



SEMITRANS®3

IGBT4 Modules

SKM400GAR12E4

Features

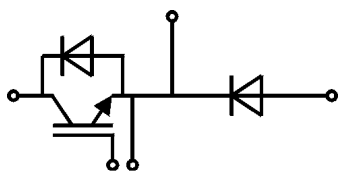
- IGBT4 = 4. Generation (Trench)IGBT
- VCEsat with positive temperature coefficient
- High short circuit capability, self limiting to $6 \times I_{C\text{NOM}}$
- Soft switching 4. Generation CAL diode (CAL4)

Typical Applications

- DC/DC – converter
- Brake chopper
- Switched reluctance motor
- DC – motor

Remarks

- Case temperature limited to $T_c = 125^\circ\text{C}$ max, recomm.
 $T_{\text{op}} = -40 \dots +150^\circ\text{C}$, product rel. results valid for $T_j = 150^\circ$



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Absolute Maximum Ratings				
Symbol	Conditions		Values	Unit
IGBT				
V_{CES}			1200	V
I_{C}	$T_j = 175^\circ\text{C}$	$T_c = 25^\circ\text{C}$	618	A
		$T_c = 80^\circ\text{C}$	475	A
I_{Cnom}			400	A
I_{CRM}	$I_{\text{CRM}} = 3 \times I_{\text{Cnom}}$		1200	A
V_{GES}			-20 ... 20	V
t_{psc}	$V_{\text{CC}} = 800\text{ V}$ $V_{\text{GE}} \leq 15\text{ V}$ $V_{\text{CES}} \leq 1200\text{ V}$	$T_j = 150^\circ\text{C}$	10	μs
T_j			-40 ... 175	$^\circ\text{C}$
Inverse diode				
I_{F}	$T_j = 175^\circ\text{C}$	$T_c = 25^\circ\text{C}$	440	A
		$T_c = 80^\circ\text{C}$	329	A
I_{Fnom}			400	A
I_{FRM}	$I_{\text{FRM}} = 3 \times I_{\text{Fnom}}$		1200	A
I_{FSM}	$t_p = 10\text{ ms, sin } 180^\circ, T_j = 25^\circ\text{C}$		1980	A
T_j			-40 ... 175	$^\circ\text{C}$
Freewheeling diode				
I_{F}	$T_j = 175^\circ\text{C}$	$T_c = 25^\circ\text{C}$	440	A
		$T_c = 80^\circ\text{C}$	329	A
I_{Fnom}			400	A
I_{FRM}	$I_{\text{FRM}} = 3 \times I_{\text{Fnom}}$		1200	A
I_{FSM}	$t_p = 10\text{ ms, sin } 180^\circ, T_j = 25^\circ\text{C}$		1980	A
T_j			-40 ... 175	$^\circ\text{C}$
Module				
$I_{\text{t(RMS)}}$			500	A
T_{stg}			-40 ... 125	$^\circ\text{C}$
V_{isol}	AC sinus 50Hz, $t = 1\text{ min}$		4000	V

Characteristics						
Symbol	Conditions		min.	typ.	max.	Unit
IGBT						
$V_{\text{CE(sat)}}$	$I_{\text{C}} = 400\text{ A}$ $V_{\text{GE}} = 15\text{ V}$ chipevel	$T_j = 25^\circ\text{C}$	1.8	2.05		V
		$T_j = 150^\circ\text{C}$	2.2	2.4		V
V_{CE0}		$T_j = 25^\circ\text{C}$	0.8	0.9		V
		$T_j = 150^\circ\text{C}$	0.7	0.8		V
r_{CE}	$V_{\text{GE}} = 15\text{ V}$	$T_j = 25^\circ\text{C}$	2.5	2.9		$\text{m}\Omega$
		$T_j = 150^\circ\text{C}$	3.8	4.0		$\text{m}\Omega$
$V_{\text{GE(th)}}$	$V_{\text{GE}} = V_{\text{CE}}, I_{\text{C}} = 15.2\text{ mA}$		5	5.8	6.5	V
I_{CES}	$V_{\text{GE}} = 0\text{ V}$ $V_{\text{CE}} = 1200\text{ V}$	$T_j = 25^\circ\text{C}$	0.1	0.3		mA
		$T_j = 150^\circ\text{C}$				mA
C_{ies}	$V_{\text{CE}} = 25\text{ V}$ $V_{\text{GE}} = 0\text{ V}$	$f = 1\text{ MHz}$		24.6		nF
C_{oes}		$f = 1\text{ MHz}$		1.62		nF
C_{res}		$f = 1\text{ MHz}$		1.38		nF
Q_{G}	$V_{\text{GE}} = -8\text{ V} \dots +15\text{ V}$			2260		nC
R_{Gint}	$T_j = 25^\circ\text{C}$			1.9		Ω



