MOSFET - Power, Dual, N-Channel, Power Clip, POWERTRENCH®, Asymmetric 25 V

NTMFD1D1N02X

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	

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

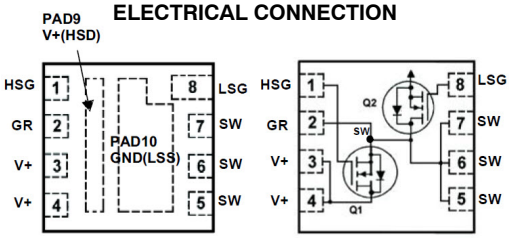
- DC−DC Converters
- System Voltage Rails

PQFN8
POWER CLIP
CASE 483AR

MARKING DIAGRAM

NTMFD1D1N02X = Specific Device Code
A = Assembly Site
WL = Wafer Lot Number
Y = Year of Production
WW = Work Week Number

ELECTRICAL CONNECTION



MAXIMUM RATINGS (T_J = 25°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°C	I_D	75	178	A
		T_C = 85°C		54	128	
Power Dissipation $R_{\theta JC}$ (Note 3)		T_C = 25°C	P_D	27	44	W
Continuous Drain Current $R_{\theta JA}$ (Notes 1, 3)	Steady State	T_A = 25°C	I_D	20	40	A
		T_A = 85°C		15	29	
Power Dissipation $R_{\theta JA}$ (Notes 1, 3)		T_A = 25°C	P_D	2.1	2.3	W
Continuous Drain Current $R_{\theta JA}$ (Notes 2, 3)	Steady State	T_A = 25°C	I_D	14	27	A
		T_A = 85°C		10	20	
Power Dissipation $R_{\theta JA}$ (Notes 2, 3)		T_A = 25°C	P_D	0.96	1.0	W
Pulsed Drain Current	T_C = 25°C, t_p = 100 μs		I_{DM}	331	625	A
Single Pulse Drain−to−Source Avalanche Energy Q1: I_L = 5.6 A_{pk}, L = 3 mH (Note 4) Q2: I_L = 13.6 A_{pk}, L = 3 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.

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	°C/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 in^2 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 mH, I_{AS} = 17.4 A.
   Q2 100% UIS tested at L = 0.1 mH, I_{AS} = 42.5 A.

Table 2. ELECTRICAL CHARACTERISTICS (T_J = 25°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 V, I_D = 250 μA		Q1	25			V
Drain−to−Source Breakdown Voltage	$V_{(BR)DSS}$	V_{GS} = 0 V, I_D = 250 μA		Q2	25			V
Drain−to−Source Breakdown Voltage Temperature Coefficient	$V_{(BR)DSS}$ / T_J	I_D = 250 μA, ref to 25°C		Q1		15		mV/°C
		I_D = 250 μA, ref to 25°C		Q2		16		
Zero Gate Voltage Drain Current	I_{DSS}	V_{GS} = 0 V, V_{DS} = 20 V	T_J = 25°C	Q1			10	μA
				Q2			10	
			T_J = 125°C	Q1			100	μA
				Q2			100	
Gate−to−Source Leakage Current	I_{GSS}	V_{DS} = 0 V, V_{GS} = +16 V / −12 V		Q1			±100	nA
		V_{DS} = 0 V, V_{GS} = +16 V / −12 V		Q2			±100	
ON CHARACTERISTICS (Note 5)								
Gate Threshold Voltage	$V_{GS(TH)}$	V_{GS} = V_{DS}, I_D = 240 μA		Q1	1.2	1.6	2.1	V
		V_{GS} = V_{DS}, I_D = 850 μA		Q2	1.2	1.6	2.1	
Threshold Temperature Coefficient	$V_{GS(TH)}$ / T_J	I_D = 240 μA, ref to 25°C		Q1		−4.0		mV/°C
		I_D = 850 μA, ref to 25°C		Q2		−4.3		
Drain−to−Source On Resistance	$R_{DS(on)}$	V_{GS} = 10 V, I_D = 20 A		Q1		2.4	3.0	mΩ
		V_{GS} = 4.5 V, I_D = 18 A				3.1	3.75	
		V_{GS} = 10 V, I_D = 37 A		Q2		0.66	0.87	
		V_{GS} = 4.5 V, I_D = 33 A			0.68	0.84	1.1	
Forward Transconductance	g_{FS}	V_{DS} = 5 V, I_D = 20 A		Q1		123		S
		V_{DS} = 5 V, I_D = 37 A		Q2		322		
Gate Resistance	R_G	T_A = 25°C		Q1		0.8		Ω
				Q2		0.9		

5. Pulse Test: pulse width ≤ 300 μs, duty cycle ≤ 2%
6. Switching characteristics are independent of operating junction temperatures

Table 2. ELECTRICAL CHARACTERISTICS (T_J = 25°C unless otherwise stated)

