

## 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
- Battery formation instrument
- Solar string inverter and solar optimizer
- EV Charger
- Motor Drives

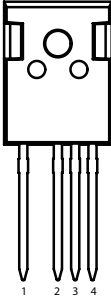
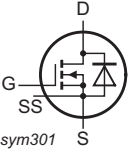
## 4. Quick reference data

Table 1. Quick reference data

Symbol	Parameter	Conditions	Notes	Values			Unit
<b>Absolute maximum rating</b>							
$V_{DS}$	drain-source voltage	$25\text{ °C} \leq T_J \leq 175\text{ °C}$		650			V
$I_D$	drain current	$V_{GS} = 18\text{ V}; T_{mb} = 25\text{ °C}$		84			A
$P_{tot}$	total power dissipation	$T_{mb} = 25\text{ °C}, T_J = 175\text{ °C}$		429			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	$V_{GS} = 15\text{ V}; I_D = 25\text{ A}; T_J = 25\text{ °C}$		-	45	58	mΩ
		$V_{GS} = 18\text{ V}; I_D = 25\text{ A}; T_J = 25\text{ °C}$		-	33	43	mΩ
<b>Dynamic characteristics</b>							
$Q_{G(tot)}$	total gate charge	$I_D = 25\text{ A}; V_{DS} = 400\text{ V}; V_{GS} = -4\text{ V}/18\text{ V}; T_J = 25\text{ °C}$		-	87	-	nC
$Q_{GD}$	gate-drain charge			-	9	-	nC
<b>Source-drain diode</b>							
$Q_r$	recovered charge	$I_{SD} = 25\text{ A}; di/dt = 500\text{ A}/\mu\text{s}; V_{DS} = 400\text{ V}; T_J = 25\text{ °C}$		-	94	-	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
WN2M45065R	TO247-4L	WN2M45065R6Q	Tube	30	TO247N-4L	17-Dec-2021

## 7. Marking

Table 4. Marking codes

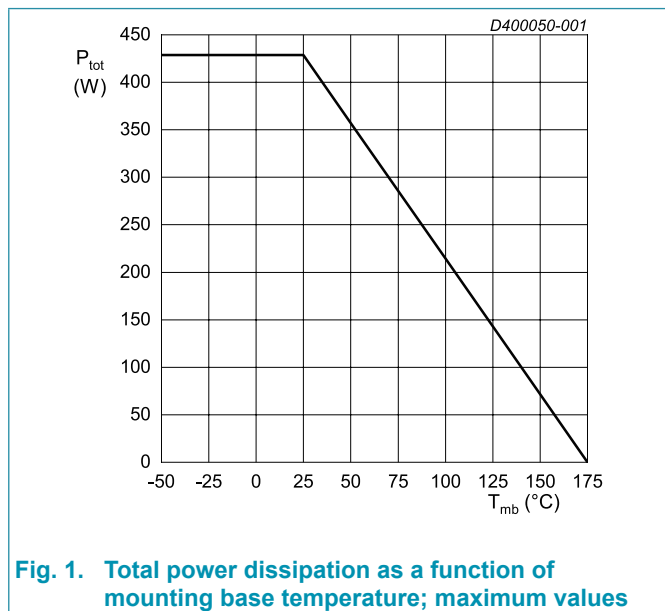
Type number	Marking codes
WN2M45065R	WN2M 45065R

