



SEMITRANS®3

Fast IGBT4 Modules

SKM400GAR12T4

Features

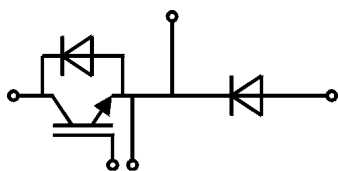
- $V_{CE(sat)}$ with positive temperature coefficient
- High short circuit capability, self limiting to 6 x I_{Cnom}
- Fast & soft inverse CAL diodes
- Large clearance (10 mm) and creepage distances (20 mm)
- Isolated copper baseplate using DBC Technology (Direct Copper Bonding)

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.
 $T_{op} = -40 \dots +150^\circ\text{C}$, 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	$T_j = 175^\circ\text{C}$	$T_c = 25^\circ\text{C}$ $T_c = 80^\circ\text{C}$	A A
I_{Cnom}		400	A
I_{CRM}	$I_{CRM} = 3 \times I_{Cnom}$	1200	A
V_{GES}		-20 ... 20	V
t_{psc}	$V_{CC} = 800\text{ V}$ $V_{GE} \leq 15\text{ V}$ $V_{CES} \leq 1200\text{ V}$	$T_j = 150^\circ\text{C}$	μs
T_j		-40 ... 175	$^\circ\text{C}$
Inverse diode			
I_F	$T_j = 175^\circ\text{C}$	$T_c = 25^\circ\text{C}$ $T_c = 80^\circ\text{C}$	A A
I_{Fnom}		400	A
I_{FRM}	$I_{FRM} = 3 \times I_{Fnom}$	1200	A
I_{FSM}	$t_p = 10\text{ ms}$, sin 180°, $T_j = 25^\circ\text{C}$	1980	A
T_j		-40 ... 175	$^\circ\text{C}$
Freewheeling diode			
I_F	$T_j = 175^\circ\text{C}$	$T_c = 25^\circ\text{C}$ $T_c = 80^\circ\text{C}$	A A
I_{Fnom}		400	A
I_{FRM}	$I_{FRM} = 3 \times I_{Fnom}$	1200	A
I_{FSM}	$t_p = 10\text{ ms}$, sin 180°, $T_j = 25^\circ\text{C}$	1980	A
T_j		-40 ... 175	$^\circ\text{C}$
Module			
$I_{t(RMS)}$		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					
$V_{CE(sat)}$	$I_C = 400\text{ A}$ $V_{GE} = 15\text{ V}$ chipelevel	$T_j = 25^\circ\text{C}$ $T_j = 150^\circ\text{C}$	1.8 2.2	2.05 2.4	V V
V_{CE0}		$T_j = 25^\circ\text{C}$ $T_j = 150^\circ\text{C}$	0.8 0.7	0.9 0.8	V V
r_{CE}	$V_{GE} = 15\text{ V}$	$T_j = 25^\circ\text{C}$ $T_j = 150^\circ\text{C}$	2.5 3.8	2.9 4.0	m Ω m Ω
$V_{GE(th)}$	$V_{GE} = V_{CE}$, $I_C = 15.2\text{ mA}$	5	5.8	6.5	V
I_{CES}	$V_{GE} = 0\text{ V}$ $V_{CE} = 1200\text{ V}$	$T_j = 25^\circ\text{C}$ $T_j = 150^\circ\text{C}$	0.1	0.3	mA mA
C_{ies}	$V_{CE} = 25\text{ V}$ $V_{GE} = 0\text{ V}$	$f = 1\text{ MHz}$	24.6		nF
C_{oes}		$f = 1\text{ MHz}$	1.62		nF
C_{res}		$f = 1\text{ MHz}$	1.38		nF
Q_G	$V_{GE} = -8\text{ V} \dots +15\text{ V}$		2260		nC
R_{Gint}	$T_j = 25^\circ\text{C}$		1.9		Ω



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- Isolated copper baseplate using DBC Technology (Direct Copper Bonding)

