

MOSFET – Power, Dual, N-Channel, Power Trench, Power Clip, Asymmetric

25 V

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
		$T_C = 85^\circ\text{C}$		53	112
Power Dissipation $R_{\theta JA}$ (Note 3)		$T_A = 25^\circ\text{C}$	P_D	25	41
		$T_A = 85^\circ\text{C}$		14	26
Continuous Drain Current $R_{\theta JA}$ (Notes 1, 3)	Steady State	$T_A = 25^\circ\text{C}$	I_D	20	36
		$T_A = 85^\circ\text{C}$		14	26
Power Dissipation $R_{\theta JA}$ (Notes 1, 3)		$T_A = 25^\circ\text{C}$	P_D	2.1	2.3
		$T_A = 85^\circ\text{C}$		1.4	1.5
Continuous Drain Current $R_{\theta JA}$ (Notes 2, 3)	Steady State	$T_A = 25^\circ\text{C}$	I_D	13	24
		$T_A = 85^\circ\text{C}$		10	17
Power Dissipation $R_{\theta JA}$ (Notes 2, 3)		$T_A = 25^\circ\text{C}$	P_D	0.96	1.0
		$T_A = 85^\circ\text{C}$		0.72	0.85
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	$Q1: I_L = 9.4\ A_{pk}$, $L = 3\ \text{mH}$ (Note 4) $Q2: I_L = 20.1\ A_{pk}$, $L = 3\ \text{mH}$ (Note 4)	E_{AS}	134	604	mJ
Operating Junction and Storage Temperature Range	T_J , T_{stg}		-55 to 150		°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.



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

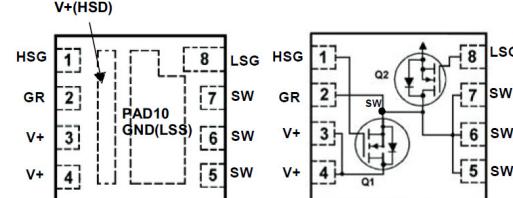


MARKING DIAGRAM



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.

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	$^{\circ}\text{C}/\text{W}$
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 $L = 0.1 \text{ mH}$, $I_{AS} = 16.5 \text{ A}$.
Q2 100% UIS tested at $L = 0.1 \text{ mH}$, $I_{AS} = 36 \text{ A}$.

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	$V_{(BR)DSS}$	$V_{GS} = 0 \text{ V}$, $I_D = 1 \text{ mA}$		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		16		$\text{mV}/^{\circ}\text{C}$
		$I_D = 1 \text{ mA}$, ref to 25°C		Q2		19		
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	
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	$V_{GS(\text{TH})}$	$V_{GS} = V_{DS}$, $I_D = 250 \mu\text{A}$	Q1	1.2	1.54	2.0	V
		$V_{GS} = V_{DS}$, $I_D = 800 \mu\text{A}$	Q2	1.2	1.55	2.0	
Threshold Temperature Coefficient	$V_{GS(\text{TH})} / T_J$	$I_D = 250 \mu\text{A}$, ref to 25°C	Q1		-4.3		$\text{mV}/^{\circ}\text{C}$
		$I_D = 800 \mu\text{A}$, ref to 25°C	Q2		-4.4		
Drain-to-Source On Resistance	$R_{DS(\text{on})}$	$V_{GS} = 10 \text{ V}$, $I_D = 20 \text{ A}$	Q1		2.6	3.3	$\text{m}\Omega$
		$V_{GS} = 4.5 \text{ V}$, $I_D = 18 \text{ A}$			3.4	4.2	
		$V_{GS} = 10 \text{ V}$, $I_D = 37 \text{ A}$	Q2		0.81	1.1	
		$V_{GS} = 4.5 \text{ V}$, $I_D = 33 \text{ A}$			1.04	1.33	
Forward Transconductance	g_{FS}	$V_{DS} = 5 \text{ V}$, $I_D = 20 \text{ A}$	Q1		125		
		$V_{DS} = 5 \text{ V}$, $I_D = 37 \text{ A}$	Q2		285		
Gate Resistance	R_G	$T_A = 25^{\circ}\text{C}$	Q1		0.44		Ω
			Q2		0.6		