## 8. Limiting values

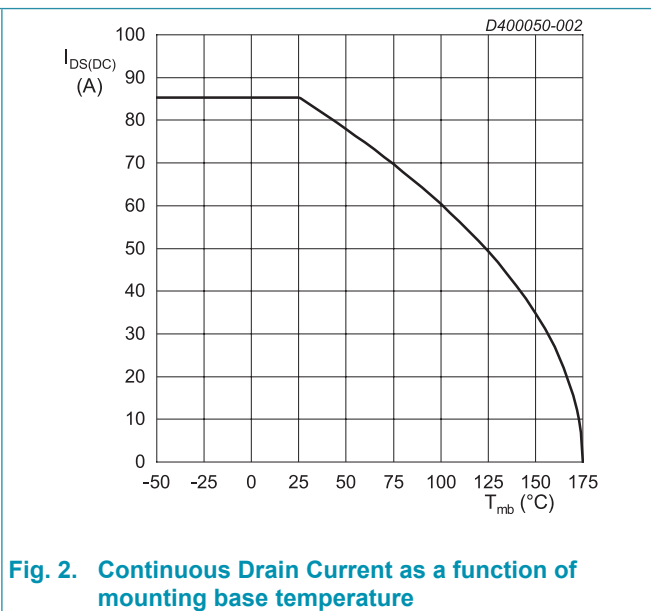
**Table 5. Limiting values**

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

Symbol	Parameter	Conditions	Notes	Values	Unit
$V_{DS}$	drain-source voltage	$25\text{ °C} \leq T_j \leq 175\text{ °C}$		650	V
$V_{GS,max}$	gate-source voltage			-10 to 22	V
$V_{GS,op}$	gate-source voltage			-4 to 18	V
$P_{tot}$	total power dissipation	$T_{mb} = 25\text{ °C}, T_j = 175\text{ °C}$		429	W
$I_D$	drain current	$V_{GS} = 18\text{ V}; T_{mb} = 25\text{ °C}$		84	A
		$V_{GS} = 18\text{ V}; T_{mb} = 100\text{ °C}$		60	A
$I_{DM}$	peak drain current	pulse width $t_p$ limited by $T_{jmax}$	Fig.17	170	A
$I_S$	continuous diode current	$V_{GS} = -4\text{ V}; T_{mb} = 25\text{ °C}$		63	A
$I_{SM}$	pulse diode current	$V_{GS} = -4\text{ V};$ pulse width $t_p$ limited by $T_{jmax}$		170	A
$E_{as}$	single pulse drain-to-source avalanche	$I_{AS} = 20\text{ A}; L = 1\text{ mH}; V_{DD} = 100\text{ V}; T_j = 25\text{ °C}$		200	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



**Fig. 1. Total power dissipation as a function of mounting base temperature; maximum values**



**Fig. 2. Continuous Drain Current as a function of mounting base temperature**

### 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			-	0.35	-	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.

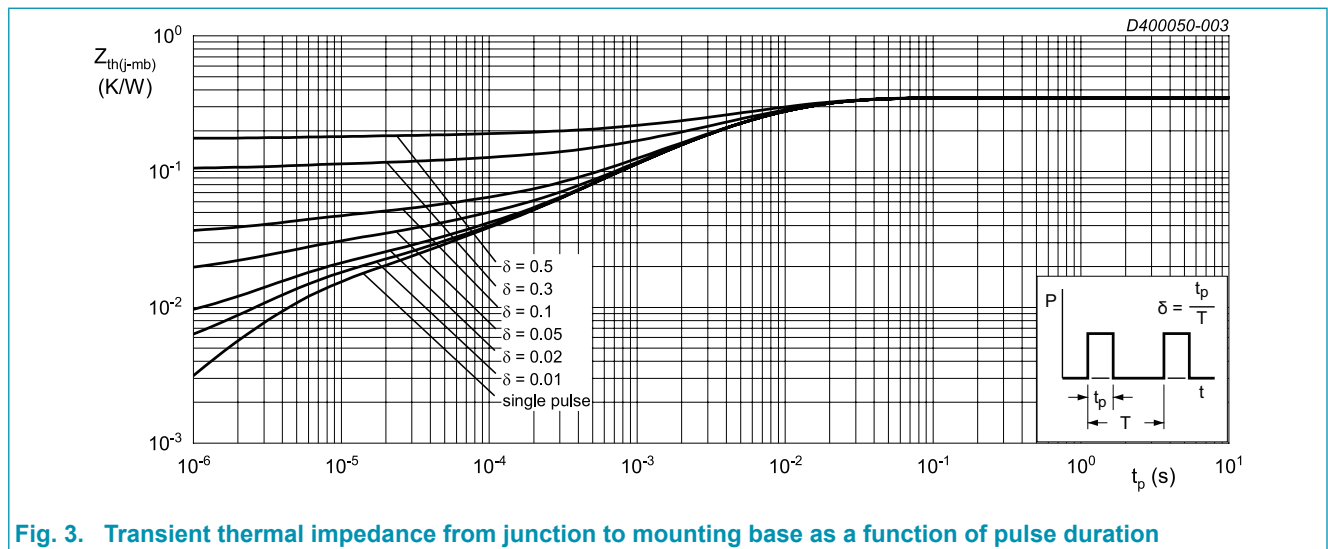
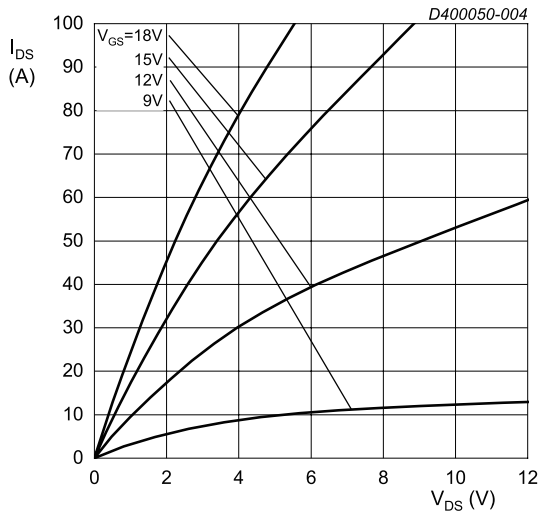


Fig. 3. Transient thermal impedance from junction to mounting base as a function of pulse duration

