

# SKM400GAL12T4



SEMITRANS®3

## Fast IGBT4 Modules

SKM400GAL12T4

### Features

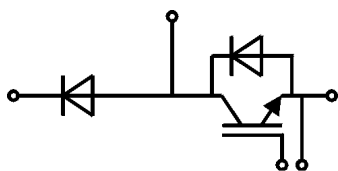
- $V_{CE(sat)}$  with positive temperature coefficient
- High short circuit capability, self limiting to 6 x  $I_{Cnom}$
- Fast & soft inverse CAL diodes
- Large clearance (10 mm) and creepage distances (20 mm)
- Isolated copper baseplate using DBC Technology (Direct Copper Bonding)

### 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	
<b>IGBT</b>					
$V_{CES}$			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	
$I_{CRM}$	$I_{CRM} = 3 \times I_{Cnom}$		1200	A	
$V_{GES}$			-20 ... 20	V	
$t_{psc}$	$V_{CC} = 800\text{ V}$ $V_{GE} \leq 15\text{ V}$ $V_{CES} \leq 1200\text{ V}$	$T_j = 150^\circ\text{C}$	10		$\mu\text{s}$
$T_j$			-40 ... 175	$^\circ\text{C}$	
<b>Inverse diode</b>					
$I_F$	$T_j = 175^\circ\text{C}$	$T_c = 25^\circ\text{C}$	440	A	
		$T_c = 80^\circ\text{C}$	329	A	
$I_{Fnom}$			400	A	
$I_{FRM}$	$I_{FRM} = 3 \times I_{Fnom}$		1200	A	
$I_{FSM}$	$t_p = 10\text{ ms, sin } 180^\circ, T_j = 25^\circ\text{C}$		1980	A	
$T_j$			-40 ... 175	$^\circ\text{C}$	
<b>Freewheeling diode</b>					
$I_F$	$T_j = 175^\circ\text{C}$	$T_c = 25^\circ\text{C}$	440	A	
		$T_c = 80^\circ\text{C}$	329	A	
$I_{Fnom}$			400	A	
$I_{FRM}$	$I_{FRM} = 3 \times I_{Fnom}$		1200	A	
$I_{FSM}$	$t_p = 10\text{ ms, sin } 180^\circ, T_j = 25^\circ\text{C}$		1980	A	
$T_j$			-40 ... 175	$^\circ\text{C}$	
<b>Module</b>					
$I_{t(RMS)}$			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
<b>IGBT</b>						
$V_{CE(sat)}$	$I_C = 400\text{ A}$ $V_{GE} = 15\text{ V}$ 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
$r_{CE}$	$V_{GE} = 15\text{ V}$	$T_j = 25^\circ\text{C}$	2.5	2.9		$\text{m}\Omega$
		$T_j = 150^\circ\text{C}$	3.8	4.0		$\text{m}\Omega$
$V_{GE(th)}$	$V_{GE} = V_{CE}, I_C = 15.2\text{ mA}$		5	5.8	6.5	V
$I_{CES}$	$V_{GE} = 0\text{ V}$ $V_{CE} = 1200\text{ V}$	$T_j = 25^\circ\text{C}$	0.1	0.3		mA
		$T_j = 150^\circ\text{C}$				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			$\Omega$



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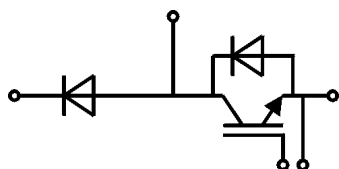
### Typical Applications