CHARGES & CAPACITANCES

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

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								
Total Gate Charge	$Q_G(\text{TOT})$		Q1		7.2		nC	
			Q2		21.5			
Gate-to-Drain Charge	Q_{GD}	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		1.35		nC	
			Q2		3.9			
Gate-to-Source Charge	Q_{GS}		Q1		3.15		nC	
			Q2		9.1			
Total Gate Charge	$Q_G(\text{TOT})$	$V_{GS} = 10\text{V}$, $V_{DS} = 13\text{V}$, $I_D = 20\text{A}$	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	$t_d(\text{ON})$		Q1		11.6		ns	
			Q2		21.4			
Rise Time	$t_r(\text{ON})$	$V_{GS} = 4.5\text{V}$ 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		2.7		ns	
			Q2		8.7			
Turn-Off Delay Time	$t_d(\text{OFF})$		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	$t_d(\text{ON})$		Q1		7.9		ns	
			Q2		10.2			
Rise Time	$t_r(\text{ON})$	$V_{GS} = 10\text{V}$ 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		1.1		ns	
			Q2		3.3			
Turn-Off Delay Time	$t_d(\text{OFF})$		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: $I_S = 20\text{A}$, $dl/dt = 100\text{A}/\mu\text{s}$ Q2: $I_S = 37\text{A}$, $dl/dt = 300\text{A}/\mu\text{s}$	Q1		21.4		ns	
			Q2		36.5			
Reverse Recovery Charge	Q_{RR}		Q1		8.3		nC	
			Q2		21.9			

