

MOSFETs Silicon Carbide N-Channel MOS

# TW048Z65C

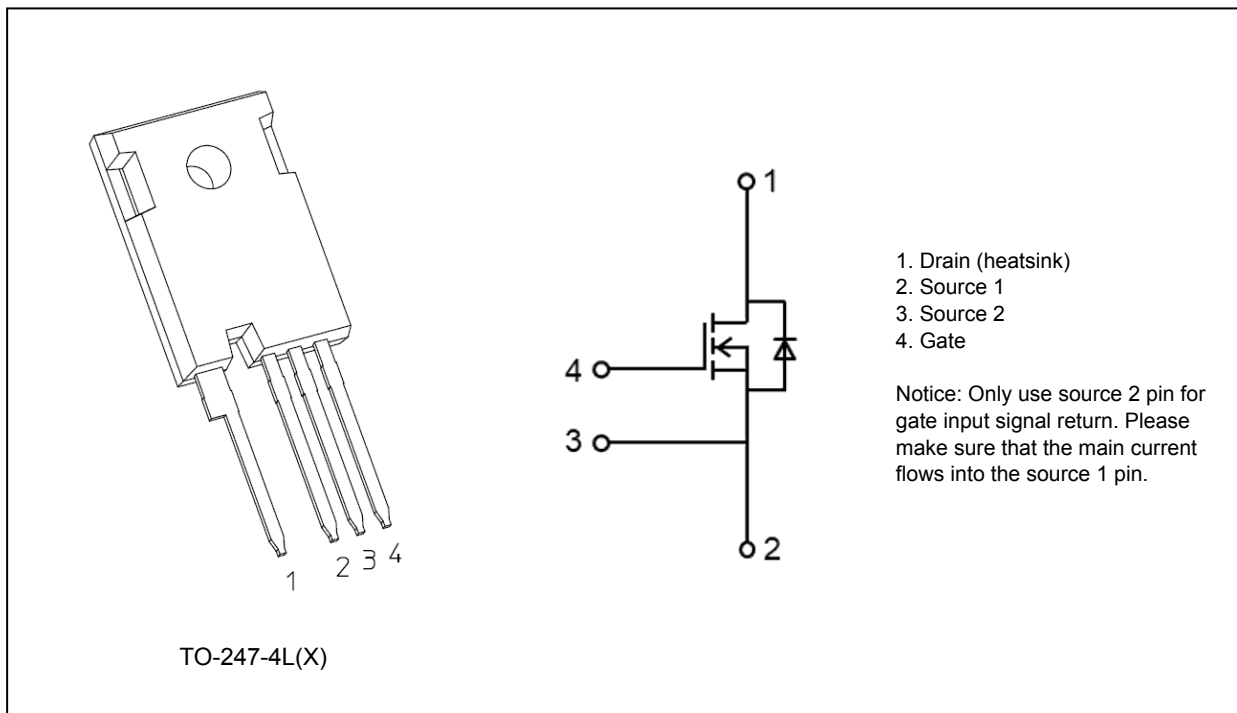
## 1. Applications

- Switching Voltage Regulators

## 2. Features

- (1) Chip design of 3rd generation (Built-in SiC schottky barrier diode)
- (2) Low diode forward voltage:  $V_{DSF} = -1.35 \text{ V}$  (typ.)
- (3) High voltage:  $V_{DSS} = 650 \text{ V}$
- (4) Low drain-source on-resistance:  $R_{DS(ON)} = 48 \text{ m}\Omega$  (typ.)
- (5) Less susceptible to malfunction due to high threshold voltage:  $V_{th} = 3.0 \text{ to } 5.0 \text{ V}$  ( $V_{DS} = 10 \text{ V}$ ,  $I_D = 1.6 \text{ mA}$ )
- (6) Recommended gate - source drive voltage:  $V_{GS_{on}} = 18 \text{ V}$ ,  $V_{GS_{off}} = 0 \text{ V}$
- (7) Enhancement mode.

