

# MOSFET – Power, Dual, N-Channel, Power Trench, Power Clip, Asymmetric 25 V



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## NTMFD1D4N02P1E

### 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	$T_C = 25^\circ\text{C}$	$I_D$	74	155	A
		$T_C = 85^\circ\text{C}$		53	112	
Power Dissipation $R_{\theta JC}$ (Note 3)		$T_A = 25^\circ\text{C}$	$P_D$	25	41	W
Continuous Drain Current $R_{\theta JA}$ (Notes 1, 3)	Steady State	$T_A = 25^\circ\text{C}$	$I_D$	20	36	A
		$T_A = 85^\circ\text{C}$		14	26	
Power Dissipation $R_{\theta JA}$ (Notes 1, 3)		$T_A = 25^\circ\text{C}$	$P_D$	2.1	2.3	W
Continuous Drain Current $R_{\theta JA}$ (Notes 2, 3)	Steady State	$T_A = 25^\circ\text{C}$	$I_D$	13	24	A
		$T_A = 85^\circ\text{C}$		10	17	
Power Dissipation $R_{\theta JA}$ (Notes 2, 3)		$T_A = 25^\circ\text{C}$	$P_D$	0.96	1.0	W
Pulsed Drain Current	$T_A = 25^\circ\text{C}$ , $t_p = 10 \mu\text{s}$		$I_{DM}$	325	552	A
Single Pulse Drain-to-Source Avalanche Energy Q1: $I_L = 9.4 \text{ A}_{pk}$ , $L = 3 \text{ mH}$ (Note 4) Q2: $I_L = 20.1 \text{ A}_{pk}$ , $L = 3 \text{ mH}$ (Note 4)			$E_{AS}$	134	604	mJ
Operating Junction and Storage Temperature Range			$T_J$ , $T_{stg}$	-55 to 150		$^\circ\text{C}$
Lead Temperature Soldering Reflow for Soldering Purposes (1/8" from case for 10 s)			$T_L$	260		$^\circ\text{C}$

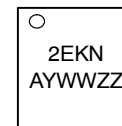
Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

FET	$V_{(BR)DSS}$	$R_{DS(on)}$ MAX	$I_D$ MAX
Q1	25 V	3.3 $\text{m}\Omega$ @ 10 V	74 A
		4.2 $\text{m}\Omega$ @ 4.5 V	
Q2	25 V	1.1 $\text{m}\Omega$ @ 10 V	155 A
		1.33 $\text{m}\Omega$ @ 4.5 V	



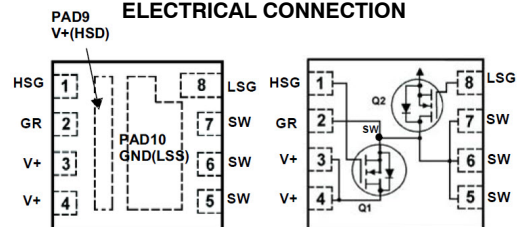
PQFN8  
POWER CLIP  
CASE 483AR

### MARKING DIAGRAM



2EKN = Specific Device Code  
A = Assembly Location  
Y = Year  
WW = Work Week  
ZZ = Assembly Lot Code

### ELECTRICAL CONNECTION



### ORDERING INFORMATION

Device	Package	Shipping†
NTMFD1D4N02P1E	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.

# NTMFD1D4N02P1E

**Table 1. THERMAL RESISTANCE RATINGS**

Parameter	Symbol	Q1 Max	Q2 Max	Units
Junction-to-Case – Steady State (Note 1, 3)	$R_{\theta JC}$	4.4	2.9	°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	

- Surface-mounted on FR4 board using 1 in<sup>2</sup> pad size, 2 oz Cu pad.
- Surface-mounted on FR4 board using minimum pad size, 2 oz Cu pad.
- 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.
- Q1 100% UIS tested at L = 0.1 mH,  $I_{AS} = 16.5$  A.  
Q2 100% UIS tested at L = 0.1 mH,  $I_{AS} = 36$  A.

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

Parameter	Symbol	Test Condition	FET	Min	Typ	Max	Unit
<b>OFF CHARACTERISTICS</b>							
Drain-to-Source Breakdown Voltage	$V_{(BR)DSS}$	$V_{GS} = 0$ V, $I_D = 250$ $\mu$ A	Q1	25			V
Drain-to-Source Breakdown Voltage	$V_{(BR)DSS}$	$V_{GS} = 0$ V, $I_D = 1$ mA	Q2	25			V
Drain-to-Source Breakdown Voltage Temperature Coefficient	$V_{(BR)DSS} / T_J$	$I_D = 250$ $\mu$ A, ref to $25^\circ\text{C}$	Q1		16		mV/°C
		$I_D = 1$ mA, ref to $25^\circ\text{C}$	Q2		19		
Zero Gate Voltage Drain Current	$I_{DSS}$	$V_{GS} = 0$ V, $V_{DS} = 20$ V	$T_J = 25^\circ\text{C}$	Q1		10	$\mu$ A
				Q2		10	
Gate-to-Source Leakage Current	$I_{GSS}$	$V_{DS} = 0$ V, $V_{GS} = +16$ V / $-12$ V	Q1			$\pm 100$	nA
			Q2			$\pm 100$	

