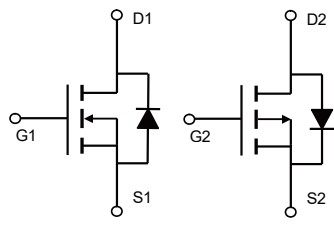


Description

Features - N-channel: 40V, 16A $R_{DS(ON)} < 19m\Omega @ V_{GS} = 10V$ $R_{DS(ON)} < 22m\Omega @ V_{GS} = 4.5V$ - P-channel: -40V, -16A $R_{DS(ON)} < 39m\Omega @ V_{GS} = -10V$ $R_{DS(ON)} < 47m\Omega @ V_{GS} = -4.5V$ - Excellent Gate Charge x $R_{DS(ON)}$ Product(FOM) - Very Low On-resistance $R_{DS(ON)}$ - Fast Switching Speed	Applications - Battery Protection - Load Switch - Power Management <i>100% UIS TESTED!</i> <i>100% ΔV_{ds} TESTED!</i>
 DFN5x6	 Schematic

Package Marking and Ordering Information

Device Marking	Device	Outline	Package	Reel Size	Reel(pcs)	Per Carton (pcs)
VSM16NP04	VSM16NP04-D56	TAPING	DFN5x6	13"	5000	50000

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

Symbol	Parameter		Value-N-channel	Value-P-channel	Units
V _{DS}	Drain-to-Source Voltage		40	-40	V
V _{GS}	Gate-to-Source Voltage		±20		V
I _D	Continuous Drain Current	T _C = 25°C	16	-16	A
		T _C = 100°C	10	-10	
I _{DM}	Pulsed Drain Current ⁽¹⁾		64	-64	A
E _{AS}	Single Pulsed Avalanche Energy ⁽²⁾		20	20	mJ
P _D	Power Dissipation	T _C = 25°C	50		W
R _{θJA}	Thermal Resistance, Junction to Ambient ⁽³⁾		50		°C/W
R _{θJC}	Thermal Resistance, Junction to Case		2.5		
T _J , T _{STG}	Junction & Storage Temperature Range		-55 to 150		°C

N-channel Electrical Characteristics ($T_J = 25^{\circ}\text{C}$ unless otherwise specified)

