

**1200V, 65A, N-channel SiC power MOSFET**
**General Description:**

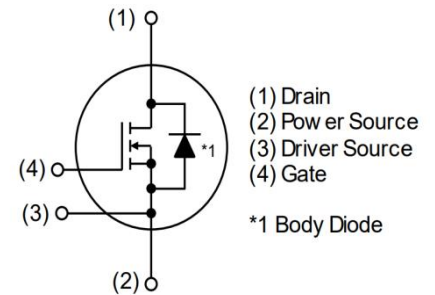
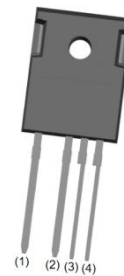
NCES120P040T4N is a SiC MOSFET that contributes to miniaturization and low power consumption of applications. This product achieves industry-leading low on-resistance without sacrificing short-circuit withstand time. This is a 4-pin package type with a driver source terminal that can maximize the high-speed switching performance that is a feature of SiC MOSFETs.

**Features**

- Low on-resistance
- Fast switching speed
- Fast reverse recovery
- Easy to parallel
- Simple to drive
- Pb-free lead plating ; RoHS compliant

**Application**

- Solar inverters
- DC/DC converters
- Switch mode power supplies
- Induction heating
- Motor drives


**Schematic diagram**

**TO-247-4LP**
**Package Marking and Ordering Information**

Device	Device Package	Device Marking
NCES120P040T4N	TO-247-4LP	NCES120P040T4N

**Absolute Maximum Ratings (T<sub>c</sub>=25°C unless otherwise noted)**

Parameter	Symbol	Limit	Unit
Drain-Source Voltage	V <sub>DS</sub>	1200	V
Gate-Source Voltage,max static voltage	V <sub>GS</sub>	-10 to +24	V
Gate-Source Voltage,max transient voltage (Note 1)	V <sub>GS</sub>	-11 to +26	V
Drain Current-Continuous (Note 2)	I <sub>D</sub>	65	A
Drain Current-Continuous(T <sub>c</sub> =100°C)	I <sub>D</sub> (100°C)	46	A
Pulsed Drain Current (Note 3)	I <sub>DM</sub>	163	A
Maximum Power Dissipation	P <sub>D</sub>	T <sub>vj</sub> = 25°C	326
		T <sub>vj</sub> = 100°C	163
Recommended turn-on gate - source drive voltage	V <sub>GS_on</sub>	+15 to +18	V
Recommended turn-off gate - source drive voltage	V <sub>GS_off</sub>	-4 to 0	V
Virtual junction temperature	T <sub>vj</sub>	175	°C
Operating Junction and Storage Temperature Range	T <sub>J</sub> , T <sub>STG</sub>	-55 To 175	°C

**Thermal Characteristic**

Symbol	Parameter	Value	Units
R <sub>θJC</sub>	Thermal Resistance, Junction to case	0.46	°C/W

**Electrical Characteristics (T<sub>c</sub>=25°C unless otherwise noted)**

Parameter	Symbol	Condition	Min	Typ	Max	Unit	
<b>Off Characteristics</b>							
Drain-Source Breakdown Voltage	BV <sub>DSS</sub>	V <sub>GS</sub> =0V, I <sub>D</sub> =100μA	1200			V	
Zero Gate Voltage Drain Current	I <sub>DSS</sub>	V <sub>DS</sub> =1200V, V <sub>GS</sub> =0V	T <sub>vj</sub> = 25°C	1	80	μA	
			T <sub>vj</sub> = 175°C	2			
Gate-Body Leakage Current	I <sub>GSS</sub>	V <sub>GS</sub> =-10V / +24V, V <sub>DS</sub> =0V			±100	nA	
<b>On Characteristics</b> (Note 4)							
Gate Threshold Voltage	V <sub>GS(th)</sub>	V <sub>DS</sub> =V <sub>GS</sub> , I <sub>D</sub> =6mA	T <sub>vj</sub> = 25°C	1.9	3.2	4.8	V
			T <sub>vj</sub> = 175°C		2.4		
Drain-Source On-State Resistance	R <sub>DS(ON)</sub>	V <sub>GS</sub> =18V, I <sub>D</sub> =20A	T <sub>vj</sub> = 25°C	40	52	mΩ	
			T <sub>vj</sub> = 175°C	65			
Gate input resistance	R <sub>G</sub>	f=1MHZ, open drain		3.0		Ω	
Forward Transconductance	g <sub>FS</sub>	V <sub>DS</sub> =20V, I <sub>D</sub> =20A		12		S	
<b>Dynamic Characteristics</b> (Note 5)							
Input Capacitance	C <sub>iss</sub>	V <sub>DS</sub> =800V, V <sub>GS</sub> =0V, f=1MHZ		2210		pF	
Output Capacitance	C <sub>OSS</sub>			86		pF	
Reverse Transfer Capacitance	C <sub>rSS</sub>			4.3		pF	
C <sub>OSS</sub> stored energy	E <sub>OSS</sub>			37		μJ	
Output charge	Q <sub>OSS</sub>	Calculated by C <sub>OSS</sub> (f)V <sub>DS</sub> @1MHZ		130		nC	
Effective output capacitance, energy related	C <sub>O(er)</sub>	V <sub>DS</sub> =0-500V, V <sub>GS</sub> =0V		104		pF	
Effective output capacitance, time related	C <sub>O(tr)</sub>	I <sub>C</sub> =constant, V <sub>DS</sub> =0-500V, V <sub>GS</sub> =0V		261		pF	
<b>Switching Characteristics</b> (Note 5)							
Turn-on Delay Time	t <sub>d(on)</sub>	V <sub>DD</sub> =800V, I <sub>D</sub> =20A, V <sub>GS</sub> =+18V / -3V, R <sub>G</sub> =2.7Ω, L=200μH		14.2		ns	
Turn-on Rise Time	t <sub>r</sub>			17.3		ns	
Turn-Off Delay Time	t <sub>d(off)</sub>			35		ns	
Turn-Off Fall Time	t <sub>f</sub>			12.8		ns	
Turn-on energy	E <sub>on</sub>	V <sub>DD</sub> =800V, I <sub>D</sub> =20A, V <sub>GS</sub> =+18V / -3V, R <sub>G</sub> =2.7Ω, L=200μH	T <sub>vj</sub> = 25°C	268		μJ	
			T <sub>vj</sub> = 175°C	412		μJ	
Turn-off energy	E <sub>off</sub>		T <sub>vj</sub> = 25°C	55		μJ	
			T <sub>vj</sub> = 175°C	66		μJ	
Total Gate Charge	Q <sub>g</sub>	V <sub>DS</sub> =800V, I <sub>D</sub> =20A, V <sub>GS</sub> =-3/18V		107		nC	
Gate-Source Charge	Q <sub>gs</sub>			27		nC	
Gate-Drain Charge	Q <sub>gd</sub>			46		nC	