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

TYPICAL CHARACTERISTICS FOR Q1

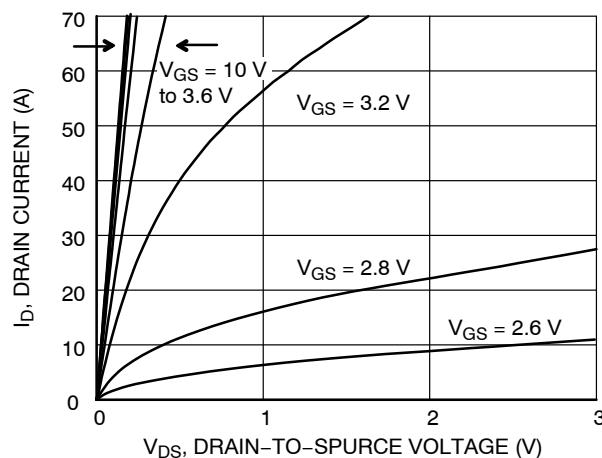


Figure 1. On-Region Characteristics

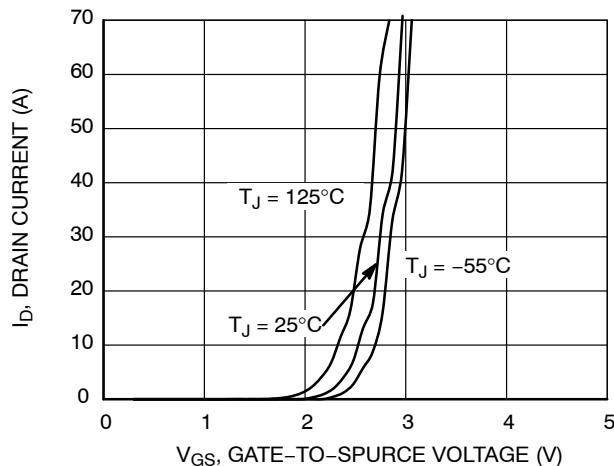


Figure 2. Transfer Characteristics

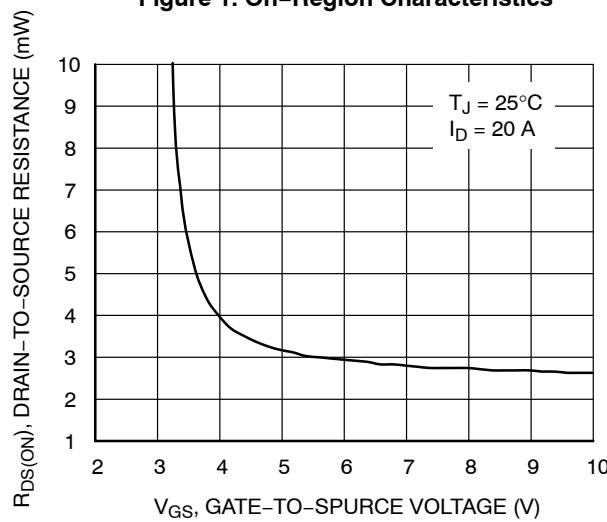


Figure 3. On-Resistance vs. Gate-to-Source Voltage

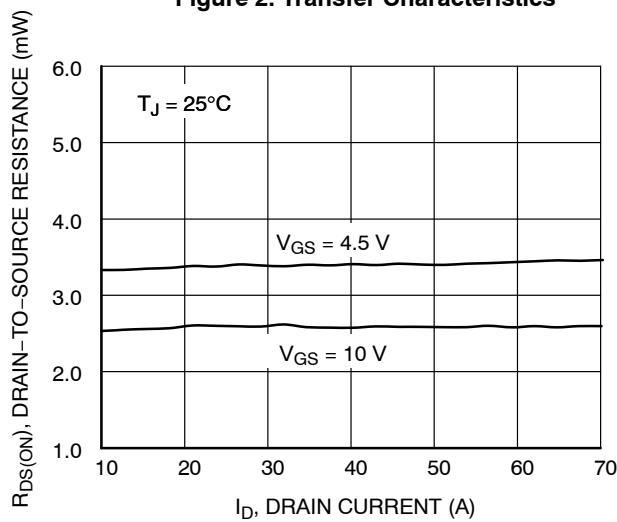


Figure 4. On-Resistance vs. Drain Current and Gate Voltage

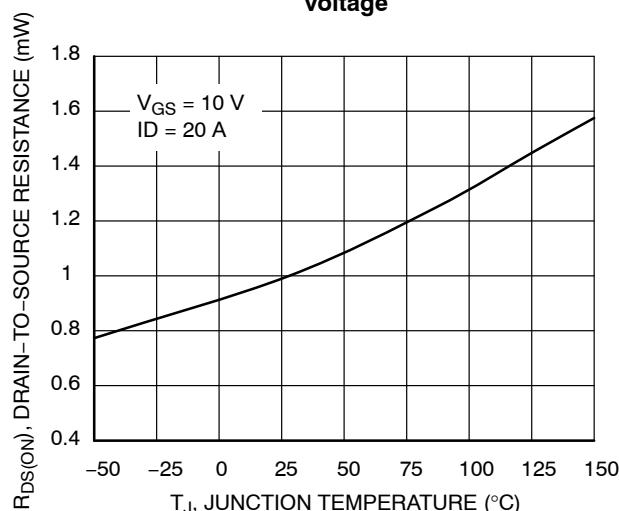


Figure 5. On-Resistance Variation with Temperature

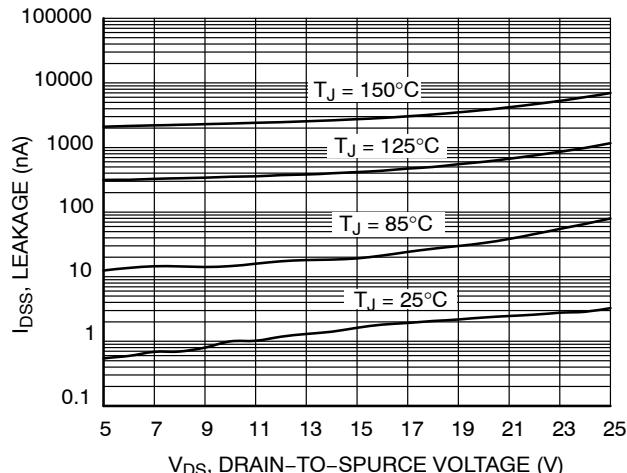


Figure 6. Drain-to-Source Leakage Current vs. Voltage

TYPICAL CHARACTERISTICS FOR Q1 (continued)

