

# NTTD4401F

## FETKY™ Power MOSFET and Schottky Diode

-20 V, -3.3 A P-Channel with 20 V, 1.0 A Schottky Diode, Micro8™ Package

The FETKY product family incorporates low  $R_{DS(on)}$ , true logic level MOSFETs packaged with industry leading, low forward drop, low leakage Schottky Barrier Diodes to offer high efficiency components in a space saving configuration. Independent pinouts for TMOS and Schottky die allow the flexibility to use a single component for switching and rectification functions in a wide variety of applications.

### Features

- Low  $V_F$  and Low Leakage Schottky Diode
- Lower Component Placement and Inventory Costs along with Board Space Savings
- Logic Level Gate Drive – Can be Driven by Logic ICs
- Pb-Free Package is Available

### Applications

- Buck Converter
- Synchronous Rectification
- Low Voltage Motor Control
- Load Management in Battery Packs, Chargers, Cell Phones, and other Portable Products

### MOSFET MAXIMUM RATINGS ( $T_A = 25^\circ\text{C}$ unless otherwise noted)

Rating		Symbol	Value	Unit
Drain-to-Source Voltage		$V_{DSS}$	-20	V
Gate-to-Source Voltage		$V_{GS}$	$\pm 10$	V
Continuous Drain Current (Note 1)	$T_A = 25^\circ\text{C}$	$I_D$	-3.3	A
	$T_A = 100^\circ\text{C}$		-2.1	
Power Dissipation (Note 1)	Steady State	$T_A = 25^\circ\text{C}$	$P_D$	1.42
		$T_A = 100^\circ\text{C}$		
Continuous Drain Current (Note 2)	$T_A = 25^\circ\text{C}$	$I_D$	-2.4	A
	$T_A = 100^\circ\text{C}$		-1.5	
Power Dissipation (Note 2)	Steady State	$T_A = 25^\circ\text{C}$	$P_D$	0.78
Pulsed Drain Current	$t = 10 \mu\text{s}$	$I_{DM}$	-10	A
Operating Junction and Storage Temperature		$T_J, T_{STG}$	-55 to 150	$^\circ\text{C}$
Single Pulse Drain-to-Source Avalanche Energy Starting $T_A = 25^\circ\text{C}$ ( $t \leq 10 \text{ s}$ )		EAS	150	mJ
Lead Temperature for Soldering Purposes (1/8" from case for 10 s)		$T_L$	260	$^\circ\text{C}$

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

1. Surface-mounted on FR4 board using 1 in sq pad size (Cu area = 1.127 in sq [1 oz] including traces).
2. Surface-mounted on FR4 board using the minimum recommended pad size (Cu area = 0.172 in sq).



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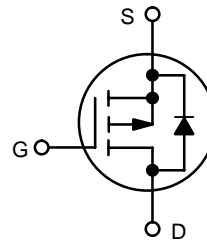
<http://onsemi.com>

### MOSFET PRODUCT SUMMARY

$V_{(BR)DSS}$	$R_{DS(on)}$ TYP	$I_D$ Max
-20 V	70 m $\Omega$ @ -4.5 V	-3.3 A
	100 m $\Omega$ @ -2.7 V	-2.7 A

### SCHOTTKY DIODE SUMMARY

$V_R$ Max	$I_F$ Max	$V_F$ Max
20 V	2.0 A	600 mV @ $I_F = 2.0 \text{ A}$

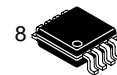


P-Channel MOSFET

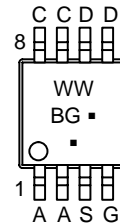


Schottky Diode

### MARKING DIAGRAM & PIN ASSIGNMENT



Micro8 CASE 846A



BG = Specific Device Code  
 WW = Work Week  
 ■ = Pb-Free Package  
 (Note: Microdot may be in either location)

### ORDERING INFORMATION

Device	Package	Shipping†
NTTD4401FR2	Micro8	4000/Tape & Reel
NTTD4401FR2G	Micro8 (Pb-Free)	4000/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.

