

## 1. General description

Silicon Carbide MOSFET in a TO247-4L plastic package, designed for high frequency, high efficiency systems.



## 2. Features and benefits

- Separate driver source pin
- Low on-resistance
- Fast switching speed
- 0V turn-off gate voltage for simple gate drive
- 100% UIS Tested
- Easy to parallel
- Controllable dV/dt for optimized EMI
- Reduced cooling requirements
- RoHS compliant

## 3. Applications

- Switch Mode Power Supplies
- UPS
- Solar string inverter and solar optimizer
- EV Charger
- Motor Drives

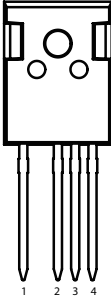
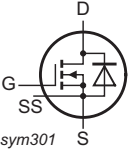
## 4. Quick reference data

Table 1. Quick reference data

Symbol	Parameter	Conditions	Notes	Values			Unit
<b>Absolute maximum rating</b>							
$V_{DS}$	drain-source voltage	$25\text{ °C} \leq T_j \leq 175\text{ °C}$		1200			V
$I_D$	drain current	$V_{GS} = 18\text{ V}; T_{mb} = 25\text{ °C}$		158.6			A
$P_{tot}$	total power dissipation	$T_{mb} = 25\text{ °C}, T_j = 175\text{ °C}$		833			W
$T_j$	junction temperature			-55 to 175			°C
Symbol	Parameter	Conditions	Notes	Min	Typ	Max	Unit
<b>Static characteristics</b>							
$R_{DS(on)}$	drain-source on-state resistance	$V_{GS} = 15\text{ V}; I_D = 50\text{ A}; T_j = 25\text{ °C}$		-	20	-	mΩ
<b>Dynamic characteristics</b>							
$Q_{G(tot)}$	total gate charge	$I_D = 50\text{ A}; V_{DS} = 800\text{ V}; V_{GS} = -4\text{ V}/18\text{ V}; T_j = 25\text{ °C}$		-	215	-	nC
$Q_{GD}$	gate-drain charge			-	32	-	nC
<b>Source-drain diode</b>							
$Q_r$	recovered charge	$I_{SD} = 50\text{ A}; di/dt = 500\text{ A}/\mu\text{s}; V_{DS} = 400\text{ V}; T_j = 25\text{ °C}$		-	276	-	nC

## 5. Pinning information

Table 2. Pinning information

Pin	Symbol	Description	Simplified outline	Graphic symbol
1	D	drain		
2	S	source		
3	SS	source sense		
4	G	gate		
mb	D	mounting base; connected to drain		

## 6. Ordering information

Table 3. Ordering information

Type number	Package Name	Orderable part number	Packing method	Small packing quantity	Package version	Package issue date
WNSC2M20120R	TO247-4L	WNSC2M20120R6Q	Tube	30	TO247N-4L	17-Dec-2021

## 7. Marking

Table 4. Marking codes

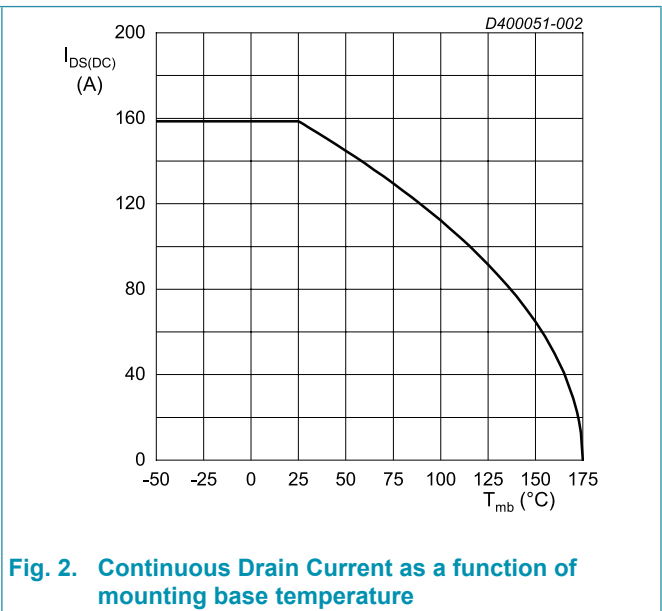
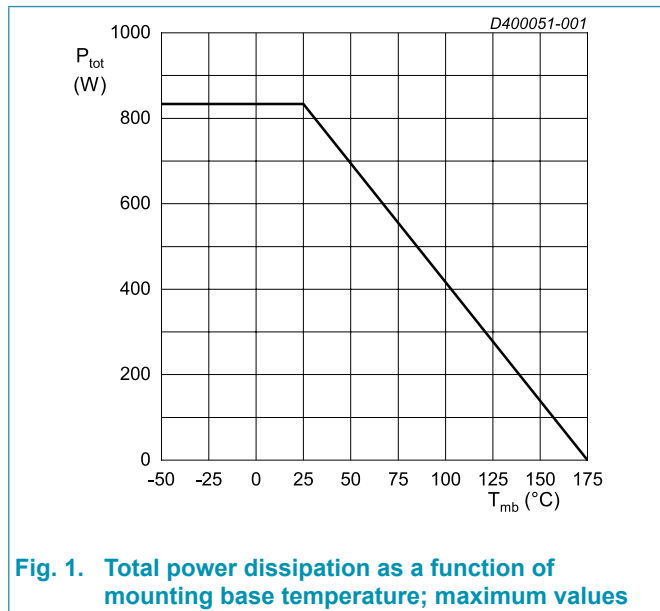
Type number	Marking codes
WNSC2M20120R	WNSC2M 20120R

### 8. Limiting values

**Table 5. Limiting values**

In accordance with the Absolute Maximum Rating System (IEC 60134).

