

SEMiX405TMLI12E4B



SEMiX® 5

3-Level TNPC IGBT-Module

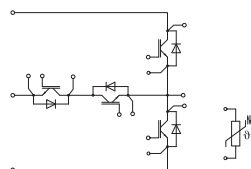
SEMiX405TMLI12E4B

Features*

- Solderless assembling solution with PressFIT signal pins and screw power terminals
- IGBT 4 Trench Gate Technology
- $V_{CE(sat)}$ with positive temperature coefficient
- Low inductance case
- Reliable mechanical design with injection moulded terminals and reliable internal connections
- UL recognized file no. E63532
- NTC temperature sensor inside

Remarks*

- Case temperature limited to $T_c=125^\circ\text{C}$ max
- Product reliability results are valid for $T_{jop}=150^\circ\text{C}$
- IGBT1: outer IGBTs T1 & T4
- IGBT2: inner IGBTs T2 & T3
- Diode1: outer diodes D1 & D4
- Diode2: inner diodes D2 & D3
- For storage and case temperature with TIM see document "TP(HALA P8) SEMiX 5p"



TMLI

Absolute Maximum Ratings				
Symbol	Conditions	Values	Unit	
IGBT1				
V_{CES}	$T_j = 25^\circ\text{C}$	1200	V	
I_C	$T_j = 175^\circ\text{C}$	$T_c = 25^\circ\text{C}$	636	A
		$T_c = 80^\circ\text{C}$	490	A
I_{Cnom}		400	A	
I_{CRM}		1200	A	
V_{GES}		-20 ... 20	V	
t_{psc}	$V_{CC} = 800\text{ V}, V_{GE} \leq 15\text{ V}, T_j = 150^\circ\text{C}, V_{CES} \leq 1200\text{ V}$	10	μs	
T_j		-40 ... 175	$^\circ\text{C}$	
IGBT2				
V_{CES}	$T_j = 25^\circ\text{C}$	650	V	
I_C	$T_j = 175^\circ\text{C}$	$T_c = 25^\circ\text{C}$	452	A
		$T_c = 80^\circ\text{C}$	339	A
I_{Cnom}		400	A	
I_{CRM}		1200	A	
V_{GES}		-20 ... 20	V	
t_{psc}	$V_{CC} = 360\text{ V}, V_{GE} \leq 15\text{ V}, T_j = 150^\circ\text{C}, V_{CES} \leq 650\text{ V}$	10	μs	
T_j		-40 ... 175	$^\circ\text{C}$	
Diode1				
V_{RRM}	$T_j = 25^\circ\text{C}$	1200	V	
I_F	$T_j = 175^\circ\text{C}$	$T_c = 25^\circ\text{C}$	461	A
		$T_c = 80^\circ\text{C}$	345	A
I_{FRM}		800	A	
I_{FSM}	10 ms, sin 180°, $T_j = 25^\circ\text{C}$	1980	A	
T_j		-40 ... 175	$^\circ\text{C}$	
Diode2				
V_{RRM}	$T_j = 25^\circ\text{C}$	650	V	
I_F	$T_j = 175^\circ\text{C}$	$T_c = 25^\circ\text{C}$	466	A
		$T_c = 80^\circ\text{C}$	338	A
I_{FRM}		800	A	
I_{FSM}	10 ms, sin 180°, $T_j = 25^\circ\text{C}$	2646	A	
T_j		-40 ... 175	$^\circ\text{C}$	
Module				
$I_{l(RMS)}$		450	A	
T_{stg}	module without TIM	-40 ... 125	$^\circ\text{C}$	
V_{isol}	AC sinus 50Hz, t = 1 min	4000	V	



SEMiX® 5

3-Level TNPC IGBT-Module

SEMiX405TMLI12E4B

Features*

- Solderless assembling solution with PressFIT signal pins and screw power terminals
- IGBT 4 Trench Gate Technology
- $V_{CE(sat)}$ with positive temperature coefficient
- Low inductance case
- Reliable mechanical design with injection moulded terminals and reliable internal connections
- UL recognized file no. E63532
- NTC temperature sensor inside

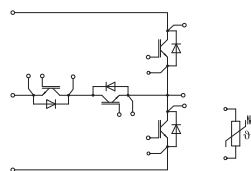
Typical Applications

- UPS
- Solar
- Motor drives

Remarks

- Case temperature limited to $T_C=125^\circ\text{C}$ max
- Product reliability results are valid for $T_{jop}=150^\circ\text{C}$
- IGBT1: outer IGBTs T1 & T4
- IGBT2: inner IGBTs T2 & T3
- Diode1: outer diodes D1 & D4
- Diode2: inner diodes D2 & D3
- For storage and case temperature with TIM see document "TP(HALA P8) SEMiX 5p"