## 3. Packaging and Internal Circuit



Start of commercial production  
2023-06

## 4. Absolute Maximum Ratings (Note) ( $T_a = 25\text{ }^\circ\text{C}$ unless otherwise specified)

Characteristics	Symbol	Rating	Unit
Drain-source voltage	$V_{DSS}$	650	V
Gate-source voltage	$V_{GSS}$	+25/-10	
Drain current (DC) ( $T_c = 25\text{ }^\circ\text{C}$ ) (Note 1)	$I_D$	40	A
Drain current (DC) ( $T_c = 100\text{ }^\circ\text{C}$ ) (Note 1)	$I_D$	28	
Drain current (pulsed) ( $T_c = 25\text{ }^\circ\text{C}$ ) (Note 1)	$I_{DP}$	103	
Drain current (pulsed) ( $T_c = 100\text{ }^\circ\text{C}$ ) (Note 1)	$I_{DP}$	80	
Power dissipation ( $T_c = 25\text{ }^\circ\text{C}$ )	$P_D$	132	W
Channel temperature	$T_{ch}$	175	$^\circ\text{C}$
Storage temperature	$T_{stg}$	-55 to 175	
Mounting torque	TOR	0.8	N · m

Note: Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) are within the absolute maximum ratings.

Please design the appropriate reliability upon reviewing the Toshiba Semiconductor Reliability Handbook ("Handling Precautions"/"Derating Concept and Methods") and individual reliability data (i.e. reliability test report and estimated failure rate, etc).

## 5. Thermal Characteristics

Characteristics	Symbol	Max	Unit
Channel-to-case thermal resistance	$R_{th(ch-c)}$	1.133	$^\circ\text{C/W}$
Channel-to-ambient thermal resistance	$R_{th(ch-a)}$	50	

Note 1: Ensure that the channel temperature does not exceed  $175\text{ }^\circ\text{C}$ .

Note: This transistor is sensitive to electrostatic discharge and should be handled with care. It should be used for switching applications.

## 6. Electrical Characteristics

### 6.1. Static Characteristics ( $T_a = 25\text{ }^\circ\text{C}$ unless otherwise specified)

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Gate leakage current	$I_{GSS}$	$V_{GS} = +25/-10\text{ V}, V_{DS} = 0\text{ V}$	—	—	$\pm 0.1$	$\mu\text{A}$
Drain cut-off current	$I_{DSS}$	$V_{DS} = 650\text{ V}, V_{GS} = 0\text{ V}$	—	3	58	
		$T_a = 150\text{ }^\circ\text{C},$ $V_{DS} = 650\text{ V}, V_{GS} = 0\text{ V}$	—	17	—	
Drain-source breakdown voltage	$V_{(BR)DSS}$	$I_D = 4\text{ mA}, V_{GS} = 0\text{ V}$	650	—	—	V
Gate threshold voltage (Note 2)	$V_{th}$	$V_{DS} = 10\text{ V}, I_D = 1.6\text{ mA}$	3.0	—	5.0	
Drain-source on-resistance	$R_{DS(ON)}$	$V_{GS} = 18\text{ V}, I_D = 20\text{ A}$	—	48	69	$\text{m}\Omega$
		$T_a = 150\text{ }^\circ\text{C},$ $V_{GS} = 18\text{ V}, I_D = 20\text{ A}$	—	53	—	

Note 2: Please be sure to apply  $I_{GSS}$  ( $V_{GS} = 25\text{ V}$ ) before the  $V_{th}$  test.