**Electrical Characteristics (T<sub>C</sub>=25°C unless otherwise noted)**

Parameter	Symbol	Condition	Min	Typ	Max	Unit
<b>Drain-Source Diode Characteristics</b>						
Diode Forward Voltage (Note 4)	V <sub>SD</sub>	V <sub>GS</sub> =0V, I <sub>D</sub> =20A	T <sub>vj</sub> = 25°C		3.5	V
			T <sub>vj</sub> = 175°C		3.2	
Reverse Recovery Time	t <sub>rr</sub>	T <sub>J</sub> = 25°C, I <sub>F</sub> =20A, V <sub>R</sub> =800V, di/dt = 2800A/μs (Note3)		15		ns
Reverse Recovery Charge	Q <sub>rr</sub>			250		nC
Peak reverse recovery current	I <sub>rrm</sub>			25		A

**Notes:**

1. t<sub>p</sub> < 500ns, D < 0.01
2. Repetitive Rating: Pulse width limited by maximum junction temperature.
3. PW ≤ 10μs, Duty cycle ≤ 1%
4. Pulse Test: Pulse Width ≤ 300μs, Duty Cycle ≤ 2%.
5. Guaranteed by design, not subject to production

Test Circuit

Fig.1-1 Gate Charge Measurement Circuit



Fig.1-2 Gate Charge Waveform

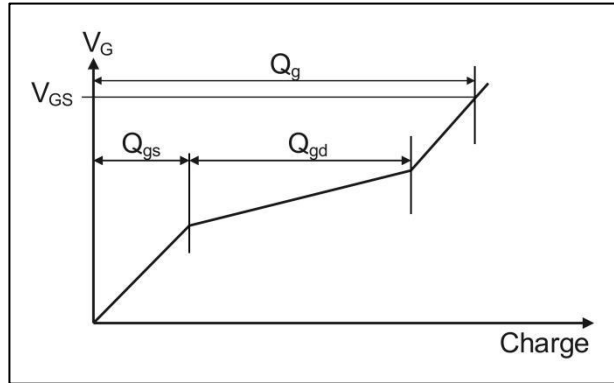


Fig.2-1 Switching Characteristics Measurement Circuit

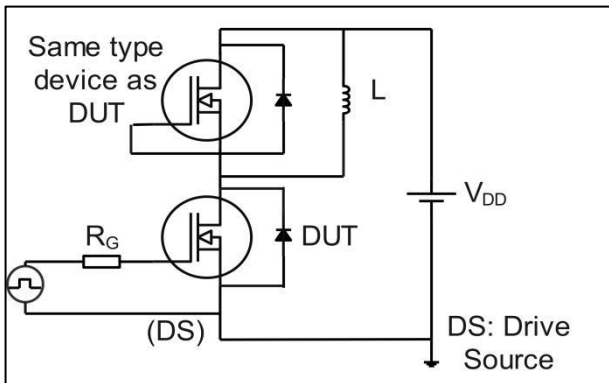
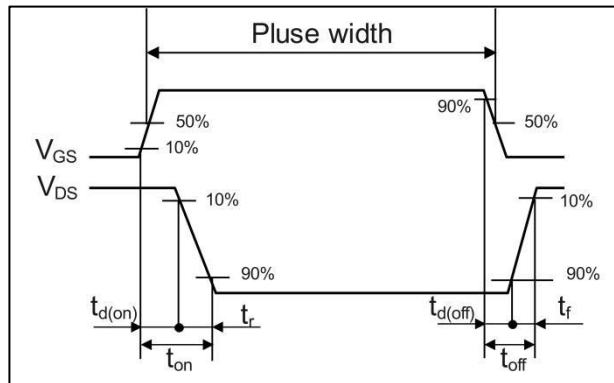


