



**THE DATASHEET OF  
NTMSD6N303R2SG**



# NTMSD6N303, NVMSD6N303

## Power MOSFET

### 6 Amps, 30 Volts N-Channel SO-8 FETKY™

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

#### Features

- These Devices are Pb-Free and are RoHS Compliant
- NVMSD Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC-Q101 Qualified and PPAP Capable

#### Applications

- Buck Converter
- Buck-Boost
- Synchronous Rectification
- Low Voltage Motor Control
- Battery Packs
- Chargers
- Cell Phones

#### MOSFET MAXIMUM RATINGS

( $T_J = 25^\circ\text{C}$  unless otherwise noted) (Note 1)

Rating	Symbol	Value	Unit
Drain-to-Source Voltage	$V_{DS}$	30	Vdc
Drain-to-Gate Voltage ( $R_{GS} = 1.0\text{ M}\Omega$ )	$V_{DGR}$	30	Vdc
Gate-to-Source Voltage - Continuous	$V_{GS}$	$\pm 20$	Vdc
Drain Current - (Note 2)			
- Continuous @ $T_A = 25^\circ\text{C}$	$I_D$	6.0	Adc
- Single Pulse ( $t_p \leq 10\ \mu\text{s}$ )	$I_{DM}$	30	Apk
Total Power Dissipation @ $T_A = 25^\circ\text{C}$ (Note 2)	$P_D$	2.0	Watts
Single Pulse Drain-to-Source Avalanche Energy - Starting $T_J = 25^\circ\text{C}$ ( $V_{DD} = 30\text{ Vdc}$ , $V_{GS} = 5.0\text{ Vdc}$ , $V_{DS} = 20\text{ Vdc}$ , $I_L = 9.0\text{ Apk}$ , $L = 10\text{ mH}$ , $R_G = 25\ \Omega$ )	$E_{AS}$	325	mJ

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. Pulse Test: Pulse Width  $\leq 250\ \mu\text{s}$ , Duty Cycle  $\leq 2.0\%$ .
2. Mounted on 2" square FR4 board  
(1 in sq, 2 oz. Cu 0.06" thick single sided), 10 sec. max.

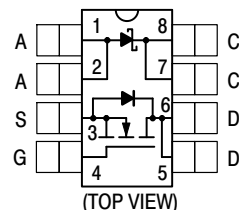


ON Semiconductor®

<http://onsemi.com>

**MOSFET**  
**6.0 AMPERES**  
**30 VOLTS**  
**24 mΩ @  $V_{GS} = 10\text{ V}$  (Typ)**

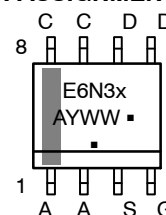
**SCHOTTKY DIODE**  
**6.0 AMPERES**  
**30 VOLTS**  
**420 mV @  $I_F = 3.0\text{ A}$**



#### MARKING DIAGRAM & PIN ASSIGNMENT



SO-8  
CASE 751  
STYLE 18



E6N3 = Device Code  
x = Blank or S  
A = Assembly Location  
Y = Year  
WW = Work Week  
▪ = Pb-Free Package  
(Note: Microdot may be in either location)

#### ORDERING INFORMATION

Device	Package	Shipping†
NTMSD6N303R2G	SO-8 (Pb-Free)	2500/Tape & Reel
NTMSD6N303R2SG	SO-8 (Pb-Free)	2500/Tape & Reel
NVMSD6N303R2G	SO-8 (Pb-Free)	2500/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.

# NTMSD6N303, NVMSD6N303

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

Rating	Symbol	Value	Unit
Peak Repetitive Reverse Voltage DC Blocking Voltage	$V_{RRM}$ $V_R$	30	Volts
Average Forward Current (Note 3) (Rated $V_R$ ) $T_A = 104^\circ\text{C}$	$I_O$	2.0	Amps
Peak Repetitive Forward Current (Note 3) (Rated $V_R$ , Square Wave, 20 kHz) $T_A = 108^\circ\text{C}$	$I_{frm}$	4.0	Amps
Non-Repetitive Peak Surge Current (Surge applied at rated load conditions, half-wave, single phase, 60 Hz)	$I_{fsm}$	30	Amps

## THERMAL CHARACTERISTICS – SCHOTTKY AND MOSFET

Thermal Resistance – Junction-to-Ambient (Note 4) – MOSFET	$R_{\theta JA}$	167	°C/W
Thermal Resistance – Junction-to-Ambient (Note 5) – MOSFET	$R_{\theta JA}$	97	
Thermal Resistance – Junction-to-Ambient (Note 3) – MOSFET	$R_{\theta JA}$	62.5	
Thermal Resistance – Junction-to-Ambient (Note 4) – Schottky	$R_{\theta JA}$	197	
Thermal Resistance – Junction-to-Ambient (Note 5) – Schottky	$R_{\theta JA}$	97	
Thermal Resistance – Junction-to-Ambient (Note 3) – Schottky	$R_{\theta JA}$	62.5	
Operating and Storage Temperature Range	$T_J, T_{stg}$	-55 to +150	

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.

3. Mounted on 2" square FR4 board (1 in sq, 2 oz. Cu 0.06" thick single sided), 10 sec. max.
4. Mounted with minimum recommended pad size, PC Board FR4.
5. Mounted on 2" square FR4 board (1 in sq, 2 oz. Cu 0.06" thick single sided), Steady State.