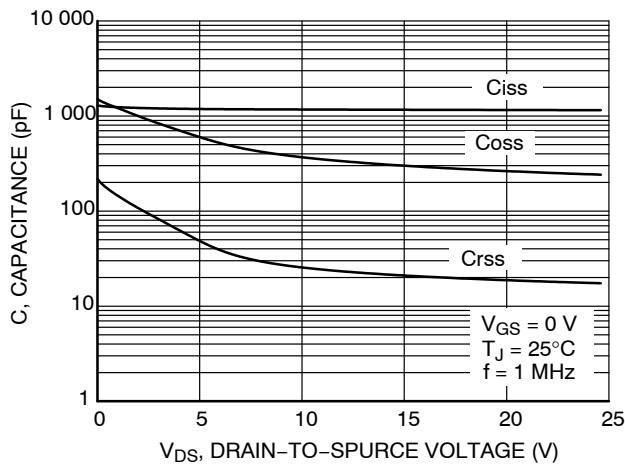


Figure 7. Capacitance Variation

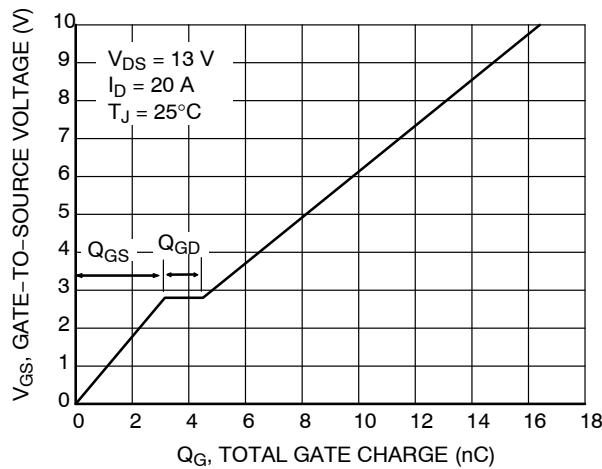


Figure 8. Gate-to-Source vs. Total Charge

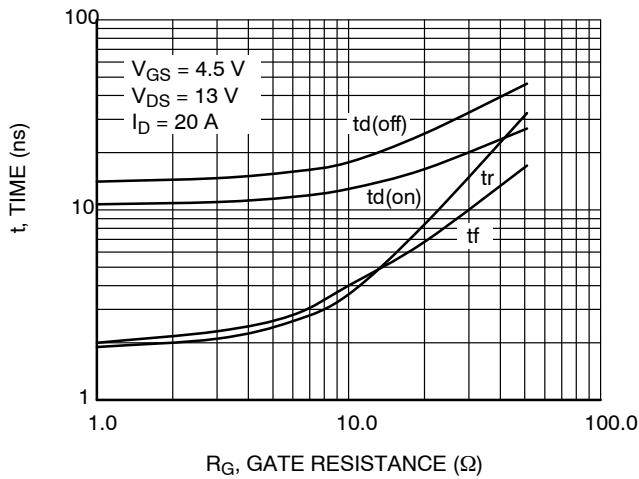


Figure 9. Resistive Switching Time Variation vs. Gate Resistance

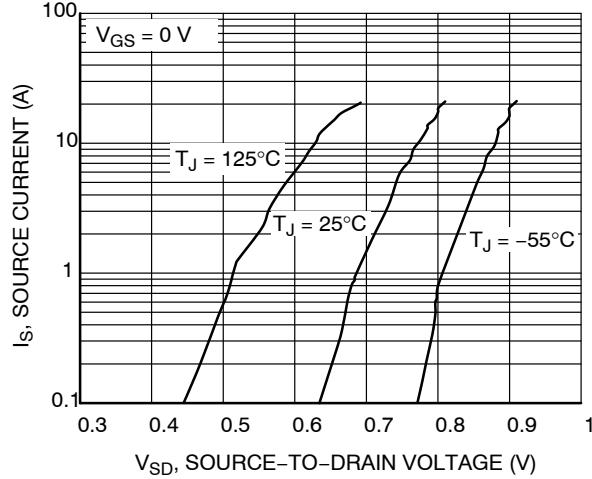


Figure 10. Diode Forward Voltage vs. Current

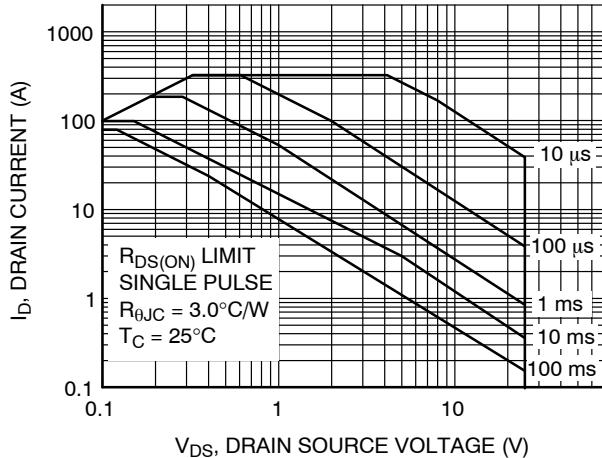


Figure 11. Maximum Rated Forward Biased Safe Operation Area

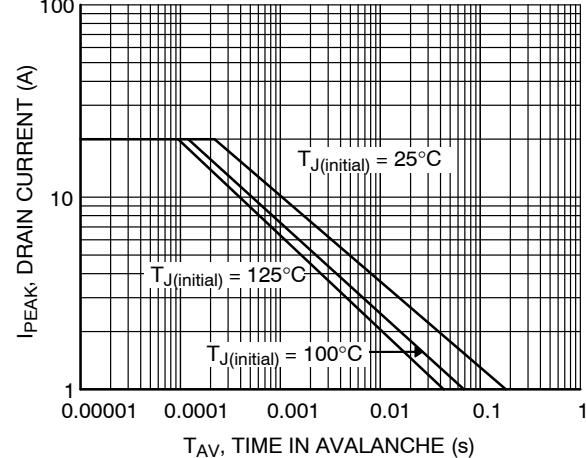


Figure 12. Maximum Drain Current vs. Time in Avalanche

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TYPICAL CHARACTERISTICS FOR Q1 (continued)

