

# MOSFET - PowerTrench®

## Power Clip, Asymmetric, Dual N-Channel

### 30 V

## NTMFD2D4N03P8

### General Description

This device includes two specialized N-Channel MOSFETs in a dual package. The switch node has been internally connected to enable easy placement and routing of synchronous buck converters. The control MOSFET (Q1) and synchronous SyncFET (Q2) have been designed to provide optimal power efficiency.

### Features

Q1: N-Channel

- Max  $r_{DS(on)}$  = 5.0 m $\Omega$  at  $V_{GS}$  = 10 V,  $I_D$  = 17 A
- Max  $r_{DS(on)}$  = 6.5 m $\Omega$  at  $V_{GS}$  = 4.5 V,  $I_D$  = 14 A

Q2: N-Channel

- Max  $r_{DS(on)}$  = 2.4 m $\Omega$  at  $V_{GS}$  = 10 V,  $I_D$  = 25 A
- Max  $r_{DS(on)}$  = 3.0 m $\Omega$  at  $V_{GS}$  = 4.5 V,  $I_D$  = 22 A
- Low Inductance Packaging Shortens Rise/Fall Times, Resulting in Lower Switching Losses
- MOSFET Integration Enables Optimum Layout for Lower Circuit Inductance and Reduced Switch Node Ringing
- These Devices are Pb-Free, Halogen Free/BFR Free and are RoHS Compliant

### Applications

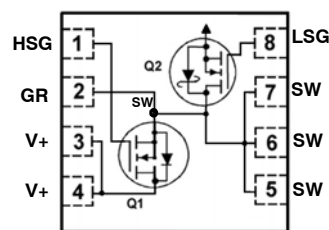
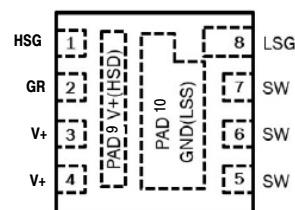
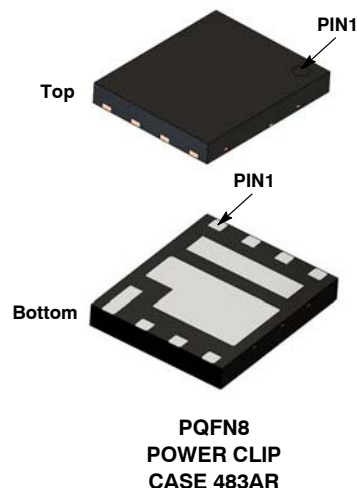
- Computing
- Communications
- General Purpose Point of Load

Pin	Name	Description
1	HSG	High Side Gate
2	GR	Gate Return
3, 4, 9	V+(HSD)	High Side Drain
5, 6, 7	SW	Switching Node, Low Side Drain
8	LSG	Low Side Gate
10	GND(LSS)	Low Side Source



ON Semiconductor®

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### ORDERING INFORMATION

See detailed ordering and shipping information on page 3 of this data sheet.



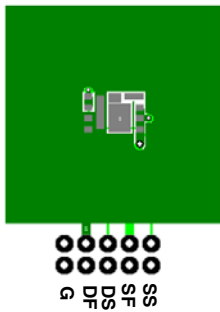
# NTMFD2D4N03P8

**Table 1. MOSFET MAXIMUM RATINGS**  $T_A = 25^\circ\text{C}$  unless otherwise noted.

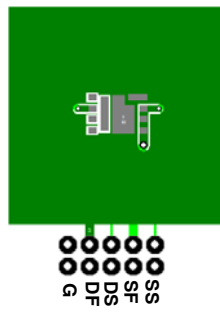
Symbol	Parameter	Q1	Q2	Units
$V_{DS}$	Drain to Source Voltage	30	30	V
$B_{VDDST}$	$B_{VDDST}$ (transient) < 100 ns	36	36	V
$V_{GS}$	Gate to Source Voltage	$\pm 20$	$\pm 12$	V
$I_D$	Drain Current – Continuous $T_C = 25^\circ\text{C}$ (Note 1)	56	84	A
	– Continuous $T_C = 100^\circ\text{C}$ (Note 1)	35	53	
	– Continuous $T_A = 25^\circ\text{C}$	17 (Note 4)	25 (Note 5)	
	– Pulsed $T_A = 25^\circ\text{C}$ (Note 2)	227	503	
$E_{AS}$	Single Pulse Avalanche Energy (Note 3)	54	96	mJ
$P_D$	Power Dissipation for Single Operation $T_C = 25^\circ\text{C}$	23	25	W
	Power Dissipation for Single Operation $T_A = 25^\circ\text{C}$	2.1 (Note 4)	2.3 (Note 5)	
	Power Dissipation for Single Operation $T_A = 25^\circ\text{C}$	1.0 (Note 6)	1.1 (Note 7)	
$T_J, T_{STG}$	Operating and Storage Junction Temperature Range	$-55$ to $+150$		$^\circ\text{C}$

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.