Characteristics						
Symbol	Conditions		min.	typ.	max.	Unit
IGBT 1						
$V_{CE(sat)}$	$I_C = 400\text{ A}$ $V_{GE} = 15\text{ V}$ chipllevel	$T_j = 25^\circ\text{C}$		1.80	2.05	V
		$T_j = 150^\circ\text{C}$		2.20	2.40	V
V_{CE0}	chipllevel	$T_j = 25^\circ\text{C}$		0.80	0.90	V
		$T_j = 150^\circ\text{C}$		0.70	0.80	V
r_{CE}	$V_{GE} = 15\text{ V}$ chipllevel	$T_j = 25^\circ\text{C}$		2.5	2.9	m Ω
		$T_j = 150^\circ\text{C}$		3.8	4.0	m Ω
$V_{GE(th)}$	$V_{GE} = V_{CE}, I_C = 15.2\text{ mA}$		5	5.8	6.5	V
I_{CES}	$V_{GE} = 0\text{ V}, V_{CE} = 1200\text{ V}, T_j = 25^\circ\text{C}$				5	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	$V_{GE} = -15\text{V}...+15\text{V}$			3026		nC
R_{Gint}	$T_j = 25^\circ\text{C}$			1.9		Ω
$t_{d(on)}$	$V_{CC} = 300\text{ V}$	$T_j = 150^\circ\text{C}$		215		ns
t_r	$I_C = 400\text{ A}$	$T_j = 150^\circ\text{C}$		116		ns
E_{on}	$V_{GE\ neg} = -15\text{ V}$ $V_{GE\ pos} = 15\text{ V}$	$T_j = 150^\circ\text{C}$		21.4		mJ
$t_{d(off)}$	$R_{G\ on} = 2.5\ \Omega$	$T_j = 150^\circ\text{C}$		434		ns
t_f	$R_{G\ off} = 1.5\ \Omega$	$T_j = 150^\circ\text{C}$		128		ns
E_{off}	$di/dt_{on} = 3010\text{ A}/\mu\text{s}$ $di/dt_{off} = 2740\text{ A}/\mu\text{s}$ $dv/dt = 2390\text{ V}/\mu\text{s}$ $L_s = 18\text{ nH}$	$T_j = 150^\circ\text{C}$		29		mJ
$t_{d(on)}$	$V_{CC} = 300\text{ V}$	$T_j = 150^\circ\text{C}$		222		ns
t_r	$I_C = 400\text{ A}$	$T_j = 150^\circ\text{C}$		97		ns
E_{on}	$V_{GE\ neg} = -15\text{ V}$ $V_{GE\ pos} = 15\text{ V}$	$T_j = 150^\circ\text{C}$		13		mJ
$t_{d(off)}$	$R_{G\ on} = 1\ \Omega$	$T_j = 150^\circ\text{C}$		770		ns
t_f	$R_{G\ off} = 1.5\ \Omega$	$T_j = 150^\circ\text{C}$		130		ns
E_{off}	$di/dt_{on} = 3800\text{ A}/\mu\text{s}$ $di/dt_{off} = 2740\text{ A}/\mu\text{s}$ $dv/dt = 2390\text{ V}/\mu\text{s}$ $C_{GE} = 22\text{ nF}$ DC-Link-snubber= 680 nF	$T_j = 150^\circ\text{C}$		29		mJ
$R_{th(j-c)}$	per IGBT				0.068	K/W
$R_{th(c-s)}$	per IGBT ($\lambda_{grease}=0.81\text{ W}/(\text{m}^2\text{K})$)			0.027		K/W
$R_{th(c-s)}$	per IGBT, pre-applied phase change material			0.015		K/W



TMLI



SEMiX® 5

3-Level TNPC IGBT-Module

SEMiX405TMLI12E4B

Features*

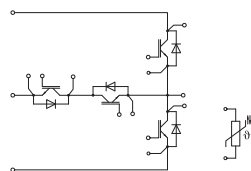
- Solderless assembling solution with PressFIT signal pins and screw power terminals
- IGBT 4 Trench Gate Technology
- $V_{CE(sat)}$ with positive temperature coefficient
- Low inductance case
- Reliable mechanical design with injection moulded terminals and reliable internal connections
- UL recognized file no. E63532
- NTC temperature sensor inside

Typical Applications

- UPS
- Solar
- Motor drives

Remarks

- Case temperature limited to $T_C=125^{\circ}\text{C}$ max
- Product reliability results are valid for $T_{jop}=150^{\circ}\text{C}$
- IGBT1: outer IGBTs T1 & T4
- IGBT2: inner IGBTs T2 & T3
- Diode1: outer diodes D1 & D4
- Diode2: inner diodes D2 & D3
- For storage and case temperature with TIM see document "TP(HALA P8) SEMiX 5p"



TMLI

Characteristics						
Symbol	Conditions		min.	typ.	max.	Unit
IGBT 2						
$V_{CE(sat)}$	$I_C = 400\text{ A}$ $V_{GE} = 15\text{ V}$ chipelevel	$T_j = 25^{\circ}\text{C}$		1.55	1.95	V
		$T_j = 150^{\circ}\text{C}$		1.75	2.15	V
V_{CE0}	chipelevel	$T_j = 25^{\circ}\text{C}$		0.90	1.00	V
		$T_j = 150^{\circ}\text{C}$		0.82	0.90	V
r_{CE}	$V_{GE} = 15\text{ V}$ chipelevel	$T_j = 25^{\circ}\text{C}$		1.63	2.4	m Ω
		$T_j = 150^{\circ}\text{C}$		2.3	3.1	m Ω
$V_{GE(th)}$	$V_{GE} = V_{CE}, I_C = 8\text{ mA}$		5.1	5.8	6.4	V
I_{CES}	$V_{GE} = 0\text{ V}, V_{CE} = 650\text{ V}, T_j = 25^{\circ}\text{C}$				0.7	mA
C_{ies}	$V_{CE} = 25\text{ V}$ $V_{GE} = 0\text{ V}$	$f = 1\text{ MHz}$		24.7		nF
C_{oes}		$f = 1\text{ MHz}$		1.54		nF
C_{res}		$f = 1\text{ MHz}$		0.73		nF
Q_G	$V_{GE} = -15\text{V}...+15\text{V}$			4420		nC
R_{Gint}	$T_j = 25^{\circ}\text{C}$			1.0		Ω
$t_{d(on)}$	$V_{CC} = 300\text{ V}$	$T_j = 150^{\circ}\text{C}$		143		ns
t_r	$I_C = 400\text{ A}$ $R_{G on} = 0.5\ \Omega$	$T_j = 150^{\circ}\text{C}$		66		ns
		$T_j = 150^{\circ}\text{C}$		2.8		mJ
E_{on}	$R_{G off} = 0.5\ \Omega$	$T_j = 150^{\circ}\text{C}$		2.8		mJ
$t_{d(off)}$	$di/dt_{on} = 5720\text{ A}/\mu\text{s}$	$T_j = 150^{\circ}\text{C}$		311		ns
t_f	$di/dt_{off} = 2970\text{ A}/\mu\text{s}$	$T_j = 150^{\circ}\text{C}$		125		ns
E_{off}	$V_{GE} = +15/-15\text{ V}$ $dv/dt = 3610\text{ V}/\mu\text{s}$ $L_s = 18\text{ nH}$	$T_j = 150^{\circ}\text{C}$		23.9		mJ
		$T_j = 150^{\circ}\text{C}$				
$R_{th(j-c)}$	per IGBT				0.14	K/W
$R_{th(c-s)}$	per IGBT ($\lambda_{grease}=0.81\text{ W}/(\text{m}^*\text{K})$)			0.058		K/W
$R_{th(c-s)}$	per IGBT, pre-applied phase change material			0.046		K/W

