



SEMiX® 3p shunt

Trench IGBT Modules

SEMiX453GB12E4I33p

Features*

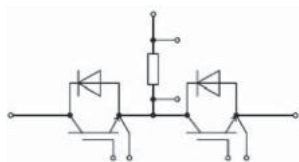
- Homogeneous Si
- Trench = Trenchgate technology
- $V_{CE(sat)}$ with positive temperature coefficient
- High short circuit capability
- Press-fit pins as auxiliary contacts
- Current sensing shunt resistor
- UL recognized, file no. E63532

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 _{CES}	T _j = 25 °C		1200	V
I _C	T _j = 175 °C	T _c = 25 °C	678	A
		T _c = 80 °C	521	A
I _{Cnom}			450	A
I _{CRM}	I _{CRM} = 3 x I _{Cnom}		1350	A
V _{GES}			-20 ... 20	V
t _{psc}	V _{CC} = 800 V V _{GE} ≤ 15 V V _{CES} ≤ 1200 V	T _j = 150 °C	10	μs
T _j			-40 ... 175	°C
Inverse diode				
V _{RRM}	T _j = 25 °C		1200	V
I _F	T _j = 175 °C	T _c = 25 °C	578	A
		T _c = 80 °C	433	A
I _{Fnom}			450	A
I _{FRM}	I _{FRM} = 2xI _{Fnom}		900	A
I _{FSM}	t _p = 10 ms, sin 180°, T _j = 25 °C		2430	A
T _j			-40 ... 175	°C
Module				
I _{t(RMS)}	T _c = 80°C		600	A
T _{stg}	module without TIM		-40 ... 125	°C
V _{isol}	AC sinus 50Hz, t = 1 min		4000	V

Characteristics

Symbol	Conditions	min.	typ.	max.	Unit
IGBT					
$V_{CE(sat)}$	$I_C = 450\text{ A}$ $V_{GE} = 15\text{ V}$ chiplevel	$T_j = 25^\circ\text{C}$	1.80	2.05	V
		$T_j = 150^\circ\text{C}$	2.19	2.40	V
V_{CE0}	chiplevel	$T_j = 25^\circ\text{C}$	0.80	0.90	V
		$T_j = 150^\circ\text{C}$	0.70	0.80	V
r_{CE}	$V_{GE} = 15\text{ V}$ chiplevel	$T_j = 25^\circ\text{C}$	2.2	2.6	$\text{m}\Omega$
		$T_j = 150^\circ\text{C}$	3.3	3.6	$\text{m}\Omega$
$V_{GE(th)}$	$V_{GE} = V_{CE}, I_C = 18\text{ mA}$	5	5.8	6.5	V
I_{CES}	$V_{GE} = 0\text{ V}, V_{CE} = 1200\text{ V}, T_j = 25^\circ\text{C}$			5	mA
C_{ies}	$V_{CE} = 25\text{ V}$ $V_{GE} = 0\text{ V}$	$f = 1\text{ MHz}$	27.9		nF
C_{oes}		$f = 1\text{ MHz}$	1.74		nF
C_{res}		$f = 1\text{ MHz}$	1.53		nF
Q_G	$V_{GE} = -8\text{ V} \dots +15\text{ V}$		2550		nC
R_{Gint}	$T_j = 25^\circ\text{C}$		1.7		Ω
$t_{d(on)}$	$V_{CC} = 600\text{ V}$	$T_j = 150^\circ\text{C}$	195		ns
t_r	$I_C = 450\text{ A}$	$T_j = 150^\circ\text{C}$	67		ns
E_{on}	$V_{GE} = +15/-15\text{ V}$ $R_{G on} = 1.1\text{ }\Omega$	$T_j = 150^\circ\text{C}$	33		mJ
$t_{d(off)}$	$R_{G off} = 1.1\text{ }\Omega$	$T_j = 150^\circ\text{C}$	505		ns
t_f	$di/dt_{on} = 6600\text{ A}/\mu\text{s}$ $di/dt_{off} = 3400\text{ A}/\mu\text{s}$ $dv/dt = 4800\text{ V}/\mu\text{s}$ $L_s = 21\text{ nH}$	$T_j = 150^\circ\text{C}$	110		ns
E_{off}		$T_j = 150^\circ\text{C}$	57		mJ
$R_{th(j-c)}$	per IGBT			0.066	K/W
$R_{th(c-s)}$	per IGBT ($\lambda_{grease} = 0.81\text{ W}/(\text{m}^2\text{K})$)		0.03		K/W
$R_{th(c-s)}$	per IGBT, pre-applied phase change material		0.021		K/W