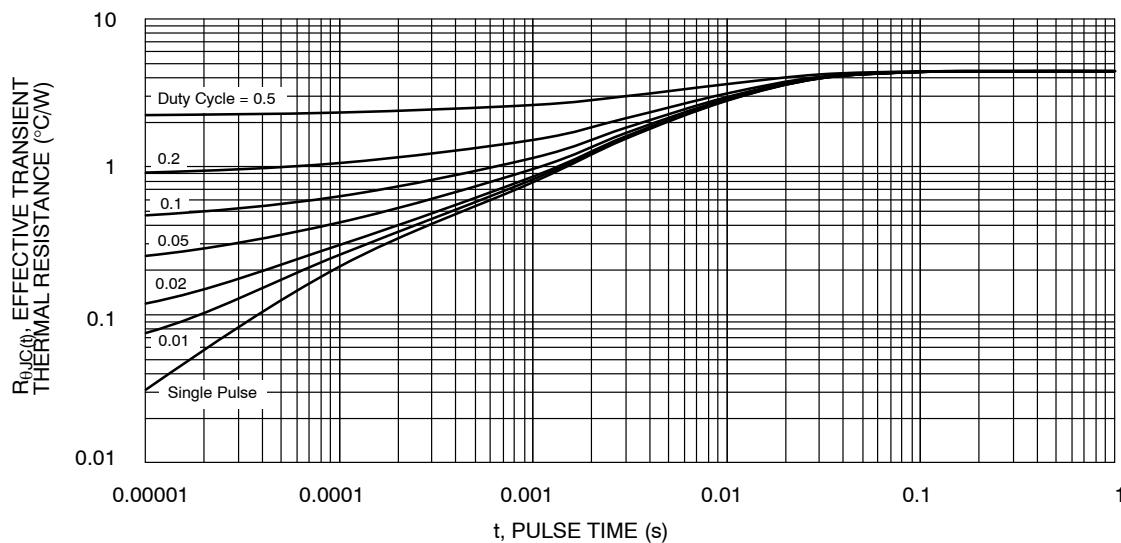
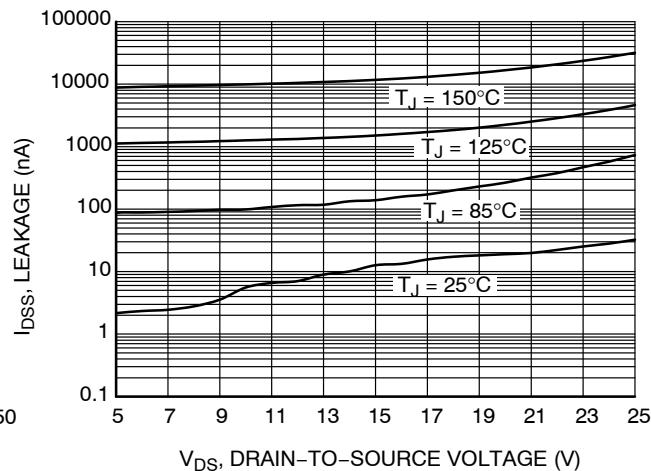
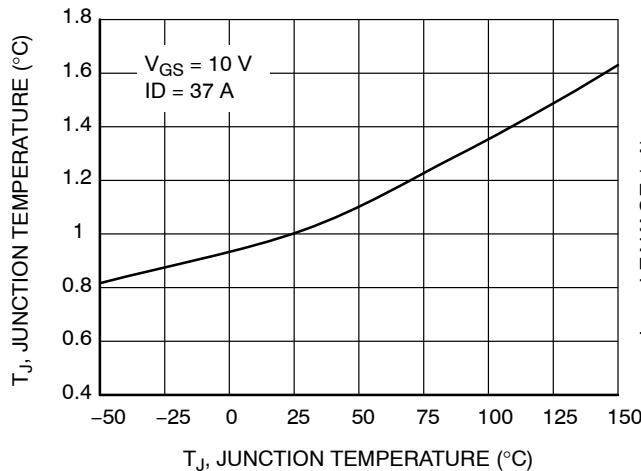
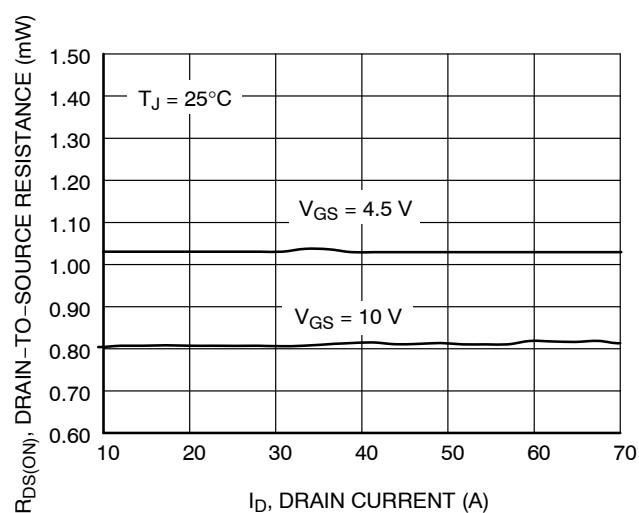
