

MOSFET - Power, Dual, N-Channel, Power Clip, POWERTRENCH®, Asymmetric

25 V

NTMFD1D1N02X

Features

- Small Footprint (5x6mm) for Compact Design
- Low $R_{DS(on)}$ to Minimize Conduction Losses
- Low Q_G and Capacitance to Minimize Driver Losses
- These are Pb-free, Halogen Free / BFR Free and are RoHS Compliant

Typical Applications

- DC-DC Converters
- System Voltage Rails

MAXIMUM RATINGS ($T_J = 25^\circ\text{C}$ unless otherwise stated)

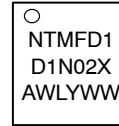
Parameter		Symbol	Q1	Q2	Unit
Drain-to-Source Voltage		V_{DSS}	25	25	V
Gate-to-Source Voltage		V_{GS}	+16V -12V	+16V -12V	V
Continuous Drain Current $R_{\theta JC}$ (Note 3)	Steady State	$T_C = 25^\circ\text{C}$	I_D	75	178
		$T_C = 85^\circ\text{C}$		54	128
Power Dissipation $R_{\theta JA}$ (Note 3)	Steady State	$T_C = 25^\circ\text{C}$	P_D	27	44
Continuous Drain Current $R_{\theta JA}$ (Notes 1, 3)		$T_A = 25^\circ\text{C}$	I_D	20	40
$T_A = 85^\circ\text{C}$			15	29	
Power Dissipation $R_{\theta JA}$ (Notes 1, 3)	Steady State	$T_A = 25^\circ\text{C}$	P_D	2.1	2.3
Continuous Drain Current $R_{\theta JA}$ (Notes 2, 3)		$T_A = 25^\circ\text{C}$	I_D	14	27
$T_A = 85^\circ\text{C}$			10	20	
Power Dissipation $R_{\theta JA}$ (Notes 2, 3)	Steady State	$T_A = 25^\circ\text{C}$	P_D	0.96	1.0
Pulsed Drain Current		$T_C = 25^\circ\text{C}$, $t_p = 100\ \mu\text{s}$	I_{DM}	331	A
Single Pulse Drain-to-Source Avalanche Energy Q1: $I_L = 5.6\ A_{pk}$, $L = 3\ \text{mH}$ (Note 4) Q2: $I_L = 13.6\ A_{pk}$, $L = 3\ \text{mH}$ (Note 4)		E_{AS}	47	277	mJ
Operating Junction and Storage Temperature Range		T_J , T_{stg}	-55 to 150		°C
Lead Temperature Soldering Reflow for Soldering Purposes (1/8" from case for 10 s)		T_L	260		°C

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

FET	$V_{(BR)DSS}$	$R_{DS(on)}\ MAX$	$I_D\ MAX$
Q1	25 V	3.0 mΩ @ 10 V	75 A
		3.75 mΩ @ 4.5 V	
Q2	25 V	0.87 mΩ @ 10 V	178 A
		1.1 mΩ @ 4.5 V	



MARKING DIAGRAM



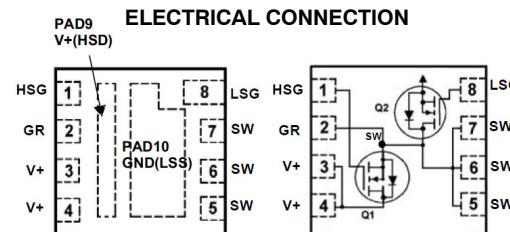
NTMFD1D1N02X = Specific Device Code

A = Assembly Site

WL = Wafer Lot Number

Y = Year of Production

WW = Work Week Number



ORDERING INFORMATION

Device	Package	Shipping [†]
NTMFD1D1N02X	PQFN8 (Pb-Free)	3000 / Tape & Reel

[†]For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specification Brochure, BRD8011/D.

Table 1. THERMAL RESISTANCE RATINGS

Parameter	Symbol	Q1 Max	Q2 Max	Units
Junction-to-Case – Steady State (Note 1, 3)	$R_{\theta JC}$	4.6	2.8	$^{\circ}\text{C}/\text{W}$
Junction-to-Ambient – Steady State (Note 1, 3)	$R_{\theta JA}$	60	55	
Junction-to-Ambient – Steady State (Note 2, 3)	$R_{\theta JA}$	130	120	

1. Surface-mounted on FR4 board using 1 in² pad size, 2 oz Cu pad.
2. Surface-mounted on FR4 board using minimum pad size, 2 oz Cu pad.
3. The entire application environment impacts the thermal resistance values shown. They are not constants and are only valid for the particular conditions noted. Actual continuous current will be limited by thermal & electro-mechanical application board design. $R_{\theta CA}$ is determined by the user's board design.
4. Q1 100% UIS tested at $L = 0.1 \text{ mH}$, $I_{AS} = 17.4 \text{ A}$.
Q2 100% UIS tested at $L = 0.1 \text{ mH}$, $I_{AS} = 42.5 \text{ A}$.

Table 2. ELECTRICAL CHARACTERISTICS ($T_J = 25^{\circ}\text{C}$ unless otherwise stated)

Parameter	Symbol	Test Condition		FET	Min	Typ	Max	Unit
OFF CHARACTERISTICS								
Drain-to-Source Breakdown Voltage	$V_{(BR)DSS}$	$V_{GS} = 0 \text{ V}$, $I_D = 250 \mu\text{A}$		Q1	25			V
Drain-to-Source Breakdown Voltage	$V_{(BR)DSS}$	$V_{GS} = 0 \text{ V}$, $I_D = 250 \mu\text{A}$		Q2	25			V
Drain-to-Source Breakdown Voltage Temperature Coefficient	$V_{(BR)DSS} / T_J$	$I_D = 250 \mu\text{A}$, ref to 25°C		Q1		15		$\text{mV}/^{\circ}\text{C}$
		$I_D = 250 \mu\text{A}$, ref to 25°C		Q2		16		
Zero Gate Voltage Drain Current	I_{DSS}	$V_{GS} = 0 \text{ V}$, $V_{DS} = 20 \text{ V}$	$T_J = 25^{\circ}\text{C}$	Q1			10	μA
				Q2			10	
		$T_J = 125^{\circ}\text{C}$		Q1			100	μA
				Q2			100	
Gate-to-Source Leakage Current	I_{GSS}	$V_{DS} = 0 \text{ V}$, $V_{GS} = +16 \text{ V} / -12 \text{ V}$	Q1			± 100	nA	
		$V_{DS} = 0 \text{ V}$, $V_{GS} = +16 \text{ V} / -12 \text{ V}$	Q2			± 100		

