



SEMiX® 3p shunt

## Trench IGBT Modules

### SEMiX603GB12E4I25p

#### Features\*

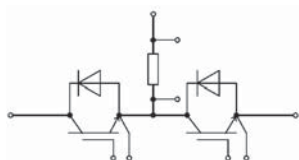
- Homogeneous Si
- Trench = Trenchgate technology
- $V_{CE(sat)}$  with positive temperature coefficient
- High short circuit capability
- Press-fit pins as auxiliary contacts
- Thermally optimized ceramic
- Current sensing shunt resistor
- UL recognized, file no. E63532

#### 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> = 3 x I <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> = 2xI <sub>Fnom</sub>		1200	A
I <sub>FSM</sub>	t <sub>p</sub> = 10 ms, sin 180°, T <sub>j</sub> = 25 °C		3456	A
T <sub>i</sub>			-40 ... 175	°C

#### Module

$I_{t(RMS)}$	$T_c = 80^\circ\text{C}$	600	A
$T_{stg}$	module without TIM	-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>					
$V_{CE(sat)}$	$I_C = 600\text{ A}$ $V_{GE} = 15\text{ V}$ chipelevel	$T_j = 25^\circ\text{C}$	1.80	2.05	V
		$T_j = 150^\circ\text{C}$	2.03	2.30	V
$V_{CE0}$	chipelevel	$T_j = 25^\circ\text{C}$	0.87	1.01	V
		$T_j = 150^\circ\text{C}$	0.77	0.90	V
$r_{CE}$	$V_{GE} = 15\text{ V}$ chipelevel	$T_j = 25^\circ\text{C}$	1.55	1.73	$\text{m}\Omega$
		$T_j = 150^\circ\text{C}$	2.1	2.3	$\text{m}\Omega$
$V_{GE(th)}$	$V_{GE} = V_{CE}, I_C = 22.2\text{ mA}$	5.3	5.8	6.3	V
$I_{CES}$	$V_{GE} = 0\text{ V}, V_{CE} = 1200\text{ V}, T_j = 25^\circ\text{C}$			5	mA
$C_{ies}$	$V_{CE} = 25\text{ V}$ $V_{GE} = 0\text{ V}$	$f = 1\text{ MHz}$	37.5		nF
$C_{oes}$		$f = 1\text{ MHz}$	2.31		nF
$C_{res}$		$f = 1\text{ MHz}$	2.04		nF
$Q_G$	$V_{GE} = -8\text{ V...} + 15\text{ V}$		3450		nC
$R_{Gint}$	$T_j = 25^\circ\text{C}$		1.2		$\Omega$
$t_{d(on)}$	$V_{CC} = 600\text{ V}$	$T_j = 150^\circ\text{C}$	260		ns
$t_r$	$I_C = 600\text{ A}$	$T_j = 150^\circ\text{C}$	85		ns
$E_{on}$	$V_{GE} = +15/-15\text{ V}$	$T_j = 150^\circ\text{C}$	63		mJ
$t_{d(off)}$	$R_{G on} = 1.5\text{ }\Omega$	$T_j = 150^\circ\text{C}$	560		ns
$t_f$	$R_{G off} = 1.5\text{ }\Omega$	$T_j = 150^\circ\text{C}$	145		ns
$E_{off}$	$di/dt_{on} = 6800\text{ A}/\mu\text{s}$ $di/dt_{off} = 3700\text{ A}/\mu\text{s}$ $dv/dt = 3400\text{ V}/\mu\text{s}$ $L_s = 21\text{ nH}$	$T_j = 150^\circ\text{C}$	80		mJ
$R_{th(j-c)}$	per IGBT			0.037	K/W
$R_{th(c-s)}$	per IGBT ( $\lambda_{grease} = 0.81\text{ W}/(\text{m}^2\text{K})$ )		0.035		K/W
$R_{th(c-s)}$	per IGBT, pre-applied phase change material		0.025		K/W



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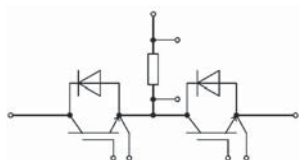
- AC inverter drives
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- Renewable energy systems