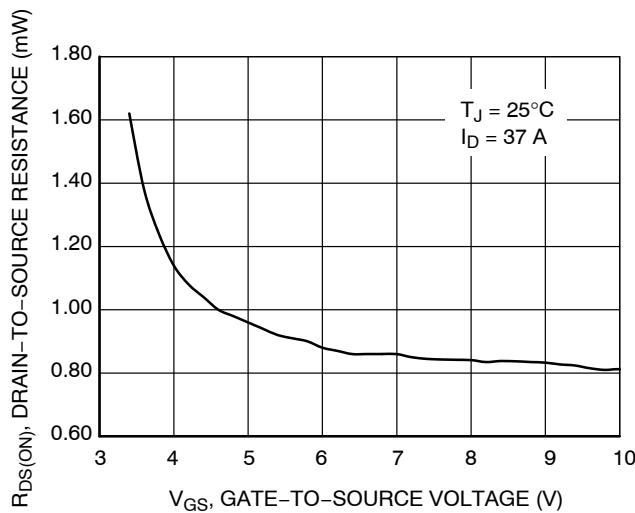
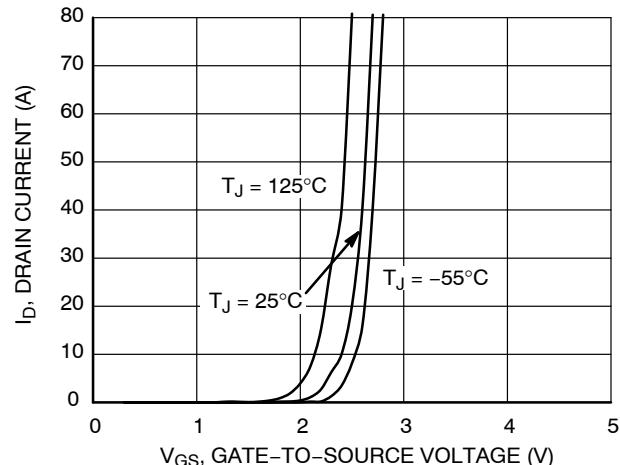
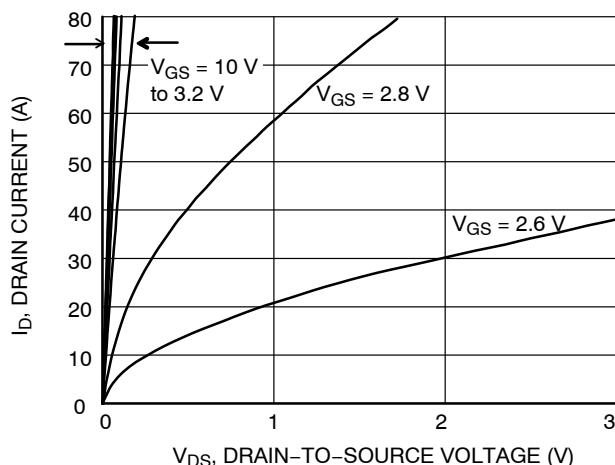


