

# SKiiP 11NAB12T4V1



MiniSKiiP® 1

## Converter-Inverter-Brake (CIB)

### SKiiP 11NAB12T4V1

#### Features\*

- Trench 4 IGBTs
- Robust and soft switching freewheeling diodes in CAL technology
- Highly reliable spring contacts for electrical connections
- UL recognized: File no. E63532

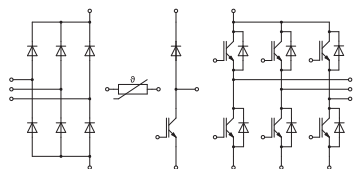
#### Typical Applications

- Inverter up to 8 kVA
- Typical motor power 4 kW

#### Remarks

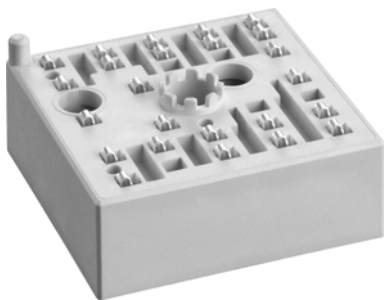
- Max. case temperature limited to  $T_C=125^\circ\text{C}$
- Product reliability results valid for  $T_J \leq 150^\circ\text{C}$  (recommended  $T_{J,op} = -40 \dots +150^\circ\text{C}$ )
- MiniSKiiP "Technical Explanations" and "Mounting Instructions" are part of the data sheet. Please refer to both documents for further information

Absolute Maximum Ratings				
Symbol	Conditions		Values	Unit
<b>Inverter - IGBT</b>				
$V_{CES}$	$T_J = 25^\circ\text{C}$		1200	V
$I_C$	$\lambda_{paste}=0.8 \text{ W/(mK)}$	$T_s = 25^\circ\text{C}$	18	A
		$T_J = 175^\circ\text{C}$	14	A
$I_C$	$\lambda_{paste}=2.5 \text{ W/(mK)}$	$T_s = 25^\circ\text{C}$	19	A
		$T_J = 175^\circ\text{C}$	16	A
$I_{Chom}$			8	A
$I_{CRM}$			24	A
$V_{GES}$			-20 ... 20	V
$t_{psc}$	$V_{CC} = 800 \text{ V}$ $V_{GE} \leq 15 \text{ V}$ $V_{CES} \leq 1200 \text{ V}$	$T_J = 150^\circ\text{C}$	10	$\mu\text{s}$
$T_J$			-40 ... 175	$^\circ\text{C}$
<b>Chopper - IGBT</b>				
$V_{CES}$	$T_J = 25^\circ\text{C}$		1200	V
$I_C$	$\lambda_{paste}=0.8 \text{ W/(mK)}$	$T_s = 25^\circ\text{C}$	18	A
		$T_J = 175^\circ\text{C}$	14	A
$I_C$	$\lambda_{paste}=2.5 \text{ W/(mK)}$	$T_s = 25^\circ\text{C}$	19	A
		$T_J = 175^\circ\text{C}$	16	A
$I_{Chom}$			8	A
$I_{CRM}$			24	A
$V_{GES}$			-20 ... 20	V
$t_{psc}$	$V_{CC} = 800 \text{ V}$ $V_{GE} \leq 15 \text{ V}$ $V_{CES} \leq 1200 \text{ V}$	$T_J = 150^\circ\text{C}$	10	$\mu\text{s}$
$T_J$			-40 ... 175	$^\circ\text{C}$
<b>Inverse - Diode</b>				
$V_{RRM}$	$T_J = 25^\circ\text{C}$		1200	V
$I_F$	$\lambda_{paste}=0.8 \text{ W/(mK)}$	$T_s = 25^\circ\text{C}$	15	A
		$T_J = 175^\circ\text{C}$	12	A
$I_F$	$\lambda_{paste}=2.5 \text{ W/(mK)}$	$T_s = 25^\circ\text{C}$	17	A
		$T_J = 175^\circ\text{C}$	13	A
$I_{FRM}$			24	A
$I_{FSM}$	$t_p = 10 \text{ ms, sin } 180^\circ, T_J = 150^\circ\text{C}$		36	A
$T_J$			-40 ... 175	$^\circ\text{C}$
<b>Freewheeling - Diode</b>				
$V_{RRM}$	$T_J = 25^\circ\text{C}$		1200	V
$I_F$	$\lambda_{paste}=0.8 \text{ W/(mK)}$	$T_s = 25^\circ\text{C}$	15	A
		$T_J = 175^\circ\text{C}$	12	A
$I_F$	$\lambda_{paste}=2.5 \text{ W/(mK)}$	$T_s = 25^\circ\text{C}$	17	A
		$T_J = 175^\circ\text{C}$	13	A
$I_{FRM}$			24	A
$I_{FSM}$	$t_p = 10 \text{ ms, sin } 180^\circ, T_J = 150^\circ\text{C}$		36	A
$T_J$			-40 ... 175	$^\circ\text{C}$



