

### Features

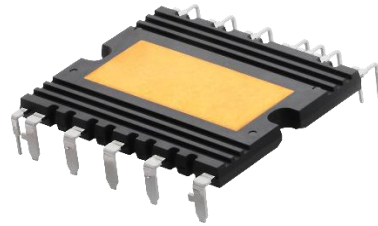
- HSDIP20 package with the 4th Generation SiC-MOSFET
- $V_{DS} = 750V$
- Low  $R_{DS(on)}$
- High-speed switching possible
- Low switching losses
- $T_{vjmax} = 175^{\circ}C$
- Compact design
- With high thermal conductivity isolation
- Integrated NTC temperature sensor
- 4.2kV AC 1s insulation

### Construction

The power module is a 6in1 module. which implements SiC-MOSFETs.

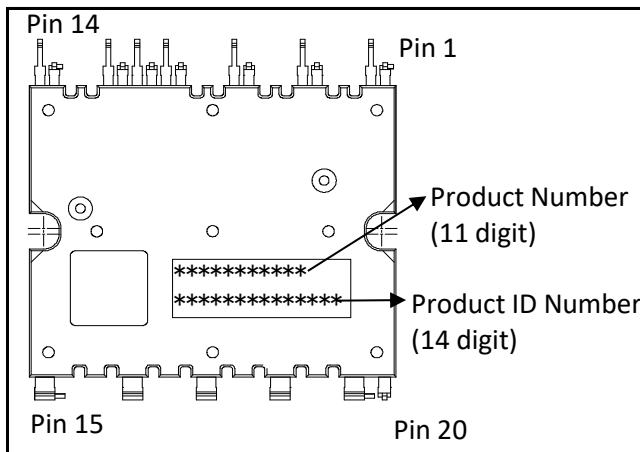
### Application

- Automotive application
- Inverter, Converter
- (Hybrid) electrical vehicles EV/HEV

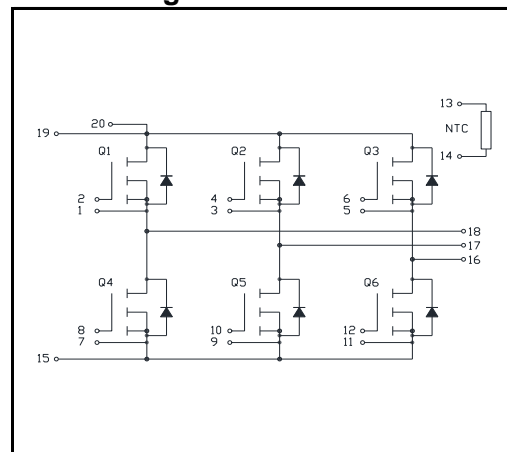


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### Outline



### Circuit diagram



Pin No.	Pin Name	Function
1	S1	MOSFET Source
2	G1	MOSFET Gate
3	S2	MOSFET Source
4	G2	MOSFET Gate
5	S3	MOSFET Source
6	G3	MOSFET Gate
7	S4	MOSFET Source
8	G4	MOSFET Gate
9	S5	MOSFET Source
10	G5	MOSFET Gate

Pin No.	Pin Name	Function
11	S6	MOSFET Source
12	G6	MOSFET Gate
13	T1	Thermistor
14	T2	Thermistor
15	N	Negative power
16	W	Output
17	V	Output
18	U	Output
19	P	Positive Power
20	Ps	Positive Power sense

**Absolute maximum ratings (Tvj = 25°C unless otherwise specified)**

Parameter	Symbol	Conditions	Rating	Unit
Drain - source voltage	$V_{DSS}$	$V_{GS} = 0V$	750	V
Gate - source voltage (DC)	$V_{GSS}$		-4 to +21	
Gate - source voltage ( $t_{surge} < 300ns$ )	$V_{GSSsurge}$		-4 to +23	
Continuous drain current (DC)	$I_D$	$T_c = 25^{\circ}C, V_{GS} = 18V$	90	A
		$T_c = 100^{\circ}C, V_{GS} = 18V$	64	
Pulsed drain current	$I_{D,pulse}$	Pulse 1ms, $T_c = 25^{\circ}C, V_{GS} = 18V$ <sup>Note 2), 5)</sup>	195	
		Pulse 1ms, $T_c = 100^{\circ}C, V_{GS} = 18V$ <sup>Note 2), 5)</sup>	138	
Continuous source current (DC)	$I_S$	$T_c = 25^{\circ}C, V_{GS} = 18V$	90	
Pulsed source current	$I_{S,pulse}$	Pulse 1.5μs, $T_c = 25^{\circ}C, V_{GS} = 18V$ <sup>Note 2)</sup>	195	
Body diode surge forward current	$I_{S,pulse}$	Pulse 1.5μs, $T_c = 100^{\circ}C, V_{GS} = 0V$ <sup>Note 2), 4), 5)</sup>	105	
Total power dissipation <sup>Note 3), 5)</sup>	$P_{tot}$	$T_c = 25^{\circ}C$	385	W
Virtual junction temperature	$T_{vj}$		-40 to +175	$^{\circ}C$
Storage temperature	$T_{stg}$		-40 to +125	

Note 1) If the product is used beyond absolute maximum ratings defined in the specifications, as its internal structure may be damaged, please replace the product with a new one.

Note 2) Repetition rate should be kept within the range where temperature rise if die should not exceed  $T_{vjmax}$ .

Note 3) Case temperature ( $T_c$ ) is defined on the cooper surface just under the chips.

Note 4) Repetitive pulse,  $PW \leq 1.5\mu s$ , Duty cycle  $\leq 5\%$

Note 5)  $T_{vj}$  is less than 175°C.