ON CHARACTERISTICS (Note 5)

Gate Threshold Voltage	$V_{GS(TH)}$	$V_{GS} = V_{DS}$, $I_D = 240 \mu\text{A}$	Q1	1.1	1.6	2.1	V
		$V_{GS} = V_{DS}$, $I_D = 850 \mu\text{A}$	Q2	1.1	1.6	2.1	
Threshold Temperature Coefficient	$V_{GS(TH)} / T_J$	$I_D = 240 \mu\text{A}$, ref to 25°C	Q1		-4.0		$\text{mV}/^{\circ}\text{C}$
		$I_D = 850 \mu\text{A}$, ref to 25°C	Q2		-4.3		
Drain-to-Source On Resistance	$R_{DS(on)}$	$V_{GS} = 10 \text{ V}$, $I_D = 20 \text{ A}$	Q1		2.4	3.0	$\text{m}\Omega$
		$V_{GS} = 4.5 \text{ V}$, $I_D = 18 \text{ A}$			3.1	3.75	
		$V_{GS} = 10 \text{ V}$, $I_D = 37 \text{ A}$	Q2		0.66	0.87	
		$V_{GS} = 4.5 \text{ V}$, $I_D = 33 \text{ A}$			0.68	0.84	1.1
Forward Transconductance	g_{FS}	$V_{DS} = 5 \text{ V}$, $I_D = 20 \text{ A}$	Q1		123		S
		$V_{DS} = 5 \text{ V}$, $I_D = 37 \text{ A}$	Q2		322		
Gate Resistance	R_G	$T_A = 25^{\circ}\text{C}$	Q1		0.8		Ω
			Q2		0.9		

5. Pulse Test: pulse width $\leq 300 \mu\text{s}$, duty cycle $\leq 2\%$
6. Switching characteristics are independent of operating junction temperatures

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Table 2. ELECTRICAL CHARACTERISTICS ($T_J = 25^\circ\text{C}$ unless otherwise stated)

Parameter	Symbol	Test Condition	FET	Min	Typ	Max	Unit
CHARGES & CAPACITANCES							
Input Capacitance	C_{ISS}	$V_{GS} = 0 \text{ V}, V_{DS} = 12 \text{ V}, f = 1 \text{ MHz}$	Q1		1080		pF
			Q2		4265		
Output Capacitance	C_{OSS}	$V_{GS} = 0 \text{ V}, V_{DS} = 12 \text{ V}, f = 1 \text{ MHz}$	Q1		322		pF
			Q2		1020		
Reverse Capacitance	C_{RSS}		Q1		47		pF
			Q2		118		
Total Gate Charge	$Q_{G(TOT)}$		Q1		6.8		nC
			Q2		27		
Gate-to-Drain Charge	Q_{GD}	$Q1: V_{GS} = 4.5 \text{ V}, V_{DS} = 12 \text{ V}, I_D = 20 \text{ A}$ $Q2: V_{GS} = 4.5 \text{ V}, V_{DS} = 12 \text{ V}, I_D = 37 \text{ A}$	Q1		1.4		nC
			Q2		5.2		
Gate-to-Source Charge	Q_{GS}		Q1		3.0		nC
			Q2		11		
Total Gate Charge	$Q_{G(TOT)}$	$Q1: V_{GS} = 10 \text{ V}, V_{DS} = 12 \text{ V}, I_D = 20 \text{ A}$ $Q2: V_{GS} = 10 \text{ V}, V_{DS} = 12 \text{ V}, I_D = 37 \text{ A}$	Q1		15		nC
			Q2		59		
Output Charge	Q_{OSS}	$V_{GS} = 0 \text{ V}, V_{DS} = 12 \text{ V}$	Q1		6.2		nC
			Q2		22		
Plateau Voltage	V_{GP}	$Q1: V_{GS} = 4.5 \text{ V}, V_{DS} = 12 \text{ V}, I_D = 20 \text{ A}$ $Q2: V_{GS} = 4.5 \text{ V}, V_{DS} = 12 \text{ V}, I_D = 37 \text{ A}$	Q1		2.8		V
			Q2		2.8		

SWITCHING CHARACTERISTICS, $V_{GS} = 4.5 \text{ V}$ (Note 6)

Turn-On Delay Time	$t_{d(ON)}$	$V_{GS} = 4.5 \text{ V}$ $Q1: I_D = 20 \text{ A}, V_{DD} = 12 \text{ V}, R_G = 2\Omega$ $Q2: I_D = 37 \text{ A}, V_{DD} = 12 \text{ V}, R_G = 2\Omega$	Q1		10		ns
Rise Time	$t_{r(ON)}$		Q2		21		
Turn-Off Delay Time	$t_{d(OFF)}$		Q1		2.5		ns
			Q2		6.6		
Fall Time	t_f		Q1		12		ns
			Q2		26		
			Q1		2.5		ns
			Q2		6.0		

SWITCHING CHARACTERISTICS, $V_{GS} = 10 \text{ V}$ (Note 6)

Turn-On Delay Time	$t_{d(ON)}$	$V_{GS} = 10 \text{ V}$ $Q1: I_D = 20 \text{ A}, V_{DD} = 12 \text{ V}, R_G = 2\Omega$ $Q2: I_D = 37 \text{ A}, V_{DD} = 12 \text{ V}, R_G = 2\Omega$	Q1		7.4		ns
Rise Time	$t_{r(ON)}$		Q2		11		
Turn-Off Delay Time	$t_{d(OFF)}$		Q1		1.1		ns
			Q2		2.9		
Fall Time	t_f		Q1		17		ns
			Q2		36		
			Q1		1.4		ns
			Q2		3.5		