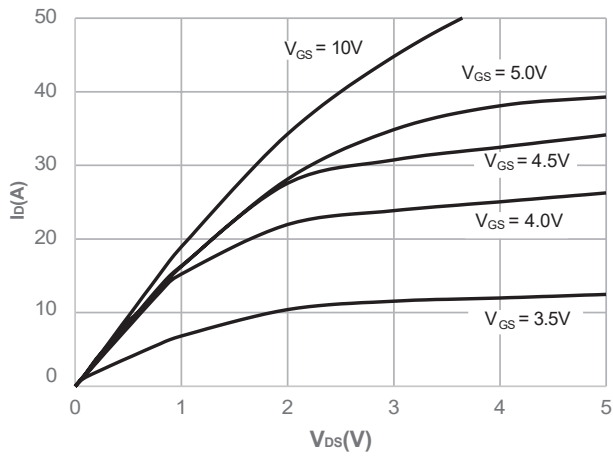
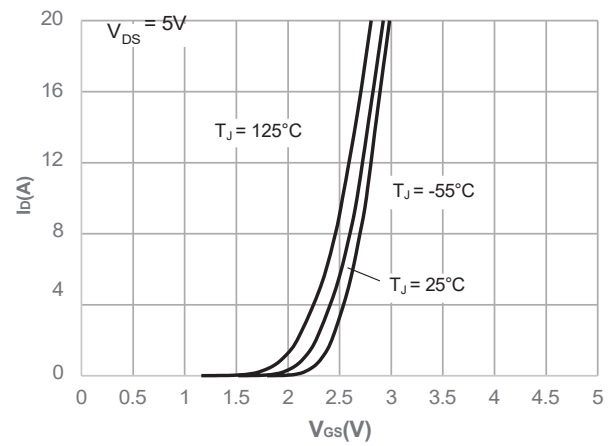
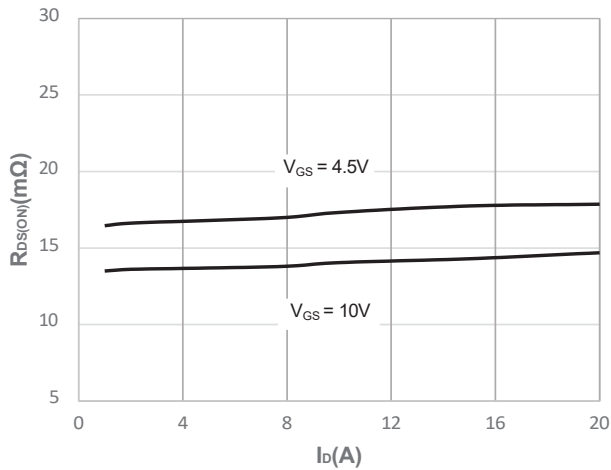
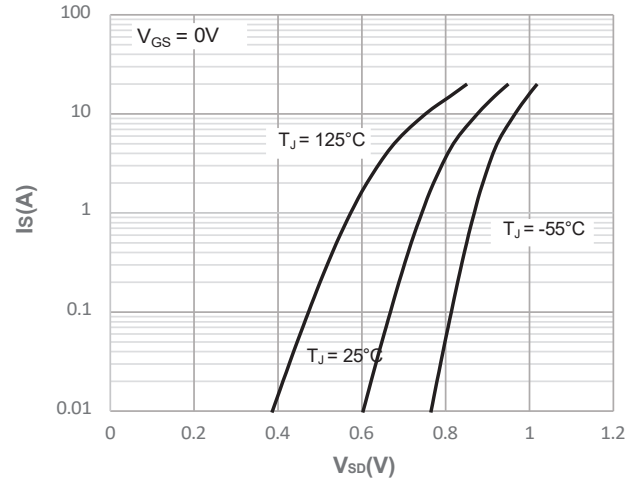
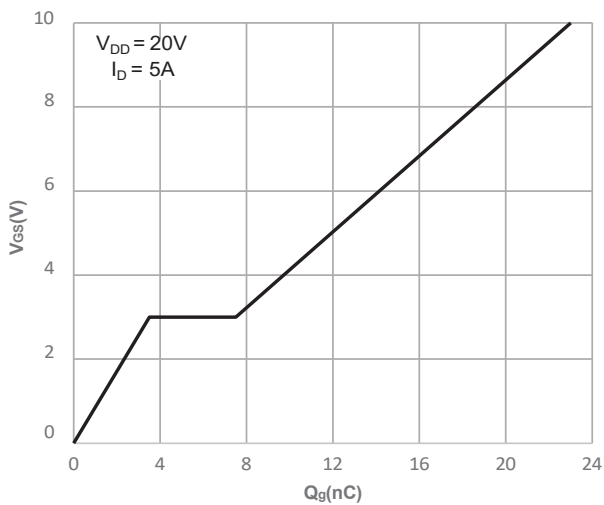
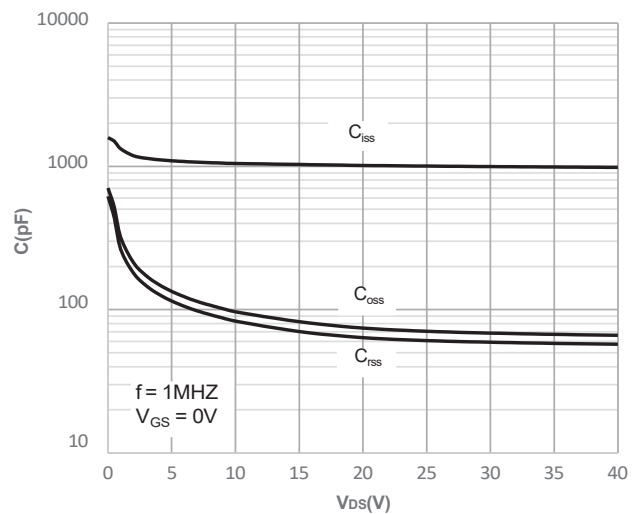
Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
Off Characteristics						
V _{(BR)DSS}	Drain-Source Breakdown Voltage	I _D = 250 μA, V _{GS} = 0V	40	-	-	V
I _{DSS}	Zero Gate Voltage Drain Current	V _{DS} = 40V, V _{GS} = 0V	-	-	1.0	μA
I _{GSS}	Gate-Body Leakage Current	V _{DS} = 0V, V _{GS} = ±20V	-	-	±100	nA
On Characteristics						
V _{GS(th)}	Gate Threshold Voltage	V _{DS} = V _{GS} , I _D = 250 μA	1.0	1.5	2.5	V
R _{DS(ON)}	Static Drain-Source ON-Resistance ⁽⁴⁾	V _{GS} = 10V, I _D = 15A	-	14	19	mΩ
		V _{GS} = 4.5V, I _D = 10A	-	17	22	mΩ
Dynamic Characteristics						
C _{iss}	Input Capacitance	V _{GS} = 0V, V _{DS} = 20V, f = 1MHz	-	1061	-	pF
C _{oss}	Output Capacitance		-	74	-	pF
C _{rss}	Reverse Transfer Capacitance		-	62	-	pF
Q _g	Total Gate Charge	V _{GS} = 0 to 10V V _{DD} = 20V, I _D = 5A	-	23	-	nC
Q _{gs}	Gate Source Charge		-	3.5	-	nC
Q _{gd}	Gate Drain("Miller") Charge		-	4	-	nC
Switching Characteristics						
t _{d(on)}	Turn-On DelayTime	V _{GS} = 10V, V _{DD} = 20V I _D = 5A, R _{GEN} = 3 Ω	-	6	-	ns
t _r	Turn-On Rise Time		-	6	-	ns
t _{d(off)}	Turn-Off DelayTime		-	24	-	ns
t _f	Turn-Off Fall Time		-	3	-	ns
Drain-Source Diode Characteristics and Max Ratings						
I _S	Maximum Continuous Drain to Source Diode Forward Current		-	-	16	A
I _{SM}	Maximum Pulsed Drain to Source Diode Forward Current		-	-	64	A
V _{SD}	Drain to Source Diode Forward Voltage	V _{GS} = 0V, I _S = 16A	-	-	1.2	V
t _{rr}	Body Diode Reverse Recovery Time	I _F =5A,di/dt=100A/μs	-	10	-	ns
Q _{rr}	Body Diode Reverse Recovery Charge		-	5	-	nC