**ON CHARACTERISTICS** (Note 5)

Gate Threshold Voltage	$V_{GS(TH)}$	$V_{GS} = V_{DS}$ , $I_D = 250$ $\mu$ A	Q1	1.2	1.54	2.0	V
		$V_{GS} = V_{DS}$ , $I_D = 800$ $\mu$ A	Q2	1.2	1.55	2.0	
Threshold Temperature Coefficient	$V_{GS(TH)} / T_J$	$I_D = 250$ $\mu$ A, ref to $25^\circ\text{C}$	Q1		-4.3		mV/°C
		$I_D = 800$ $\mu$ A, ref to $25^\circ\text{C}$	Q2		-4.4		
Drain-to-Source On Resistance	$R_{DS(on)}$	$V_{GS} = 10$ V, $I_D = 20$ A	Q1		2.6	3.3	m $\Omega$
		$V_{GS} = 4.5$ V, $I_D = 18$ A			3.4	4.2	
		$V_{GS} = 10$ V, $I_D = 37$ A	Q2		0.81	1.1	
		$V_{GS} = 4.5$ V, $I_D = 33$ A			1.04	1.33	
Forward Transconductance	$g_{FS}$	$V_{DS} = 5$ V, $I_D = 20$ A	Q1		125		
		$V_{DS} = 5$ V, $I_D = 37$ A	Q2		285		
Gate Resistance	$R_G$	$T_A = 25^\circ\text{C}$	Q1		0.44		$\Omega$
			Q2		0.6		

**CHARGES & CAPACITANCES**

Input Capacitance	$C_{ISS}$	$V_{GS} = 0$ V, $V_{DS} = 13$ V, $f = 1$ MHz	Q1		1180		pF
			Q2		3603		
Output Capacitance	$C_{OSS}$		Q1		320		pF
			Q2		940		
Reverse Capacitance	$C_{RSS}$		Q1		22		pF
			Q2		64		

- Pulse Test: pulse width  $\leq 300$   $\mu$ s, duty cycle  $\leq 2\%$
- Switching characteristics are independent of operating junction temperatures

# NTMFD1D4N02P1E

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

Parameter	Symbol	Test Condition	FET	Min	Typ	Max	Unit
<b>CHARGES &amp; CAPACITANCES</b>							
Total Gate Charge	$Q_{G(TOT)}$	Q1: $V_{GS} = 4.5\text{V}$ , $V_{DS} = 13\text{V}$ , $I_D = 20\text{A}$ Q2: $V_{GS} = 4.5\text{V}$ , $V_{DS} = 13\text{V}$ , $I_D = 37\text{A}$	Q1		7.2		nC
			Q2		21.5		
Gate-to-Drain Charge	$Q_{GD}$		Q1		1.35		nC
			Q2		3.9		
Gate-to-Source Charge	$Q_{GS}$		Q1		3.15		nC
			Q2		9.1		
Total Gate Charge	$Q_{G(TOT)}$	$V_{GS} = 10\text{V}$ , $V_{DS} = 13\text{V}$ , $I_D = 20\text{A}$	Q1		16.4		nC
		$V_{GS} = 10\text{V}$ , $V_{DS} = 13\text{V}$ , $I_D = 37\text{A}$	Q2		48.6		

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

Turn-On Delay Time	$t_{d(ON)}$	$V_{GS} = 4.5\text{V}$ Q1: $I_D = 20\text{A}$ , $V_{DD} = 13\text{V}$ , $R_G = 6\Omega$ Q2: $I_D = 37\text{A}$ , $V_{DD} = 13\text{V}$ , $R_G = 6\Omega$	Q1		11.6		ns
			Q2		21.4		
Rise Time	$t_r(ON)$		Q1		2.7		ns
			Q2		8.7		
Turn-Off Delay Time	$t_{d(OFF)}$		Q1		15.6		ns
			Q2		30.7		
Fall Time	$t_f$	Q1		3.2		ns	
		Q2		8.5			

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

Turn-On Delay Time	$t_{d(ON)}$	$V_{GS} = 10\text{V}$ Q1: $I_D = 20\text{A}$ , $V_{DD} = 13\text{V}$ , $R_G = 6\Omega$ Q2: $I_D = 37\text{A}$ , $V_{DD} = 13\text{V}$ , $R_G = 6\Omega$	Q1		7.9		ns
			Q2		10.2		
Rise Time	$t_r(ON)$		Q1		1.1		ns
			Q2		3.3		
Turn-Off Delay Time	$t_{d(OFF)}$		Q1		21.3		ns
			Q2		48.9		
Fall Time	$t_f$	Q1		2.2		ns	
		Q2		7.4			

**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		0.8	1.2	V
			$T_J = 125^\circ\text{C}$			0.7		
		$V_{GS} = 0\text{V}$ , $I_S = 37\text{A}$	$T_J = 25^\circ\text{C}$	Q2		0.8	1.2	
			$T_J = 125^\circ\text{C}$			0.65		
Reverse Recovery Time	$t_{RR}$	$V_{GS} = 0\text{V}$ , Q1: $I_S = 20\text{A}$ , $dI/dt = 100\text{A}/\mu\text{s}$ Q2: $I_S = 37\text{A}$ , $dI/dt = 300\text{A}/\mu\text{s}$	Q1		21.4		ns	
			Q2		36.5			
Reverse Recovery Charge	$Q_{RR}$		Q1		8.3		nC	
			Q2		21.9			

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.