Figure 1. Example of acceptable  $V_{GS}$  waveform

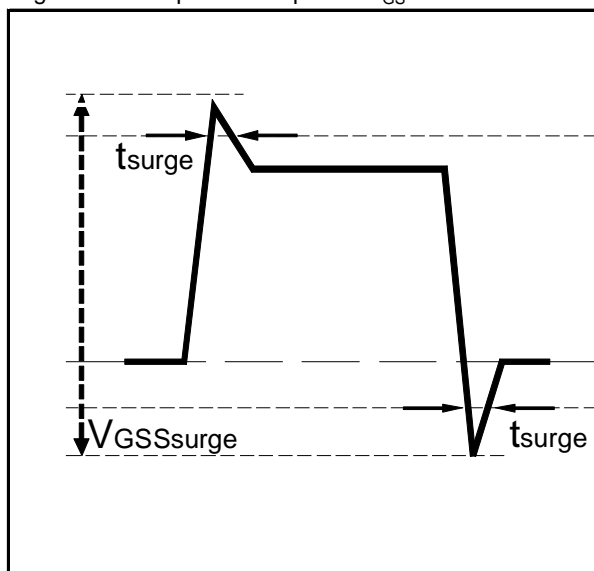
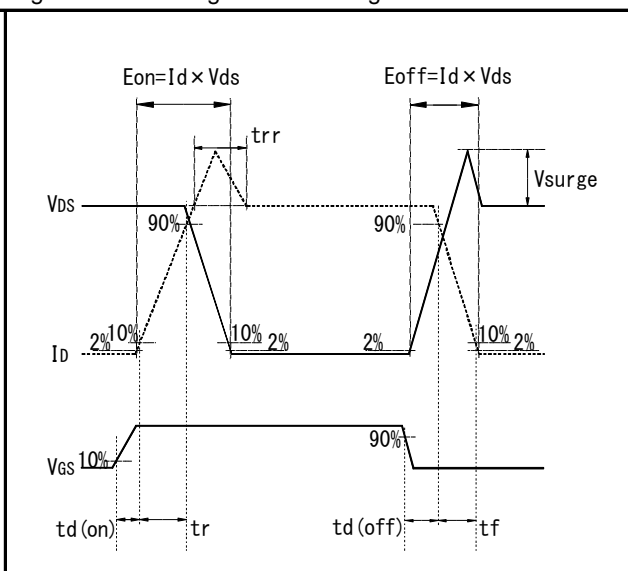


Figure 2. Wavelength for switching test



Module (Tvj = 25°C unless otherwise specified)

Parameter	Symbol	Conditions	Values			Unit
			Min.	Typ.	Max.	
Isolation test voltage	V <sub>isol</sub>	All terminals to baseplate AC 60Hz 1sec.	4200	—	—	V <sub>rms</sub>
Stray inductance	L <sub>s</sub>	Terminal P to Terminal N	—	46	—	nH
Creepage distance	—	Terminal to heat sink	13.9	—	—	mm
		Terminal to terminal	8.2	—	—	
Clearance distance	—	Terminal to heat sink	10.2	—	—	mm
		Terminal to terminal	4.3	—	—	
Module flatness (Heatsink side)	—	Measurement point is shown in Figure 3.	0	—	100	μm
Mounting torque	—	Mounting to heatsink with M3 screw <sup>Note 6)</sup>	0.59	0.69	0.78	N·m
Terminal pulling strength	—	Load:4.9N(Control terminal), 9.8N(Power terminal) <sup>Note 7)</sup>	10	—	—	s
Terminal bending strength	—	Load:2.45N (Control terminal), 4.9N(Power terminal) <sup>Note7)</sup>	2	—	—	time
Thermal resistance, junction - case	R <sub>th(j-c)</sub>	1 arm heating <sup>Note 3)</sup>	—	0.28	0.39	°C/W

- Note 6) 8 mm (outside diameter) plain washers (ISO 7089 to 7094) are recommended.
- Note 7) EIAJ-ED-4701/400
- Note 8) R<sub>th(j-c)</sub> was measured after 1chip heating. Heatsink temperature was keep in 25°C.  
The R<sub>th(j-c)</sub> result was calculated from measured structure function, based on JESD51-14 guideline.  
100μm thickness of thermally conductive grease was introduced between module and heatsink and fastened with two M4 screws with 0.85N·m torque.
- Note 9) When installing a module to a heat sink, excessive uneven fastening force might apply stress to inside chips or ceramic of heat sink plate, which will break or crack or degrade a module.  
An example of recommended fastening sequence is shown in Figure 5. The temporary fastening torque is set to 20 to 30% of the maximum torque rating.

Figure 3. Measurement point of module flatness

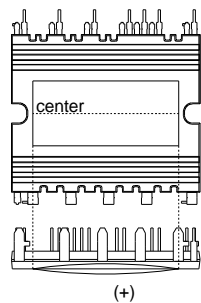


Figure 4. Flatness after installing to a heatsink (when using a heat radiation sheet)

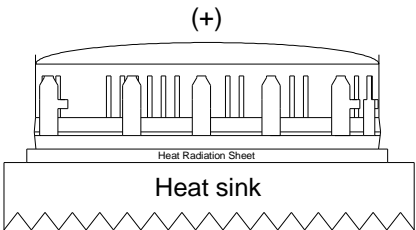
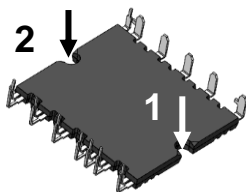