Parameter	Symbol	Test Condition	FET	Min	Typ	Max	Unit
CHARGES & CAPACITANCES							
Input Capacitance	C_{ISS}	V_{GS} = 0 V, V_{DS} = 12 V, f = 1 MHz	Q1		1080		pF
			Q2		4265		
Output Capacitance	C_{OSS}		Q1		322		pF
			Q2		1020		
Reverse Capacitance	C_{RSS}		Q1		47		pF
			Q2		118		
Total Gate Charge	$Q_{G(TOT)}$	Q1: V_{GS} = 4.5V, V_{DS} = 12V, I_D = 20A Q2: V_{GS} = 4.5V, V_{DS} = 12V, I_D = 37A	Q1		6.8		nC
			Q2		27		
Gate−to−Drain Charge	Q_{GD}		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} = 10V, V_{DS} = 12V, I_D = 20A Q2: V_{GS} = 10V, V_{DS} = 12V, I_D = 37A	Q1		15		nC
			Q2		59		
Output Charge	Q_{OSS}	V_{GS} = 0 V, V_{DS} = 12 V	Q1		6.2		nC
			Q2		22		
Plateau Voltage	V_{GP}	Q1: V_{GS} = 4.5V, V_{DS} = 12V, I_D = 20A Q2: V_{GS} = 4.5V, V_{DS} = 12V, I_D = 37A	Q1		2.8		V
			Q2		2.8		
SWITCHING CHARACTERISTICS, VGS = 4.5 V (Note 6)							
Turn−On Delay Time	$t_{d(ON)}$	V_{GS} = 4.5 V Q1: I_D = 20 A, V_{DD} = 12 V, R_G = 2Ω Q2: I_D = 37 A, V_{DD} = 12 V, R_G = 2Ω	Q1		10		ns
			Q2		21		
Rise Time	$t_{r(ON)}$		Q1		2.5		ns
			Q2		6.6		
Turn−Off Delay Time	$t_{d(OFF)}$		Q1		12		ns
			Q2		26		
Fall Time	t_f		Q1		2.5		ns
			Q2		6.0		
SWITCHING CHARACTERISTICS, VGS = 10 V (Note 6)							
Turn−On Delay Time	$t_{d(ON)}$	V_{GS} = 10 V Q1: I_D = 20 A, V_{DD} = 12 V, R_G = 2Ω Q2: I_D = 37 A, V_{DD} = 12 V, R_G = 2Ω	Q1		7.4		ns
			Q2		11		
Rise Time	$t_{r(ON)}$		Q1		1.1		ns
			Q2		2.9		
Turn−Off Delay Time	$t_{d(OFF)}$		Q1		17		ns
			Q2		36		
Fall Time	t_f		Q1		1.4		ns
			Q2		3.5		

5. Pulse Test: pulse width ≤ 300 μs, duty cycle ≤ 2%
6. Switching characteristics are independent of operating junction temperatures

Table 2. ELECTRICAL CHARACTERISTICS (T_J = 25°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 V, I_S = 20 A	T_J = 25°C	Q1		0.81		V
			T_J = 125°C			0.68		
		V_{GS} = 0 V, I_S = 37 A	T_J = 25°C	Q2		0.8		
			T_J = 125°C			0.65		
Reverse Recovery Time	t_{RR}	V_{GS} = 0 V, Q1: I_S = 20 A, dI/dt = 100 A/μs Q2: I_S = 37 A, dI/dt = 300 A/μs		Q1		18		ns
				Q2		35		
Reverse Recovery Charge	Q_{RR}			Q1		6.6		nC
				Q2		44		