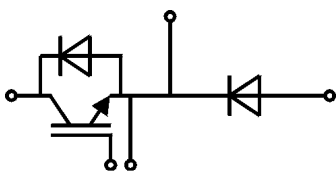
Typical Applications

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

Remarks

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

Characteristics					
Symbol	Conditions		min.	typ.	max. Unit
$t_{d(on)}$	$V_{CC} = 600 \text{ V}$	$T_j = 150^\circ\text{C}$		220	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
$t_{d(off)}$	$R_{G on} = 1 \Omega$	$T_j = 150^\circ\text{C}$		505	ns
t_f	$R_{G off} = 1 \Omega$	$T_j = 150^\circ\text{C}$		78	ns
E_{off}	$di/dt_{on} = 9700 \text{ A}/\mu\text{s}$	$T_j = 150^\circ\text{C}$		42	mJ
$R_{th(j-c)}$	$di/dt_{off} = 4300 \text{ A}/\mu\text{s}$	$T_j = 150^\circ\text{C}$			0.072 K/W
	per IGBT				
Inverse diode					
$V_F = V_{EC}$	$I_F = 400 \text{ A}$	$T_j = 25^\circ\text{C}$		2.2	2.52 V
	$V_{GE} = 0 \text{ V}$	$T_j = 150^\circ\text{C}$		2.15	2.47 V
	chip				
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 mΩ
		$T_j = 150^\circ\text{C}$		3.1	3.4 mΩ
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}	$V_{GE} = \pm 15 \text{ V}$	$T_j = 150^\circ\text{C}$		30.5	mJ
	$V_{CC} = 600 \text{ V}$	$T_j = 150^\circ\text{C}$			
$R_{th(j-c)}$	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
	$V_{GE} = 0 \text{ V}$	$T_j = 150^\circ\text{C}$		2.15	2.47 V
	chip				
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 mΩ
		$T_j = 150^\circ\text{C}$		3.1	3.4 mΩ
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}	$V_{GE} = \pm 15 \text{ V}$	$T_j = 150^\circ\text{C}$		30.5	mJ
	$V_{CC} = 600 \text{ V}$	$T_j = 150^\circ\text{C}$			
$R_{th(j-c)}$	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	mΩ
		$T_c = 125^\circ\text{C}$		0.5	mΩ
$R_{th(c-s)}$	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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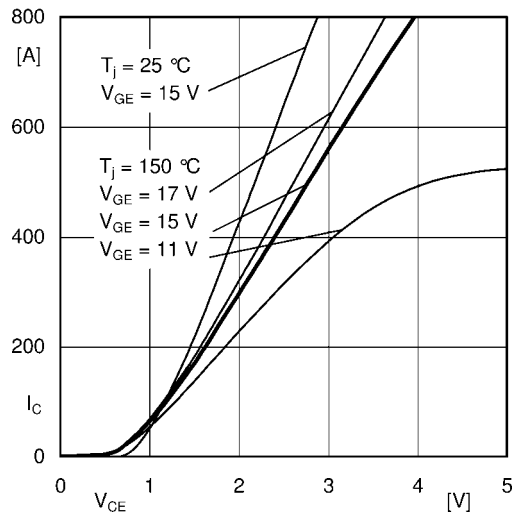