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

Characteristics	Symbol	Value		Unit
		$T_J = 25^\circ\text{C}$	$T_J = 125^\circ\text{C}$	
Maximum Instantaneous Forward Voltage (Note 6)  $I_F = 100 \text{ mAdc}$ $I_F = 3.0 \text{ Adc}$ $I_F = 6.0 \text{ Adc}$	$V_F$	$T_J = 25^\circ\text{C}$	$T_J = 125^\circ\text{C}$	Volts
		0.28	0.13	
		0.42	0.33	
		0.50	0.45	
Maximum Instantaneous Reverse Current (Note 6)  $V_R = 30 \text{ V}$	$I_R$	$T_J = 25^\circ\text{C}$	$T_J = 125^\circ\text{C}$	$\mu\text{A}$ mA
		250 -	- 25	
Maximum Voltage Rate of Change  $V_R = 30 \text{ V}$	$dV/dt$	10,000		V/ $\mu\text{s}$

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

# NTMSD6N303, NVMSD6N303

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

Characteristic	Symbol	Min	Typ	Max	Unit
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### OFF CHARACTERISTICS

Drain-to-Source Breakdown Voltage ( $V_{GS} = 0 \text{ Vdc}$ , $I_D = 250 \mu\text{A}$ ) Temperature Coefficient (Positive)	$V_{(BR)DSS}$	30 -	- 30	- -	Vdc mV/ $^\circ\text{C}$
Zero Gate Voltage Drain Current ( $V_{DS} = 24 \text{ Vdc}$ , $V_{GS} = 0 \text{ Vdc}$ , $T_J = 25^\circ\text{C}$ ) ( $V_{DS} = 24 \text{ Vdc}$ , $V_{GS} = 0 \text{ Vdc}$ , $T_J = 125^\circ\text{C}$ )	$I_{DSS}$	- -	- -	1.0 20	$\mu\text{Adc}$
Gate-Body Leakage Current ( $V_{GS} = \pm 20 \text{ Vdc}$ , $V_{DS} = 0 \text{ Vdc}$ )	$I_{GSS}$	-	-	100	nAdc

### ON CHARACTERISTICS (Note 7)

Gate Threshold Voltage ( $V_{DS} = V_{GS}$ , $I_D = 250 \mu\text{Adc}$ ) Temperature Coefficient (Negative)	$V_{GS(th)}$	1.0 -	1.8 4.6	2.5 -	Vdc mV/ $^\circ\text{C}$
Static Drain-to-Source On-State Resistance ( $V_{GS} = 10 \text{ Vdc}$ , $I_D = 6 \text{ Adc}$ ) ( $V_{GS} = 4.5 \text{ Vdc}$ , $I_D = 3.9 \text{ Adc}$ )	$R_{DS(on)}$	- -	0.024 0.030	0.032 0.040	$\Omega$
Forward Transconductance ( $V_{DS} = 15 \text{ Vdc}$ , $I_D = 5.0 \text{ Adc}$ )	$g_{FS}$	-	10	-	Mhos

### DYNAMIC CHARACTERISTICS

Input Capacitance	$(V_{DS} = 24 \text{ Vdc}$ , $V_{GS} = 0 \text{ Vdc}$ , $f = 1.0 \text{ MHz}$ )	$C_{iss}$	-	680	950	pF
Output Capacitance		$C_{oss}$	-	210	300	
Reverse Transfer Capacitance		$C_{rss}$	-	70	135	

### SWITCHING CHARACTERISTICS (Notes 7 & 8)

Turn-On Delay Time	$(V_{DD} = 15 \text{ Vdc}$ , $I_D = 1 \text{ A}$ , $V_{GS} = 10 \text{ V}$ , $R_G = 6 \Omega$ )	$t_{d(on)}$	-	9	18	ns
Rise Time		$t_r$	-	22	40	
Turn-Off Delay Time		$t_{d(off)}$	-	45	80	
Fall Time		$t_f$	-	45	80	
Turn-On Delay Time	$(V_{DD} = 15 \text{ Vdc}$ , $I_D = 1 \text{ A}$ , $V_{GS} = 4.5 \text{ V}$ , $R_G = 6 \Omega$ )	$t_{d(on)}$	-	13	30	ns
Rise Time		$t_r$	-	27	50	
Turn-Off Delay Time		$t_{d(off)}$	-	22	40	
Fall Time		$t_f$	-	34	70	
Gate Charge	$(V_{DS} = 15 \text{ Vdc}$ , $V_{GS} = 10 \text{ Vdc}$ , $I_D = 5 \text{ A}$ )	$Q_T$	-	19	30	nC
		$Q_1$	-	2.4	-	
		$Q_2$	-	5.0	-	
		$Q_3$	-	4.3	-	

### BODY-DRAIN DIODE RATINGS (Note 7)

Diode Forward On-Voltage	$(I_S = 1.7 \text{ Adc}$ , $V_{GS} = 0 \text{ V}$ ) $(I_S = 1.7 \text{ Adc}$ , $V_{GS} = 0 \text{ V}$ , $T_J = 150^\circ\text{C}$ )	$V_{SD}$	-	0.75 0.62	1.0 -	Vdc
Reverse Recovery Time	$(I_S = 5 \text{ A}$ , $V_{GS} = 0 \text{ V}$ , $dI_S/dt = 100 \text{ A}/\mu\text{s}$ )	$t_{rr}$	-	26	-	ns
		$t_a$	-	11	-	
		$t_b$	-	15	-	
Reverse Recovery Stored Charge ( $I_S = 5 \text{ A}$ , $dI_S/dt = 100 \text{ A}/\mu\text{s}$ , $V_{GS} = 0 \text{ V}$ )		$Q_{RR}$	-	0.015	-	$\mu\text{C}$