Figure 5. Example of recommended fastening sequence



Temporary fastening: 1→2  
Permanent fastening: 1→2

**MOSFET electrical characteristics (Tvj = 25°C unless otherwise specified)**

Parameter	Symbol	Conditions		Values			Unit
				Min.	Typ.	Max.	
Drain - source on resistance	R <sub>DS(on)</sub>	I <sub>D</sub> = 58A, V <sub>GS</sub> = 18V	Tvj = 25°C	—	13	—	mΩ
		I <sub>D</sub> = 91A, V <sub>GS</sub> = 18V	Tvj = 25°C	—	14	19	
			Tvj = 175°C	—	27	—	
Zero gate voltage drain current	I <sub>DSS</sub>	V <sub>DS</sub> = 750V, V <sub>GS</sub> = 0V		—	—	80	μA
Drain-Source breakdown voltage	V <sub>(BR)DSS</sub>	V <sub>GS</sub> = 0V, I <sub>D</sub> =18.6mA, T <sub>vj</sub> =25°C		750	—	—	V
Gate - source threshold voltage	V <sub>GS(th)</sub>	V <sub>DS</sub> = 10V, I <sub>D</sub> = 30.8mA <sup>Note 12)</sup>		2.8	—	4.8	V
Gate - source leakage current	I <sub>GSS</sub>	V <sub>GS</sub> = +21V, V <sub>DS</sub> = 0V		—	—	0.1	μA
		V <sub>GS</sub> = -4V, V <sub>DS</sub> = 0V		-0.1	—	—	
Turn - on delay time	t <sub>d(on)</sub>	V <sub>GS(on)</sub> = 18V, V <sub>GS(off)</sub> = 0V V <sub>DS</sub> = 400V I <sub>D</sub> = 90A R <sub>G(on)</sub> = 18Ω, R <sub>G(off)</sub> = 18Ω Inductive load		—	49.3	—	ns
Rise time	t <sub>r</sub>			—	39.3	—	
Turn - off delay time	t <sub>d(off)</sub>			—	213.2	—	
Fall time	t <sub>f</sub>			—	14.2	—	
Turn - on switching loss	E <sub>on</sub>			—	1.61	—	mJ
Turn - off switching loss	E <sub>off</sub>			—	1.79	—	
Input capacitance	C <sub>iss</sub>	V <sub>DS</sub> = 500V, V <sub>GS</sub> = 0V, 1MHz		—	4.58	—	nF
Total gate charge	Q <sub>g</sub>	V <sub>GS(on)</sub> = 18V, V <sub>GS(off)</sub> = 0V V <sub>DS</sub> = 500V I <sub>D</sub> = 58A		—	170	—	nC
Gate - source charge	Q <sub>gs</sub>			—	39	—	
Gate - drain charge	Q <sub>gd</sub>			—	42	—	
Internal gate resistance	R <sub>Gint</sub>	Tvj = 25°C		—	1	—	Ω

Note 10) Evenly apply thermally-conductive grease with 100μm to 200μm thickness over the contact surface between the module and the heat sink. Pay attention not to have any dirt left on the contact surface between the module and the heat sink.

It is recommended to install a module directly to a heat sink after applying grease.

Note 11) When installing a module to a heat sink, inserting a heat radiation sheet between a module and a heat sink might apply stress depending on thickness and elastic modulus of the sheet to inside chips or ceramic of heat sink plate, which will break or crack or degrade a module.  
When using a heat radiation sheet, it is needed to prevent power module from bending into + side of Figure 4.

Note 12) Tested after applying  $V_{GS} = 21V$  for 100ms.

Note 13) SiC devices have lower short circuit withstand capability due to high current density.  
Please be advised to pay careful attention to short circuit accident and try to adjust protection time to shutdown them as short as possible.

Body diode electrical characteristics (Tvj = 25°C unless otherwise specified)

Parameter	Symbol	Conditions	Values			Unit
			Min.	Typ.	Max.	
Souce - drain voltage	VSD	VGS = 0V, IS = 91A	Tvj = 25°C	—	3.9	—
			Tvj = 175°C	—	4.0	—
		VGS =18V, IS = 91A	Tvj = 25°C	—	1.15	—
			Tvj = 175°C	—	2.03	—

NTC Thermistor electrical characteristics (Tvj = 25°C unless otherwise specified)

Parameter	Symbol	Conditions	Values			Unit
			Min.	Typ.	Max.	
NTC rated resistance	R25	Tc = 25°C	—	10	—	kΩ
NTC B Value	B50/25		—	3380	—	K
Maximum operating current	—		—	—	0.1	mA

Electrical characteristic curves (Typical)

Figure 6. Output characteristic at 25°C (Typ.)

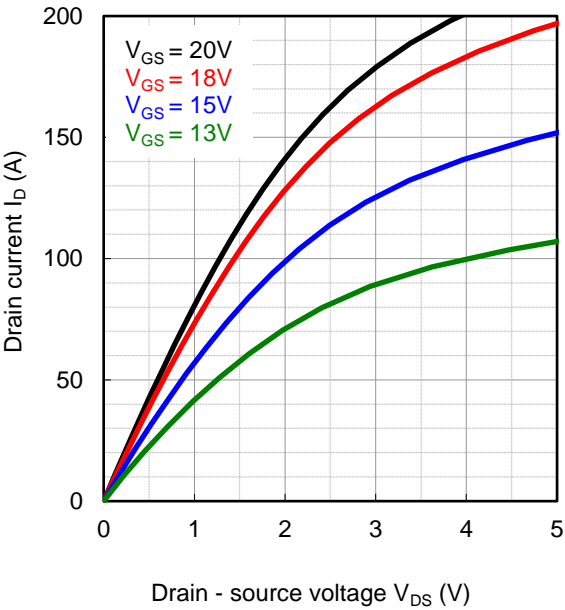


Figure 7. Drain - source voltage characteristic (Typ.)

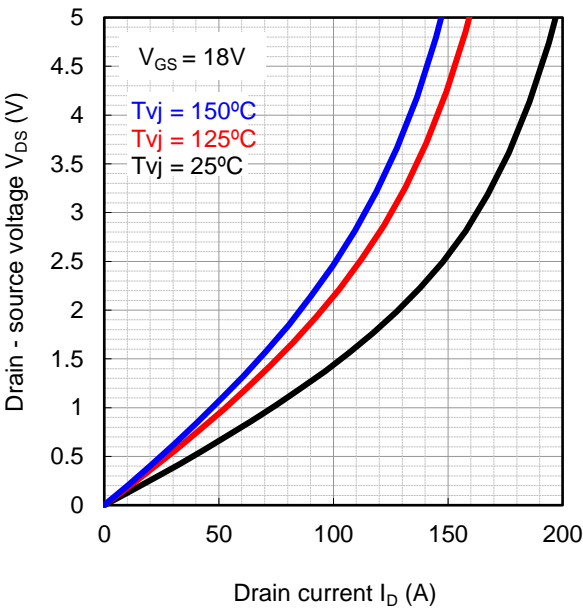
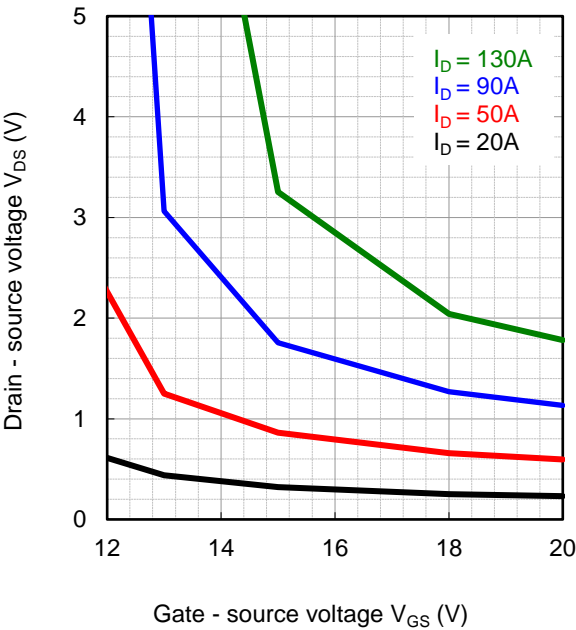


Figure 8. Drain - source voltage characteristic at 25°C (Typ.)