5. Pulse Test: pulse width ≤ 300 μs, duty cycle ≤ 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.

TYPICAL CHARACTERISTICS – Q1

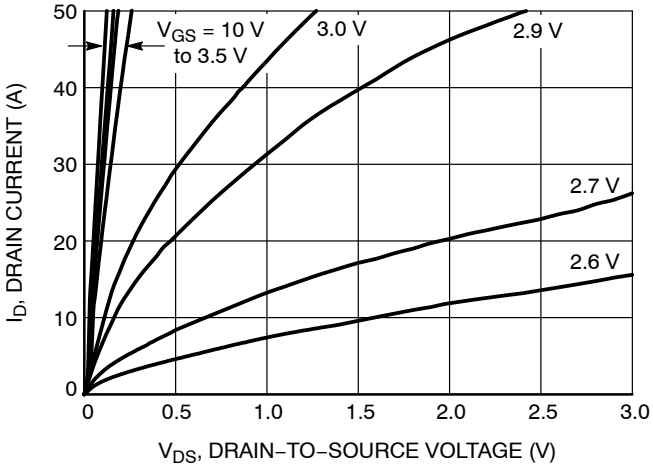


Figure 1. On−Region Characteristics

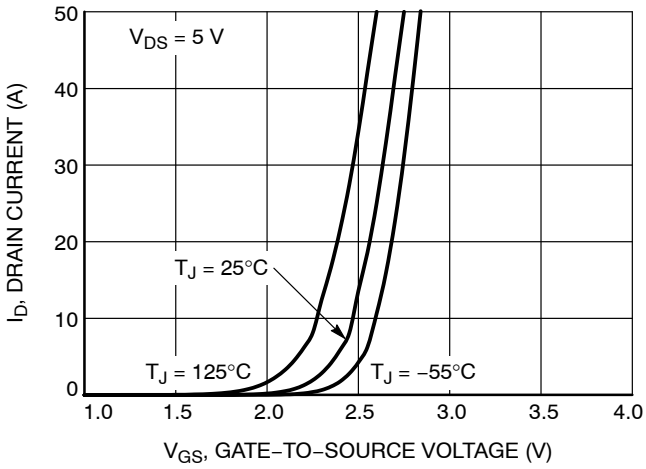


Figure 2. Transfer Characteristics

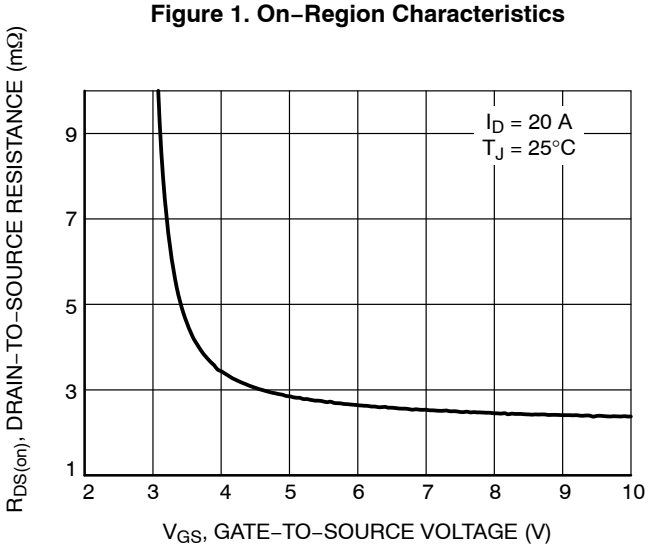


Figure 3. On−Resistance vs. Gate−to−Source Voltage

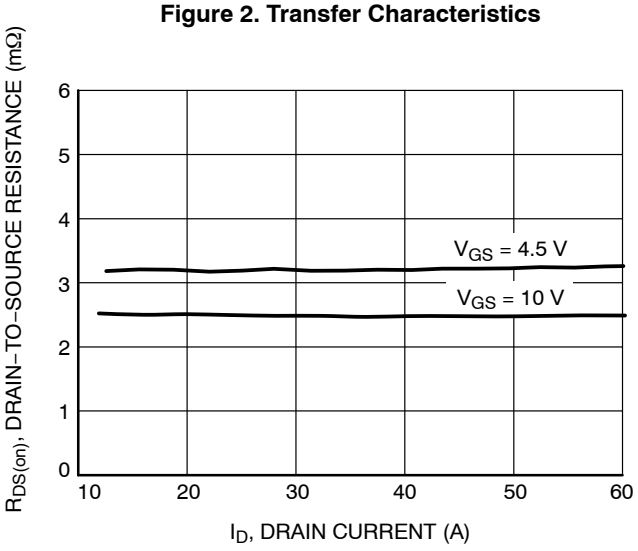


Figure 4. On−Resistance vs. Drain Current and Gate Voltage

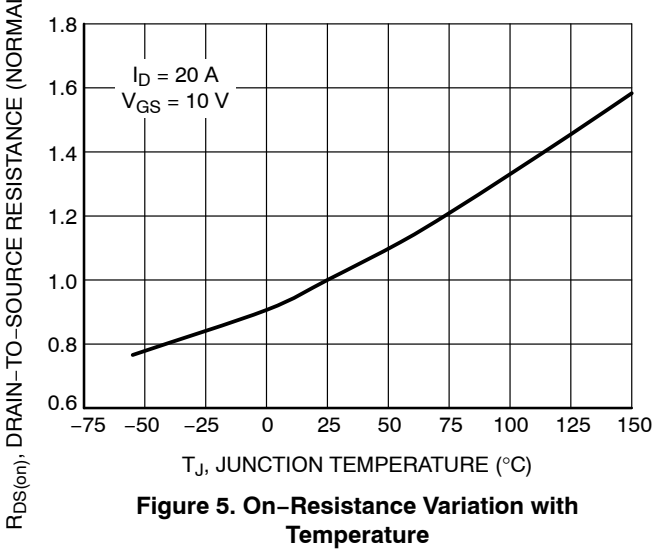


Figure 5. On−Resistance Variation with Temperature