7. Pulse Test: Pulse Width  $\leq 300 \mu\text{s}$ , Duty Cycle  $\leq 2\%$ .

8. Switching characteristics are independent of operating junction temperature.

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## TYPICAL MOSFET ELECTRICAL CHARACTERISTICS

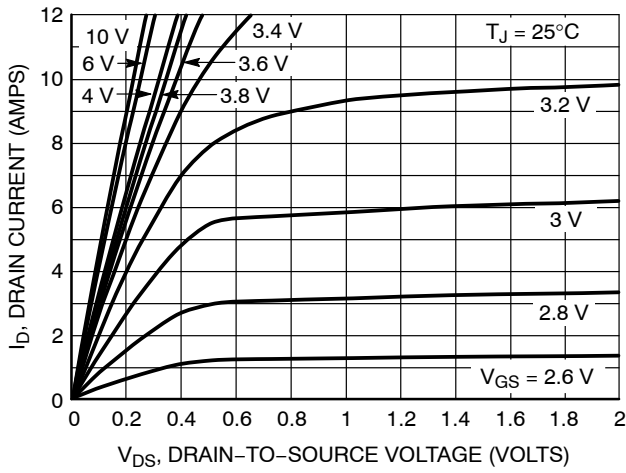


Figure 1. On-Region Characteristics

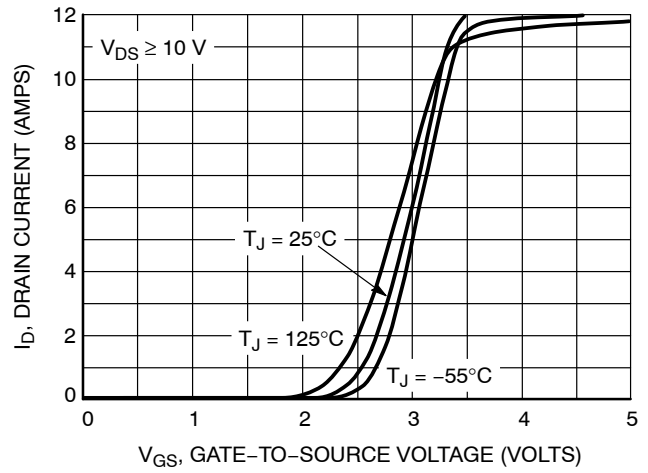


Figure 2. Transfer Characteristics

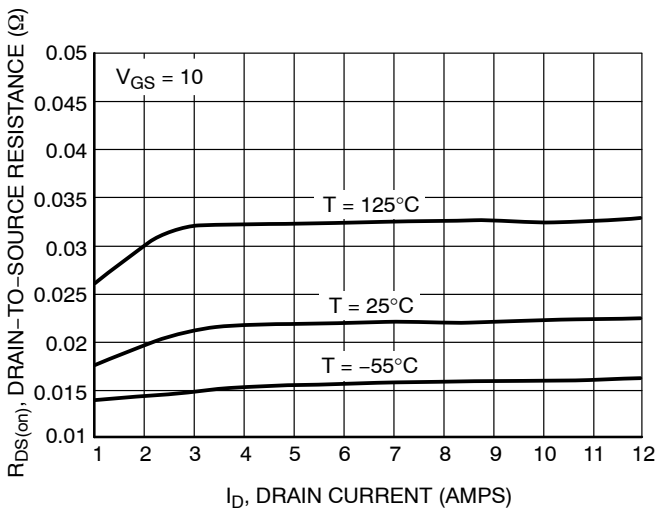


Figure 3. On-Resistance versus Drain Current and Temperature