Symbol	Parameter	Conditions	Notes	Values	Unit
$V_{DS}$	drain-source voltage	$25\text{ °C} \leq T_j \leq 175\text{ °C}$		1200	V
$V_{GS,max}$	gate-source voltage			-12 to 24	V
$V_{GS,op}$	gate-source voltage			-4 to 18	V
$P_{tot}$	total power dissipation	$T_{mb} = 25\text{ °C}, T_j = 175\text{ °C}$		833	W
$I_D$	drain current	$V_{GS} = 18\text{ V}; T_{mb} = 25\text{ °C}$		158.6	A
		$V_{GS} = 18\text{ V}; T_{mb} = 100\text{ °C}$		112.2	A
$I_{DM}$	peak drain current	pulse width $t_p$ limited by $T_{jmax}$	Fig.17	300	A
$I_S$	continuous diode current	$V_{GS} = -4\text{ V}; T_{mb} = 25\text{ °C}$		111.6	A
$I_{SM}$	pulse diode current	$V_{GS} = -4\text{ V};$ pulse width $t_p$ limited by $T_{jmax}$		300	A
$E_{as}$	single pulse drain-to-source avalanche	$I_{AS} = 30\text{ A}; L = 1\text{ mH}; V_{DD} = 100\text{ V}; T_j = 25\text{ °C}$		450	mJ
$T_{stg}$	storage temperature			-55 to 175	°C
$T_j$	junction temperature			-55 to 175	°C
$T_{sld(M)}$	peak soldering temperature			260	°C



### 9. Thermal & Mechanical characteristics

Table 6. Thermal & Mechanical characteristics

Symbol	Parameter	Conditions	Notes	Min	Typ	Max	Unit
$R_{th(j-mb)}$	thermal resistance from junction to mounting base			-	0.18	-	K/W
$R_{th(j-a)}$	thermal resistance from junction to ambient	in free air		-	40	-	K/W
$M_d$	Mounting torque	M3 or 6 - 32 screw		-	-	0.6	Nm

Note: It is recommended that a metal washer is inserted between screw head and mounting tab.  
 Do not use self-tapping screws.  
 Device is ESD sensitive. Handling precautions are recommended.

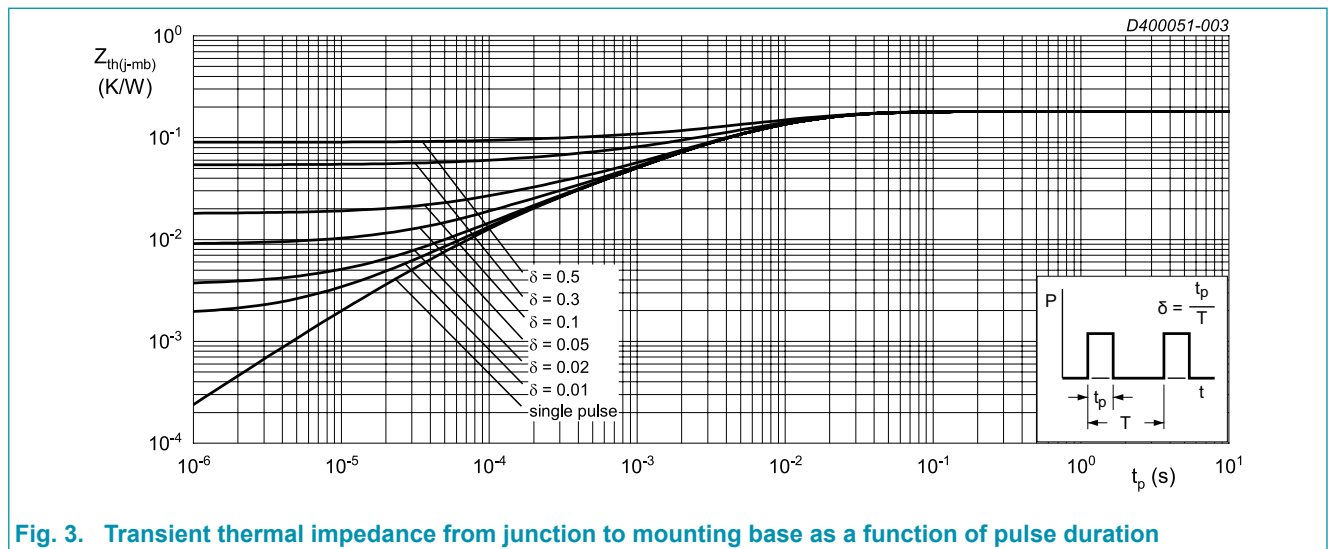
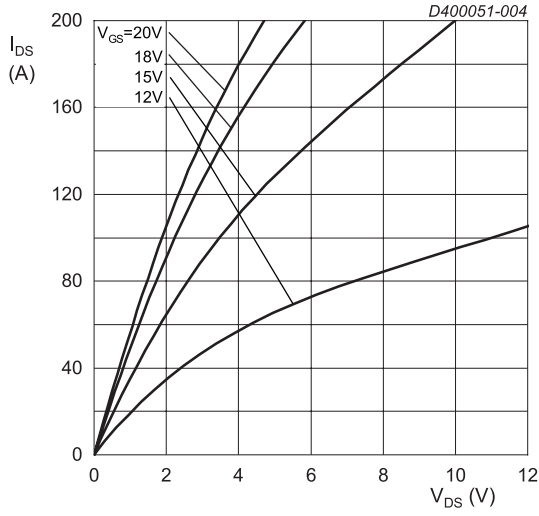