Electrical characteristic curves (Typical)

Figure 9.  $R_{DS(on)}$  vs.  $T_{vj}$  characteristic (Typ.)

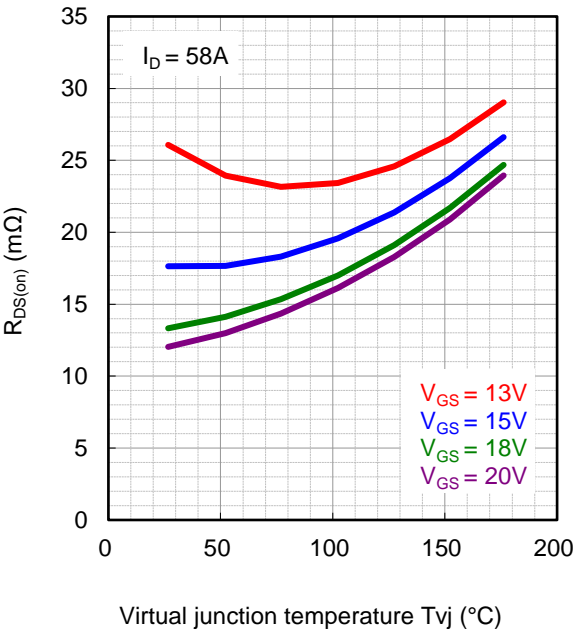


Figure 10. Forward characteristic of diode  $V_{GS} = 18V$  (Typ.)

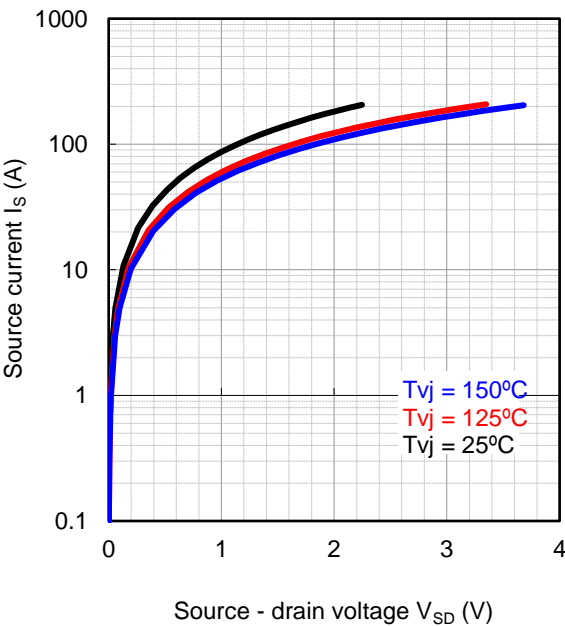
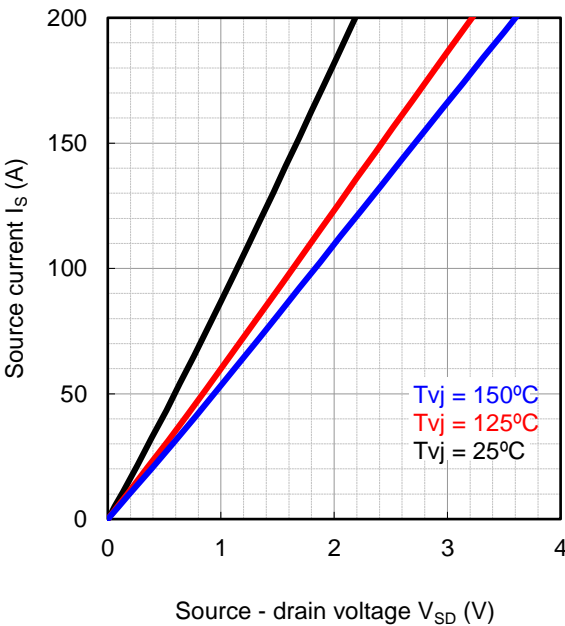


Figure 11. Forward characteristic of diode  $V_{GS} = 18V$  (Typ.)



Electrical characteristic curves (Typical)

Figure 12. Forward characteristic of diode  
 $V_{GS} = 0V$  (Typ.)

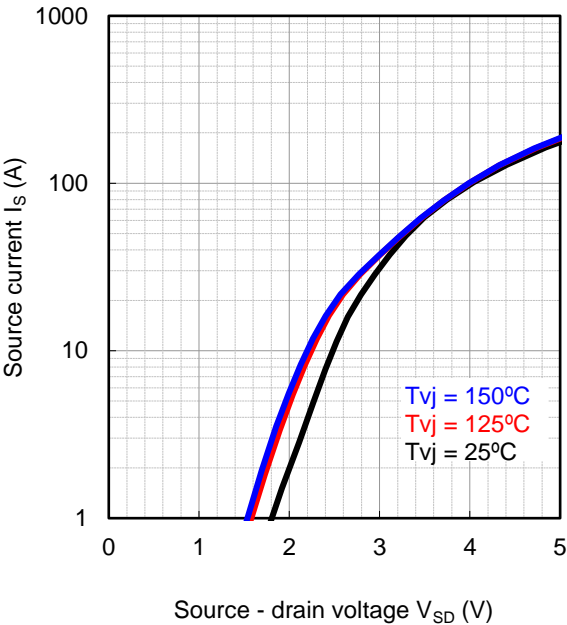


Figure 13. Forward characteristic of diode  
 $V_{GS} = 0V$  (Typ.)