Fig.2-2 Waveforms for Switching Time



Typical Electrical and Thermal Characteristics

Fig.1 Power Dissipation Derating Curve

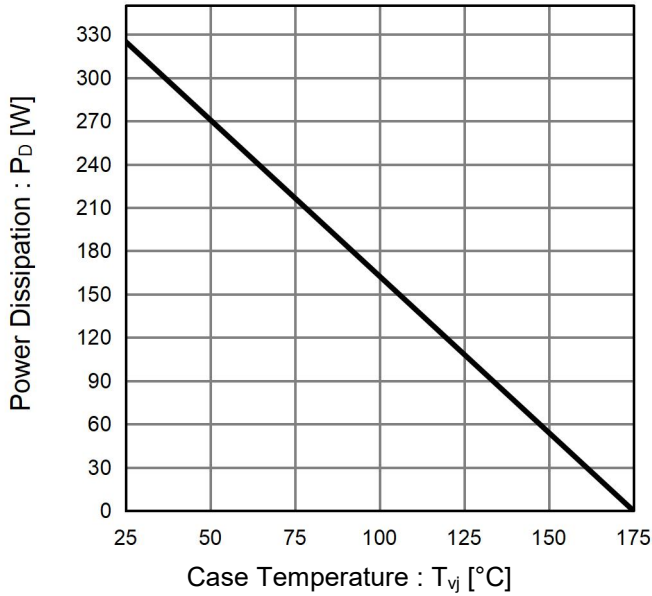


Fig.2 Maximum Safe Operating Area

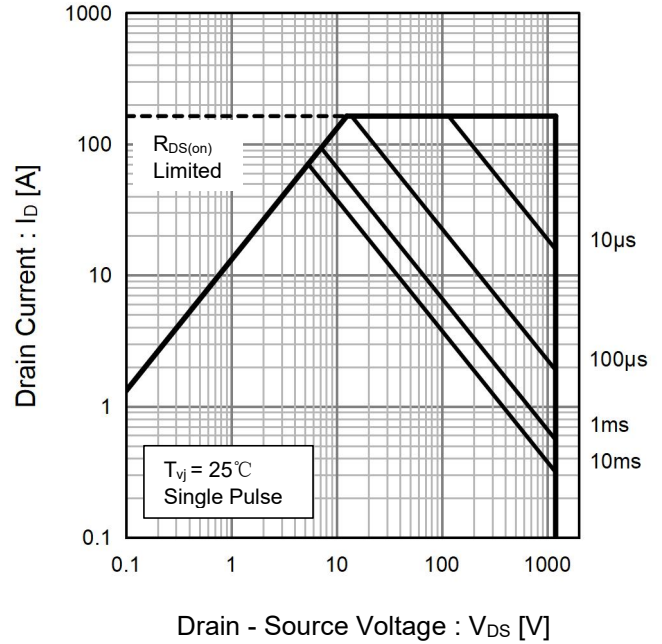


Fig.3 Typical Transient Thermal Impedance vs. Pulse Width

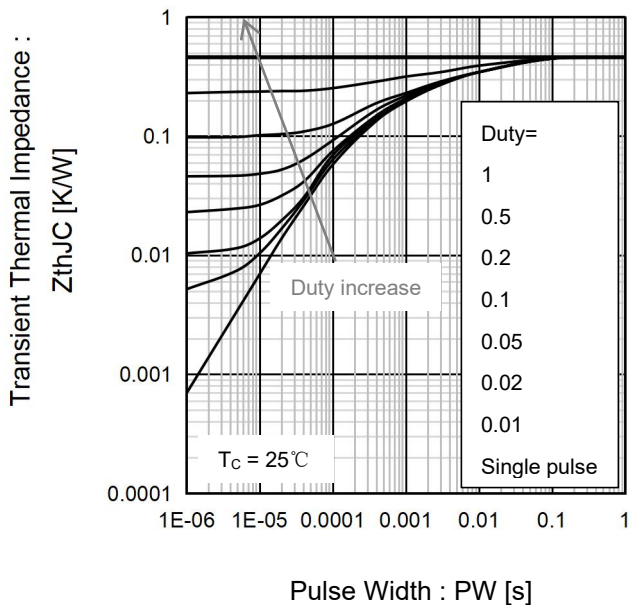


Fig.4  $T_{vj} = 25^{\circ}\text{C}$  Typical Output Characteristics