## 6.2. Dynamic Characteristics ( $T_a = 25\text{ }^\circ\text{C}$ unless otherwise specified)

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Input capacitance	$C_{iss}$	$V_{DS} = 400\text{ V}, V_{GS} = 0\text{ V},$ $f = 100\text{ kHz}$	—	1362	—	pF
Reverse transfer capacitance	$C_{rss}$		—	4.4	—	
Output capacitance	$C_{oss}$		—	156	—	
Effective output capacitance (energy related)	$C_{o(er)}$		—	175	—	
Effective output capacitance (time related)	$C_{o(tr)}$		—	258	—	
Output charge	$Q_{oss}$		—	103	—	
$C_{oss}$ stored energy	$E_{oss}$	—	14	—	$\mu\text{J}$	
Gate resistance	$r_g$	$V_{DS} = \text{OPEN}, f = 1\text{ MHz}$	—	3.6	—	$\Omega$
Turn-on delay time	$t_{d(on)}$	See Fig. 6.2.1	—	30	—	ns
Switching time (rise time)	$t_r$		—	14	—	
Turn-off delay time	$t_{d(off)}$		—	41	—	
Switching time (fall time)	$t_f$		—	16	—	
Turn-on switching loss	$E_{on}$		—	122	—	
Turn-off switching loss	$E_{off}$	—	58	—	$\mu\text{J}$	

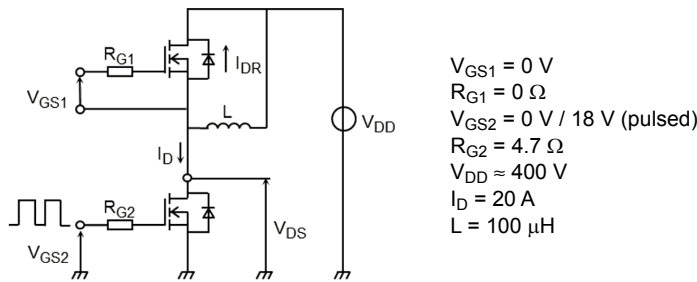


Fig. 6.2.1 Switching Time Test Circuit

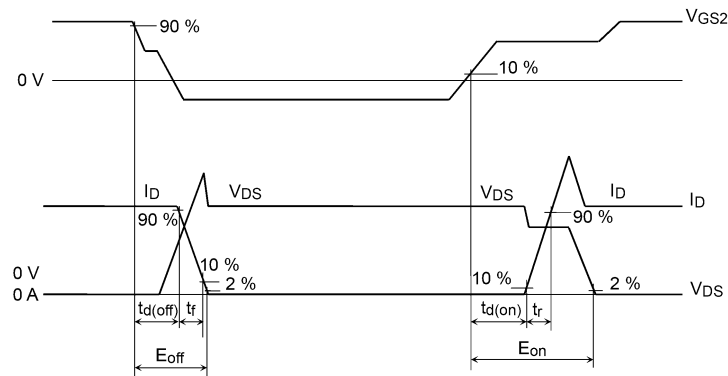


Fig. 6.2.2 Timing Diagrams

### 6.3. Gate Charge Characteristics ( $T_a = 25\text{ }^\circ\text{C}$ unless otherwise specified)

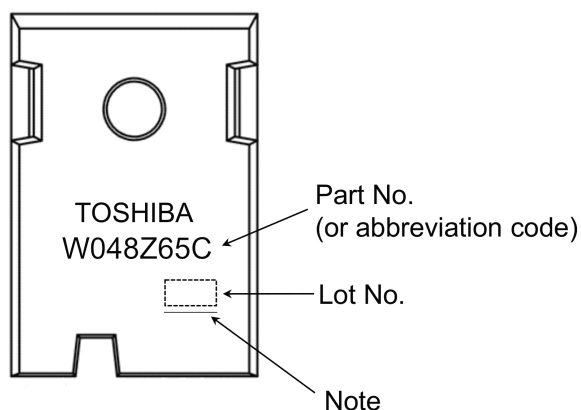
Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Total gate charge (gate-source plus gate-drain)	$Q_g$	$V_{DD} \approx 400\text{ V}$ , $V_{GS} = 18\text{ V}$ , $I_D = 20\text{ A}$	—	41	—	nC
Gate-source charge 1	$Q_{gs1}$		—	17	—	
Gate-drain charge	$Q_{gd}$		—	6.2	—	