# NTTD4401F

## SCHOTTKY DIODE MAXIMUM RATINGS ( $T_A = 25^\circ\text{C}$ unless otherwise noted)

Rating	Symbol	Value	Unit
Peak Repetitive Reverse Voltage	V	20	V
Average Forward Current (Rated $V_R$ , $T_A = 100^\circ\text{C}$ )	$I_O$	1.0	A
Peak Repetitive Forward Current (Note 3)	$I_{FRM}$	2.0	A
Non-Repetitive Peak Surge Current (Note 4)	$I_{FSM}$	20	A

## THERMAL RESISTANCE RATINGS

Rating	Symbol	FET	Schottky	Unit
		Max		
Junction-to-Ambient – Steady State (Note 5)	$R_{\theta JA}$	88	135	$^\circ\text{C/W}$
Junction-to-Ambient – Steady State (Note 6)	$R_{\theta JA}$	160	250	$^\circ\text{C/W}$

## MOSFET ELECTRICAL CHARACTERISTICS ( $T_A = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Test Condition	Min	Typ	Max	Unit
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### OFF CHARACTERISTICS

Drain-to-Source Breakdown Voltage	$V_{(BR)DSS}$	$V_{GS} = 0\text{ V}$	-20	-	-	V
Zero Gate Voltage Drain Current (Note 7)	$I_{DSS}$	$V_{GS} = 0\text{ V}, V_{DS} = -16\text{ V}$	-	-	-1.0	$\mu\text{A}$
		$V_{GS} = 0\text{ V}, T_J = 125^\circ\text{C}, V_{DS} = -16\text{ V}$	-	-	-25	
Gate-to-Source Leakage Current	$I_{GSS}$	$V_{DS} = 0\text{ V}, V_{GS} = \pm 10\text{ V}$	-	-	$\pm 100$	nA

### ON CHARACTERISTICS

Gate Threshold Voltage	$V_{GS(TH)}$	$V_{GS} = V_{DS}, I_D = -250\ \mu\text{A}$	-0.5	-	-1.5	V
Negative Threshold Temperature Coefficient	$V_{GS(TH)}/T_J$	-	-	2.5	-	$\text{mV}/^\circ\text{C}$
Drain-to-Source On Resistance	$R_{DS(on)}$	$V_{GS} = -4.5\text{ V}, I_D = -3.3\text{ A}$	-	70	90	$\text{m}\Omega$
		$V_{GS} = -2.5\text{ V}, I_D = -1.2\text{ A}$	-	100	150	
Forward Transconductance	$g_{FS}$	$V_{DS} = -10\text{ V}, I_D = -2.7\text{ A}$	-	4.2	-	S

### CHARGES, CAPACITANCES AND GATE RESISTANCE

Input Capacitance	$C_{ISS}$	$V_{GS} = 0\text{ V}, f = 1.0\text{ MHz}, V_{DS} = -16\text{ V}$	-	550	750	$\text{pF}$
Output Capacitance	$C_{OSS}$		-	200	300	
Reverse Transfer Capacitance	$C_{RSS}$		-	50	175	
Total Gate Charge	$Q_{G(TOT)}$	$V_{GS} = -4.5\text{ V}, V_{DS} = -16\text{ V}, I_D = -3.3\text{ A}$	-	10	18	$\text{nC}$
Gate-to-Source Gate Charge	$Q_{GS}$		-	1.5	3.0	
Gate-to-Drain "Miller" Charge	$Q_{GD}$		-	5.0	10	

### SWITCHING CHARACTERISTICS

Turn-On Delay Time	$t_{d(ON)}$	$V_{GS} = -4.5\text{ V}, V_{DD} = -10\text{ V}, I_D = -3.3\text{ A}, R_G = 6.0\ \Omega$	-	11	20	ns
Rise Time	$t_r$		-	35	65	
Turn-Off Delay Time	$t_{d(OFF)}$		-	33	60	
Fall Time	$t_f$		-	29	55	

### DRAIN-SOURCE DIODE CHARACTERISTICS

Forward Diode Voltage	$V_{SD}$	$V_{GS} = 0\text{ V}, I_S = -2.0\text{ A}$	-	-0.88	-1.0	V
Reverse Recovery Time	$t_{RR}$	$V_{GS} = 0\text{ V}, dI_S/dt = 100\text{ A}/\mu\text{s}, I_S = -3.3\text{ A}$	-	37	50	ns
Charge Time	$t_a$		-	16	-	
Discharge Time	$t_b$		-	21	-	
Reverse Recovery Charge	$Q_{RR}$	-	-	0.025	0.05	nC

- Rated  $V_R$ , square wave, 20 kHz,  $T_A = 105^\circ\text{C}$ .
- Surge applied at rated load conditions, half-wave, single phase, 60 Hz.
- Surface-mounted on FR4 board using 1 inch sq pad size (Cu area = 1.127 in sq [1 oz] including traces).
- Surface-mounted on FR4 board using the minimum recommended pad size (Cu area = 0.172 in sq).
- Body diode leakage current.