Characteristics						
Symbol	Conditions		min.	typ.	max.	Unit
Diode 1						
$V_F = V_{EC}$	$I_F = 400\text{ A}$ $V_{GE} = 0\text{ V}$ chipelevel	$T_j = 25^{\circ}\text{C}$		2.20	2.52	V
		$T_j = 150^{\circ}\text{C}$		2.15	2.47	V
V_{F0}	chipelevel	$T_j = 25^{\circ}\text{C}$		1.30	1.50	V
		$T_j = 150^{\circ}\text{C}$		0.90	1.10	V
r_F	chipelevel	$T_j = 25^{\circ}\text{C}$		2.3	2.6	m Ω
		$T_j = 150^{\circ}\text{C}$		3.1	3.4	m Ω
I_{RRM}	$I_F = 400\text{ A}$	$T_j = 150^{\circ}\text{C}$		292		A
Q_{rr}	$di/dt_{off} = 5720\text{ A}/\mu\text{s}$	$T_j = 150^{\circ}\text{C}$		52.9		μC
E_{rr}	$V_{GE} = -15\text{ V}$ $V_{CC} = 300\text{ V}$	$T_j = 150^{\circ}\text{C}$		16.4		mJ
$R_{th(j-c)}$	per diode				0.13	K/W
$R_{th(c-s)}$	per diode ($\lambda_{grease}=0.81\text{ W}/(\text{m}^*\text{K})$)			0.036		K/W
$R_{th(c-s)}$	per diode, pre-applied phase change material			0.028		K/W

SEMiX405TMLI12E4B



SEMiX® 5

3-Level TNPC IGBT-Module

SEMiX405TMLI12E4B

Features*

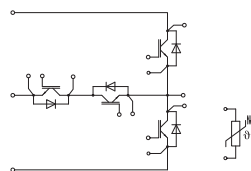
- Solderless assembling solution with PressFIT signal pins and screw power terminals
- IGBT 4 Trench Gate Technology
- $V_{CE(sat)}$ with positive temperature coefficient
- Low inductance case
- Reliable mechanical design with injection moulded terminals and reliable internal connections
- UL recognized file no. E63532
- NTC temperature sensor inside

Typical Applications

- UPS
- Solar
- Motor drives

Remarks

- Case temperature limited to $T_C=125^\circ\text{C}$ max
- Product reliability results are valid for $T_{jop}=150^\circ\text{C}$
- IGBT1: outer IGBTs T1 & T4
- IGBT2: inner IGBTs T2 & T3
- Diode1: outer diodes D1 & D4
- Diode2: inner diodes D2 & D3
- For storage and case temperature with TIM see document "TP(HALA P8) SEMiX 5p"



TMLI

Characteristics						
Symbol	Conditions		min.	typ.	max.	Unit
Diode 2						
$V_F = V_{EC}$	$I_F = 400\text{ A}$ $V_{GE} = 0\text{ V}$ chipllevel	$T_j = 25^\circ\text{C}$	1.39	1.75		V
		$T_j = 150^\circ\text{C}$	1.38	1.76		V
V_{F0}	chipllevel	$T_j = 25^\circ\text{C}$	1.04	1.24		V
		$T_j = 150^\circ\text{C}$	0.85	0.99		V
r_F	chipllevel	$T_j = 25^\circ\text{C}$	0.88	1.30		mΩ
		$T_j = 150^\circ\text{C}$	1.32	1.93		mΩ
I_{RRM}	$I_F = 400\text{ A}$	$T_j = 150^\circ\text{C}$		227		A
Q_{rr}	$di/dt_{off} = 3010\text{ A}/\mu\text{s}$	$T_j = 150^\circ\text{C}$		33.5		μC
E_{rr}	$V_{GE} = -15\text{ V}$ $V_{CC} = 300\text{ V}$	$T_j = 150^\circ\text{C}$		7.8		mJ
I_{RRM}	$I_F = 400\text{ A}$	$T_j = 150^\circ\text{C}$		314		A
Q_{rr}	$di/dt_{off} = 3800\text{ A}/\mu\text{s}$	$T_j = 150^\circ\text{C}$		37		μC
E_{rr}	$V_{GE} = -15\text{ V}$ $V_R = 300\text{ V}$	$T_j = 150^\circ\text{C}$		8.5		mJ
$R_{th(j-c)}$	per diode				0.18	K/W
$R_{th(c-s)}$	per diode ($\lambda_{grease}=0.81\text{ W}/(\text{m}^*\text{K})$)			0.053		K/W
$R_{th(c-s)}$	per diode, pre-applied phase change material			0.046		K/W