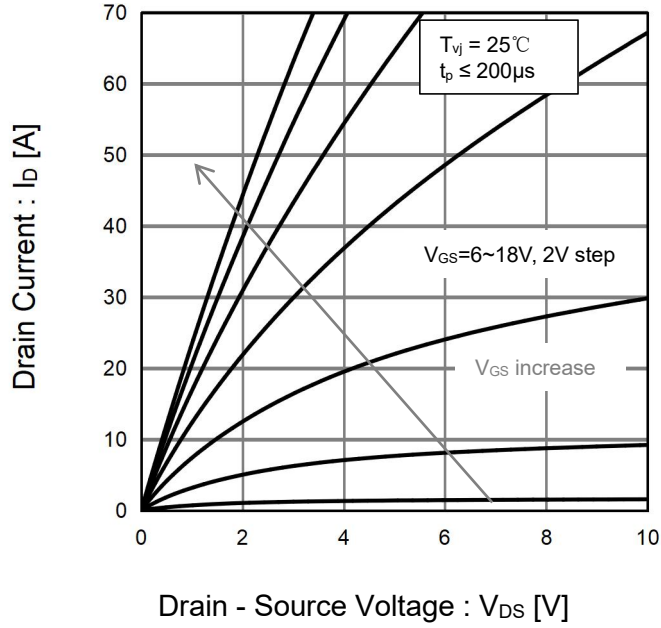


Fig.5  $T_{vj} = 25^{\circ}\text{C}$  3rd Quadrant Characteristics

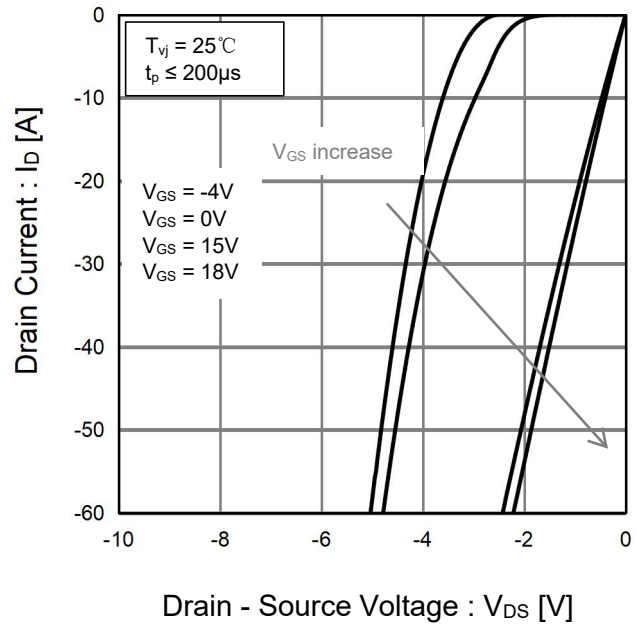


Fig.6  $T_{vj} = 175^{\circ}\text{C}$  Typical Output Characteristics

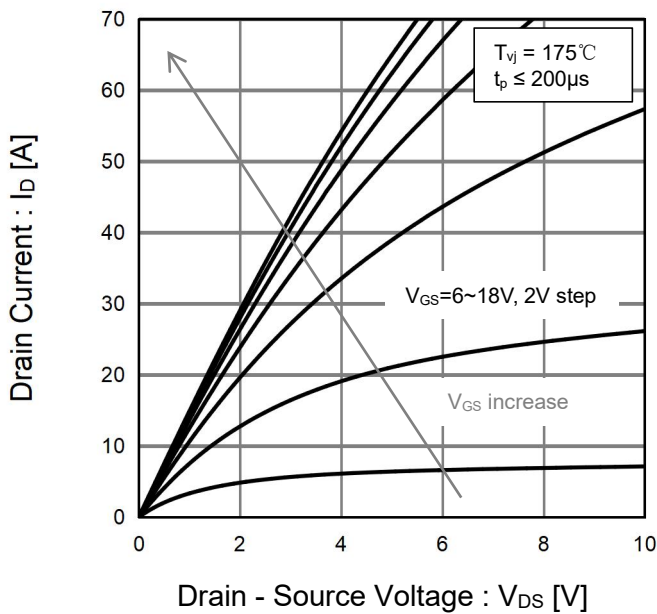


Fig.7  $T_{vj} = 175^{\circ}\text{C}$  3rd Quadrant Characteristics

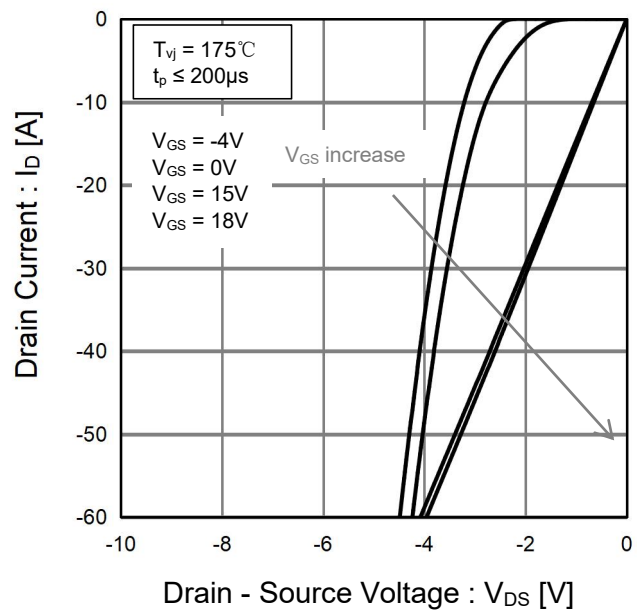


