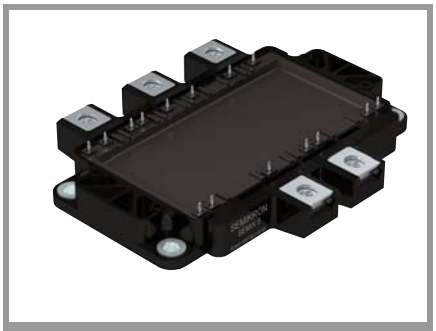
SEMiX405MLI10S7SC



SEMiX® 5

3-Level NPC IGBT-Module

SEMiX405MLI10S7SC

Features*

- 950V Generation 7 IGBTs (S7, L7)
- 950V Generation 7 freewheeling diodes (EC7)
- Silicon Carbide (SiC) clamping diodes
- Solderless assembling with PressFIT signal pins, screw power terminals
- Reliable mechanical design with injection moulded terminals
- UL recognized file no. E63532
- NTC temperature sensor inside

Typical Applications

- Solar

Remarks*

- Case temperature limited to T_C=125°C max.
- Product reliability results valid for T_j≤150°C
- T_j under switching conditions is limited to $T_{j,op}$ = -40°C...+150°C
- IGBT1: outer IGBTs T1 & T4
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- Diode1: outer diodes D1 & D4
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- Diode5: clamping diodes D5 & D6
- For storage and case temperature with TIM see document "TP(HALA P8) SEMiX 5p"

Footnotes

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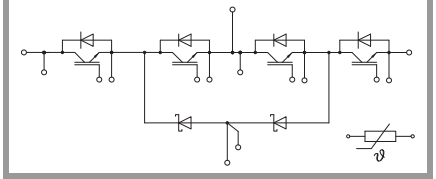
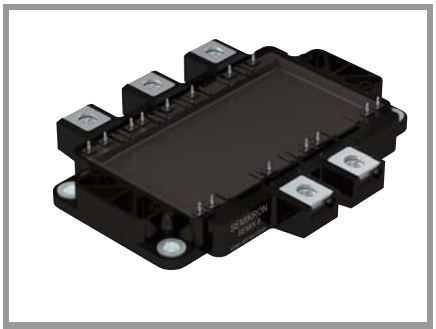


MLI

Absolute Maximum Ratings				
Symbol	**Conditions**		**Values**	**Unit**
IGBT1				
V_{CES}			950	V
I_C	T_j = 175 °C	T_c = 25 °C	356	A
		T_c = 80 °C	257	A
I_{Cnom}			400	A
I_{CRM}			800	A
V_{GES}			-20 ... 20	V
t_{psc}	V_{CC} = 600 V, V_{GE} ≤ 15 V, T_j = 150 °C, V_{CES} ≤ 950 V		not capable	µs
T_j			-40 ... 175	°C
IGBT2				
V_{CES}			950	V
I_C	T_j = 175 °C	T_c = 25 °C	594	A
		T_c = 80 °C	441	A
I_{Cnom}			400	A
I_{CRM}			800	A
V_{GES}			-20 ... 20	V
t_{psc}	V_{CC} = 600 V, V_{GE} ≤ 15 V, T_j = 150 °C, V_{CES} ≤ 950 V		not capable	µs
T_j			-40 ... 175	°C
Diode1				
V_{RRM}	T_j = 25 °C		950	V
I_F	T_j = 175 °C	T_c = 25 °C	157	A
		T_c = 80 °C	116	A
I_{FRM}			400	A
I_{FSM}	10 ms, sin 180°, T_j = 25 °C		817	A
T_j			-40 ... 175	°C
Diode2				
V_{RRM}	T_j = 25 °C		950	V
I_F	T_j = 175 °C	T_c = 25 °C	154	A
		T_c = 80 °C	114	A
I_{FRM}			400	A
I_{FSM}	10 ms, sin 180°, T_j = 25 °C		817	A
T_j			-40 ... 175	°C
Diode5				
V_{RRM}	T_j = 25 °C		1200	V
I_F	T_j = 175 °C	T_c = 25 °C	241	A
		T_c = 80 °C	182	A
I_{FRM}			600	A
I_{FSM}	10 ms, sin 180°, T_j = 25 °C		684	A
T_j			-40 ... 175	°C
Module				
$I_{t(RMS)}$			450	A
T_{stg}	module without TIM		-40 ... 125	°C
V_{isol}	AC sinus 50Hz, t = 1 min		4000	V



SEMiX® 5

3-Level NPC IGBT-Module

SEMiX405MLI10S7SC

Features*

- 950V Generation 7 IGBTs (S7, L7)
- 950V Generation 7 freewheeling diodes (EC7)
- Silicon Carbide (SiC) clamping diodes
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- Reliable mechanical design with injection moulded terminals
- UL recognized file no. E63532
- NTC temperature sensor inside

Typical Applications

- Solar

Remarks

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- Product reliability results valid for T_j≤150°C
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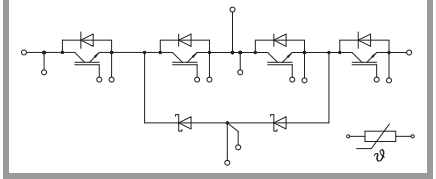
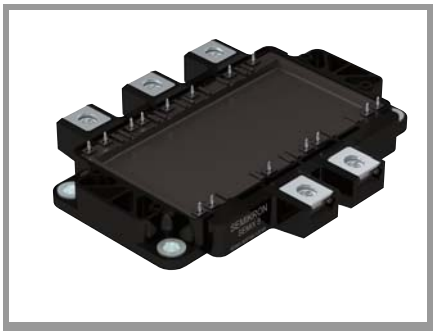