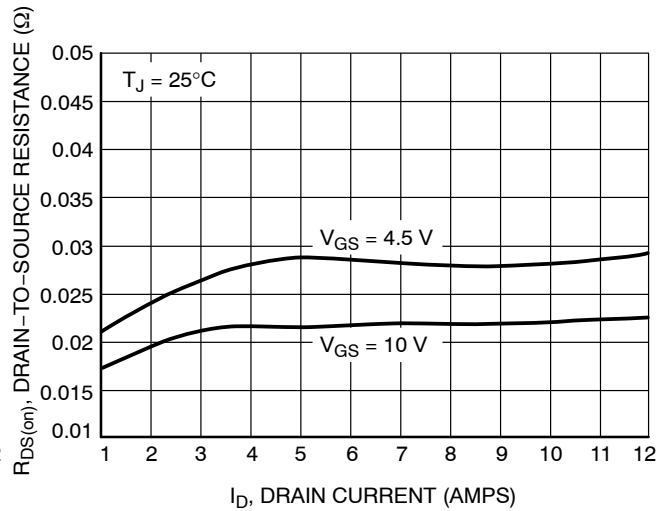


Figure 4. On-Resistance versus Drain Current and Gate Voltage

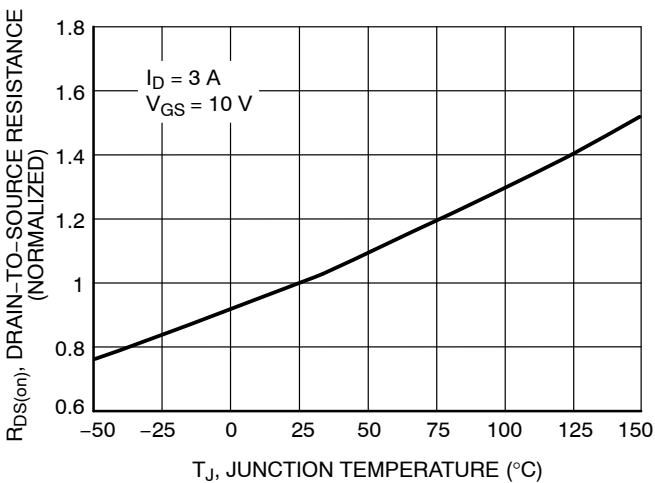


Figure 5. On-Resistance Variation with Temperature

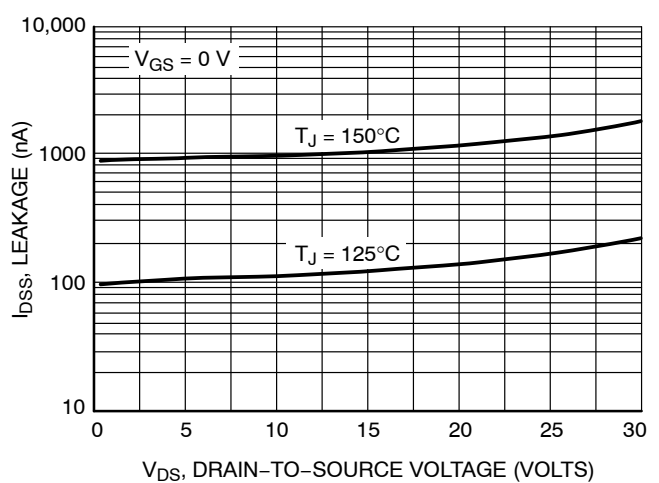
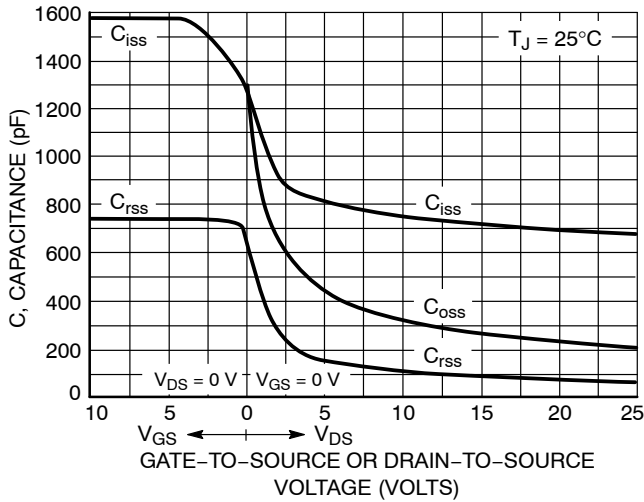
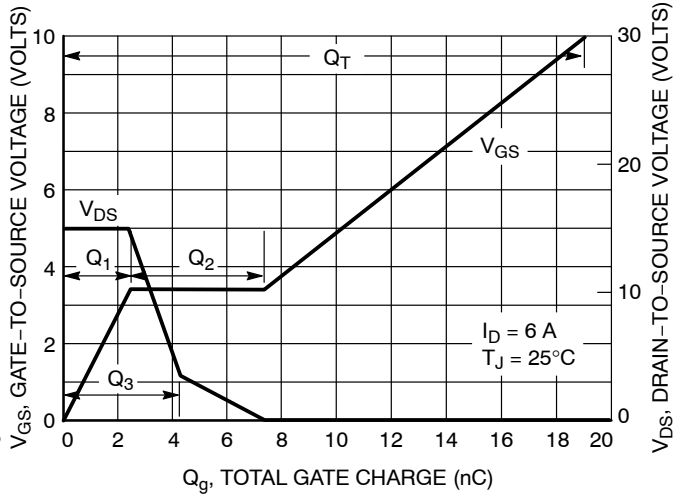


Figure 6. Drain-to-Source Leakage Current versus Voltage

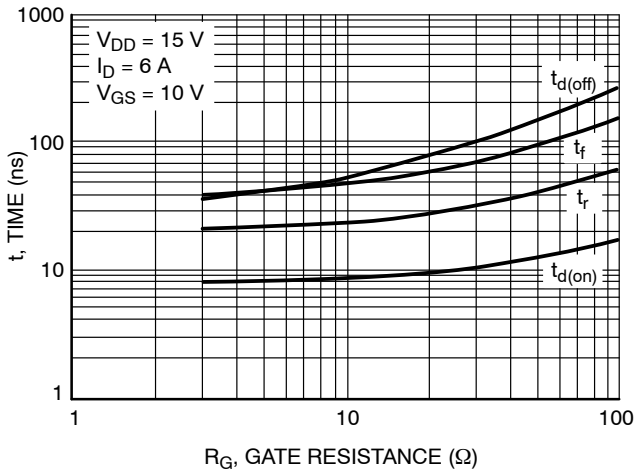
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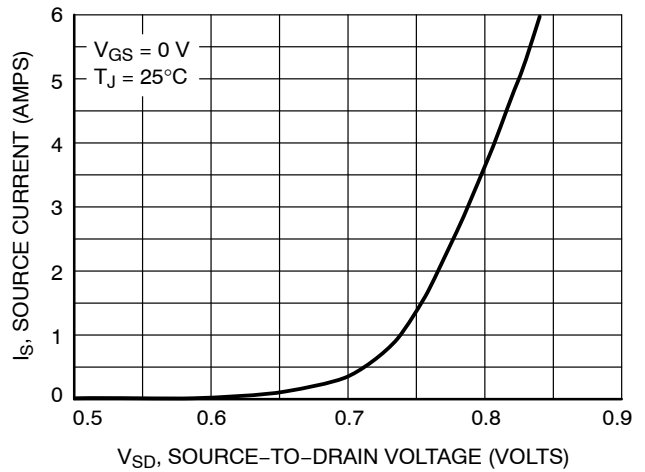
**Figure 7. Capacitance Variation**