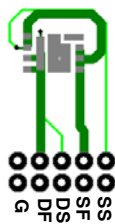
1. Computed continuous current limited to Max Junction Temperature only, actual continuous current will be limited by thermal & electro-mechanical application board design.
2. Pulsed  $I_D$  refer to Figure 11 and Figure 24 SOA curve for more details.
3. Q1 :EAS of 54 mJ is based on starting  $T_J = 25^\circ\text{C}$ ;  $L = 3$  mH,  $I_{AS} = 6$  A,  $V_{DD} = 30$  V,  $V_{GS} = 10$  V. 100% tested at  $L = 0.1$  mH,  $I_{AS} = 20$  A.  
Q2: EAS of 96 mJ is based on starting  $T_J = 25^\circ\text{C}$ ;  $L = 3$  mH,  $I_{AS} = 8$  A,  $V_{DD} = 30$  V,  $V_{GS} = 10$  V. 100% tested at  $L = 0.1$  mH,  $I_{AS} = 27$  A.



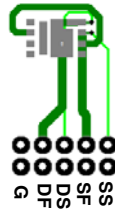
4.  $60^\circ\text{C/W}$  when mounted on a  $1\text{ in}^2$  pad of 2 oz copper



5.  $55^\circ\text{C/W}$  when mounted on a  $1\text{ in}^2$  pad of 2 oz copper



6.  $130^\circ\text{C/W}$  when mounted on a  $1\text{ in}^2$  pad of 2 oz copper



7.  $120^\circ\text{C/W}$  when mounted on a  $1\text{ in}^2$  pad of 2 oz copper



# NTMFD2D4N03P8

**Table 2. PACKAGE MARKING AND ORDERING INFORMATION**

Device Marking	Device	Package	Reel Size	Tape Width	Quantity
D2D4	NTMFD2D4N03P8	Power Clip 56	13"	12 mm	3000 units

**Table 3. THERMAL CHARACTERISTICS**

$R_{\theta JC}$	Thermal Resistance, Junction to Case	5.6	4.3	$^{\circ}\text{C}/\text{W}$
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	60 (Note 8)	55 (Note 8)	
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	130 (Note 8)	120 (Note 8)	

8.  $R_{\theta JA}$  is determined with the device mounted on a 1 in<sup>2</sup> pad 2 oz copper pad on a 1.5 x 1.5 in. board of FR-4 material,  $R_{\theta CA}$  is determined by the user's board design.

**Table 4. ELECTRICAL CHARACTERISTICS**  $T_J = 25^{\circ}\text{C}$  unless otherwise noted.

Symbol	Parameter	Test Conditions	Type	Min	Typ	Max	Units
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## OFF CHARACTERISTICS

$BV_{DSS}$	Drain to Source Breakdown Voltage	$I_D = 250 \mu\text{A}$ , $V_{GS} = 0 \text{ V}$ $I_D = 1 \text{ mA}$ , $V_{GS} = 0 \text{ V}$	Q1 Q2	30 30			V
$\Delta BV_{DSS} / \Delta T_J$	Breakdown Voltage Temperature Coefficient	$I_D = 250 \mu\text{A}$ , referenced to $25^{\circ}\text{C}$ $I_D = 10 \text{ mA}$ , referenced to $25^{\circ}\text{C}$	Q1 Q2		15 16		mV/ $^{\circ}\text{C}$
$I_{DSS}$	Zero Gate Voltage Drain Current	$V_{DS} = 24 \text{ V}$ , $V_{GS} = 0 \text{ V}$ $V_{DS} = 24 \text{ V}$ , $V_{GS} = 0 \text{ V}$	Q1 Q2			1 500	$\mu\text{A}$ $\mu\text{A}$
$I_{GSS}$	Gate to Source Leakage Current, Forward	$V_{GS} = 20 \text{ V}$ , $V_{DS} = 0 \text{ V}$ $V_{GS} = 12 \text{ V}$ , $V_{DS} = 0 \text{ V}$	Q1 Q2			100 100	nA nA

## ON CHARACTERISTICS

$V_{GS(th)}$	Gate to Source Threshold Voltage	$V_{GS} = V_{DS}$ , $I_D = 250 \mu\text{A}$ $V_{GS} = V_{DS}$ , $I_D = 1 \text{ mA}$	Q1 Q2	1.0 1.0	1.7 1.6	3.0 3.0	V
$\Delta V_{GS(th)} / \Delta T_J$	Gate to Source Threshold Voltage Temperature Coefficient	$I_D = 250 \mu\text{A}$ , referenced to $25^{\circ}\text{C}$ $I_D = 10 \text{ mA}$ , referenced to $25^{\circ}\text{C}$	Q1 Q2		-5 -3		mV/ $^{\circ}\text{C}$
$r_{DS(on)}$	Drain to Source On Resistance	$V_{GS} = 10 \text{ V}$ , $I_D = 17 \text{ A}$ $V_{GS} = 4.5 \text{ V}$ , $I_D = 14 \text{ A}$ $V_{GS} = 10 \text{ V}$ , $I_D = 17 \text{ A}$ , $T_J = 125^{\circ}\text{C}$	Q1 Q2		4.1 5.4 5.7	5.0 6.5 7.0	m $\Omega$
$g_{FS}$	Forward Transconductance	$V_{DS} = 5 \text{ V}$ , $I_D = 17 \text{ A}$ $V_{DS} = 5 \text{ V}$ , $I_D = 25 \text{ A}$	Q1 Q2		93 139		S