Fig.8 Typical Transfer Characteristics

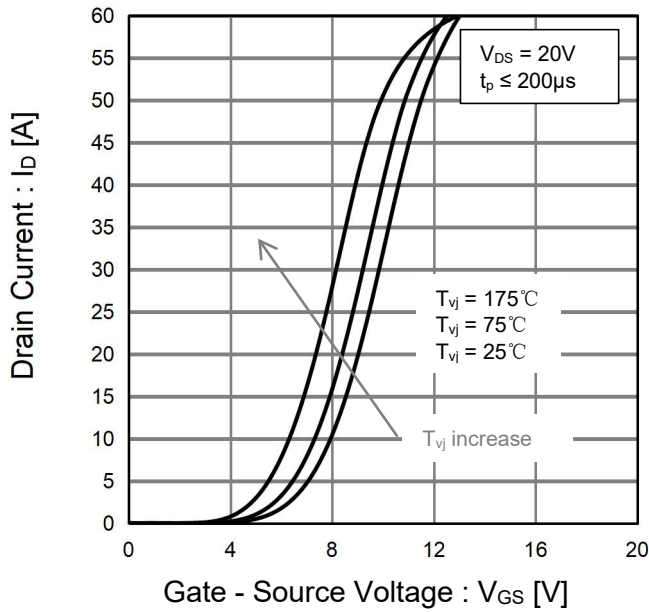


Fig.9 Static Drain - Source On - State Resistance vs. Gate - Source Voltage

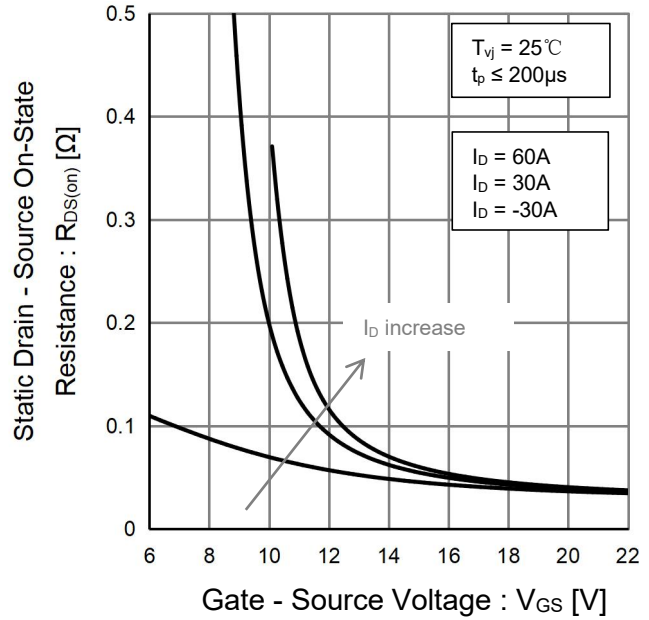


Fig.10 Static Drain - Source On - State Resistance vs. Drain Current

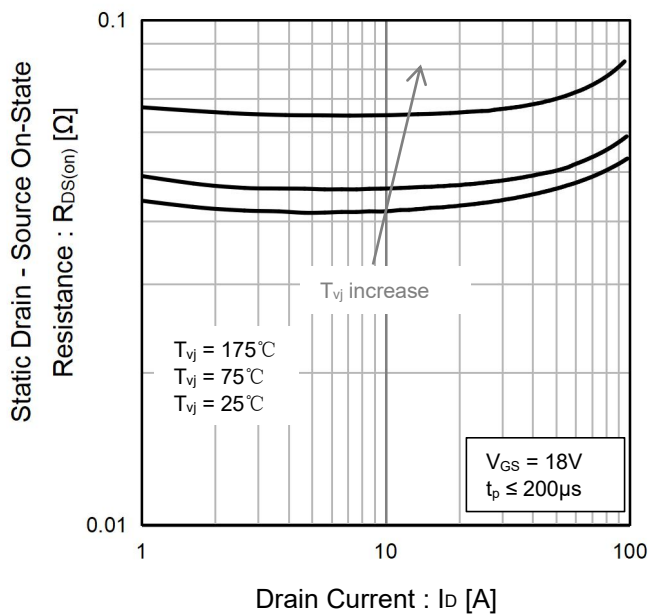


Fig.11 Static Drain - Source On - State Resistance vs. Virtual Junction Temperature