Fig. 3. Transient thermal impedance from junction to mounting base as a function of pulse duration

## 10. Characteristics

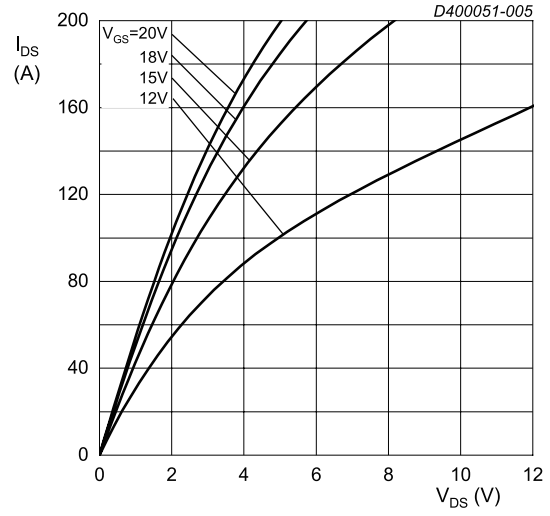
Table 7. Characteristics

Symbol	Parameter	Conditions	Notes	Min	Typ	Max	Unit
<b>Static characteristics</b>							
$V_{(BR)DSS}$	drain-source breakdown voltage	$I_D = 100 \mu A$ ; $V_{GS} = 0 V$ ; $T_j = 25 \text{ }^\circ C$		1200	-	-	V
$V_{GS(th)}$	gate-source threshold voltage	$I_D = 20 \text{ mA}$ ; $V_{DS} = 10 V$ ; $T_j = 25 \text{ }^\circ C$		1.9	2.6	3.5	V
		$I_D = 20 \text{ mA}$ ; $V_{DS} = 10 V$ ; $T_j = 175 \text{ }^\circ C$		-	1.9	-	V
$I_{DSS}$	drain leakage current	$V_{DS} = 1200 V$ ; $V_{GS} = 0 V$ ; $T_j = 25 \text{ }^\circ C$		-	0.2	100	$\mu A$
		$V_{DS} = 1200 V$ ; $V_{GS} = 0 V$ ; $T_j = 175 \text{ }^\circ C$		-	2	-	$\mu A$
$I_{GSS}$	gate leakage current	$V_{GS} = 24 V$ ; $V_{DS} = 0 V$ ; $T_j = 25 \text{ }^\circ C$		-	10	100	nA
		$V_{GS} = -12 V$ ; $V_{DS} = 0 V$ ; $T_j = 25 \text{ }^\circ C$		-	10	100	nA
$R_{DS(on)}$	drain-source on-state resistance	$V_{GS} = 15 V$ ; $I_D = 50 A$ ; $T_j = 25 \text{ }^\circ C$		-	20	-	m $\Omega$
		$V_{GS} = 18 V$ ; $I_D = 50 A$ ; $T_j = 25 \text{ }^\circ C$		-	16.3	29	m $\Omega$
		$V_{GS} = 18 V$ ; $I_D = 50 A$ ; $T_j = 175 \text{ }^\circ C$		-	27.6	-	m $\Omega$
$R_G$	gate resistance	$f = 1 \text{ MHz}$ ; $T_j = 25 \text{ }^\circ C$		-	0.6	-	$\Omega$
$g_{fs}$	transconductance	$V_{DS} = 20 V$ ; $I_D = 50 A$ ; $T_j = 25 \text{ }^\circ C$		-	32	-	S
<b>Dynamic characteristics</b>							
$Q_{G(tot)}$	total gate charge	$I_D = 50 A$ ; $V_{DS} = 800 V$ ; $V_{GS} = -4 V/18 V$ ; $T_j = 25 \text{ }^\circ C$		-	215	-	nC
$Q_{GS}$	gate-source charge			-	83	-	nC
$Q_{GD}$	gate-drain charge			-	32	-	nC
$C_{iss}$	input capacitance	$V_{DS} = 1000 V$ ; $V_{GS} = 0 V$ ; $f = 1 \text{ MHz}$ ; $T_j = 25 \text{ }^\circ C$		-	4701	-	pF
$C_{oss}$	output capacitance			-	199	-	pF
$C_{rss}$	reverse transfer capacitance			-	20	-	pF
$E_{oss}$	Coss stored energy			-	99.5	-	$\mu J$
$t_{d(on)}$	turn-on delay time	$V_{DS} = 800 V$ ; $V_{GS} = -4 V/18 V$ ; $R_{G(ext)} = 2.4 \Omega$ ; $I_D = 50 A$ ; $L = 100 \mu H$ ; $T_j = 25 \text{ }^\circ C$		-	17	-	ns
$t_r$	rise time			-	26	-	ns
$t_{d(off)}$	turn-off delay time			-	45	-	ns
$t_f$	fall time			-	16	-	ns
$E_{on}$	turn-on energy (SiC Diode FWD)		Fig.20	-	601	-	$\mu J$
$E_{off}$	turn-off energy (SiC Diode FWD)		Fig.20	-	330	-	$\mu J$
$E_{on}$	turn-on energy (Body Diode FWD)	Fig.20	-	781	-	$\mu J$	
$E_{off}$	turn-off energy (Body Diode FWD)	Fig.20	-	380	-	$\mu J$	
<b>Source-drain diode</b>							
$V_{SD}$	source-drain voltage	$V_{GS} = 0 V$ ; $I_{SD} = 25 A$ ; $T_j = 25 \text{ }^\circ C$		-	2.9	-	V
		$V_{GS} = -4 V$ ; $I_{SD} = 25 A$ ; $T_j = 25 \text{ }^\circ C$		-	4.7	-	V
		$V_{GS} = -4 V$ ; $I_{SD} = 25 A$ ; $T_j = 175 \text{ }^\circ C$		-	4.1	-	V
$t_{rr}$	reverse recovery time	$I_{SD} = 50 A$ ; $di/dt = 500 A/\mu s$ ; $V_{DS} = 400 V$ ; $T_j = 25 \text{ }^\circ C$		-	54	-	ns
$Q_r$	recovered charge			-	276	-	nC
$I_{rrm}$	reverse recovery current			-	9	-	A