## DYNAMIC CHARACTERISTICS

$C_{iss}$	Input Capacitance	Q1: $V_{DS} = 15 \text{ V}$ , $V_{GS} = 0 \text{ V}$ , $f = 1 \text{ MHz}$ Q2: $V_{DS} = 15 \text{ V}$ , $V_{GS} = 0 \text{ V}$ , $f = 1 \text{ MHz}$	Q1 Q2		1224 2730	1715 3825	pF
$C_{oss}$	Output Capacitance		Q1 Q2		397 801	560 1125	pF
$C_{rss}$	Reverse Transfer Capacitance		Q1 Q2		42 72	60 100	pF
$R_g$	Gate Resistance		Q1 Q2	0.1 0.1	0.5 1.1	1.5 2.2	$\Omega$

## SWITCHING CHARACTERISTICS

$t_{d(on)}$	Turn-On Delay Time	Q1: $V_{DD} = 15 \text{ V}$ , $I_D = 17 \text{ A}$ , $R_{GEN} = 6 \Omega$ Q2: $V_{DD} = 15 \text{ V}$ , $I_D = 25 \text{ A}$ , $R_{GEN} = 6 \Omega$	Q1 Q2		8 10	16 19	ns
$t_r$	Rise Time		Q1 Q2		2 4	10 10	ns
$t_{d(off)}$	Turn-Off Delay Time		Q1 Q2		18 30	33 48	ns
$t_f$	Fall Time		Q1 Q2		2 3	10 10	ns



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**Table 4. ELECTRICAL CHARACTERISTICS**  $T_J = 25^\circ\text{C}$  unless otherwise noted.

Symbol	Parameter	Test Conditions	Type	Min	Typ	Max	Units
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## SWITCHING CHARACTERISTICS

$Q_g$	Total Gate Charge	$V_{GS} = 0\text{ V to }10\text{ V}$	Q1 $V_{DD} = 15\text{ V},$ $I_D = 17\text{ A}$  Q2 $V_{DD} = 15\text{ V},$ $I_D = 25\text{ A}$	Q1		17	24	nC
$Q_g$	Total Gate Charge	$V_{GS} = 0\text{ V to }4.5\text{ V}$		Q2		39	55	
$Q_{gs}$	Gate to Source Gate Charge			Q1		8	11	nC
$Q_{gd}$	Gate to Drain "Miller" Charge			Q2		18	26	
				Q1		3.1		nC
				Q2		6.1		
				Q1		2.0		nC
				Q2		4.3		

## DRAIN-SOURCE DIODE CHARACTERISTICS

$V_{SD}$	Source to Drain Diode Forward Voltage	$V_{GS} = 0\text{ V}, I_S = 17\text{ A (Note 9)}$ $V_{GS} = 0\text{ V}, I_S = 25\text{ A (Note 9)}$	Q1 Q2		0.8 0.8	1.2 1.2	V
$t_{rr}$	Reverse Recovery Time	Q1 $I_F = 17\text{ A}, di/dt = 100\text{ A}/\mu\text{s}$ Q2 $I_F = 25\text{ A}, di/dt = 230\text{ A}/\mu\text{s}$	Q1 Q2		23 27	37 44	ns
$Q_{rr}$	Reverse Recovery Charge		Q1 Q2		8 31	16 50	nC

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.

9. Pulse Test: Pulse Width < 300  $\mu\text{s}$ , Duty Cycle < 2.0%.





Typical Characteristics (Q1 N-Channel)  $T_J = 25^\circ\text{C}$  unless otherwise noted.

