

# TW031V65C

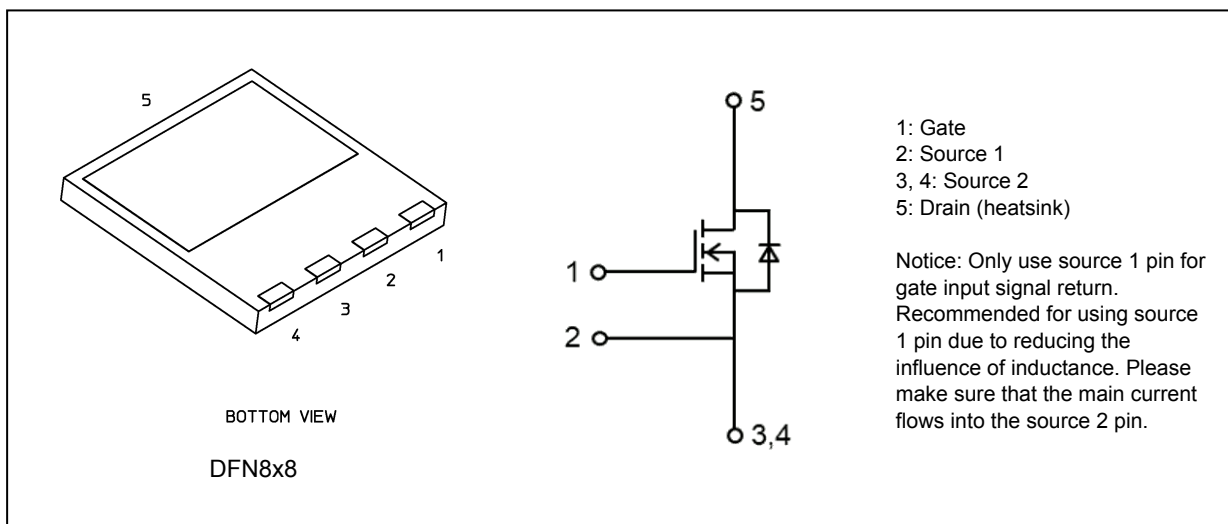
## 1. Applications

- 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:  $R_{DS(ON)} = 31 \text{ m}\Omega$  (typ.)
- (5) Less susceptible to malfunction due to high threshold voltage:  $V_{th} = 3.0 \text{ to } 5.0 \text{ V}$  ( $V_{DS} = 10 \text{ V}$ ,  $I_D = 3 \text{ mA}$ )
- (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  
2025-02

## 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)	$I_D$	53	A
Drain current (DC) ( $T_c = 100\text{ }^\circ\text{C}$ ) (Note 1)	$I_D$	38	
Drain current (pulsed) ( $T_c = 25\text{ }^\circ\text{C}$ ) (Note 1)	$I_{DP}$	163	
Drain current (pulsed) ( $T_c = 100\text{ }^\circ\text{C}$ ) (Note 1)	$I_{DP}$	122	
Power dissipation ( $T_c = 25\text{ }^\circ\text{C}$ )	$P_D$	156	W
Channel temperature	$T_{ch}$	175	$^\circ\text{C}$
Storage temperature	$T_{stg}$	-55 to 175	

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	$R_{th(ch-c)}$	0.961	$^\circ\text{C}/\text{W}$

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	$I_{DSS}$	$V_{DS} = 650\text{ V}, V_{GS} = 0\text{ V}$	—	7.0	100	
		$T_a = 150\text{ }^\circ\text{C},$ $V_{DS} = 650\text{ V}, V_{GS} = 0\text{ V}$	—	37	—	
Drain-source breakdown voltage	$V_{(BR)DSS}$	$I_D = 4\text{ mA}, V_{GS} = 0\text{ V}$	650	—	—	V
Gate threshold voltage (Note 2)	$V_{th}$	$V_{DS} = 10\text{ V}, I_D = 3\text{ mA}$	3.0	—	5.0	
Drain-source on-resistance	$R_{DS(ON)}$	$V_{GS} = 18\text{ V}, I_D = 29\text{ A}$	—	31	45	$\text{m}\Omega$
		$T_a = 150\text{ }^\circ\text{C},$ $V_{GS} = 18\text{ V}, I_D = 29\text{ A}$	—	35	—	