# NTMFD1D4N02P1E

## TYPICAL CHARACTERISTICS FOR Q1

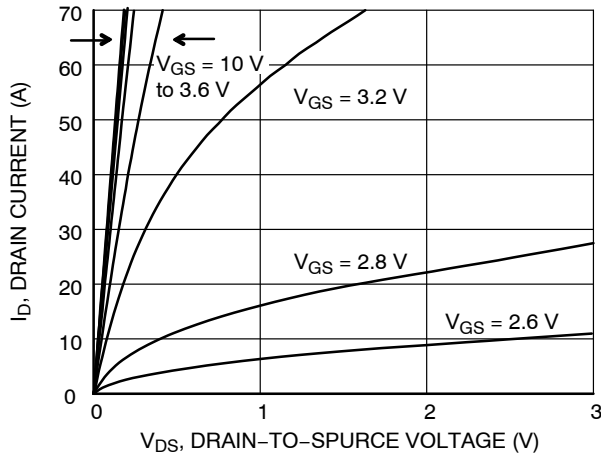


Figure 1. On-Region Characteristics

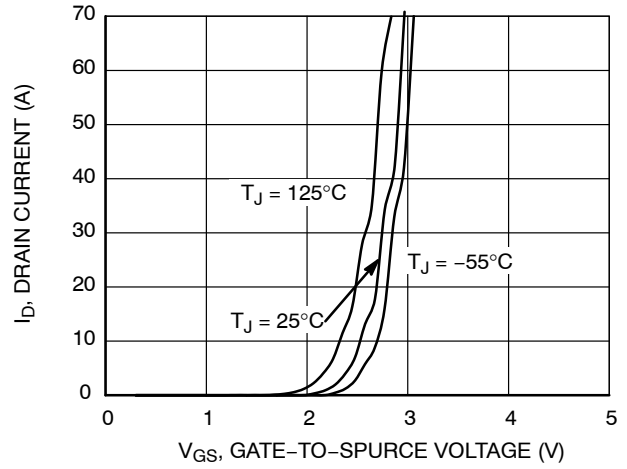


Figure 2. Transfer Characteristics

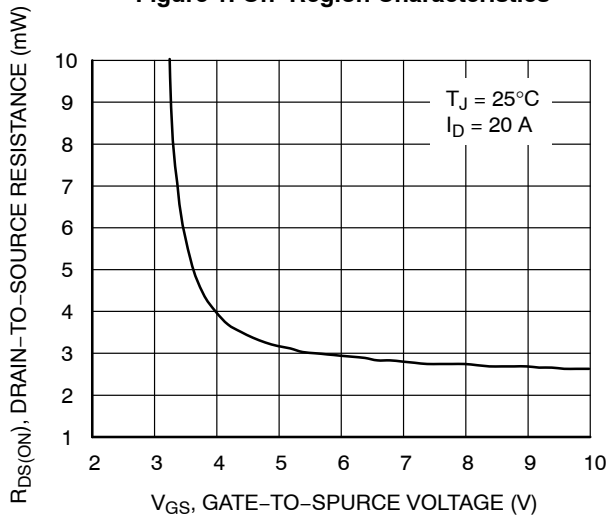


Figure 3. On-Resistance vs. Gate-to-Source Voltage

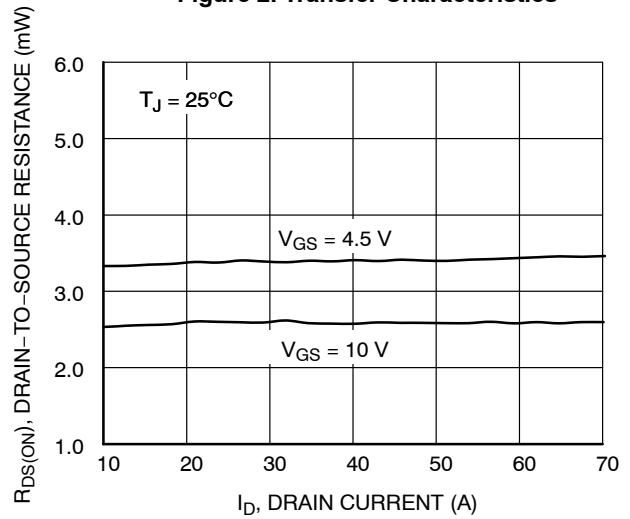


Figure 4. On-Resistance vs. Drain Current and Gate Voltage

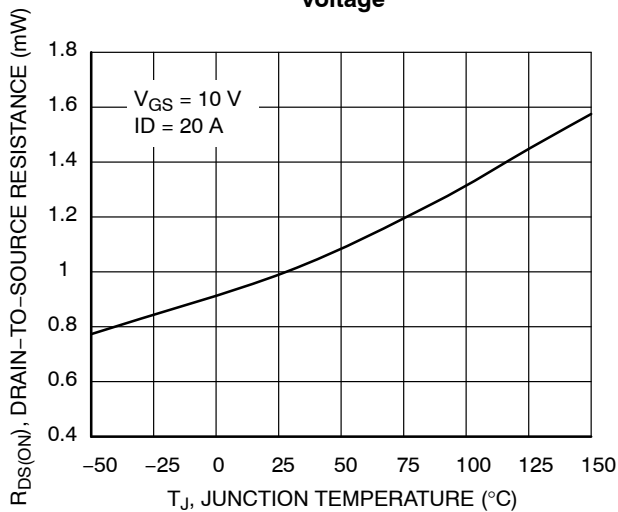


Figure 5. On-Resistance Variation with Temperature