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### Remarks

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Characteristics						
Symbol	Conditions		min.	typ.	max.	Unit
$t_{d(on)}$	$V_{CC} = 600\text{ V}$	$T_j = 150^\circ\text{C}$		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
	$di/dt_{off} = 4300\text{ A}/\mu\text{s}$	$T_j = 150^\circ\text{C}$				
$R_{th(j-c)}$	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
	$V_{GE} = 0\text{ V}$	$T_j = 150^\circ\text{C}$		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	m $\Omega$
		$T_j = 150^\circ\text{C}$		3.1	3.4	m $\Omega$
$I_{RRM}$	$I_F = 400\text{ A}$	$T_j = 150^\circ\text{C}$		450		A
$Q_{rr}$	$di/dt_{off} = 8800\text{ A}/\mu\text{s}$	$T_j = 150^\circ\text{C}$		68		$\mu\text{C}$
$E_{rr}$	$V_{GE} = \pm 15\text{ V}$	$T_j = 150^\circ\text{C}$		30.5		mJ
	$V_{CC} = 600\text{ V}$					
$R_{th(j-c)}$	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	m $\Omega$
		$T_j = 150^\circ\text{C}$		3.1	3.4	m $\Omega$
$I_{RRM}$	$I_F = 400\text{ A}$	$T_j = 150^\circ\text{C}$		450		A
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$E_{rr}$	$V_{GE} = \pm 15\text{ V}$	$T_j = 150^\circ\text{C}$		30.5		mJ
	$V_{CC} = 600\text{ V}$					
$R_{th(j-c)}$	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 $\Omega$
		$T_c = 125^\circ\text{C}$		0.5		m $\Omega$
$R_{th(c-s)}$	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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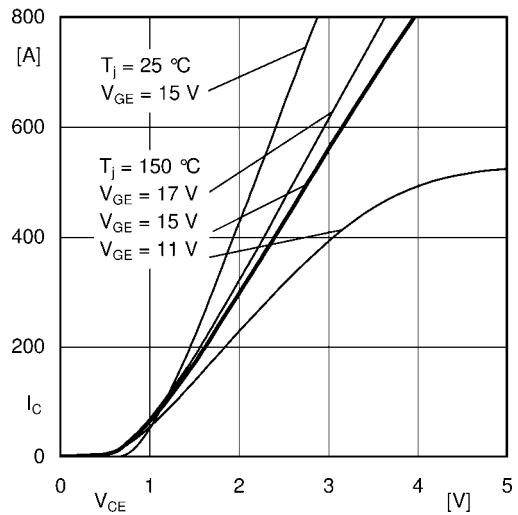