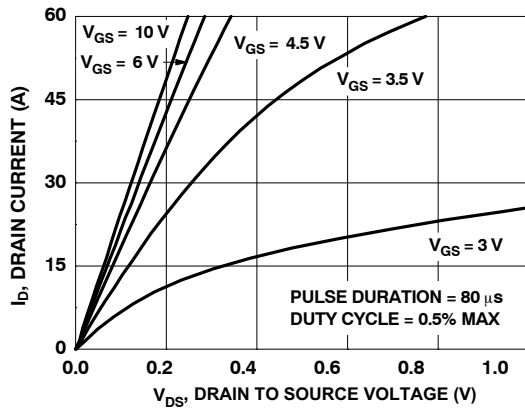


Figure 1. On Region Characteristics

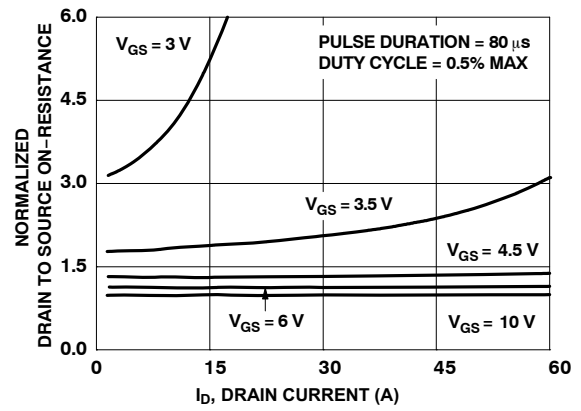


Figure 2. Normalized On-Resistance vs. Drain Current and Gate Voltage

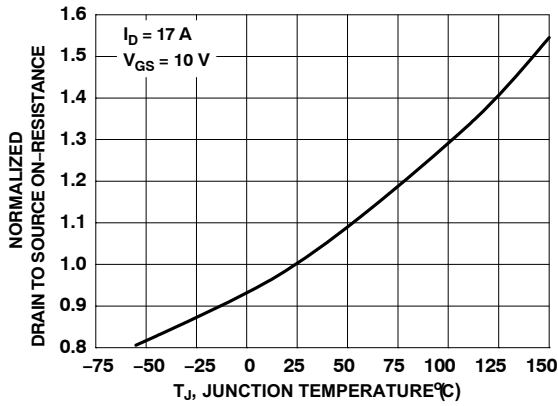


Figure 3. Normalized On-Resistance vs. Junction Temperature

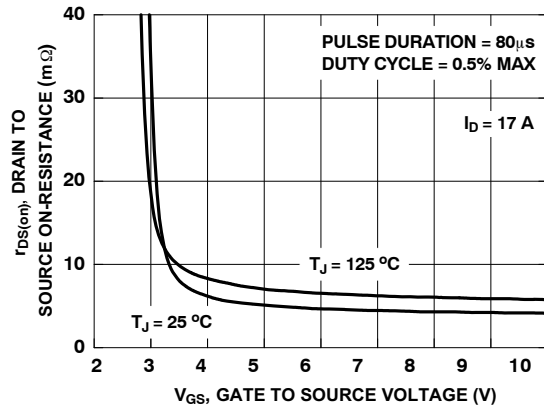


Figure 4. On-Resistance vs. Gate to Source Voltage

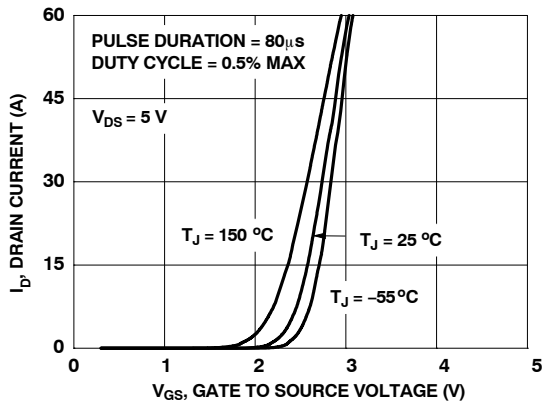


Figure 5. Transfer Characteristics

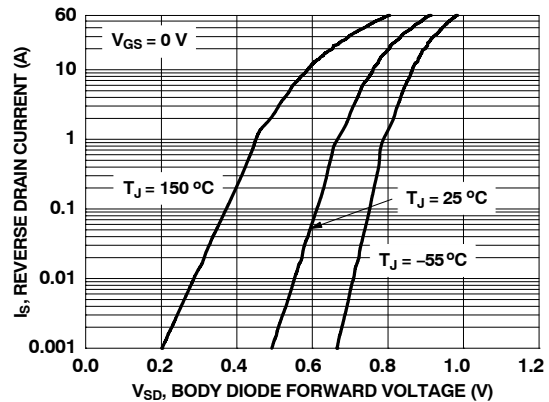


Figure 6. Source to Drain Diode Forward Voltage vs. Source Current



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Typical Characteristics (Q1 N-Channel)  $T_J = 25^\circ\text{C}$  unless otherwise noted.

