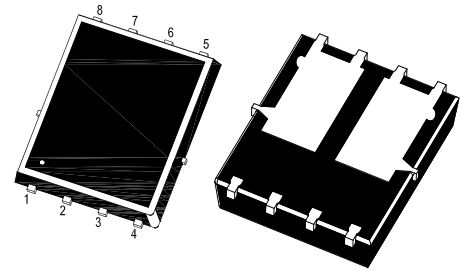
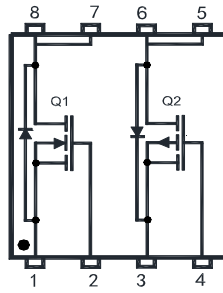


WTM604C400LS-HAF

Complementary N/P-Channel Enhancement Mode MOSFET

Features

- Surface-mounted package
- Low Gate-Source Threshold Voltage
- Halogen and Antimony Free(HAF), RoHS compliant



Q1:1.Source 2.Gate 7.Drain 8.Drain
Q2:3.Source 4.Gate 5.Drain 6.Drain
DFN5060 Plastic Package

Key Parameters(Q1)

Parameter	Value	Unit
BV_{DSS}	40	V
$R_{DS(ON)}$ Max	20 @ $V_{GS} = 10$ V	m Ω
	24 @ $V_{GS} = 4.5$ V	
$V_{GS(th)}$ typ	1.7	V
Q_g typ	22 @ $V_{GS} = 10$ V	nC

Key Parameters(Q2)

Parameter	Value	Unit
$-BV_{DSS}$	40	V
$R_{DS(ON)}$ Max	44 @ $-V_{GS} = 10$ V	m Ω
	59 @ $-V_{GS} = 4.5$ V	
$-V_{GS(th)}$ typ	1.6	V
Q_g typ	19 @ $-V_{GS} = 10$ V	nC

Absolute Maximum Ratings (at $T_a = 25^\circ\text{C}$ unless otherwise specified)

Parameter	Symbol	Value		Unit	
		Q1	Q2		
Drain-Source Voltage	V_{DS}	40	- 40	V	
Gate-Source Voltage	V_{GS}	± 20	± 20	V	
Continuous Drain Current	I_D	$T_c = 25^\circ\text{C}$	26	- 15	A
		$T_c = 100^\circ\text{C}$	16	- 9.4	A
Peak Drain Current, Pulsed ¹⁾	I_{DM}	100	- 60	A	
Avalanche Current	I_{AS}	9.8	-16.8	A	
Single Pulse Avalanche Energy ²⁾	E_{AS}	24	14.1	mJ	
Total Power Dissipation	P_{tot}	$T_c = 25^\circ\text{C}$ 15.6		W	
Operating Junction and Storage Temperature Range	T_J, T_{stg}	- 55 to + 150		$^\circ\text{C}$	

Thermal Characteristics(Q1\Q2)

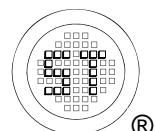
Parameter	Symbol	Max.	Unit
Thermal Resistance from Junction to Case	$R_{\theta JC}$	8	$^\circ\text{C}/\text{W}$
Thermal Resistance from Junction to Ambient ³⁾	$R_{\theta JA}$	67	$^\circ\text{C}/\text{W}$

¹⁾ Pulse Test: Pulse Width ≤ 100 μs , Duty Cycle $\leq 2\%$, Repetitive rating, pulse width limited by junction temperature $T_{J(MAX)} = 150^\circ\text{C}$.

²⁾ Q1: Limited by $T_{J(MAX)}$, starting $T_J = 25^\circ\text{C}$, $L = 0.5$ mH, $R_g = 25$ Ω , $I_{AS} = 9.8$ A, $V_{GS} = 10$ V.

Q2: Limited by $T_{J(MAX)}$, starting $T_J = 25^\circ\text{C}$, $L = 0.1$ mH, $R_g = 25$ Ω , $-I_{AS} = 16.8$ A, $V_{GS} = 10$ V.

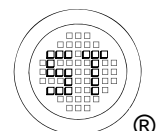
³⁾ Device mounted on FR-4 substrate PC board, 2oz copper, with 1-inch square copper plate in still air.



WTM604C400LS-HAF

Characteristics at $T_a = 25^\circ\text{C}$ unless otherwise specified (Q1)

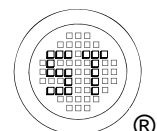
Parameter	Symbol	Min.	Typ.	Max.	Unit
STATIC PARAMETERS					
Drain-Source Breakdown Voltage at $I_D = 250 \mu\text{A}$	BV_{DSS}	40	-	-	V
Drain-Source Leakage Current at $V_{DS} = 32 \text{ V}$	I_{DSS}	-	-	1	μA
Gate-Source Leakage Current at $V_{GS} = \pm 20 \text{ V}$	I_{GSS}	-	-	± 100	nA
Gate-Source Threshold Voltage at $V_{DS} = V_{GS}, I_D = 250 \mu\text{A}$	$V_{GS(th)}$	1	-	2.5	V
Drain-Source On-State Resistance at $V_{GS} = 10 \text{ V}, I_D = 10 \text{ A}$ at $V_{GS} = 4.5 \text{ V}, I_D = 5 \text{ A}$	$R_{DS(on)}$	- -	16 -	20 24	$\text{m}\Omega$
DYNAMIC PARAMETERS					
Forward Transconductance at $V_{DS} = 5 \text{ V}, I_D = 5 \text{ A}$	g_{fs}	-	11.3	-	S
Gate resistance at $V_{DS} = 0 \text{ V}, f = 1 \text{ MHz}$	R_g	-	1.2	-	Ω
Input Capacitance at $V_{GS} = 0 \text{ V}, V_{DS} = 20 \text{ V}, f = 1 \text{ MHz}$	C_{iss}	-	1038	-	pF
Output Capacitance at $V_{GS} = 0 \text{ V}, V_{DS} = 20 \text{ V}, f = 1 \text{ MHz}$	C_{oss}	-	83	-	pF
Reverse Transfer Capacitance at $V_{GS} = 0 \text{ V}, V_{DS} = 20 \text{ V}, f = 1 \text{ MHz}$	C_{rss}	-	52	-	pF
Gate charge total at $V_{DS} = 20 \text{ V}, I_D = 10 \text{ A}, V_{GS} = 10 \text{ V}$ at $V_{DS} = 20 \text{ V}, I_D = 10 \text{ A}, V_{GS} = 4.5 \text{ V}$	Q_g	- -	22 10	- -	nC
Gate to Source Charge at $V_{DS} = 20 \text{ V}, I_D = 10 \text{ A}, V_{GS} = 10 \text{ V}$	Q_{gs}	-	4	-	nC
Gate to Drain Charge at $V_{DS} = 20 \text{ V}, I_D = 10 \text{ A}, V_{GS} = 10 \text{ V}$	Q_{gd}	-	4	-	nC
Turn-On Delay Time at $V_{DS} = 20 \text{ V}, I_D = 10 \text{ A}, V_{GS} = 10 \text{ V}, R_g = 3.3 \Omega$	$t_{d(on)}$	-	10	-	ns
Turn-On Rise Time at $V_{DS} = 20 \text{ V}, I_D = 10 \text{ A}, V_{GS} = 10 \text{ V}, R_g = 3.3 \Omega$	t_r	-	21	-	ns
Turn-Off Delay Time at $V_{DS} = 20 \text{ V}, I_D = 10 \text{ A}, V_{GS} = 10 \text{ V}, R_g = 3.3 \Omega$	$t_{d(off)}$	-	10	-	ns
Turn-Off Fall Time at $V_{DS} = 20 \text{ V}, I_D = 10 \text{ A}, V_{GS} = 10 \text{ V}, R_g = 3.3 \Omega$	t_f	-	1.6	-	ns
Body-Diode PARAMETERS					
Drain-Source Diode Forward Voltage at $I_S = 1 \text{ A}, V_{GS} = 0 \text{ V}$	V_{SD}	-	-	1.2	V
Body-Diode Continuous Current	I_S	-	-	26	A
Body-Diode Continuous Current, Pulsed	I_{SM}	-	-	100	A
Body Diode Reverse Recovery Time at $I_S = 10 \text{ A}, di/dt = 100 \text{ A} / \mu\text{s}$	t_{rr}	-	9	-	ns
Body Diode Reverse Recovery Charge at $I_S = 10 \text{ A}, di/dt = 100 \text{ A} / \mu\text{s}$	Q_{rr}	-	4	-	nC