Characteristics						
Symbol	Conditions		min.	typ.	max.	Unit
Module						
L_{sCE1}				31		nH
L_{CE}				42		nH
$R_{CC'+EE'}$	measured between terminal 5 and 1	$T_C = 25^\circ\text{C}$		0.8		mΩ
		$T_C = 125^\circ\text{C}$		1.1		mΩ
$R_{th(c-s)1}$	calculated without thermal coupling			0.005		K/W
$R_{th(c-s)2}$	including thermal coupling, T_s underneath module ($\lambda_{grease}=0.81\text{ W}/(\text{m}^*\text{K})$)			0.008		K/W
$R_{th(c-s)2}$	including thermal coupling, T_s underneath module, pre-applied phase change material			0.006		K/W
M_s	to heat sink (M5)		3		6	Nm
M_t	to terminals (M6)		3		6	Nm
w				398		g

Characteristics						
Symbol	Conditions		min.	typ.	max.	Unit
Temperature Sensor						
R_{100}	$T_C=100^\circ\text{C}$ ($R_{25}=5\text{ k}\Omega$)			$493 \pm 5\%$		Ω
$B_{100/125}$	$R_{(T)}=R_{100}\exp[B_{100/125}(1/T-1/T_{100})]$; $T[\text{K}]$;			$3550 \pm 2\%$		K