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	$C_{iss}$	$V_{DS} = 400\text{ V}, V_{GS} = 0\text{ V},$ $f = 100\text{ kHz}$	—	2288	—	pF
Reverse transfer capacitance	$C_{rss}$		—	6.6	—	
Output capacitance	$C_{oss}$		—	249	—	
Effective output capacitance (energy related)	$C_{o(er)}$		—	288	—	
Effective output capacitance (time related)	$C_{o(tr)}$		—	413	—	
Output charge	$Q_{oss}$		—	165	—	
$C_{oss}$ stored energy	$E_{oss}$	—	23	—	$\mu\text{J}$	
Gate resistance	$r_g$	$V_{DS} = \text{OPEN}, f = 1\text{ MHz}$	—	2.1	—	$\Omega$
Turn-on delay time	$t_{d(on)}$	See Fig. 6.2.1	—	30	—	ns
Switching time (rise time)	$t_r$		—	15	—	
Turn-off delay time	$t_{d(off)}$		—	42	—	
Switching time (fall time)	$t_f$		—	18	—	
Turn-on switching loss	$E_{on}$		—	163	—	
Turn-off switching loss	$E_{off}$	—	100	—	$\mu\text{J}$	

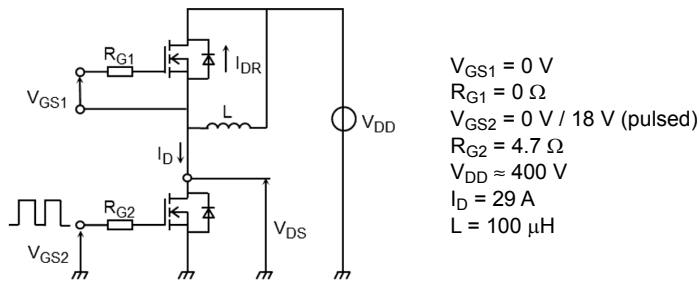


Fig. 6.2.1 Switching Time Test Circuit

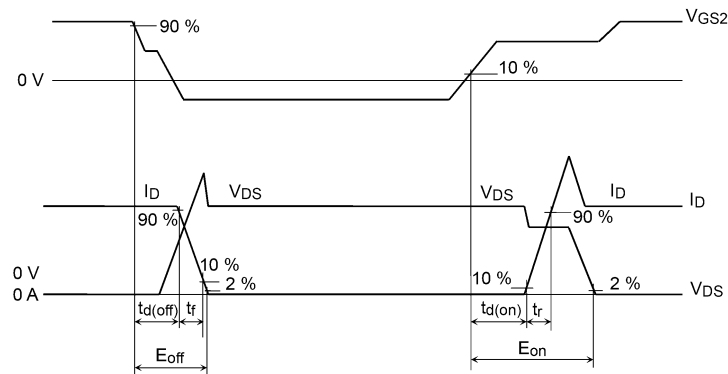


Fig. 6.2.2 Timing Diagrams

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

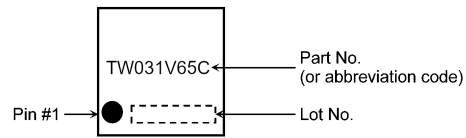
Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Total gate charge (gate-source plus gate-drain)	$Q_g$	$V_{DD} \approx 400\text{ V}$ , $V_{GS} = 18\text{ V}$ , $I_D = 29\text{ A}$	—	65	—	nC
Gate-source charge 1	$Q_{gs1}$		—	26	—	
Gate-drain charge	$Q_{gd}$		—	10	—	

