	W	27	8,38	21,8	B-	49			
6				28	2,46	-21,8	g1	50	-12,23	15,4	rect-
7				29				51	-12,23	18,6	rect-
8	24,38	12,2	g6	30	2,46	-15,4	E1	52			
9				31	2,46	-12,2	U	53	-24,38	-21,8	L3
10	24,38	18,6	T+	32				54			
11	24,38	21,8	T-	33	2,46	-5,8	U	55	-24,38	-15,4	L3
12	16,58	12,2	g4	34	0,03	5,8	B	56			
13	16,58	15,4	DC-	35	0,03	9	B	57			
14				36				58			
15	16,58	21,8	DC-	37				59	-24,38	-2,5	L2
16	13,42	-21,8	g3	38	0,03	18,6	B-	60			
17				39	0,03	21,8	g14	61	-24,38	3,9	L2
18	13,42	-15,4	E3	40	-8,51	-21,8	rect+	62			
19	13,42	-12,2	V	41	-8,51	-18,6	rect+	63	-24,38	15,4	L1
20				42				64			
21	13,42	-5,8	V	43	-8,51	-12,2	DC+	65	-24,38	21,8	L1
22				44							

all values in mm



Pinout



Pinout

This is an electrostatic discharge sensitive device (ESDS) due to international standard IEC 61340.

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