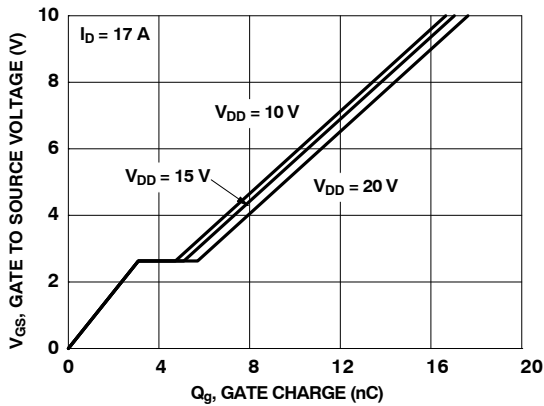


Figure 7. Gate Charge Characteristics

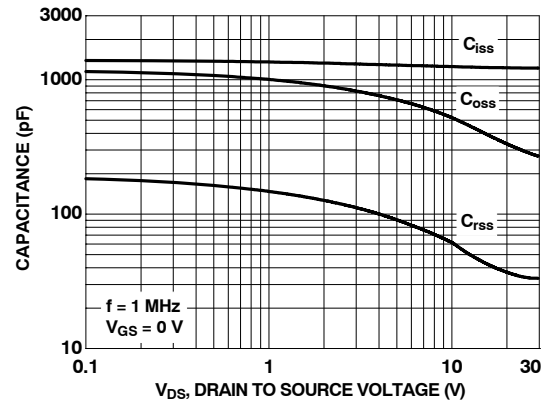


Figure 8. Capacitance vs. Drain to Source Voltage

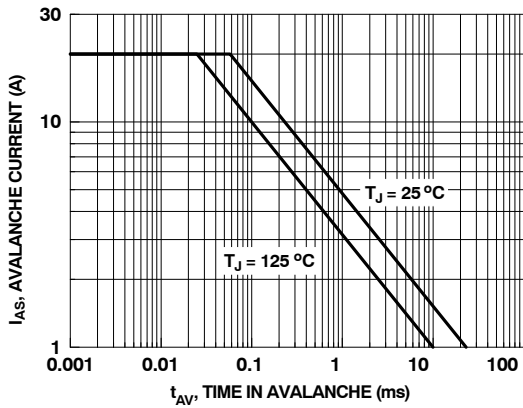


Figure 9. Unclamped Inductive Switching Capability

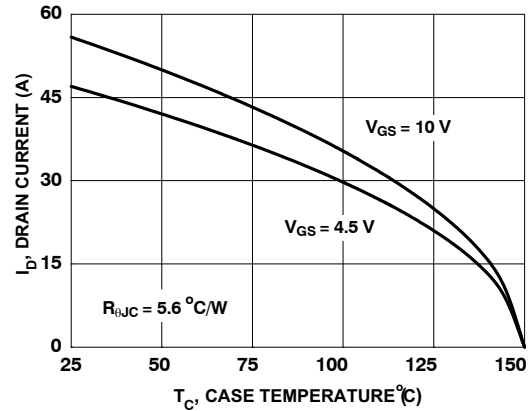


Figure 10. Maximum Continuous Drain Current vs. Case Temperature

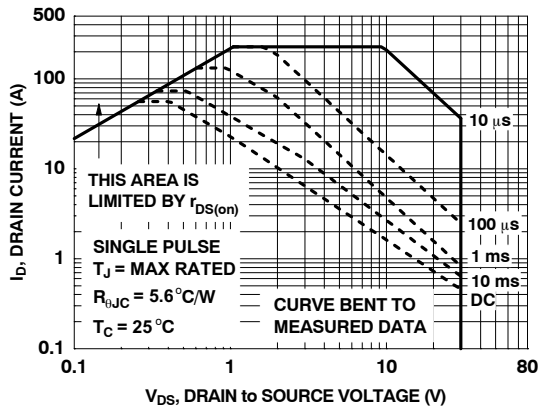


Figure 11. Forward Bias Safe Operating Area

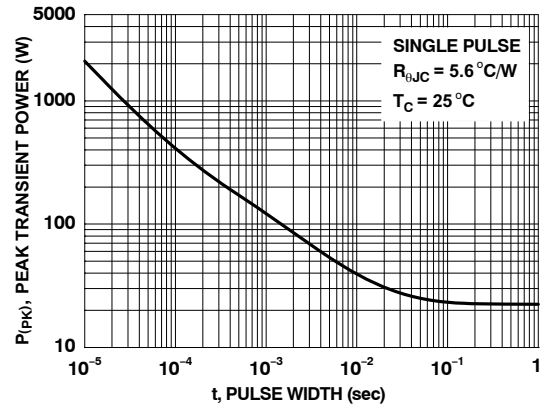


Figure 12. Single Pulse Maximum Power Dissipation



# NTMFD2D4N03P8

Typical Characteristics (Q1 N-Channel)  $T_J = 25^\circ\text{C}$  unless otherwise noted.

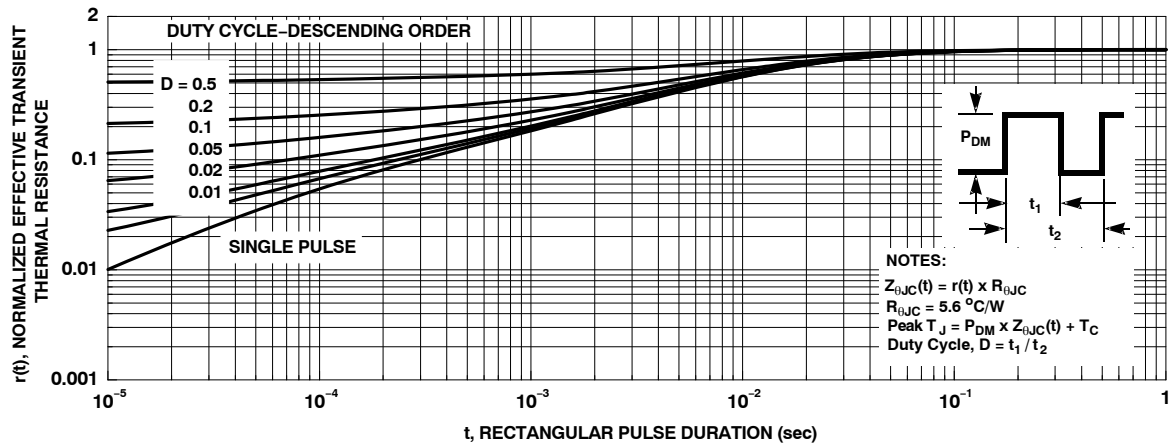


Figure 13. Junction-to-Case Transient Thermal Response Curve



Typical Characteristics (Q2 N-Channel)  $T_J = 25^\circ\text{C}$  unless otherwise noted.