### 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)	$I_{DR}$	$T_c = 25\text{ }^\circ\text{C}$ , $V_{GS} = -5\text{ V}$	—	—	44	A
		$T_c = 100\text{ }^\circ\text{C}$ , $V_{GS} = -5\text{ V}$	—	—	29	
		$T_c = 25\text{ }^\circ\text{C}$ , $V_{GS} = 18\text{ V}$	—	—	53	
		$T_c = 100\text{ }^\circ\text{C}$ , $V_{GS} = 18\text{ V}$	—	—	38	
Reverse drain current (pulsed) (Note 3)	$I_{DRP}$	$T_c = 25\text{ }^\circ\text{C}$ , $V_{GS} = -5\text{ V}$	—	—	163	
		$T_c = 100\text{ }^\circ\text{C}$ , $V_{GS} = -5\text{ V}$	—	—	75	
		$T_c = 25\text{ }^\circ\text{C}$ , $V_{GS} = 18\text{ V}$	—	—	163	
		$T_c = 100\text{ }^\circ\text{C}$ , $V_{GS} = 18\text{ V}$	—	—	122	
Diode forward voltage	$V_{DSF}$	$I_{DR} = 21\text{ A}$ , $V_{GS} = -5\text{ V}$	—	-1.35	-1.80	V
		$T_a = 150\text{ }^\circ\text{C}$ , $I_{DR} = 21\text{ A}$ , $V_{GS} = -5\text{ V}$	—	-1.57	—	
Reverse recovery time	$t_{rr}$	$I_{DR} = 19\text{ A}$ , $V_{GS} = 0\text{ V}$ , $V_{DD} = 400\text{ V}$ , $-dI_{DR}/dt = 1000\text{ A}/\mu\text{s}$	—	55	—	ns
Reverse recovery charge	$Q_{rr}$		—	358	—	nC
Peak reverse recovery current	$I_{rr}$		—	13	—	A

