# Power MOSFET 1 Amp, 20 Volts

# P-Channel SOT-23 Package

#### **Features**

• Ultra Low On-Resistance Provides Higher Efficiency and Extends Battery Life

 $R_{DS(on)} = 0.180 \ \Omega, \ V_{GS} = 10 \ V$ 

 $R_{DS(on)} = 0.280 \Omega$ ,  $V_{GS} = 4.5 V$ 

- Power Management in Portable and Battery-Powered Products
- Miniature SOT-23 Surface Mount Package Saves Board Space
- Mounting Information for SOT-23 Package Provided

#### **Applications**

- DC-DC Converters
- Computers
- Printers
- PCMCIA Cards
- Cellular and Cordless Telephones

#### **MAXIMUM RATINGS** (T<sub>J</sub> = 25°C unless otherwise noted)

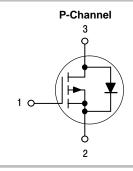
Rating	Symbol	Value	Unit
Drain-to-Source Voltage	$V_{DSS}$	20	Vdc
Gate-to-Source Voltage - Continuous	V <sub>GS</sub>	±20	Vdc
Drain Current - Continuous @ $T_A = 25^{\circ}C$ - Pulsed Drain Current $(t_p \le 1 \mu s)$	I <sub>D</sub>	1.0 2.67	Α
Total Power Dissipation @ T <sub>A</sub> = 25°C	P <sub>D</sub>	400	mW
Operating and Storage Temperature Range	T <sub>J</sub> , T <sub>stg</sub>	- 55 to 150	°C
Thermal Resistance - Junction-to-Ambient	$R_{\theta JA}$	300	°C/W
Maximum Lead Temperature for Soldering Purposes, 1/8" from case for 10 seconds	T <sub>L</sub>	260	°C



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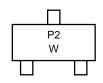
# 1 AMPERE 20 VOLTS 148 m $\Omega$ @ V<sub>GS</sub> = 10 V (Typ)



#### MARKING DIAGRAM

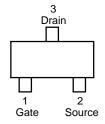


SOT-23 CASE 318 STYLE 21



P2 = Device Code W = Work Week

#### **PIN ASSIGNMENT**



#### **ORDERING INFORMATION**

Device	Package	Shipping	
NTR1P02T1	SOT-23	3000/Tape & Reel	
NTR1P02T3	SOT-23	10,000/Tape & Reel	