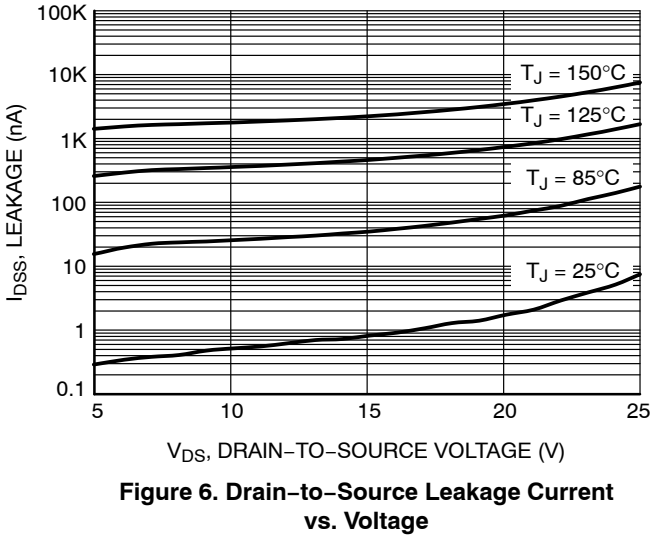


Figure 6. Drain−to−Source Leakage Current vs. Voltage

TYPICAL CHARACTERISTICS – Q1

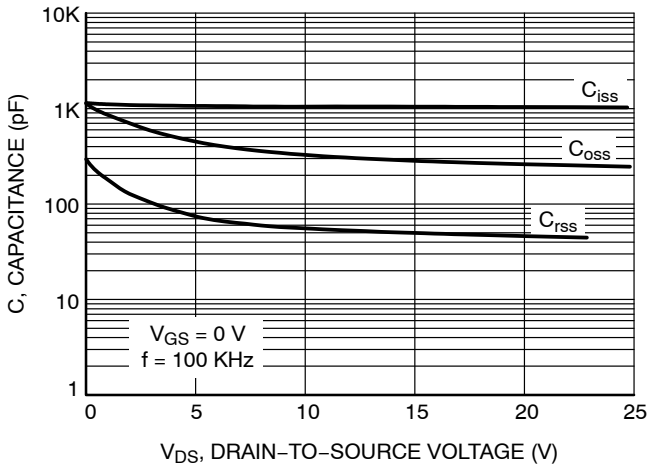


Figure 7. Capacitance Variation

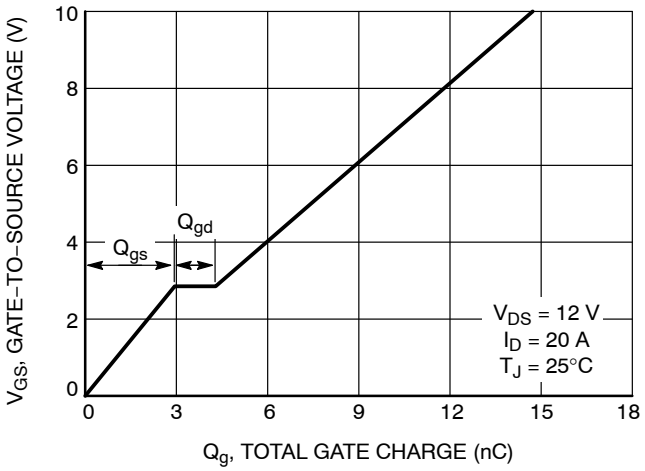


Figure 8. Gate−to−Source vs. Total Charge

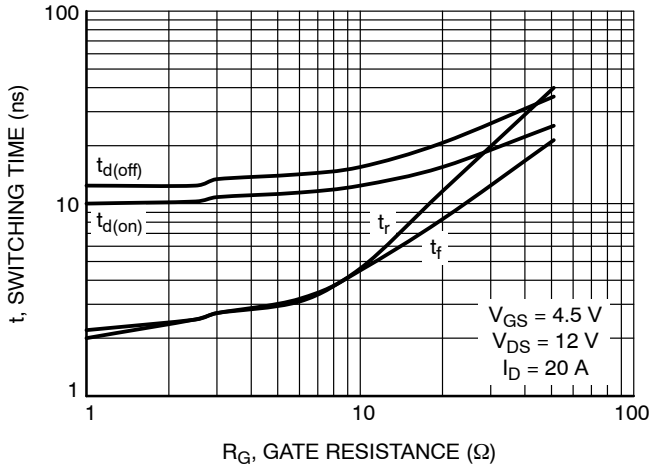


Figure 9. Resistive Switching Time Variation vs. Gate Resistance

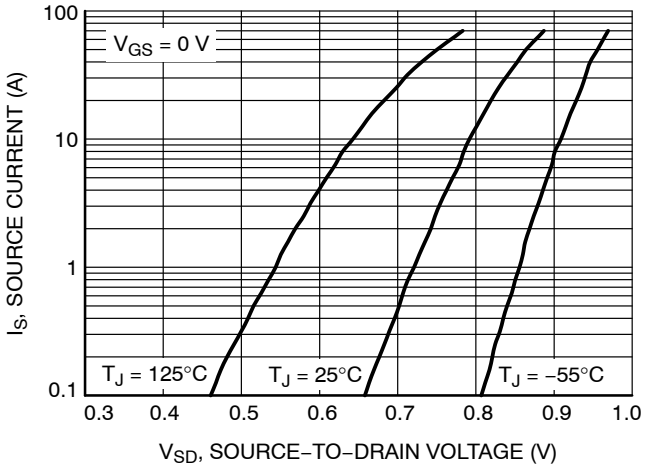


Figure 10. Diode Forward Voltage vs. Current

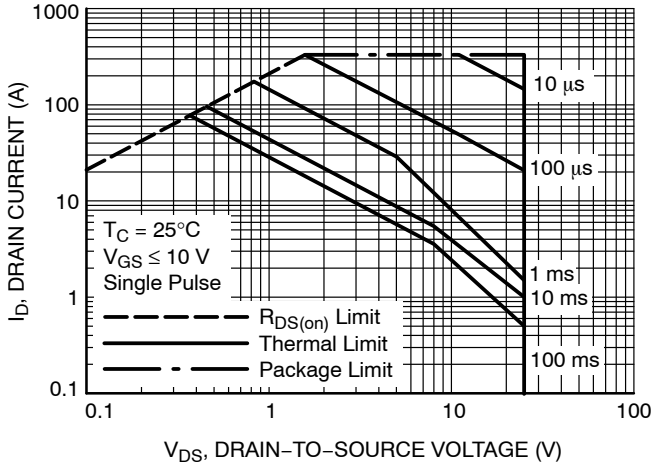