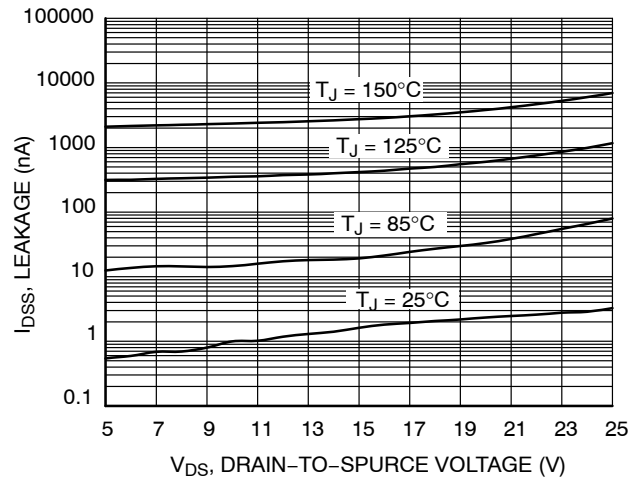
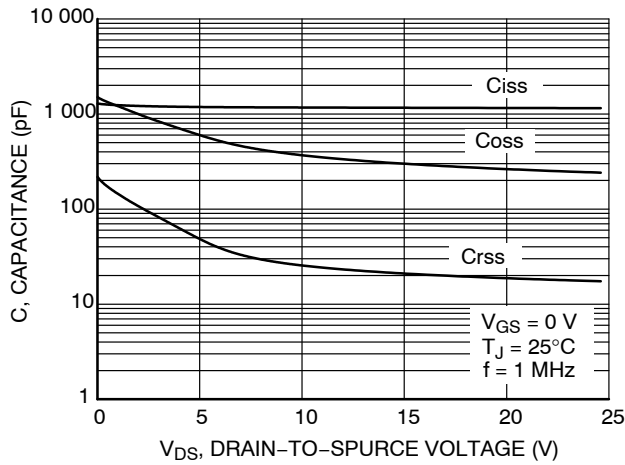


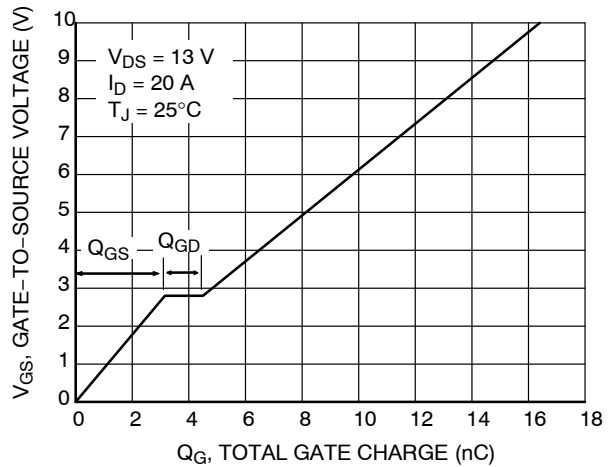
Figure 6. Drain-to-Source Leakage Current vs. Voltage

# NTMFD1D4N02P1E

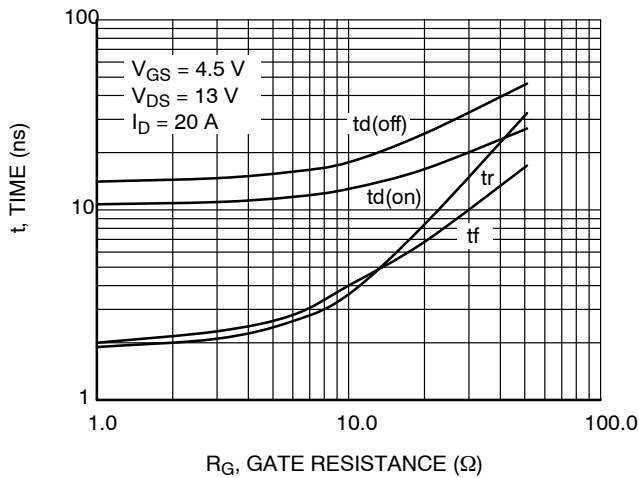
## TYPICAL CHARACTERISTICS FOR Q1 (continued)



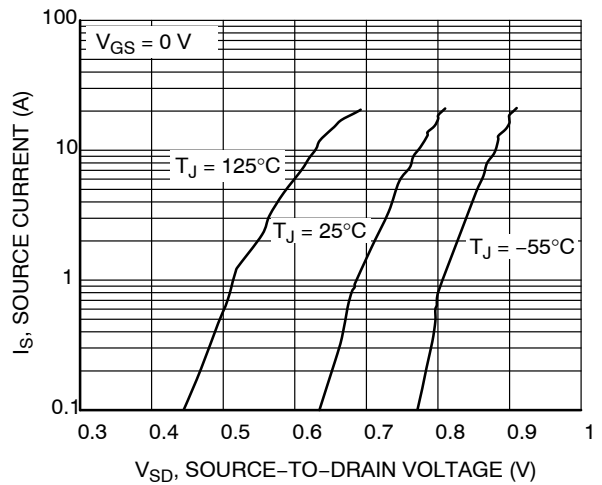
**Figure 7. Capacitance Variation**



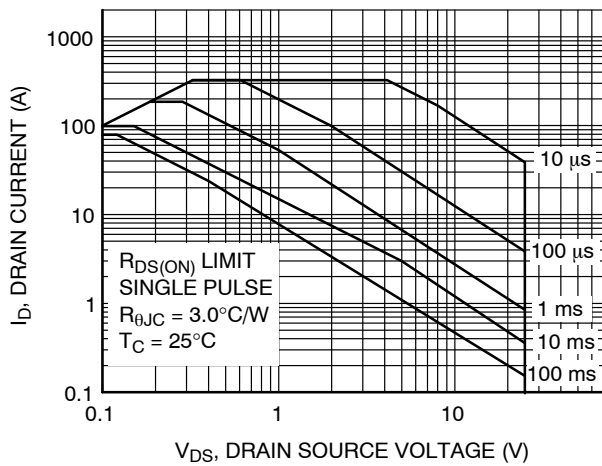
**Figure 8. Gate-to-Source vs. Total Charge**