WTM604C400LS-HAF

Characteristics at $T_a = 25^\circ\text{C}$ unless otherwise specified (Q2)

Parameter	Symbol	Min.	Typ.	Max.	Unit
STATIC PARAMETERS					
Drain-Source Breakdown Voltage at $-I_D = 250 \mu\text{A}$	$-BV_{DSS}$	40	-	-	V
Drain-Source Leakage Current at $-V_{DS} = 40 \text{ V}$	$-I_{DSS}$	-	-	1	μA
Gate Leakage Current at $V_{GS} = \pm 20 \text{ V}$	I_{GSS}	-	-	± 100	nA
Gate-Source Threshold Voltage at $V_{DS} = V_{GS}$, $-I_D = 250 \mu\text{A}$	$-V_{GS(th)}$	1	-	2.5	V
Drain-Source On-State Resistance at $-V_{GS} = 10 \text{ V}$, $-I_D = 12 \text{ A}$ at $-V_{GS} = 4.5 \text{ V}$, $-I_D = 10 \text{ A}$	$R_{DS(on)}$	-	38	44	$\text{m}\Omega$
		-	-	59	
DYNAMIC PARAMETERS					
Forward Transconductance at $-V_{DS} = 5 \text{ V}$, $-I_D = 10 \text{ A}$	g_{fs}	-	16	-	S
Gate Resistance at $V_{GS} = 0 \text{ V}$, $V_{DS} = 0 \text{ V}$, $f = 1 \text{ MHz}$	R_g	-	6.1	-	Ω
Input Capacitance at $V_{GS} = 0 \text{ V}$, $-V_{DS} = 20 \text{ V}$, $f = 1 \text{ MHz}$	C_{iss}	-	1083	-	pF
Output Capacitance at $V_{GS} = 0 \text{ V}$, $-V_{DS} = 20 \text{ V}$, $f = 1 \text{ MHz}$	C_{oss}	-	79	-	pF
Reverse Transfer Capacitance at $V_{GS} = 0 \text{ V}$, $-V_{DS} = 20 \text{ V}$, $f = 1 \text{ MHz}$	C_{rss}	-	40	-	pF
Total Gate Charge at $-V_{DS} = 20 \text{ V}$, $-I_D = 12 \text{ A}$, $-V_{GS} = 10 \text{ V}$ at $-V_{DS} = 20 \text{ V}$, $-I_D = 12 \text{ A}$, $-V_{GS} = 4.5 \text{ V}$	Q_g	-	19	-	nC
		-	8.8	-	
Gate-Source Charge at $-V_{DS} = 20 \text{ V}$, $-I_D = 12 \text{ A}$, $-V_{GS} = 10 \text{ V}$	Q_{gs}	-	4.5	-	nC
Gate-Drain Charge at $-V_{DS} = 20 \text{ V}$, $-I_D = 12 \text{ A}$, $-V_{GS} = 10 \text{ V}$	Q_{gd}	-	3	-	nC
Turn-On Delay Time at $-V_{DS} = 20 \text{ V}$, $-I_D = 12 \text{ A}$, $-V_{GS} = 10 \text{ V}$, $R_g = 3.3 \Omega$	$t_{d(on)}$	-	8	-	ns
Turn-On Rise Time at $-V_{DS} = 20 \text{ V}$, $-I_D = 12 \text{ A}$, $-V_{GS} = 10 \text{ V}$, $R_g = 3.3 \Omega$	t_r	-	29	-	ns
Turn-Off Delay Time at $-V_{DS} = 20 \text{ V}$, $-I_D = 12 \text{ A}$, $-V_{GS} = 10 \text{ V}$, $R_g = 3.3 \Omega$	$t_{d(off)}$	-	14	-	ns
Turn-Off Fall Time at $-V_{DS} = 20 \text{ V}$, $-I_D = 12 \text{ A}$, $-V_{GS} = 10 \text{ V}$, $R_g = 3.3 \Omega$	t_f	-	3	-	ns
Body-Diode PARAMETERS					
Drain-Source Diode Forward Voltage at $-I_S = 1 \text{ A}$, $V_{GS} = 0 \text{ V}$	$-V_{SD}$	-	-	1.2	V
Body-Diode Continuous Current	$-I_S$	-	-	15	A
Body-Diode Continuous Current, Pulsed	$-I_{SM}$	-	-	60	A
Body Diode Reverse Recovery Time at $-I_S = 12 \text{ A}$, $di/dt = 100 \text{ A} / \mu\text{s}$	t_{rr}	-	10	-	ns
Body Diode Reverse Recovery Charge at $-I_S = 12 \text{ A}$, $di/dt = 100 \text{ A} / \mu\text{s}$	Q_{rr}	-	5	-	nC



Electrical Characteristics Curves(Q1)