Figure 11. Maximum Rated Forward Biased Safe Operating Area

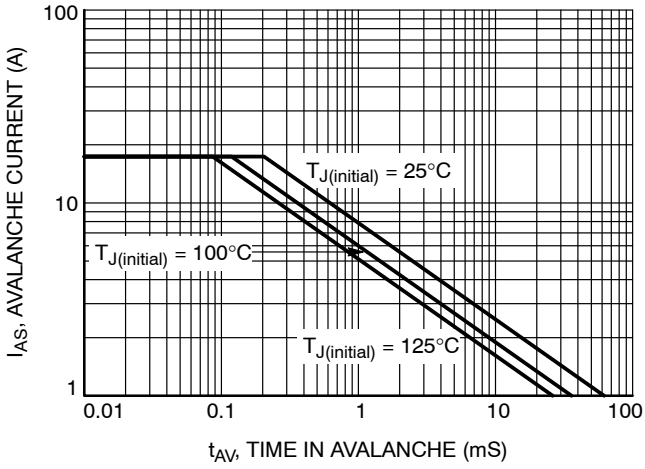


Figure 12. Avalanche Current vs. Time in Avalanche

TYPICAL CHARACTERISTICS – Q1

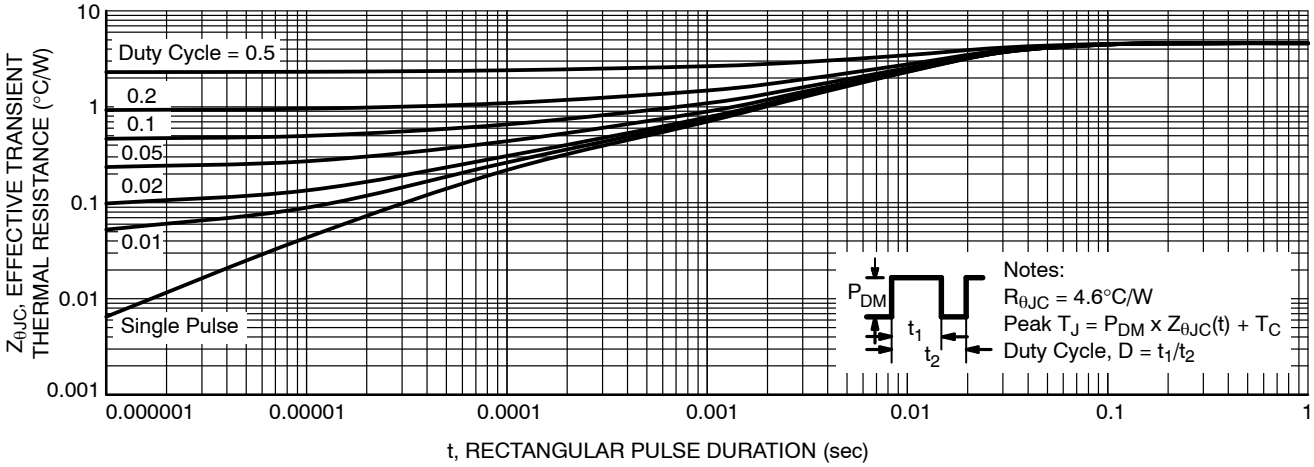


Figure 13. Transient Thermal Impedance

TYPICAL CHARACTERISTICS – Q2

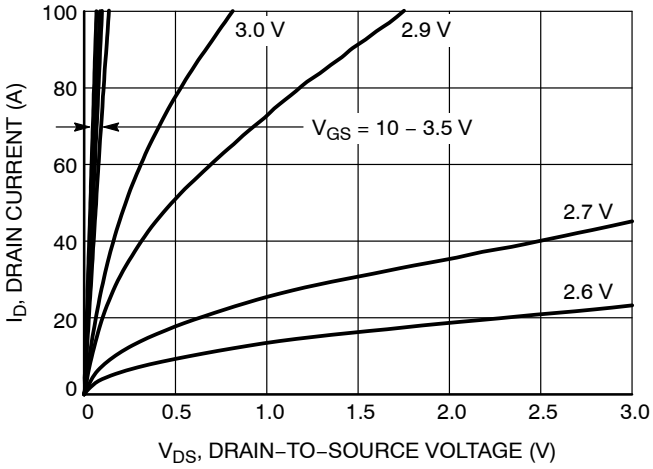


Figure 14. On–Region Characteristics

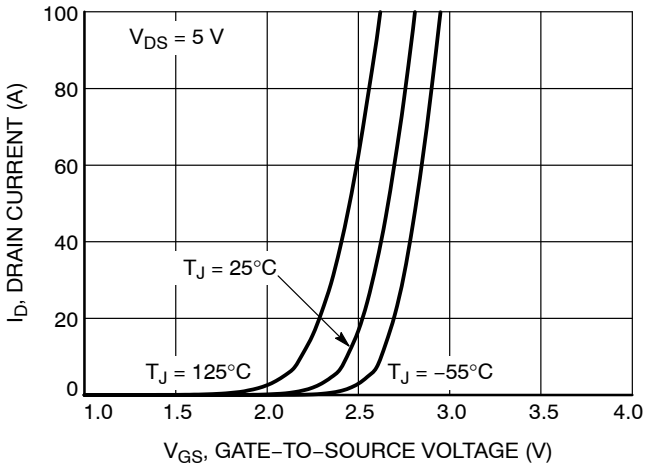


Figure 15. Transfer Characteristics

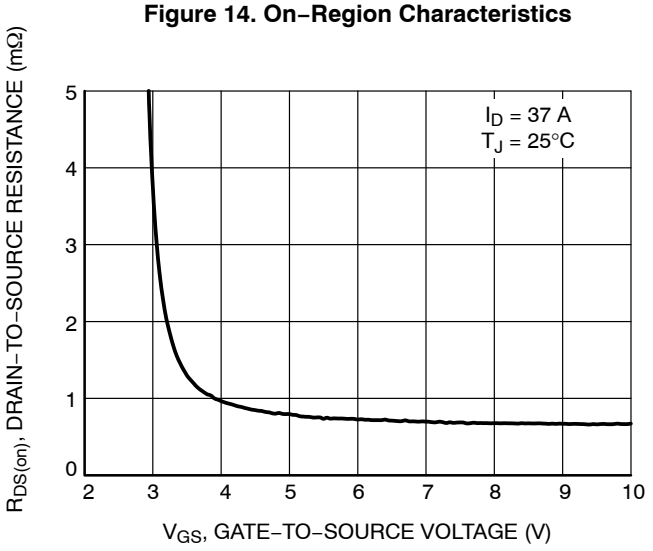


Figure 16. On–Resistance vs. Gate–to–Source Voltage

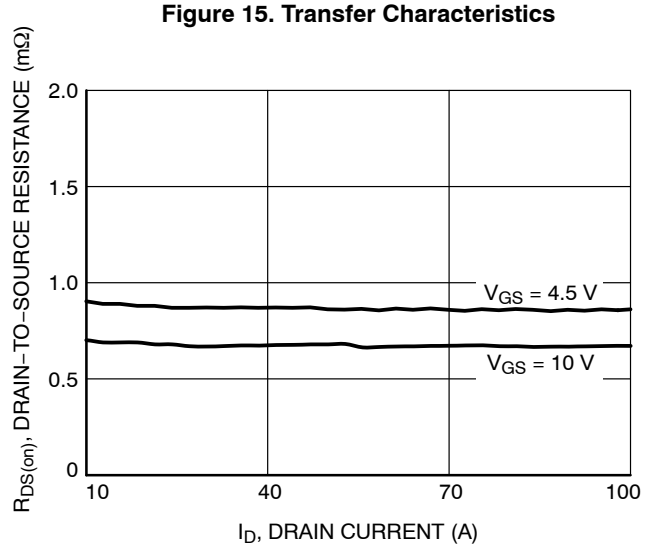