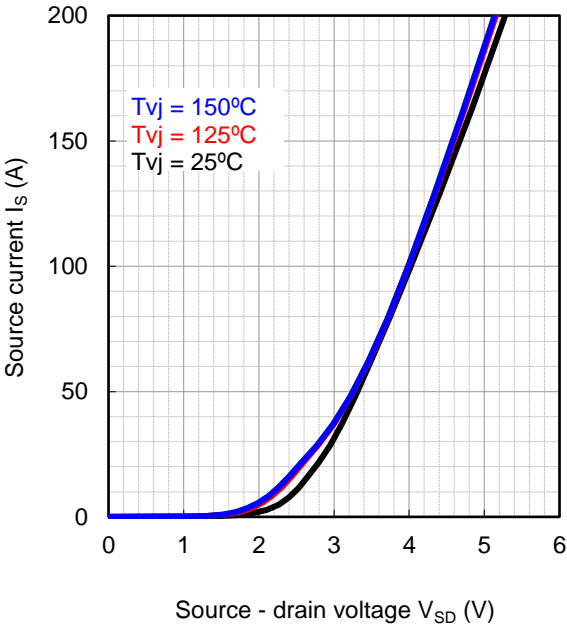


Figure 14. Drain current vs. Gate - source voltage (Typ.)

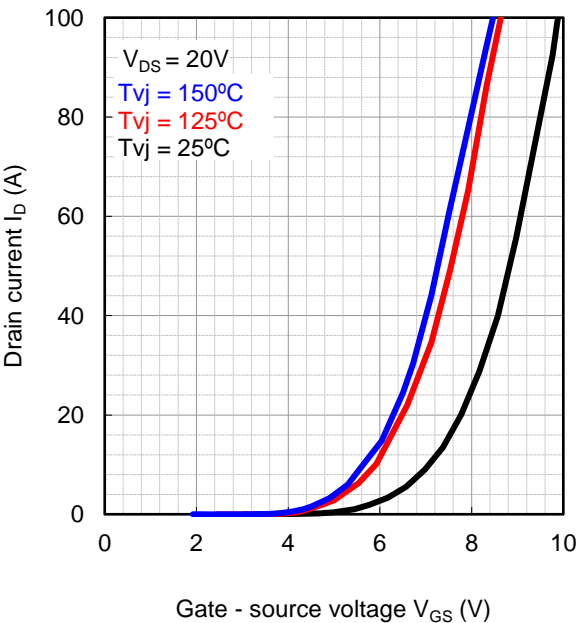
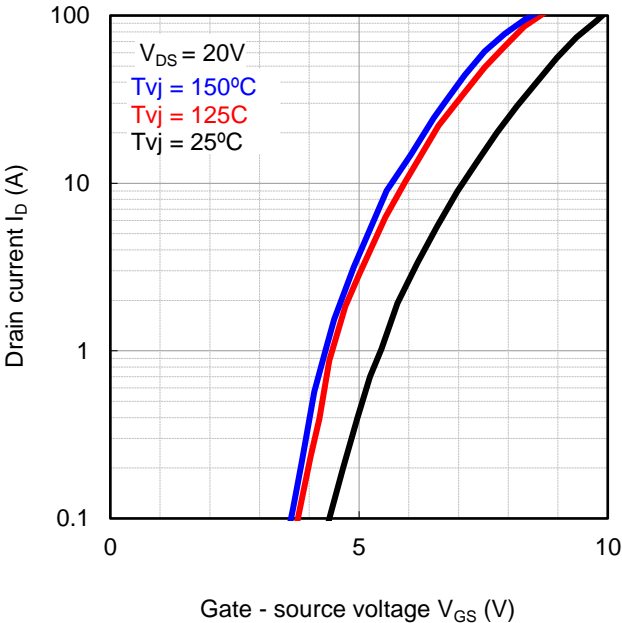


Figure 15. Drain current vs. Gate - source voltage (Typ.)





Electrical characteristic curves (Typical)

Figure 16. Switching time vs. Drain current at 25°C (Typ.)

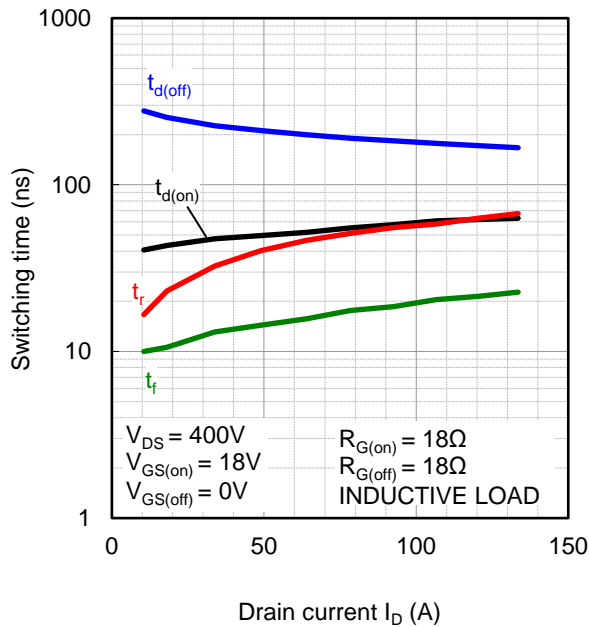


Figure 17. Switching time vs. Drain current at 150°C (Typ.)

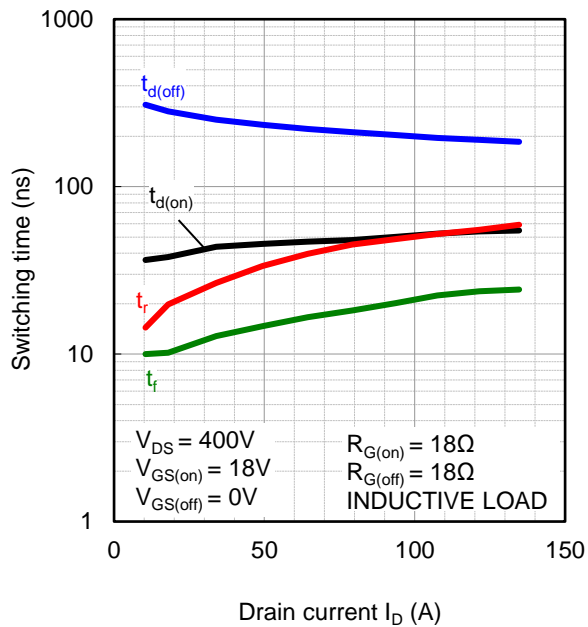


Figure 18. Switching loss vs. Drain current at 25°C (Typ.)