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- Soft switching 4. Generation CAL diode (CAL4)

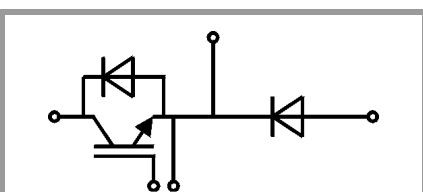
Typical Applications

- DC/DC – converter
- Brake chopper
- Switched reluctance motor
- DC – motor

Remarks

- Case temperature limited to $T_c = 125^\circ\text{C}$ max, recomm.
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Characteristics						
Symbol	Conditions		min.	typ.	max.	Unit
$t_{d(on)}$	$V_{CC} = 600\text{ V}$	$T_j = 150^\circ\text{C}$		242		ns
t_r	$I_c = 400\text{ A}$	$T_j = 150^\circ\text{C}$		47		ns
E_{on}	$V_{GE} = \pm 15\text{ V}$	$T_j = 150^\circ\text{C}$		33		mJ
$t_{d(off)}$	$R_{G\ on} = 1\ \Omega$	$T_j = 150^\circ\text{C}$		580		ns
t_f	$R_{G\ off} = 1\ \Omega$	$T_j = 150^\circ\text{C}$		101		ns
E_{off}	$di/dt_{on} = 9700\text{ A}/\mu\text{s}$	$T_j = 150^\circ\text{C}$		56		mJ
$R_{th(j-c)}$	per IGBT				0.072	K/W
Inverse diode						
$V_F = V_{EC}$	$I_F = 400\text{ A}$	$T_j = 25^\circ\text{C}$		2.2	2.52	V
	$V_{GE} = 0\text{ V}$ chip	$T_j = 150^\circ\text{C}$		2.15	2.47	V
V_{F0}		$T_j = 25^\circ\text{C}$		1.3	1.5	V
		$T_j = 150^\circ\text{C}$		0.9	1.1	V
r_F		$T_j = 25^\circ\text{C}$		2.3	2.5	m Ω
		$T_j = 150^\circ\text{C}$		3.1	3.4	m Ω
I_{RRM}	$I_F = 400\text{ A}$	$T_j = 150^\circ\text{C}$		450		A
Q_{rr}	$di/dt_{off} = 8800\text{ A}/\mu\text{s}$	$T_j = 150^\circ\text{C}$		68		μC
E_{rr}	$V_{GE} = \pm 15\text{ V}$ $V_{CC} = 600\text{ V}$	$T_j = 150^\circ\text{C}$		30.5		mJ
$R_{th(j-c)}$	per diode				0.14	K/W
Freewheeling diode						
$V_F = V_{EC}$	$I_F = 400\text{ A}$	$T_j = 25^\circ\text{C}$		2.2	2.52	V
	$V_{GE} = 0\text{ V}$ chip	$T_j = 150^\circ\text{C}$		2.15	2.47	V
V_{F0}		$T_j = 25^\circ\text{C}$		1.3	1.5	V
		$T_j = 150^\circ\text{C}$		0.9	1.1	V
r_F		$T_j = 25^\circ\text{C}$		2.3	2.5	m Ω
		$T_j = 150^\circ\text{C}$		3.1	3.4	m Ω
I_{RRM}	$I_F = 400\text{ A}$	$T_j = 150^\circ\text{C}$		450		A
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E_{rr}	$V_{GE} = \pm 15\text{ V}$ $V_{CC} = 600\text{ V}$	$T_j = 150^\circ\text{C}$		30.5		mJ
$R_{th(j-c)}$	per Diode				0.14	K/W
Module						
L_{CE}				15	20	nH
$R_{CC+EE'}$	terminal-chip	$T_c = 25^\circ\text{C}$		0.25		m Ω
		$T_c = 125^\circ\text{C}$		0.5		m Ω
$R_{th(c-s)}$	per module			0.02	0.038	K/W
M_s	to heat sink M6			3	5	Nm
M_t		to terminals M6		2.5	5	Nm
						Nm
w					325	g