## **ELECTRICAL CHARACTERISTICS** (T<sub>A</sub> = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS	1		·		·
Drain-to-Source Breakdown Voltage (V <sub>GS</sub> = 0 Vdc, I <sub>D</sub> = 10 μAdc)	V <sub>(BR)DSS</sub>	20	-	-	Vdc
(Positive Temperature Coefficient)		-	32	-	mV/°C
Zero Gate Voltage Drain Current	I <sub>DSS</sub>				μAdc
$(V_{DS} = 20 \text{ Vdc}, V_{GS} = 0 \text{ Vdc}, T_{J} = 25^{\circ}\text{C})$ $(V_{DS} = 20 \text{ Vdc}, V_{GS} = 0 \text{ Vdc}, T_{J} = 150^{\circ}\text{C})$		-	-	1.0 10	
Gate-Body Leakage Current ( $V_{GS} = \pm 20 \text{ Vdc}$ , $V_{DS} = 0 \text{ Vdc}$ )	I <sub>GSS</sub>	-	-	±100	nAdc
ON CHARACTERISTICS (Note 1)					
Gate Threshold Voltage	V <sub>GS(th)</sub>				Vdc
$(V_{DS} = V_{GS}, I_D = 250 \mu Adc)$ (Negative Temperature Coefficient)		1.1 -	1.9 -4.0	2.3	mV/°C
Static Drain-to-Source On-State Resistance	R <sub>DS(on)</sub>				Ω
$(V_{GS} = 10 \text{ Vdc}, I_D = 1.5 \text{ Adc})$ $(V_{GS} = 4.5 \text{ Vdc}, I_D = 0.75 \text{ Adc})$		-	0.148 0.235	0.180 0.280	
DYNAMIC CHARACTERISTICS					
Input Capacitance $(V_{DS} = 5 \text{ Vdc}, V_{GS} = 0 \text{ Vdc}, f = 1.0 \text{ MHz})$	C <sub>iss</sub>	-	165	-	pF
Output Capacitance (V <sub>DS</sub> = 5 Vdc, V <sub>GS</sub> = 0 Vdc, f = 1.0 MHz)	C <sub>oss</sub>	-	110	-	
Reverse Transfer Capacitance (V <sub>DS</sub> = 5 Vdc, V <sub>GS</sub> = 0 Vdc, f = 1.0 MHz)	C <sub>rss</sub>	-	35	-	
SWITCHING CHARACTERISTICS (Note 2)	•		•	•	•
Turn-On Delay Time $(V_{DD}=15\ Vdc,\ I_D=1\ A,\ V_{GS}=5\ Vdc,\ R_G=2.5\ \Omega)$	t <sub>d(on)</sub>	-	7.0	-	ns
Rise Time $(V_{DD} = 15 \text{ Vdc}, I_D = 1 \text{ A}, V_{GS} = 5 \text{ Vdc}, R_G = 2.5 \Omega)$	t <sub>r</sub>	-	9.0	-	
Turn-Off Delay Time $(V_{DD} = 15 \text{ Vdc}, I_D = 1 \text{ A}, V_{GS} = 5 \text{ Vdc}, R_G = 2.5 \Omega)$	t <sub>d(off)</sub>	-	9.0	-	
Fall Time $(V_{DD} = 15 \text{ Vdc}, I_D = 1 \text{ A}, V_{GS} = 5 \text{ Vdc}, R_G = 2.5 \Omega)$	t <sub>f</sub>	=	3.0	-	
Total Gate Charge $(V_{DS} = 15 \text{ Vdc}, V_{GS} = 5 \text{ Vdc}, I_D = 0.8 \text{ A})$	Q <sub>tot</sub>	-	2.5	-	nC
Gate-Source Charge $(V_{DS} = 15 \text{ Vdc}, V_{GS} = 5 \text{ Vdc}, I_D = 0.8 \text{ A})$	$Q_{gs}$	-	0.75	-	
Gate-Drain Charge $(V_{DS} = 15 \text{ Vdc}, V_{GS} = 5 \text{ Vdc}, I_D = 0.8 \text{ A})$	Q <sub>gd</sub>	=	1.0	-	
BODY-DRAIN DIODE RATINGS (Note 1)			•		
Diode Forward On-Voltage (Note 2)	V <sub>SD</sub>				Vdc
$(I_S = 0.6 \text{ Adc}, V_{GS} = 0 \text{ V})$ $(I_S = 0.6 \text{ Adc}, V_{GS} = 0 \text{ V}, T_J = 150^{\circ}\text{C})$		1 1	0.8 0.6	1.0	
Reverse Recovery Time	t <sub>rr</sub>	-	13.5	-	ns
$(I_S = 1 \text{ A, } dI_S/dt = 100 \text{ A/}\mu\text{s, } V_{GS} = 0 \text{ V})$	t <sub>a</sub>	-	10.5	-	
	t <sub>b</sub>	-	3.0	-	
Reverse Recovery Stored Charge ( $I_S = 1 \text{ A}$ , $dI_S/dt = 100 \text{ A/}\mu\text{s}$ , $V_{GS} = 0 \text{ V}$ )	$Q_{RR}$	-	0.008	-	μС
Pulsa Tast: Pulsa Width < 300 us Duty Cycla < 2%	4		•		

Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2%.
 Switching characteristics are independent of operating junction temperature.