P-channel Electrical Characteristics ($T_J = 25^\circ\text{C}$ unless otherwise specified)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
Off Characteristics						
V _{(BR)DSS}	Drain-Source Breakdown Voltage	I _D = -250 μA, V _{GS} = 0V	-40	-	-	V
I _{DSS}	Zero Gate Voltage Drain Current	V _{DS} = -40V, V _{GS} = 0V	-	-	-1.0	μA
I _{GSS}	Gate-Body Leakage Current	V _{DS} = 0V, V _{GS} = ±20V	-	-	±100	nA
On Characteristics						
V _{GS(th)}	Gate Threshold Voltage	V _{DS} = V _{GS} , I _D = -250 μA	-1.2	-1.8	-2.3	V
R _{DS(ON)}	Static Drain-Source ON-Resistance ⁽⁴⁾	V _{GS} = -10V, I _D = -5A	-	30	39	mΩ
		V _{GS} = -4.5V, I _D = -3A	-	36	47	mΩ
Dynamic Characteristics						
C _{iss}	Input Capacitance	V _{GS} = 0V, V _{DS} = -20V, f = 1MHz	-	1117	-	pF
C _{oss}	Output Capacitance		-	89	-	pF
C _{rss}	Reverse Transfer Capacitance		-	74	-	pF
Q _g	Total Gate Charge	V _{GS} = 0 to -10V V _{DD} = -20V, I _D = -5A	-	22	-	nC
Q _{gs}	Gate Source Charge		-	4	-	nC
Q _{gd}	Gate Drain("Miller") Charge		-	4	-	nC
Switching Characteristics						
t _{d(on)}	Turn-On DelayTime	V _{GS} = -10V, V _{DD} = -20V I _D = -5A, R _{GEN} = 3 Ω	-	5	-	ns
t _r	Turn-On Rise Time		-	2	-	ns
t _{d(off)}	Turn-Off DelayTime		-	54	-	ns
t _f	Turn-Off Fall Time		-	25	-	ns
Drain-Source Diode Characteristics and Max Ratings						
I _S	Maximum Continuous Drain to Source Diode Forward Current		-	-	-16	A
I _{SM}	Maximum Pulsed Drain to Source Diode Forward Current		-	-	-64	A
V _{SD}	Drain to Source Diode Forward Voltage	V _{GS} = 0V, I _S = -16A	-	-	-1.2	V
trr	Body Diode Reverse Recovery Time	I _F =-5A,di/dt=100A/μs	-	13	-	ns
Qrr	Body Diode Reverse Recovery Charge		-	7	-	nC

- Notes:
1. Repetitive Rating: Pulse Width Limited by Maximum Junction Temperature.
 2. E_{AS} condition: Starting $T_J = 25^\circ\text{C}$, $V_{DD} = 20\text{V}$, $V_G = 10\text{V}$, $R_G = 25\text{ohm}$, $L = 0.5\text{mH}$, $I_{AS} = 9\text{A}$
Starting $T_J = 25^\circ\text{C}$, $V_{DD} = -20\text{V}$, $V_G = -10\text{V}$, $R_G = 25\text{ohm}$, $L = 0.5\text{mH}$, $I_{AS} = -9\text{A}$
 3. $R_{\theta JA}$ is measured with the device mounted on a 1inch² pad of 2oz copper FR4 PCB
 4. Pulse Test: Pulse Width $\leq 300\mu\text{s}$, Duty Cycle $\leq 0.5\%$.