Fig. 1 Typical Output Characteristics

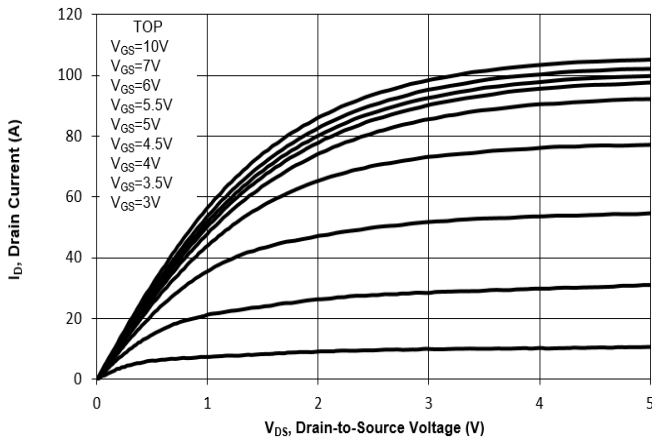


Fig. 2 Typical Transfer Characteristics

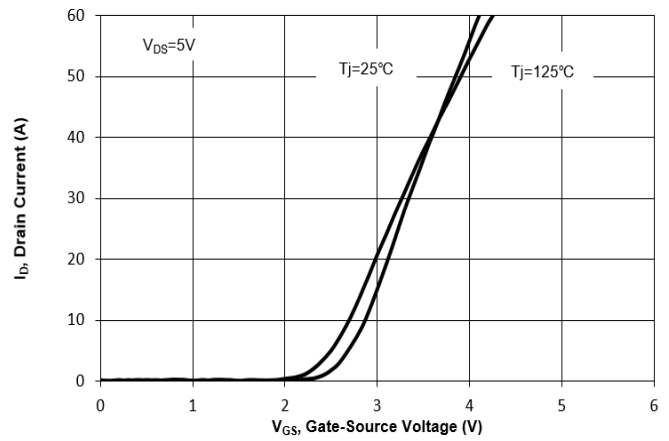


Fig. 3 on-Resistance vs. Drain Current

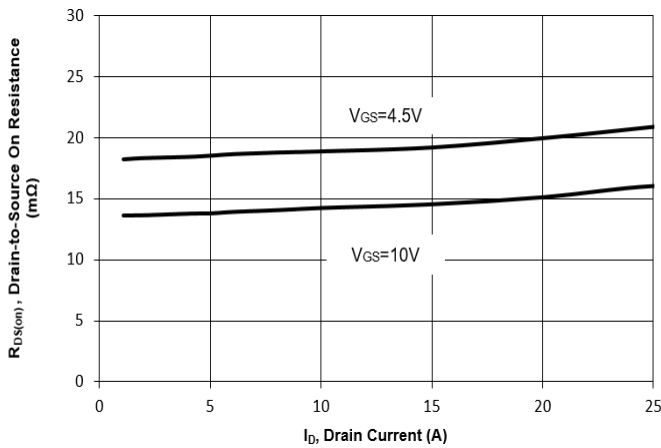


Fig. 4 on-Resistance vs. Gate to Source Voltage

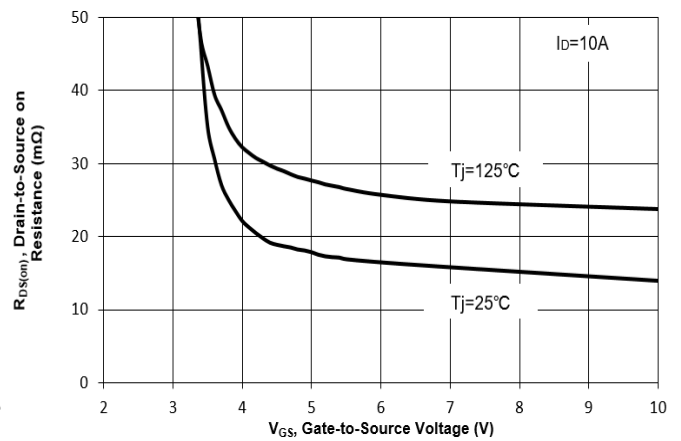


Fig. 5 on-Resistance vs. T_j

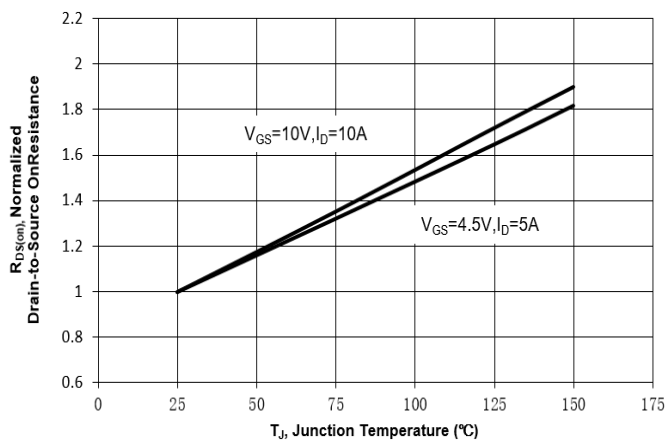
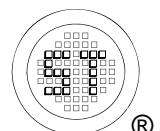
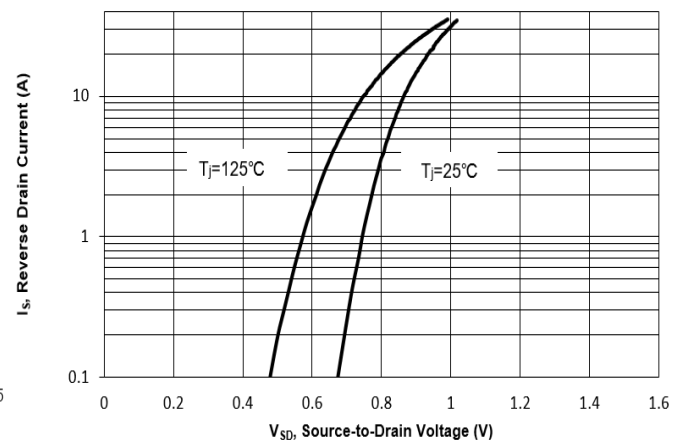


Fig. 6 Typical Body-Diode Forward Characteristics



Electrical Characteristics Curves(Q1)