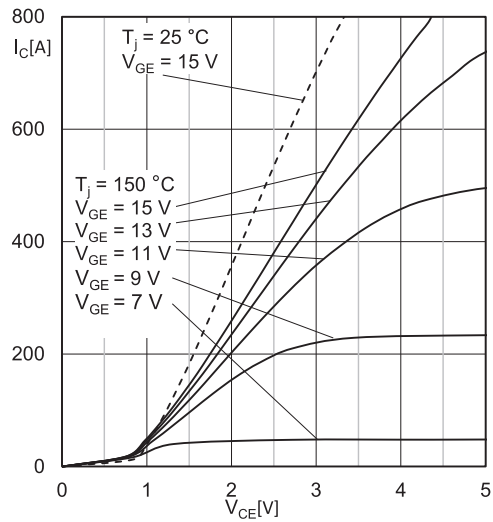


Fig. 1: Typ. IGBT1 output characteristic, incl. $R_{CC'+EE'}$

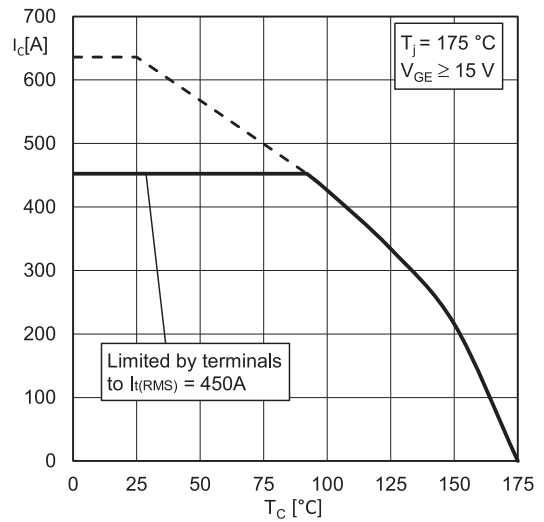


Fig. 2: IGBT1 rated current vs. Temperature $I_c=f(T_c)$

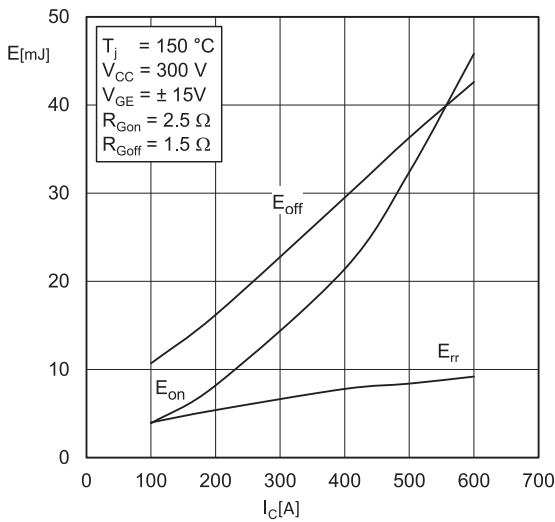


Fig. 3: Typ. IGBT1 & Diode2 turn-on /-off energy = $f(I_c)$

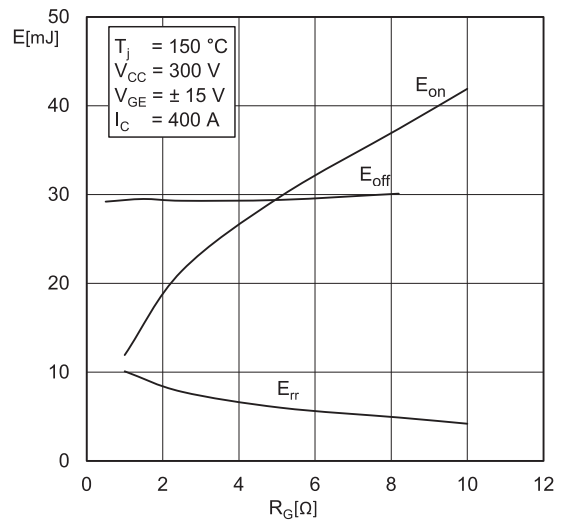


Fig. 4: Typ. IGBT1 & Diode2 turn-on /-off energy = $f(R_G)$

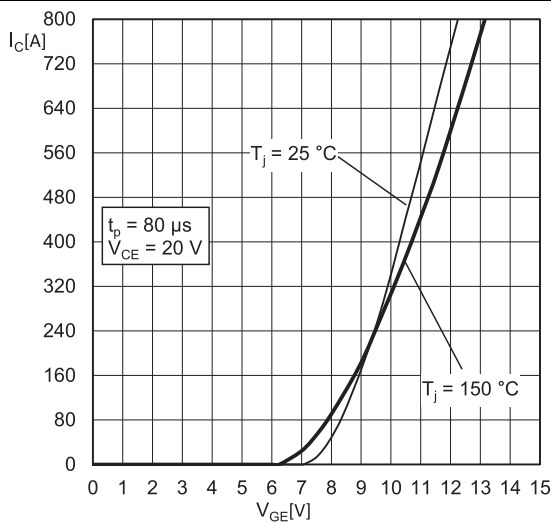


Fig. 5: Typ. IGBT1 transfer characteristic

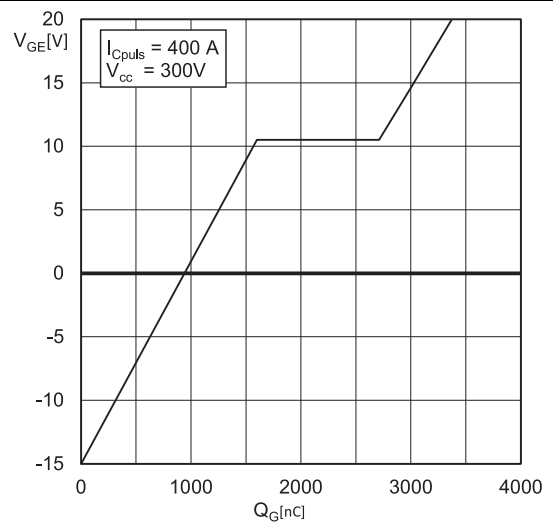


Fig. 6: Typ. IGBT1 gate charge characteristic

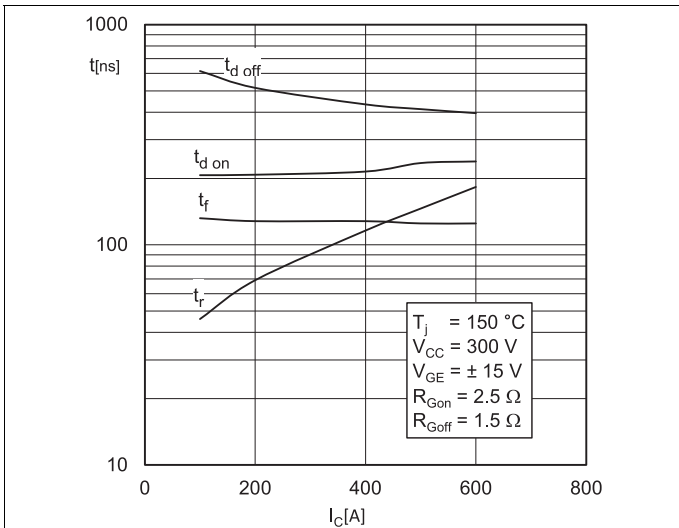


Fig. 7: Typ. IGBT1 switching times vs. I_C

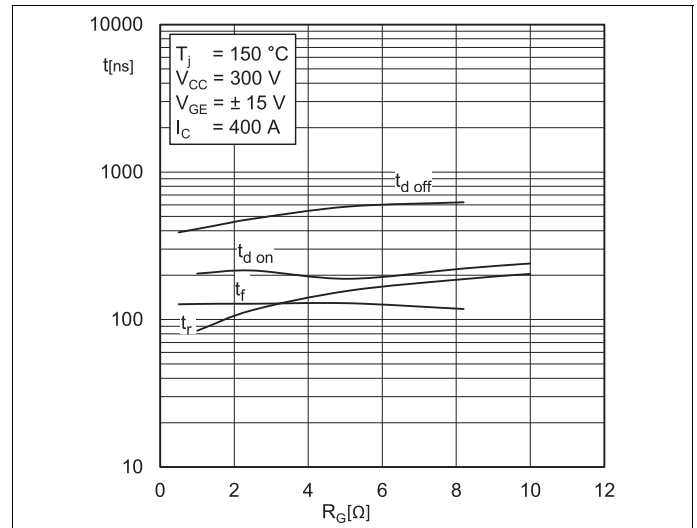


Fig. 8: Typ. IGBT1 switching times vs. gate resistor R_G

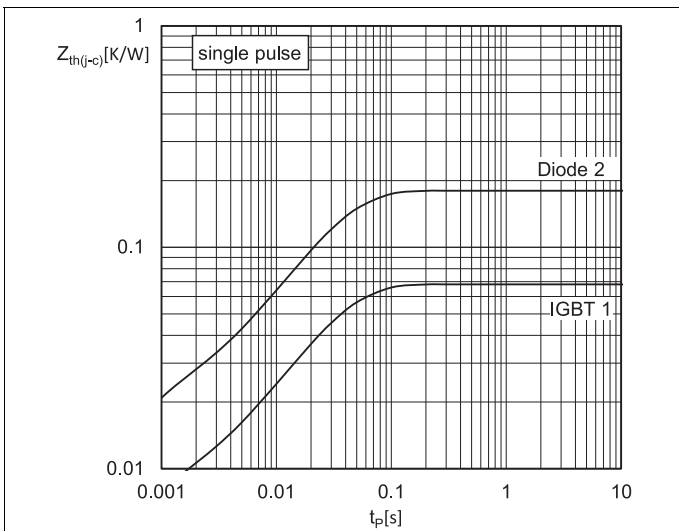


Fig. 9: Typ. Transient thermal impedance of IGBT1 & Diode2

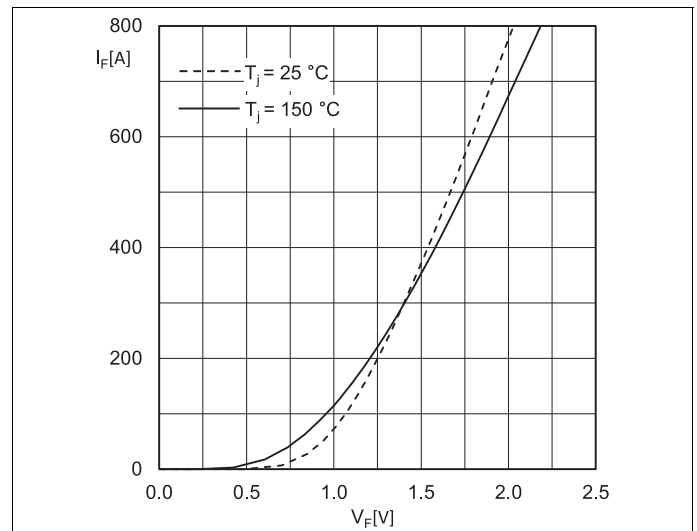


Fig. 10: Typ. Diode2 forward characteristic, incl. $R_{CC+EE'}$

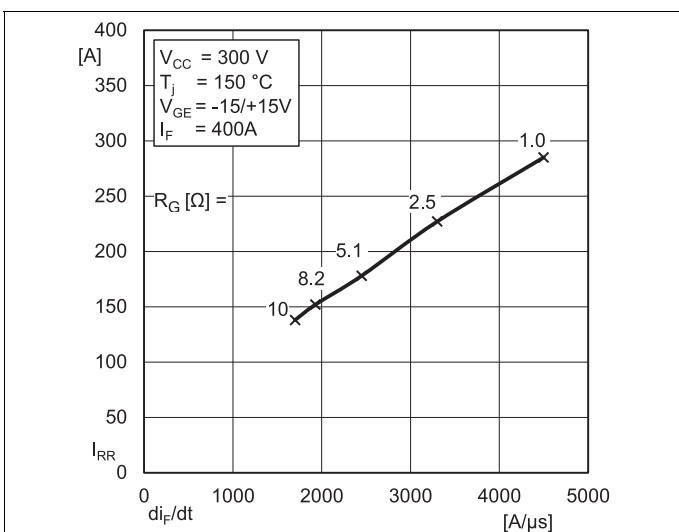


Fig. 11: Typ. Diode2 peak reverse recovery current

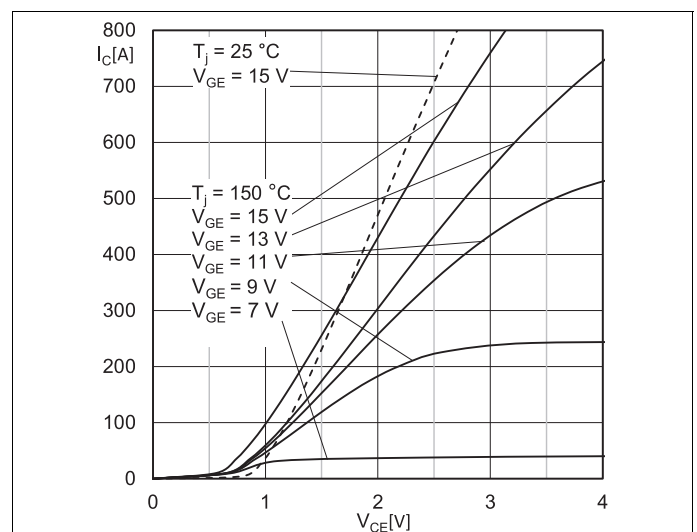