5. Pulse Test: pulse width $\leq 300 \mu\text{s}$, duty cycle $\leq 2\%$

6. Switching characteristics are independent of operating junction temperatures

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Table 2. ELECTRICAL CHARACTERISTICS ($T_J = 25^\circ\text{C}$ unless otherwise stated)

Parameter	Symbol	Test Condition		FET	Min	Typ	Max	Unit				
SOURCE-TO-DRAIN DIODE CHARACTERISTICS												
Forward Diode Voltage	V_{SD}	$V_{GS} = 0 \text{ V}$, $I_S = 20 \text{ A}$	$T_J = 25^\circ\text{C}$	Q1		0.81		V				
			$T_J = 125^\circ\text{C}$			0.68						
		$V_{GS} = 0 \text{ V}$, $I_S = 37 \text{ A}$	$T_J = 25^\circ\text{C}$	Q2		0.8						
			$T_J = 125^\circ\text{C}$			0.65						
	t_{RR}	$V_{GS} = 0 \text{ V}$, Q1: $I_S = 20 \text{ A}$, $dl/dt = 100 \text{ A}/\mu\text{s}$ Q2: $I_S = 37 \text{ A}$, $dl/dt = 300 \text{ A}/\mu\text{s}$			Q1	18		ns				
					Q2	35						
	Q_{RR}				Q1	6.6		nC				
					Q2	44						

5. Pulse Test: pulse width $\leq 300 \mu\text{s}$, duty cycle $\leq 2\%$

6. Switching characteristics are independent of operating junction temperatures

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

PowerTrench is a registered trademark of Semiconductor Components Industries, LLC.