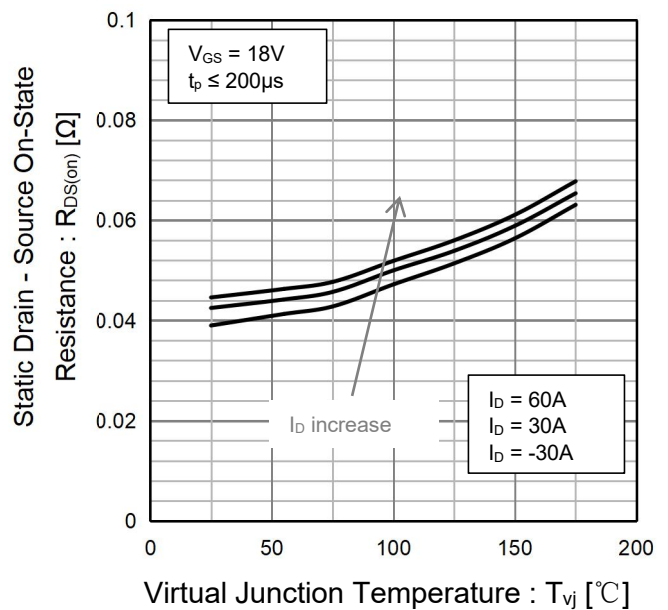


Fig.12 Body Diode Forward Voltage vs. Gate - Source Voltage

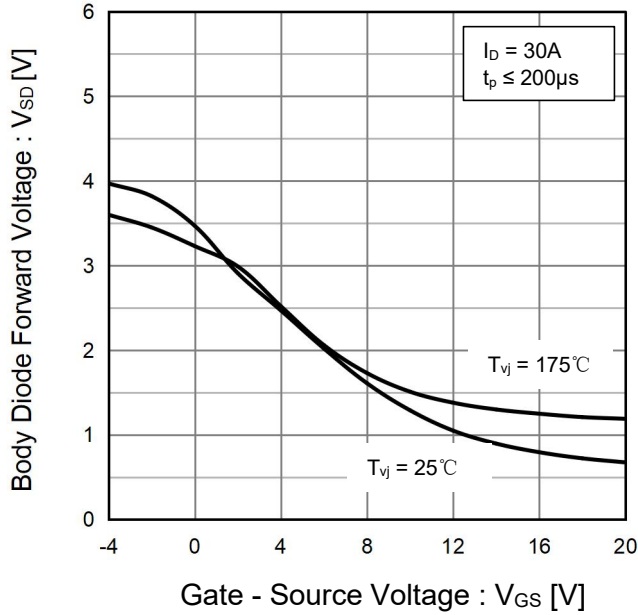


Fig.13 Gate Threshold Voltage vs. Virtual Junction Temperature

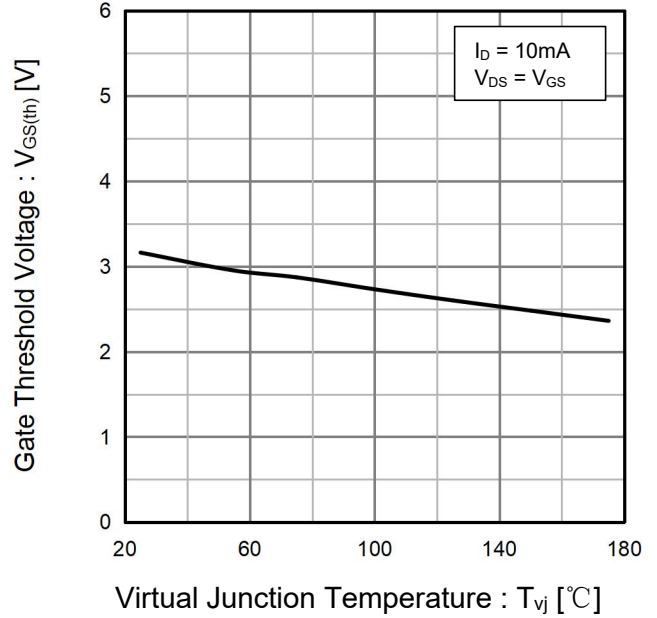


Fig.14 Typical Capacitance vs. Drain - Source Voltage

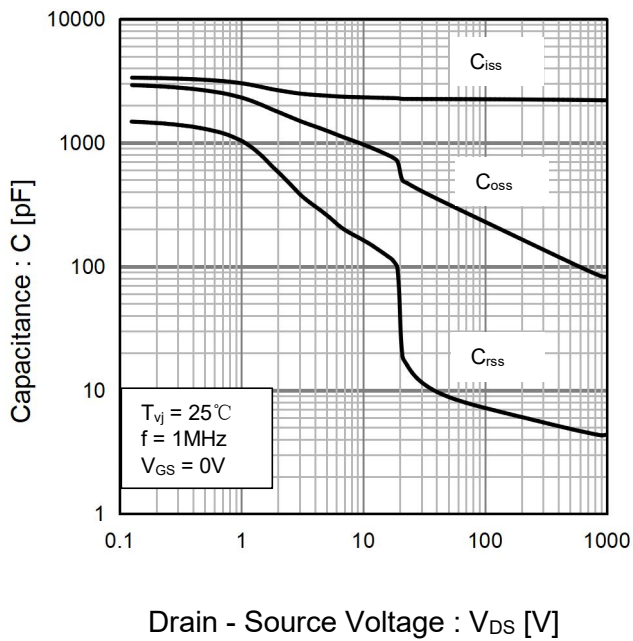


Fig.15 Coss Stored Energy

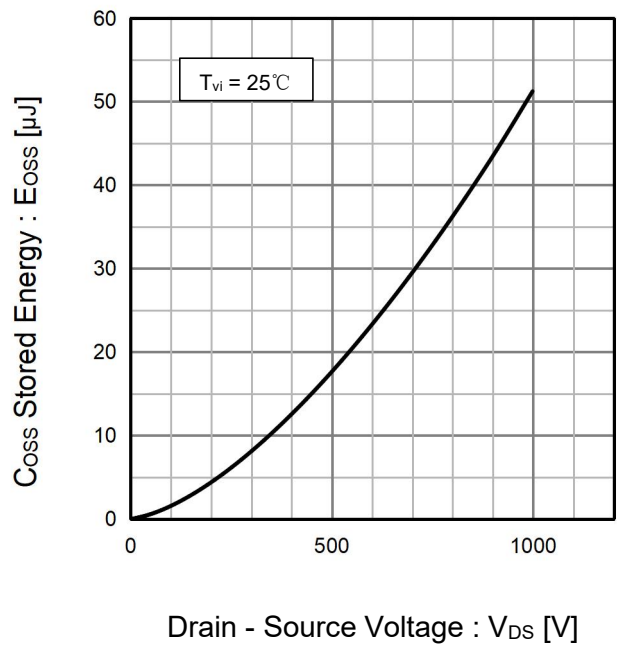


Fig.16 Dynamic Input Characteristics

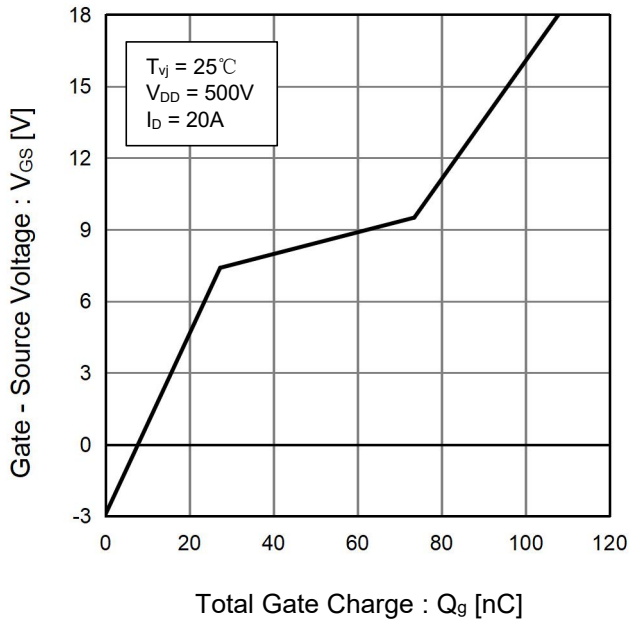