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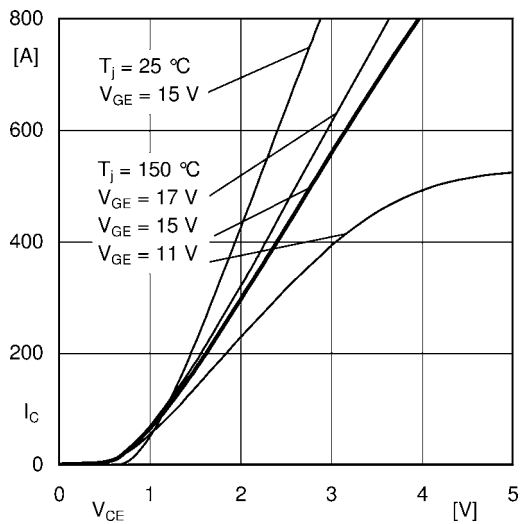


Fig. 1: Typ. output characteristic, inclusive $R_{CC'+EE'}$

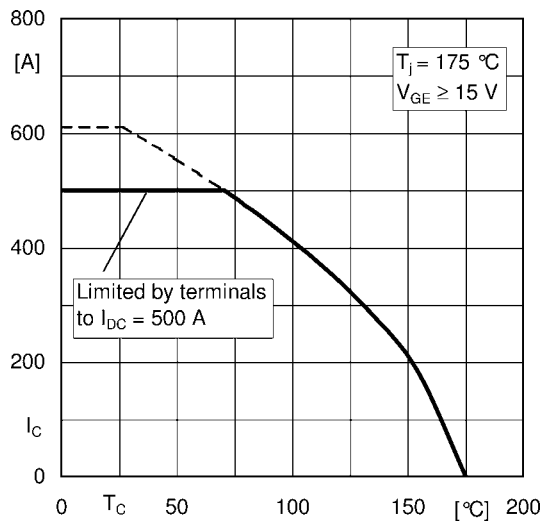


Fig. 2: Rated current vs. temperature $I_C = f(T_C)$

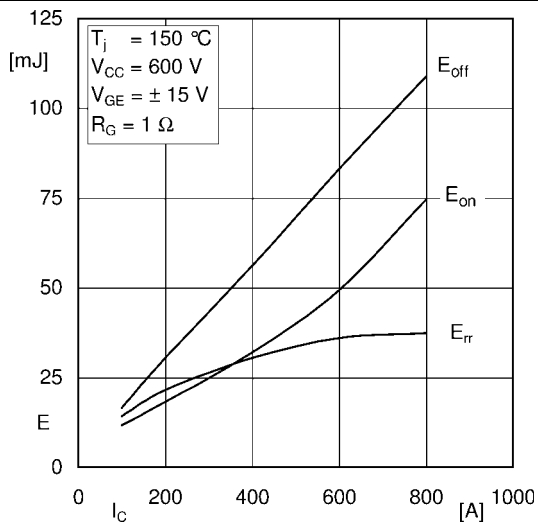


Fig. 3: Typ. turn-on /-off energy = $f(I_C)$

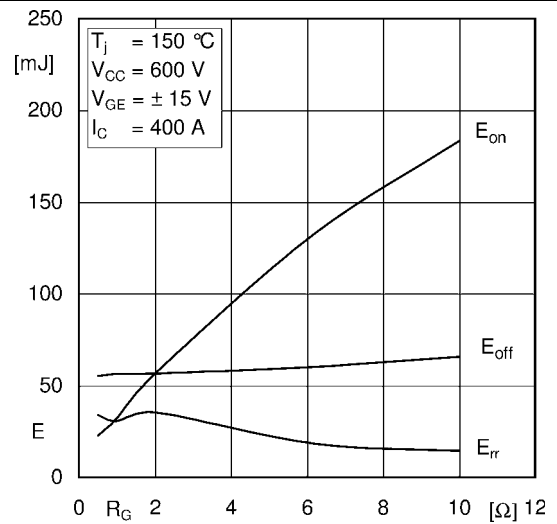


Fig. 4: Typ. turn-on /-off energy = $f(R_G)$

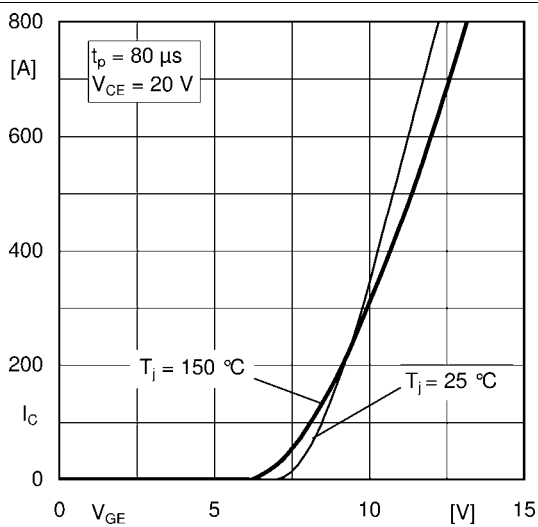