Figure 17. On–Resistance vs. Drain Current and Gate Voltage

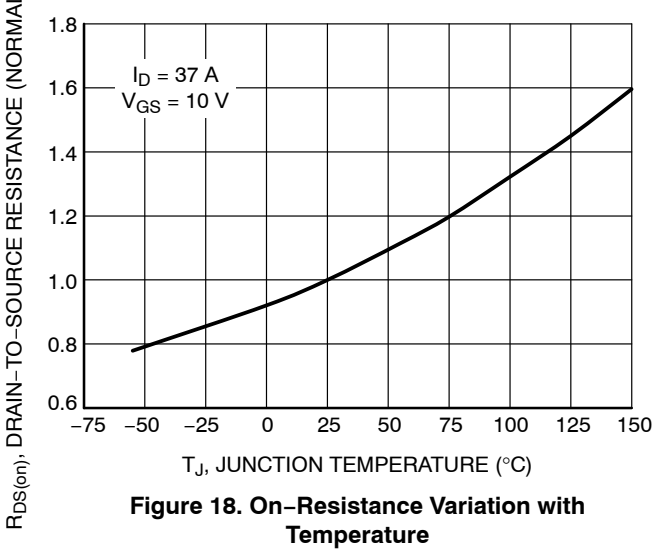


Figure 18. On–Resistance Variation with Temperature

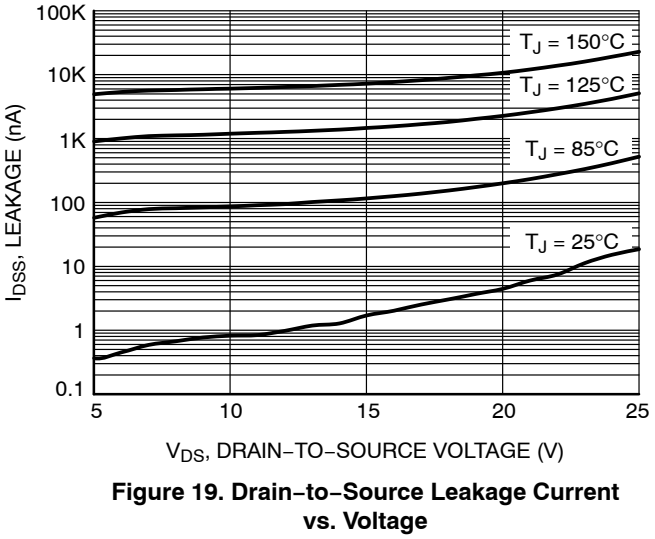


Figure 19. Drain–to–Source Leakage Current vs. Voltage

TYPICAL CHARACTERISTICS – Q2

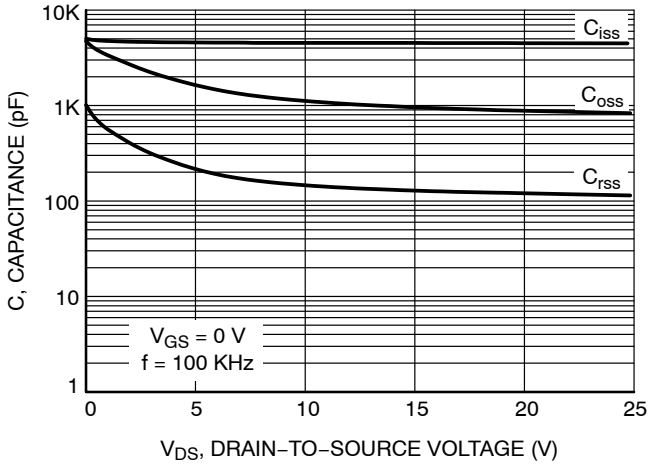


Figure 20. Capacitance Variation

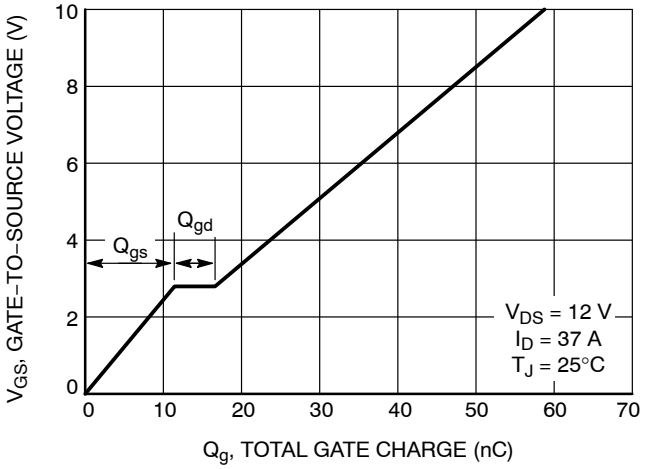


Figure 21. Gate−to−Source vs. Total Charge

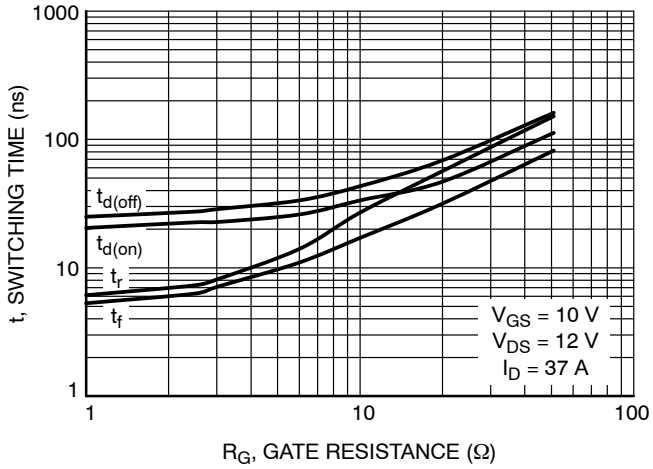


Figure 22. Resistive Switching Time Variation vs. Gate Resistance