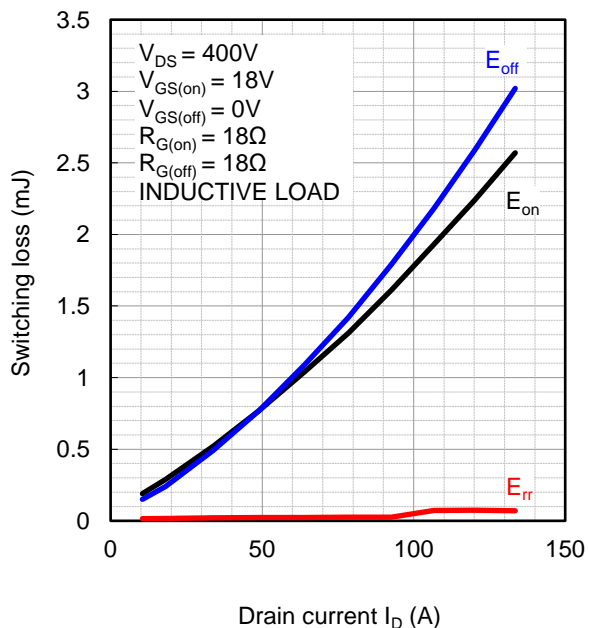
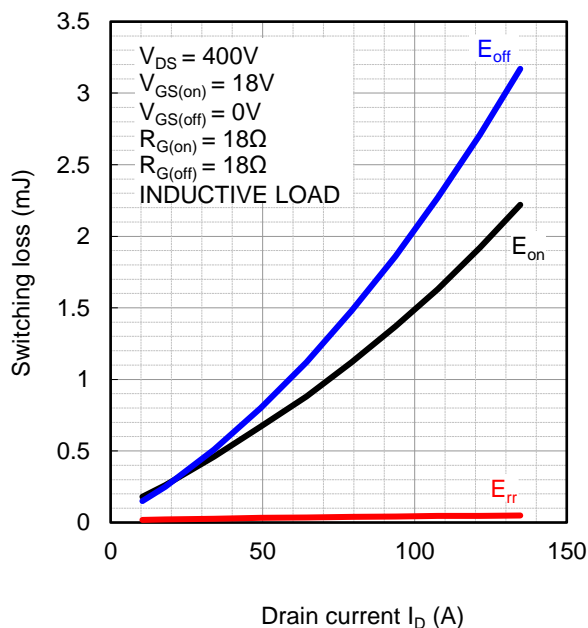


Figure 19. Switching loss vs. Drain current at 150°C (Typ.)



Electrical characteristic curves (Typical)

Figure 20. Recovery characteristic vs. Drain current at 25°C (Typ.)

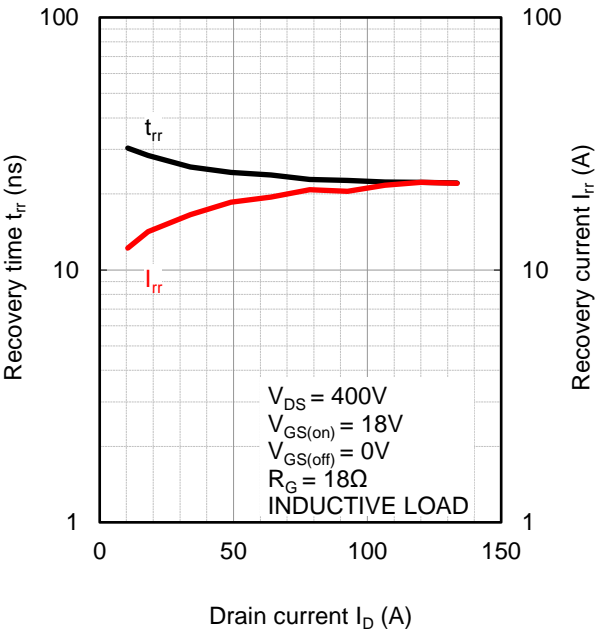


Figure 21. Recovery characteristic vs. Drain current at 150°C (Typ.)

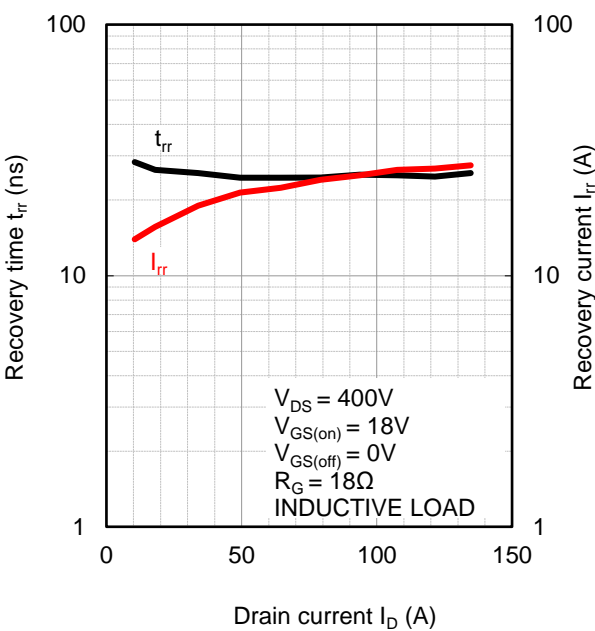


Figure 22. Switching time vs. Gate resistance at 25°C (Typ.)