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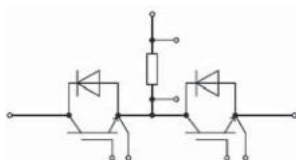
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Remarks

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Characteristics						
Symbol	Conditions		min.	typ.	max.	Unit
Inverse diode						
V _F = V _{EC}	I _F = 450 A	T _j = 25 °C		2.14	2.46	V
	V _{GE} = 0 V chiplevel	T _j = 150 °C		2.07	2.38	V
V _{F0}	chiplevel	T _j = 25 °C		1.30	1.50	V
		T _j = 150 °C		0.90	1.10	V
r _F	chiplevel	T _j = 25 °C		1.87	2.1	mΩ
		T _j = 150 °C		2.6	2.8	mΩ
I _{RRM}	I _F = 450 A	T _j = 150 °C		455		A
Q _{rr}	di/dt _{off} = 6800 A/μs	T _j = 150 °C		85		μC
E _{rr}	V _{GE} = -15 V	T _j = 150 °C		39		mJ
	V _{CC} = 600 V	T _j = 150 °C				
R _{th(j-c)}	per diode				0.1	K/W
R _{th(c-s)}	per diode (λ _{grease} =0.81 W/(m*K))			0.045		K/W
R _{th(c-s)}	per diode, pre-applied phase change material			0.036		K/W
Module						
L _{CE}				20		nH
R _{CC'+EE'}	measured per switch, shunt excluded	T _C = 25 °C		0.95		mΩ
		T _C = 125 °C		1.25		mΩ
R _{th(c-s)1}	calculated without thermal coupling			0.009		K/W
R _{th(c-s)2}	including thermal coupling, Ts underneath module (λ _{grease} =0.81 W/(m*K))			0.014		K/W
R _{th(c-s)2}	including thermal coupling, Ts underneath module, pre-applied phase change material			0.010		K/W
M _s	to heat sink (M5)		3		6	Nm
M _t		to terminals (M6)	3		6	Nm
						Nm
w					350	g
Temperature Sensor						
R ₁₀₀	T _C =100°C (R ₂₅ =5 kΩ)			493 ± 5%		Ω
B _{100/125}	R(T)=R ₁₀₀ exp[B _{100/125} (1/T-1/T ₁₀₀)]; T[K];			3550 ±2%		K

Characteristics					
Symbol	Conditions	min.	typ.	max.	Unit
Shunt					
R _{Shunt}	Tolerance = ±1 %, T _c = 20°C		0.33		mΩ
α				50	ppm/K
T _{Shunt}				170	°C
R _{th(r-c)}				2.5	K/W
P _{Shunt}	T _c = 80 °C			36	W