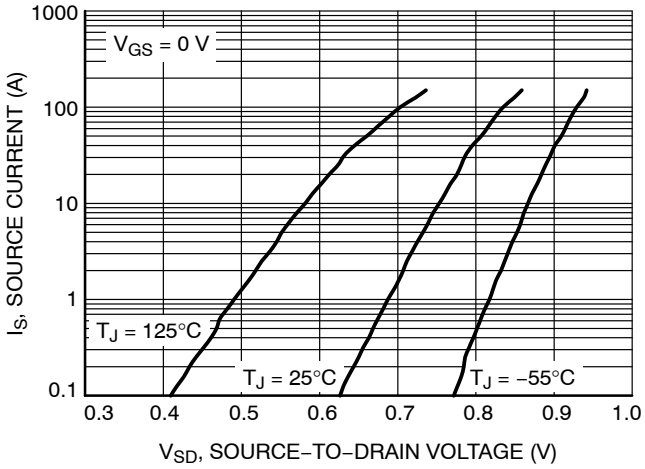


Figure 23. Diode Forward Voltage vs. Current

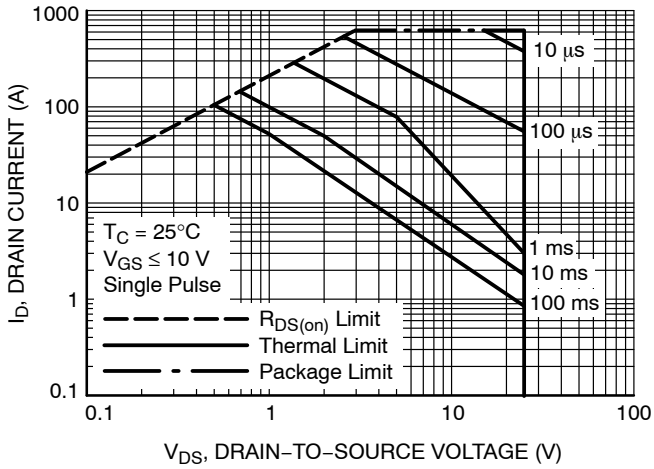


Figure 24. Maximum Rated Forward Biased Safe Operating Area

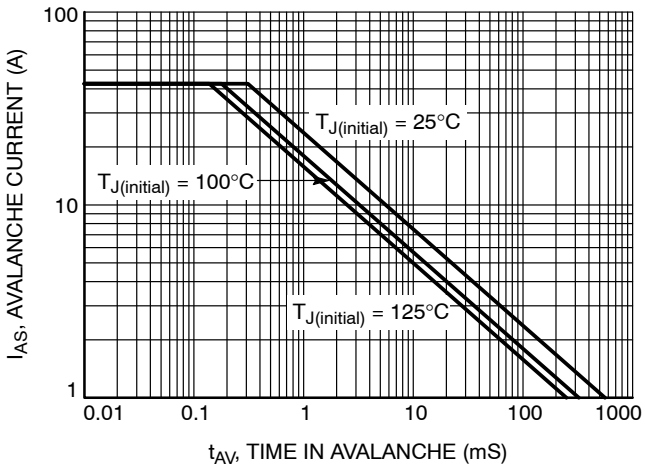


Figure 25. Avalanche Current vs. Time in Avalanche

TYPICAL CHARACTERISTICS – Q2

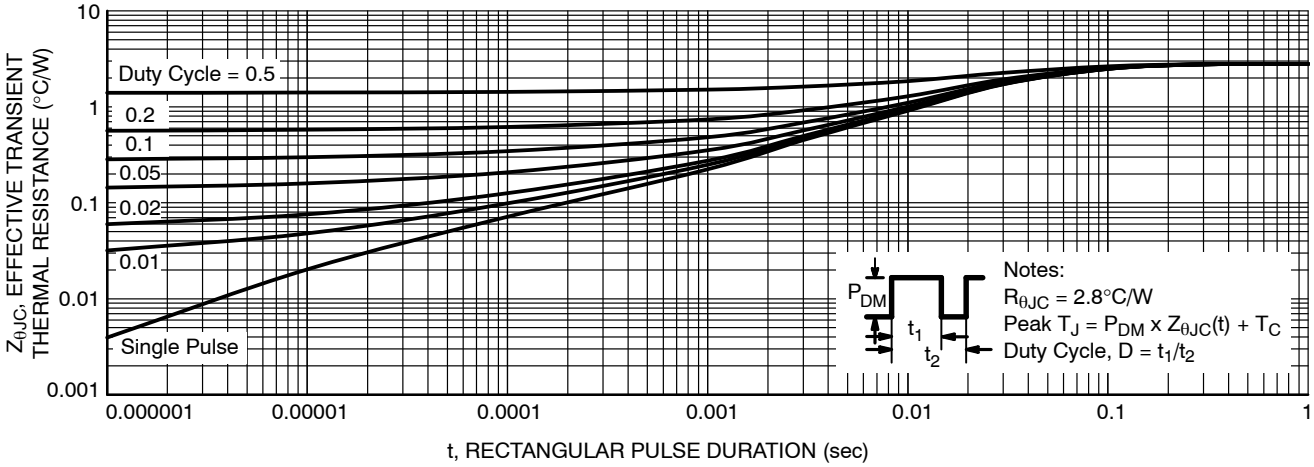
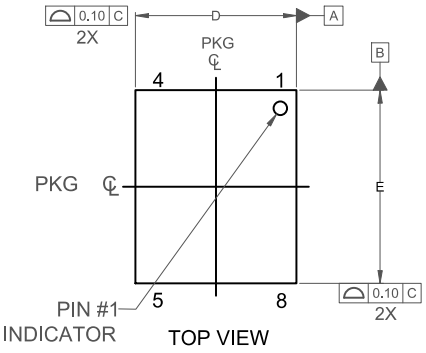


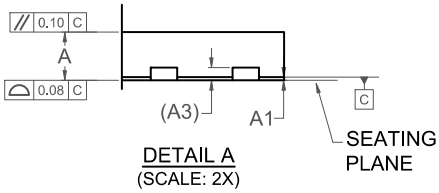
Figure 26. Transient Thermal Impedance

NTMFD1D1N02X

PACKAGE DIMENSIONS

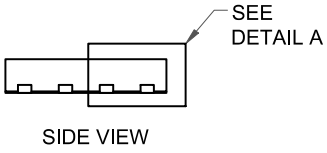
PQFN8 5X6, 1.27P
CASE 483AR