# NTTD4401F

## SCHOTTKY DIODE ELECTRICAL CHARACTERISTICS ( $T_J = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Test Condition	Min	Typ	Max	Unit	
Reverse Breakdown Voltage	$B_V$	$I_R = 1.0 \text{ mA}$	20	-	-	V	
Reverse Leakage Current	$I_R$	$V_R = 20 \text{ V}$	$T_A = 25^\circ\text{C}$	-	-	0.05	mA
			$T_A = 125^\circ\text{C}$	-	-	10	
Forward Voltage	$V_F$	$I_F = 1.0 \text{ A}$	$T_A = 25^\circ\text{C}$	-	-	0.5	V
			$T_A = 125^\circ\text{C}$	-	-	0.39	
		$I_F = 2.0 \text{ A}$	$T_A = 25^\circ\text{C}$	-	-	0.6	
			$T_A = 125^\circ\text{C}$	-	-	0.53	
Voltage Rate of Change	$dV/dt$	$V_R = 20 \text{ V}$	-	10,000	-	V/ $\mu\text{s}$	

TYPICAL ELECTRICAL CHARACTERISTICS

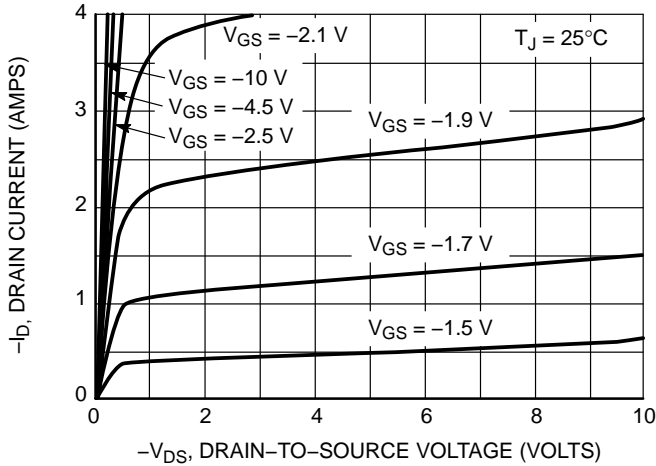


Figure 1. On-Region Characteristics

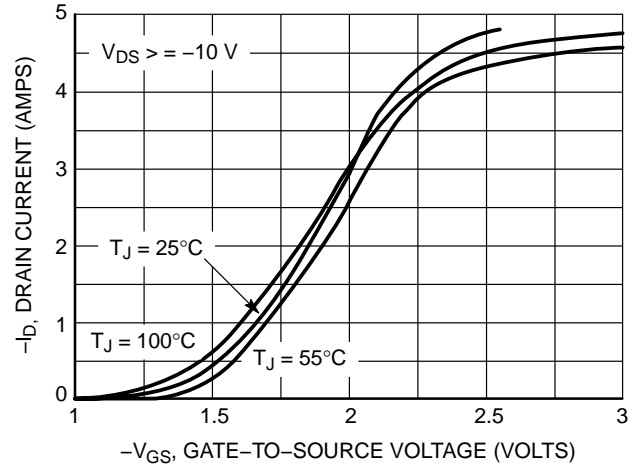


Figure 2. Transfer Characteristics

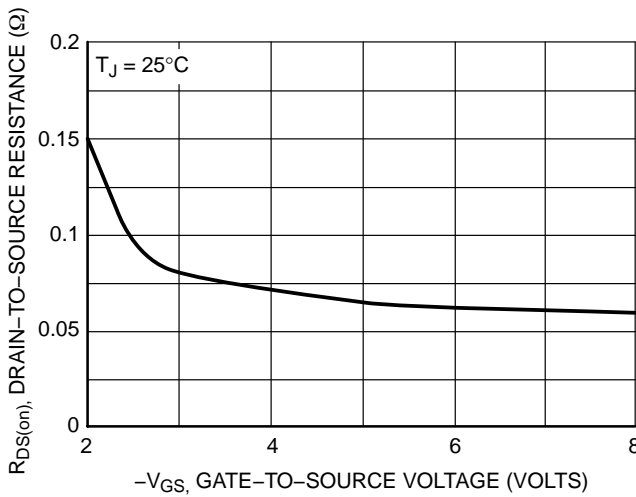


Figure 3. On-Resistance vs. Gate-to-Source Voltage

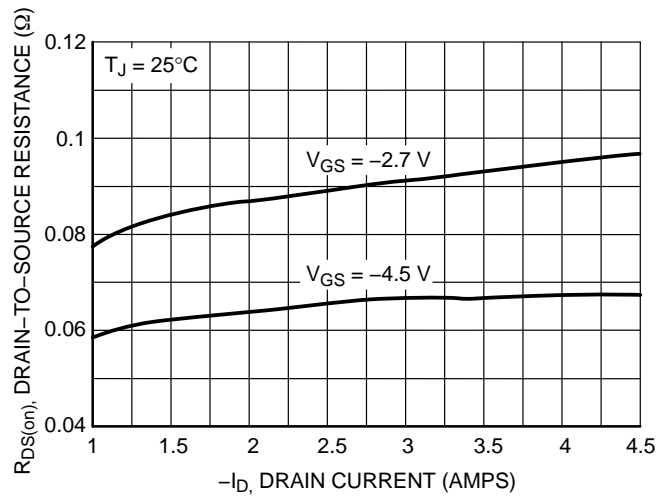