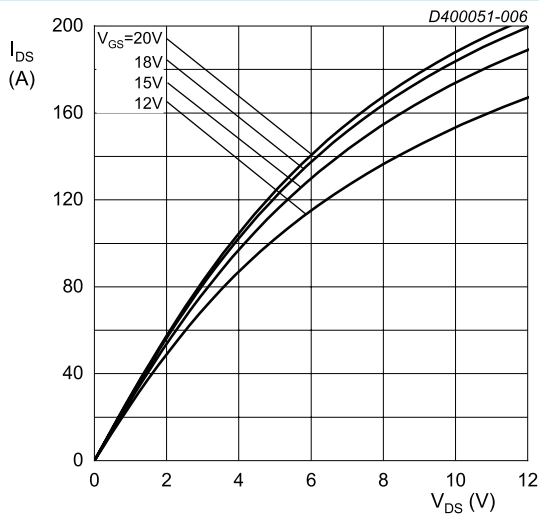
$T_j = -55\text{ }^\circ\text{C}; t_p < 200\text{ }\mu\text{s}$

**Fig. 4. Output characteristics; drain current as a function of drain-source voltage; typical values**



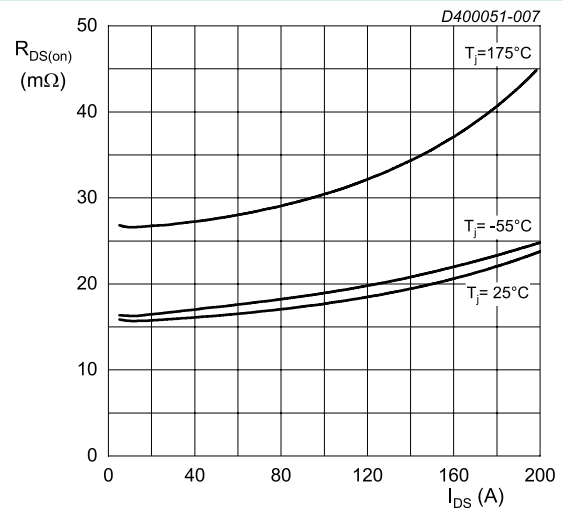
$T_j = 25\text{ }^\circ\text{C}; t_p < 200\text{ }\mu\text{s}$

**Fig. 5. Output characteristics; drain current as a function of drain-source voltage; typical values**



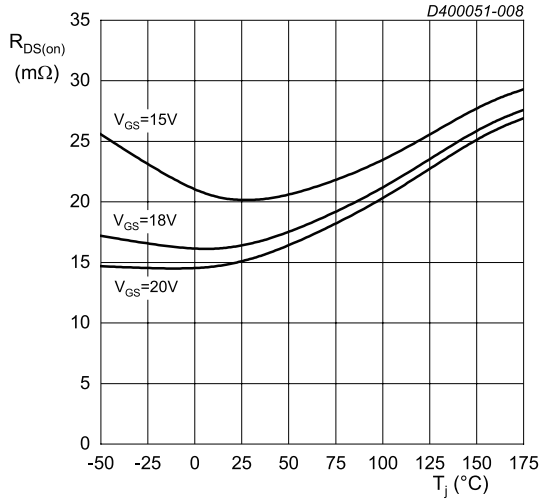
$T_j = 175\text{ }^\circ\text{C}; t_p < 200\text{ }\mu\text{s}$

