



SEMiX® 3p shunt

## Trench IGBT Modules

### SEMiX603GB12E4Ip

#### Features

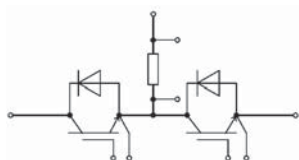
- Homogeneous Si
- Trench = Trenchgate technology
- $V_{CE(sat)}$  with positive temperature coefficient
- High short circuit capability
- Press-fit pins as auxiliary contacts
- Thermally optimized ceramic
- Current sensing shunt resistor
- UL recognized, file no. E63532

#### Typical Applications\*

- AC inverter drives
- UPS
- Renewable energy systems

#### Remarks

- Product reliability results are valid for  $T_j = 150^\circ\text{C}$
- $V_{isol}$  between temperature sensor and power section is only 2500V
- For storage and case temperature with TIM see document "TP(\*) SEMiX 3p"



GB + shunt

Absolute Maximum Ratings						
Symbol	Conditions		Values			Unit
IGBT						
V <sub>CES</sub>	T <sub>j</sub> = 25 °C		1200			V
I <sub>C</sub>	T <sub>j</sub> = 175 °C	T <sub>c</sub> = 25 °C	1110			A
		T <sub>c</sub> = 80 °C	853			A
I <sub>Cnom</sub>			600			A
I <sub>CRM</sub>	I <sub>CRM</sub> = 3xI <sub>Cnom</sub>		1800			A
V <sub>GES</sub>			-20 ... 20			V
t <sub>psc</sub>	V <sub>CC</sub> = 800 V V <sub>GE</sub> ≤ 15 V V <sub>CES</sub> ≤ 1200 V	T <sub>j</sub> = 150 °C	10			μs
T <sub>j</sub>			-40 ... 175			°C
Inverse diode						
V <sub>RRM</sub>	T <sub>j</sub> = 25 °C		1200			V
I <sub>F</sub>	T <sub>j</sub> = 175 °C	T <sub>c</sub> = 25 °C	856			A
		T <sub>c</sub> = 80 °C	640			A
I <sub>Fnom</sub>			600			A
I <sub>FRM</sub>	I <sub>FRM</sub> = 3xI <sub>Fnom</sub>		1800			A
I <sub>FSM</sub>	t <sub>p</sub> = 10 ms, sin 180°, T <sub>j</sub> = 25 °C		3456			A
T <sub>j</sub>			-40 ... 175			°C
Module						
I <sub>t(RMS)</sub>			407			A
T <sub>stg</sub>	module without TIM		-40 ... 125			°C
V <sub>isol</sub>	AC sinus 50Hz, t = 1 min		4000			V
Characteristics						
Symbol	Conditions		min.	typ.	max.	Unit
IGBT						
V <sub>CE(sat)</sub>	I <sub>C</sub> = 600 A V <sub>GE</sub> = 15 V chipelevel	T <sub>j</sub> = 25 °C		1.80	2.05	V
		T <sub>j</sub> = 150 °C		2.03	2.30	V
V <sub>CE0</sub>	chipelevel	T <sub>j</sub> = 25 °C		0.87	1.01	V
		T <sub>j</sub> = 150 °C		0.77	0.90	V
r <sub>CE</sub>	V <sub>GE</sub> = 15 V chipelevel	T <sub>j</sub> = 25 °C		1.55	1.73	mΩ
		T <sub>j</sub> = 150 °C		2.1	2.3	mΩ
V <sub>GE(th)</sub>	V <sub>GE</sub> =V <sub>CE</sub> , I <sub>C</sub> = 22.2 mA		5.3	5.8	6.3	V
I <sub>CES</sub>	V <sub>GE</sub> = 0 V, V <sub>CE</sub> = 1200 V, T <sub>j</sub> = 25 °C				5	mA
C <sub>ies</sub>	V <sub>CE</sub> = 25 V V <sub>GE</sub> = 0 V	f = 1 MHz		37.5		nF
C <sub>oes</sub>		f = 1 MHz		2.31		nF
C <sub>res</sub>		f = 1 MHz		2.04		nF
Q <sub>G</sub>	V <sub>GE</sub> = - 8 V...+ 15 V			3450		nC
R <sub>Gint</sub>	T <sub>j</sub> = 25 °C			1.2		Ω
t <sub>d(on)</sub>	V <sub>CC</sub> = 600 V I <sub>C</sub> = 600 A V <sub>GE</sub> = +15/-15 V	T <sub>j</sub> = 150 °C		260		ns
t <sub>r</sub>		T <sub>j</sub> = 150 °C		85		ns
E <sub>on</sub>	R <sub>G on</sub> = 1.5 Ω R <sub>G off</sub> = 1.5 Ω	T <sub>j</sub> = 150 °C		63		mJ
t <sub>d(off)</sub>		T <sub>j</sub> = 150 °C		560		ns
t <sub>f</sub>	di/dt <sub>on</sub> = 6800 A/μs di/dt <sub>off</sub> = 3700 A/μs	T <sub>j</sub> = 150 °C		145		ns
E <sub>off</sub>	du/dt = 3400 V/μs L <sub>s</sub> = 21 nH	T <sub>j</sub> = 150 °C		80		mJ
R <sub>th(j-c)</sub>	per IGBT				0.037	K/W
R <sub>th(c-s)</sub>	per IGBT (λ <sub>grease</sub> =0.81 W/(m²K))			0.035		K/W
R <sub>th(c-s)</sub>	per IGBT, pre-applied phase change material			0.025		K/W