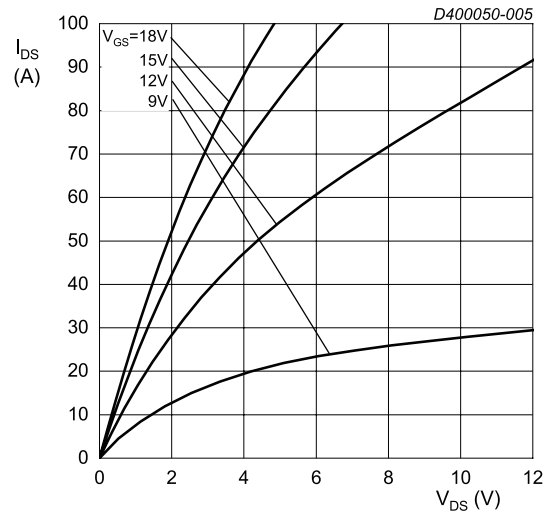
## 10. Characteristics

Table 7. Characteristics

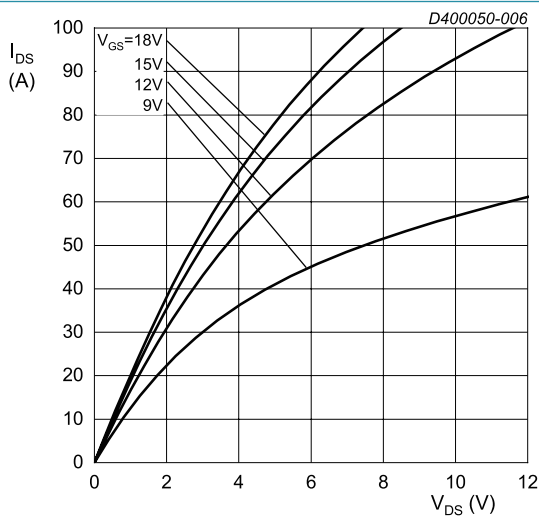
Symbol	Parameter	Conditions	Notes	Min	Typ	Max	Unit
<b>Static characteristics</b>							
$V_{(BR)DSS}$	drain-source breakdown voltage	$I_D = 100 \mu A; V_{GS} = 0 V; T_j = 25 \text{ }^\circ C$		650	-	-	V
$V_{GS(th)}$	gate-source threshold voltage	$I_D = 6 \text{ mA}; V_{DS} = V_{GS}; T_j = 25 \text{ }^\circ C$		1.9	2.6	3.5	V
		$I_D = 6 \text{ mA}; V_{DS} = V_{GS}; T_j = 175 \text{ }^\circ C$		-	1.9	-	V
$I_{DSS}$	drain leakage current	$V_{DS} = 650 \text{ V}; V_{GS} = 0 \text{ V}; T_j = 25 \text{ }^\circ C$		-	0.1	50	$\mu A$
		$V_{DS} = 650 \text{ V}; V_{GS} = 0 \text{ V}; T_j = 175 \text{ }^\circ C$		-	5	-	$\mu A$
$I_{GSS}$	gate leakage current	$V_{GS} = 22 \text{ V}; V_{DS} = 0 \text{ V}; T_j = 25 \text{ }^\circ C$		-	5	100	nA
		$V_{GS} = -10 \text{ V}; V_{DS} = 0 \text{ V}; T_j = 25 \text{ }^\circ C$		-	5	100	nA
$R_{DS(on)}$	drain-source on-state resistance	$V_{GS} = 15 \text{ V}; I_D = 25 \text{ A}; T_j = 25 \text{ }^\circ C$		-	45	58	m $\Omega$
		$V_{GS} = 18 \text{ V}; I_D = 25 \text{ A}; T_j = 25 \text{ }^\circ C$		-	33	43	m $\Omega$
		$V_{GS} = 18 \text{ V}; I_D = 25 \text{ A}; T_j = 175 \text{ }^\circ C$		-	49	-	m $\Omega$
$R_G$	gate resistance	$f = 1 \text{ MHz}; T_j = 25 \text{ }^\circ C$		-	3.1	-	$\Omega$
$g_{fs}$	transconductance	$V_{DS} = 20 \text{ V}; I_D = 25 \text{ A}; T_j = 25 \text{ }^\circ C$		-	15	-	S
<b>Dynamic characteristics</b>							
$Q_{G(tot)}$	total gate charge	$I_D = 25 \text{ A}; V_{DS} = 400 \text{ V}; V_{GS} = -4 \text{ V}/18 \text{ V}; T_j = 25 \text{ }^\circ C$		-	87	-	nC
$Q_{GS}$	gate-source charge			-	35	-	nC
$Q_{GD}$	gate-drain charge			-	9	-	nC
$C_{iss}$	input capacitance	$V_{DS} = 400 \text{ V}; V_{GS} = 0 \text{ V}; f = 1 \text{ MHz}; T_j = 25 \text{ }^\circ C$		-	2167	-	pF
$C_{oss}$	output capacitance			-	191	-	pF
$C_{rss}$	reverse transfer capacitance			-	8	-	pF
$E_{oss}$	Coss stored energy			-	95.5	-	$\mu J$
$t_{d(on)}$	turn-on delay time	$V_{DS} = 400 \text{ V}; V_{GS} = -4 \text{ V}/18 \text{ V}; R_{G(ext)} = 5.1 \Omega; I_D = 12.5 \text{ A}; L = 100 \mu H; T_j = 25 \text{ }^\circ C$		-	12	-	ns
$t_r$	rise time			-	16	-	ns
$t_{d(off)}$	turn-off delay time			-	26	-	ns
$t_f$	fall time			-	12	-	ns
$E_{on}$	turn-on energy (SiC Diode FWD)		Fig.19	-	80	-	$\mu J$
$E_{off}$	turn-off energy (SiC Diode FWD)		Fig.19	-	19	-	$\mu J$
$E_{on}$	turn-on energy (Body Diode FWD)		Fig.19	-	81	-	$\mu J$
$E_{off}$	turn-off energy (Body Diode FWD)		Fig.19	-	21	-	$\mu J$
<b>Source-drain diode</b>							
$V_{SD}$	source-drain voltage	$V_{GS} = 0 \text{ V}; I_{SD} = 25 \text{ A}; T_j = 25 \text{ }^\circ C$		-	3.4	-	V
		$V_{GS} = -4 \text{ V}; I_{SD} = 25 \text{ A}; T_j = 25 \text{ }^\circ C$		-	3.9	-	V
		$V_{GS} = -4 \text{ V}; I_{SD} = 25 \text{ A}; T_j = 175 \text{ }^\circ C$		-	3.4	-	V
$t_{rr}$	reverse recovery time	$I_{SD} = 25 \text{ A}; di/dt = 500 \text{ A}/\mu s; V_{DS} = 400 \text{ V}; T_j = 25 \text{ }^\circ C$		-	32	-	ns
$Q_r$	recovered charge			-	94	-	nC
$I_{rrm}$	reverse recovery current			-	28.8	-	A