**Fig. 6. Output characteristics; drain current as a function of drain-source voltage; typical values**

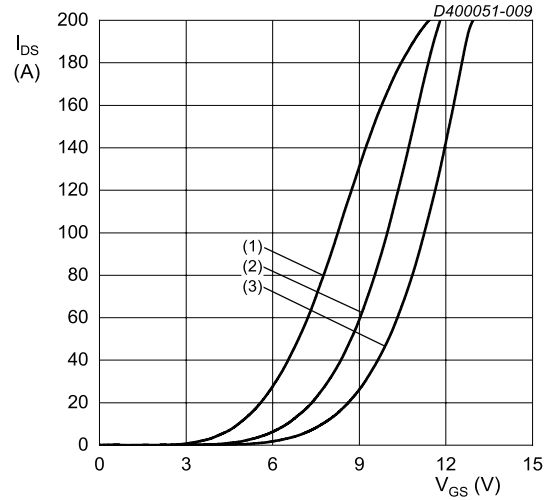


$V_{GS} = 18\text{ V}; t_p < 200\text{ }\mu\text{s}$

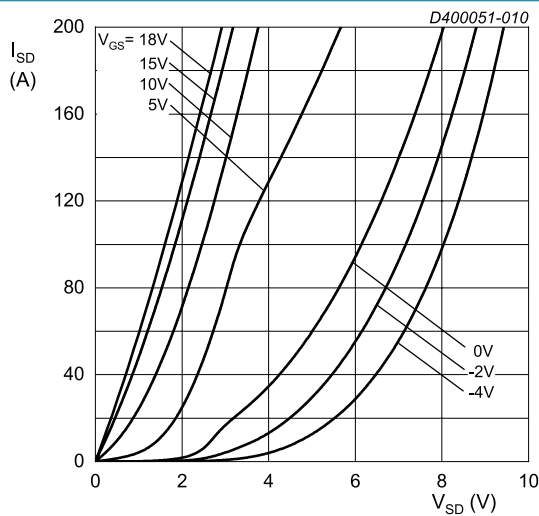
**Fig. 7. Drain-source on-state resistance as a function of drain current; typical values**



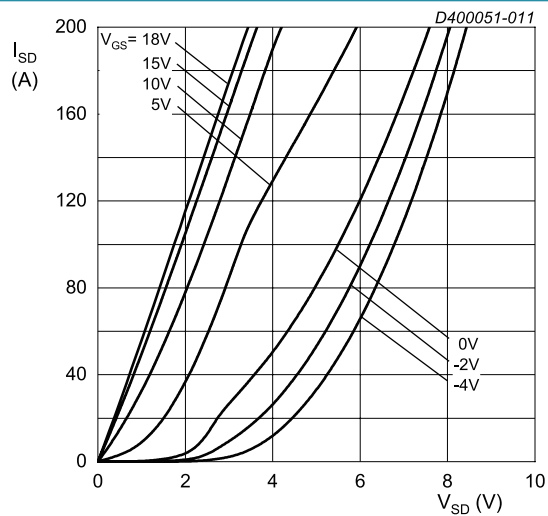
$I_{DS} = 50 \text{ A}; t_p < 200 \mu\text{s}$   
**Fig. 8. Drain-source on-state resistance as a function of junction temperature**



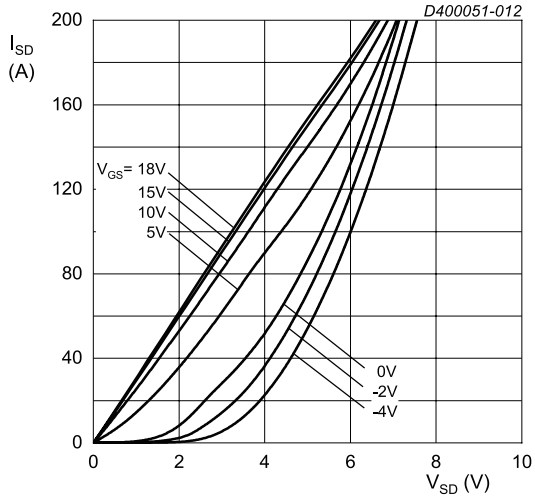
$V_{DS} = 20 \text{ V}; t_p < 200 \mu\text{s}$   
 (1)  $T_j = 175 \text{ }^\circ\text{C}$   
 (2)  $T_j = 25 \text{ }^\circ\text{C}$   
 (3)  $T_j = -55 \text{ }^\circ\text{C}$   
**Fig. 9. Transfer characteristics; drain current as a function of gate-source voltage; typical values**



$T_j = -55 \text{ }^\circ\text{C}; t_p < 200 \mu\text{s}$   
**Fig. 10. Body diode forward characteristics; typical values**

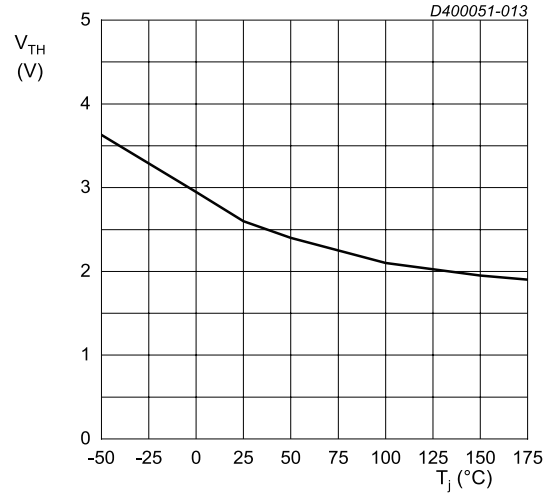


$T_j = 25 \text{ }^\circ\text{C}; t_p < 200 \mu\text{s}$   
**Fig. 11. Body diode forward characteristics; typical values**