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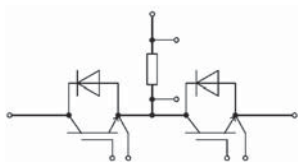
- AC inverter drives
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#### Remarks

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Characteristics						
Symbol	Conditions		min.	typ.	max.	Unit
Inverse diode						
V <sub>F</sub> = V <sub>EC</sub>	I <sub>F</sub> = 600 A	T <sub>j</sub> = 25 °C		2.08	2.44	V
	V <sub>GE</sub> = 0 V chiplevel	T <sub>j</sub> = 150 °C		2.08	2.34	V
V <sub>F0</sub>	chiplevel	T <sub>j</sub> = 25 °C		1.39	1.59	V
		T <sub>j</sub> = 150 °C		1.08	1.18	V
r <sub>F</sub>	chiplevel	T <sub>j</sub> = 25 °C		1.16	1.42	mΩ
		T <sub>j</sub> = 150 °C		1.67	1.93	mΩ
I <sub>RRM</sub>	I <sub>F</sub> = 600 A	T <sub>j</sub> = 150 °C		465		A
Q <sub>rr</sub>	di/dt <sub>off</sub> = 6500 A/μs	T <sub>j</sub> = 150 °C		108		μC
E <sub>rr</sub>	V <sub>GE</sub> = -15 V	T <sub>j</sub> = 150 °C		40		mJ
	V <sub>CC</sub> = 600 V					
R <sub>th(j-c)</sub>	per diode				0.065	K/W
R <sub>th(c-s)</sub>	per diode (λ <sub>grease</sub> =0.81 W/(m*K))			0.039		K/W
R <sub>th(c-s)</sub>	per diode, pre-applied phase change material			0.031		K/W
Module						
L <sub>CE</sub>				20		nH
R <sub>CC'+EE'</sub>	measured per switch, shunt excluded	T <sub>C</sub> = 25 °C		1.2		mΩ
		T <sub>C</sub> = 125 °C		1.65		mΩ
R <sub>th(c-s)1</sub>	calculated without thermal coupling			0.009		K/W
R <sub>th(c-s)2</sub>	including thermal coupling, Ts underneath module (λ <sub>grease</sub> =0.81 W/(m*K))			0.015		K/W
R <sub>th(c-s)2</sub>	including thermal coupling, Ts underneath module, pre-applied phase change material			0.011		K/W
M <sub>s</sub>	to heat sink (M5)		3		6	Nm
M <sub>t</sub>		to terminals (M6)	3		6	Nm
						Nm
w					350	g
Temperature Sensor						
R <sub>100</sub>	T <sub>C</sub> =100°C (R <sub>25</sub> =5 kΩ)			493 ± 5%		Ω
B <sub>100/125</sub>	R <sub>(T)</sub> =R <sub>100</sub> exp[B <sub>100/125</sub> (1/T-1/T <sub>100</sub> )]; T[K];			3550 ±2%		K