Fig. 7 Typical Junction Capacitance

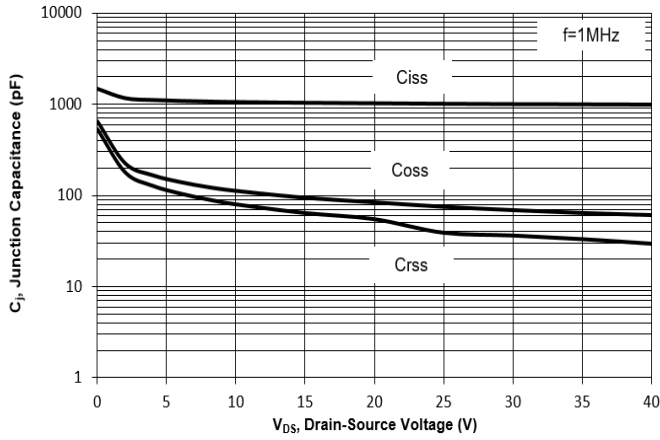


Fig. 8 Drain-Source Leakage Current vs. T_j

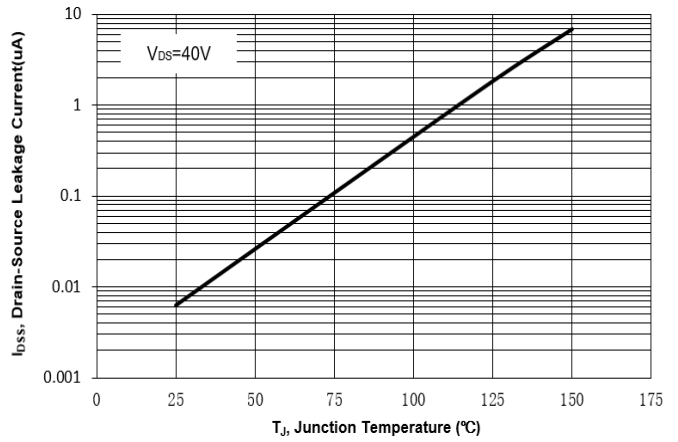


Fig. 9 $V_{(BR)DSS}$ vs. Junction Temperature

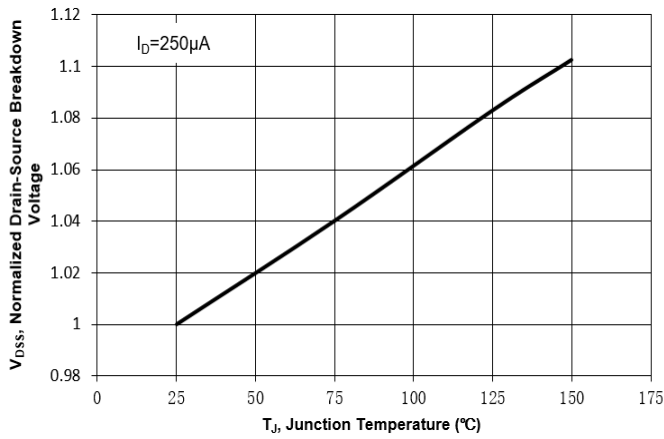


Fig. 10 Gate Threshold Variation vs. T_j

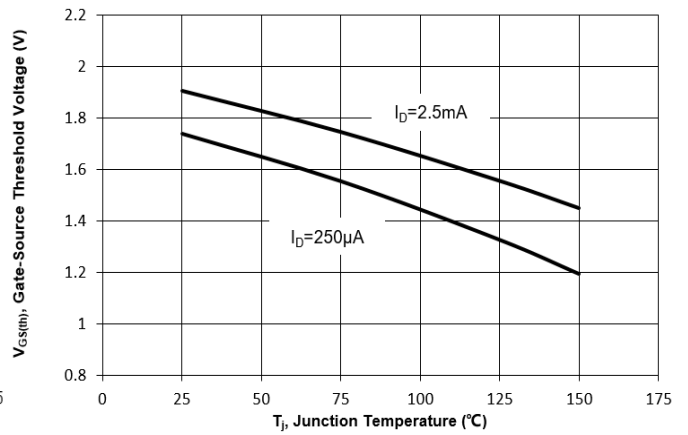


Fig. 11 Gate Charge

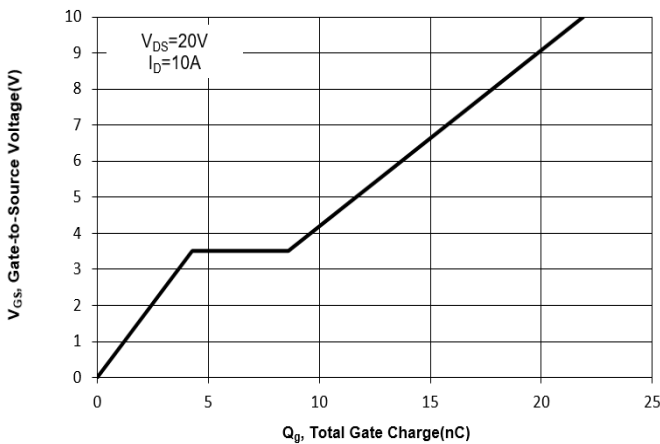
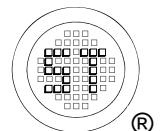
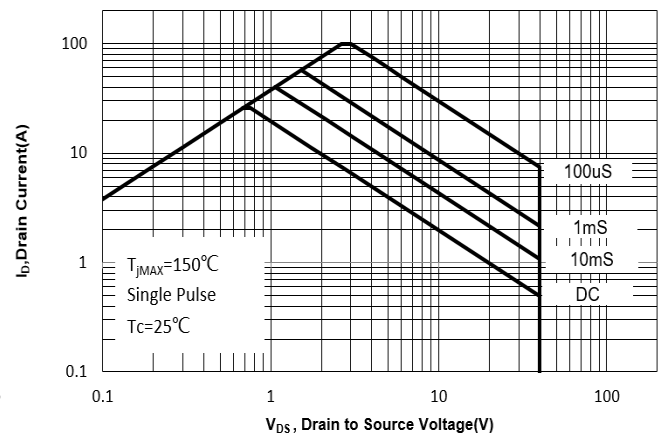


Fig. 12 Safe Operation Area



WTM604C400LS-HAF

Electrical Characteristics Curves(Q1)

Fig. 13 Normalized Maximum Transient Thermal Impedance($Z_{\theta JC}$)

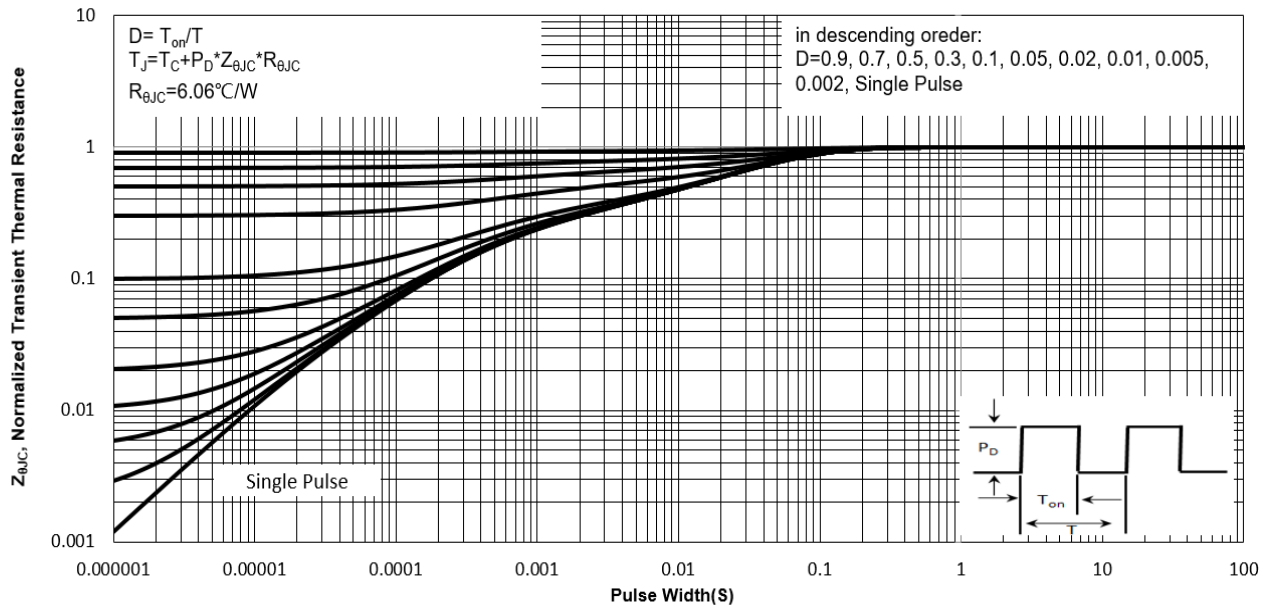
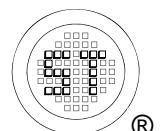
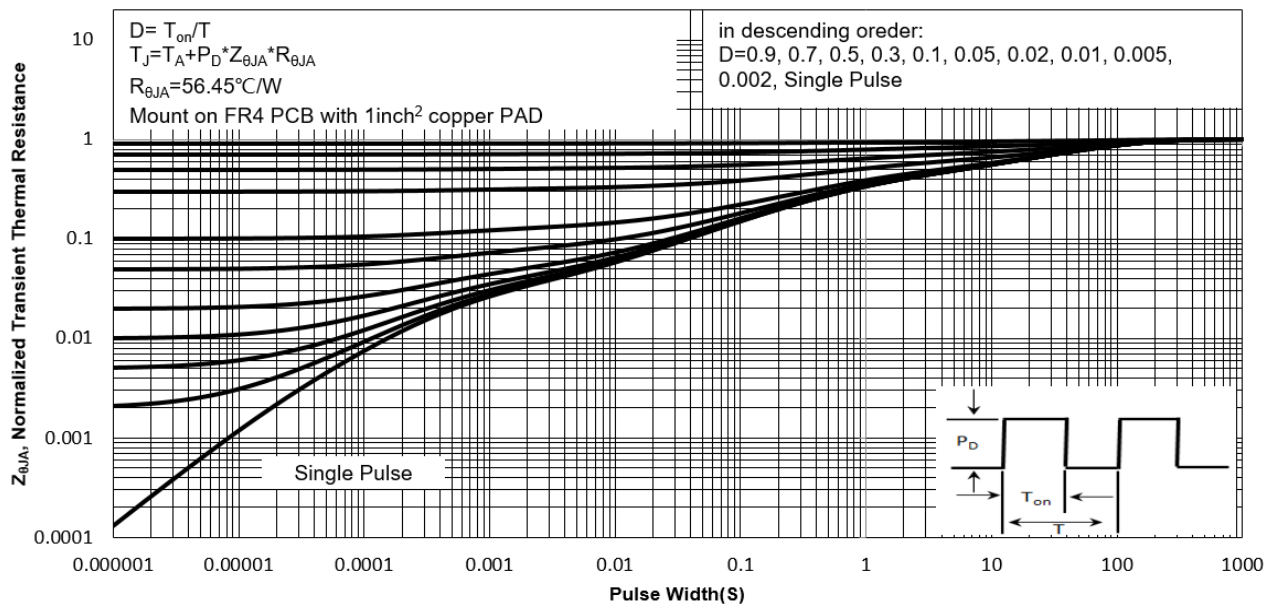