Figure 4. On-Resistance vs. Drain Current and Gate Voltage

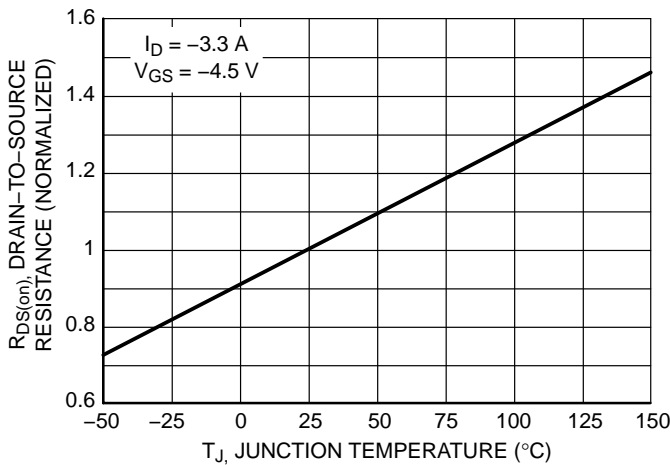


Figure 5. On-Resistance Variation with Temperature

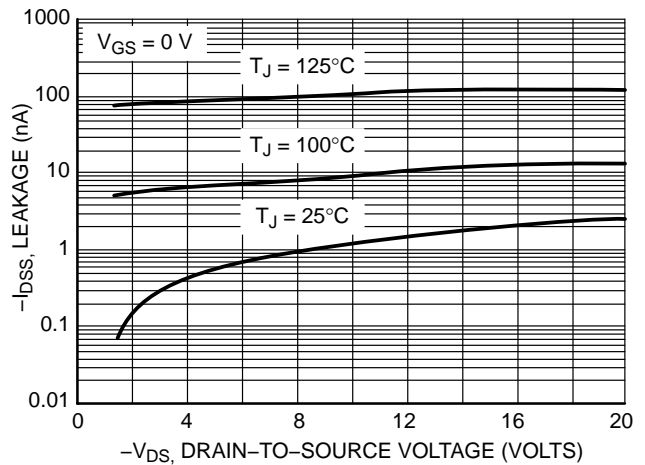


Figure 6. Drain-to-Source Leakage Current vs. Voltage

TYPICAL ELECTRICAL CHARACTERISTICS

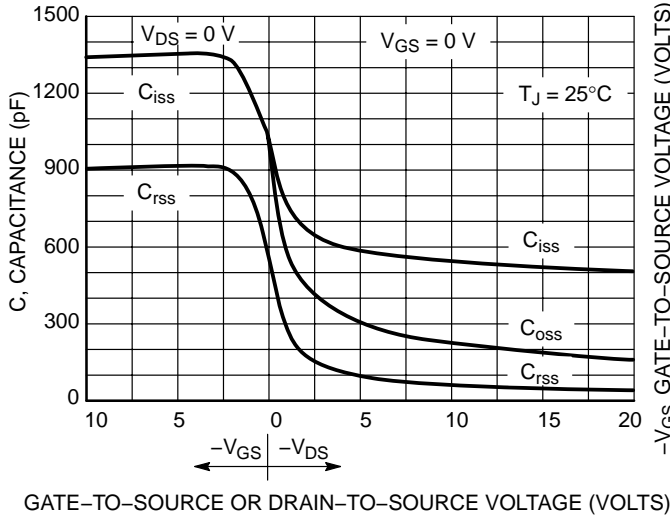


Figure 7. Capacitance Variation

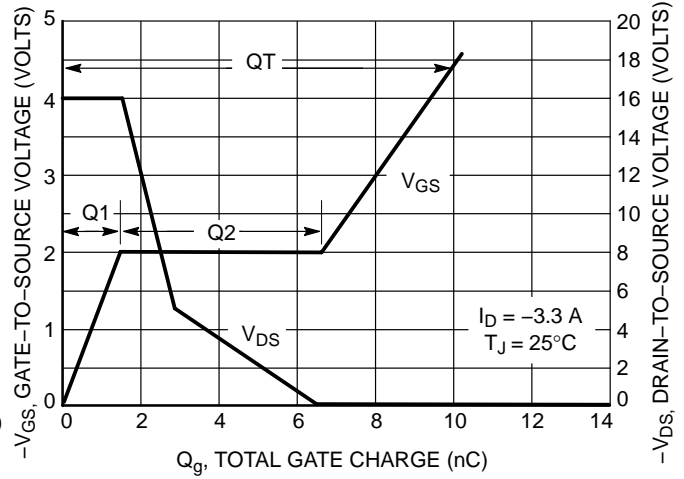


Figure 8. Gate-to-Source and Drain-to-Source Voltage vs. Total Charge