Characteristics					
Symbol	Conditions	min.	typ.	max.	Unit
Shunt					
I <sub>Shunt</sub>	T <sub>c</sub> = 100 °C, T <sub>Shunt,max</sub> = 170 °C, R <sub>th</sub> = 2.3 K/W			407	A
R <sub>Shunt</sub>	Tolerance = ±5 %		0.19		mΩ
α				75	ppm/K



GB + shunt

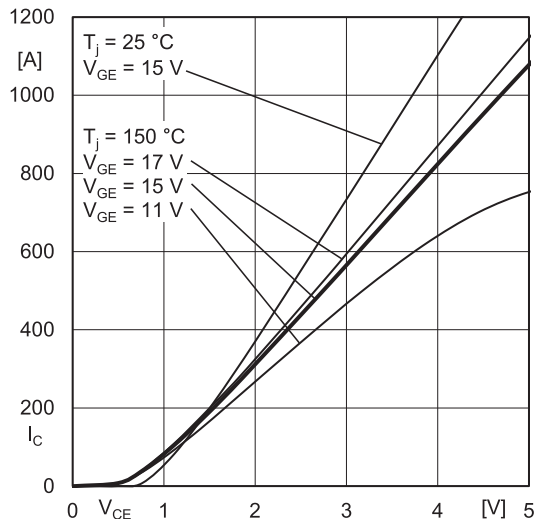


Fig. 1: Typ. output characteristic, inclusive  $R_{CC'+EE'}$

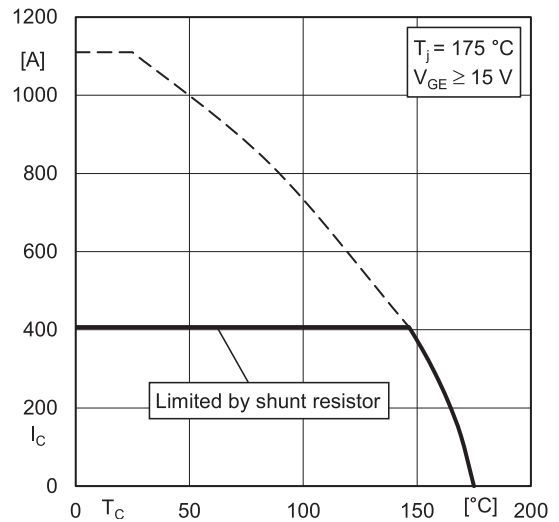


Fig. 2: Rated current vs. temperature  $I_C = f(T_C)$

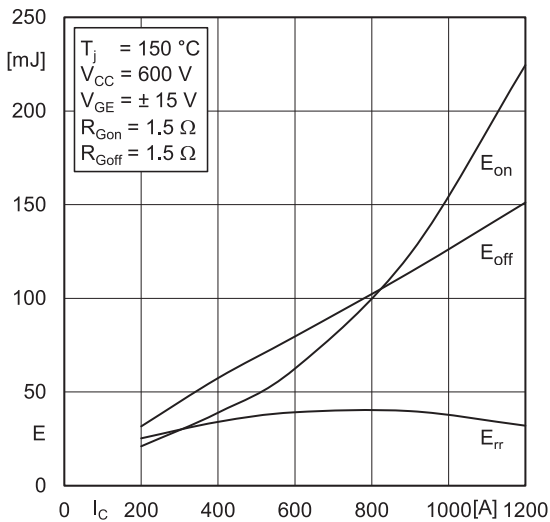