Fig. 14 Normalized Maximum Transient Thermal Impedance($Z_{\theta JA}$)



Electrical Characteristics Curves(Q2)

Fig. 1 Typical Output Characteristics

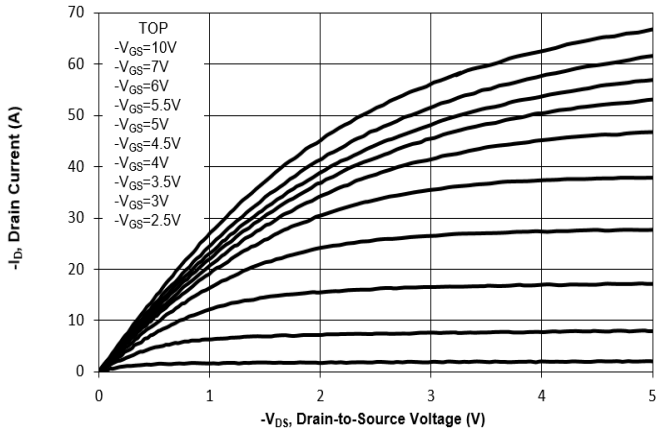


Fig. 2 Typical Transfer Characteristics

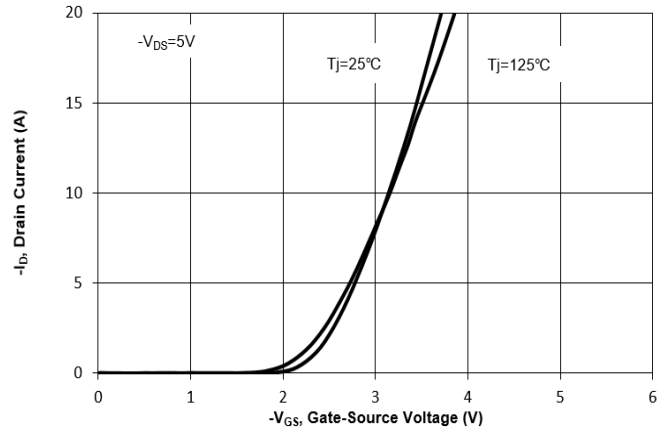


Fig. 3 on-Resistance vs. Drain Current

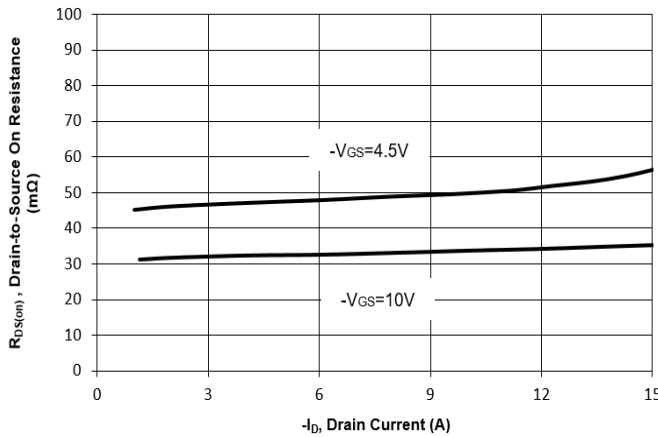


Fig. 4 on-Resistance vs. Gate to Source Voltage

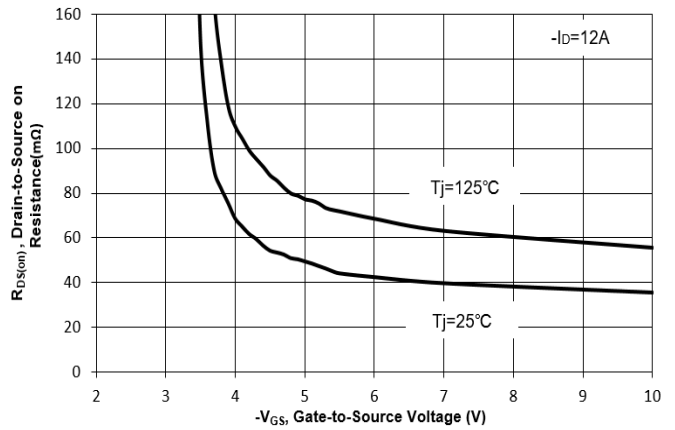


Fig. 5 on-Resistance vs. Tj

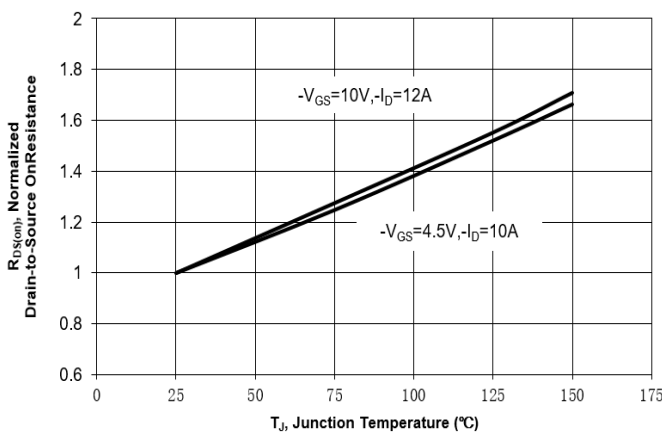
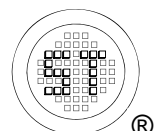
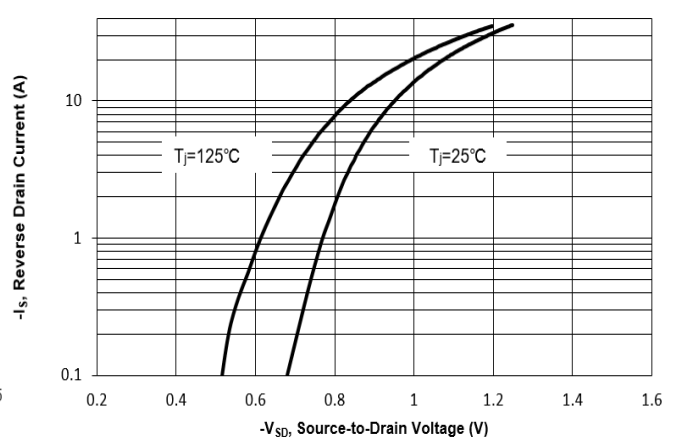


Fig. 6 Typical Body-Diode Forward Characteristics



Electrical Characteristics Curves(Q2)