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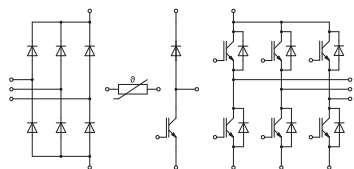
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- Max. case temperature limited to  $T_C=125^\circ\text{C}$
- Product reliability results valid for  $T_j \leq 150^\circ\text{C}$  (recommended  $T_{j,op} = -40 \dots +150^\circ\text{C}$ )
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Absolute Maximum Ratings				
Symbol	Conditions	Values	Unit	
<b>Rectifier - Diode</b>				
$V_{RRM}$	$T_j = 25^\circ\text{C}$	1600	V	
$I_F$	$\lambda_{paste}=0.8 \text{ W/(mK)}$	$T_s = 25^\circ\text{C}$	39	A
	$T_j = 150^\circ\text{C}$	$T_s = 70^\circ\text{C}$	29	A
$I_F$	$\lambda_{paste}=2.5 \text{ W/(mK)}$	$T_s = 25^\circ\text{C}$	42	A
	$T_j = 150^\circ\text{C}$	$T_s = 70^\circ\text{C}$	32	A
$I_{FSM}$	$t_p = 10 \text{ ms}$	$T_j = 25^\circ\text{C}$	220	A
	$\sin 180^\circ$	$T_j = 150^\circ\text{C}$	200	A
$i^2t$	$t_p = 10 \text{ ms}$	$T_j = 25^\circ\text{C}$	242	$\text{A}^2\text{s}$
	$\sin 180^\circ$	$T_j = 150^\circ\text{C}$	200	$\text{A}^2\text{s}$
$T_j$		-40 ... 150	$^\circ\text{C}$	
<b>Module</b>				
$I_{t(RMS)}$	$T_{terminal} = 80^\circ\text{C}$ ,	12	A	
$T_{stg}$	module without TIM	-40 ... 125	$^\circ\text{C}$	
$V_{isol}$	AC sinus 50 Hz, 1 min	2500	V	

Characteristics					
Symbol	Conditions	min.	typ.	max.	Unit
<b>Inverter - IGBT</b>					
$V_{CE(sat)}$	$I_C = 8 \text{ A}$	$T_j = 25^\circ\text{C}$	1.85	2.10	V
	$V_{GE} = 15 \text{ V}$ chipelevel	$T_j = 150^\circ\text{C}$	2.25	2.45	V
$V_{CE0}$	chipelevel	$T_j = 25^\circ\text{C}$	0.80	0.90	V
		$T_j = 150^\circ\text{C}$	0.70	0.80	V
$r_{CE}$	$V_{GE} = 15 \text{ V}$ chipelevel	$T_j = 25^\circ\text{C}$	131	150	$\text{m}\Omega$
		$T_j = 150^\circ\text{C}$	194	206	$\text{m}\Omega$
$V_{GE(th)}$	$V_{GE} = V_{CE}, I_C = 1 \text{ mA}$	5	5.8	6.5	V
$I_{CES}$	$V_{GE} = 0 \text{ V}, V_{CE} = 1200 \text{ V}, T_j = 25^\circ\text{C}$			1	$\text{mA}$
$C_{ies}$	$V_{CE} = 25 \text{ V}$ $V_{GE} = 0 \text{ V}$	$f = 1 \text{ MHz}$	0.49		$\text{nF}$
$C_{oes}$		$f = 1 \text{ MHz}$	0.05		$\text{nF}$
$C_{res}$		$f = 1 \text{ MHz}$	0.03		$\text{nF}$
$Q_G$	$V_{GE} = -8 \text{ V} \dots +15 \text{ V}$		45		$\text{nC}$
$R_{Gint}$	$T_j = 25^\circ\text{C}$		0		$\Omega$
$t_{d(on)}$	$V_{CC} = 600 \text{ V}$ $I_C = 8 \text{ A}$	$T_j = 150^\circ\text{C}$	31		$\text{ns}$
$t_r$	$R_{G on} = 47 \Omega$ $R_{G off} = 47 \Omega$	$T_j = 150^\circ\text{C}$	31		$\text{ns}$
$E_{on}$		$T_j = 150^\circ\text{C}$	0.87		$\text{mJ}$
$t_{d(off)}$		$T_j = 150^\circ\text{C}$	290		$\text{ns}$
$t_f$		$T_j = 150^\circ\text{C}$	70		$\text{ns}$
$E_{off}$	$V_{GE} = +15/-15 \text{ V}$	$T_j = 150^\circ\text{C}$	0.74		$\text{mJ}$
$R_{th(j-s)}$	per IGBT, $\lambda_{paste}=0.8 \text{ W/(mK)}$		1.84		$\text{K/W}$
$R_{th(j-s)}$	per IGBT, $\lambda_{paste}=2.5 \text{ W/(mK)}$		1.58		$\text{K/W}$