ISSUE A

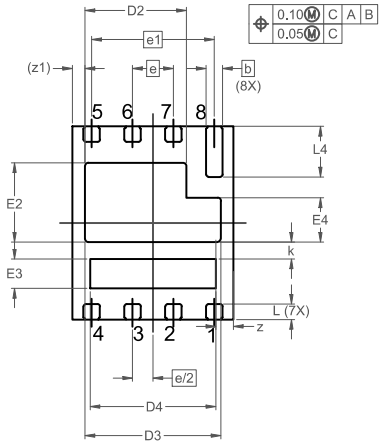


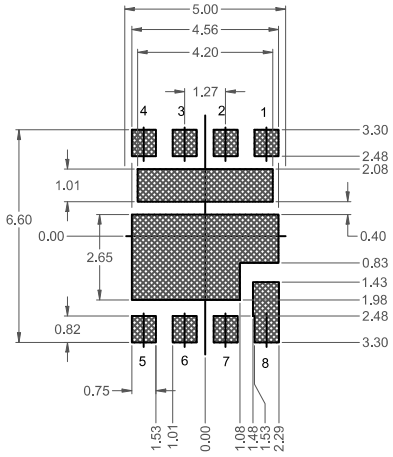


NOTES: UNLESS OTHERWISE SPECIFIED

A) DOES NOT FULLY CONFORM TO JEDEC REGISTRATION, MO-229, DATED 11/2001.
B) ALL DIMENSIONS ARE IN MILLIMETERS.
C) DIMENSIONS DO NOT INCLUDE BURRS OR MOLD FLASH. MOLD FLASH OR BURRS DOES NOT EXCEED 0.10MM.
D) DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994.







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

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		

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