Fig. 1: Typ. output characteristic, inclusive  $R_{CC'+EE'}$

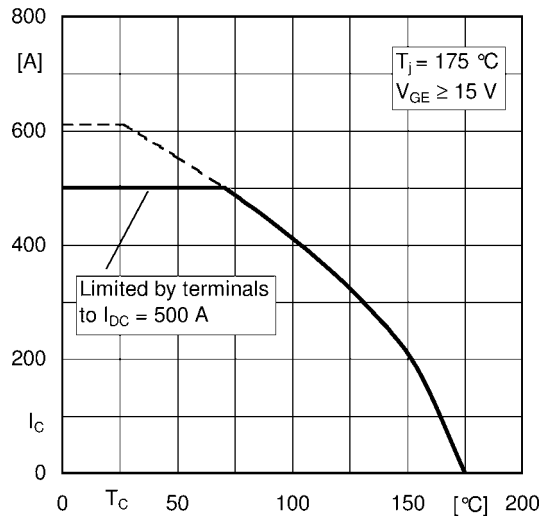


Fig. 2: Rated current vs. temperature  $I_C = f(T_C)$

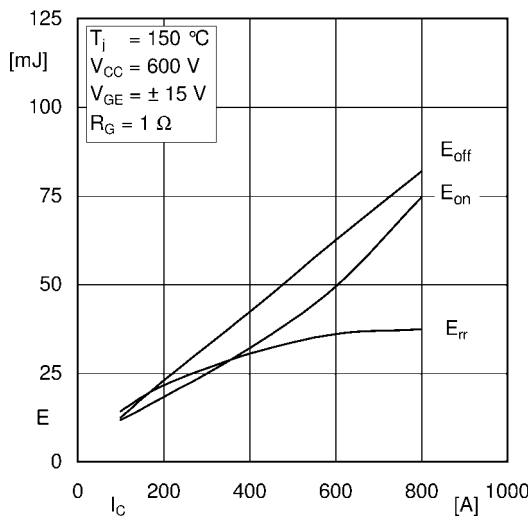


Fig. 3: Typ. turn-on /-off energy =  $f(I_C)$

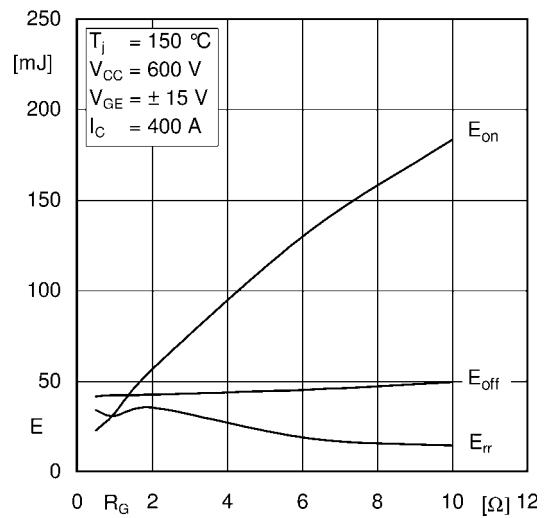


Fig. 4: Typ. turn-on /-off energy =  $f(R_G)$

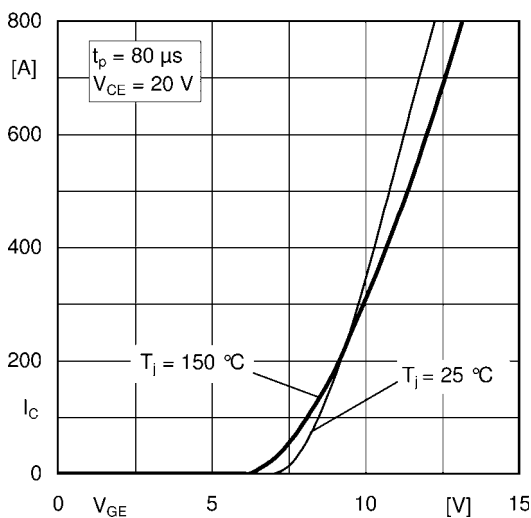


Fig. 5: Typ. transfer characteristic

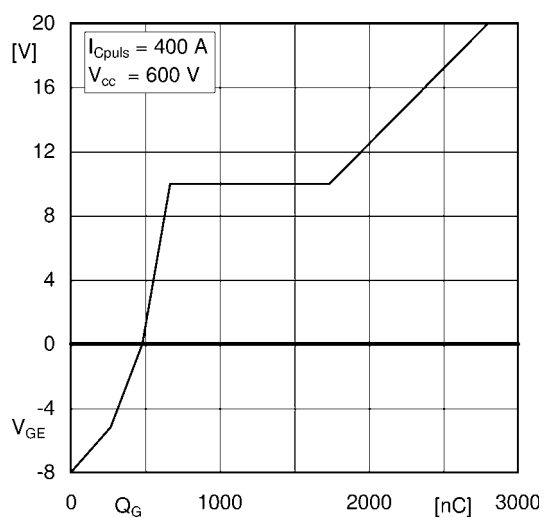


Fig. 6: Typ. gate charge characteristic

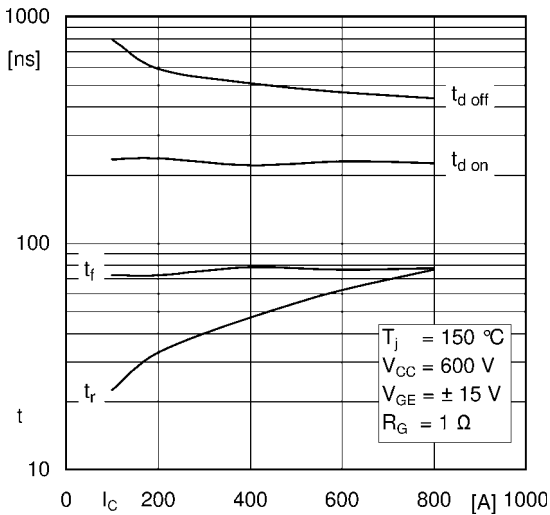


Fig. 7: Typ. switching times vs.  $I_C$