Typical Performance Characteristics-N

Figure 1: Output Characteristics

Figure 2: Typical Transfer Characteristics

Figure 3: On-resistance vs. Drain Current

Figure 4: Body Diode Characteristics

Figure 5: Gate Charge Characteristics

Figure 6: Capacitance Characteristics


Typical Performance Characteristics-N

Figure 7: Normalized Breakdown voltage vs. Junction Temperature

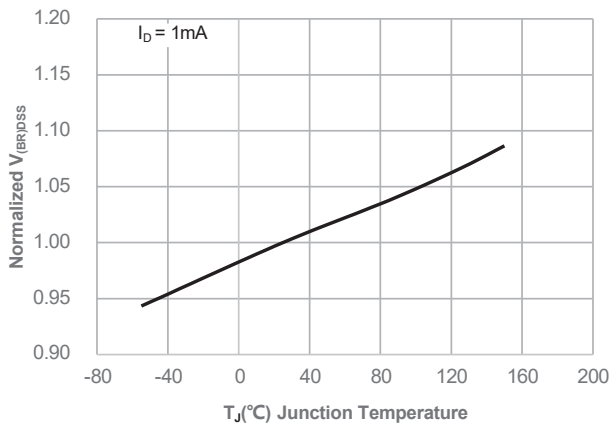


Figure 8: Normalized on Resistance vs. Junction Temperature

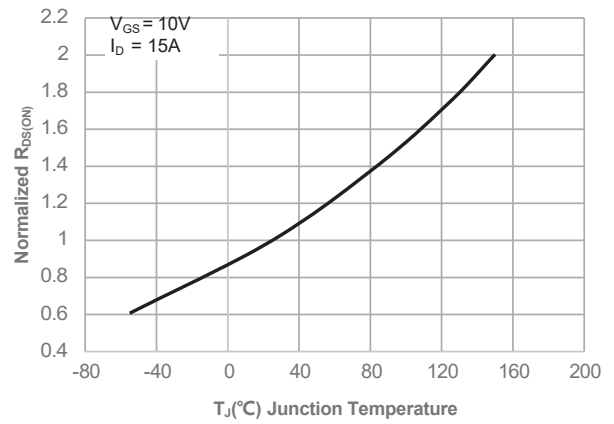


Figure 9: Maximum Safe Operating Area