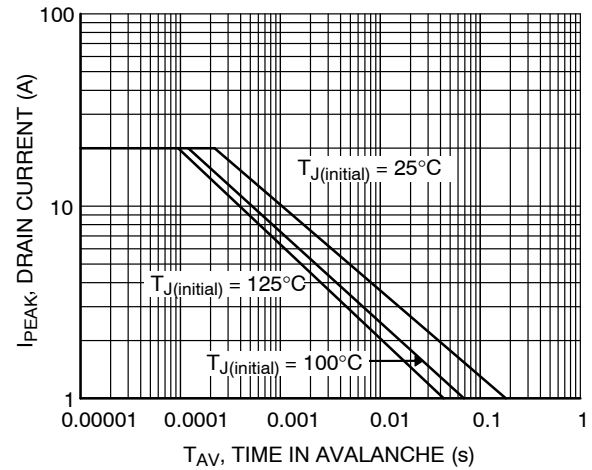
**Figure 9. Resistive Switching Time Variation vs. Gate Resistance**



**Figure 10. Diode Forward Voltage vs. Current**



**Figure 11. Maximum Rated Forward Biased Safe Operating Area**



**Figure 12. Maximum Drain Current vs. Time in Avalanche**

# NTMFD1D4N02P1E

## TYPICAL CHARACTERISTICS FOR Q1 (continued)

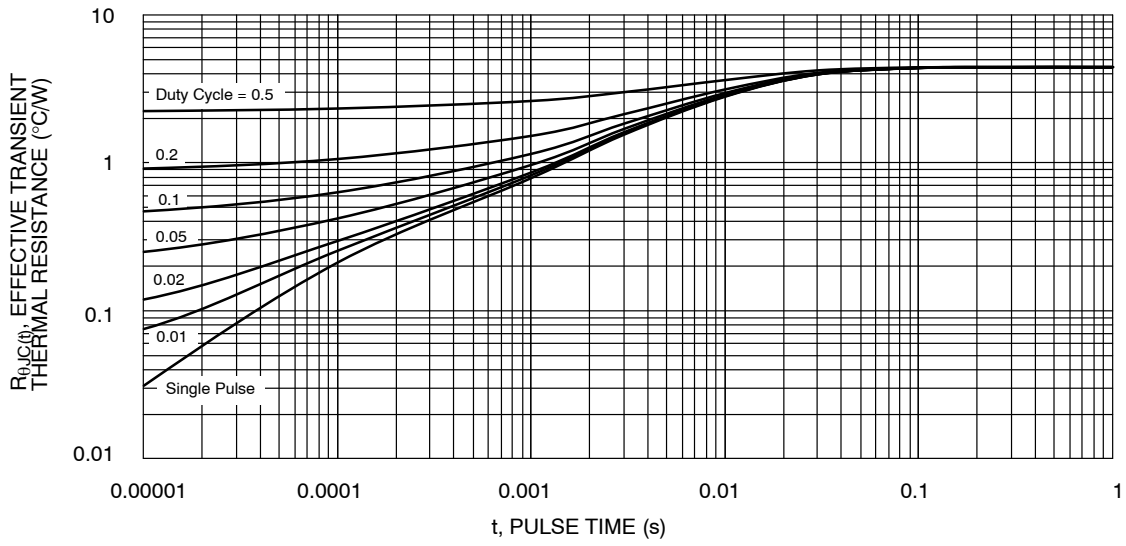


Figure 13. Thermal Response

# NTMFD1D4N02P1E

## TYPICAL CHARACTERISTICS FOR Q2

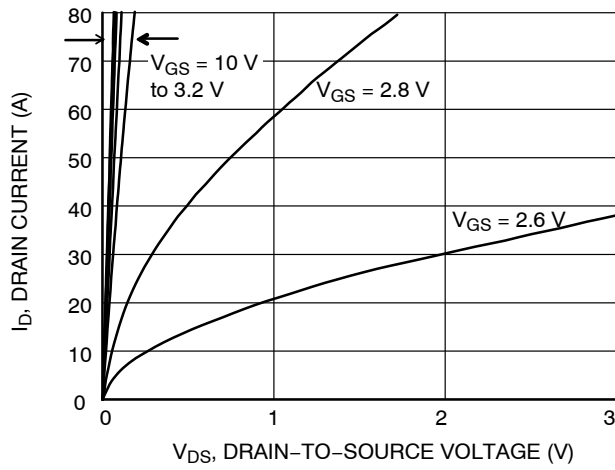