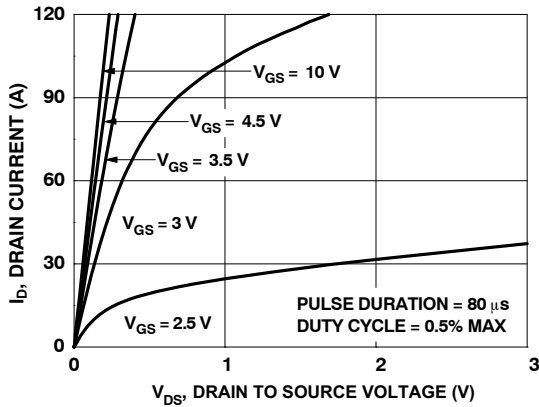


Figure 14. On Region Characteristics

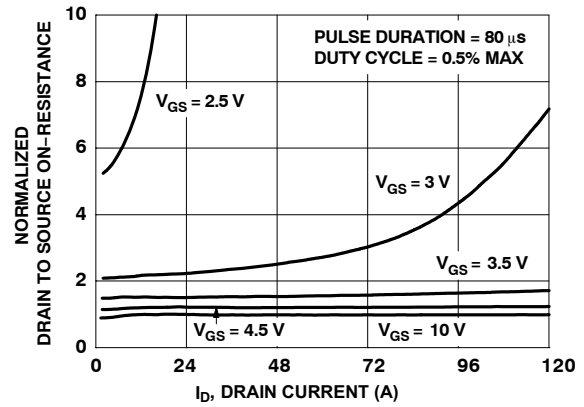


Figure 15. Normalized On-Resistance vs. Drain Current and Gate Voltage

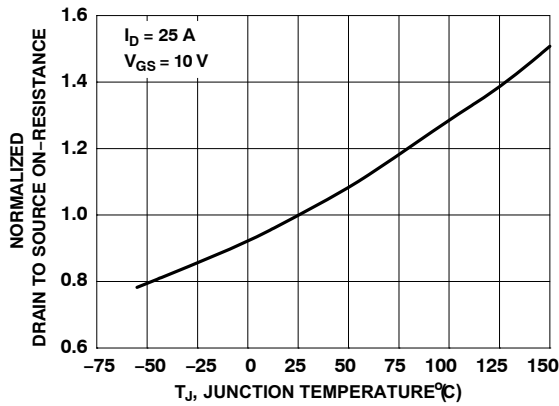


Figure 16. Normalized On-Resistance vs. Junction Temperature

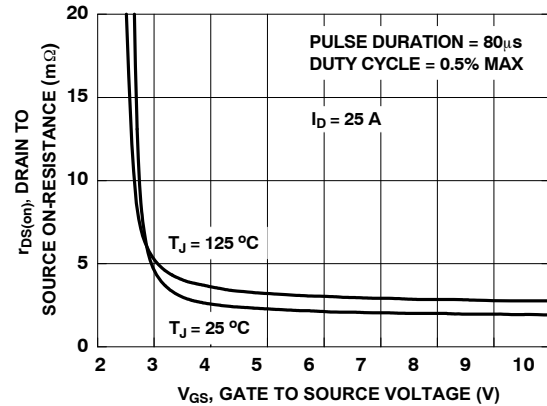


Figure 17. On-Resistance vs. Gate to Source Voltage

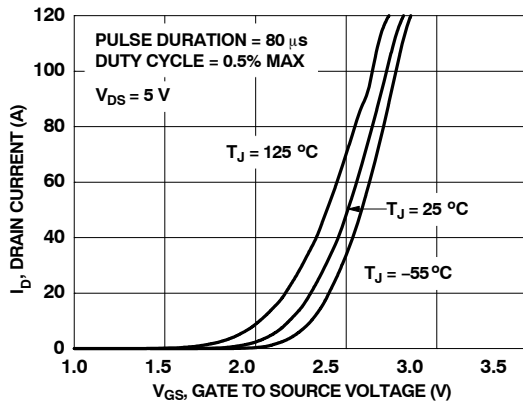


Figure 18. Transfer Characteristics

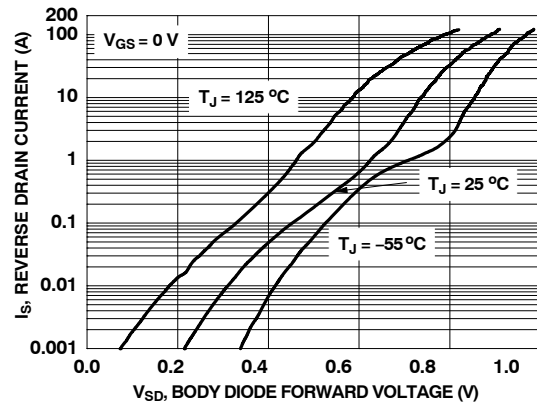


Figure 19. Source to Drain Diode Forward Voltage vs. Source Current





# NTMFD2D4N03P8

Typical Characteristics (Q2 N-Channel)  $T_J = 25^\circ\text{C}$  unless otherwise noted.