Fig. 1: Typ. output characteristic, inclusive $R_{CC'} + E_{E'}$

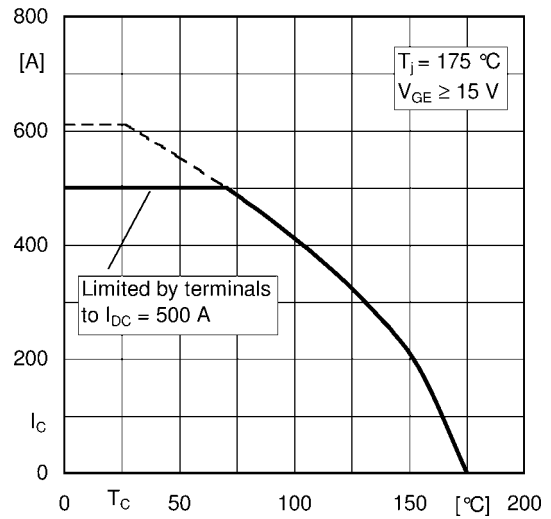


Fig. 2: Rated current vs. temperature $I_C = f(T_C)$

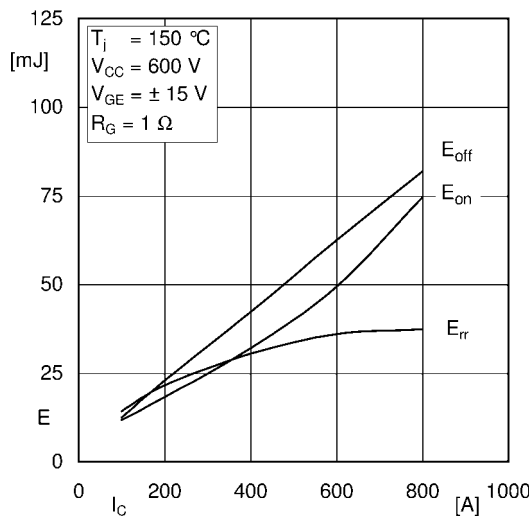


Fig. 3: Typ. turn-on /-off energy = $f(I_C)$

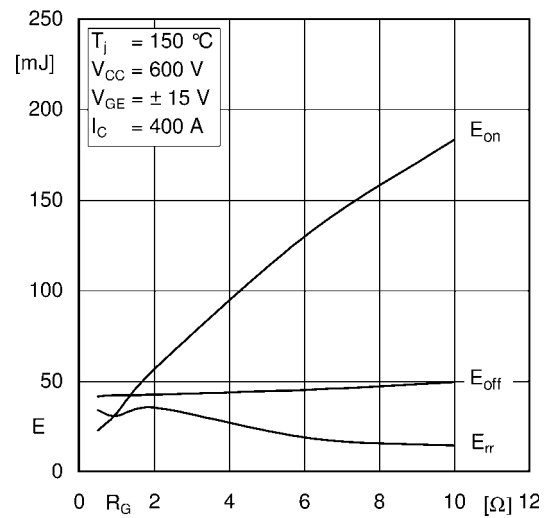


Fig. 4: Typ. turn-on /-off energy = $f(R_G)$

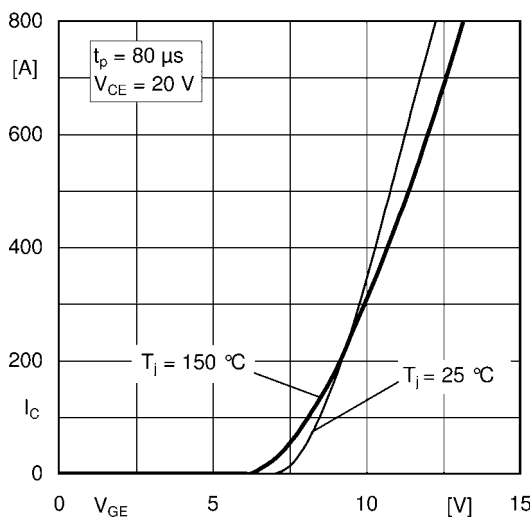


Fig. 5: Typ. transfer characteristic

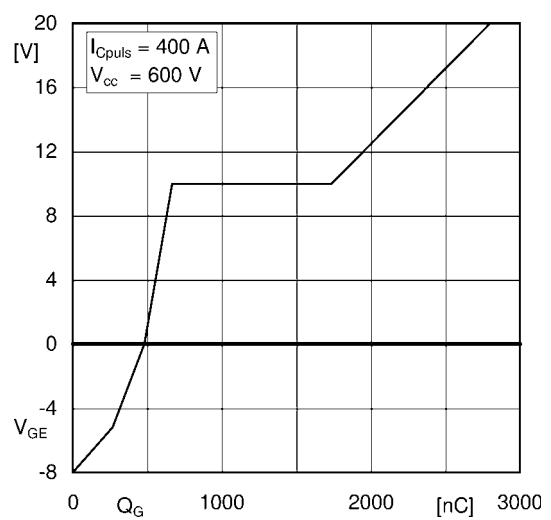


Fig. 6: Typ. gate charge characteristic

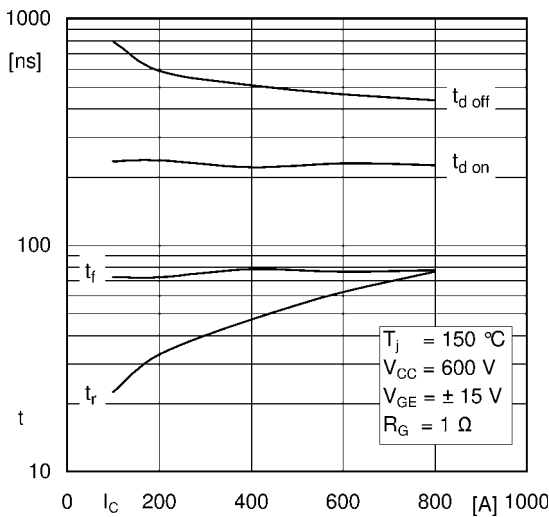


Fig. 7: Typ. switching times vs. I_C