### 6.4. Source · Drain Characteristics ( $T_a = 25\text{ }^\circ\text{C}$ unless otherwise specified)

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Reverse drain current (DC) (Note 3)	$I_{DR}$	$T_c = 25\text{ }^\circ\text{C}$ , $V_{GS} = -5\text{ V}$	—	—	35	A
		$T_c = 100\text{ }^\circ\text{C}$ , $V_{GS} = -5\text{ V}$	—	—	23	
		$T_c = 25\text{ }^\circ\text{C}$ , $V_{GS} = 18\text{ V}$	—	—	40	
		$T_c = 100\text{ }^\circ\text{C}$ , $V_{GS} = 18\text{ V}$	—	—	28	
Reverse drain current (pulsed) (Note 3)	$I_{DRP}$	$T_c = 25\text{ }^\circ\text{C}$ , $V_{GS} = -5\text{ V}$	—	—	103	
		$T_c = 100\text{ }^\circ\text{C}$ , $V_{GS} = -5\text{ V}$	—	—	41	
		$T_c = 25\text{ }^\circ\text{C}$ , $V_{GS} = 18\text{ V}$	—	—	103	
		$T_c = 100\text{ }^\circ\text{C}$ , $V_{GS} = 18\text{ V}$	—	—	80	
Diode forward voltage	$V_{DSF}$	$I_{DR} = 12\text{ A}$ , $V_{GS} = -5\text{ V}$	—	-1.35	-1.80	V
		$T_a = 150\text{ }^\circ\text{C}$ , $I_{DR} = 12\text{ A}$ , $V_{GS} = -5\text{ V}$	—	-1.60	—	
Reverse recovery time	$t_{rr}$	$I_{DR} = 13\text{ A}$ , $V_{GS} = 0\text{ V}$ , $V_{DD} = 400\text{ V}$ , $-dI_{DR}/dt = 1000\text{ A}/\mu\text{s}$	—	50	—	ns
Reverse recovery charge	$Q_{rr}$		—	250	—	nC
Peak reverse recovery current	$I_{rr}$		—	10	—	A

Note 3: Ensure that the channel temperature does not exceed  $175\text{ }^\circ\text{C}$ .

## 7. Marking (Note)



**Fig. 7.1 Marking**

Note: A line under a Lot No. identifies the indication of product Labels.

Not underlined: [[Pb]]/INCLUDES > MCV

Underlined: [[G]]/RoHS COMPATIBLE or [[G]]/RoHS [[Pb]]

Please contact your TOSHIBA sales representative for details as to environmental matters such as the RoHS compatibility of Product.