TYPICAL CHARACTERISTICS – Q1

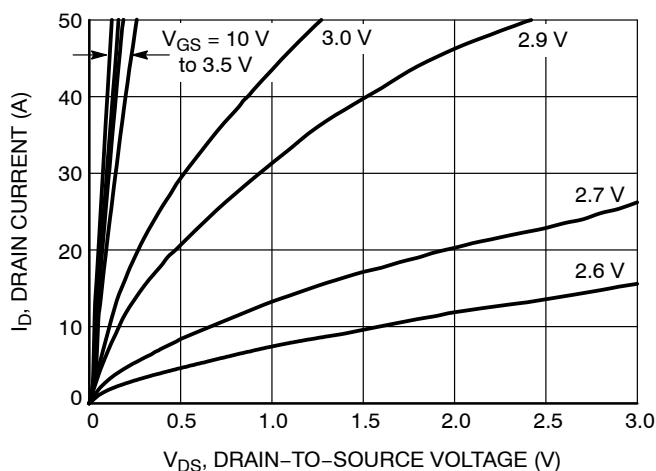


Figure 1. On-Region Characteristics

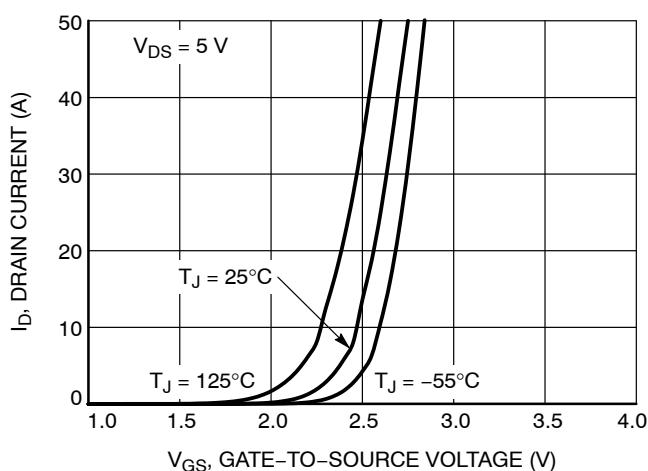


Figure 2. Transfer Characteristics

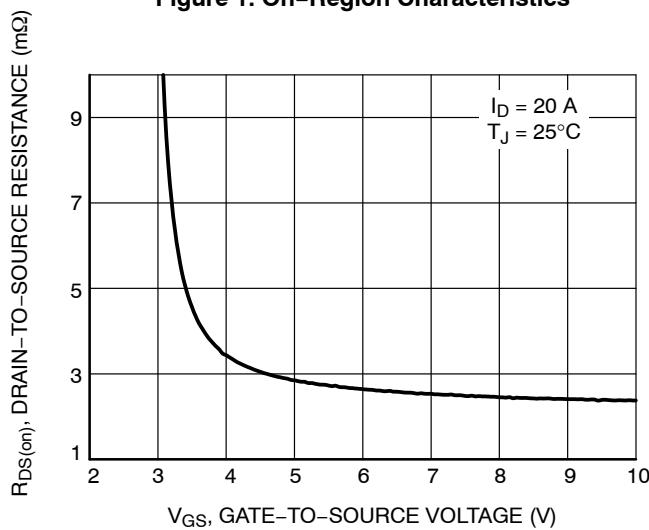


Figure 3. On-Resistance vs. Gate-to-Source Voltage

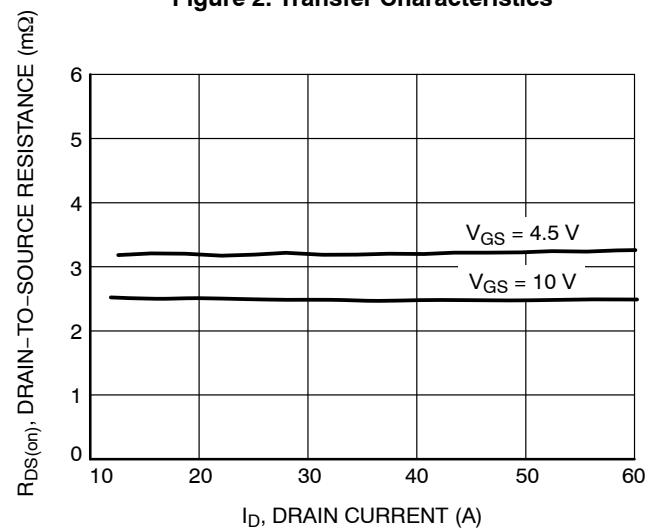


Figure 4. On-Resistance vs. Drain Current and Gate Voltage