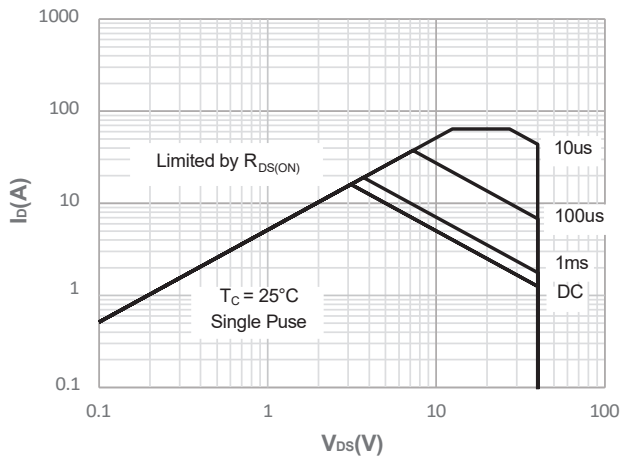


Figure 10: Maximum Continuous Drain Current vs. Case Temperature

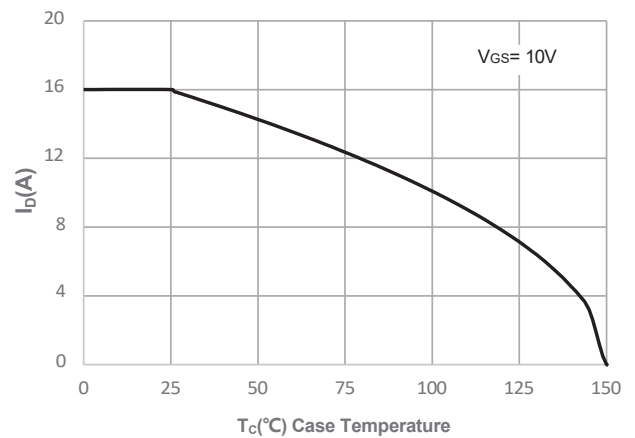


Figure 11: Normalized Maximum Transient Thermal Impedance

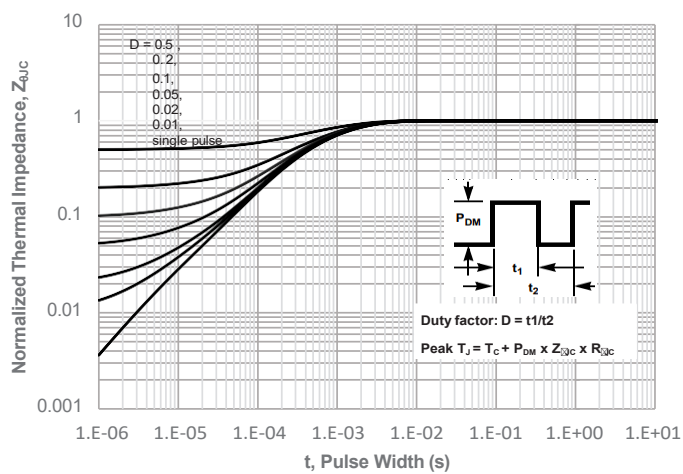
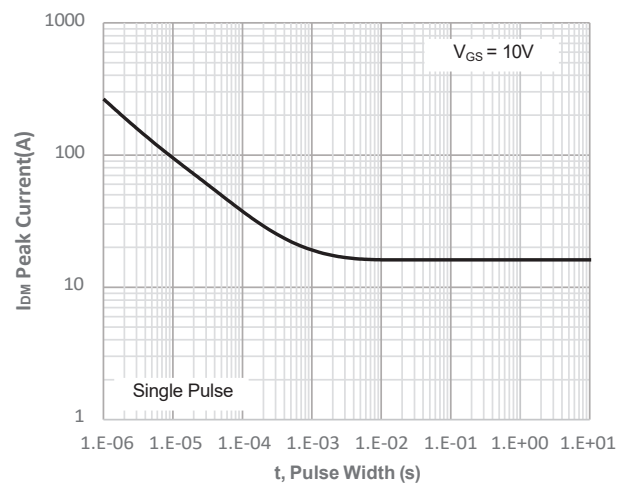
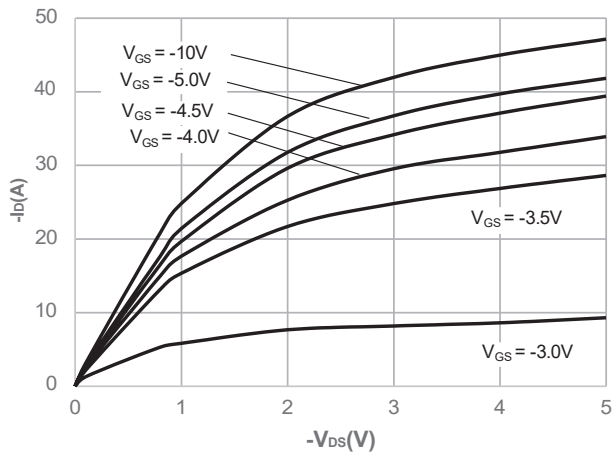
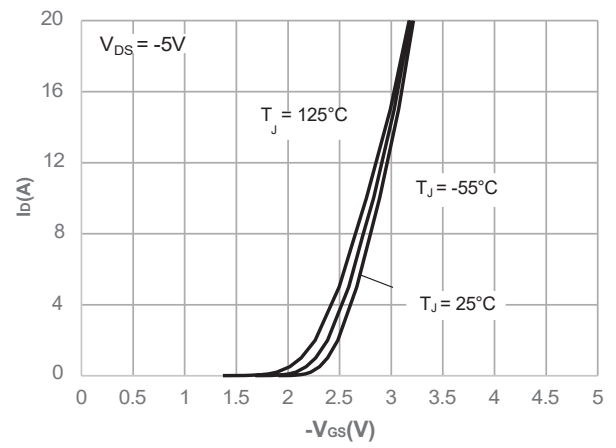
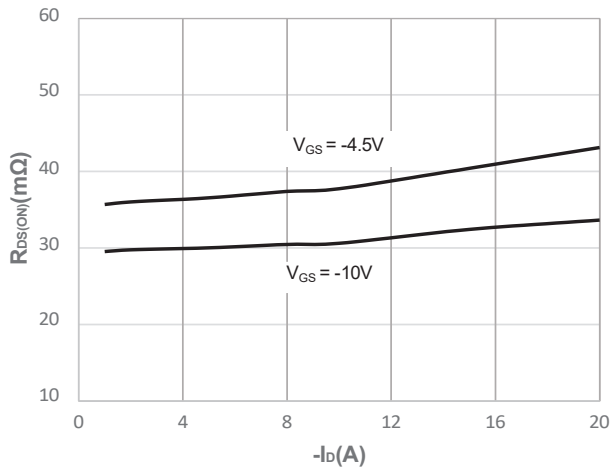
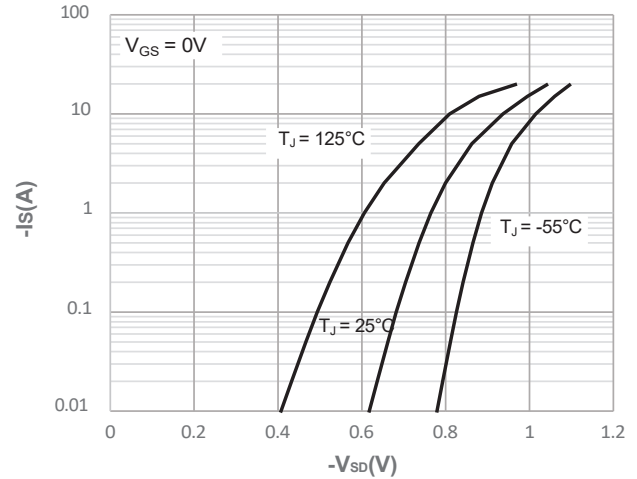
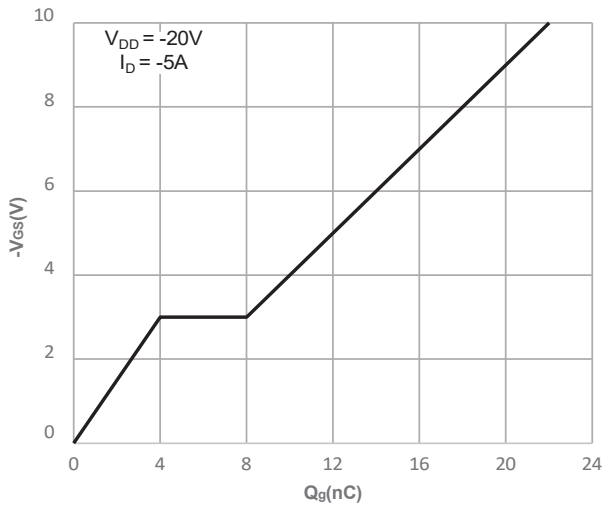
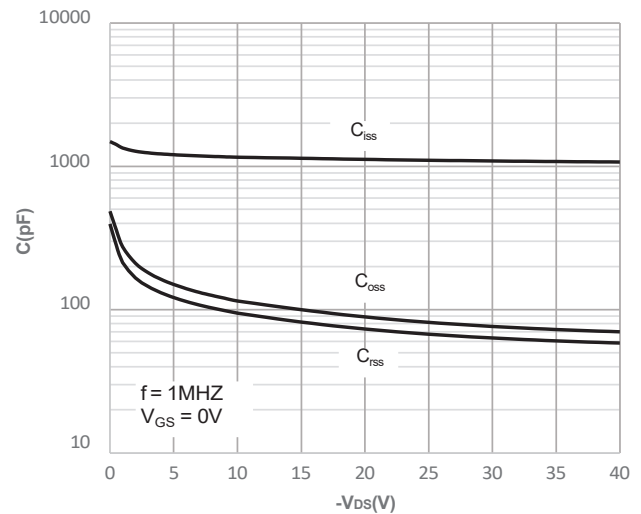