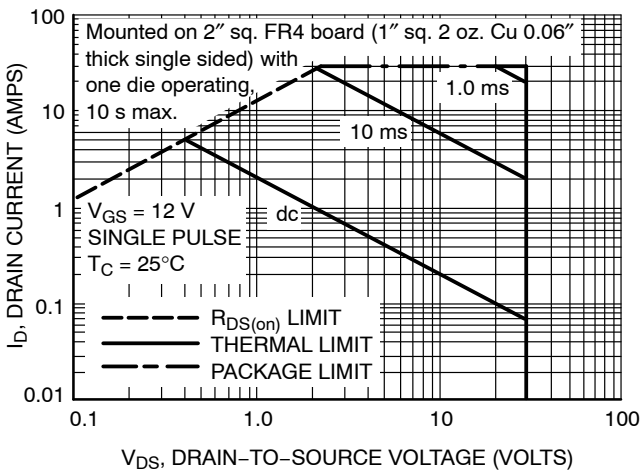
**Figure 8. Gate-to-Source and Drain-to-Source Voltage versus Total Charge**



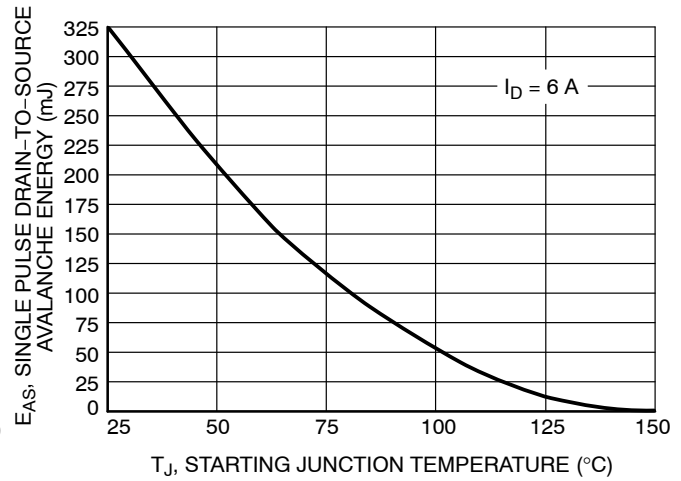
**Figure 9. Resistive Switching Time Variation versus Gate Resistance**



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



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



**Figure 12. Maximum Avalanche Energy versus Starting Junction Temperature**

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## TYPICAL FET ELECTRICAL CHARACTERISTICS