MLI

Characteristics

Symbol	Conditions		min.	typ.	max.	Unit
IGBT 1						
$V_{CE(sat)}$	I_C = 400 A V_{GE} = 15 V chiplevel	T_j = 25 °C		1.85	2.25	V
		T_j = 150 °C		2.15	2.55	V
V_{CE0}	chiplevel	T_j = 25 °C		1.10	1.45	V
		T_j = 150 °C		1.05	1.40	V
r_{CE}	V_{GE} = 15 V chiplevel	T_j = 25 °C		1.88	2.0	mΩ
		T_j = 150 °C		2.8	2.9	mΩ
$V_{GE(th)}$	V_{GE} = V_{CE}, I_C = 6.5 mA		4.35	5.1	5.85	V
I_{CES}	V_{GE} = 0 V, V_{CE} = 950 V, T_j = 25 °C				4.0	mA
C_{ies}	V_{CE} = 25 V V_{GE} = 0 V	f = 1 MHz		25.2		nF
C_{oes}		f = 1 MHz		0.54		nF
C_{res}		f = 1 MHz		0.08		nF
Q_G	V_{GE} = -15V...+15V			900		nC
R_{Gint}	T_j = 25 °C			0.8		Ω
$t_{d(on)}$	V_{CC} = 500 V I_C = 200 A V_{GE} = +15/-15 V $R_{G\,on}$ = 3.3 Ω $R_{G\,off}$ = 3.3 Ω di/dt$_{on}$ = 4240 A/µs di/dt$_{off}$ = 2899 A/µs dv/dt = 7026 V/µs L_s = 27 nH	T_j = 150 °C		76		ns
t_r		T_j = 150 °C		35		ns
E_{on}		T_j = 150 °C		5.29		mJ
$t_{d(off)}$		T_j = 150 °C		275		ns
t_f		T_j = 150 °C		67		ns
E_{off}		T_j = 150 °C		8.39		mJ
$t_{d(on)}$	V_{CC} = 500 V I_C = 400 A V_{GE} = +15/-15 V $R_{G\,on}$ = 10 Ω $R_{G\,off}$ = 44 Ω di/dt$_{on}$ = 2769 A/µs di/dt$_{off}$ = 5000 A/µs dv/dt = 4169 V/µs L_s = 27 nH	T_j = 150 °C		154		ns
t_r		T_j = 150 °C		117		ns
E_{on}		T_j = 150 °C		38		mJ
$t_{d(off)}$		T_j = 150 °C		1215		ns
t_f		T_j = 150 °C		74		ns
E_{off}		T_j = 150 °C		31		mJ
$R_{th(j-c)}$	per IGBT				0.17	K/W
$R_{th(c-s)}$	per IGBT, pre-applied High Performance TIM			0.017		K/W
$R_{th(c-s)}$	per IGBT, pre-applied phase change material			TBD		K/W

SEMiX405MLI10S7SC



SEMiX® 5

3-Level NPC IGBT-Module

SEMiX405MLI10S7SC

Features*

- 950V Generation 7 IGBTs (S7, L7)
- 950V Generation 7 freewheeling diodes (EC7)
- Silicon Carbide (SiC) clamping diodes
- Solderless assembling with PressFIT signal pins, screw power terminals
- Reliable mechanical design with injection moulded terminals
- UL recognized file no. E63532
- NTC temperature sensor inside

Typical Applications

- Solar

Remarks

- Case temperature limited to T_C=125°C max.
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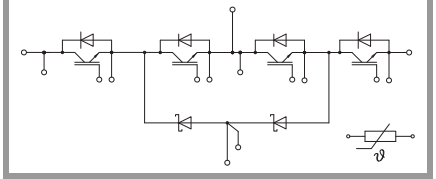
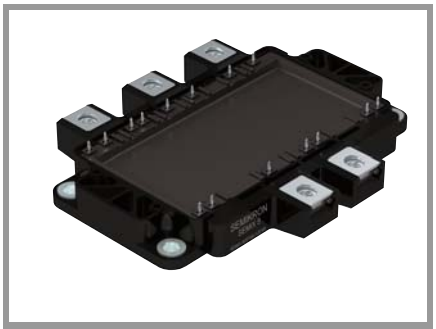