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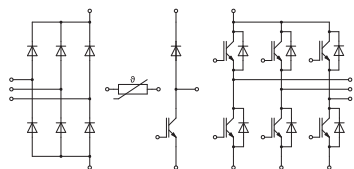
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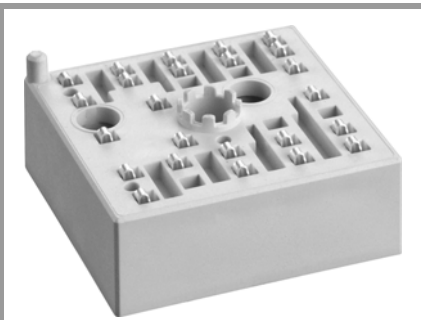
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Characteristics						
Symbol	Conditions		min.	typ.	max.	Unit
<b>Chopper - IGBT</b>						
$V_{CE(sat)}$	$I_C = 8 \text{ A}$ $V_{GE} = 15 \text{ V}$ chipelevel	$T_j = 25^\circ\text{C}$		1.85	2.10	V
		$T_j = 150^\circ\text{C}$		2.25	2.45	V
$V_{CE0}$	chipelevel	$T_j = 25^\circ\text{C}$		0.80	0.90	V
		$T_j = 150^\circ\text{C}$		0.70	0.80	V
$r_{CE}$	$V_{GE} = 15 \text{ V}$ chipelevel	$T_j = 25^\circ\text{C}$		131	150	m $\Omega$
		$T_j = 150^\circ\text{C}$		194	206	m $\Omega$
$V_{GE(th)}$	$V_{GE} = V_{CE}, I_C = 1 \text{ mA}$		5	5.8	6.5	V
$I_{CES}$	$V_{GE} = 0 \text{ V}, V_{CE} = 1200 \text{ V}, T_j = 25^\circ\text{C}$				1	mA
$C_{ies}$	$V_{CE} = 25 \text{ V}$ $V_{GE} = 0 \text{ V}$	$f = 1 \text{ MHz}$		0.49		nF
$C_{oes}$		$f = 1 \text{ MHz}$		0.05		nF
$C_{res}$		$f = 1 \text{ MHz}$		0.03		nF
$Q_G$	$V_{GE} = -8 \text{ V} \dots +15 \text{ V}$			45		nC
$R_{Gint}$	$T_j = 25^\circ\text{C}$			0		$\Omega$
$t_{d(on)}$	$V_{CC} = 600 \text{ V}$ $I_C = 8 \text{ A}$	$T_j = 150^\circ\text{C}$		31		ns
$t_r$		$T_j = 150^\circ\text{C}$		31		ns
$E_{on}$	$R_{G\ on} = 47 \ \Omega$ $R_{G\ off} = 47 \ \Omega$	$T_j = 150^\circ\text{C}$		0.87		mJ
$t_{d(off)}$		$T_j = 150^\circ\text{C}$		290		ns
$t_f$	$T_j = 150^\circ\text{C}$			70		ns
$E_{off}$	$V_{GE} = +15/-15 \text{ V}$			0.74		mJ
$R_{th(j-s)}$	per IGBT, $\lambda_{paste}=0.8 \text{ W}/(\text{mK})$			1.84		K/W
$R_{th(j-s)}$	per IGBT, $\lambda_{paste}=2.5 \text{ W}/(\text{mK})$			1.58		K/W
<b>Inverse - Diode</b>						
$V_F = V_{EC}$	$I_F = 8 \text{ A}$ $V_{GE} = 0 \text{ V}$ chipelevel	$T_j = 25^\circ\text{C}$		2.33	2.65	V
		$T_j = 150^\circ\text{C}$		2.35	2.68	V
$V_{F0}$	chipelevel	$T_j = 25^\circ\text{C}$		1.30	1.50	V
		$T_j = 150^\circ\text{C}$		0.90	1.10	V
$r_F$	chipelevel	$T_j = 25^\circ\text{C}$		129	144	m $\Omega$
		$T_j = 150^\circ\text{C}$		181	198	m $\Omega$
$I_{RRM}$	$I_F = 8 \text{ A}$	$T_j = 150^\circ\text{C}$		8.3		A
$Q_{rr}$	$di/dt_{off} = 380 \text{ A}/\mu\text{s}$ $V_{GE} = -15 \text{ V}$	$T_j = 150^\circ\text{C}$		1.35		$\mu\text{C}$
$E_{rr}$	$V_{CC} = 600 \text{ V}$	$T_j = 150^\circ\text{C}$		0.57		mJ
$R_{th(j-s)}$	per Diode, $\lambda_{paste}=0.8 \text{ W}/(\text{mK})$			2.53		K/W
$R_{th(j-s)}$	per Diode, $\lambda_{paste}=2.5 \text{ W}/(\text{mK})$			2.2		K/W
<b>Freewheeling - Diode</b>						
$V_F = V_{EC}$	$I_F = 8 \text{ A}$ $V_{GE} = 0 \text{ V}$ chipelevel	$T_j = 25^\circ\text{C}$		2.33	2.65	V
		$T_j = 150^\circ\text{C}$		2.35	2.68	V
$V_{F0}$	chipelevel	$T_j = 25^\circ\text{C}$		1.30	1.50	V
		$T_j = 150^\circ\text{C}$		0.90	1.10	V
$r_F$	chipelevel	$T_j = 25^\circ\text{C}$		129	144	m $\Omega$
		$T_j = 150^\circ\text{C}$		181	198	m $\Omega$
$I_{RRM}$	$I_F = 8 \text{ A}$	$T_j = 150^\circ\text{C}$		8.3		A
$Q_{rr}$	$di/dt_{off} = 380 \text{ A}/\mu\text{s}$ $V_{GE} = -15 \text{ V}$	$T_j = 150^\circ\text{C}$		1.35		$\mu\text{C}$
$E_{rr}$	$V_{CC} = 600 \text{ V}$	$T_j = 150^\circ\text{C}$		0.57		mJ
$R_{th(j-s)}$	per Diode, $\lambda_{paste}=0.8 \text{ W}/(\text{mK})$			2.53		K/W
$R_{th(j-s)}$	per Diode, $\lambda_{paste}=2.5 \text{ W}/(\text{mK})$			2.2		K/W