Figure 12: Peak Current Capacity



Typical Performance Characteristics-P

Figure 1: Output Characteristics

Figure 2: Typical Transfer Characteristics

Figure 3: On-resistance vs. Drain Current

Figure 4: Body Diode Characteristics

Figure 5: Gate Charge Characteristics

Figure 6: Capacitance Characteristics


Typical Performance Characteristics-P

Figure 7: Normalized Breakdown voltage vs. Junction Temperature

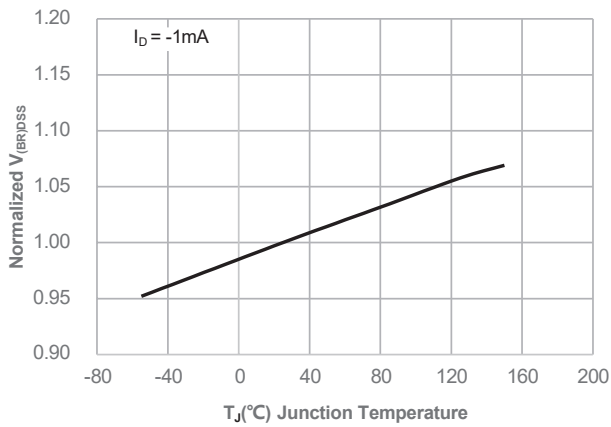


Figure 8: Normalized on Resistance vs. Junction Temperature

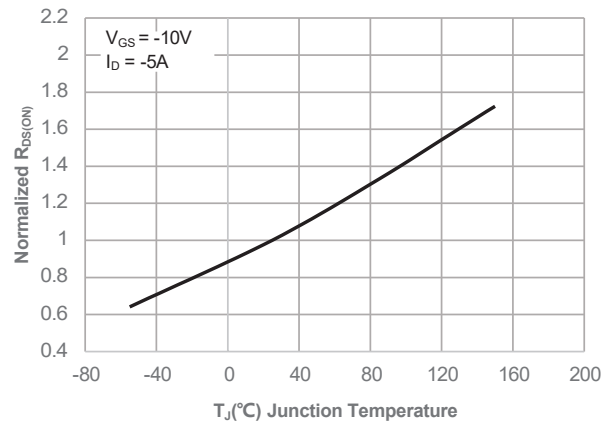


Figure 9: Maximum Safe Operating Area

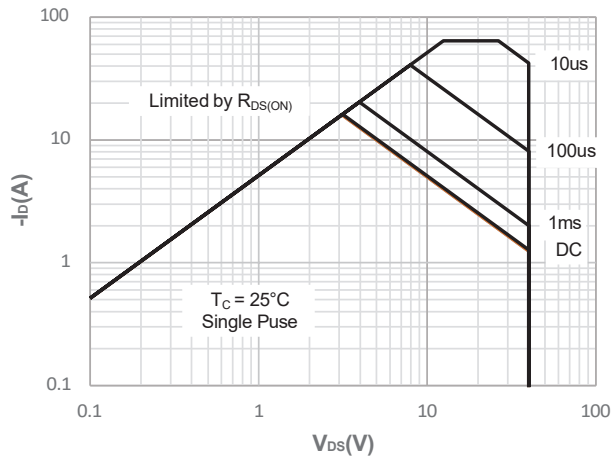


Figure 10: Maximum Continuous Drain Current vs. Case Temperature

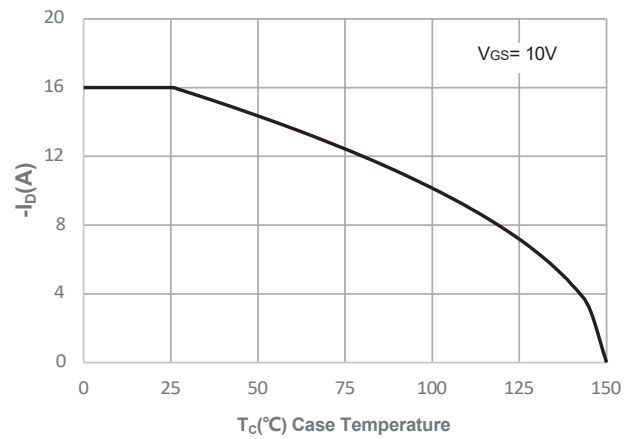


Figure 11: Normalized Maximum Transient Thermal Impedance

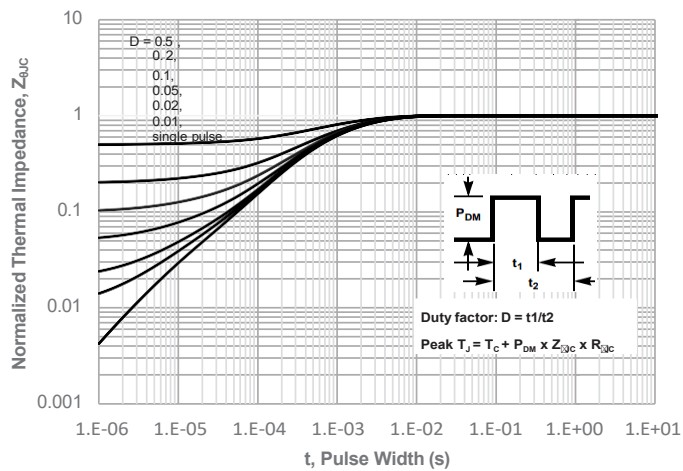
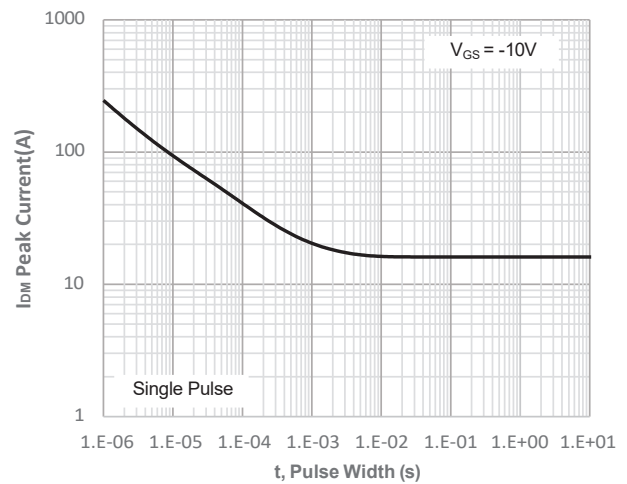