Fig. 3: Typ. turn-on /-off energy =  $f(I_C)$

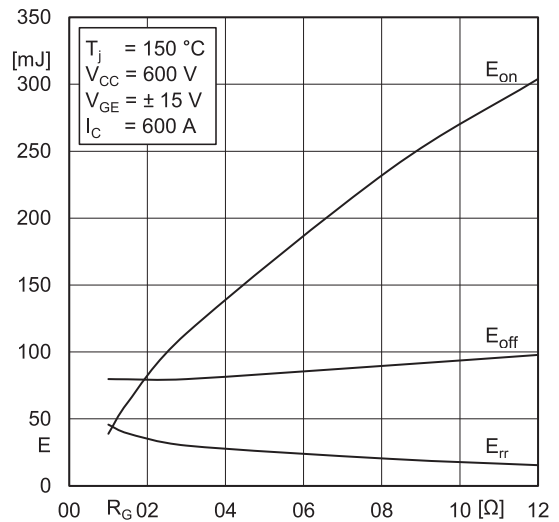


Fig. 4: Typ. turn-on /-off energy =  $f(R_G)$

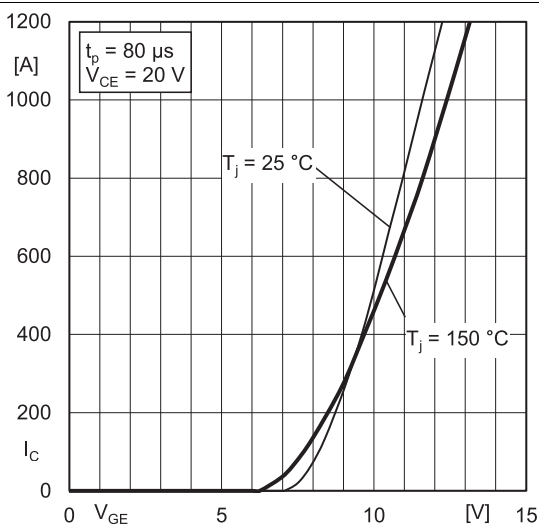


Fig. 5: Typ. transfer characteristic

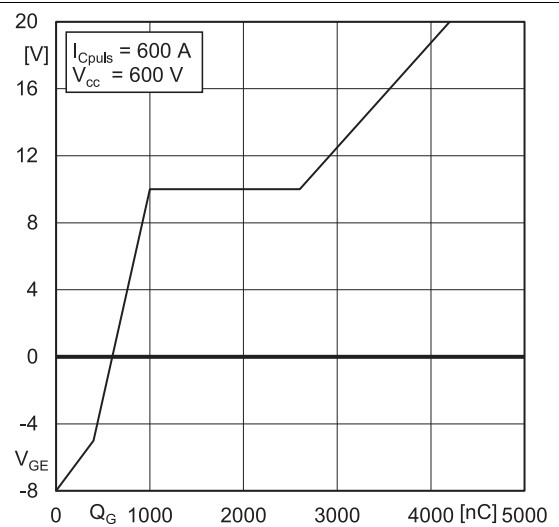


Fig. 6: Typ. gate charge characteristic

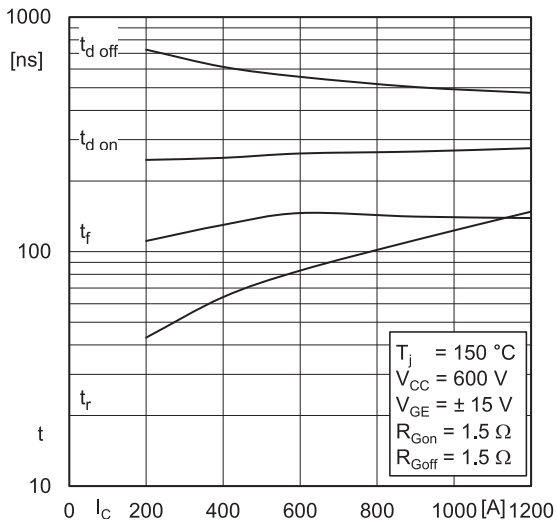


Fig. 7: Typ. switching times vs.  $I_C$

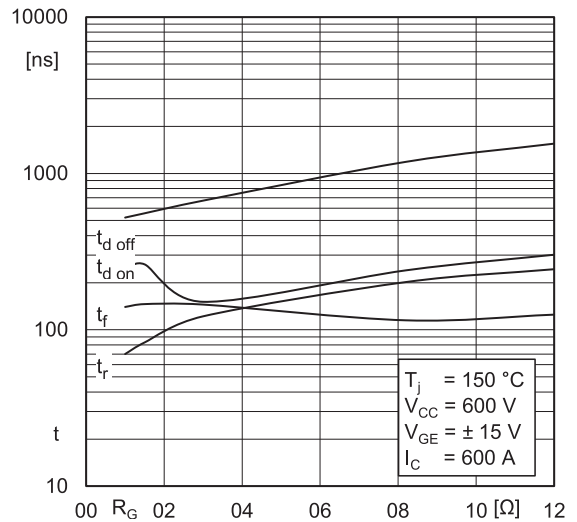


Fig. 8: Typ. switching times vs. gate resistor  $R_G$