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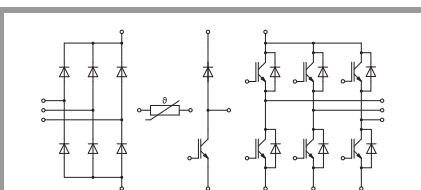
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Characteristics						
Symbol	Conditions		min.	typ.	max.	Unit
<b>Rectifier - Diode</b>						
$V_F = V_{EC}$	$I_F = 8 \text{ A}$ chipelevel	$T_j = 25^\circ\text{C}$		1.00	1.21	V
		$T_j = 125^\circ\text{C}$		0.90	1.10	V
$V_{F0}$	chipelevel	$T_j = 25^\circ\text{C}$		0.88	0.98	V
		$T_j = 125^\circ\text{C}$		0.73	0.83	V
$r_F$	chipelevel	$T_j = 25^\circ\text{C}$		15	29	m $\Omega$
		$T_j = 125^\circ\text{C}$		21	34	m $\Omega$
$I_R$	$T_j = 145^\circ\text{C}, V_{RRM}$				1.1	mA
$R_{th(j-s)}$	per Diode, $\lambda_{paste}=0.8 \text{ W/(mK)}$			1.5		K/W
$R_{th(j-s)}$	per Diode, $\lambda_{paste}=2.5 \text{ W/(mK)}$			1.29		K/W
<b>Module</b>						
$M_s$	to heat sink		2		2.5	Nm
$w$				30		g
$L_{CE}$				-		nH
<b>Temperature Sensor</b>						
$R_{100}$	$T_r=100^\circ\text{C} (R_{25}=1000\Omega)$			1670 $\pm$ 3%		$\Omega$
$R_{(T)}$	$R_{(T)}=1000\Omega[1+A(T-25^\circ\text{C})+B(T-25^\circ\text{C})^2]$ , $A = 7.635 \cdot 10^{-3} \text{ }^\circ\text{C}^{-1}$ , $B = 1.731 \cdot 10^{-5} \text{ }^\circ\text{C}^{-2}$					