The RoHS is the Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

## 8. Characteristics Curves (Note)

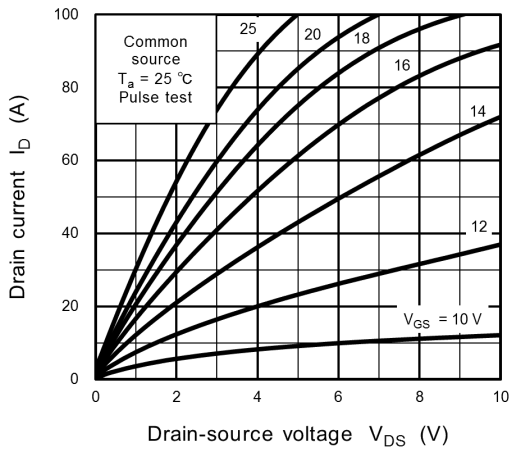


Fig. 8.1  $I_D - V_{DS}$

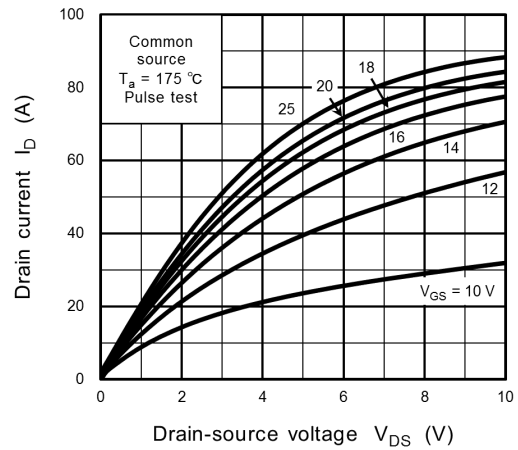


Fig. 8.2  $I_D - V_{DS}$

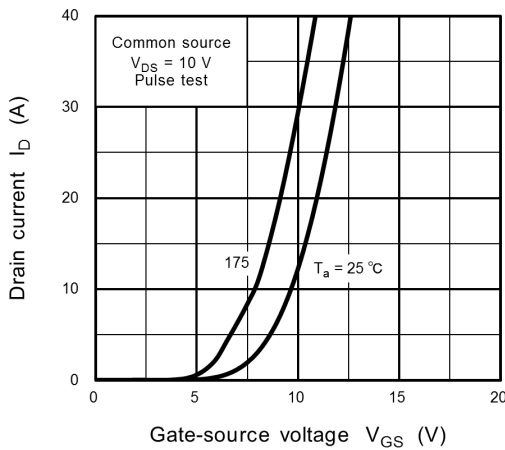