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

## 7. Marking



**Fig. 7.1 Marking**

## 8. Characteristics Curves (Note)

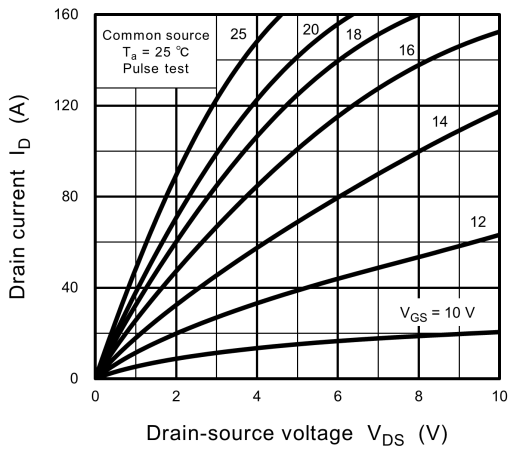


Fig. 8.1  $I_D - V_{DS}$

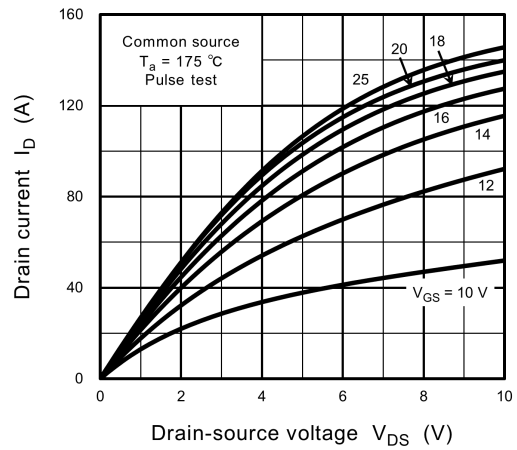


Fig. 8.2  $I_D - V_{DS}$

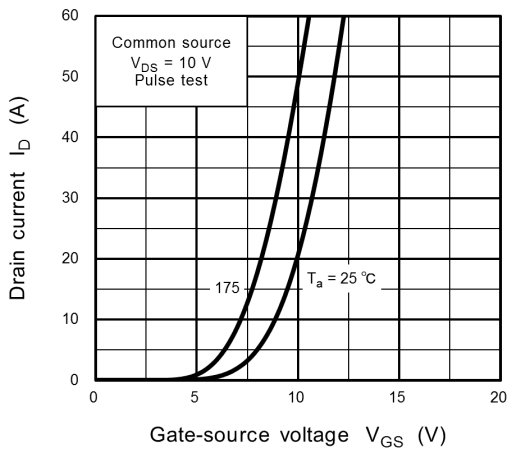


Fig. 8.3  $I_D - V_{GS}$