MLI

Characteristics

Symbol	Conditions		min.	typ.	max.	Unit
IGBT 2						
$V_{CE(sat)}$	I_C = 400 A V_{GE} = 15 V chiplevel	T_j = 25 °C		1.30	1.40	V
		T_j = 150 °C		1.35	1.45	V
V_{CE0}	chiplevel	T_j = 25 °C		0.86	0.91	V
		T_j = 150 °C		0.74	0.79	V
r_{CE}	V_{GE} = 15 V chiplevel	T_j = 25 °C		1.10	1.23	mΩ
		T_j = 150 °C		1.53	1.65	mΩ
$V_{GE(th)}$	V_{GE} = V_{CE}, I_C = 6.5 mA		4.15	4.85	5.65	V
I_{CES}	V_{GE} = 0 V, V_{CE} = 950 V, T_j = 25 °C				4	mA
C_{ies}	V_{CE} = 25 V V_{GE} = 0 V	f = 1 MHz		49.2		nF
C_{oes}		f = 1 MHz		0.53		nF
C_{res}		f = 1 MHz		0.22		nF
Q_G	V_{GE} = -15V...+15V			4100		nC
R_{Gint}	T_j = 25 °C			0.8		Ω
$t_{d(on)}$	V_{CC} = 500 V I_C = 200 A $R_{G\,on}$ = 4 Ω $R_{G\,off}$ = 4 Ω di/dt$_{on}$ = 5100 A/µs di/dt$_{off}$ = 482 A/µs V_{GE} = +15/-15 V dv/dt = 2038 V/µs L_s = 27 nH	T_j = 150 °C		166		ns
t_r		T_j = 150 °C		37		ns
E_{on}		T_j = 150 °C		4.9		mJ
$t_{d(off)}$		T_j = 150 °C		700		ns
t_f		T_j = 150 °C		235		ns
E_{off}		T_j = 150 °C		41.5		mJ
$t_{d(on)}$	V_{CC} = 500 V I_C = 400 A $R_{G\,on}$ = 15 Ω $R_{G\,off}$ = 22 Ω di/dt$_{on}$ = 3500 A/µs di/dt$_{off}$ = 1900 A/µs V_{GE} = +15/-15 V dv/dt = 2667 V/µs L_s = 27 nH	T_j = 150 °C		325		ns
t_r		T_j = 150 °C		165		ns
E_{on}		T_j = 150 °C		35		mJ
$t_{d(off)}$		T_j = 150 °C		2023		ns
t_f		T_j = 150 °C		137		ns
E_{off}		T_j = 150 °C		66		mJ
$R_{th(j-c)}$	per IGBT				0.14	K/W
$R_{th(c-s)}$	per IGBT, pre-applied High Performance TIM			0.021		K/W
$R_{th(c-s)}$	per IGBT, pre-applied phase change material			TBD		K/W



SEMiX® 5

3-Level NPC IGBT-Module

SEMiX405MLI10S7SC

Features*

- 950V Generation 7 IGBTs (S7, L7)
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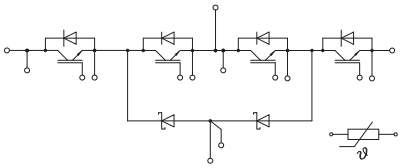

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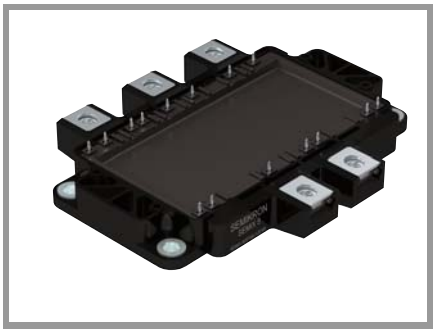
Characteristics						
Symbol	**Conditions**		**min.**	**typ.**	**max.**	**Unit**
Diode 1						
$V_F = V_{EC}$	I_F = 200 A V_{GE} = 0 V chiplevel	T_j = 25 °C		2.50	2.80	V
		T_j = 150 °C		2.35	2.65	V
V_{F0}	chiplevel	T_j = 25 °C		1.35	1.51	V
		T_j = 150 °C		1.00	1.12	V
r_F	chiplevel	T_j = 25 °C		5.8	6.5	mΩ
		T_j = 150 °C		6.8	7.7	mΩ
I_{RRM}	I_F = 200 A di/dt_{off} = 5100 A/µs V_{GE} = 15 V V_R = 500 V	T_j = 150 °C		249		A
Q_{rr}		T_j = 150 °C		25.4		µC
E_{rr}		T_j = 150 °C		9		mJ
I_{RRM}	I_F = 400 A di/dt_{off} = 3500 A/µs V_{GE} = 15 V V_R = 500 V	T_j = 150 °C		269		A
Q_{rr}		T_j = 150 °C		31		µC
E_{rr}		T_j = 150 °C		10.4		mJ
$R_{th(j-c)}$	per diode				0.42	K/W
$R_{th(c-s)}$	per IGBT, pre-applied High Performance TIM			0.042		K/W
$R_{th(c-s)}$	per diode, pre-applied phase change material			TBD		K/W

Characteristics						
Symbol	**Conditions**		**min.**	**typ.**	**max.**	**Unit**
Diode 2						
$V_F = V_{EC}$	I_F = 200 A V_{GE} = 0 V chiplevel	T_j = 25 °C		2.50	2.80	V
		T_j = 150 °C		2.35	2.65	V
V_{F0}	chiplevel	T_j = 25 °C		1.35	1.51	V
		T_j = 150 °C		1.00	1.12	V
r_F	chiplevel	T_j = 25 °C		5.8	6.5	mΩ
		T_j = 150 °C		6.8	7.7	mΩ
I_{RRM}	I_F = 200 A	T_j = 150 °C		-		A
Q_{rr}	V_{GE} = 15 V	T_j = 150 °C		-		µC
E_{rr}	V_R = 500 V	T_j = 150 °C		- [1)]		mJ
$R_{th(j-c)}$	per diode				0.43	K/W
$R_{th(c-s)}$	per IGBT, pre-applied High Performance TIM			0.033		K/W
$R_{th(c-s)}$	per diode, pre-applied phase change material			TBD		K/W



SEMiX® 5

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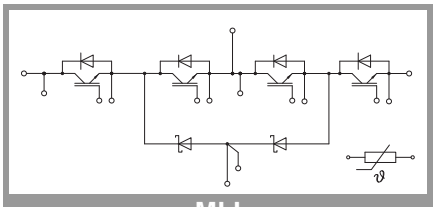