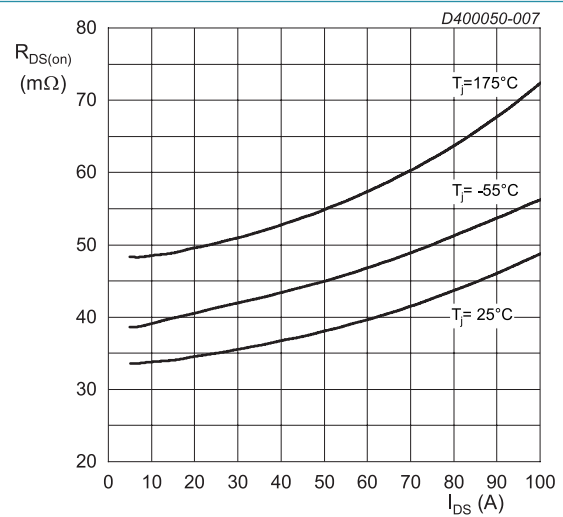
$T_j = -55\text{ }^\circ\text{C}; t_p < 200\text{ }\mu\text{s}$   
**Fig. 4. Output characteristics; drain current as a function of drain-source voltage; typical values**



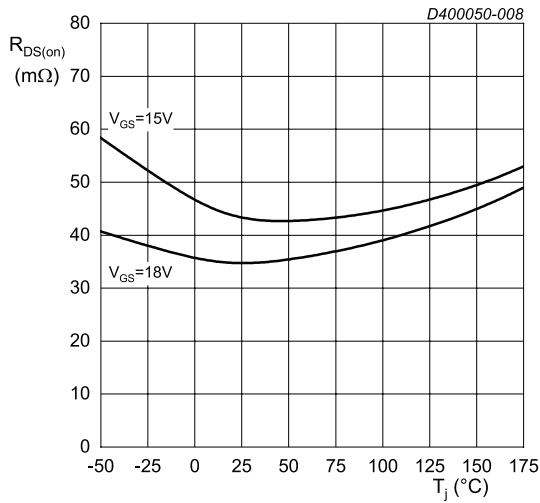
$T_j = 25\text{ }^\circ\text{C}; t_p < 200\text{ }\mu\text{s}$   
**Fig. 5. Output characteristics; drain current as a function of drain-source voltage; typical values**