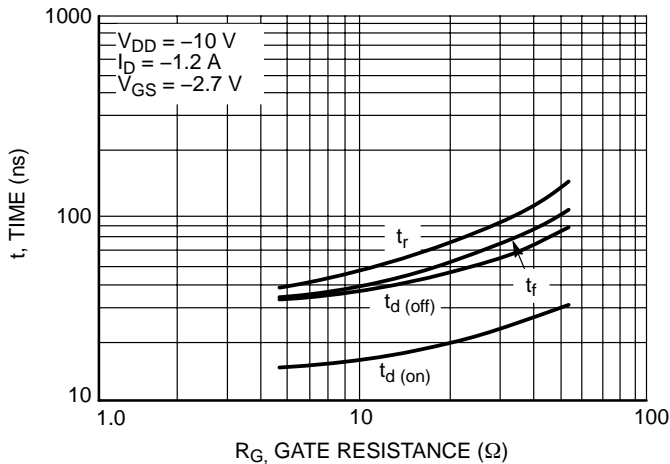


Figure 9. Resistive Switching Time Variation vs. Gate Resistance

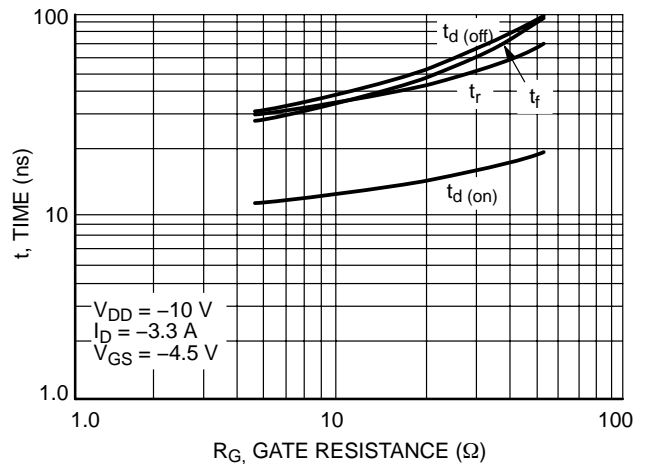


Figure 10. Resistive Switching Time Variation vs. Gate Resistance

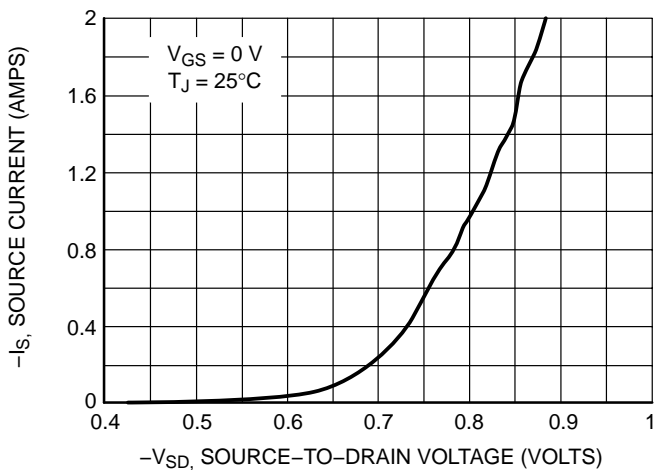


Figure 11. Diode Forward Voltage vs. Current

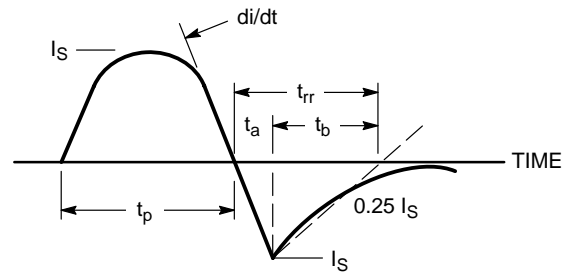


Figure 12. Diode Reverse Recovery Waveform

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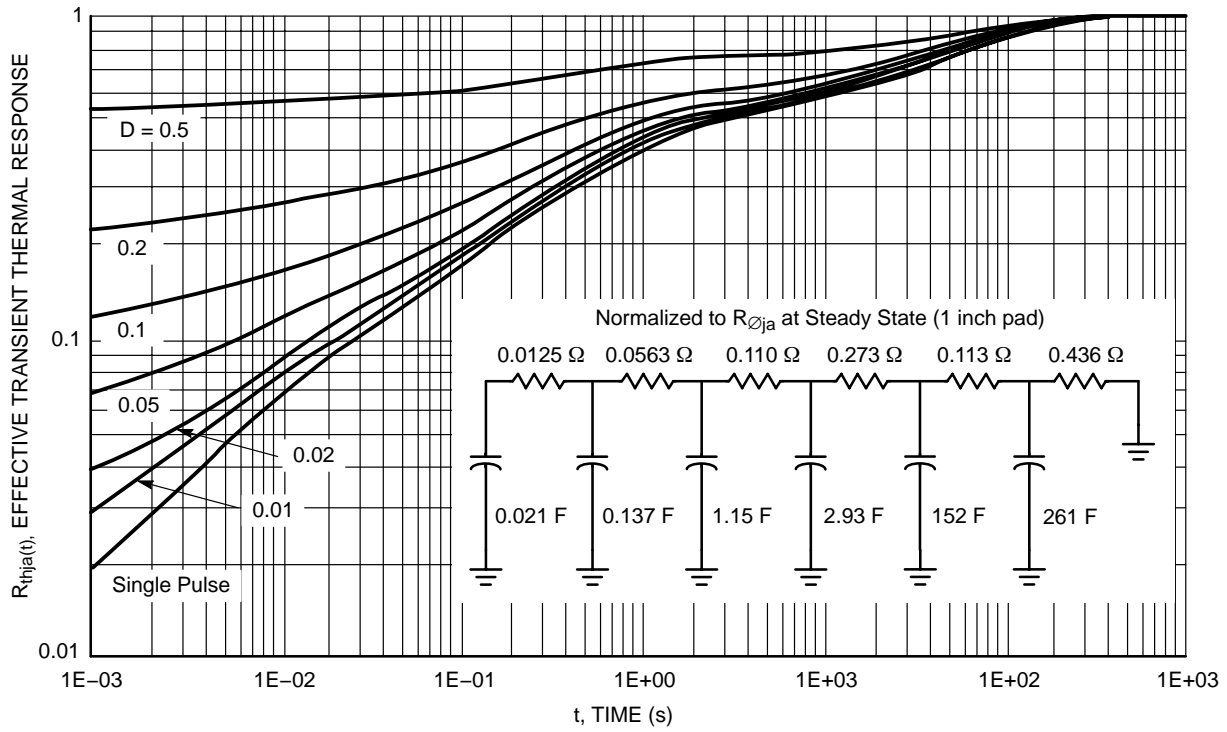