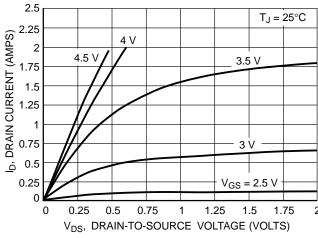


Figure 1. On-Region Characteristics

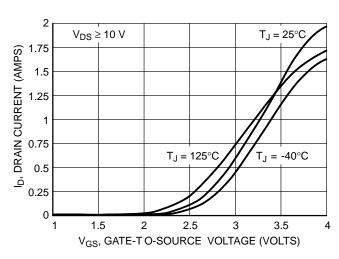


Figure 2. Transfer Characteristics

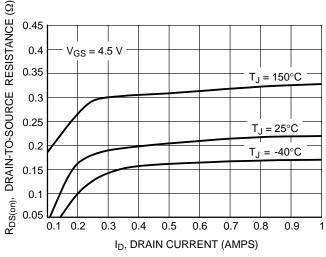


Figure 3. On-Resistance versus Drain Current and Temperature

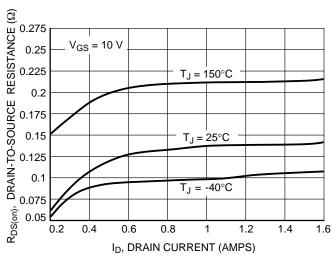


Figure 4. On-Resistance versus Drain Current and Temperature

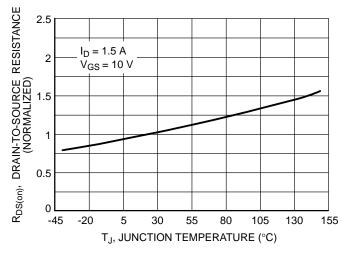


Figure 5. On-Resistance Variation with Temperature

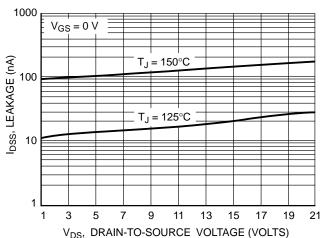


Figure 6. Drain-to-Source Leakage Current versus Voltage

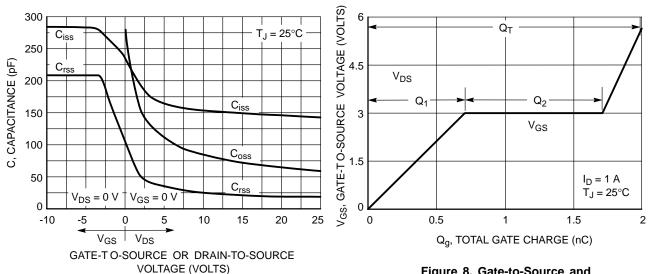


Figure 7. Capacitance Variation

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

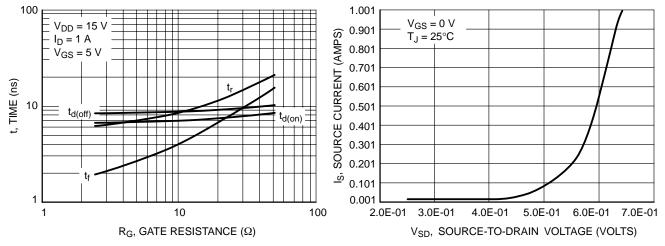


Figure 9. Resistive Switching Time Variation versus Gate Resistance

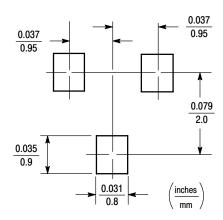
Figure 10. Diode Forward Voltage versus Current

#### INFORMATION FOR USING THE SOT-23 SURFACE MOUNT PACKAGE

#### MINIMUM RECOMMENDED FOOTPRINT FOR SURFACE MOUNTED APPLICATIONS

Surface mount board layout is a critical portion of the total design. The footprint for the semiconductor packages must be the correct size to insure proper solder connection

interface between the board and the package. With the correct pad geometry, the packages will self align when subjected to a solder reflow process.