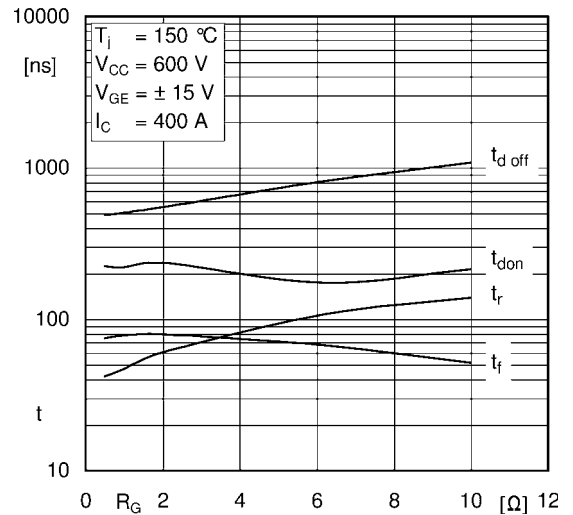


Fig. 8: Typ. switching times vs. gate resistor  $R_G$

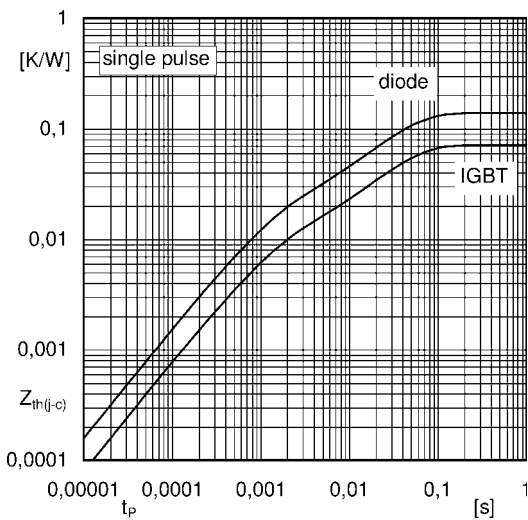


Fig. 9: Transient thermal impedance

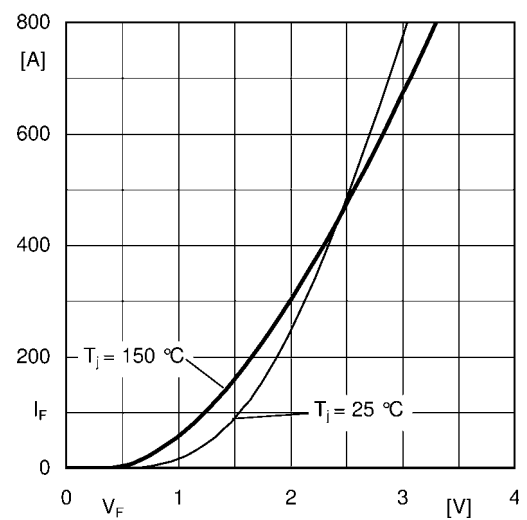


Fig. 10: CAL diode forward characteristic

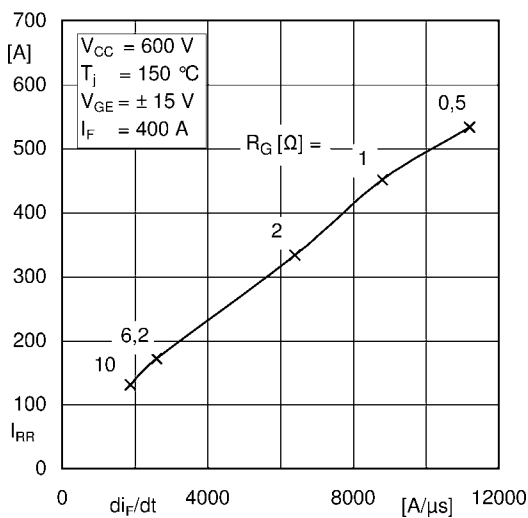


Fig. 11: CAL diode peak reverse recovery current

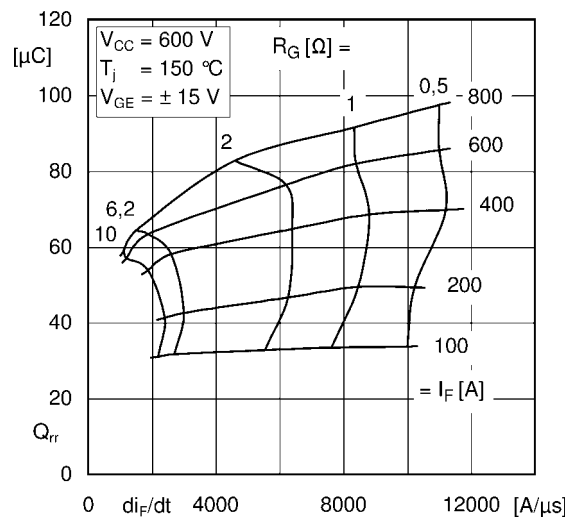
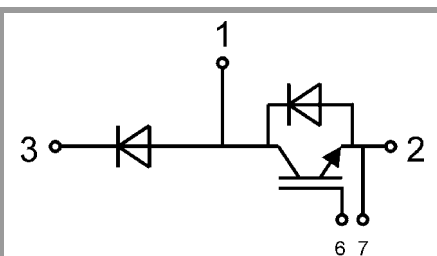


Fig. 12: Typ. CAL diode peak reverse recovery charge



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

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