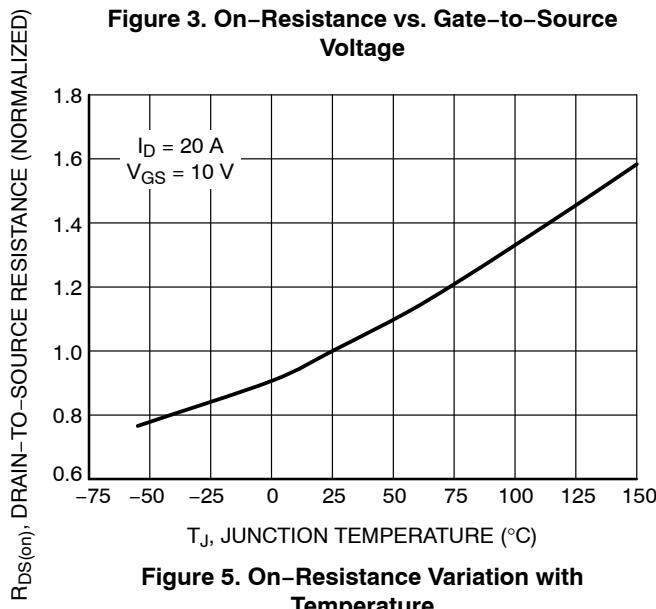


Figure 5. On-Resistance Variation with Temperature

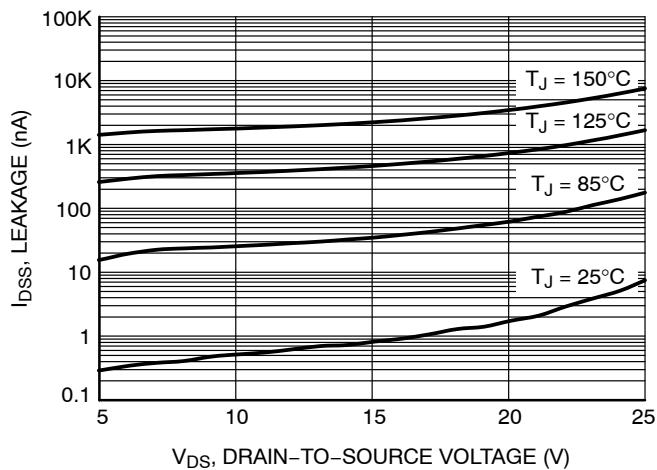
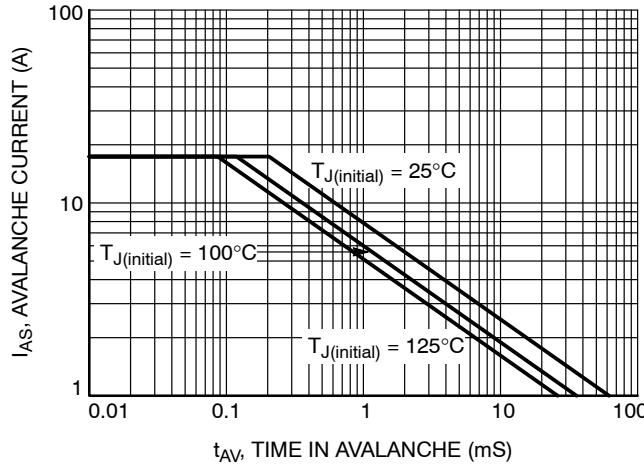
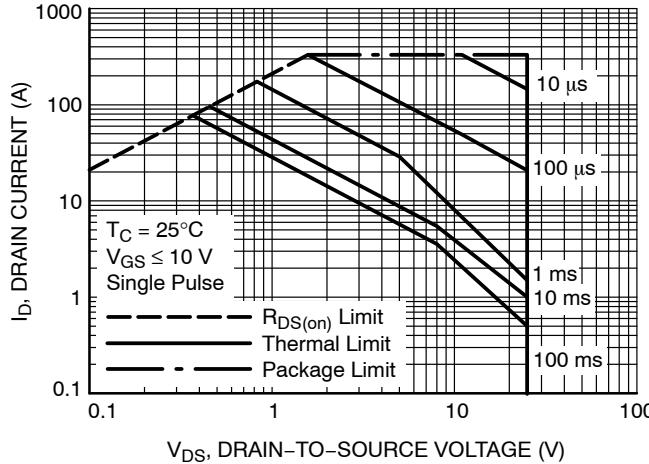
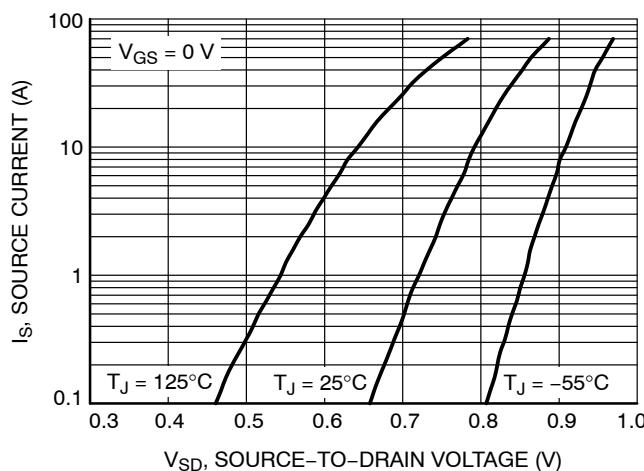
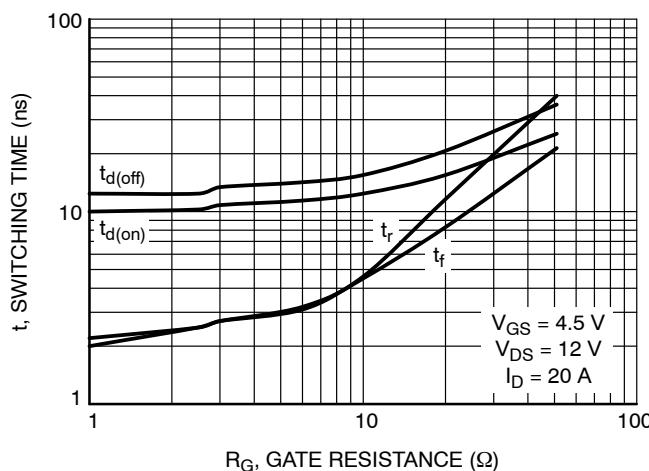
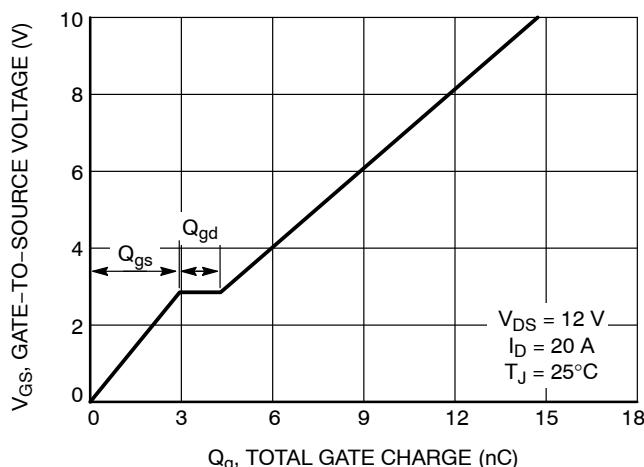
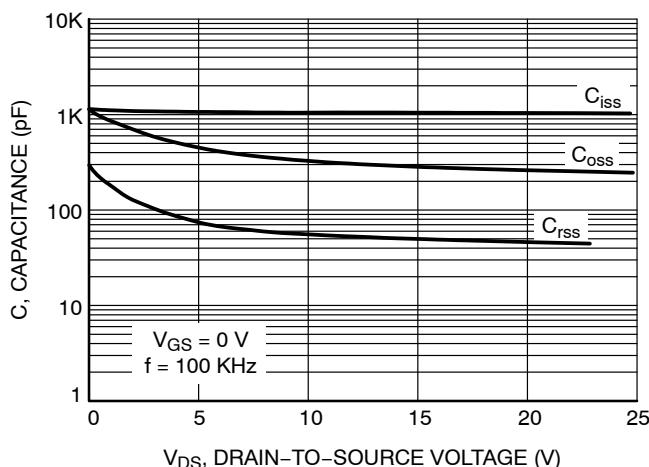