#### 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 chipelevel	T <sub>j</sub> = 150 °C		2.08	2.34	V
V <sub>F0</sub>	chipelevel	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>	chipelevel	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		0.95		mΩ
		T <sub>C</sub> = 125 °C		1.25		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(T)=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					
R <sub>Shunt</sub>	Tolerance = ±1 %, T <sub>c</sub> = 20°C		0.26		mΩ
α				50	ppm/K
T <sub>Shunt</sub>				170	°C
R <sub>th(r-c)</sub>				2	K/W
P <sub>Shunt</sub>	T <sub>c</sub> = 80 °C			45	W



GB + shunt

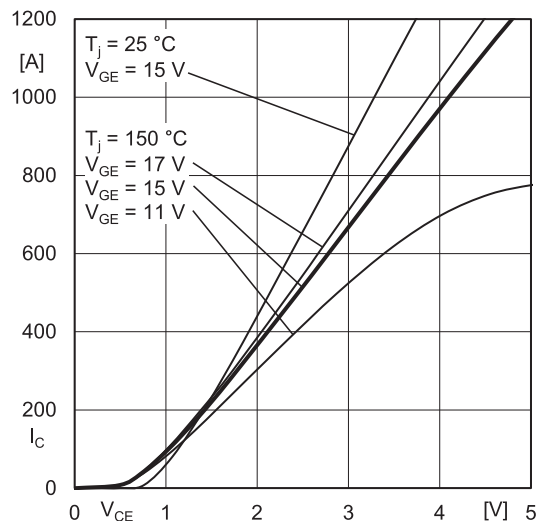


Fig. 1: Typ. output characteristic, inclusive  $R_{CC'+EE'}$

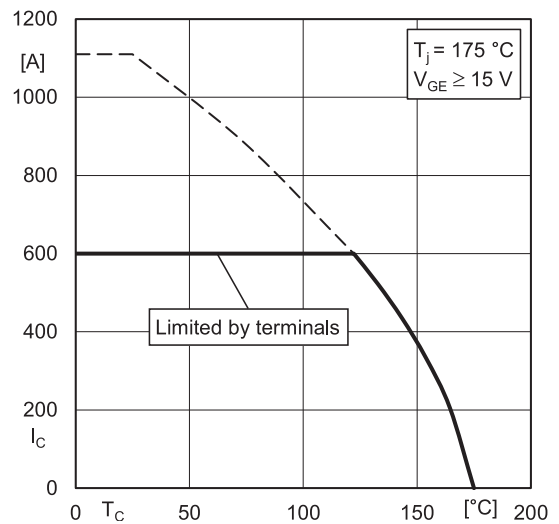


Fig. 2: Rated current vs. temperature  $I_C = f(T_C)$

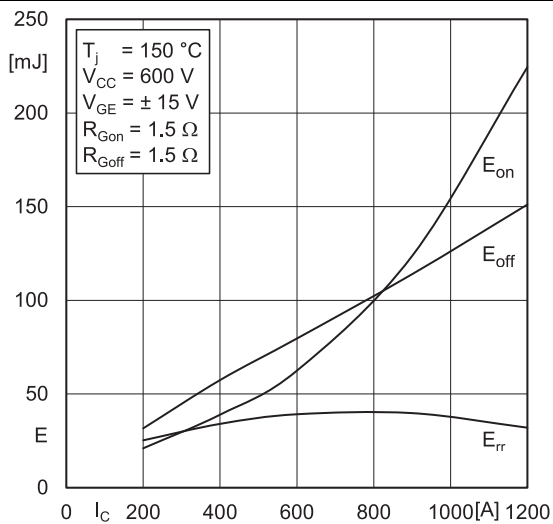


Fig. 3: Typ. turn-on /-off energy =  $f(I_C)$

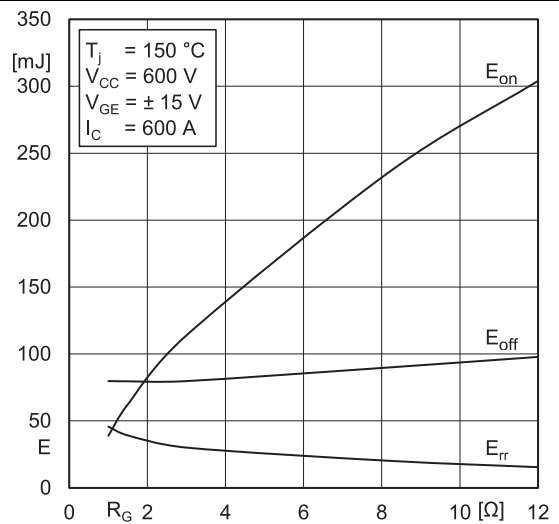


Fig. 4: Typ. turn-on /-off energy =  $f(R_G)$

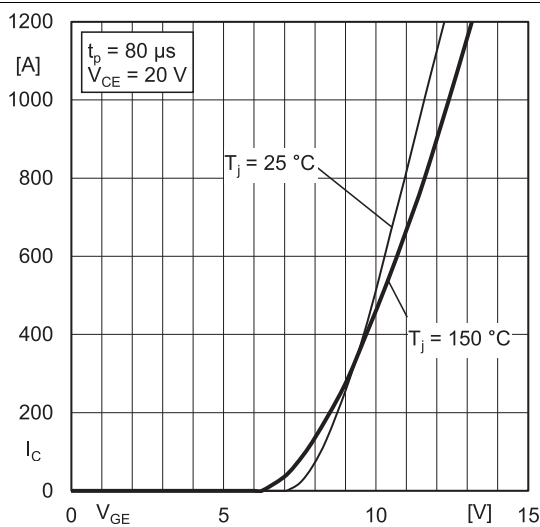


Fig. 5: Typ. transfer characteristic