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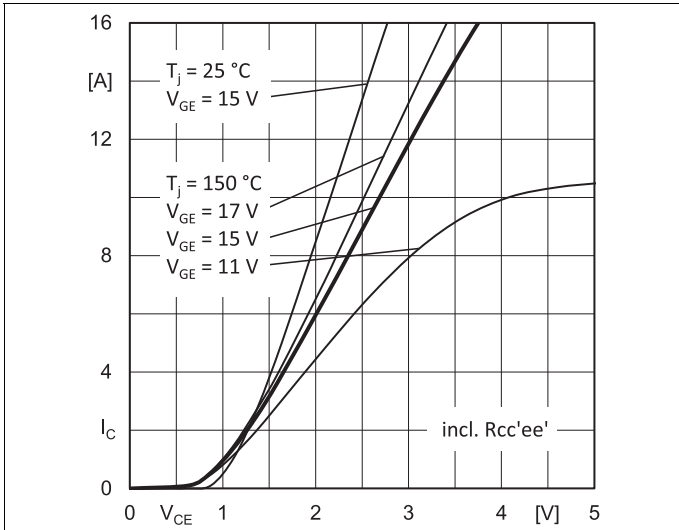


Fig. 1: Typ. output characteristic

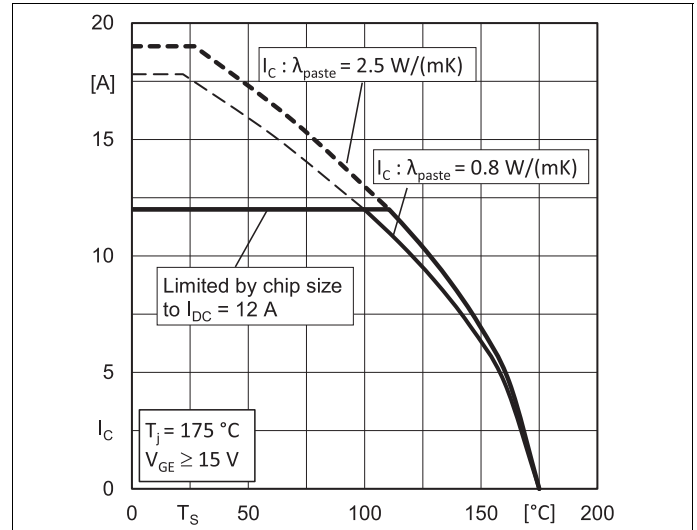


Fig. 2: Typ. rated current vs. temperature  $I_C = f(T_s)$

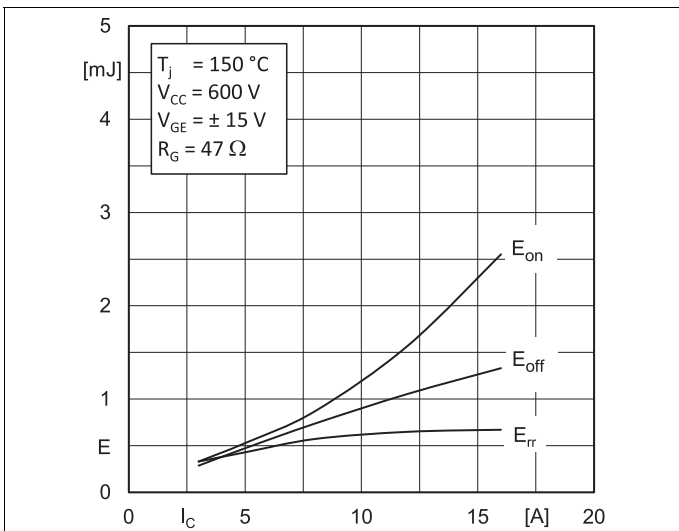


Fig. 3: Typ. turn-on /-off energy =  $f(I_C)$

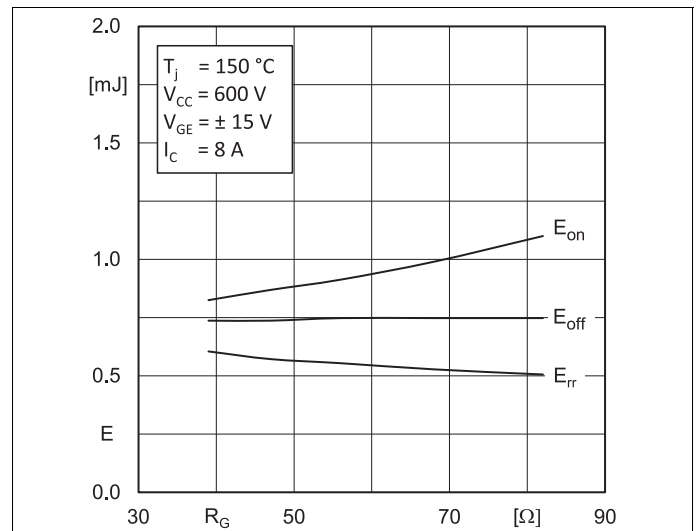


Fig. 4: Typ. turn-on /-off energy =  $f(R_G)$

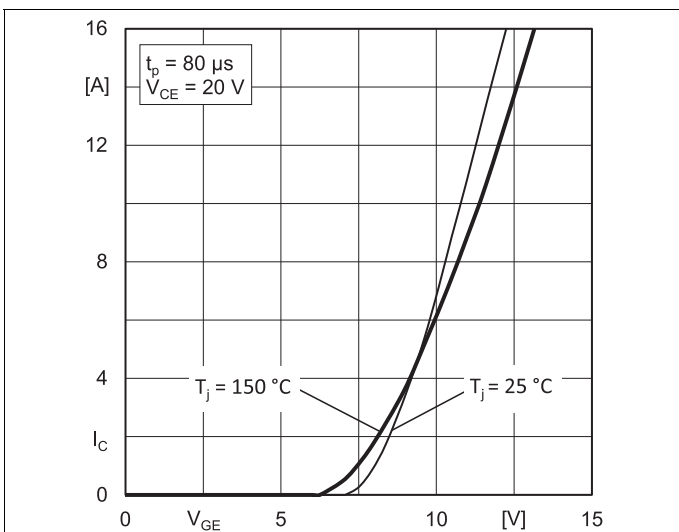


Fig. 5: Typ. transfer characteristic