MLI

Characteristics

Symbol	Conditions		min.	typ.	max.	Unit
Diode5						
$V_F = V_{EC}$	I_F = 200 A	T_j = 25 °C		1.40	1.60	V
	chiplevel	T_j = 150 °C		1.80	3.00	V
V_{F0}	chiplevel	T_j = 25 °C		0.95	1.05	V
		T_j = 150 °C		0.80	0.90	V
r_F	chiplevel	T_j = 25 °C		2.3	2.8	mΩ
		T_j = 150 °C		5.0	11	mΩ
C_j	V_R = 1 V, f = 1 MHz, T_{vj} = 25 °C			10.4		nF
Q_c	V_R = 500 V, di/dt_{off} = 500 A/µs, T_j = 25 °C			0.29		µC
$R_{th(j-c)}$	per diode				0.25	K/W
$R_{th(c-s)}$	per IGBT, pre-applied High Performance TIM			0.067		K/W
$R_{th(c-s)}$	per diode, pre-applied phase change material			TBD		K/W

Characteristics

Symbol	Conditions		min.	typ.	max.	Unit
Module						
L_{sCE1}				27		nH
L_{CE}				34		nH
$R_{CC'+EE'}$	measured between terminal 5 and 1	T_C = 25 °C		0.27		mΩ
		T_C = 125 °C		0.72		mΩ
$R_{th(c-s)1}$	calculated without thermal coupling			0.003		K/W
$R_{th(c-s)2}$	including thermal coupling, Ts underneath module (pre-applied High Performance TIM)			0.046		K/W
$R_{th(c-s)2}$	including thermal coupling, T_s underneath module, pre-applied phase change material			t.b.d.		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°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

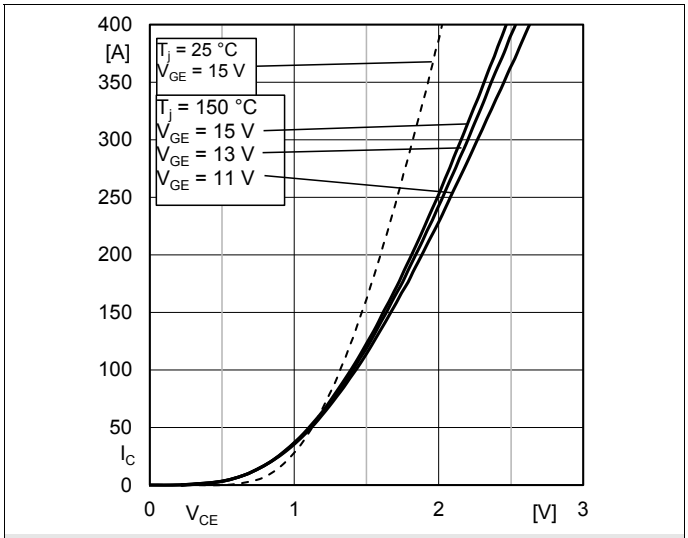


Fig. 1: Typ. IGBT1 output characteristic, incl. $R_{CC'+EE'}$

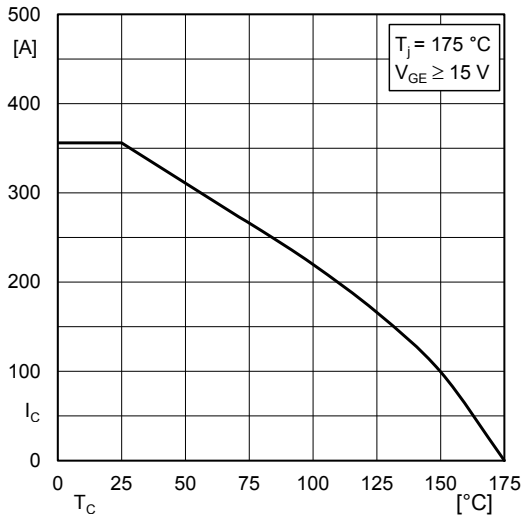


Fig. 2: IGBT1 rated current vs. Temperature $I_c=f(T_c)$

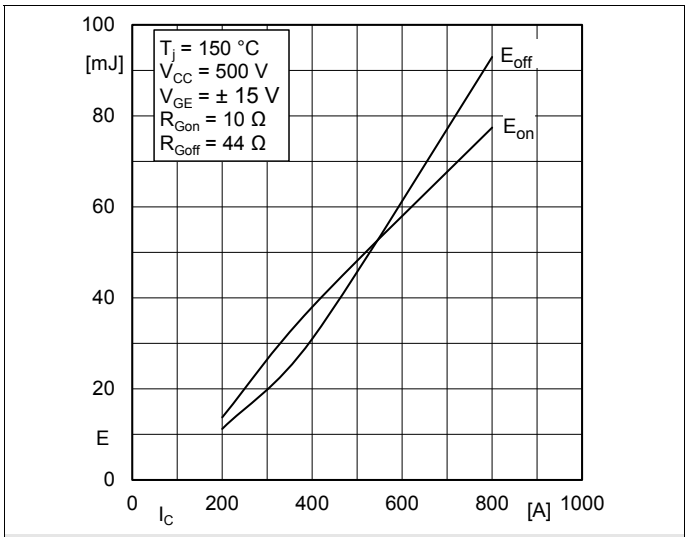


Fig. 3: Typ. IGBT 1 turn-on /-off energy = f (I_C)