Figure 13. FET Thermal Response

## TYPICAL SCHOTTKY ELECTRICAL CHARACTERISTICS

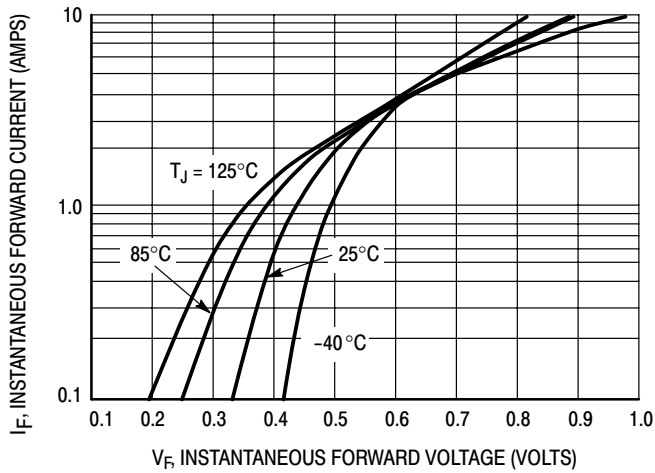


Figure 14. Typical Forward Voltage

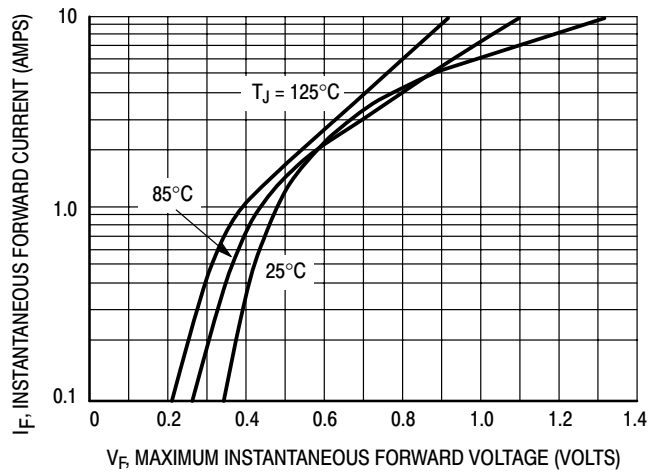


Figure 15. Maximum Forward Voltage

TYPICAL SCHOTTKY ELECTRICAL CHARACTERISTICS

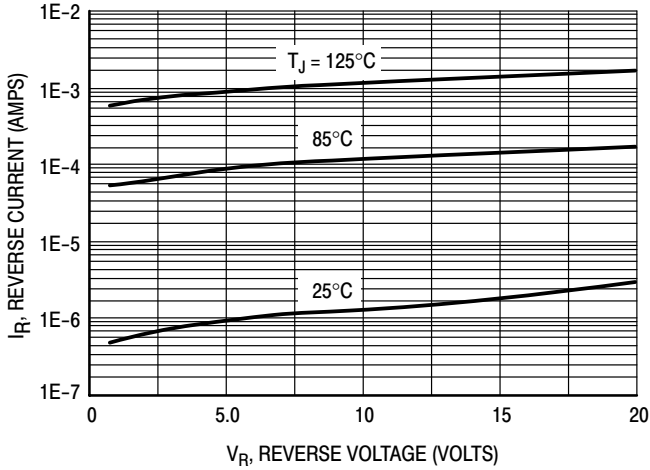


Figure 16. Typical Reverse Current

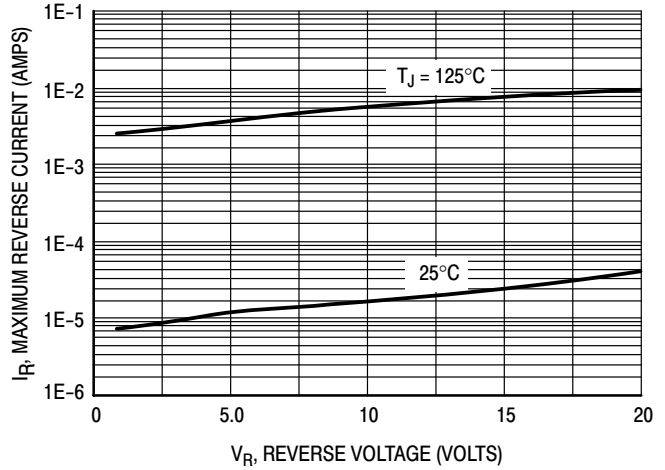


Figure 17. Maximum Reverse Current

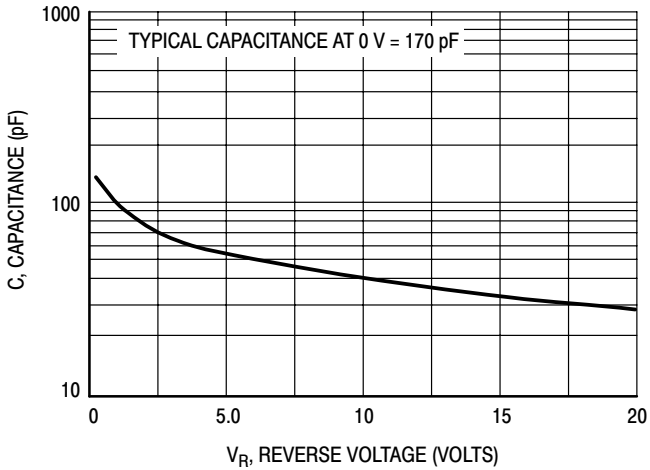


Figure 18. Typical Capacitance

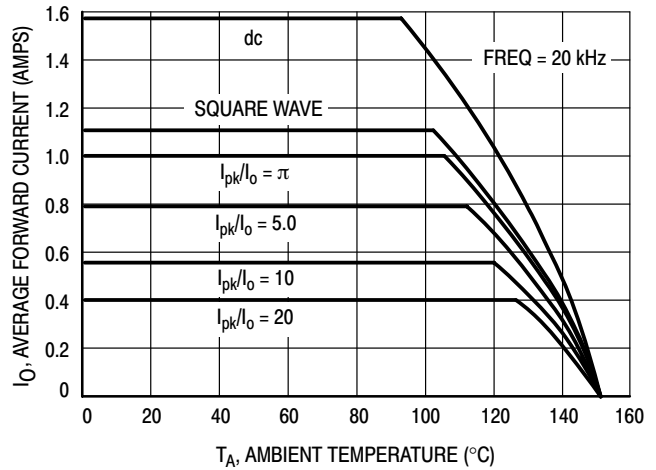


Figure 19. Current Derating

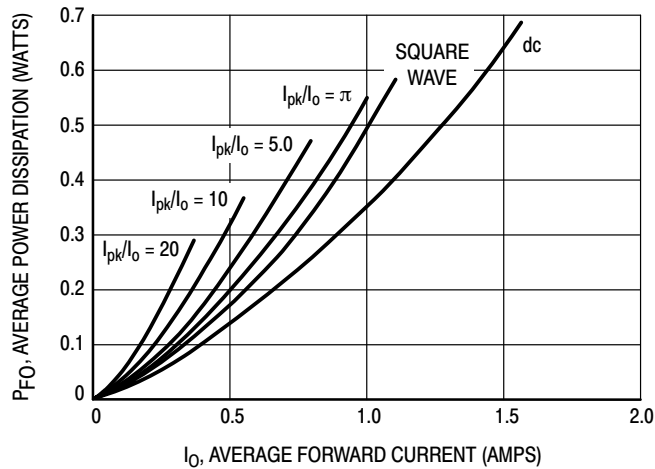


Figure 20. Forward Power Dissipation

# MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS

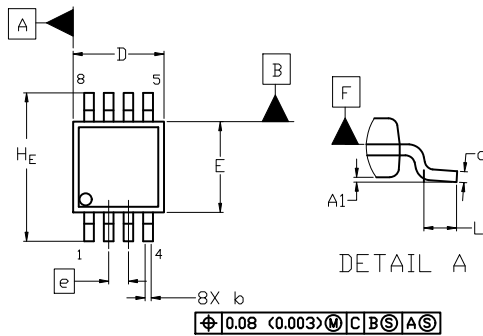
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SCALE 2:1

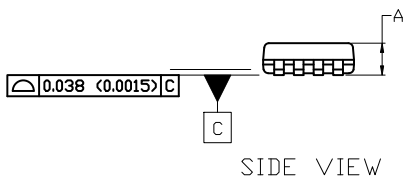
## Micro8 CASE 846A-02 ISSUE K

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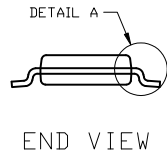


TOP VIEW

NOTE 3



SIDE VIEW

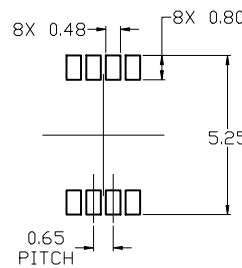


END VIEW

### NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 2009.
2. CONTROLLING DIMENSION: MILLIMETERS
3. DIMENSION *b* DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE PROTRUSION SHALL BE 0.10 mm IN EXCESS OF MAXIMUM MATERIAL CONDITION.