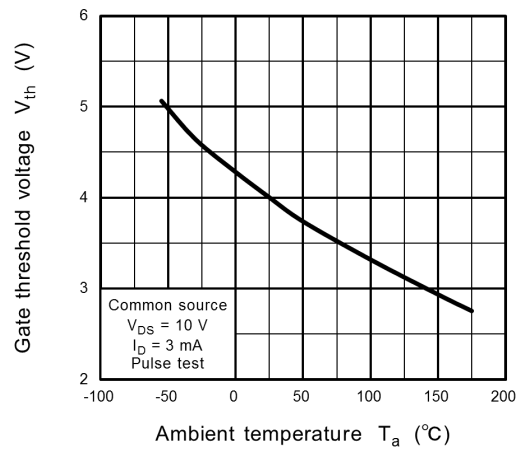


Fig. 8.4  $V_{th} - T_a$

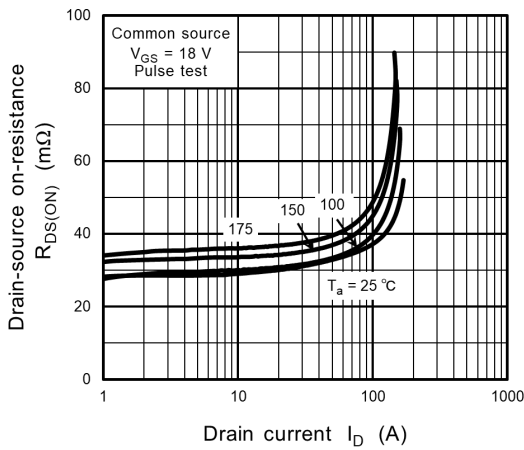


Fig. 8.5  $R_{DS(ON)} - I_D$

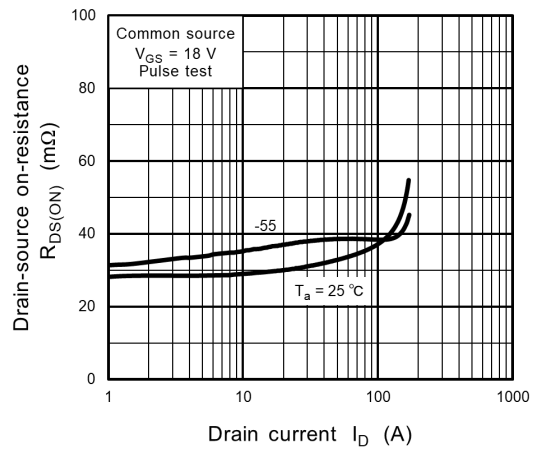


Fig. 8.6  $R_{DS(ON)} - I_D$

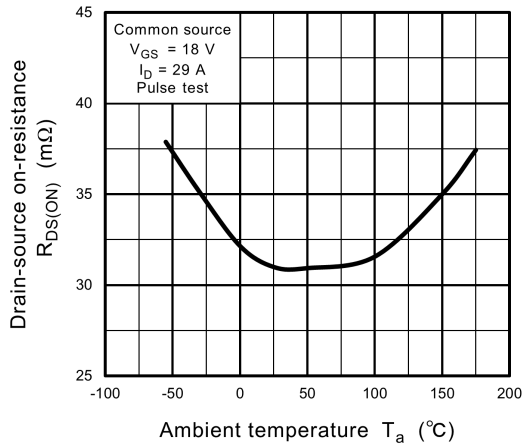


Fig. 8.7  $R_{DS(ON)} - T_a$

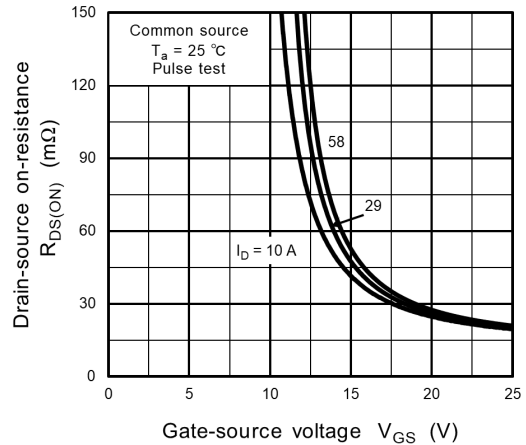


Fig. 8.8  $R_{DS(ON)} - V_{GS}$