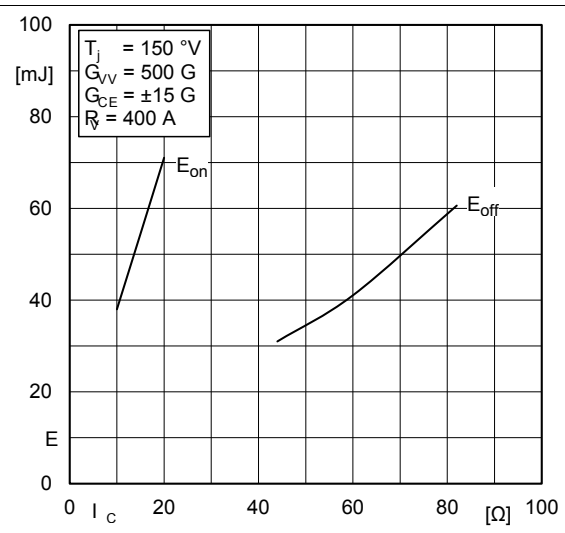


Fig. 4: Typ. IGBT1 turn-on /-off energy = f(R_G)

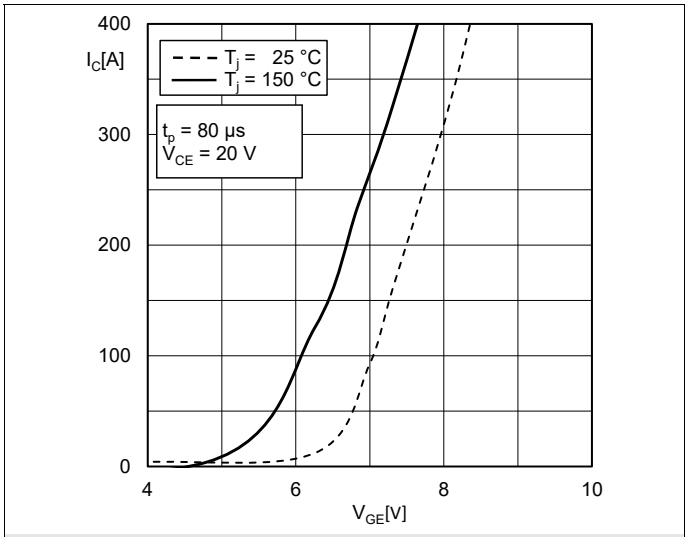


Fig. 5: Typ. transfer characteristic

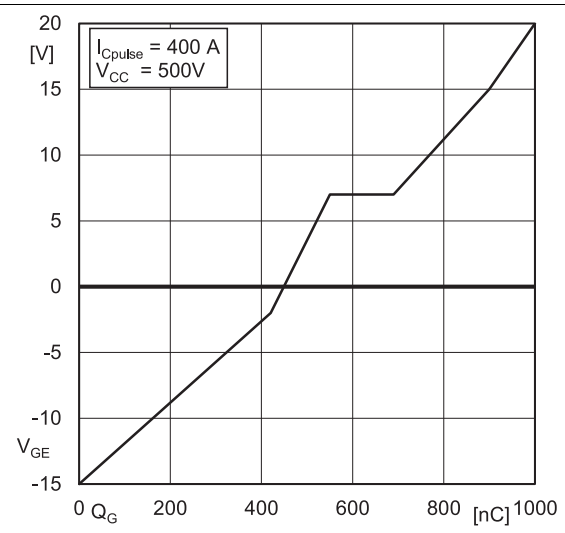


Fig. 6: Typ. IGBT1 gate charge characteristic

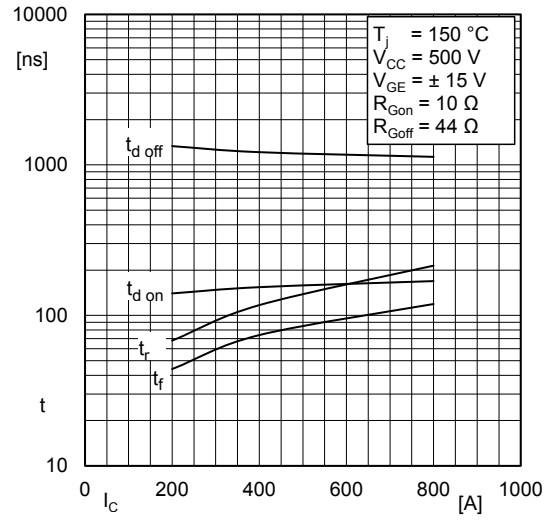


Fig. 7: Typ. IGBT2 switching times vs. I_C

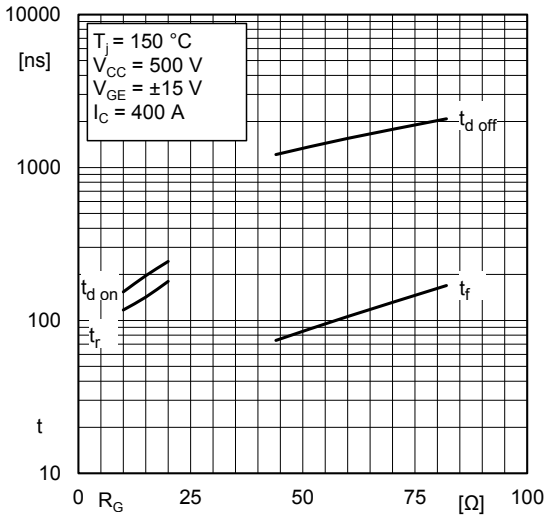


Fig. 8: Typ. IGBT1 switching times vs. gate resistor R_G

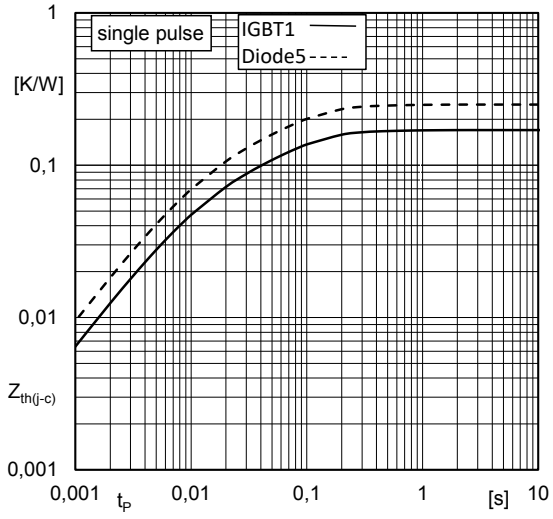