GB + shunt

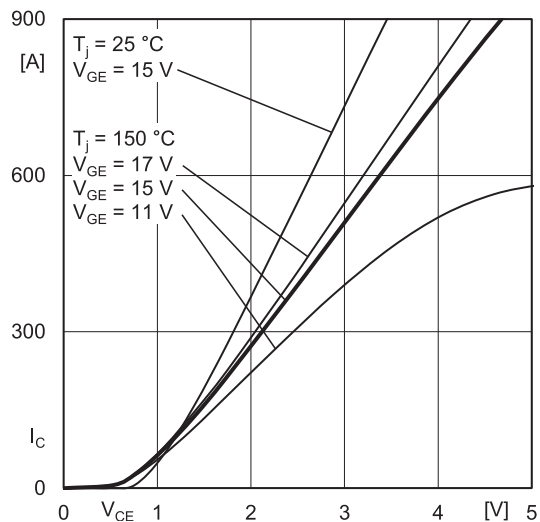
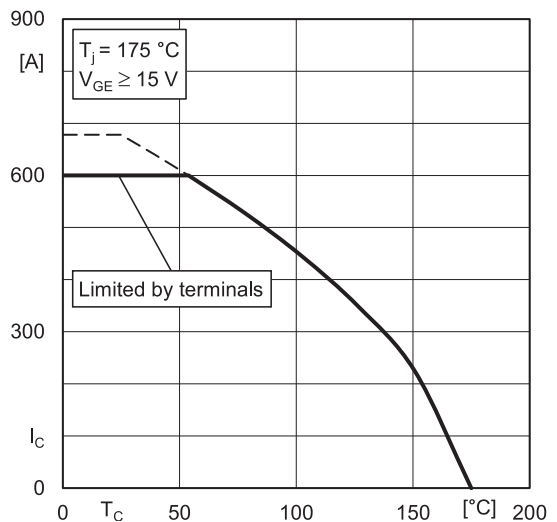
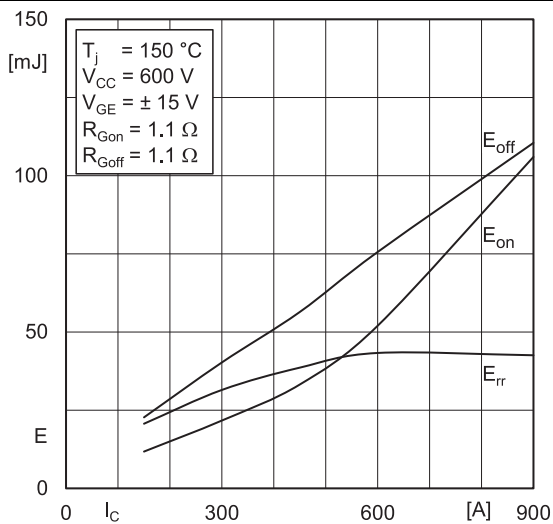
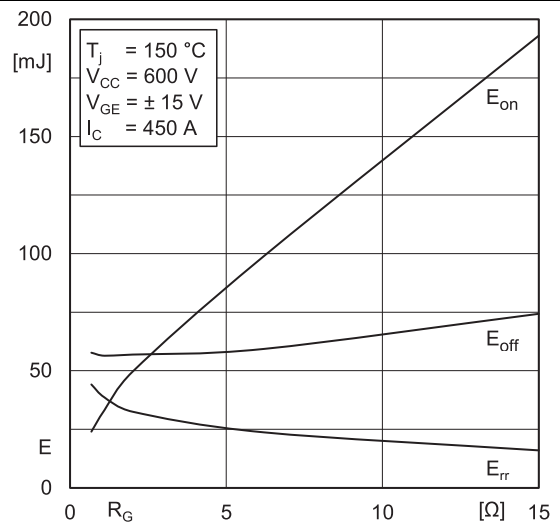
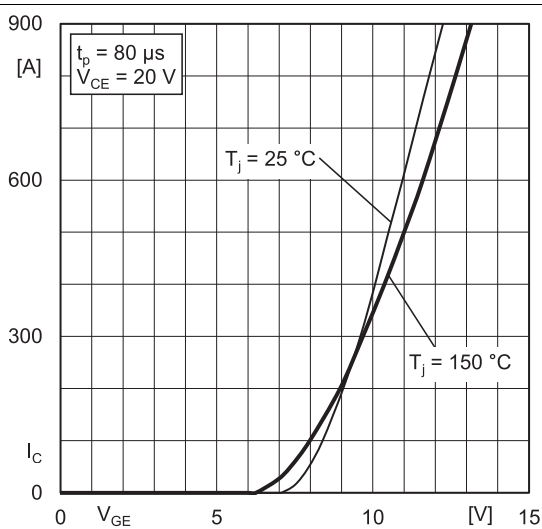
Fig. 1: Typ. output characteristic, inclusive $R_{CC'} + E_{E'}$ Fig. 2: Rated current vs. temperature $I_C = f(T_C)$ Fig. 3: Typ. turn-on /-off energy = $f(I_C)$ Fig. 4: Typ. turn-on /-off energy = $f(R_G)$ 