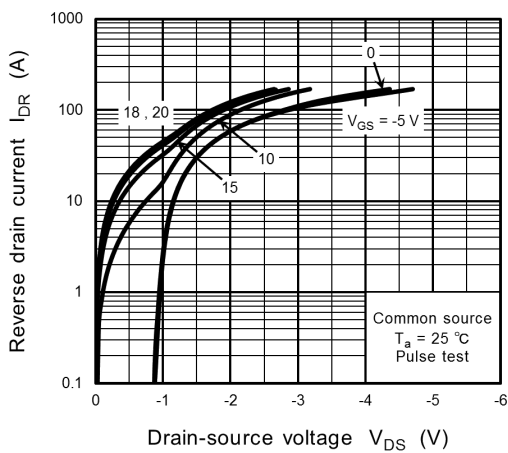


Fig. 8.9  $I_{DR} - V_{DS}$

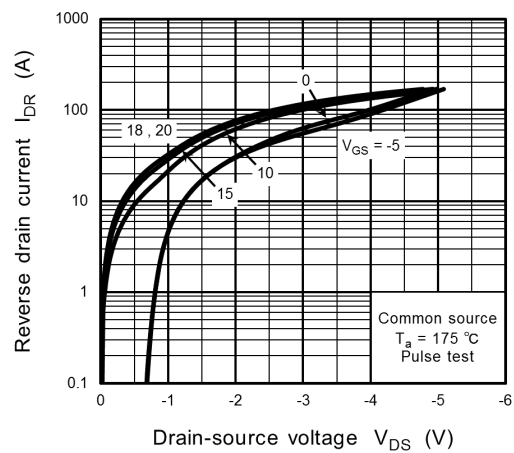


Fig. 8.10  $I_{DR} - V_{DS}$

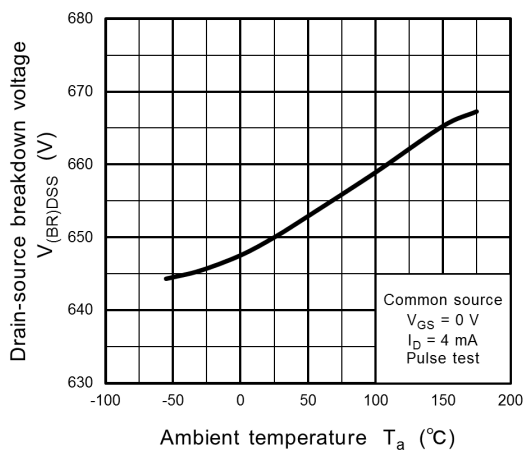


Fig. 8.11  $V_{(BR)DSS} - T_a$

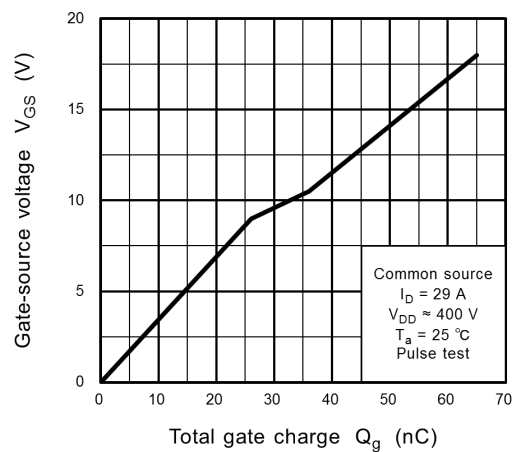
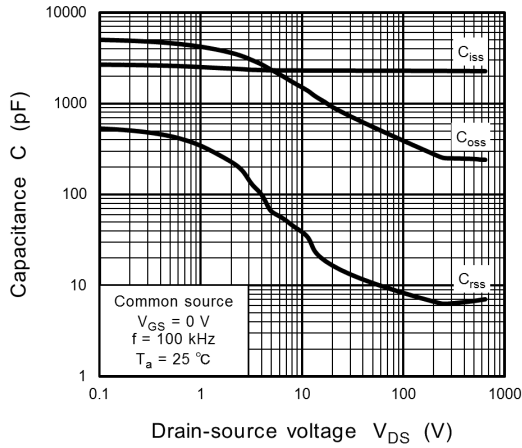
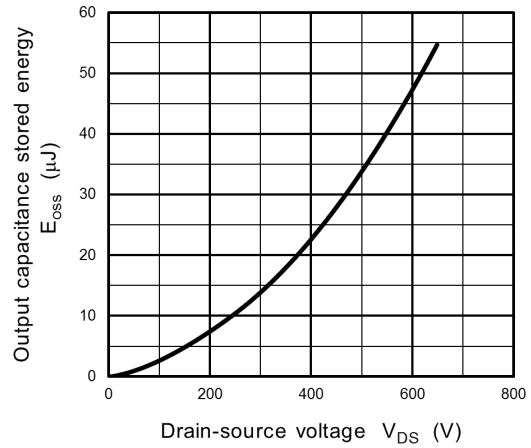