Fig. 5: Typ. transfer characteristic

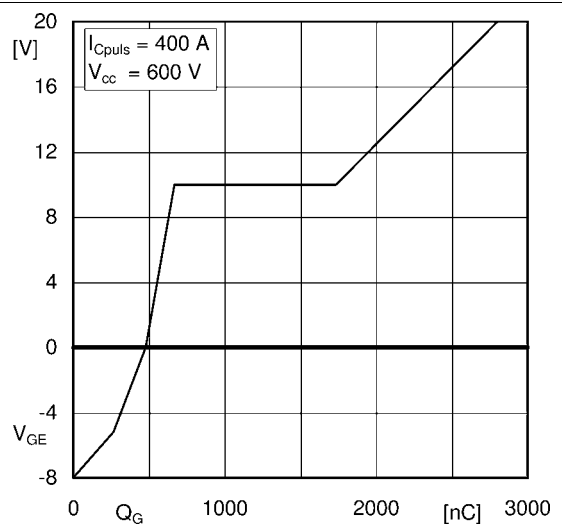


Fig. 6: Typ. gate charge characteristic

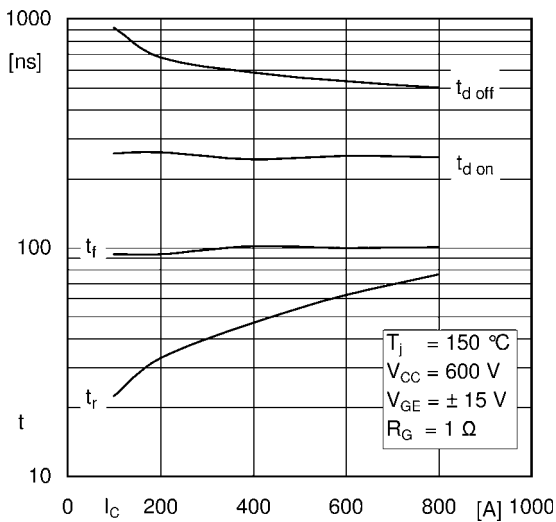


Fig. 7: Typ. switching times vs. I_C

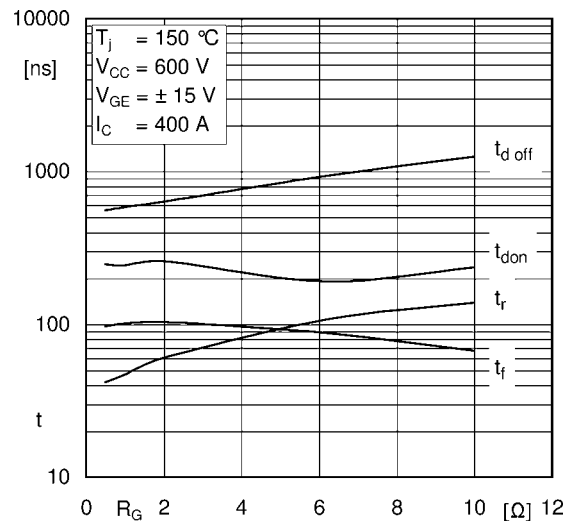


Fig. 8: Typ. switching times vs. gate resistor R_G

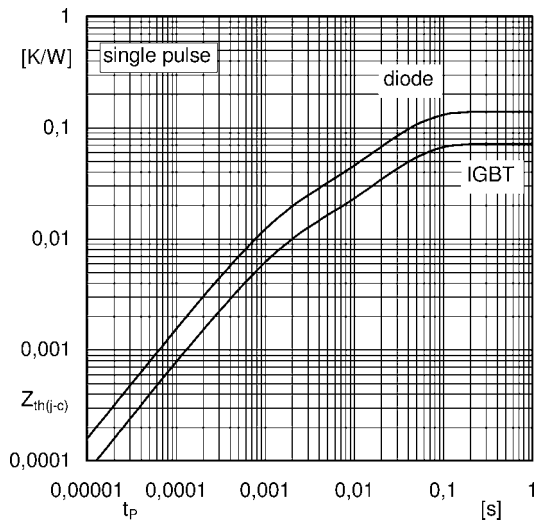


Fig. 9: Transient thermal impedance

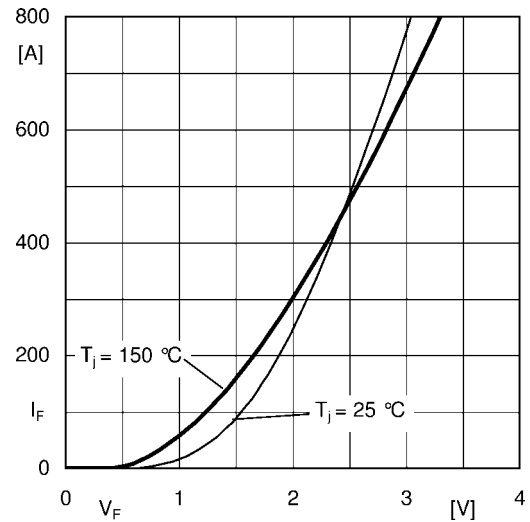


Fig. 10: CAL diode forward characteristic