Fig. 9: Transient thermal impedance

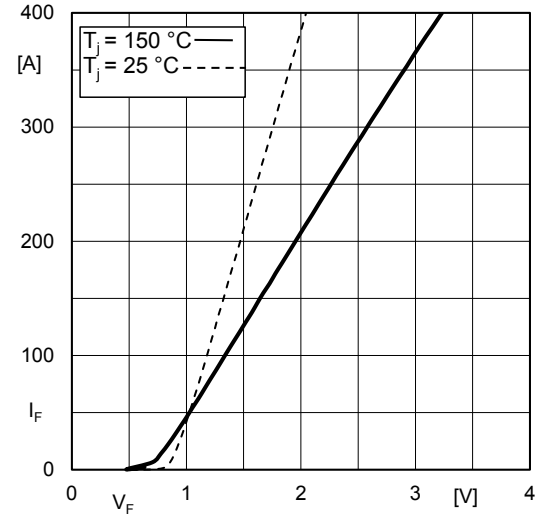


Fig. 10: Typ. Diode5 forward characteristic, incl. $R_{CC'+EE'}$

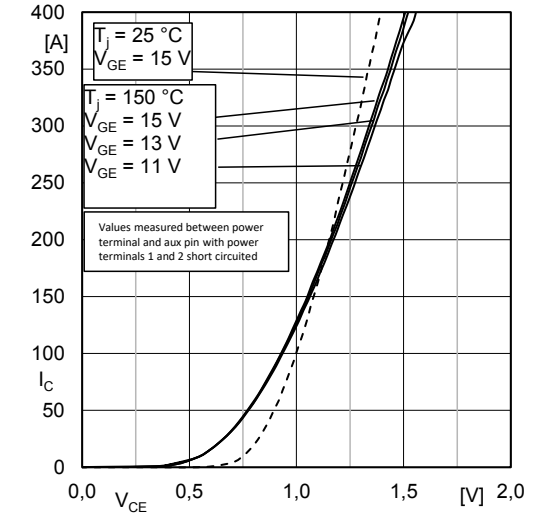


Fig. 13: Typ. IGBT2 output characteristic, incl. $R_{CC'+EE'}$

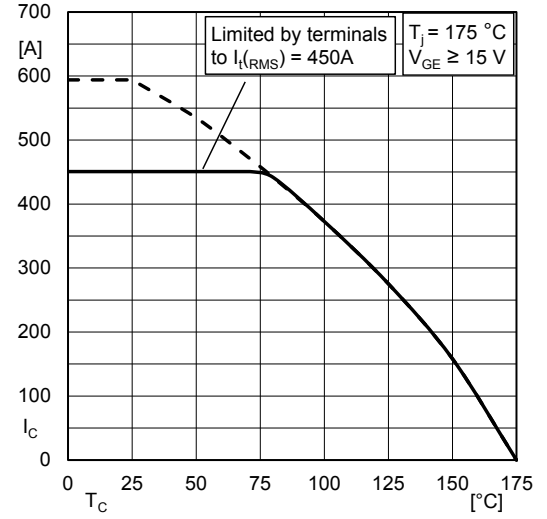


Fig. 14: IGBT2 rated current vs. Temperature I_c= f (T_c)

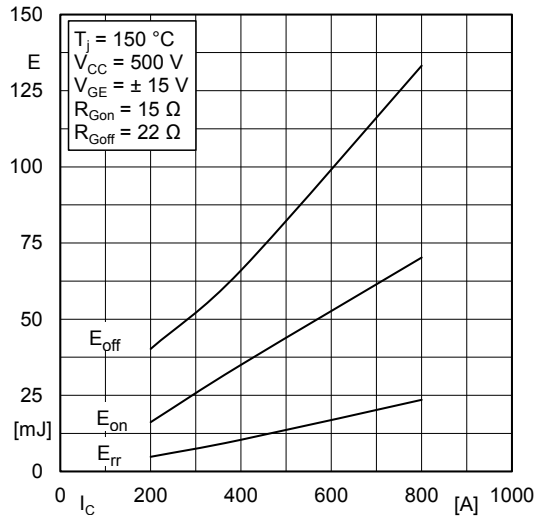


Fig. 15: Typ. IGBT2 & Diode1 turn-on /-off energy = f (I_C)