Figure 12: Peak Current Capacity



Test Circuit-N

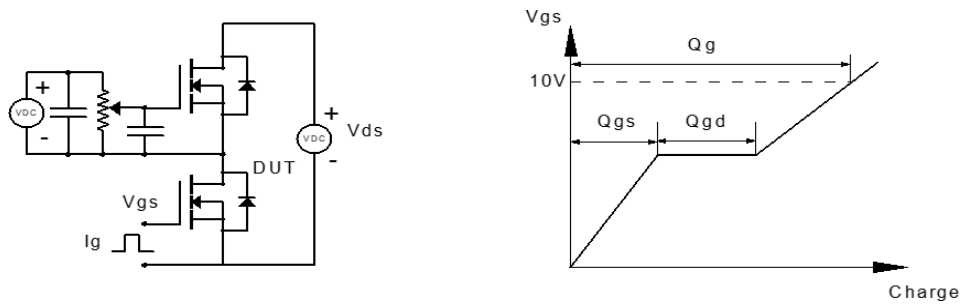


Figure 1: Gate Charge Test Circuit & Waveform

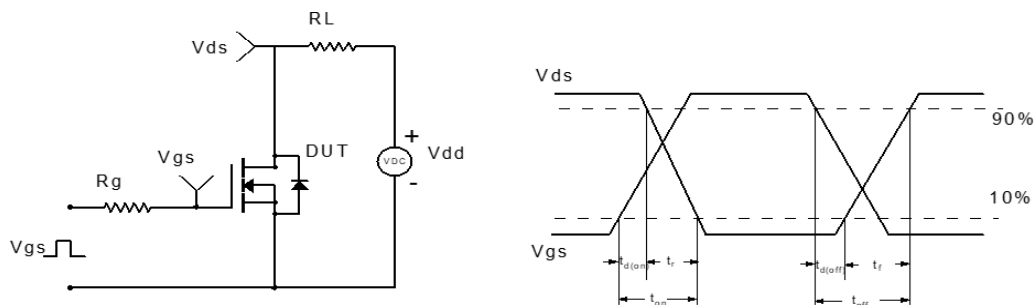


Figure 2: Resistive Switching Test Circuit & Waveform

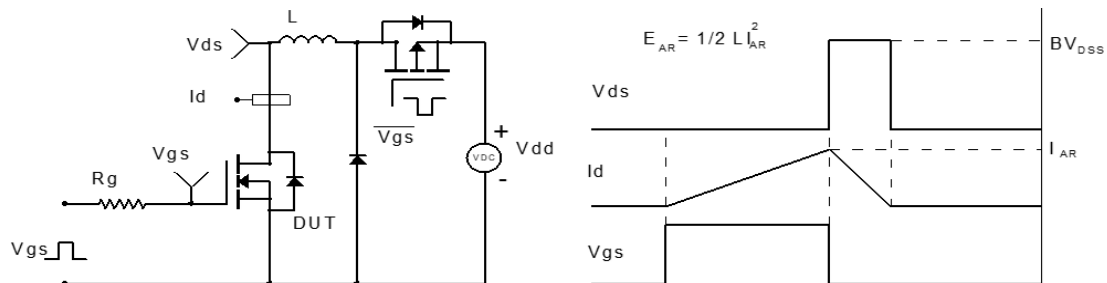


Figure 3: Unclamped Inductive Switching Test Circuit & Waveform

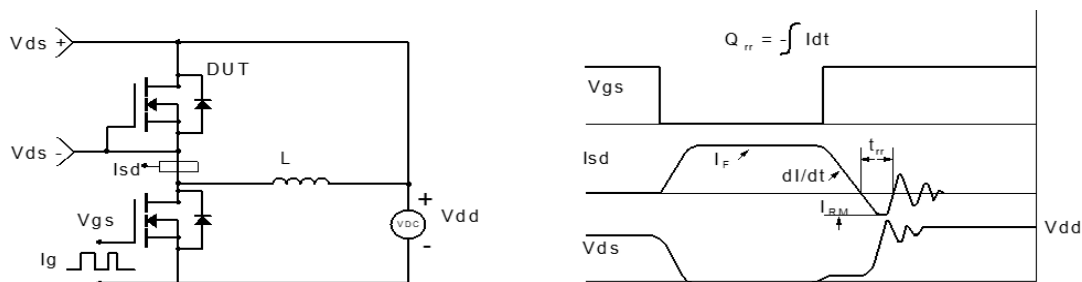


Figure 4: Diode Recovery Test Circuit & Waveform