Fig. 5: Typ. transfer characteristic

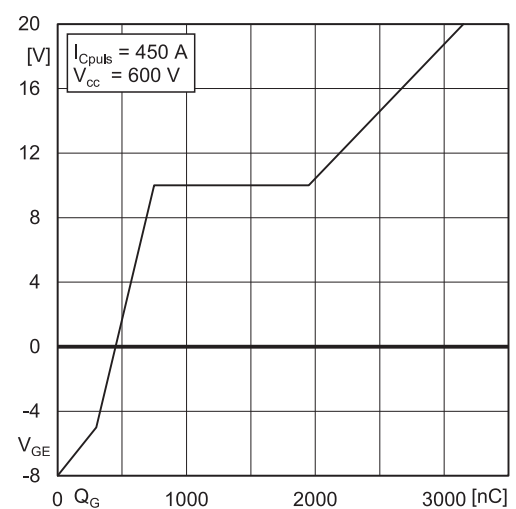


Fig. 6: Typ. gate charge characteristic

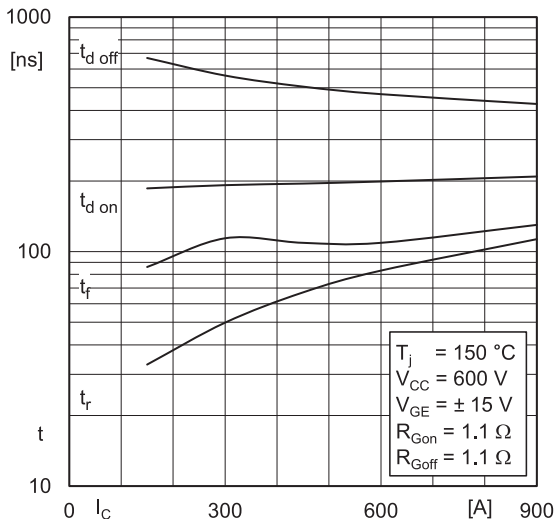


Fig. 7: Typ. switching times vs. I_C

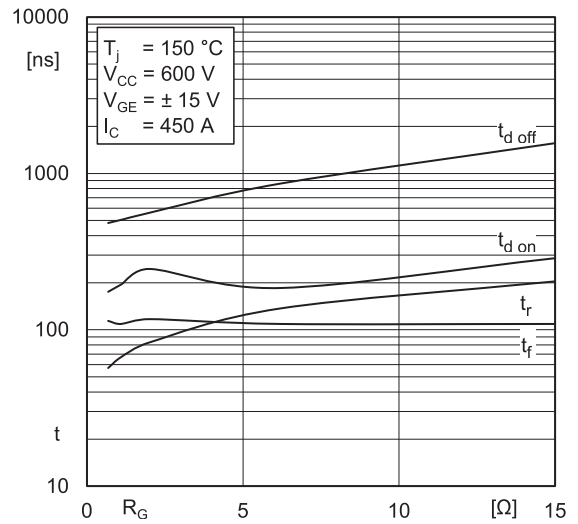


Fig. 8: Typ. switching times vs. gate resistor R_G

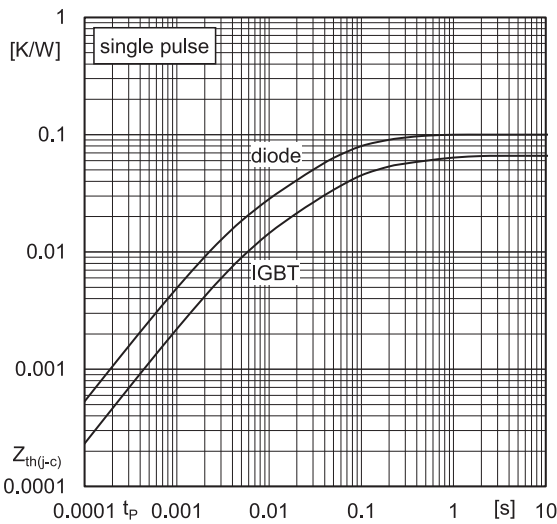


Fig. 9: Transient thermal impedance