Fig.17 Typical Switching Time vs. External Gate Resistance

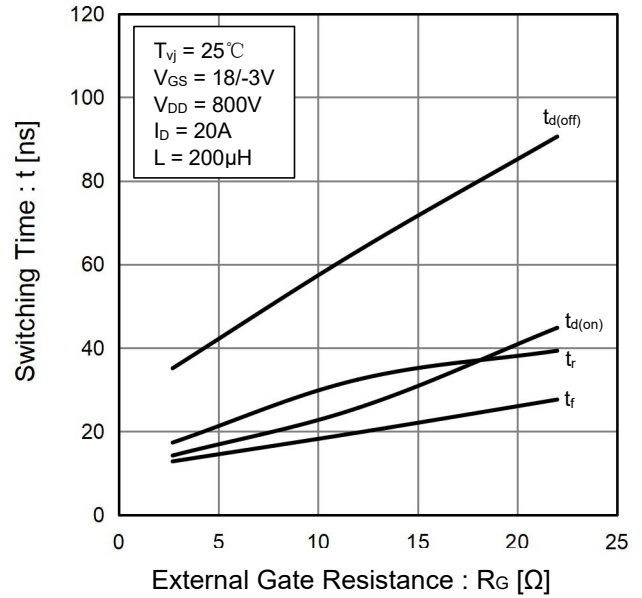


Fig.18 Typical Switching Energy vs. External Gate Resistance

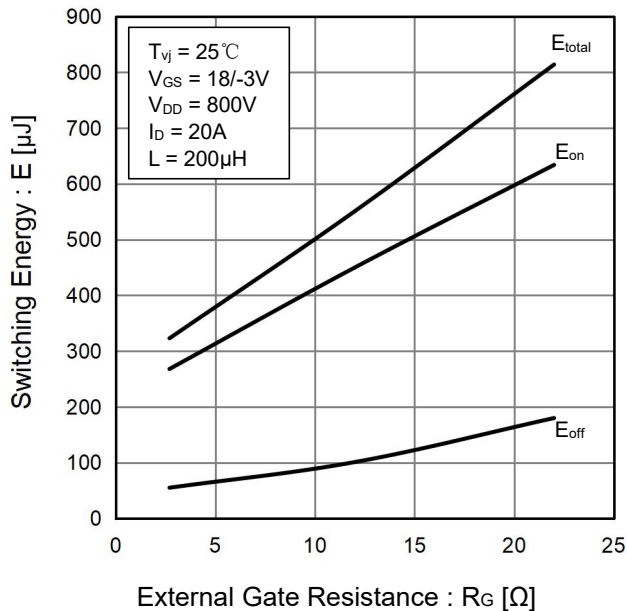


Fig.19 Typical Switching Energy vs. Drain Current

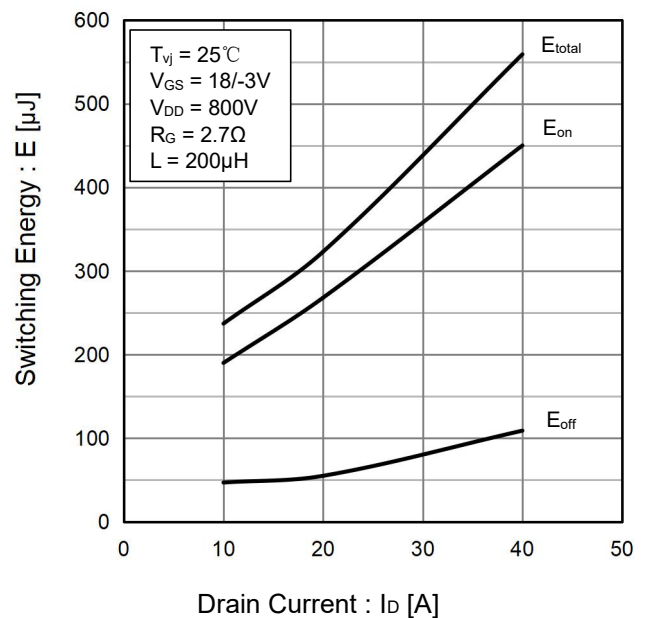
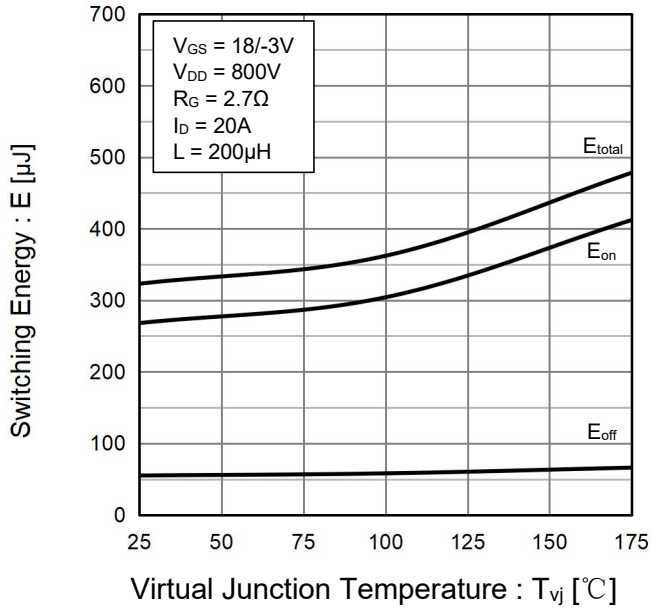
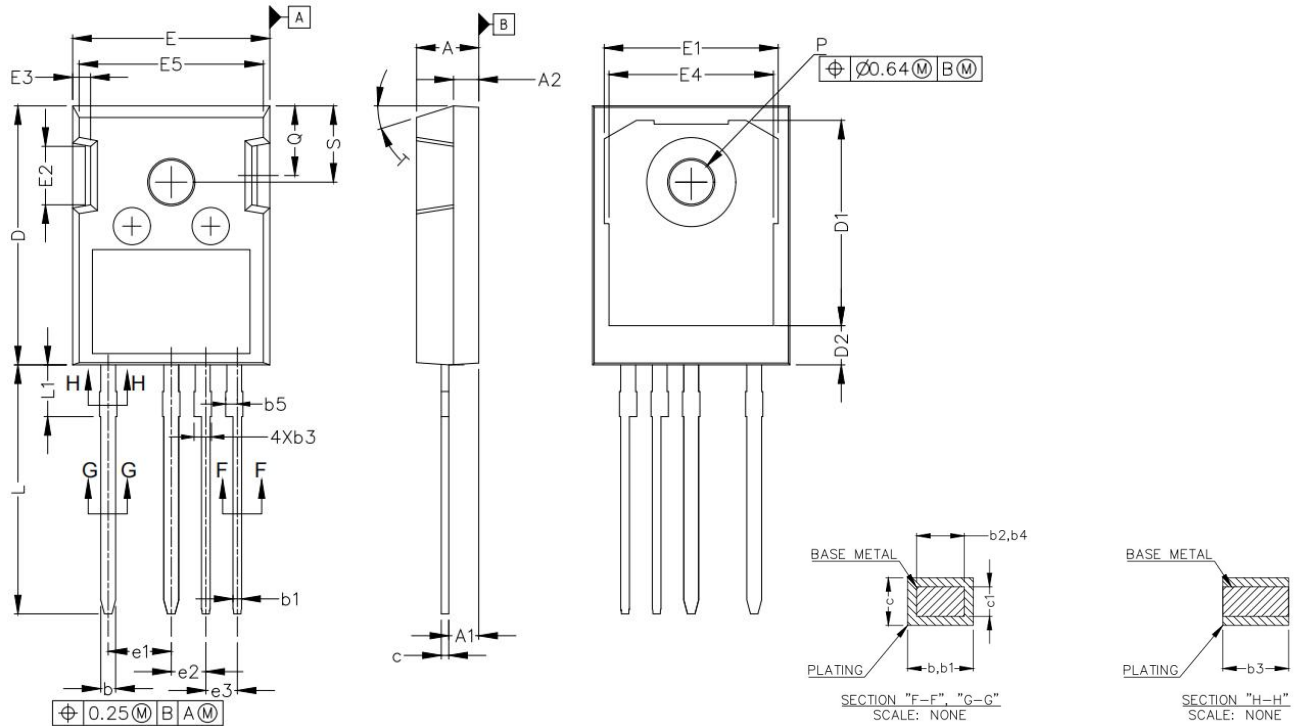


Fig.20 Typical Switching Energy vs. Virtual Junction Temperature



# TO-247-4LP Package Information



SYM	MILLIMETERS	
	MIN	MAX
A	4.83	5.21
A1	2.29	2.54
A2	1.91	2.16
b	1.10	1.30
b1	0.65	0.79
b2	1.10	1.25
b3	1.34	1.44
b4	0.65	0.74
b5	0.74	1.14
c	0.55	0.68
c1	0.55	0.65
D	20.80	21.10
D1	16.25	17.65
D2	2.95	3.35
E	15.75	16.13
E1	13.10	14.15
E2	4.32	5.10
E3	1.00	1.90
E4	12.38	13.43
E5	14.65	15.05
e1	5.08 BSC	
e2	2.79 BSC	
e3	2.54 BSC	
L	19.72	20.32
L1	3.97	4.37
øP	3.51	3.65
Q	5.49	6.00
S	6.04	6.30
T	17.5° REF.	

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