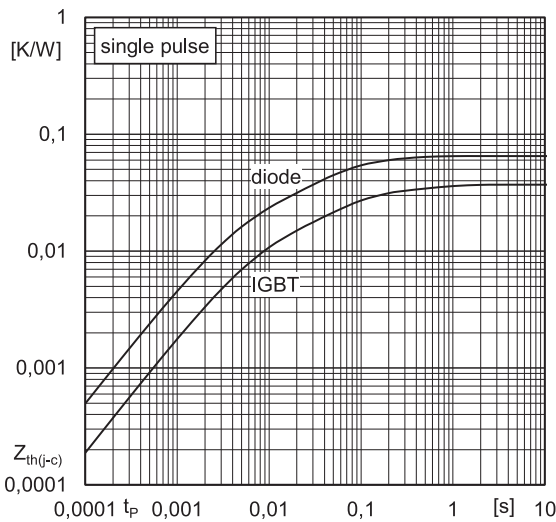


Fig. 9: Transient thermal impedance

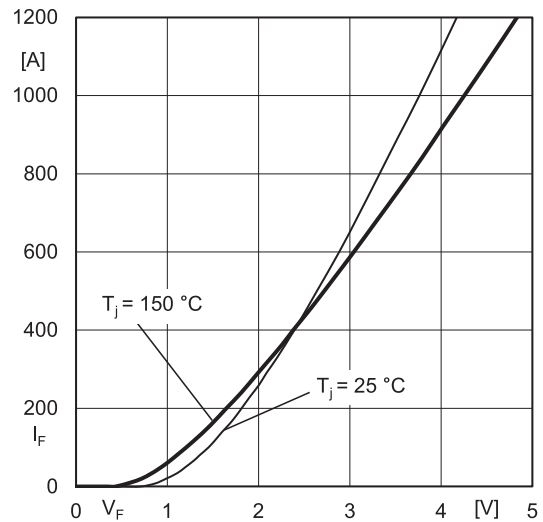


Fig. 10: Typ. CAL diode forward charact., incl.  $R_{CC'+EE'}$

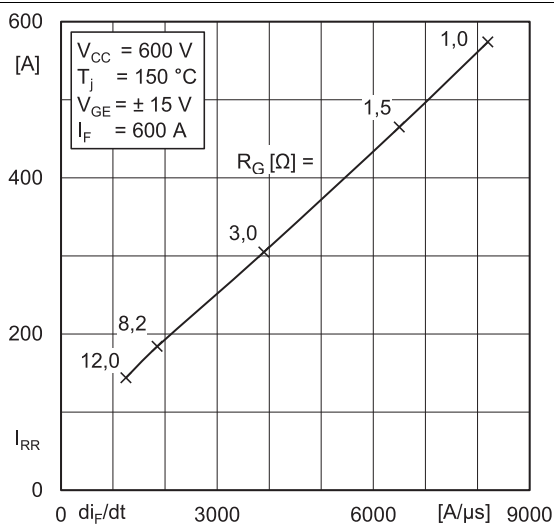


Fig. 11: Typ. CAL diode peak reverse recovery current

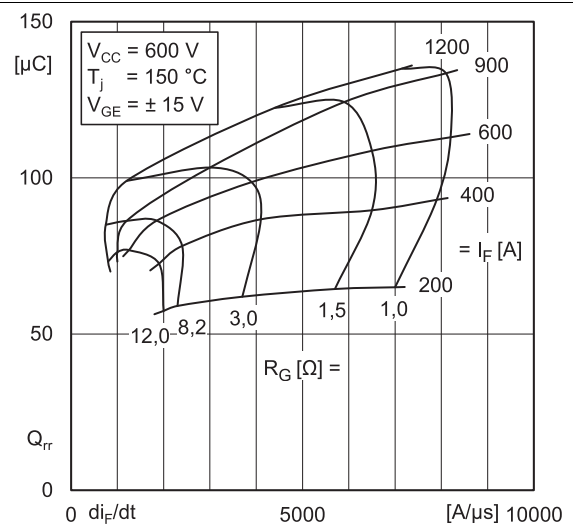


Fig. 12: Typ. CAL diode recovery charge



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

## **\*IMPORTANT INFORMATION AND WARNINGS**

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