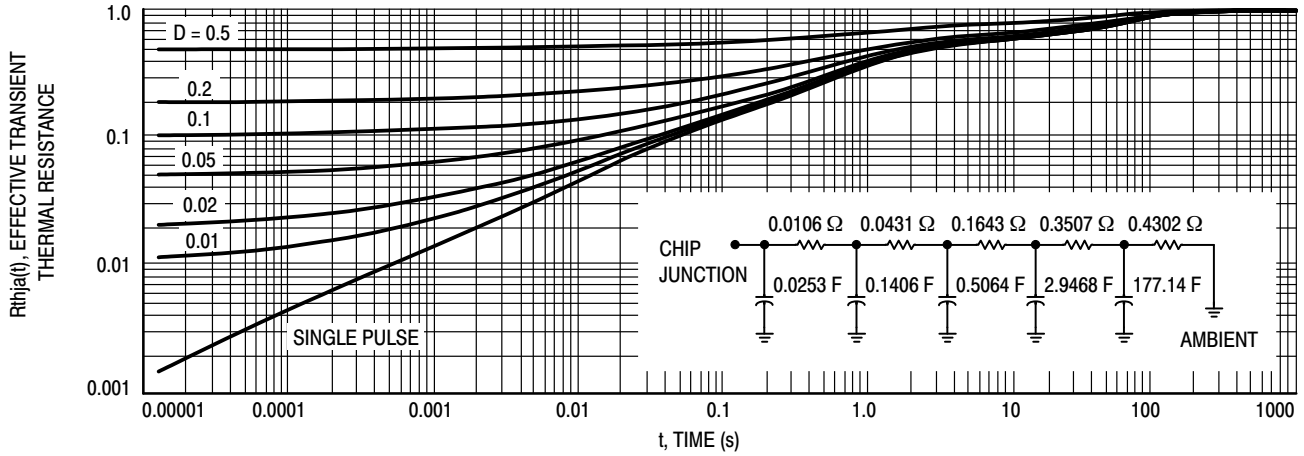


Figure 13. FET Thermal Response

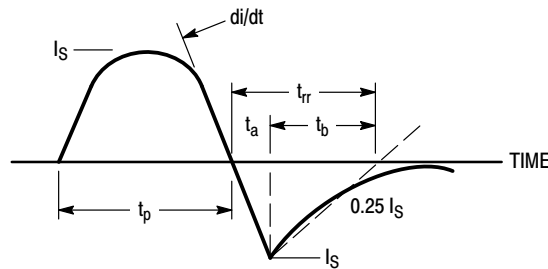


Figure 14. Diode Reverse Recovery Waveform

## TYPICAL SCHOTTKY ELECTRICAL CHARACTERISTICS

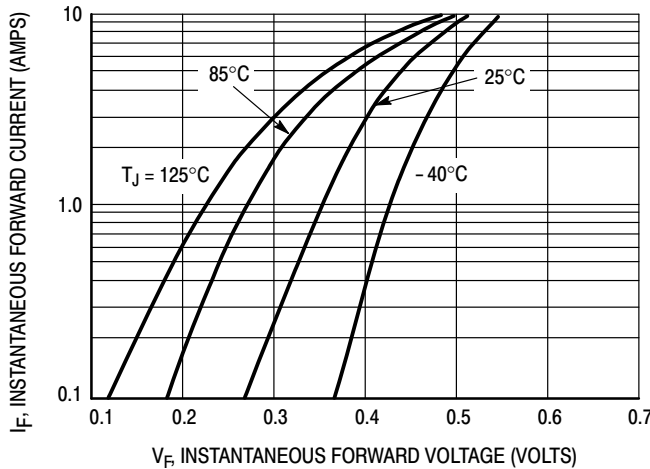


Figure 15. Typical Forward Voltage

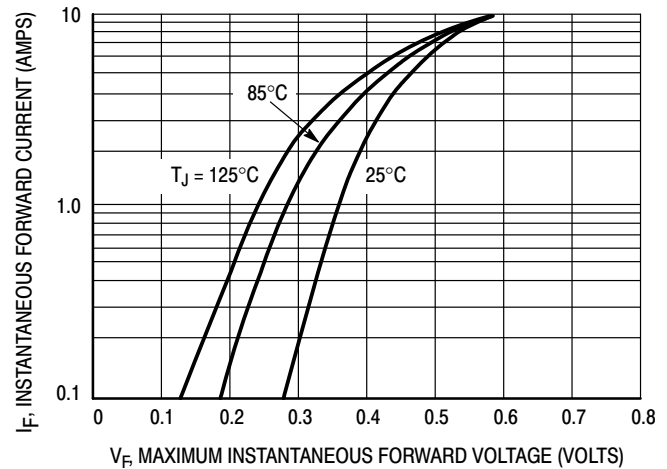


Figure 16. Maximum Forward Voltage

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## TYPICAL SCHOTTKY ELECTRICAL CHARACTERISTICS

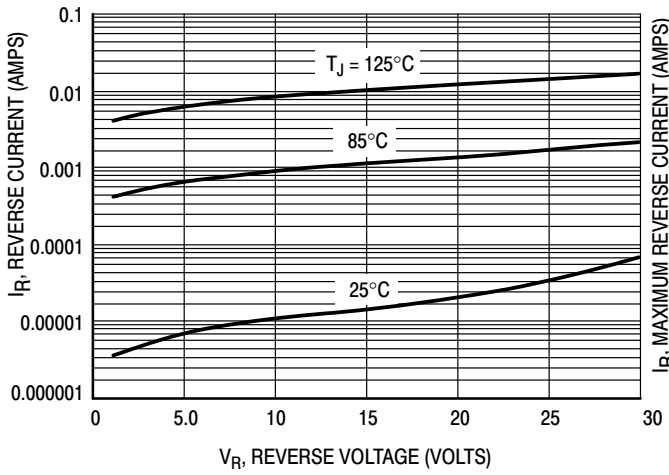