4. DIMENSIONS *D* AND *E* DO NOT INCLUDE MOLD FLASH, PROTRUSION OR GATE BURRS. MOLD FLASH, PROTRUSIONS, OR GATE BURRS SHALL NOT EXCEED 0.15 mm PER SIDE. DIMENSION *E* DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION. INTERLEAD FLASH OR PROTRUSION SHALL NOT EXCEED 0.25 mm PER SIDE. DIMENSIONS *D* AND *E* ARE DETERMINED AT DATUM *F*.
5. DATUMS *A* AND *B* ARE TO BE DETERMINED AT DATUM *F*.
6. *A1* IS DEFINED AS THE VERTICAL DISTANCE FROM THE SEATING PLANE TO THE LOWEST POINT ON THE PACKAGE BODY.

⌀ 0.08 (0.003) M C B S A S

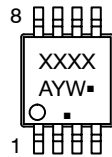


RECOMMENDED  
MOUNTING FOOTPRINT

DIM	MILLIMETERS		
	MIN.	NDM.	MAX.
A	---	---	1.10
A1	0.05	0.08	0.15
<i>b</i>	0.25	0.33	0.40
<i>c</i>	0.13	0.18	0.23
<i>D</i>	2.90	3.00	3.10
<i>E</i>	2.90	3.00	3.10
<i>e</i>	0.65 BSC		
<i>H<sub>E</sub></i>	4.75	4.90	5.05
<i>L</i>	0.40	0.55	0.70

■ For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERM/D.

### GENERIC MARKING DIAGRAM\*



- XXXX = Specific Device Code
- A = Assembly Location
- Y = Year
- W = Work Week
- = Pb-Free Package

(Note: Microdot may be in either location)

\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "■", may or may not be present. Some products may not follow the Generic Marking.

### STYLE 1:

1. SOURCE
2. SOURCE
3. SOURCE
4. GATE
5. DRAIN
6. DRAIN
7. DRAIN
8. DRAIN

### STYLE 2:

1. SOURCE 1
2. GATE 1
3. SOURCE 2
4. GATE 2
5. DRAIN 2
6. DRAIN 2
7. DRAIN 1
8. DRAIN 1

### STYLE 3:

1. N-SOURCE
2. N-GATE
3. P-SOURCE
4. P-GATE
5. P-DRAIN
6. P-DRAIN
7. N-DRAIN
8. N-DRAIN

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