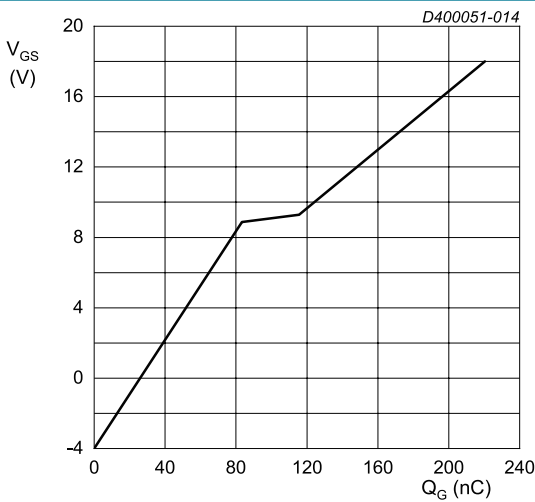
$T_j = 175\text{ }^\circ\text{C}$ ;  $t_p < 200\text{ }\mu\text{s}$

Fig. 12. Body diode forward characteristics; typical values



$V_{DS} = 10\text{ V}$ ;  $I_{DS} = 20\text{ mA}$

Fig. 13. Threshold voltage as a function of junction temperature



$I_{DS} = 50\text{ A}$ ;  $I_{GS} = 0.1\text{ mA}$ ;  $V_{DS} = 800\text{ V}$ ;  $T_j = 25\text{ }^\circ\text{C}$

Fig. 14. Gate-source voltage as a function of gate charge; typical values

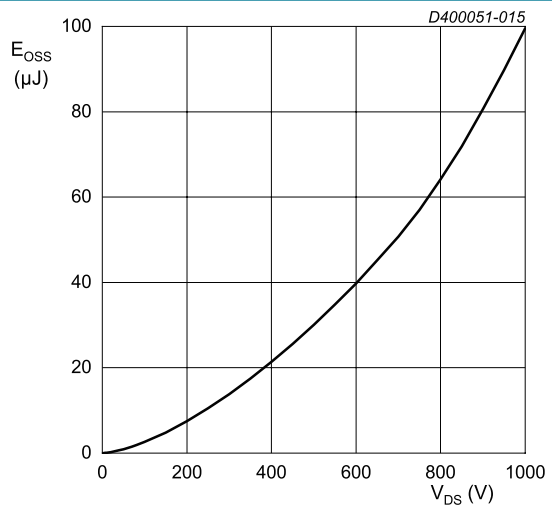
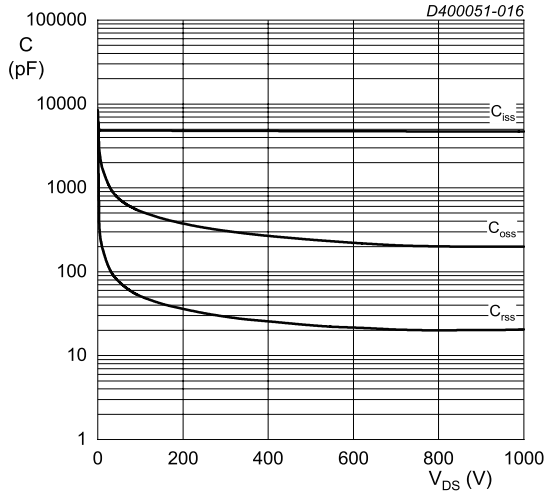


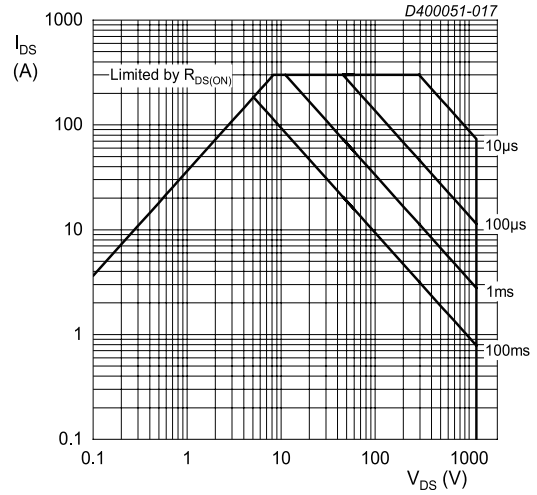
Fig. 15. Output capacitor stored energy as a function of drain-source voltage





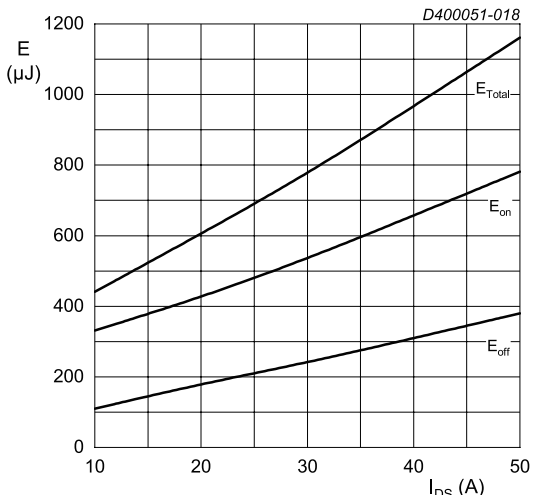
$V_{DS} = 0 - 1000 \text{ V}$   
 $T_j = 25 \text{ }^\circ\text{C}; V_{AC} = 25 \text{ mV}; f = 1 \text{ MHz}$