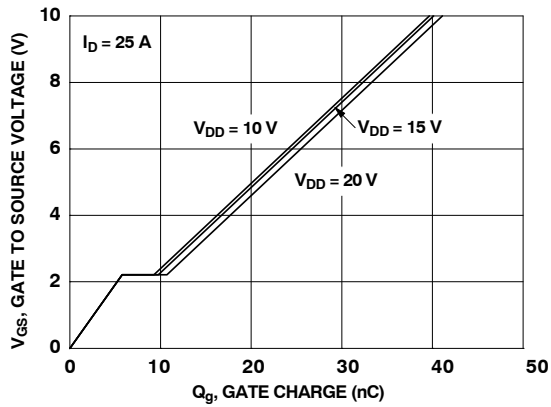


Figure 20. Gate Charge Characteristics

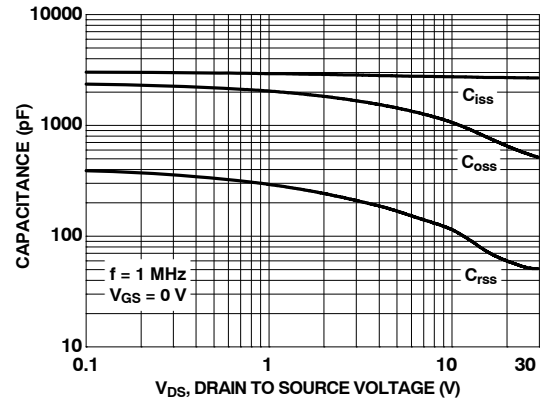


Figure 21. Capacitance vs. Drain to Source Voltage

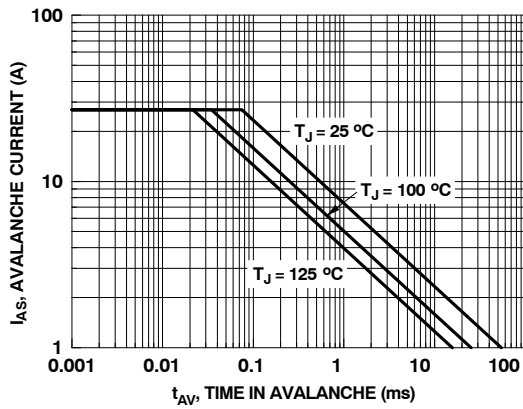


Figure 22. Unclamped Inductive Switching Capability

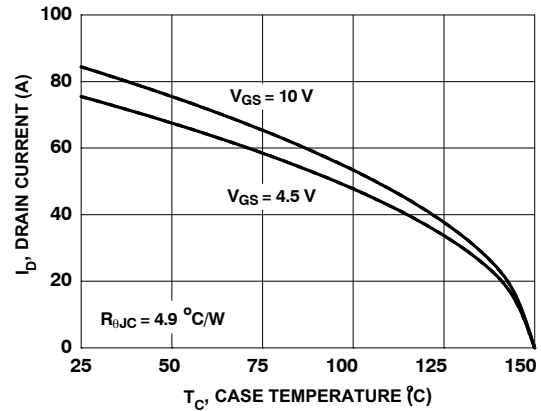


Figure 23. Maximum Continuous Drain Current vs. Case Temperature

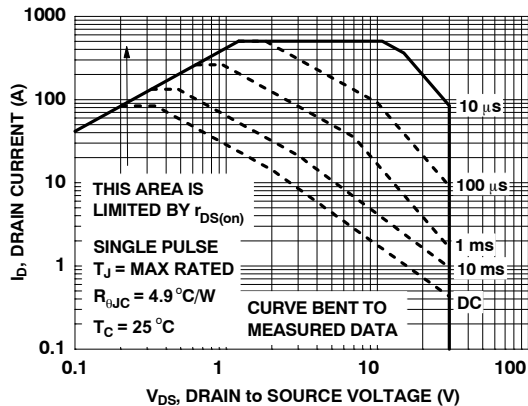


Figure 24. Forward Bias Safe Operating Area

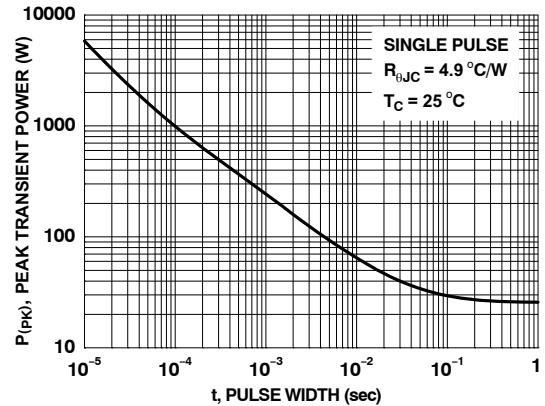


Figure 25. Single Pulse Maximum Power Dissipation



Typical Characteristics (Q2 N-Channel)  $T_J = 25^\circ\text{C}$  unless otherwise noted.

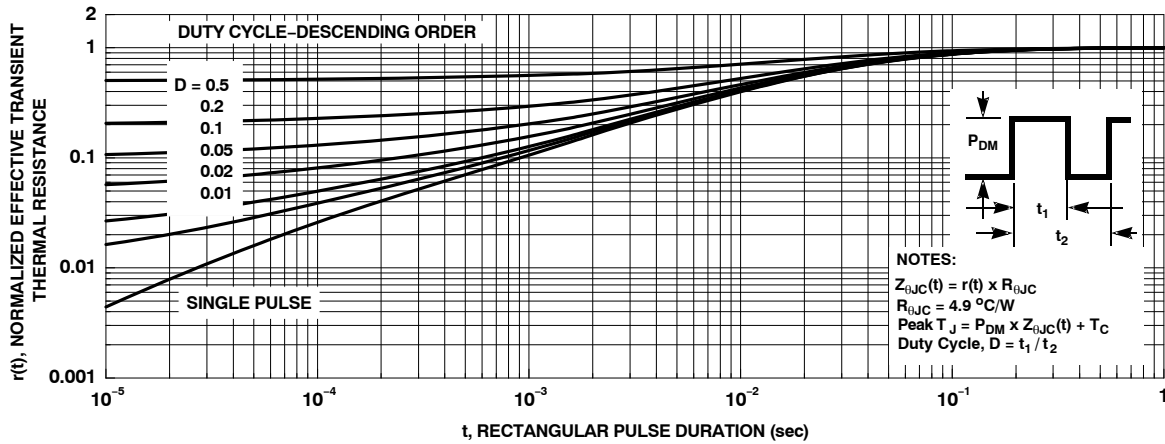


Figure 26. Junction-to-Case Transient Thermal Response Curve

Typical Characteristics

SyncFET Schottky Body Diode Characteristics

ON Semiconductor's SyncFET process embeds a Schottky diode in parallel with PowerTrench MOSFET. This diode exhibits similar characteristics to a discrete external Schottky diode in parallel with a MOSFET. Figure 27 shows the reverse recovery characteristic of the FDPC5018SG.