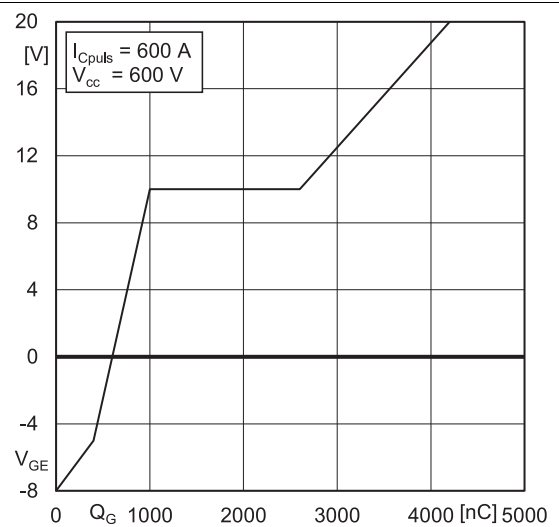


Fig. 6: Typ. gate charge characteristic

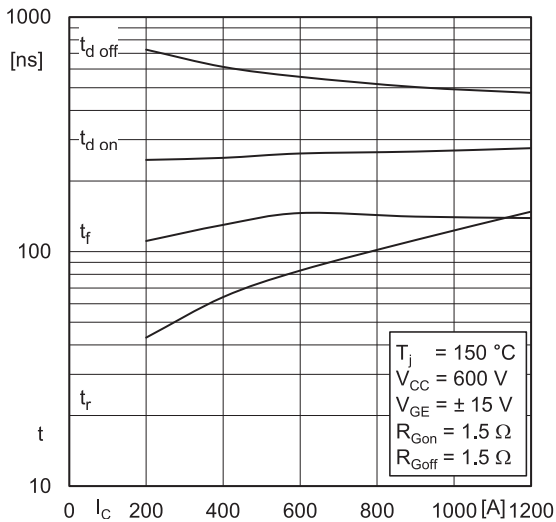


Fig. 7: Typ. switching times vs.  $I_C$

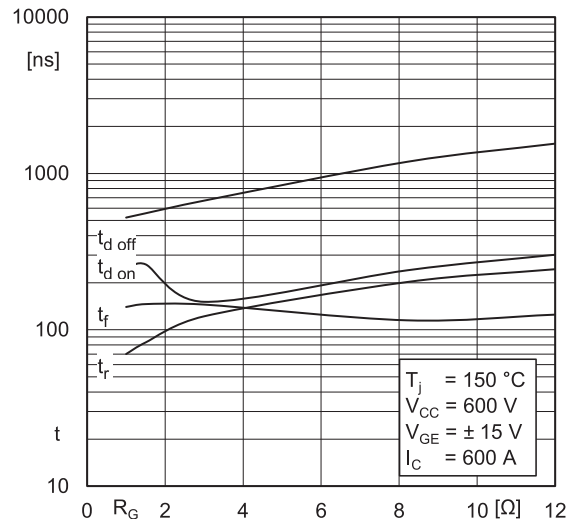


Fig. 8: Typ. switching times vs. gate resistor  $R_G$

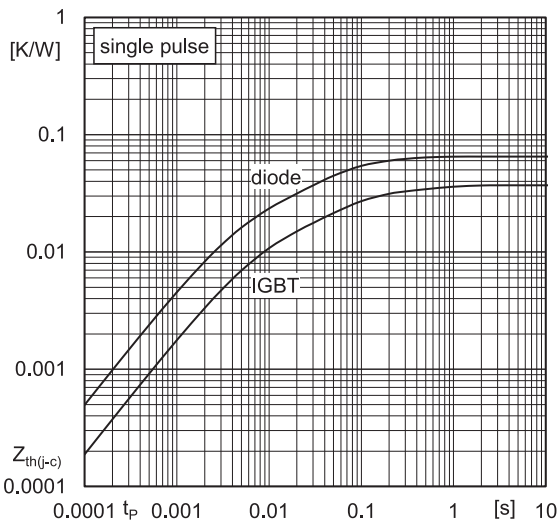


Fig. 9: Transient thermal impedance

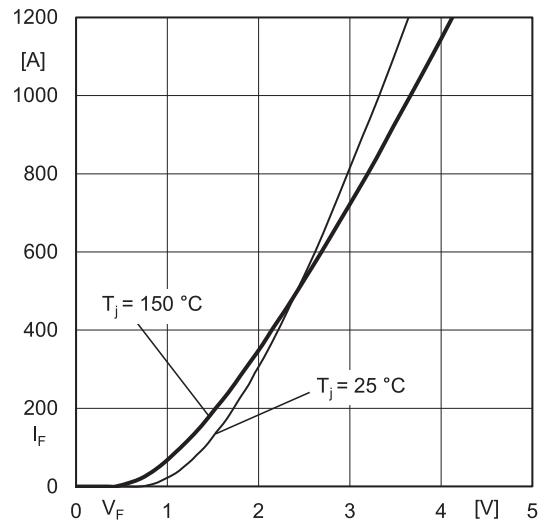


Fig. 10: Typ. CAL diode forward charact., incl.  $R_{CC'+EE'}$

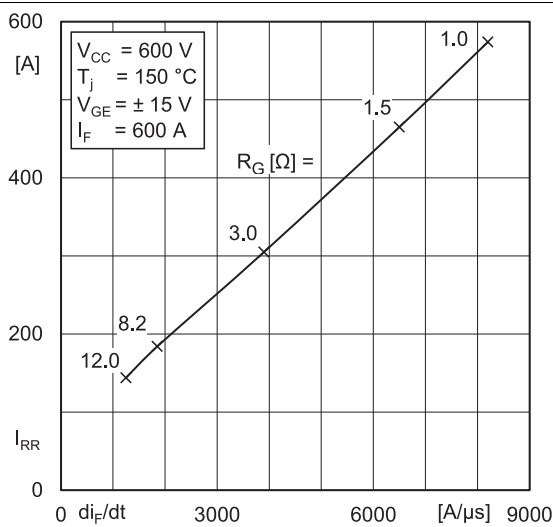


Fig. 11: Typ. CAL diode peak reverse recovery current