Figure 14. On-Region Characteristics

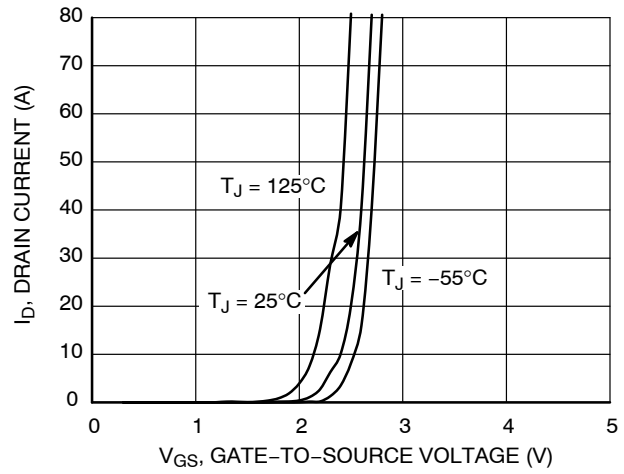


Figure 15. Transfer Characteristics

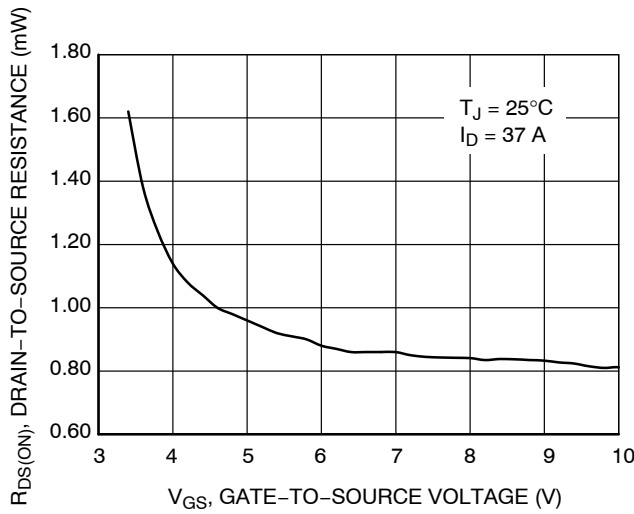


Figure 16. On-Resistance vs. Gate-to-Source Voltage

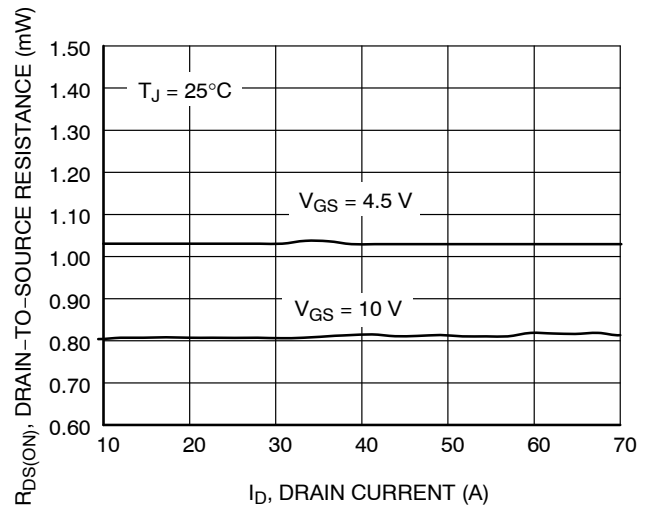


Figure 17. On-Resistance vs. Drain Current and Gate Voltage

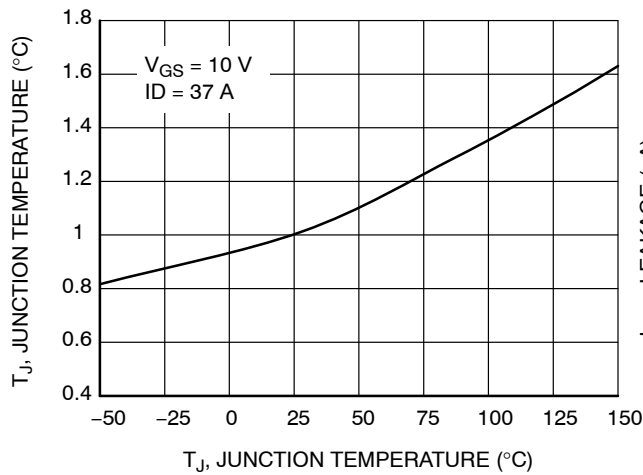


Figure 18. On-Resistance Variation with Temperature

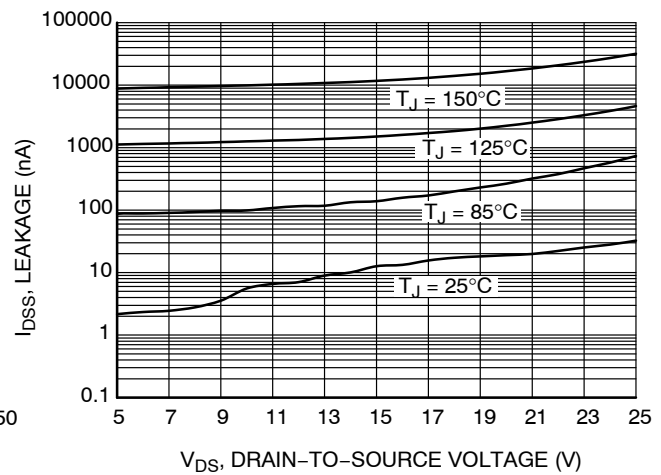


Figure 19. Drain-to-Source Leakage Current vs. Voltage