Fig. 13: Typ. IGBT2 output characteristic, incl. $R_{CC+EE'}$

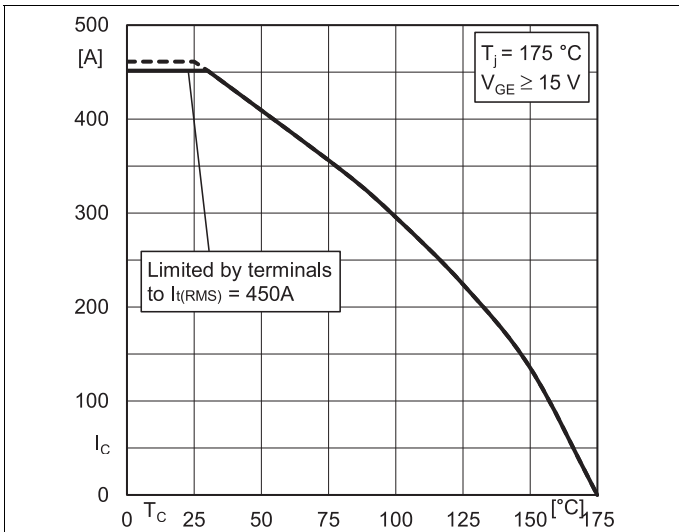


Fig. 14: IGBT2 Rated current vs. Temperature $I_c = f(T_c)$

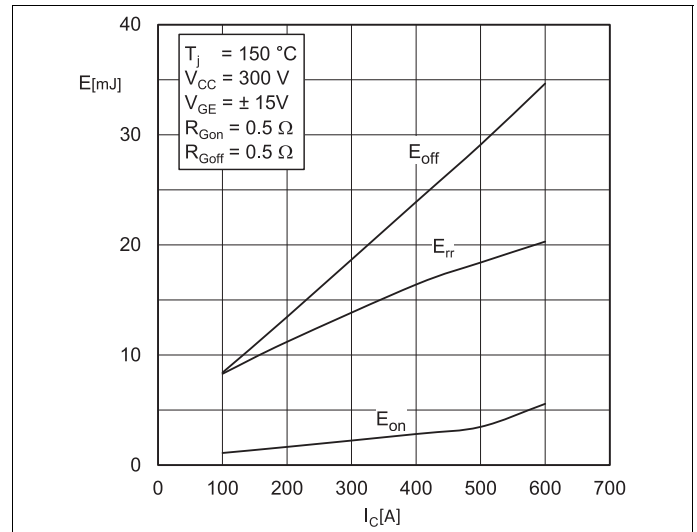


Fig. 15: Typ. IGBT2 & Diode1 turn-on /-off energy = $f(I_c)$

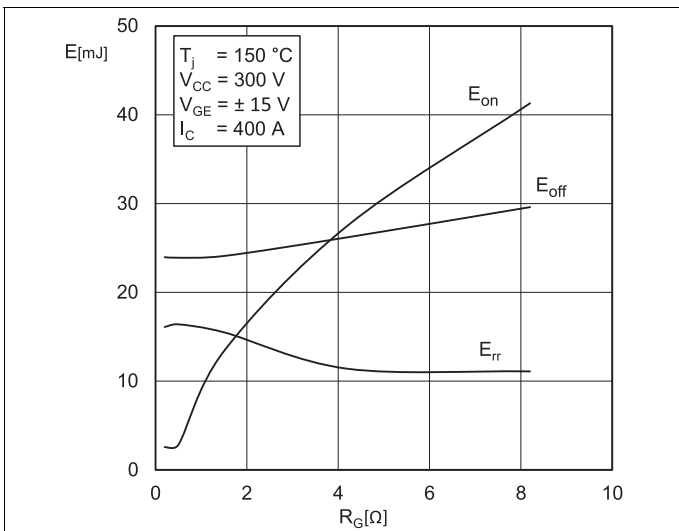


Fig. 16: Typ. IGBT2 & Diode1 turn-on /-off energy = $f(R_G)$

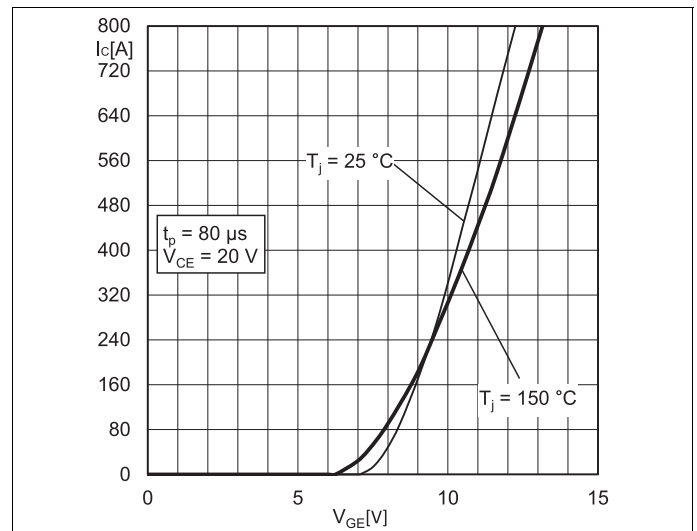


Fig. 17: Typ. IGBT2 transfer characteristic

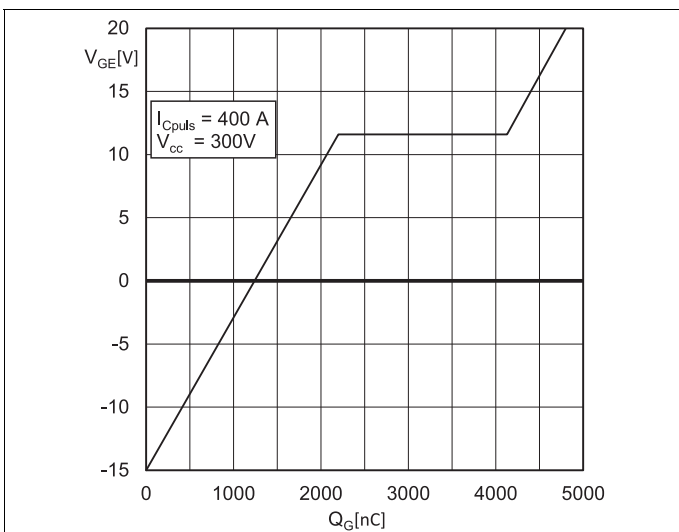


Fig. 18: Typ. IGBT2 gate charge characteristic

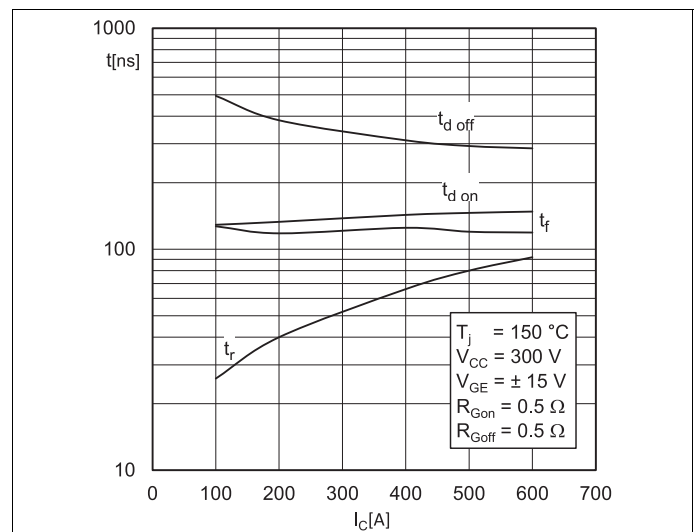


Fig. 19: Typ. IGBT2 switching times vs. I_c

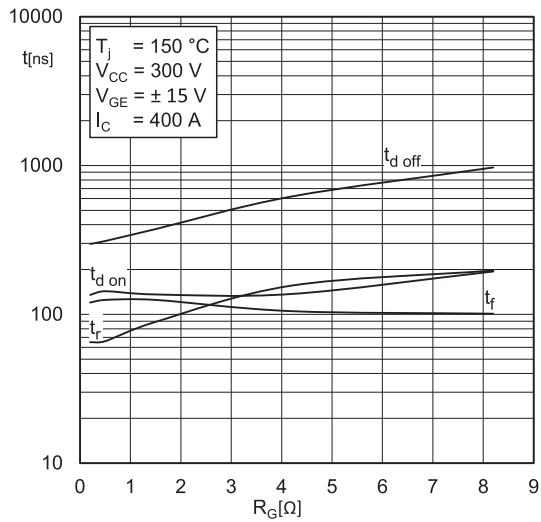


Fig. 20: Typ. IGBT2 switching times vs. gate resistor R_G

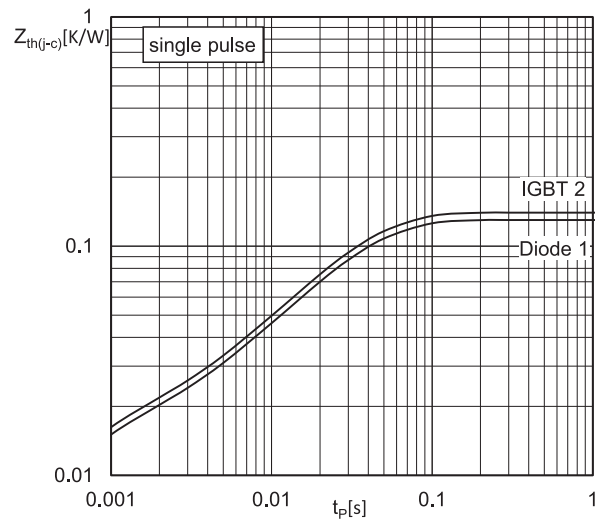


Fig. 21: Transient thermal impedance of IGBT2 & Diode1

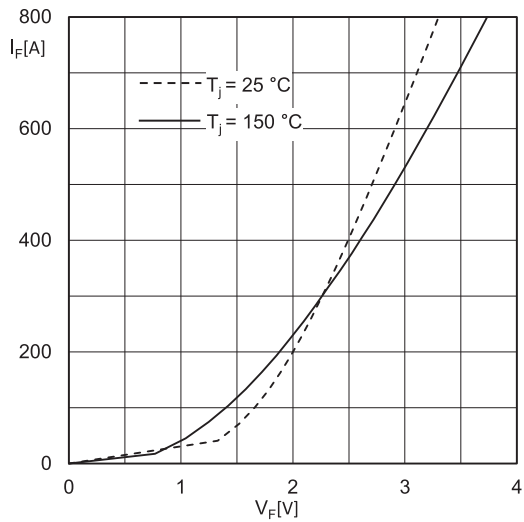


Fig. 22: Typ. Diode1 forward characteristic, incl. R_{CC+EE}

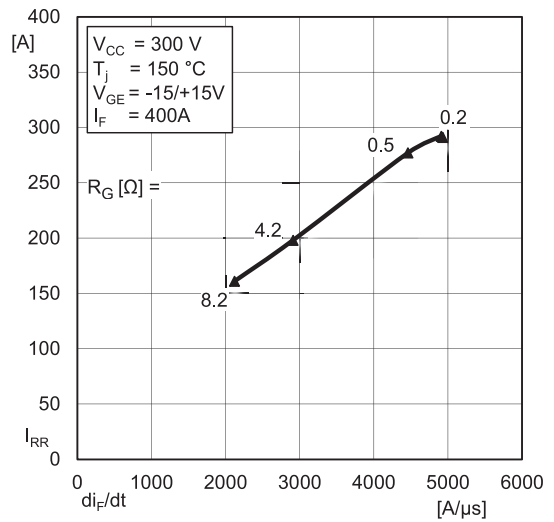


Fig. 23: Typ. Diode1 peak reverse recovery current

This is an electrostatic discharge sensitive device (ESDS) due to international standard IEC 61340.