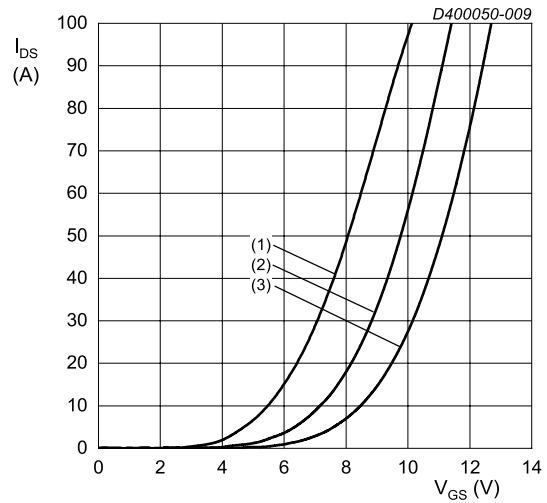
$T_j = 175\text{ }^\circ\text{C}; t_p < 200\text{ }\mu\text{s}$   
**Fig. 6. Output characteristics; drain current as a function of drain-source voltage; typical values**



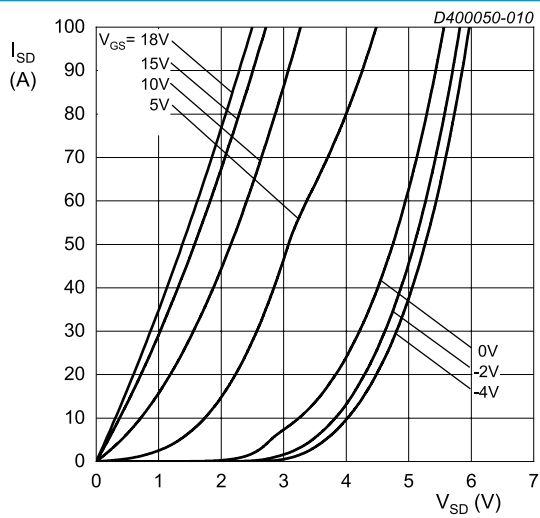
$V_{GS} = 18\text{ V}; t_p < 200\text{ }\mu\text{s}$   
**Fig. 7. Drain-source on-state resistance as a function of drain current; typical values**



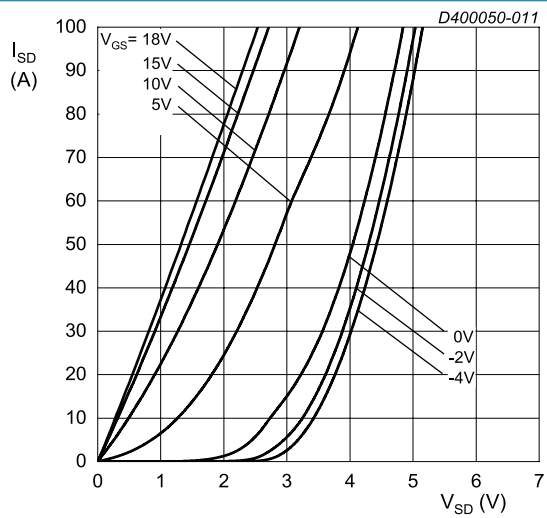
$I_{DS} = 25\text{ A}; t_p < 200\ \mu\text{s}$   
**Fig. 8. Drain-source on-state resistance as a function of junction temperature**



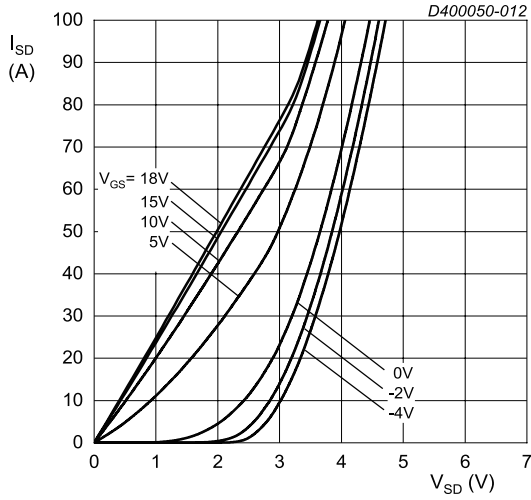
$V_{DS} = 20\text{ V}; t_p < 200\ \mu\text{s}$   
 (1)  $T_j = 175\text{ °C}$   
 (2)  $T_j = 25\text{ °C}$   
 (3)  $T_j = -55\text{ °C}$   
**Fig. 9. Transfer characteristics; drain current as a function of gate-source voltage; typical values**



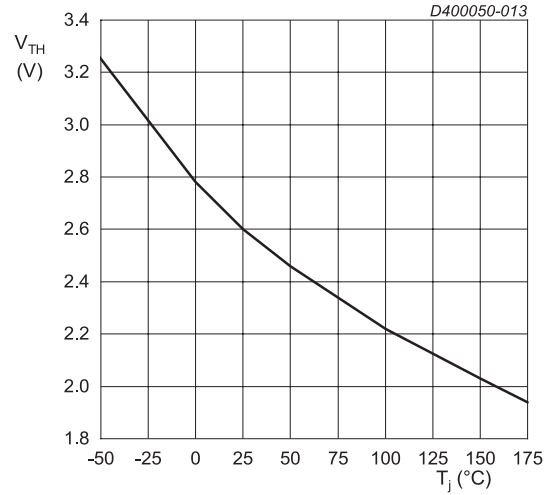
$T_j = -55\text{ °C}; t_p < 200\ \mu\text{s}$   
**Fig. 10. Body diode forward characteristics; typical values**