Fig. 7 Typical Junction Capacitance

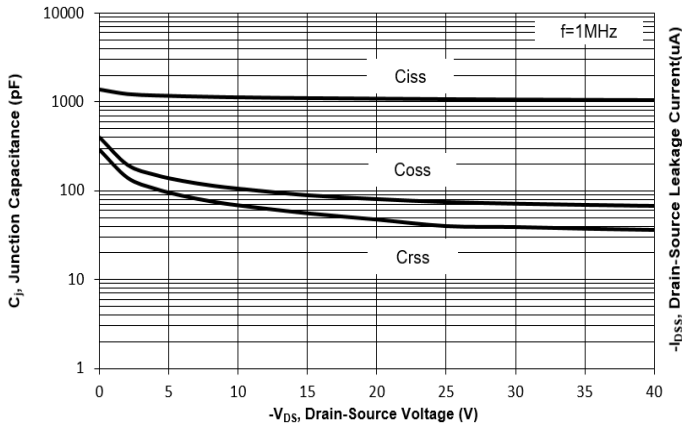


Fig. 8 Drain-Source Leakage Current vs. T_j

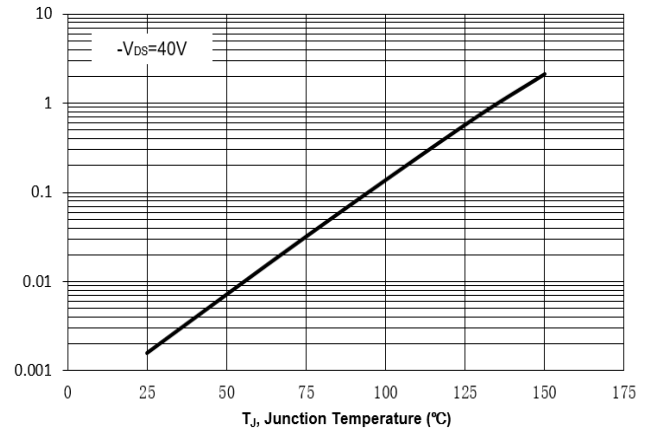


Fig. 9 V_{(BR)DSS} vs. Junction Temperature

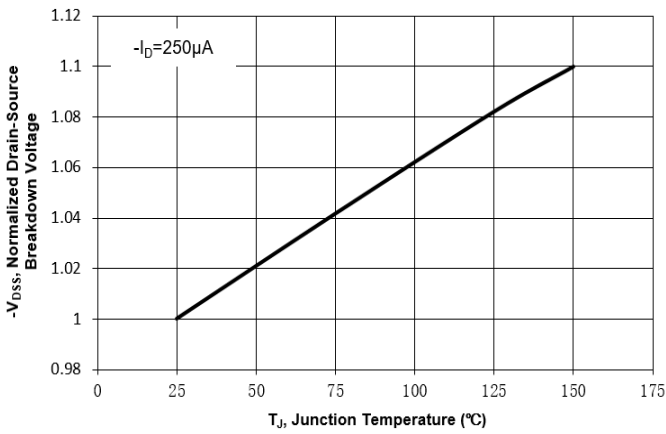


Fig. 10 Gate Threshold Variation vs. T_j

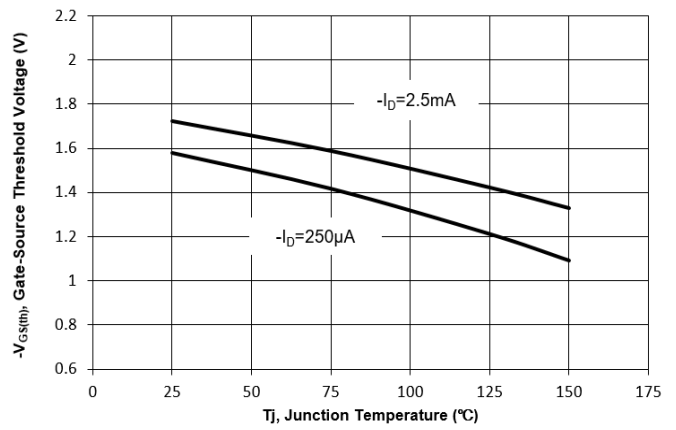


Fig. 11 Gate Charge

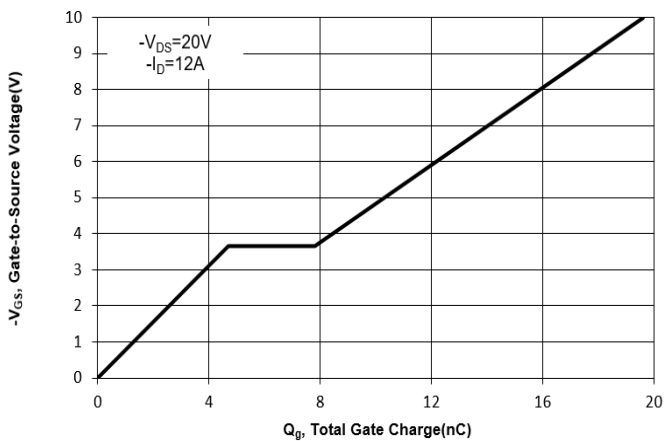
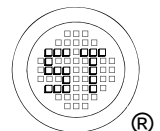
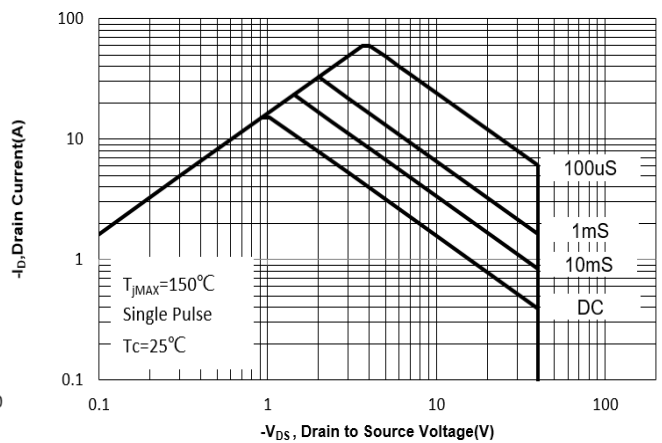


Fig. 12 Safe Operation Area



WTM604C400LS-HAF

Electrical Characteristics Curves(Q2)

Fig. 13 Normalized Maximum Transient Thermal Impedance($Z_{\theta JC}$)