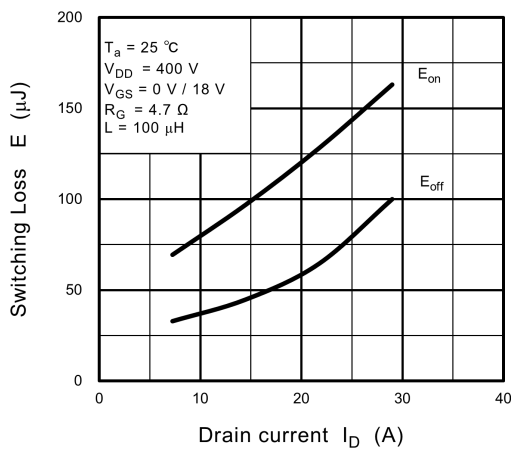
Fig. 8.12 Dynamic Input Characteristics



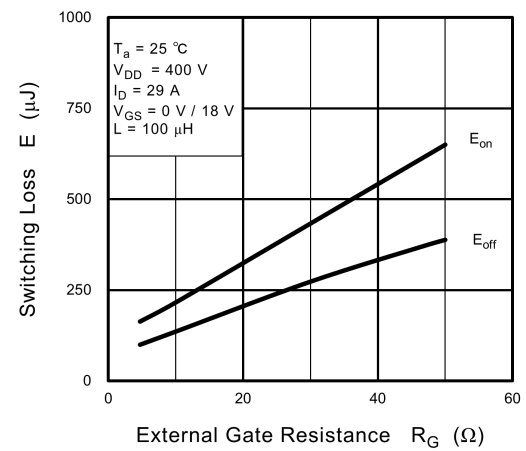
**Fig. 8.13 C - V<sub>DS</sub>**



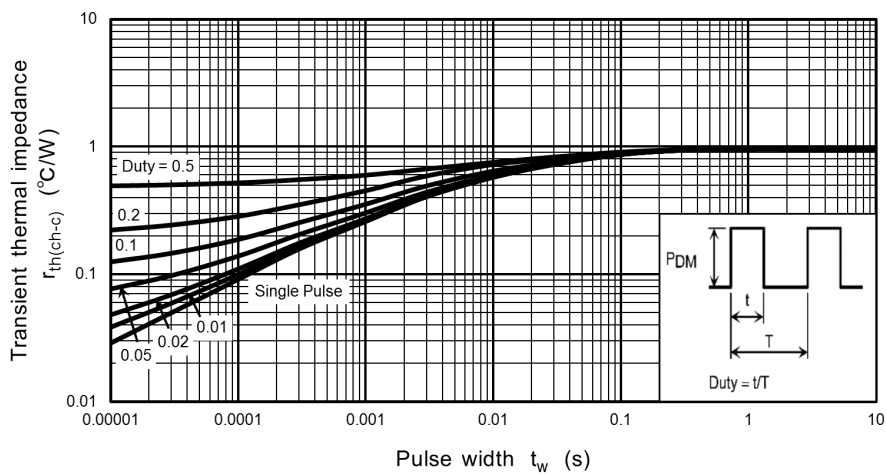
**Fig. 8.14 E<sub>oss</sub> - V<sub>DS</sub>**



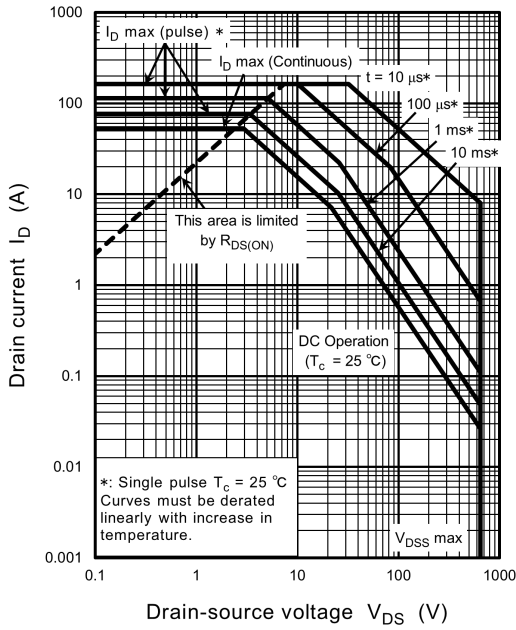
**Fig. 8.15 E - I<sub>D</sub>**



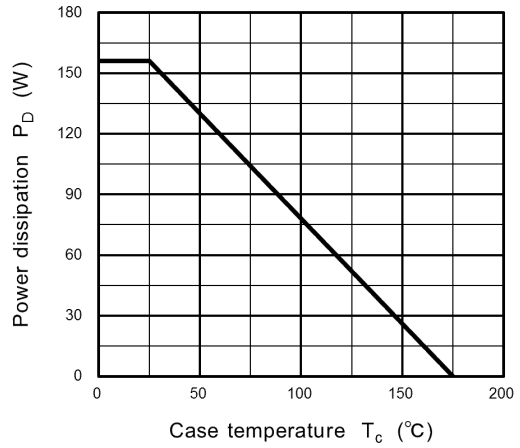
**Fig. 8.16 E - R<sub>G</sub>**



**Fig. 8.17 r<sub>th(ch-c)</sub> - t<sub>w</sub>  
(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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