Figure 13. Thermal Response

TYPICAL CHARACTERISTICS FOR Q2



TYPICAL CHARACTERISTICS FOR Q2 (continued)

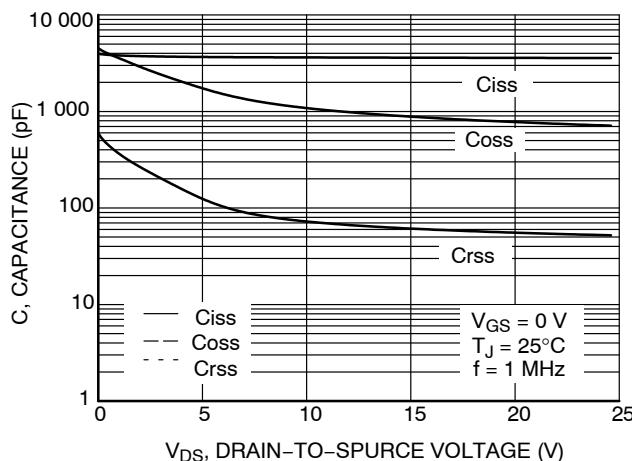


Figure 20. Capacitance Variation

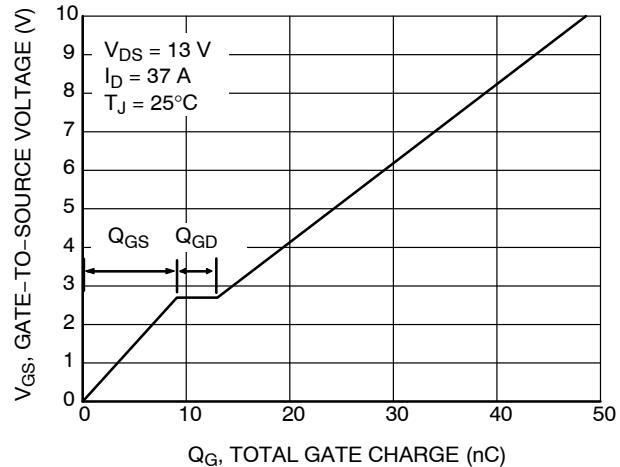


Figure 21. Gate-to-Source vs. Total Charge

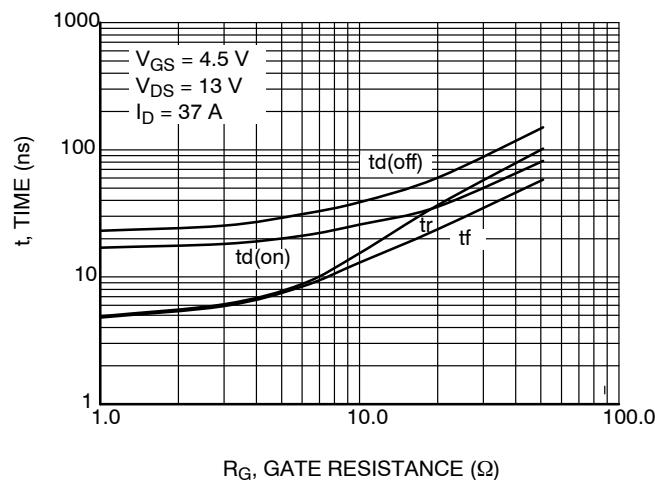


Figure 22. Resistive Switching Time Variation vs. Gate Resistance

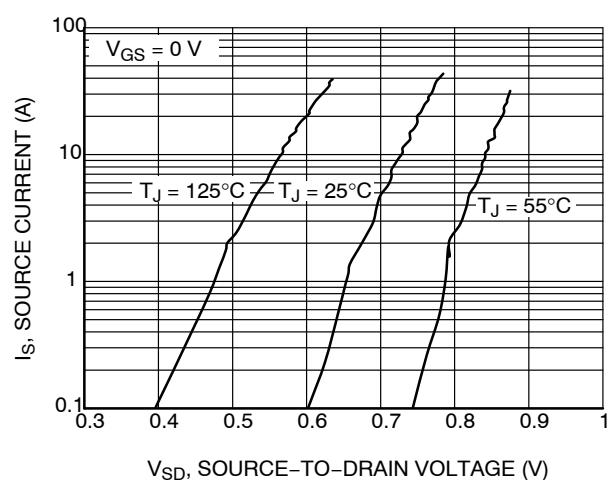


Figure 23. Diode Forward Voltage vs. Current

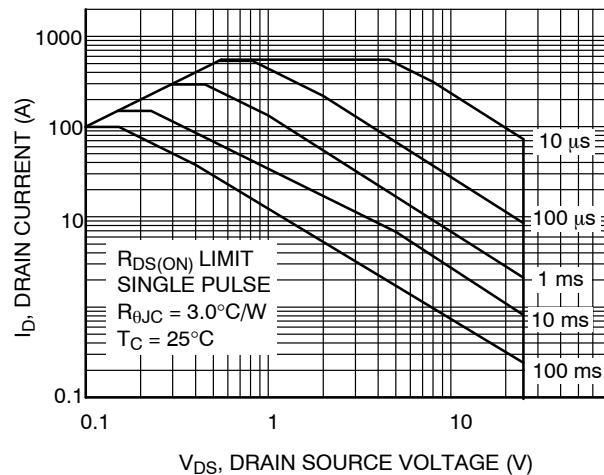


Figure 24. Maximum Rated Forward Biased Safe Operating Area

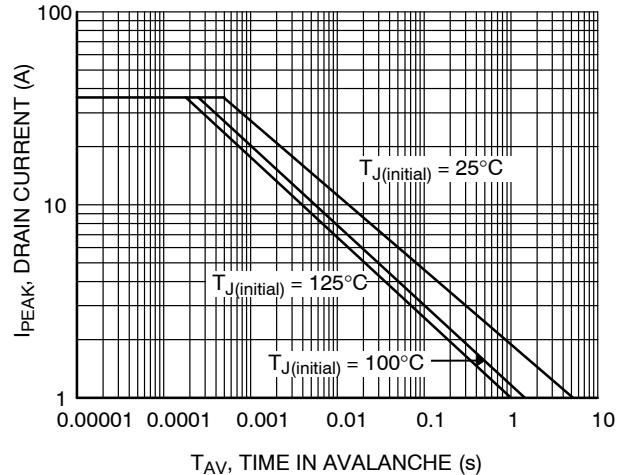
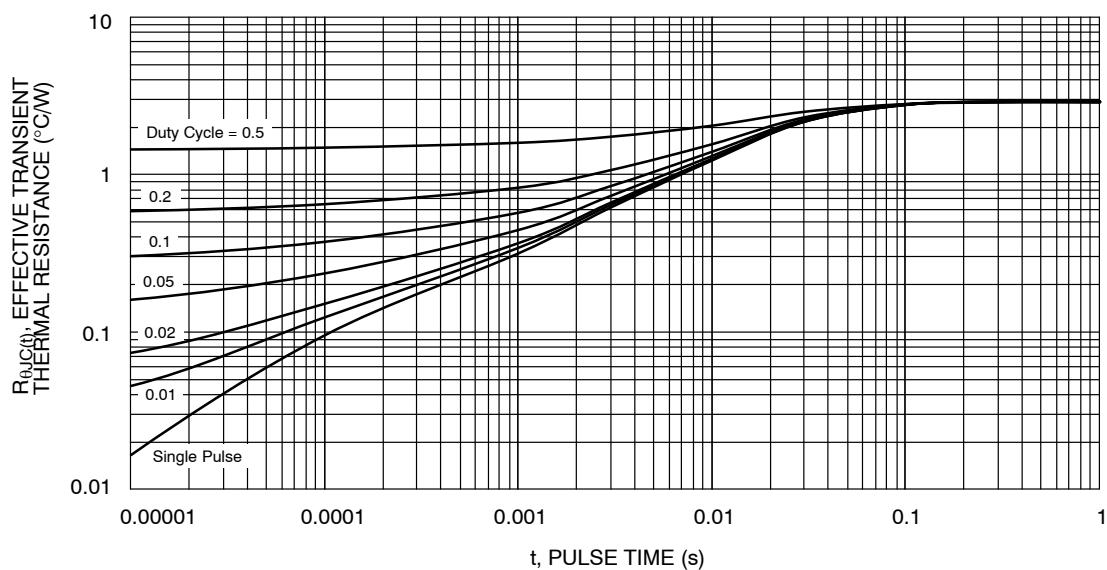
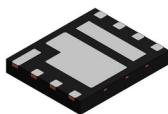
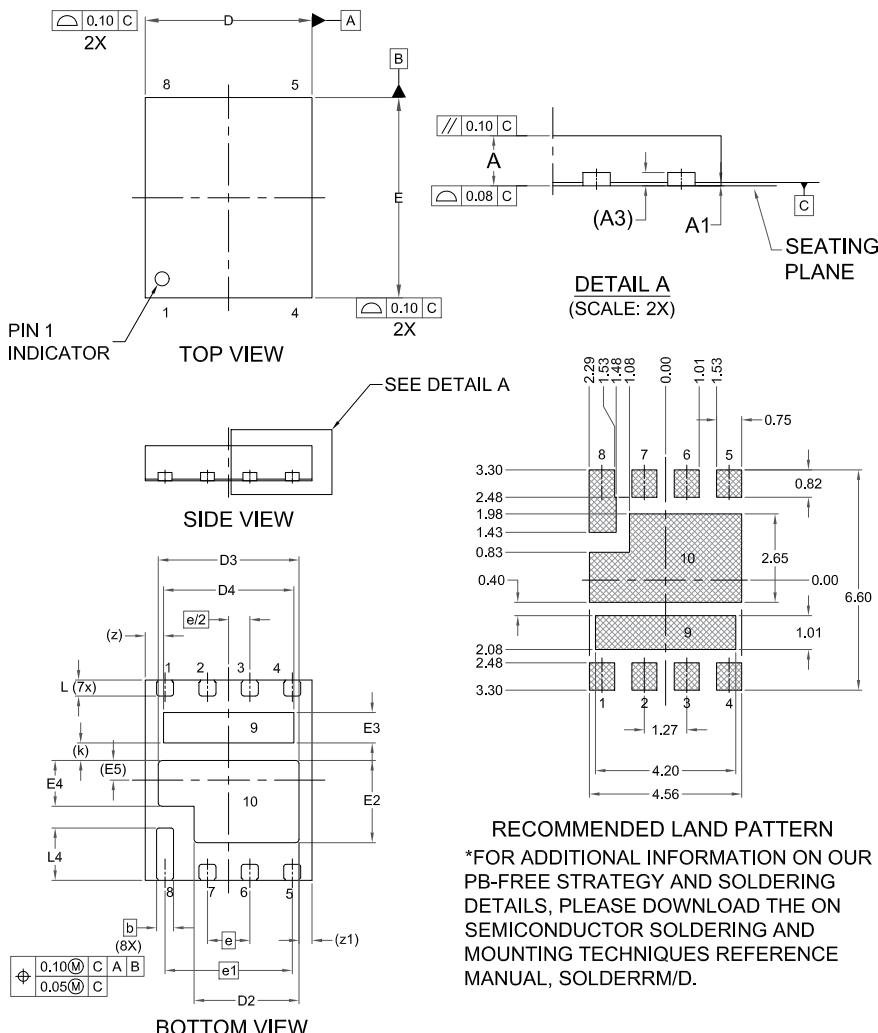


Figure 25. Maximum Drain Current vs. Time in Avalanche

TYPICAL CHARACTERISTICS FOR Q2 (continued)**Figure 26. Thermal Response**


PQFN8 5.00x6.00x0.75, 1.27P
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RECOMMENDED LAND PATTERN
 *FOR ADDITIONAL INFORMATION ON OUR
 PB-FREE STRATEGY AND SOLDERING
 DETAILS, PLEASE DOWNLOAD THE ON
 SEMICONDUCTOR SOLDERING AND
 MOUNTING TECHNIQUES REFERENCE
 MANUAL, SOLDERRM/D.

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.

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
E5	0.59 REF		
e	1.27 BSC		
e/2	0.635 BSC		
e1	3.81 BSC		
k	0.52 REF		
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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