***IMPORTANT INFORMATION AND WARNINGS**

The specifications of SEMIKRON products may not be considered as guarantee or assurance of product characteristics ("Beschaffenheitsgarantie"). The specifications of SEMIKRON products describe only the usual characteristics of products to be expected in typical applications, which may still vary depending on the specific application. Therefore, products must be tested for the respective application in advance. Application adjustments may be necessary. The user of SEMIKRON products is responsible for the safety of their applications embedding SEMIKRON products and must take adequate safety measures to prevent the applications from causing a physical injury, fire or other problem if any of SEMIKRON products become faulty. The user is responsible to make sure that the application design is compliant with all applicable laws, regulations, norms and standards. Except as otherwise explicitly approved by SEMIKRON in a written document signed by authorized representatives of SEMIKRON, SEMIKRON products may not be used in any applications where a failure of the product or any consequences of the use thereof can reasonably be expected to result in personal injury. No representation or warranty is given and no liability is assumed with respect to the accuracy, completeness and/or use of any information herein, including without limitation, warranties of non-infringement of intellectual property rights of any third party. SEMIKRON does not assume any liability arising out of the applications or use of any product; neither does it convey any license under its patent rights, copyrights, trade secrets or other intellectual property rights, nor the rights of others. SEMIKRON makes no representation or warranty of non-infringement or alleged non-infringement of intellectual property rights of any third party which may arise from applications. Due to technical requirements our products may contain dangerous substances. For information on the types in question please contact the nearest SEMIKRON sales office. This document supersedes and replaces all information previously supplied and may be superseded by updates. SEMIKRON reserves the right to make changes.