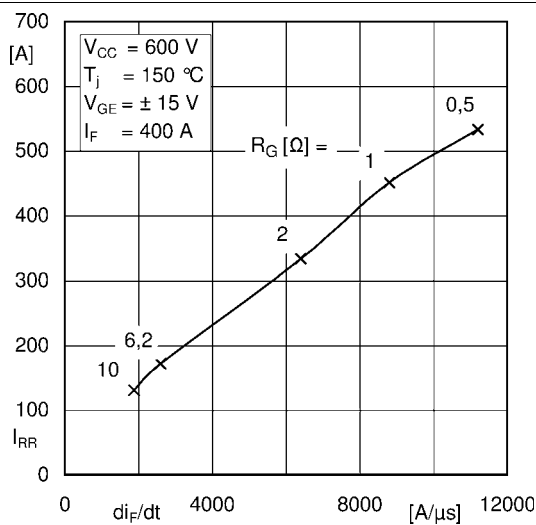


Fig. 11: CAL diode peak reverse recovery current

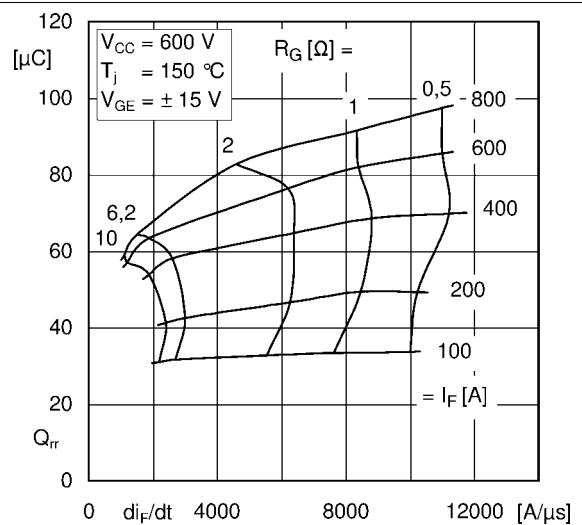
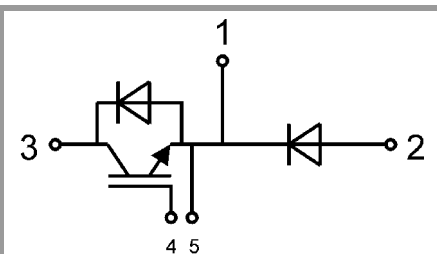


Fig. 12: Typ. CAL diode peak reverse recovery charge



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This is an electrostatic discharge sensitive device (ESDS), international standard IEC 60747-1, Chapter IX.

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