Fig. 8.3  $I_D - V_{GS}$

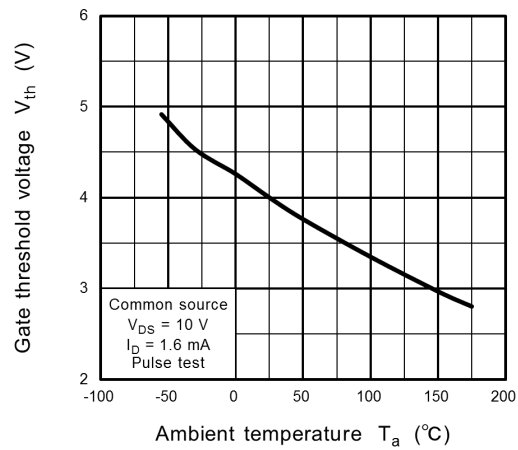


Fig. 8.4  $V_{th} - T_a$

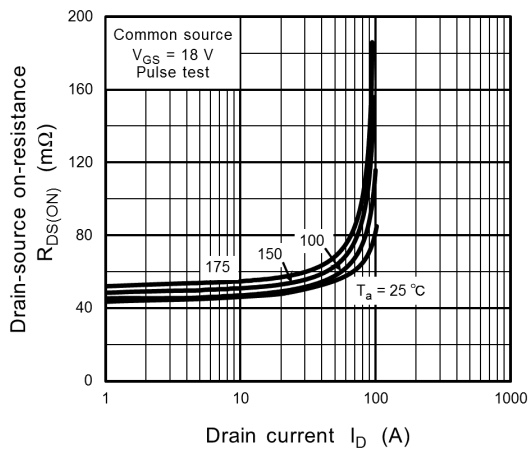


Fig. 8.5  $R_{DS(ON)} - I_D$

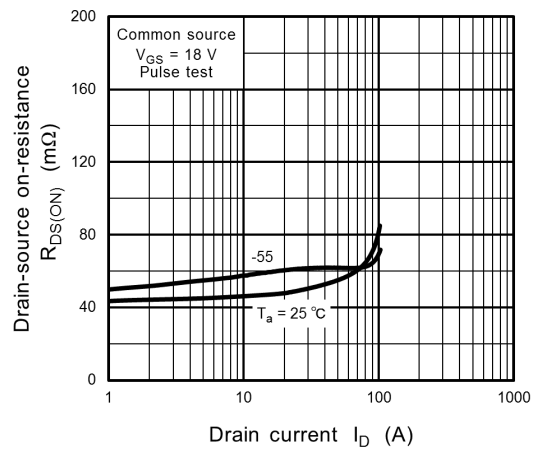
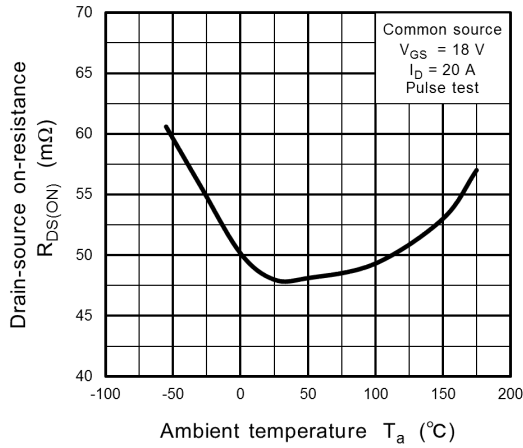
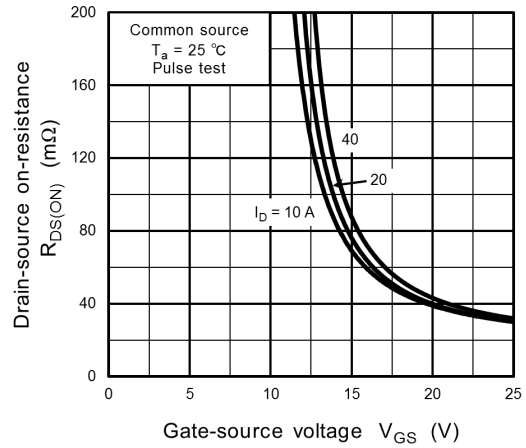