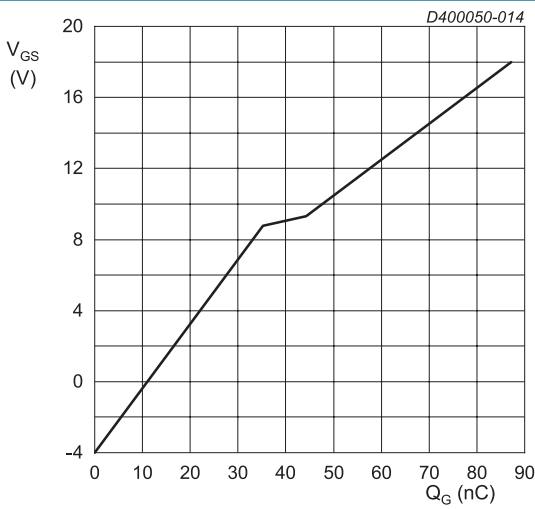
$T_j = 25\text{ °C}; t_p < 200\ \mu\text{s}$   
**Fig. 11. Body diode forward characteristics; typical values**



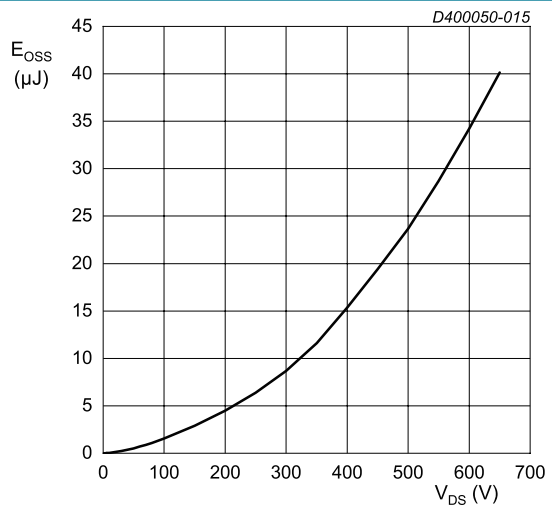
$T_j = 175\text{ }^\circ\text{C}$ ;  $t_p < 200\text{ }\mu\text{s}$   
**Fig. 12. Body diode forward characteristics; typical values**



$V_{DS} = V_{GS}$ ;  $I_{DS} = 6\text{ mA}$   
**Fig. 13. Threshold voltage as a function of junction temperature**

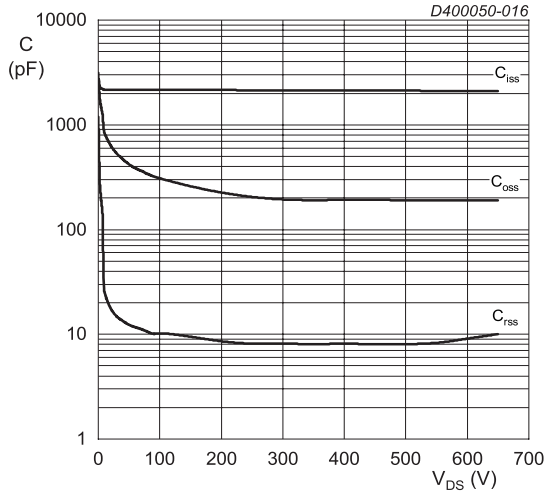


$I_{DS} = 25\text{ A}$ ;  $I_{GS} = 0.1\text{ mA}$ ;  $V_{DS} = 400\text{ V}$ ;  $T_j = 25\text{ }^\circ\text{C}$   
**Fig. 14. Gate-source voltage as a function of gate charge; typical values**



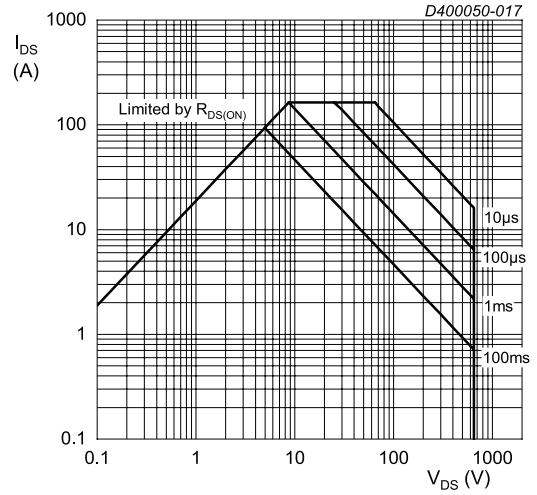
**Fig. 15. Output capacitor stored energy as a function of drain-source voltage**