**Fig. 16. Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values**



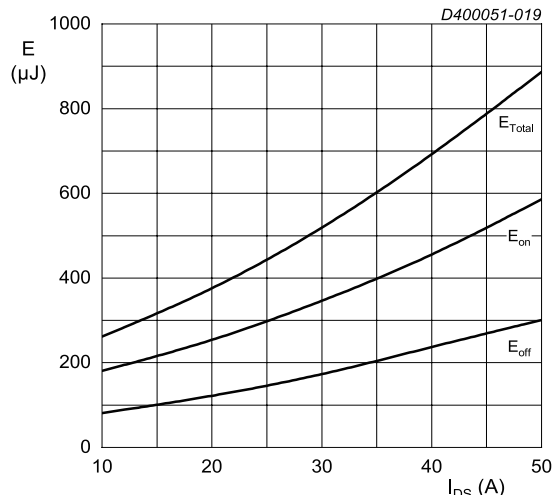
$T_j = 25 \text{ }^\circ\text{C}; D = 0$   
 Parameter:  $t_p$

**Fig. 17. Forward bias safe operating area**



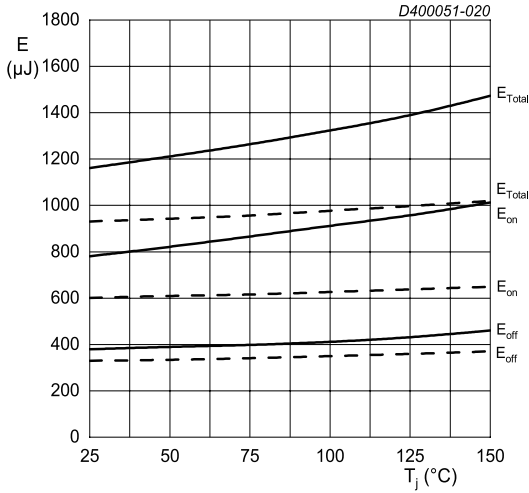
$T_j = 25 \text{ }^\circ\text{C}; V_{DD} = 800 \text{ V}; R_{G(ext)} = 2.4 \text{ } \Omega;$   
 $V_{GS} = -4 \text{ V}/18 \text{ V}; L = 100 \text{ } \mu\text{H}$   
 FWD = WNSC2M20120R

**Fig. 18. Clamped Inductive Switching Energy as a function of drain current**



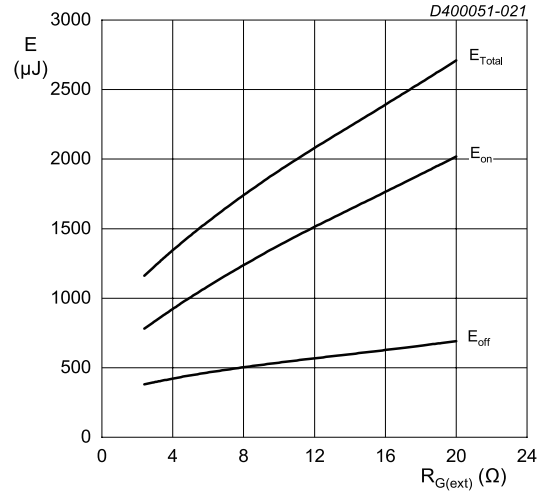
$T_j = 25 \text{ }^\circ\text{C}; V_{DD} = 600 \text{ V}; R_{G(ext)} = 2.4 \text{ } \Omega;$   
 $V_{GS} = -4 \text{ V}/18 \text{ V}; L = 100 \text{ } \mu\text{H}$   
 FWD = WNSC2M20120R

**Fig. 19. Clamped Inductive Switching Energy as a function of drain current**



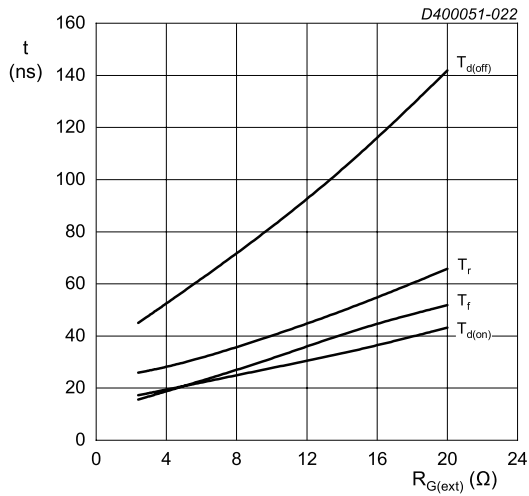
$I_{DS} = 50 \text{ A}; V_{DD} = 800 \text{ V}; R_{G(ext)} = 2.4 \text{ } \Omega;$   
 $V_{GS} = -4 \text{ V}/18 \text{ V}; L = 100 \text{ } \mu\text{H}$   
 FWD = WNSC2M20120R  
 FWD = WNSC2D201200W(---)

Fig. 20. Clamped Inductive Switching Energy as a function of junction temperature



$T_j = 25 \text{ } ^\circ\text{C}; V_{DD} = 800 \text{ V}; I_{DS} = 50 \text{ A}; V_{GS} = -4 \text{ V}/18 \text{ V}$   
 FWD = WNSC2M20120R;  $L = 100 \text{ } \mu\text{H}$

Fig. 21. Clamped Inductive Switching Energy as a function of external gate resistance



$T_j = 25 \text{ } ^\circ\text{C}; V_{DD} = 800 \text{ V}; I_{DS} = 50 \text{ A}; V_{GS} = -4 \text{ V}/18 \text{ V}$   
 FWD = WNSC2M20120R;  $L = 100 \text{ } \mu\text{H}$