#### **SOT-23 POWER DISSIPATION**

The power dissipation of the SOT-23 is a function of the drain pad size. This can vary from the minimum pad size for soldering to a pad size given for maximum power dissipation. Power dissipation for a surface mount device is determined by  $T_{J(max)}$ , the maximum rated junction temperature of the die,  $R_{\theta JA}$ , the thermal resistance from the device junction to ambient, and the operating temperature,  $T_A$ . Using the values provided on the data sheet for the SOT-23 package,  $P_D$  can be calculated as follows:

$$P_D = \frac{T_{J(max)} - T_A}{R_{\theta JA}}$$

The values for the equation are found in the maximum ratings table on the data sheet. Substituting these values into the equation for an ambient temperature  $T_A$  of 25°C,

one can calculate the power dissipation of the device which in this case is 416 milliwatts.

$$P_D = \frac{150^{\circ}C - 25^{\circ}C}{300^{\circ}C/W} = 416 \text{ milliwatts}$$

The 300°C/W for the SOT-23 package assumes the use of the recommended footprint on a glass epoxy printed circuit board to achieve a power dissipation of 416 milliwatts. There are other alternatives to achieving higher power dissipation from the SOT-23 package. Another alternative would be to use a ceramic substrate or an aluminum core board such as Thermal Clad<sup>®</sup>. Using a board material such as Thermal Clad, an aluminum core board, the power dissipation can be doubled using the same footprint.

#### **SOLDERING PRECAUTIONS**

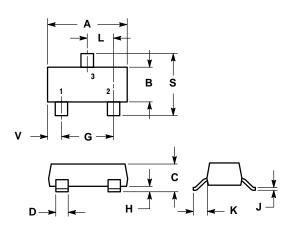
The melting temperature of solder is higher than the rated temperature of the device. When the entire device is heated to a high temperature, failure to complete soldering within a short time could result in device failure. Therefore, the following items should always be observed in order to minimize the thermal stress to which the devices are subjected.

- Always preheat the device.
- The delta temperature between the preheat and soldering should be 100°C or less.\*
- When preheating and soldering, the temperature of the leads and the case must not exceed the maximum temperature ratings as shown on the data sheet. When using infrared heating with the reflow soldering method, the difference shall be a maximum of 10°C.

- The soldering temperature and time shall not exceed 260°C for more than 10 seconds.
- When shifting from preheating to soldering, the maximum temperature gradient shall be 5°C or less.
- After soldering has been completed, the device should be allowed to cool naturally for at least three minutes.
   Gradual cooling should be used as the use of forced cooling will increase the temperature gradient and result in latent failure due to mechanical stress.
- Mechanical stress or shock should not be applied during cooling.
- \* \* Soldering a device without preheating can cause excessive thermal shock and stress which can result in damage to the device.

#### **PACKAGE DIMENSIONS**

**SOT-23 (TO-236)** CASE 318-09 **ISSUE AH** 



- NOTES:
  1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
  2. CONTROLLING DIMENSION: INCH.
  3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH THICKNESS. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF BASE MATERIAL.
  4. 318-01, -02, AND -06 OBSOLETE, NEW STANDARD 318-09.

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
Α	0.1102	0.1197	2.80	3.04
В	0.0472	0.0551	1.20	1.40
С	0.0385	0.0498	0.99	1.26
D	0.0140	0.0200	0.36	0.50
G	0.0670	0.0826	1.70	2.10
Н	0.0040	0.0098	0.10	0.25
J	0.0034	0.0070	0.085	0.177
K	0.0180	0.0236	0.45	0.60
L	0.0350	0.0401	0.89	1.02
S	0.0830	0.0984	2.10	2.50
V	0.0177	0.0236	0.45	0.60

- STYLE 21:
  PIN 1. GATE
  2. SOURCE
  3. DRAIN

# **Notes**

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