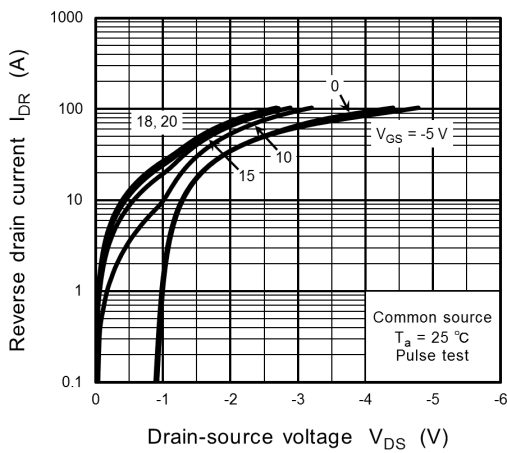
Fig. 8.6  $R_{DS(ON)} - I_D$



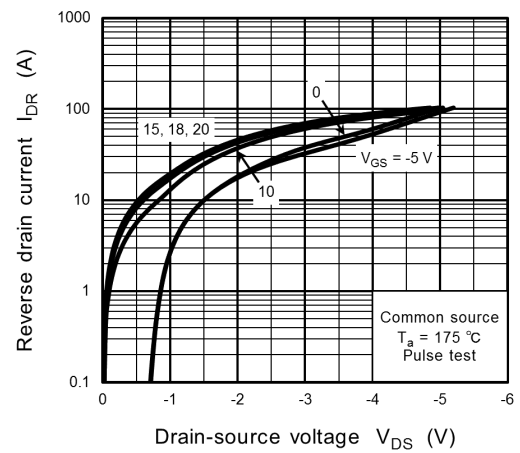
**Fig. 8.7  $R_{DS(ON)} - T_a$**



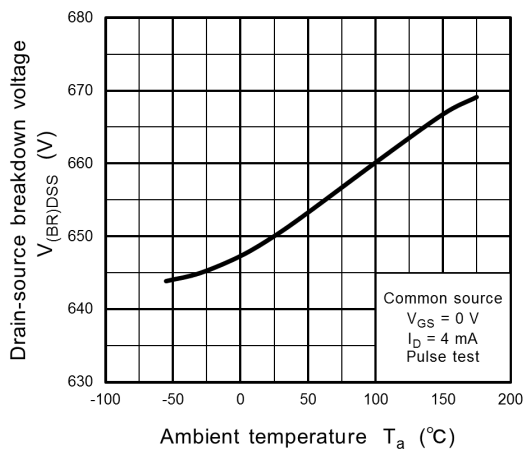
**Fig. 8.8  $R_{DS(ON)} - V_{GS}$**



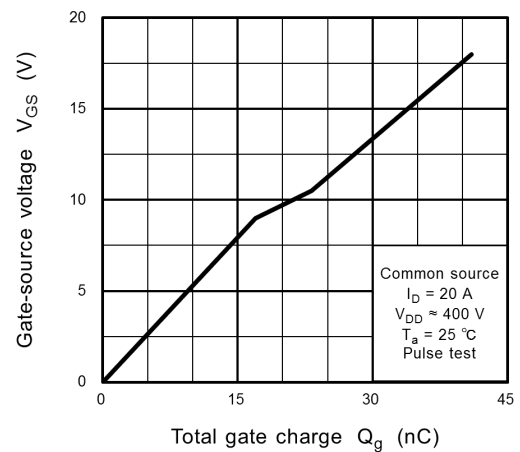
**Fig. 8.9  $I_{DR} - V_{DS}$**



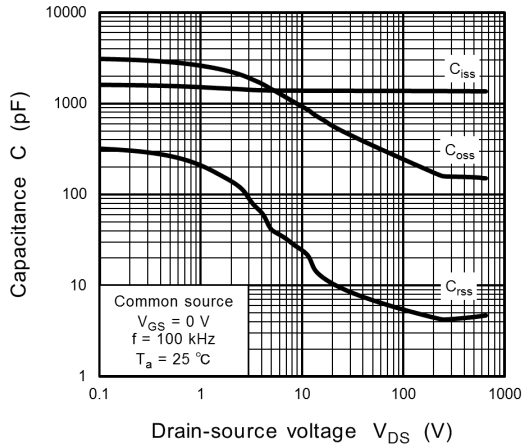
**Fig. 8.10  $I_{DR} - V_{DS}$**



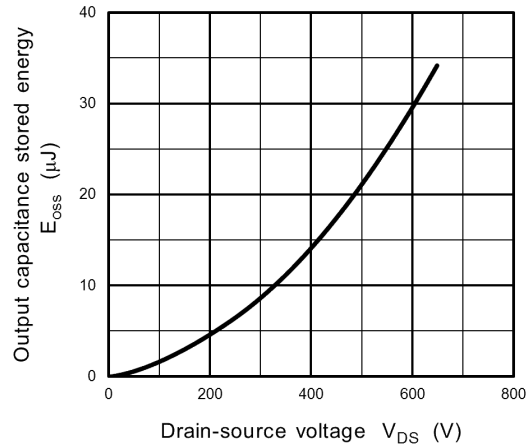
**Fig. 8.11  $V_{(BR)DSS} - T_a$**



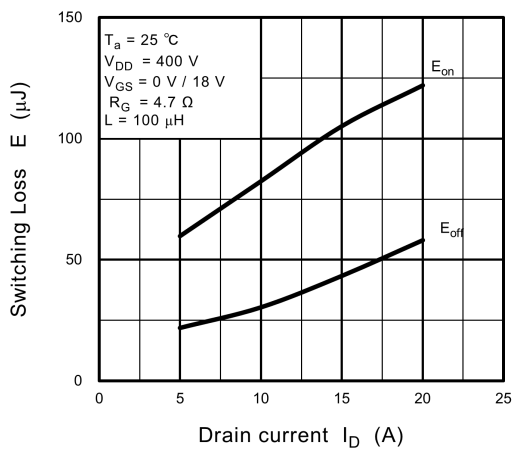
**Fig. 8.12 Dynamic Input Characteristics**