# NTMFD1D4N02P1E

## TYPICAL CHARACTERISTICS FOR Q2 (continued)

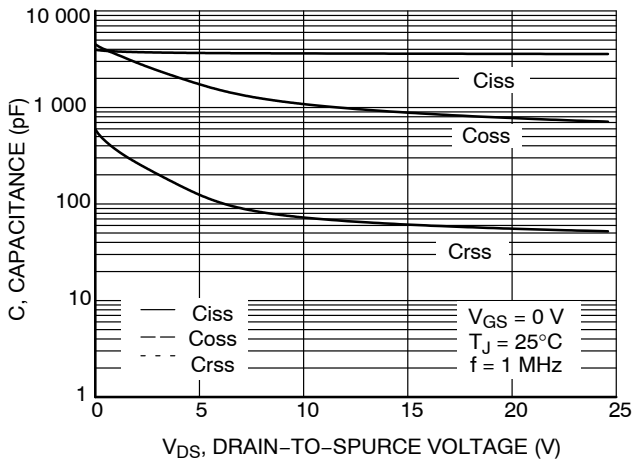


Figure 20. Capacitance Variation

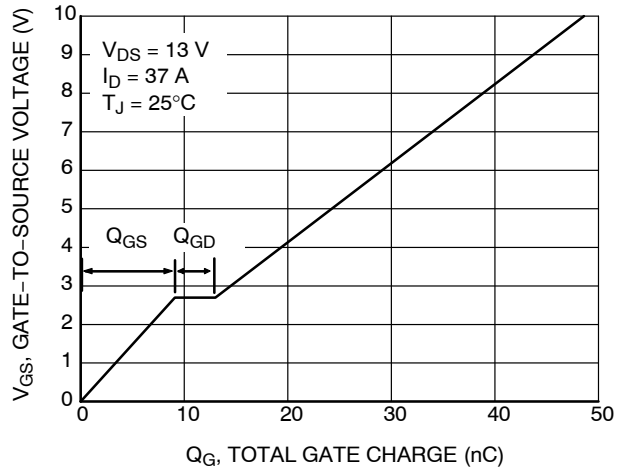


Figure 21. Gate-to-Source vs. Total Charge

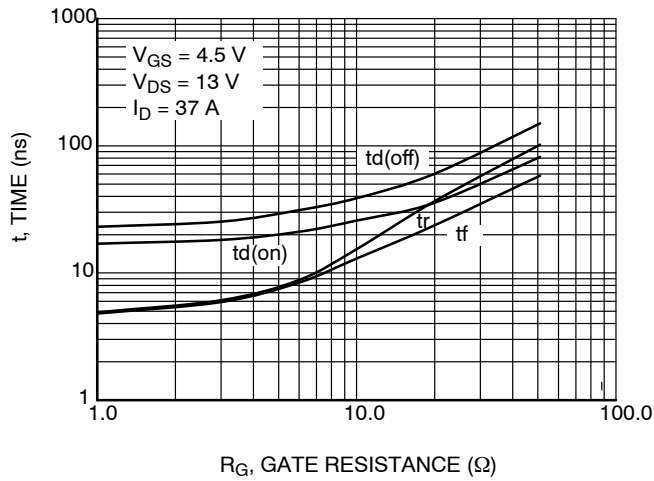


Figure 22. Resistive Switching Time Variation vs. Gate Resistance

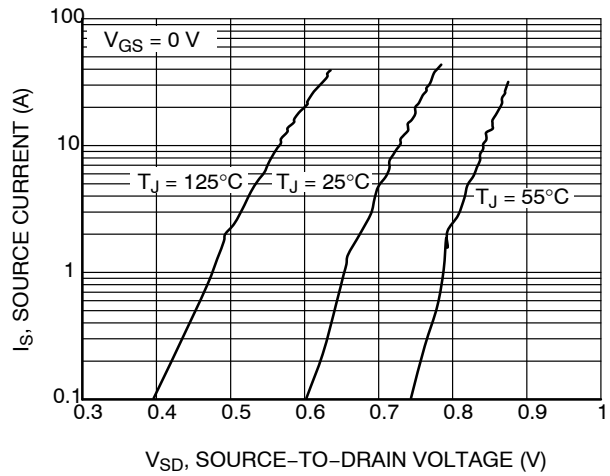


Figure 23. Diode Forward Voltage vs. Current

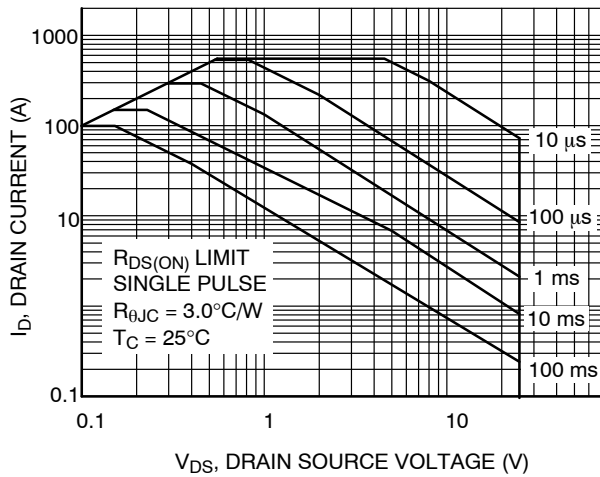


Figure 24. Maximum Rated Forward Biased Safe Operating Area

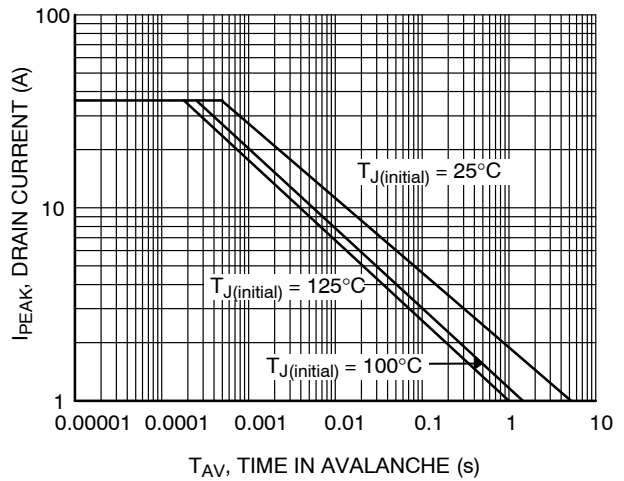