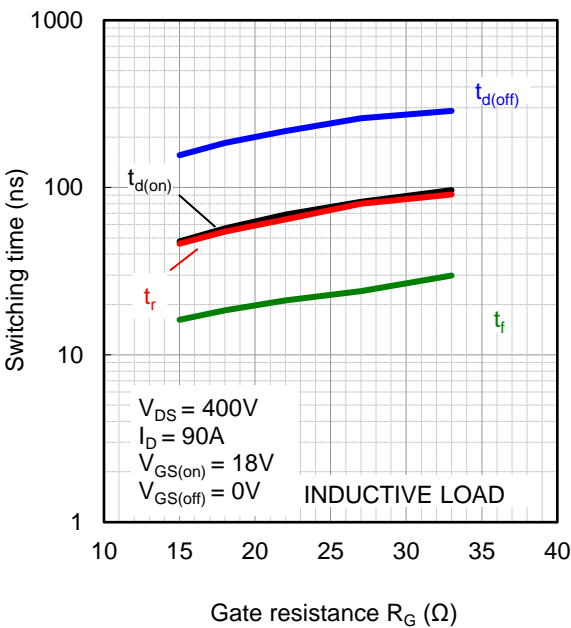
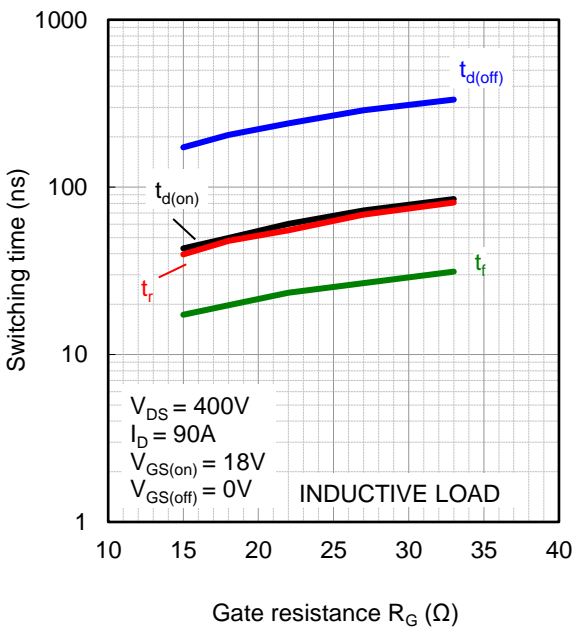


Figure 23. Switching time vs. Gate resistance at 150°C (Typ.)



Electrical characteristic curves (Typical)

Figure 24. Switching loss vs. Gate resistance at 25°C (Typ.)

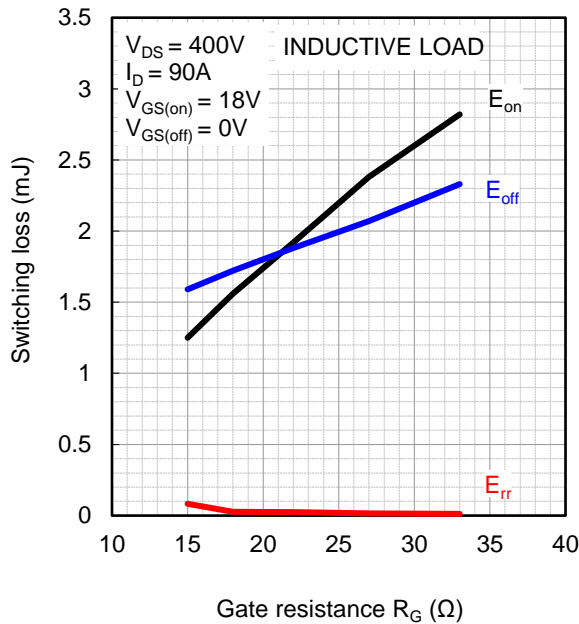


Figure 25. Switching loss vs. Gate resistance at 150°C (Typ.)

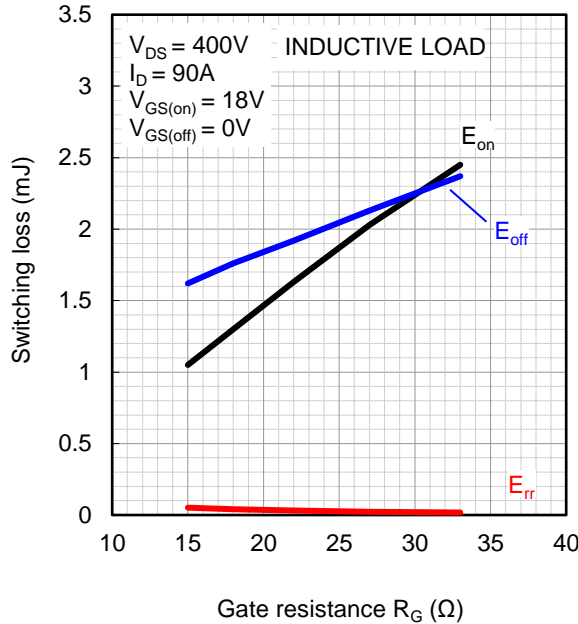


Figure 26. Capacitance vs. Drain - source voltage at 25°C (Typ.)