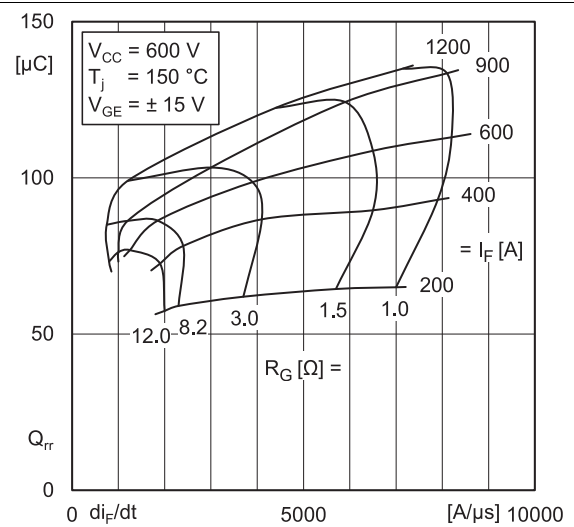
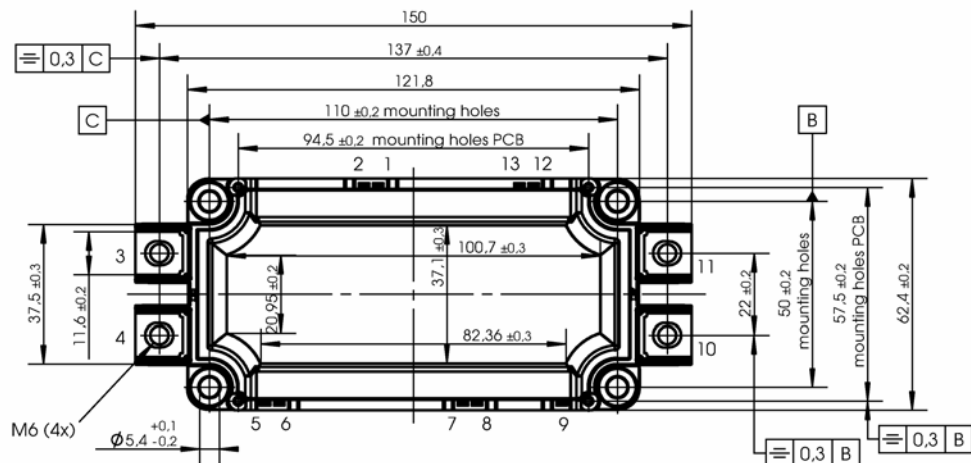
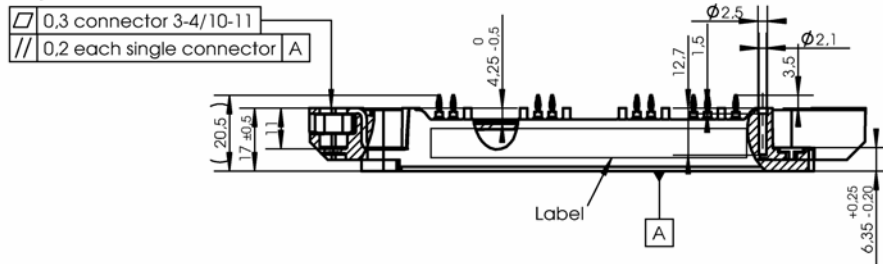
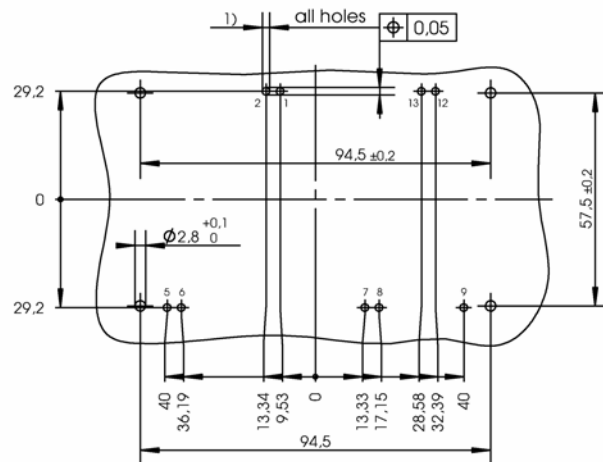


Fig. 12: Typ. CAL diode recovery charge

Package outline



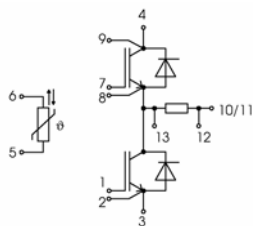
PCB drillhole pattern



Dimensions valid in mounted status

1) PCB hole specification see Mounting Instructions SEMiX press-fit

## SEMiX 3p shunt



pinout

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

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