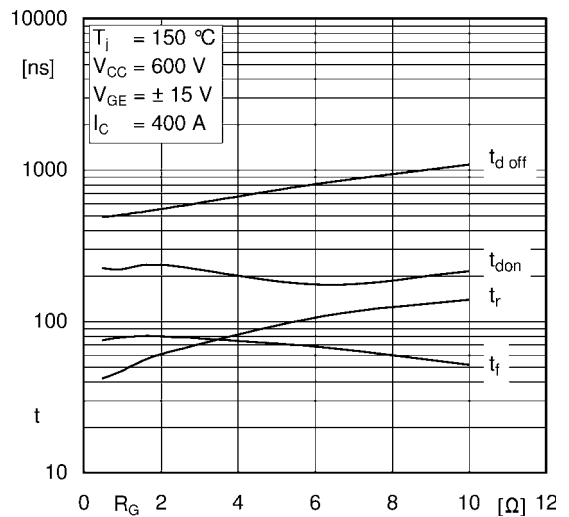


Fig. 8: Typ. switching times vs. gate resistor R_G

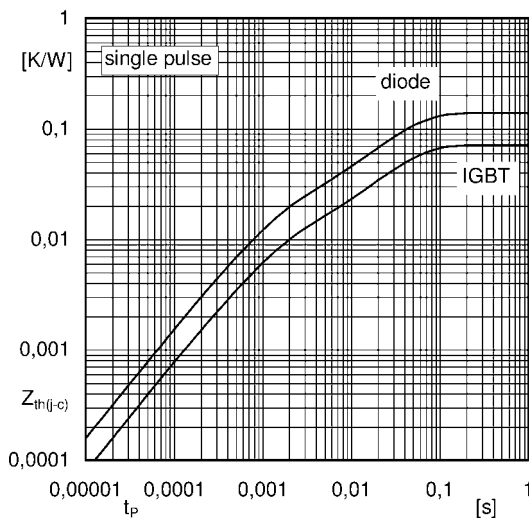


Fig. 9: Transient thermal impedance

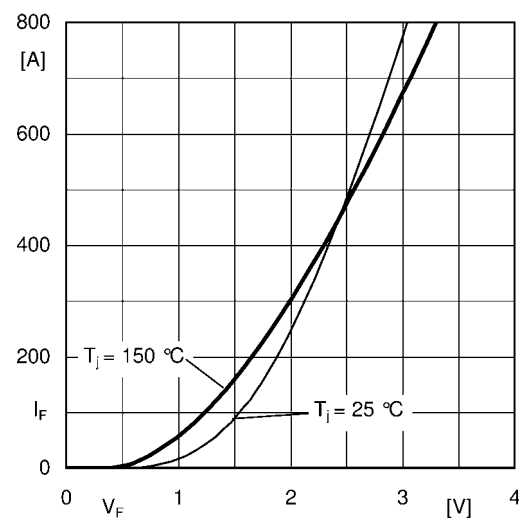


Fig. 10: CAL diode forward characteristic

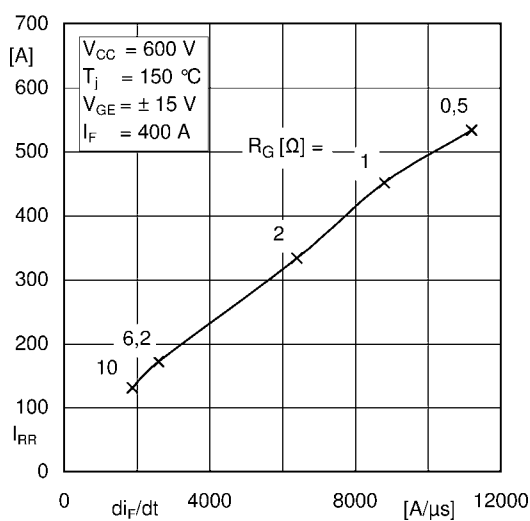


Fig. 11: CAL diode peak reverse recovery current

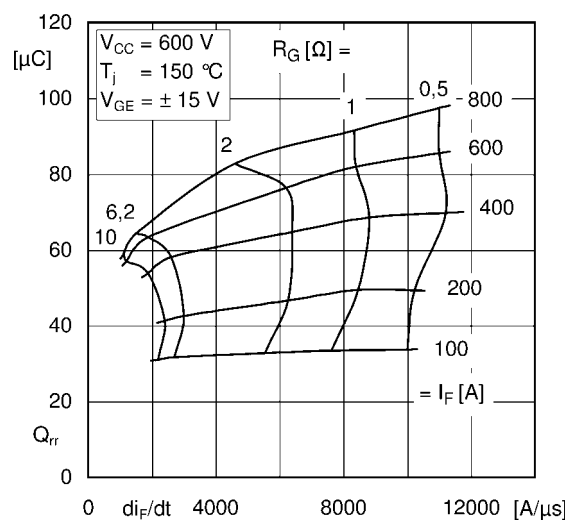
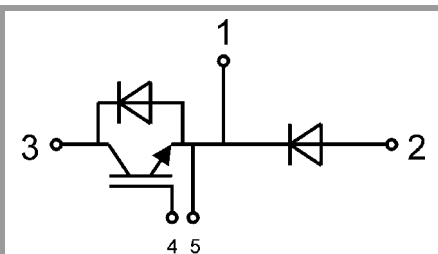


Fig. 12: Typ. CAL diode peak reverse recovery charge



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

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