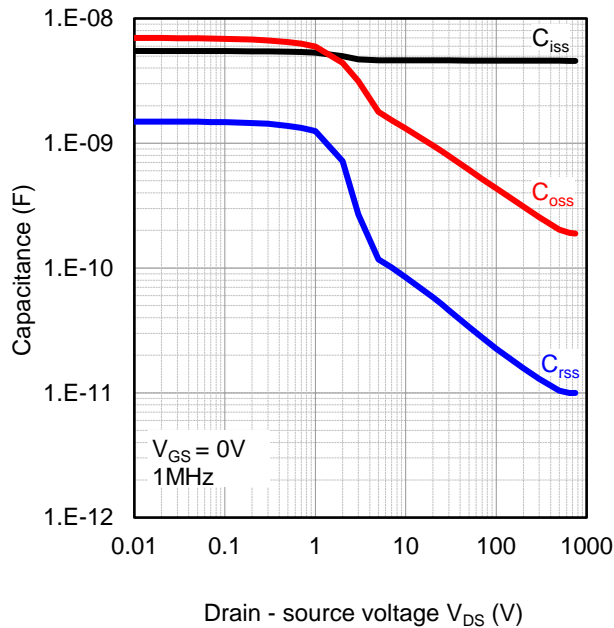
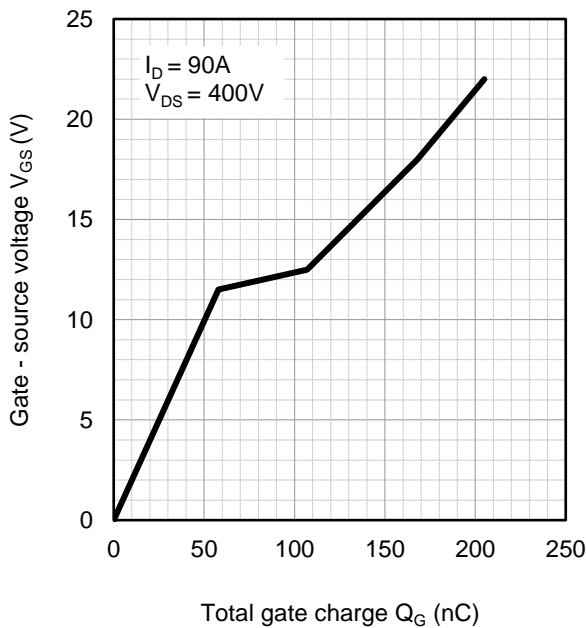
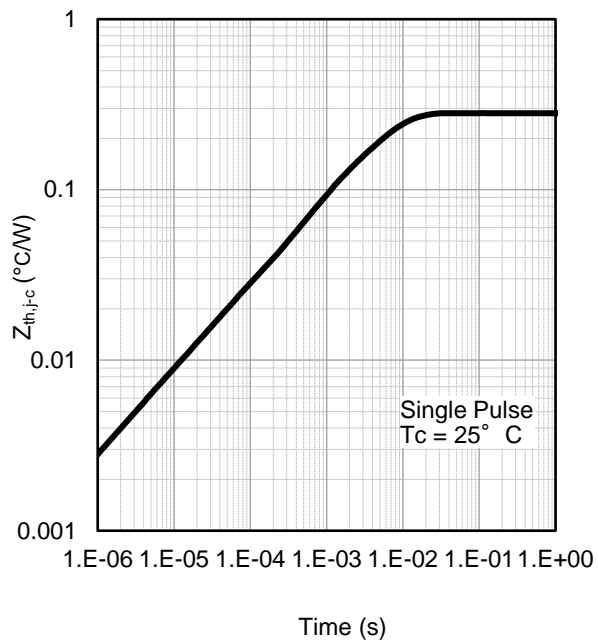


Figure 27. Gate charge characteristic at 25°C (Typ.)



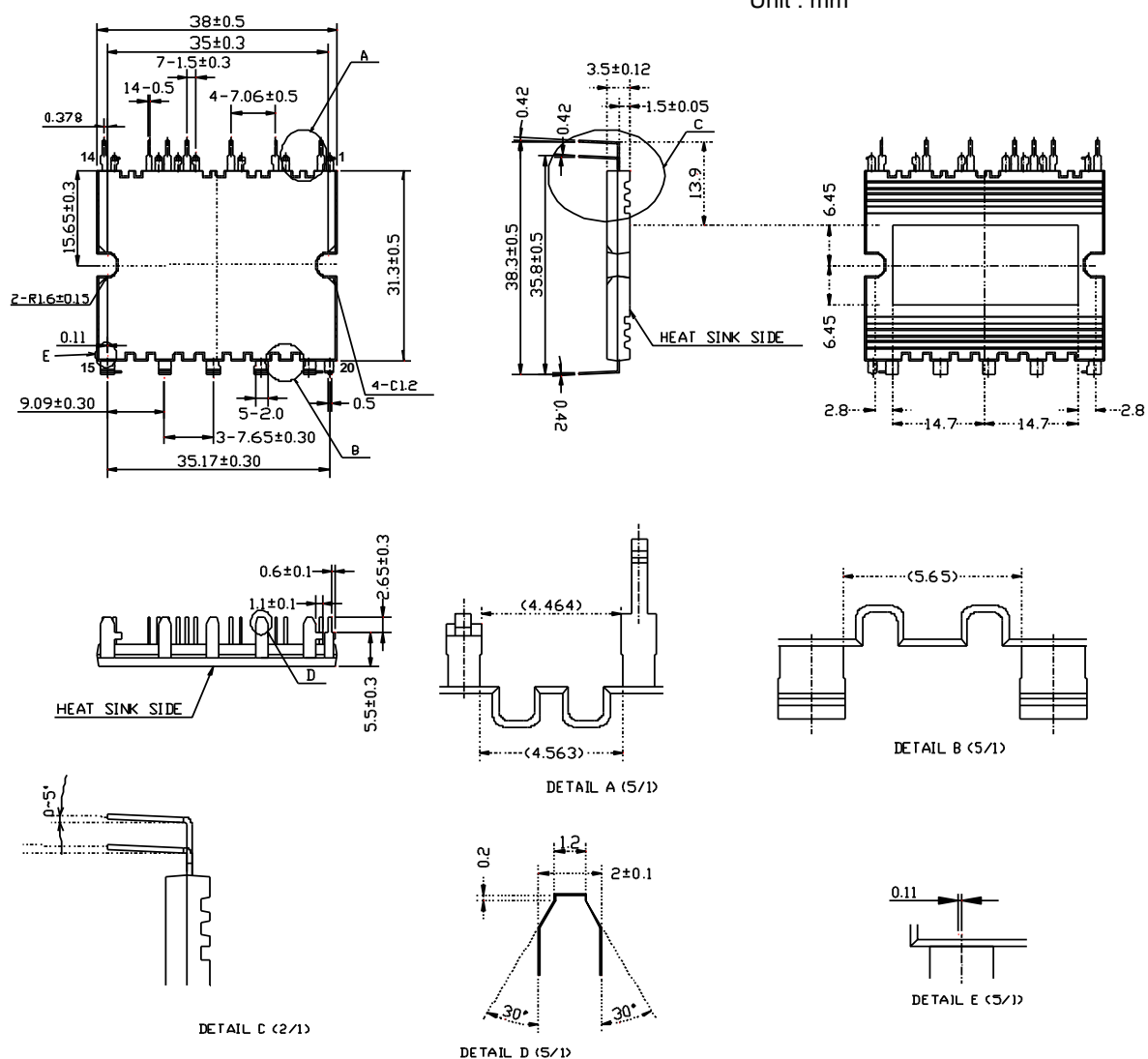
## Electrical characteristic curves (Typical)

Figure 28. Transient thermal impedance (Typ.)



## Package outlines

Unit : mm



## Notes

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