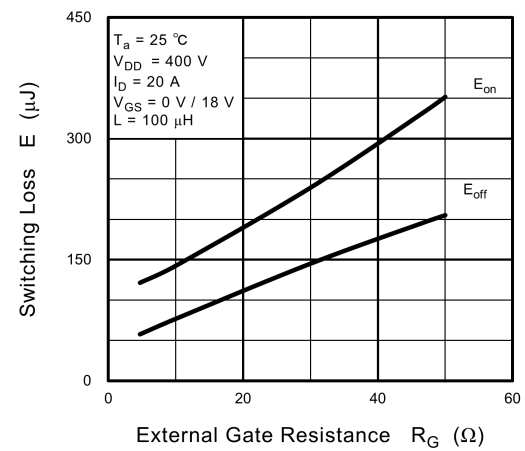
**Fig. 8.13 C -  $V_{DS}$**



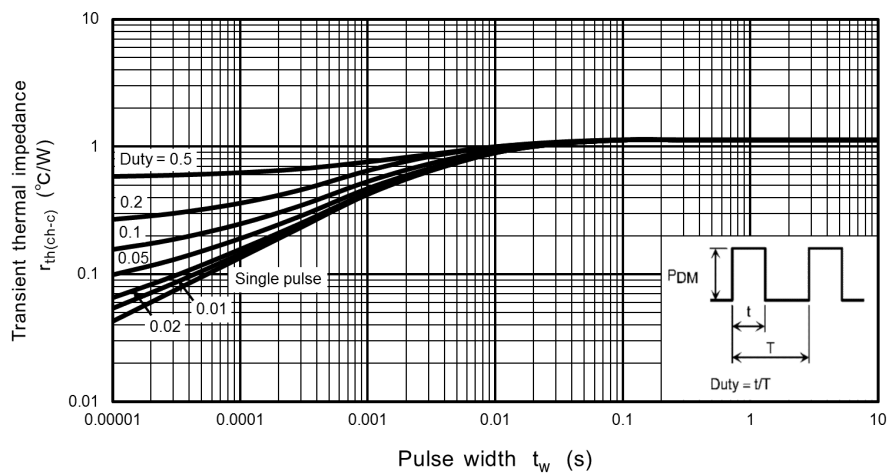
**Fig. 8.14  $E_{oss}$  -  $V_{DS}$**



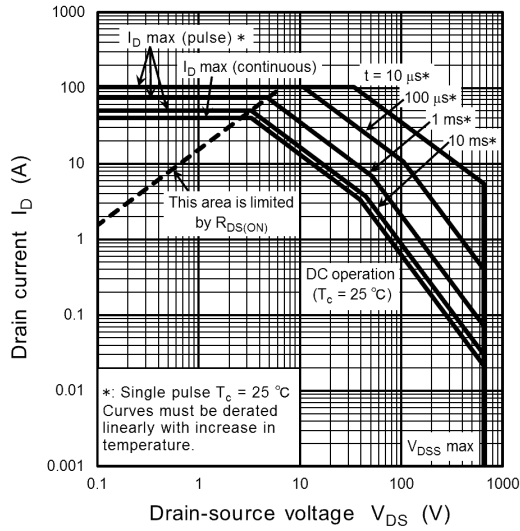
**Fig. 8.15 E -  $I_D$**



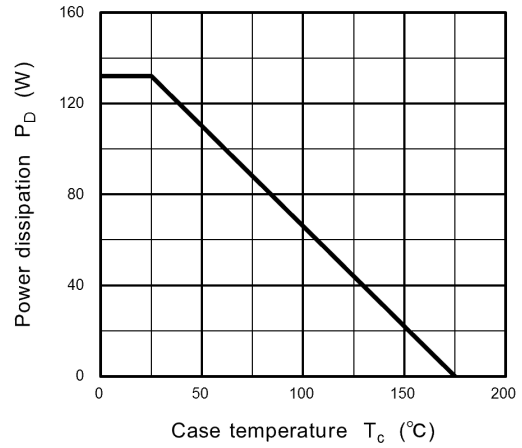
**Fig. 8.16 E -  $R_G$**



**Fig. 8.17  $r_{th(ch-c)}$  -  $t_w$   
 (Guaranteed Maximum)**



**Fig. 8.18 Safe Operating Area (Guaranteed Maximum)**



**Fig. 8.19  $P_D - T_c$  (Guaranteed Maximum)**

Note: The above characteristics curves are presented for reference only and not guaranteed by production test, unless otherwise noted.



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