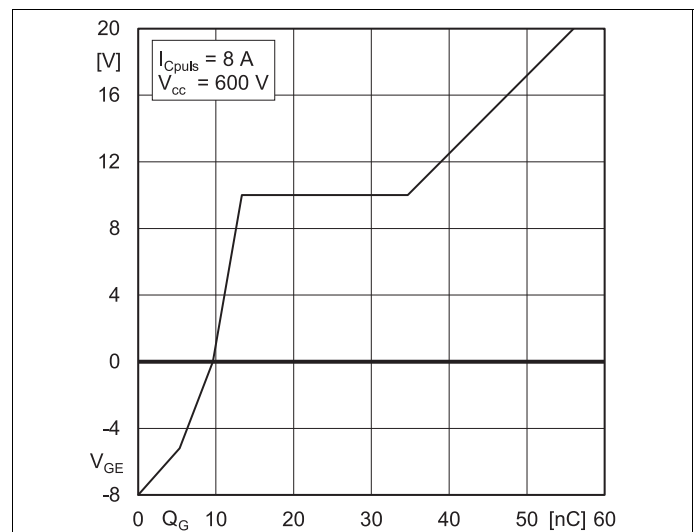


Fig. 6: Typ. gate charge characteristic

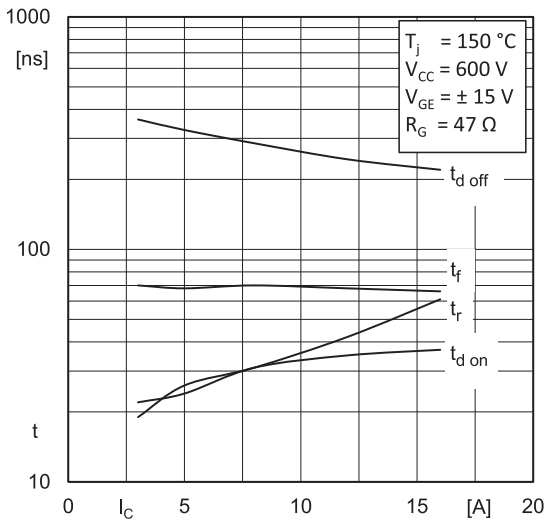


Fig. 7: Typ. switching times vs.  $I_C$

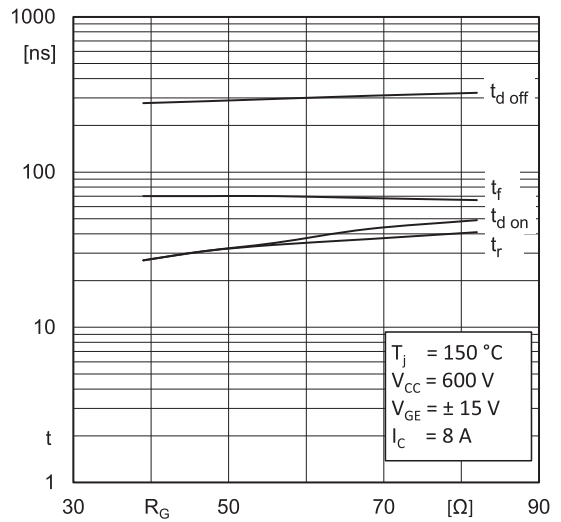


Fig. 8: Typ. switching times vs. gate resistor  $R_G$

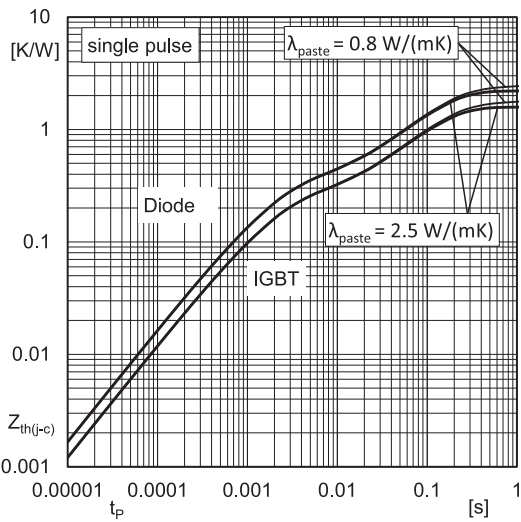


Fig. 9: Typ. transient thermal impedance

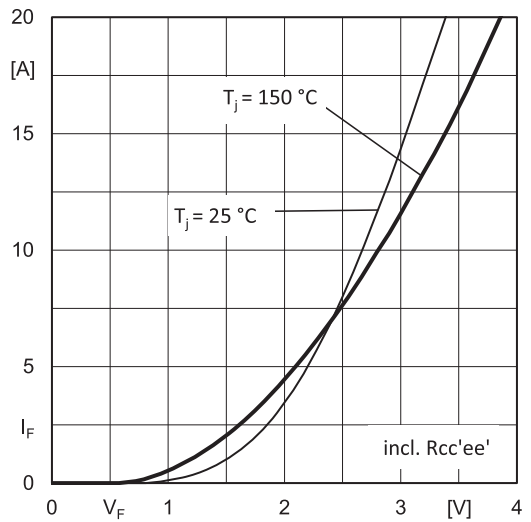


Fig. 10: Typ. CAL diode forward characteristic

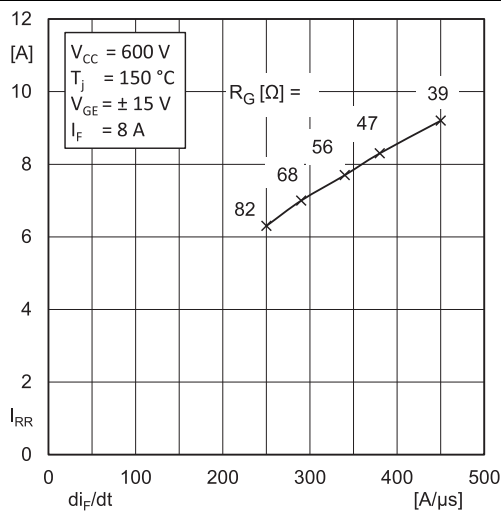