Schottky barrier diodes exhibit significant leakage at high temperature and high reverse voltage. This will increase the power in the device.

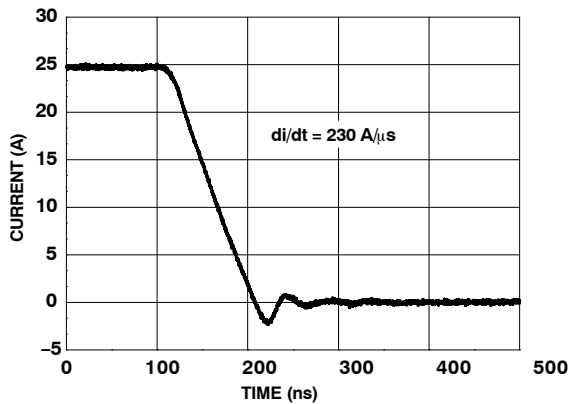


Figure 27. SyncFET Body Diode Reverse Recovery Characteristic

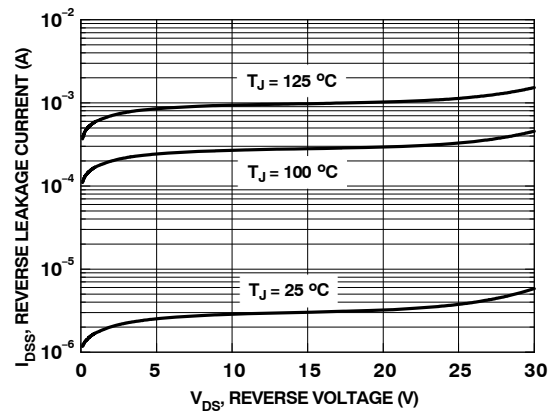


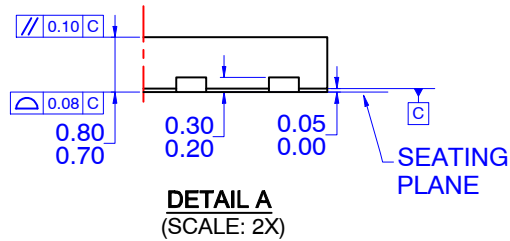
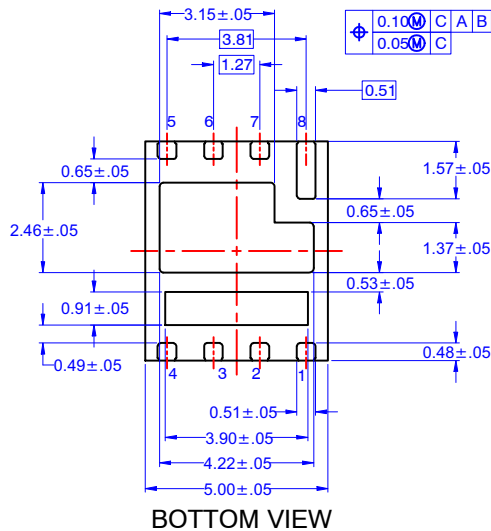
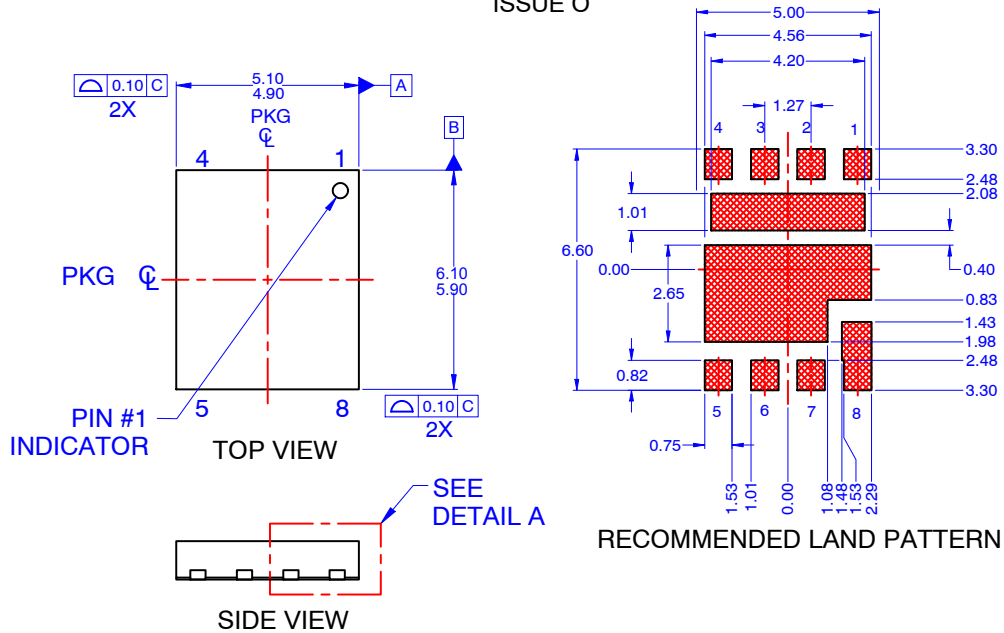
Figure 28. SyncFET Body Diode Reverse Leakage vs. Drain-Source Voltage



# NTMFD2D4N03P8

## 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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