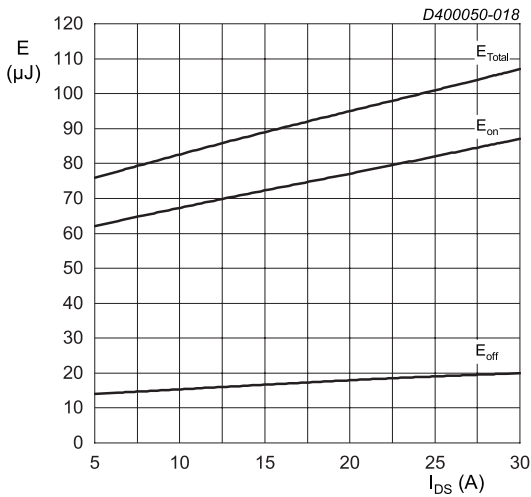
$V_{DS} = 0 - 650 \text{ V}$   
 $T_j = 25 \text{ }^\circ\text{C}; V_{AC} = 25 \text{ mV}; f = 1 \text{ MHz}$

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



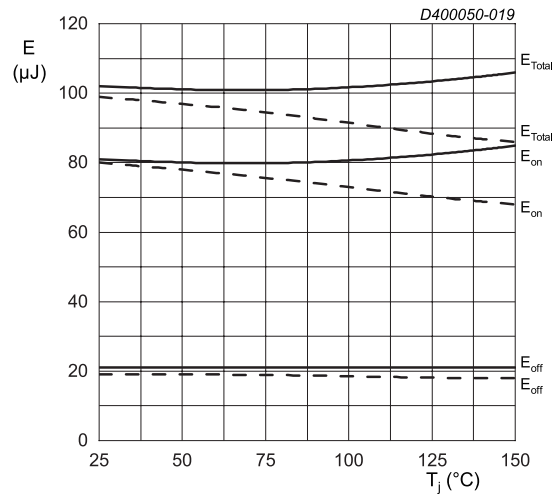
$T_j = 25 \text{ }^\circ\text{C}; D = 0$   
 Parameter:  $t_p$

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



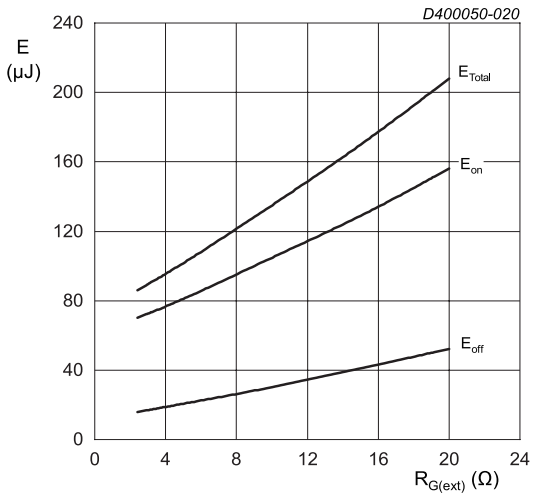
$T_j = 25 \text{ }^\circ\text{C}; V_{DD} = 400 \text{ V}; R_{G(ext)} = 2.4 \text{ } \Omega;$   
 $V_{GS} = -4 \text{ V}/18 \text{ V}; L = 100 \text{ } \mu\text{H}$   
 FWD = WNSC2M45065R

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



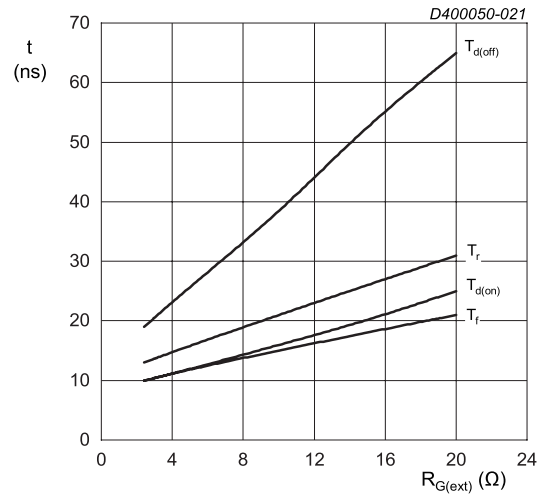
$I_{DS} = 12.5 \text{ A}; V_{DD} = 400 \text{ V}; R_{G(ext)} = 5.1 \text{ } \Omega;$   
 $V_{GS} = -4 \text{ V}/18 \text{ V}; L = 100 \text{ } \mu\text{H}$   
 FWD = WNSC2M45065R  
 FWD = WNSC6D20650(- - -)

**Fig. 19. Clamped Inductive Switching Energy as a function of junction temperature**



T<sub>j</sub> = 25 °C; V<sub>DD</sub> = 400 V; I<sub>DS</sub> = 12.5 A; V<sub>GS</sub> = -4 V/18 V  
 FWD = WNSC2M45065R; L = 100 μH