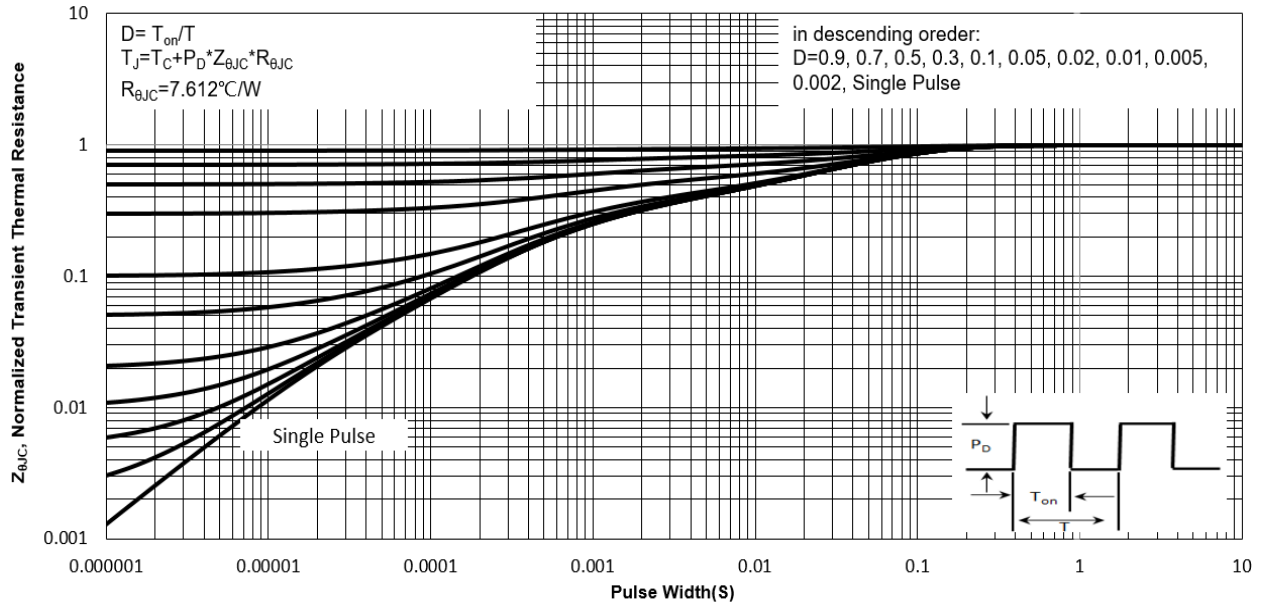
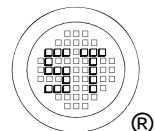
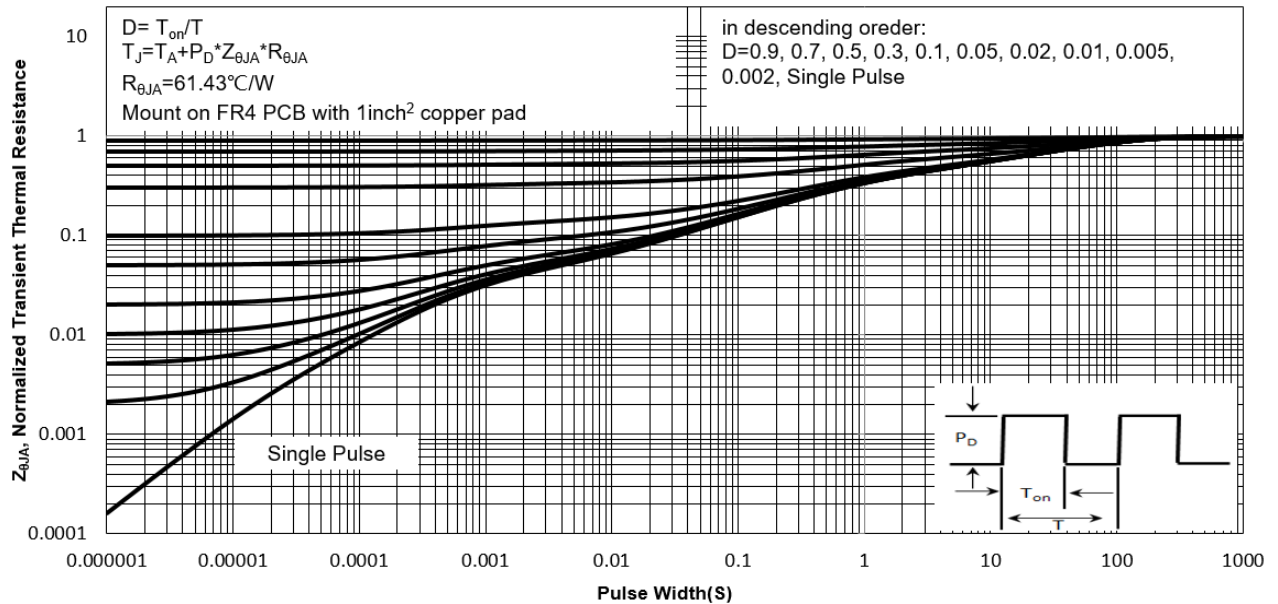


Fig. 14 Normalized Maximum Transient Thermal Impedance($Z_{\theta JA}$)



WTM604C400LS-HAF

Test Circuits(Q1)

Fig.1-1 Switching times test circuit

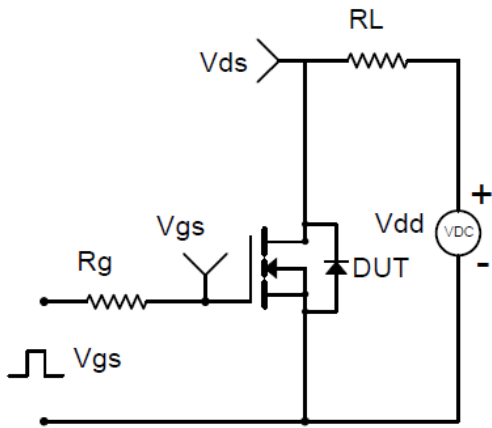


Fig.1-2 Switching Waveform

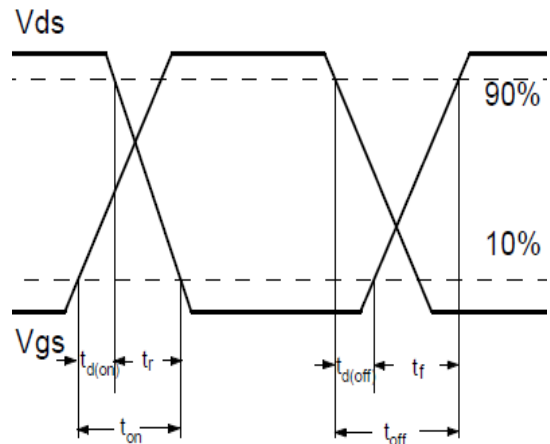


Fig.2-1 Gate charge test circuit

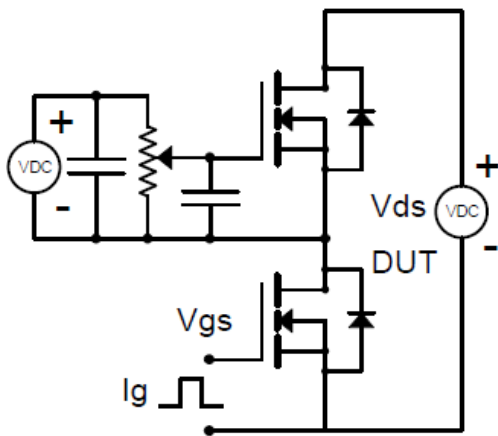


Fig.2-2 Gate charge waveform

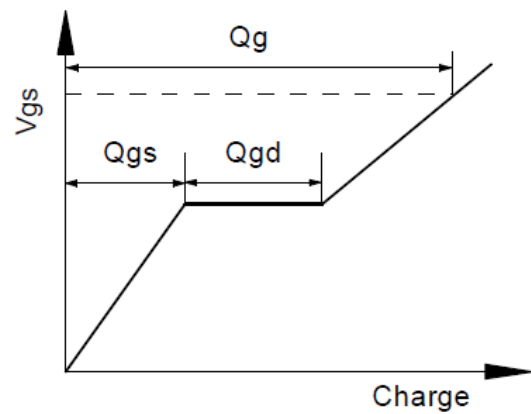


Fig.3-1 Avalanche test circuit

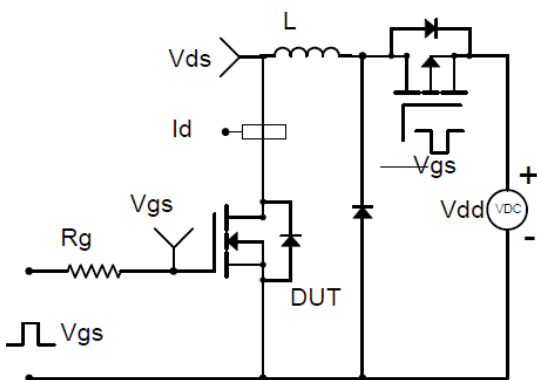
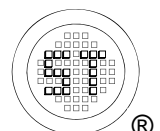
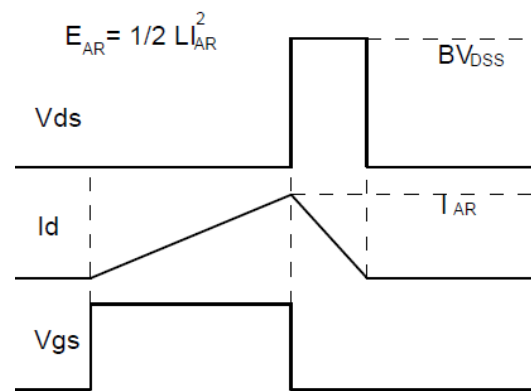


Fig.3-2 Avalanche waveform



WTM604C400LS-HAF

Test Circuits(Q2)