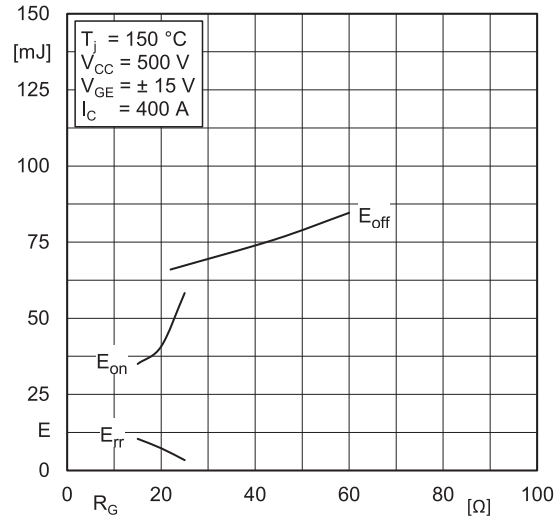


Fig. 16: Typ. IGBT2 & Diode1 turn-on / -off energy = f(R_G)

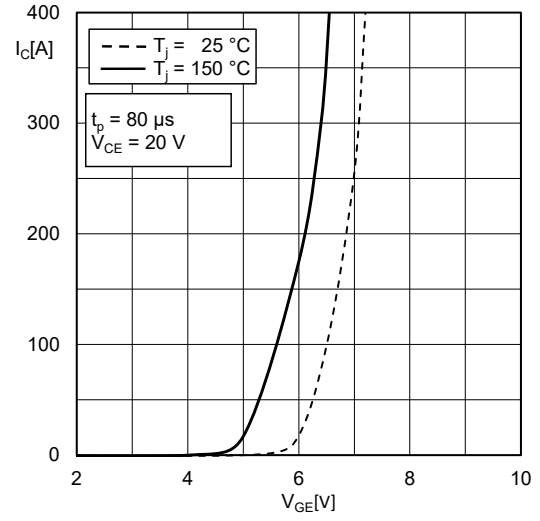


Fig. 17: Typ. IGBT2 transfer characteristic

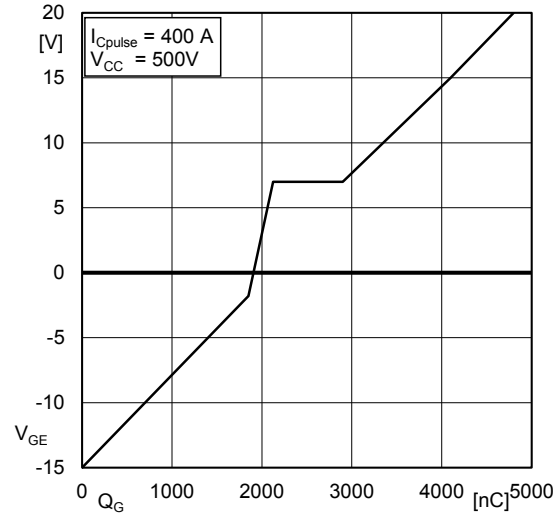


Fig. 18: Typ. IGBT2 gate charge characteristic

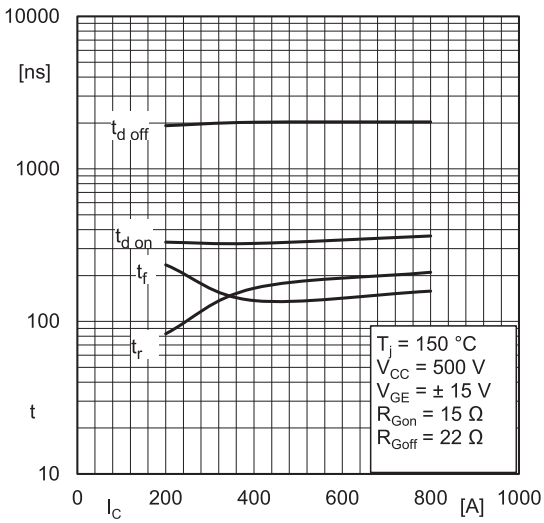


Fig. 19: Typ. IGBT2 switching times vs. I_C

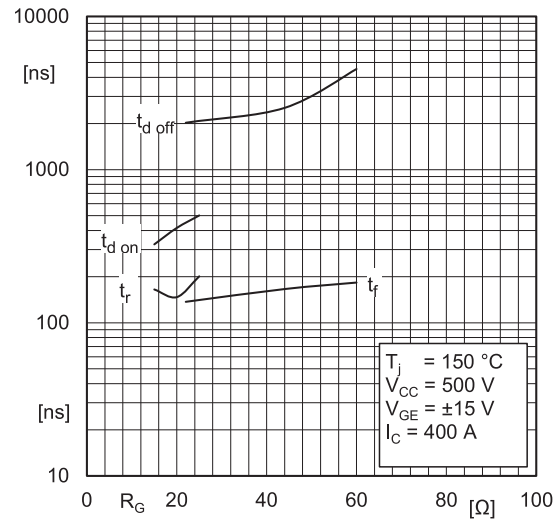


Fig. 20: Typ. IGBT2 switching times vs. gate resistor R_G

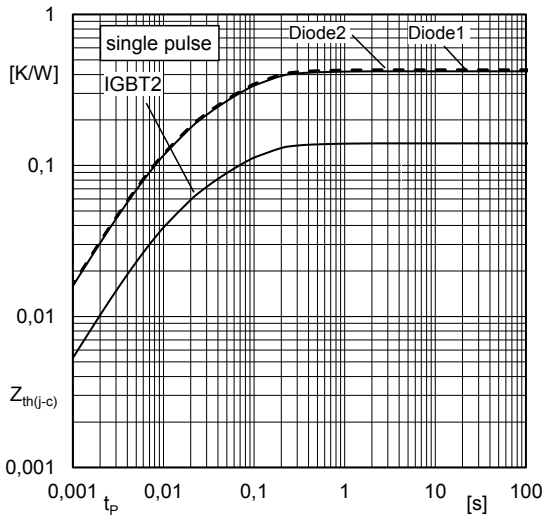


Fig. 21: Transient thermal impedance