Figure 17. Typical Reverse Current

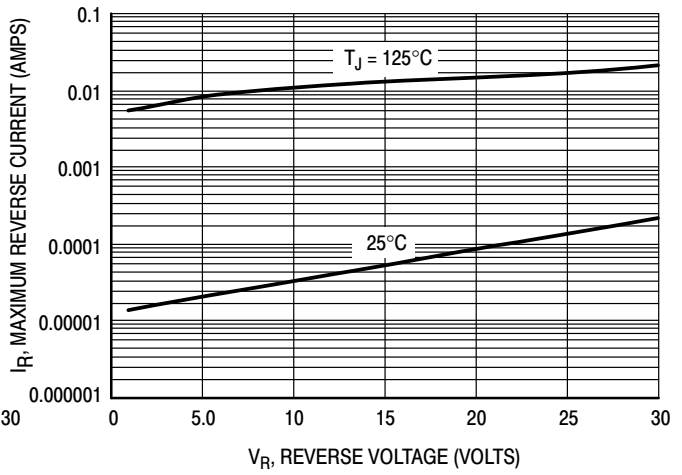


Figure 18. Maximum Reverse Current

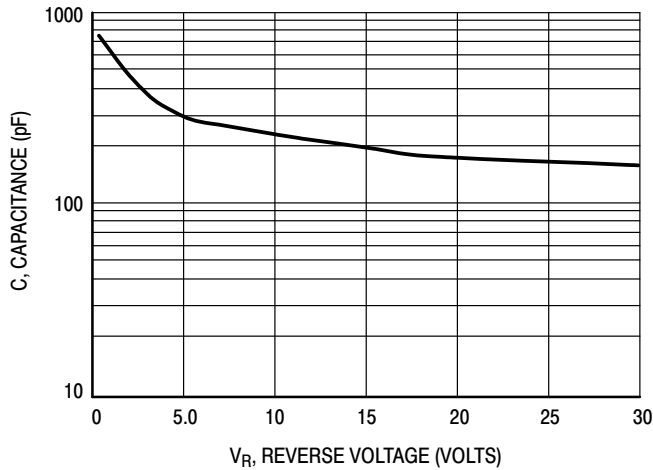


Figure 19. Typical Capacitance

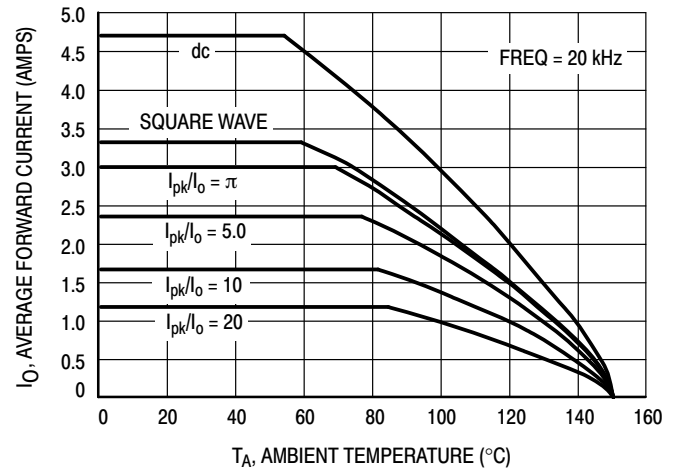


Figure 20. Current Derating

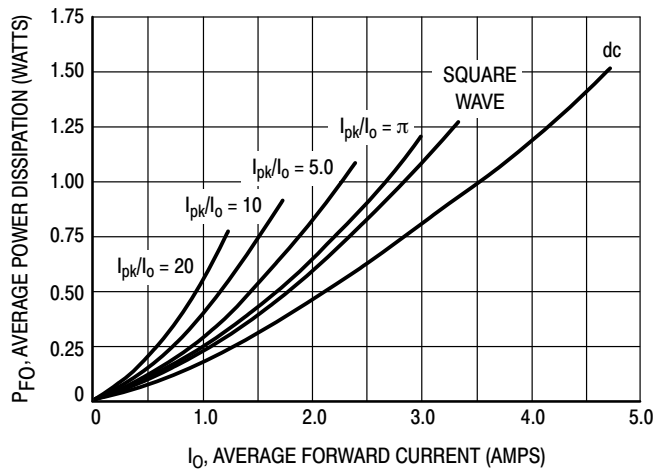


Figure 21. Forward Power Dissipation

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## TYPICAL SCHOTTKY ELECTRICAL CHARACTERISTICS

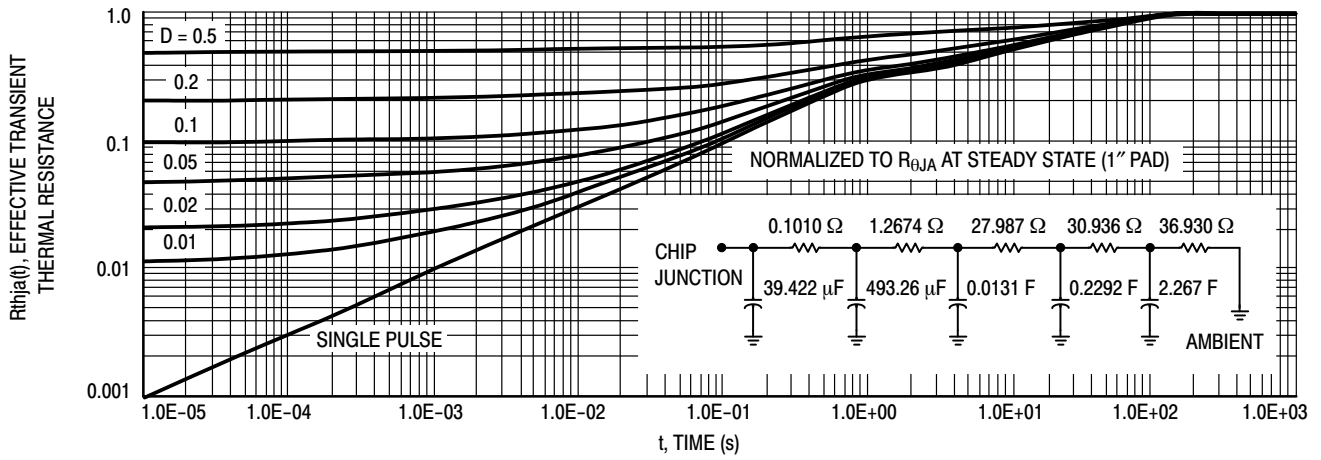
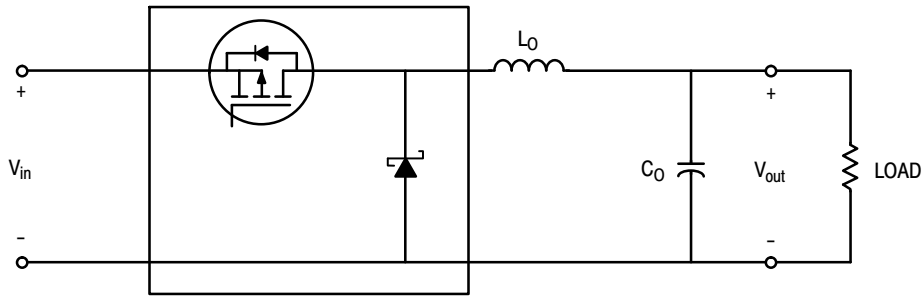