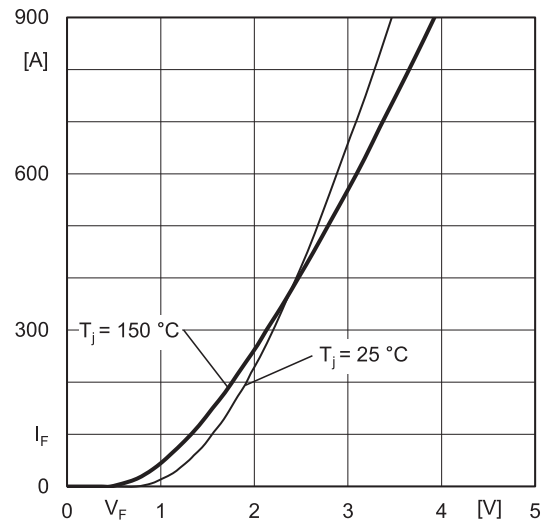


Fig. 10: Typ. CAL diode forward charact., incl. $R_{CC'} + EE'$

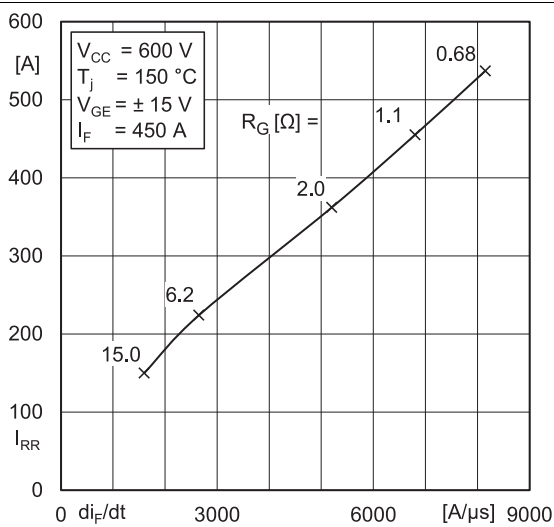


Fig. 11: Typ. CAL diode peak reverse recovery current

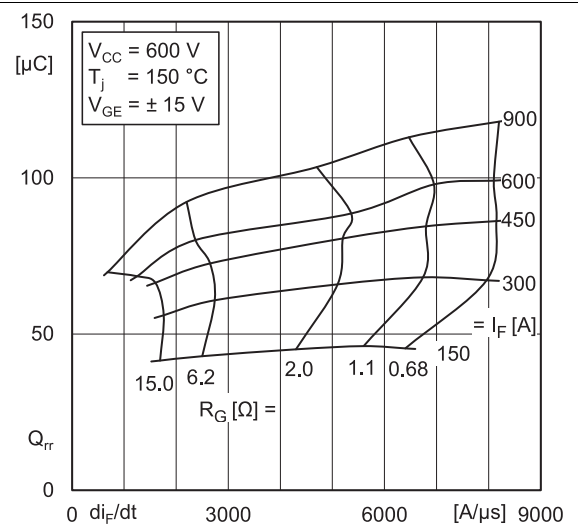


Fig. 12: Typ. CAL diode recovery charge

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

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