Fig. 11: Typ. CAL diode peak reverse recovery current

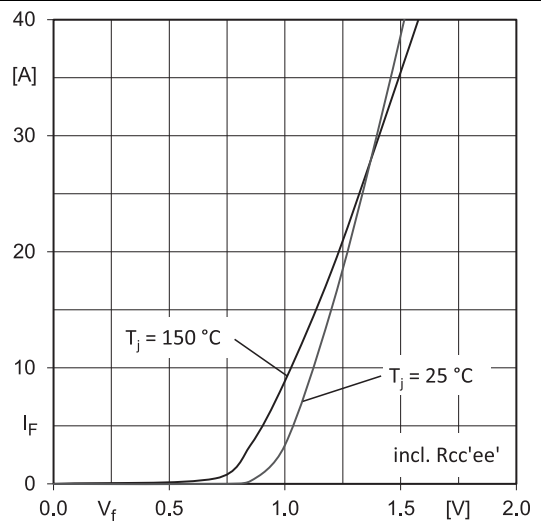
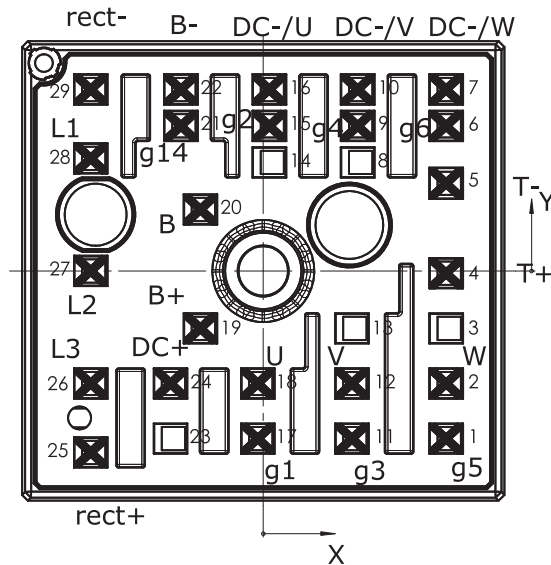


Fig. 12: Typ. input bridge forward characteristic

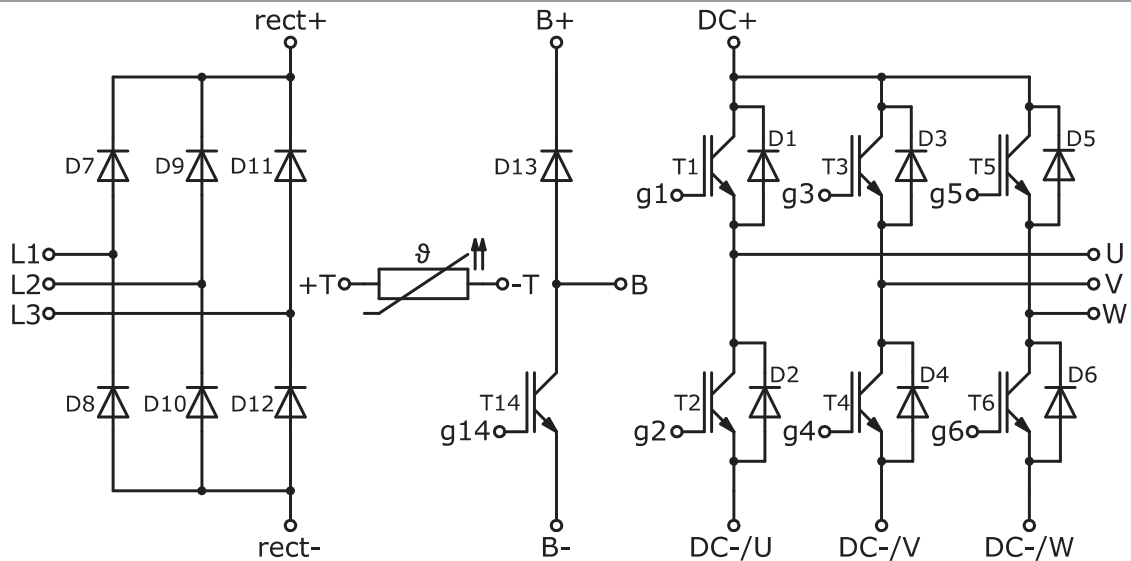
# SKiP 11NAB12T4V1

Pin out							
Pin	X	Y	Function	Pin	X	Y	Function
1	15,93	-14,60	g5	16	0,53	15,80	DC-/U
2	15,93	-9,80	W	17	-0,48	-14,6	g1
3	15,93	-5,00		18	-0,48	-9,80	U
4	15,93	-0,20	T+	19	-5,48	-5,00	B+
5	15,93	7,63	T-	20	-5,48	5,35	B
6	15,93	12,63	g6	21	-7,18	12,63	g14
7	15,93	15,80	DC-/W	22	-7,18	15,80	B-
8	8,23	9,45		23	-8,08	-14,60	
9	8,23	12,63	g4	24	-8,08	-9,80	DC+
10	8,23	15,80	DC-/V	25	-15,03	-15,80	rect+
11	7,73	-14,60	g3	26	-15,03	-9,80	L3
12	7,73	-9,80	V	27	-15,03	0	L2
13	7,73	-5,00		28	-15,03	9,80	L1
14	0,53	9,45		29	-15,03	15,80	rect-
15	0,53	12,63	g2				

all values in mm



Pinout and Dimensions



Pinout

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

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