Figure 6. Drain-to-Source Leakage Current vs. Voltage

TYPICAL CHARACTERISTICS – Q1



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TYPICAL CHARACTERISTICS – Q1

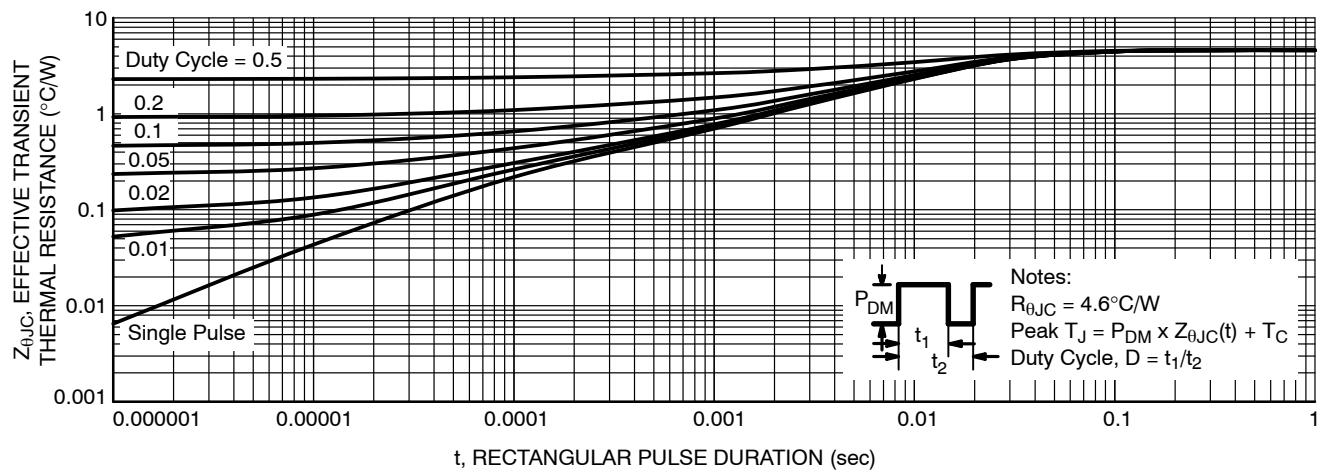


Figure 13. Transient Thermal Impedance

TYPICAL CHARACTERISTICS – Q2

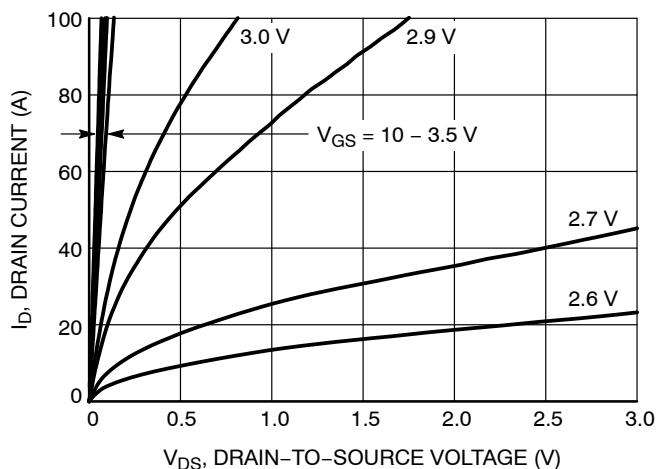


Figure 14. On-Region Characteristics

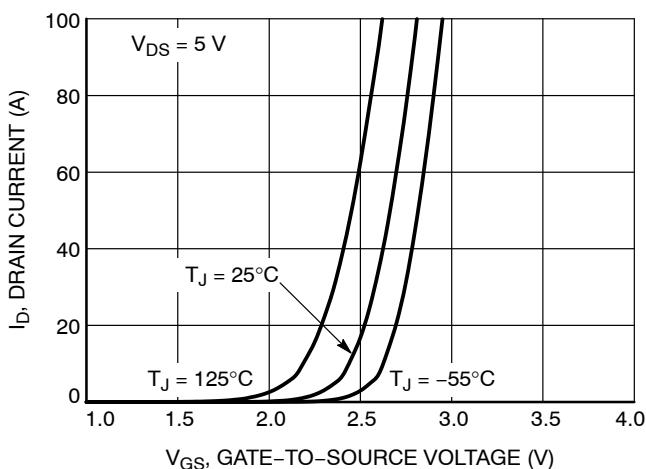


Figure 15. Transfer Characteristics

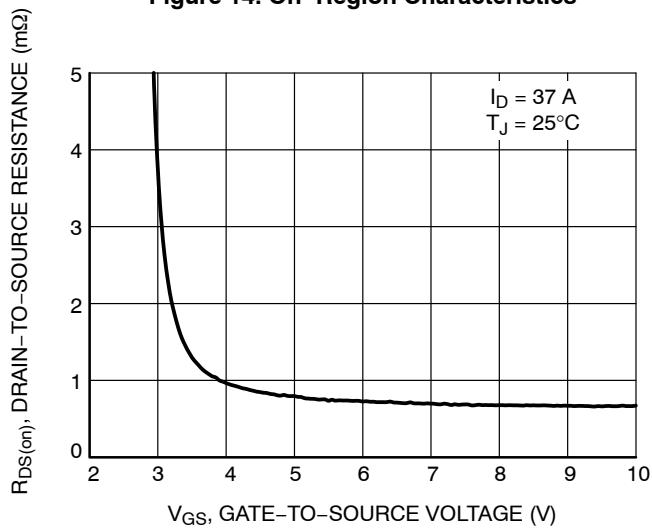


Figure 16. On-Resistance vs. Gate-to-Source Voltage

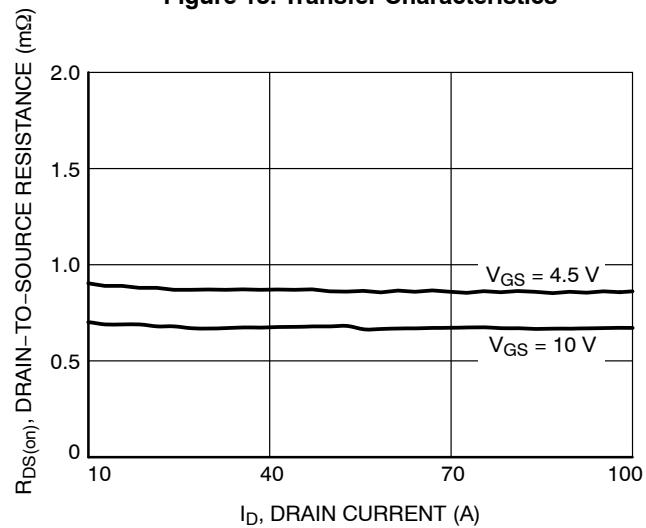


Figure 17. On-Resistance vs. Drain Current and Gate Voltage

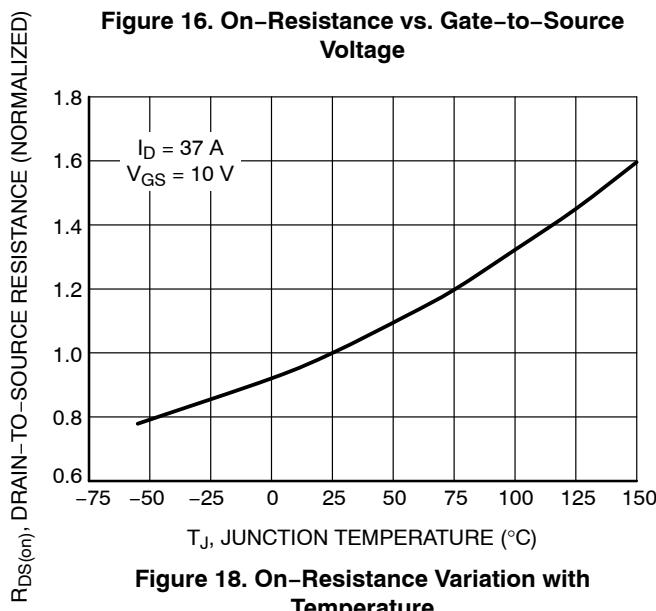


Figure 18. On-Resistance Variation with Temperature