Fig. 22. Switching time as a function of external gate resistance

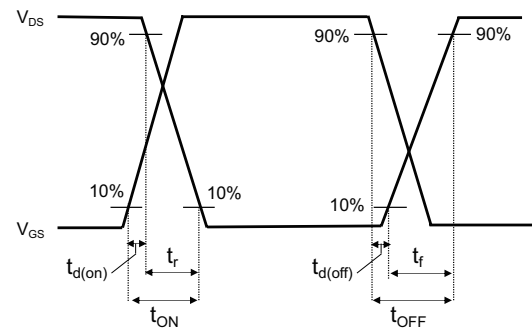
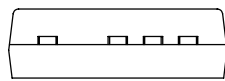
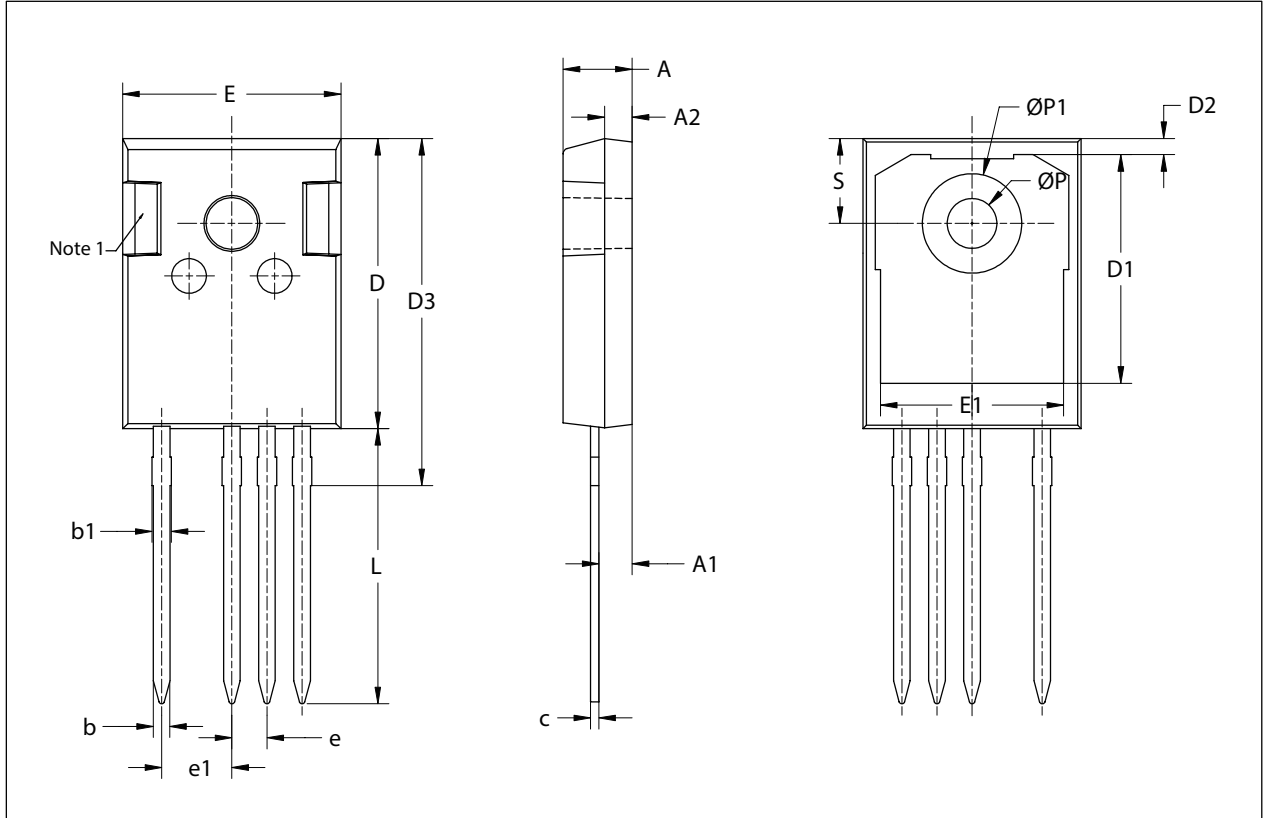


Fig. 23. Switching time definition

### 11. Package outline

Plastic single-ended through-hole package; heatsink mounted; 1 mounting hole; 4 leads TO-247

TO247-4L



**SIDE VIEW**

UNIT	A	A1	A2	b	b1	c	D	D1	D2	D3	E	E1	e	e1	L	P	P1	S	
<b>mm</b>	<b>MAX</b>	5.10	2.51	2.10	1.30	1.80	0.70	21.10	16.85	1.35	25.27	15.90	13.50	2.64	5.18	20.10	3.70	(7.40)	(6.15)
	<b>NOM</b>													2.54	5.08				
	<b>MIN</b>	4.90	2.31	1.90	1.10	0.50	20.90	16.25	1.05	24.97	15.70	13.10	2.44	4.98	19.80	3.50	-		

Note:

1. Metal exposed with Sn plating.
2. All dimensions do not include mold flash & gate remain

## 12. Legal information

### Data sheet status

Document status [1][2]	Product status [3]	Definition
Objective [short] data sheet	Development	This document contains data from the objective specification for product development.
Preliminary [short] data sheet	Qualification	This document contains data from the preliminary specification.
Product [short] data sheet	Production	This document contains the product specification.

- [1] Please consult the most recently issued document before initiating or completing a design.
- [2] The term 'short data sheet' is explained in section "Definitions".
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