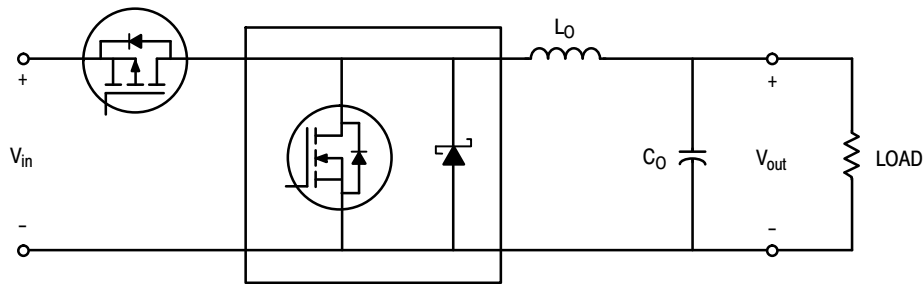
Figure 22. Schottky Thermal Response

## TYPICAL APPLICATIONS

### STEP DOWN SWITCHING REGULATORS



Buck Regulator

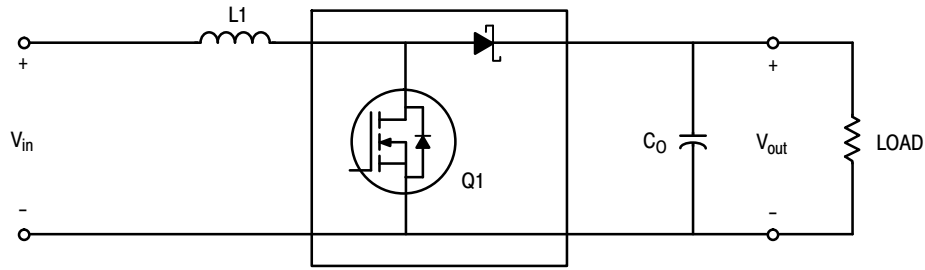


Synchronous Buck Regulator

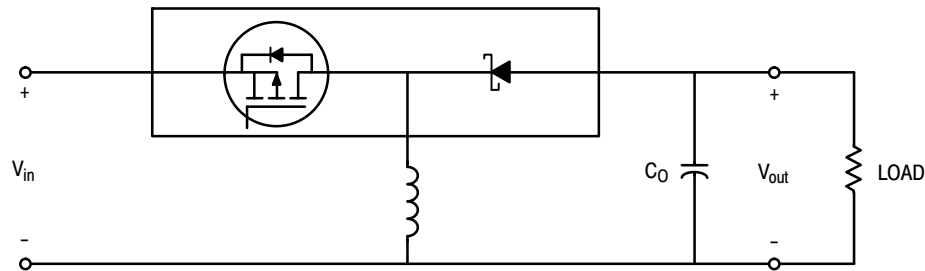
# NTMSD6N303, NVMSD6N303

## TYPICAL APPLICATIONS

### STEP UP SWITCHING REGULATORS

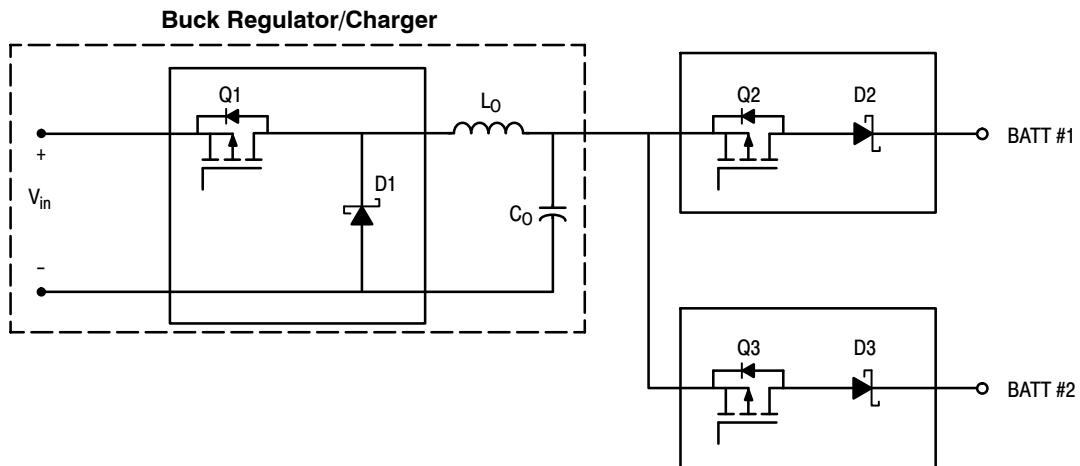


**Boost Regulator**



**Buck-Boost Regulator**

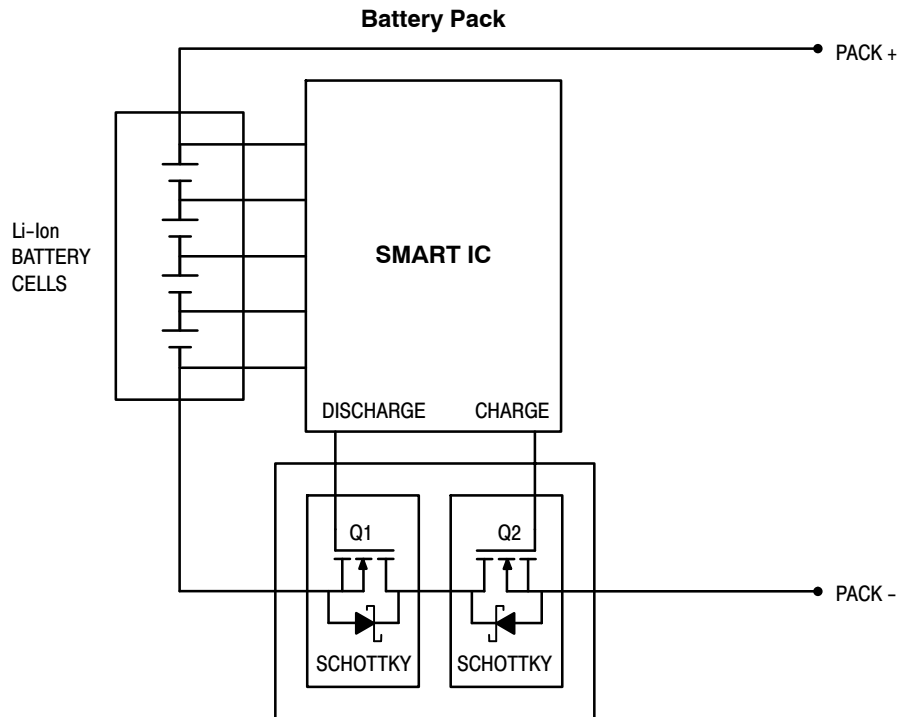
### MULTIPLE BATTERY CHARGERS



# NTMSD6N303, NVMSD6N303

## TYPICAL APPLICATIONS

### Li-Ion BATTERY PACK APPLICATIONS



- Applicable in battery packs which require a high current level.
- During charge cycle Q2 is on and Q1 is off. Schottky can reduce power loss during fast charge.
- During discharge Q1 is on and Q2 is off. Again, Schottky can reduce power dissipation.
- Under normal operation, both transistors are on.



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