Test Circuit-P

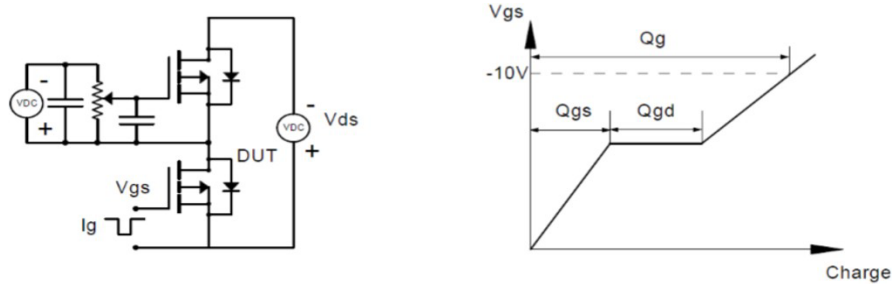


Figure 1: Gate Charge Test Circuit & Waveform

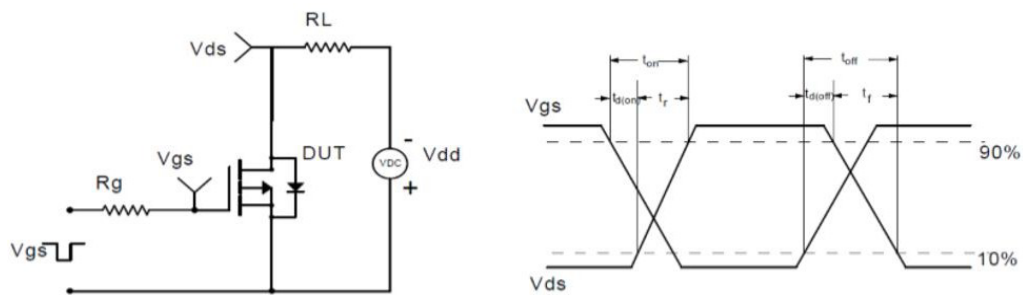


Figure 2: Resistive Switching Test Circuit & Waveform

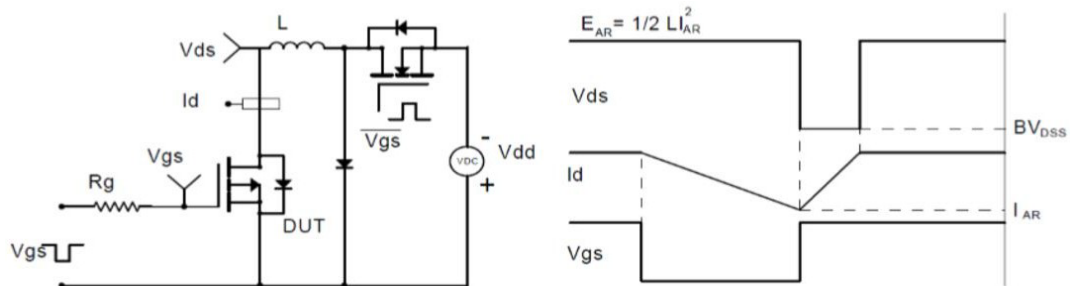


Figure 3: Unclamped Inductive Switching Test Circuit& Waveform

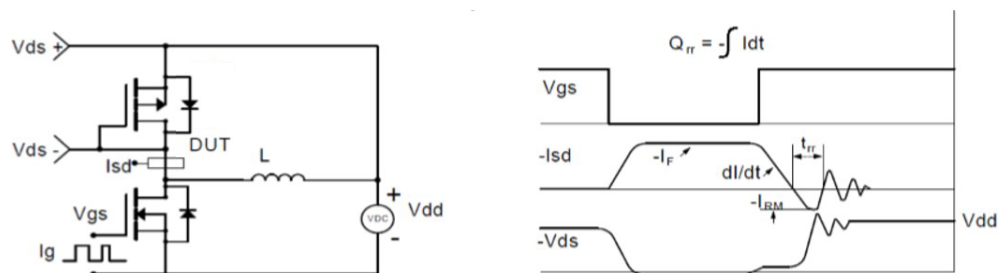


Figure 4: Diode Recovery Test Circuit & Waveform