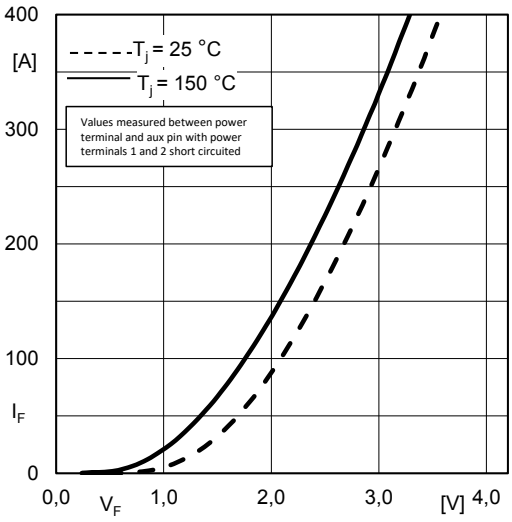
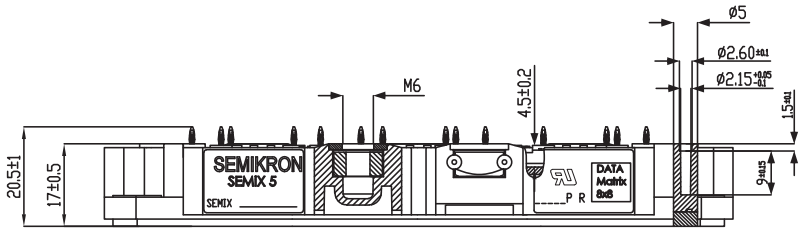
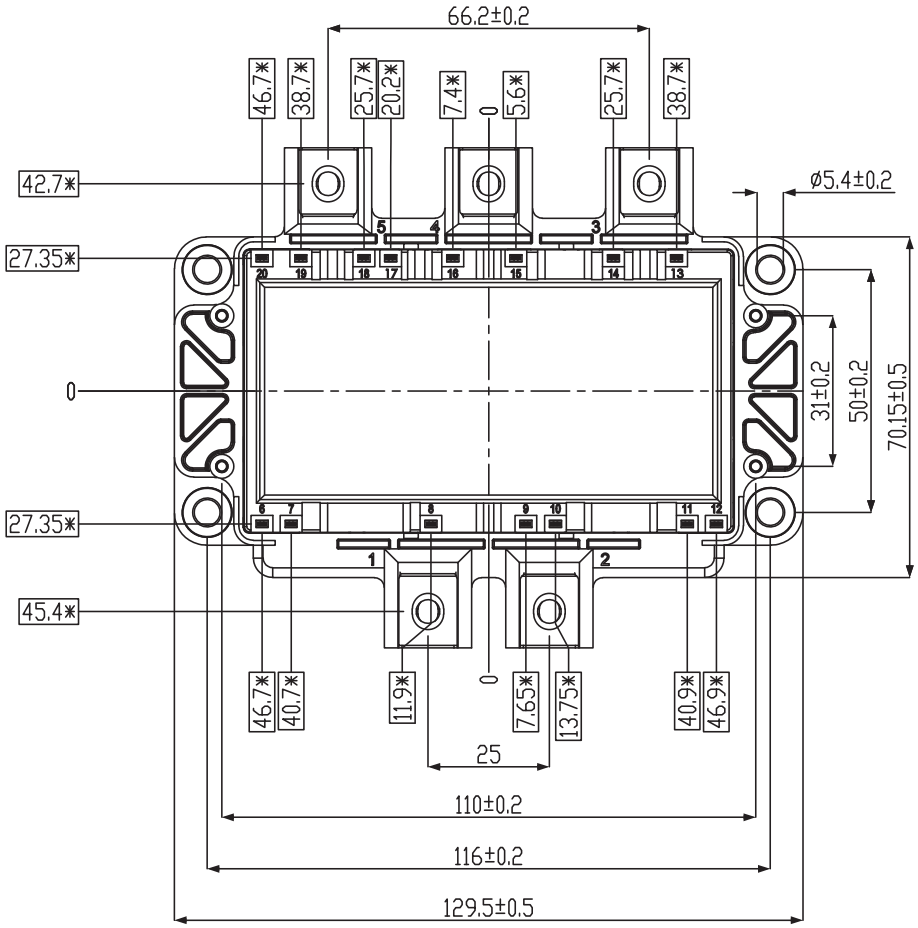


Fig. 22: Typ. Diode1 & Diode2 forward characteristic, incl. $R_{CC'+EE'}$

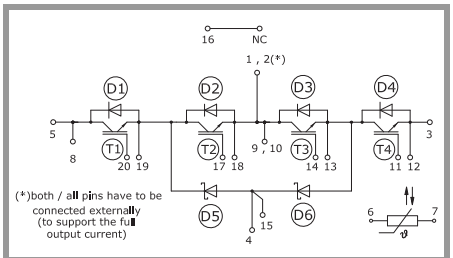




* = Dimensions in mm with tolerance of ⌖ | Ø 0.4

For technical details please refer
to SEMiX(R)5 Mounting Instruction

SEMiX5p



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IMPORTANT INFORMATION AND WARNINGS

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