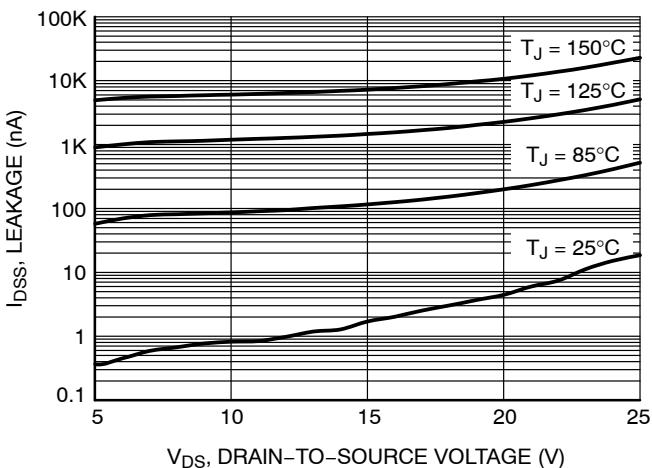


Figure 19. Drain-to-Source Leakage Current vs. Voltage

TYPICAL CHARACTERISTICS – Q2

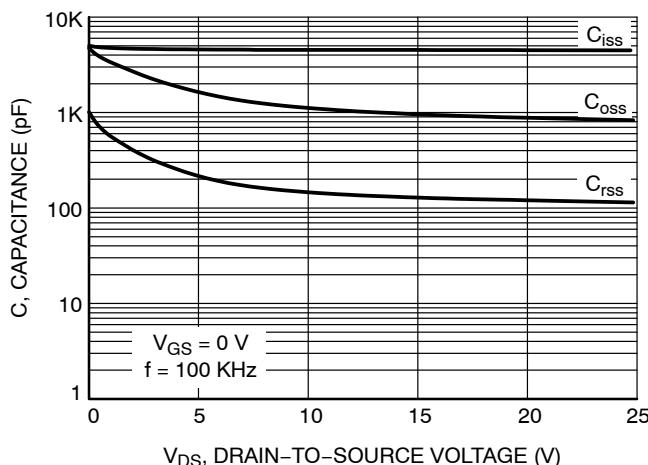


Figure 20. Capacitance Variation

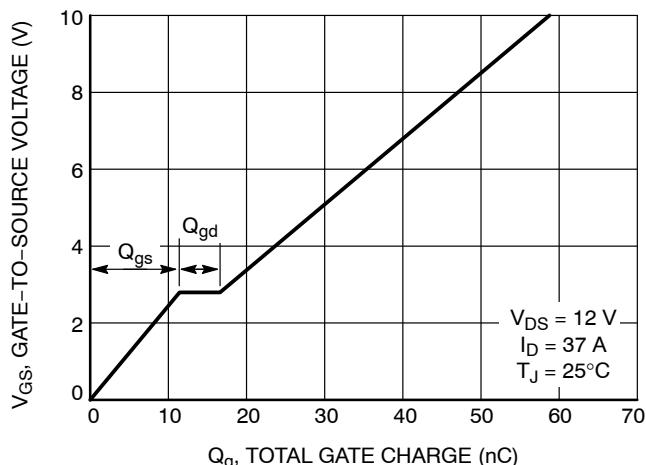


Figure 21. Gate-to-Source vs. Total Charge

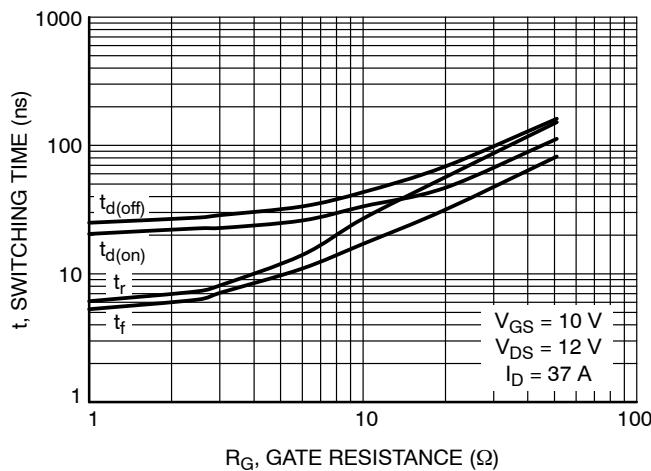


Figure 22. Resistive Switching Time Variation vs. Gate Resistance

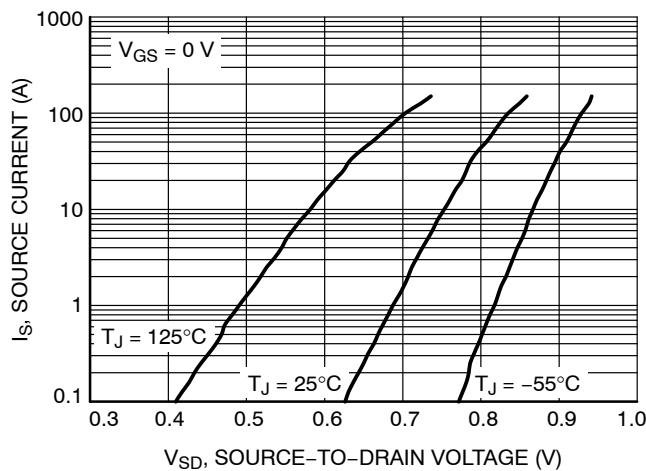


Figure 23. Diode Forward Voltage vs. Current

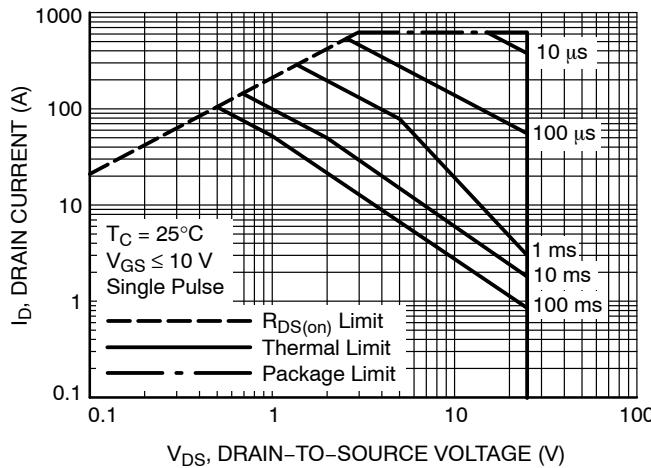


Figure 24. Maximum Rated Forward Biased Safe Operating Area

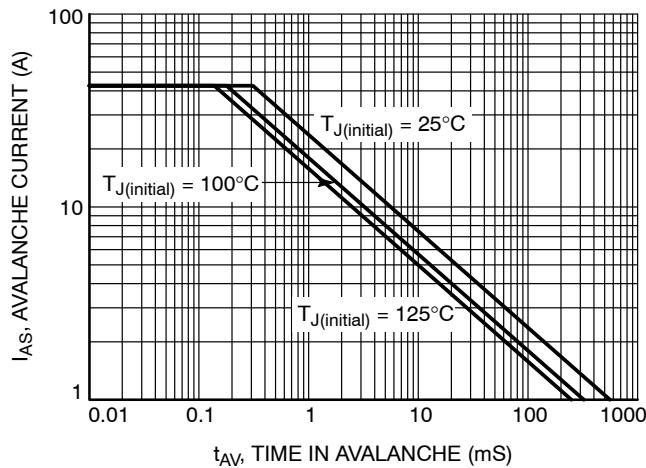


Figure 25. Avalanche Current vs. Time in Avalanche

TYPICAL CHARACTERISTICS – Q2

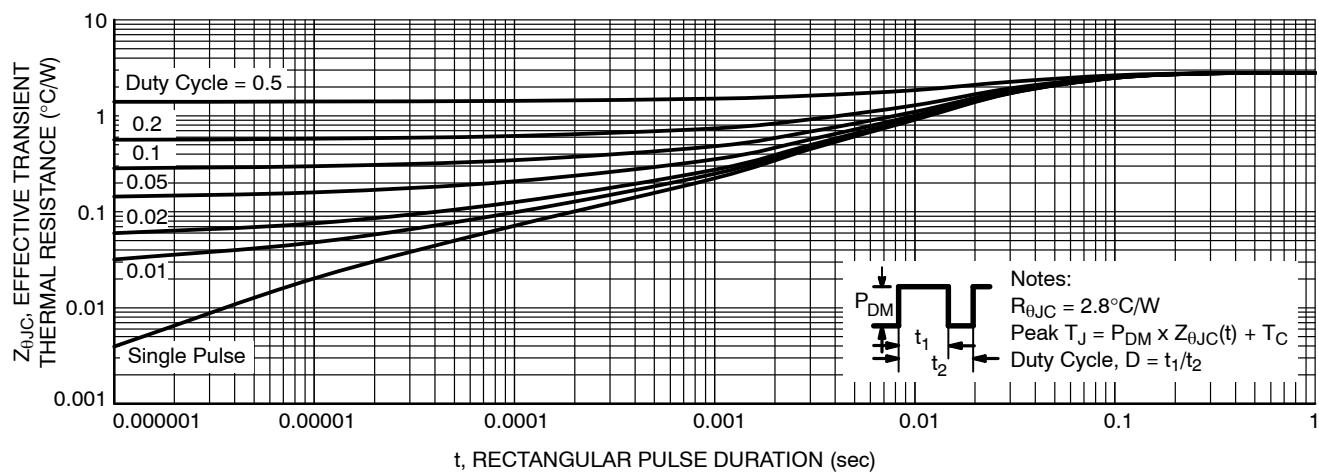