Fig. 20. Clamped Inductive Switching Energy as a function of external gate resistance



T<sub>j</sub> = 25 °C; V<sub>DD</sub> = 400 V; I<sub>DS</sub> = 12.5 A; V<sub>GS</sub> = -4 V/18 V  
 FWD = WNSC2M45065R; L = 100 μH

Fig. 21. Switching time as a function of external gate resistance

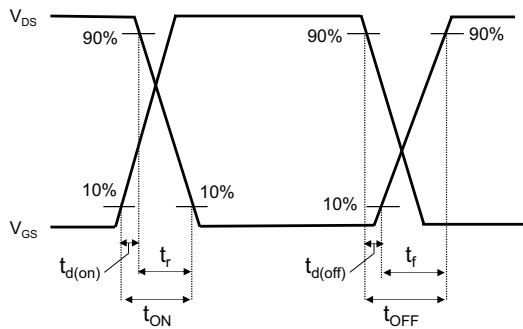
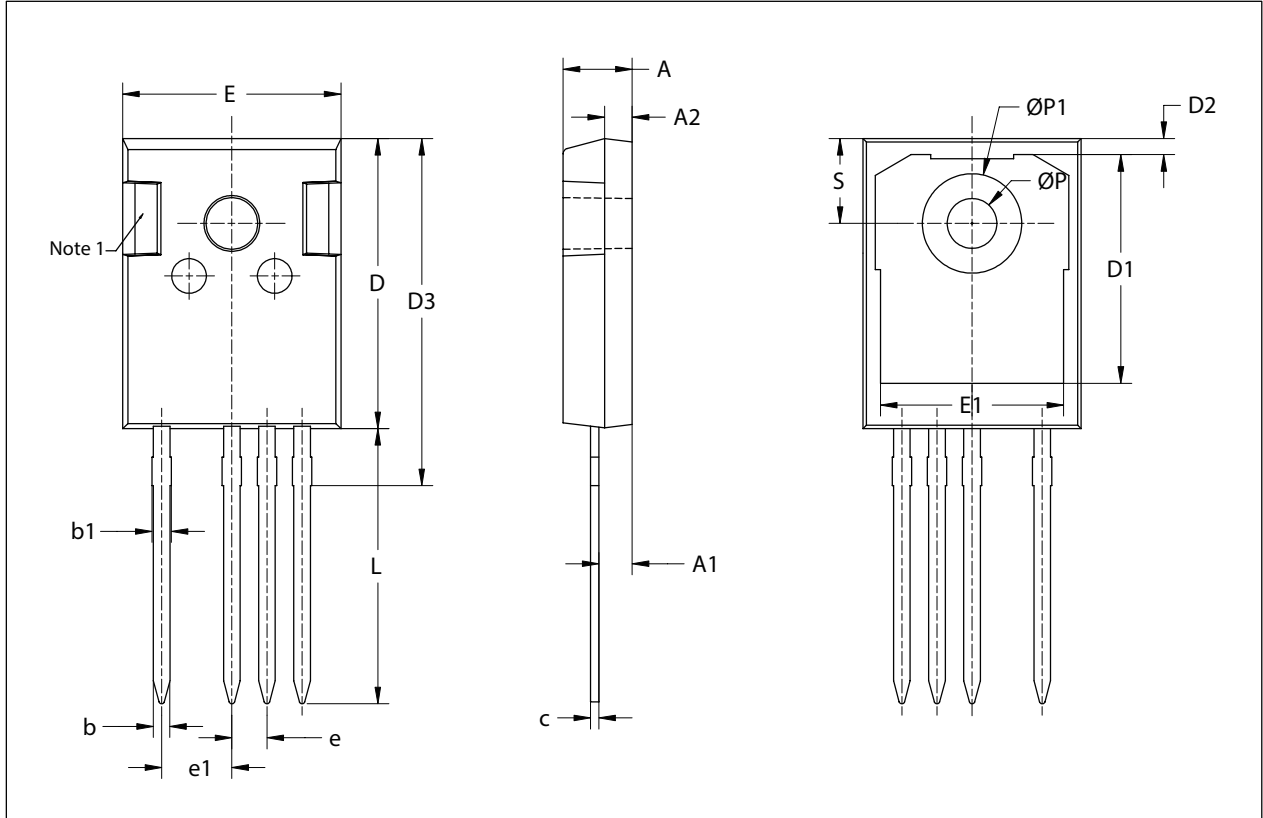


Fig. 22. Switching time definition

### 11. Package outline

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

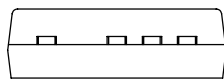
TO247-4L



**TOP VIEW**

**SIDE VIEW**

**BOTTOM VIEW**



**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".
- [3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the Internet at URL <http://www.ween-semi.com>.

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For more information, please visit: <http://www.ween-semi.com>  
For sales office addresses, please send an email to: [salesaddresses@ween-semi.com](mailto:salesaddresses@ween-semi.com)  
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