Figure 25. Maximum Drain Current vs. Time in Avalanche



# NTMFD1D4N02P1E

## TYPICAL CHARACTERISTICS FOR Q2 (continued)

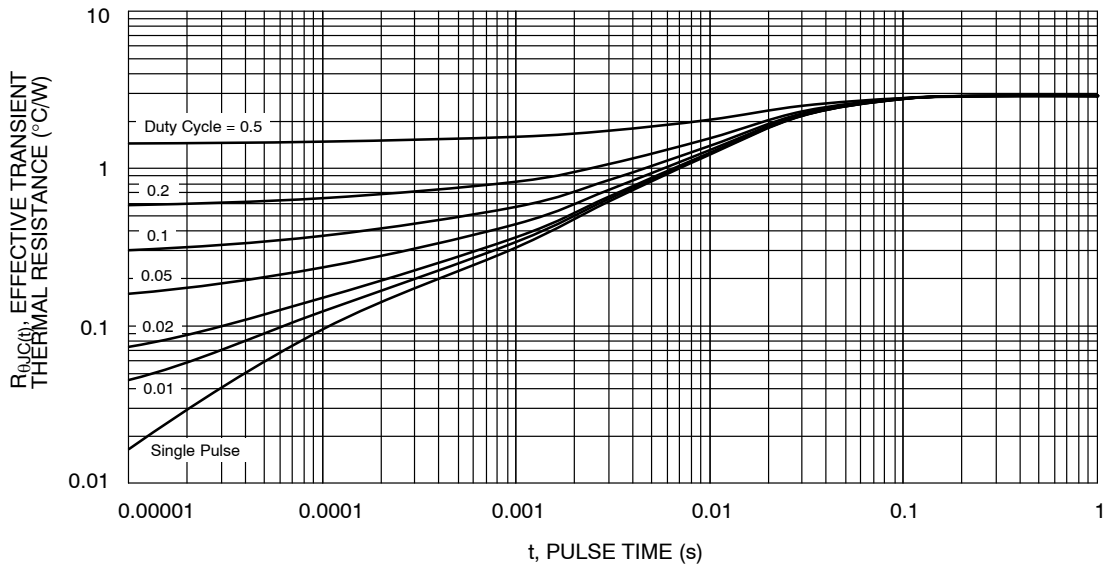
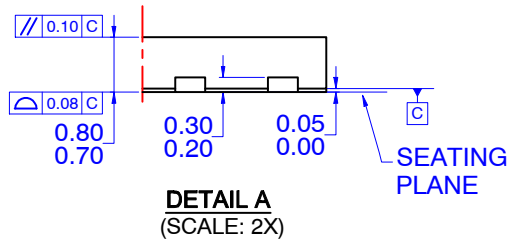
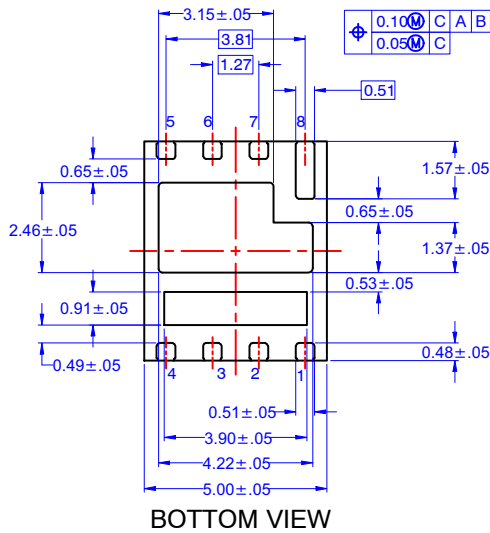
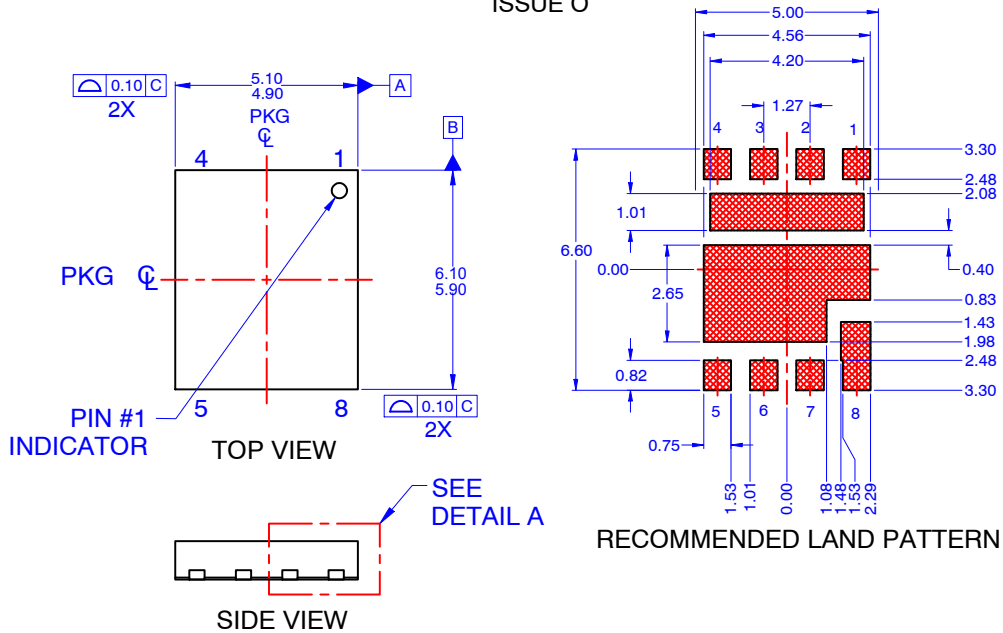


Figure 26. Thermal Response

# NTMFD1D4N02P1E


## PACKAGE DIMENSIONS

**PQFN8 5X6, 1.27P**  
**CASE 483AR**  
**ISSUE O**



### 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.

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