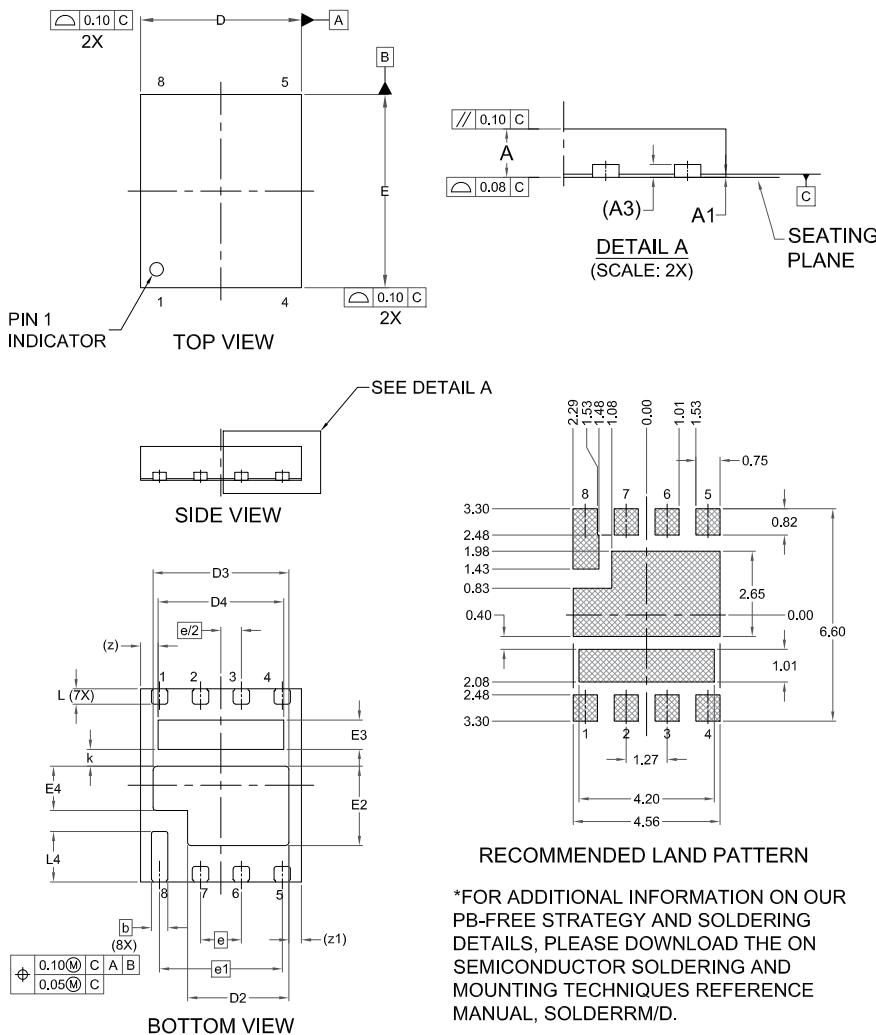


Figure 26. Transient Thermal Impedance

NTMFD1D1N02X

PACKAGE DIMENSIONS

PQFN8 5.00x6.00x0.75, 1.27P CASE 483AR ISSUE B



DIM	MILLIMETERS		
	MIN.	NOM.	MAX.
A	0.70	0.75	0.80
A1	0.00	-	0.05
A3	0.20	REF	
b	0.51	BSC	
D	4.90	5.00	5.10
D2	3.05	3.15	3.25
D3	4.12	4.22	4.32
D4	3.80	3.90	4.00
E	5.90	6.00	6.10
E2	2.36	2.46	2.56
E3	0.81	0.91	1.01
E4	1.27	1.37	1.47
e	1.27	BSC	
e/2	0.635	BSC	
e1	3.81	BSC	
k	0.42	0.52	0.62
L	0.38	0.48	0.58
L4	1.47	1.57	1.67
z	0.55	REF	
z1	0.39	REF	

*FOR ADDITIONAL INFORMATION ON OUR PB-FREE STRATEGY AND SOLDERING DETAILS, PLEASE DOWNLOAD THE ON SEMICONDUCTOR SOLDERING AND MOUNTING TECHNIQUES REFERENCE MANUAL, SODERRM/D.

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