Fig.1-1 Switching times test circuit

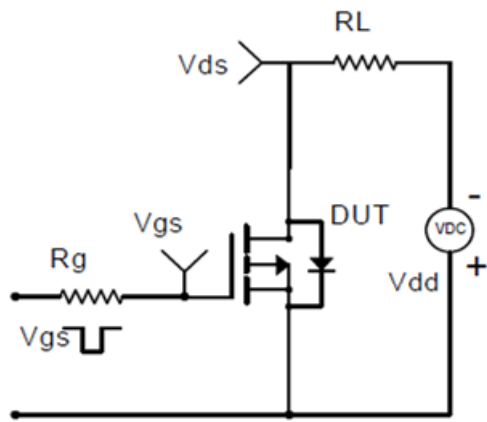


Fig.1-2 Switching Waveform

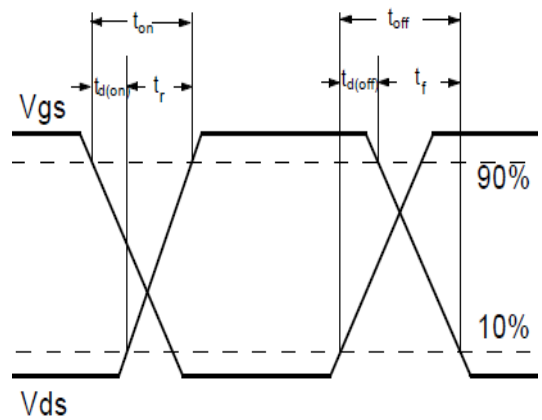


Fig.2-1 Gate charge test circuit

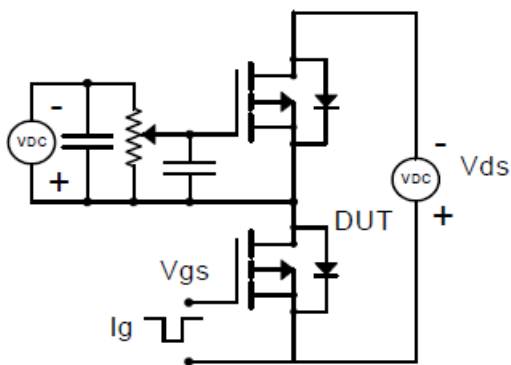


Fig.2-2 Gate charge waveform

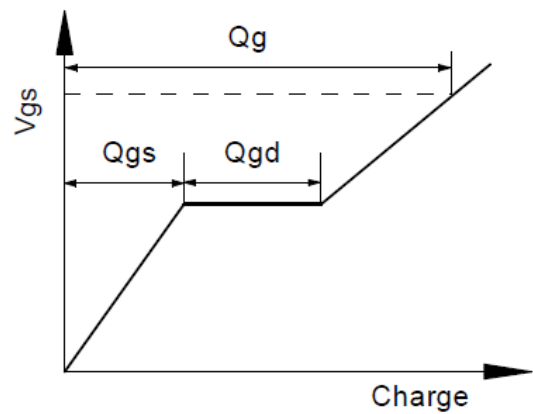


Fig.3-1 Avalanche test circuit

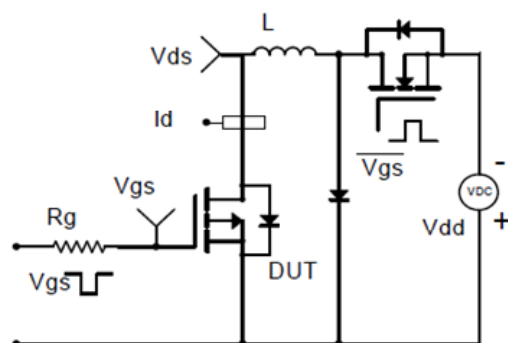
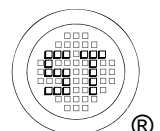
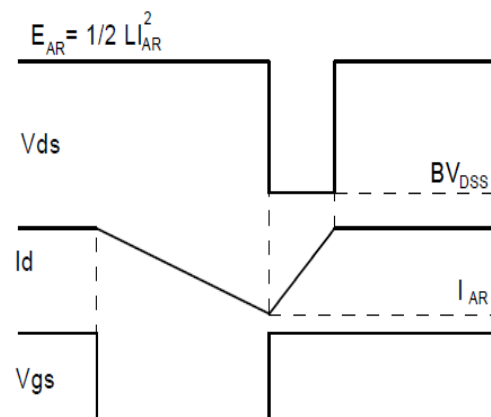


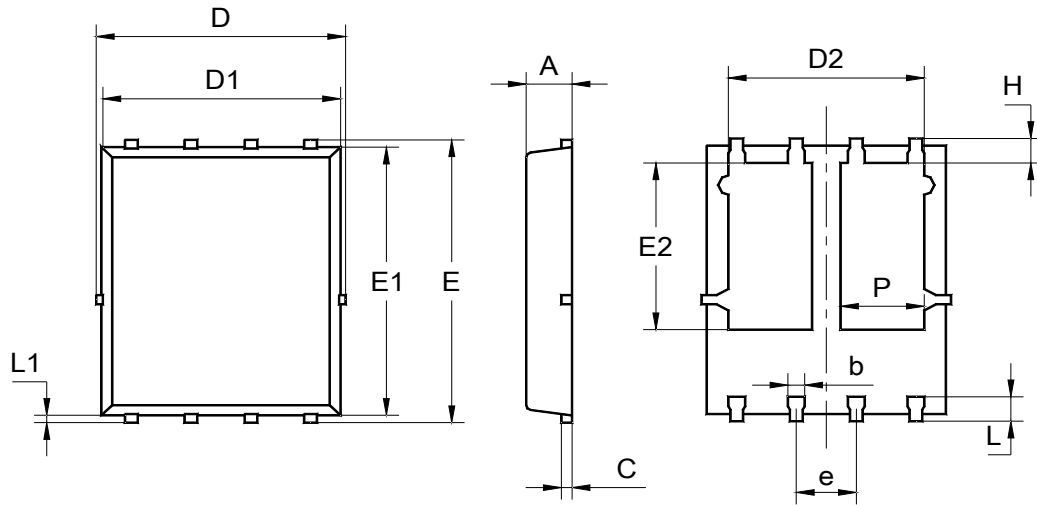
Fig.3-2 Avalanche waveform



WTM604C400LS-HAF

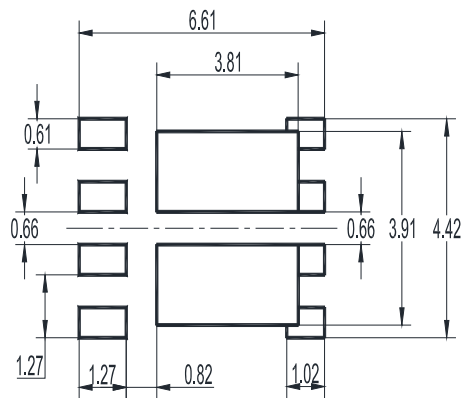
Package Outline Dimensions (Units: mm)

DFN5060



Unit	A	b	C	D	D1	D2	E	E1	E2	e	L	L1	H	P
mm	1.12	0.51	0.34	5.26	5.1	4.5	6.25	6	3.66	1.37	0.71	0.2	0.71	2.0
	0.9	0.33	0.11	4.7	4.7	3.56	5.75	5.6	3.18	1.17	0.35	0.06	0.35	1.6

Recommended Soldering Footprint



Packing information

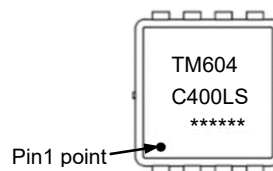
Package	Tape Width (mm)	Pitch		Reel Size		Per Reel Packing Quantity
		mm	inch	mm	inch	
DFN5060	12	8 ± 0.1	0.315 ± 0.004	330	13	5,000

Marking information

" TM604C400LS " = Part No.

" ***** " = Date Code Marking

Font type: Arial



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