

# NTLGD3502N

## MOSFET – Power, Dual, N-Channel, DFN6 3X3 mm 20 V, 5.8 A/4.6 A



ON Semiconductor®

<http://onsemi.com>

### Features

- Exposed Drain Package
- Excellent Thermal Resistance for Superior Heat Dissipation
- Low Threshold Levels
- Low Profile (< 1 mm) Allows It to Fit Easily into Extremely Thin Environments
- This is a Pb-Free Device

### Applications

- DC-DC Converters (Buck and Boost Circuits)
- Power Supplies
- Hard Disk Drives

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

Parameter	Symbol	Value	Unit		
Drain-to-Source Voltage	V <sub>DSS</sub>	20	V		
Gate-to-Source Voltage	V <sub>GS</sub>	±20	V		
Continuous Drain Current (Note 1)	Steady State	T <sub>A</sub> = 25°C	4.3	A	
		T <sub>A</sub> = 85°C	3.0		
	t ≤ 5.0 s	T <sub>A</sub> = 25°C	5.8		
Power Dissipation (Note 1)	Steady State	T <sub>A</sub> = 25°C	P <sub>D</sub>	1.74	W
Pulsed Drain Current	t ≤ 10 μs	I <sub>DM</sub>	17.2	A	
Operating Junction and Storage Temperature	T <sub>J</sub> , T <sub>STG</sub>	-55 to 150	°C		
Source Current (Body Diode)	I <sub>S</sub>	1.6	A		
Lead Temperature for Soldering Purposes (1/8" from case for 10 s)	T <sub>L</sub>	260	°C		

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

Parameter	Symbol	Value	Unit		
Drain-to-Source Voltage	V <sub>DSS</sub>	20	V		
Gate-to-Source Voltage	V <sub>GS</sub>	±12	V		
Continuous Drain Current (Note 1)	Steady State	T <sub>A</sub> = 25°C	3.6	A	
		T <sub>A</sub> = 85°C	2.5		
	t ≤ 5.0 s	T <sub>A</sub> = 25°C	4.6		
Power Dissipation (Note 1)	Steady State	T <sub>A</sub> = 25°C	P <sub>D</sub>	1.74	W
Pulsed Drain Current	t ≤ 10 μs	I <sub>DM</sub>	13.8	A	
Operating Junction and Storage Temperature	T <sub>J</sub> , T <sub>STG</sub>	-55 to 150	°C		
Source Current (Body Diode)	I <sub>S</sub>	1.7	A		
Lead Temperature for Soldering Purposes (1/8" from case for 10 s)	T <sub>L</sub>	260	°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)

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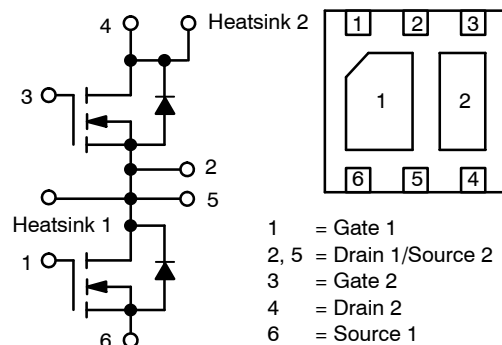
<http://onsemi.com>

#### MOSFET I

V <sub>(BR)DSS</sub>	R <sub>DS(on)</sub> MAX	I <sub>D</sub> MAX
20 V	60 mΩ @ 4.5 V	5.8 A

#### MOSFET II

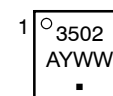
V <sub>(BR)DSS</sub>	R <sub>DS(on)</sub> MAX	I <sub>D</sub> MAX
20 V	90 mΩ @ 4.5 V	4.6 A



#### MARKING DIAGRAMS



DFN6  
CASE 506AG



- 3502 = Specific Device Code
- A = Assembly Location
- Y = Year
- WW = Work Week
- = Pb-Free Package

#### ORDERING INFORMATION

Device	Package	Shipping†
NTLGD3502NT1G	DFN6 (Pb-free)	3000/Tape & Reel
NTLGD3502NT2G	DFN6 (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 Specifications Brochure, BRD8011/D.

## NTLGD3502N

2. Surface Mounted on FR4 Board using the minimum recommended pad size of 30 mm<sup>2</sup>, 1 oz. Cu

# NTLGD3502N

## THERMAL RESISTANCE RATINGS

Parameter	Symbol	Max	Unit
Junction-to-Ambient – Steady State (Note 1)	$R_{\theta JA}$	72	°C/W
Junction-to-Ambient – $t \leq 5$ s (Note 1)	$R_{\theta JA}$	40	
Junction-to-Ambient – Steady State min Pad (Note 2)	$R_{\theta JA}$	110	
Junction-to-Ambient – Pulsed (25% duty cycle) min Pad (Note 2)	$R_{\theta JA}$	60	

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

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
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### Off Characteristics

Drain-to-Source Breakdown Voltage	$V_{(BR)DSS}$	$V_{GS} = 0\text{ V}, I_D = 250\ \mu\text{A}$	20			V
Drain-to-Source Breakdown Voltage Temperature Coefficient	$V_{(BR)DSS}/T_J$	$I_D = 250\ \mu\text{A}$ , ref to $25^\circ\text{C}$		10		mV/°C
Zero Gate Voltage Drain Current	$I_{DSS}$	$V_{GS} = 0\text{ V}, V_{DS} = 16\text{ V}$	$T_J = 25^\circ\text{C}$		1.0	$\mu\text{A}$
			$T_J = 125^\circ\text{C}$		10	
Gate-to-Source Leakage Current	$I_{GSS}$	$V_{DS} = 0\text{ V}, V_{GS} = \pm 20\text{ V}$			$\pm 100$	nA

### On Characteristics (Note 3)

Gate Threshold Voltage	$V_{GS(TH)}$	$V_{GS} = V_{DS}, I_D = 250\ \mu\text{A}$	1.0	1.7	2.0	V
Negative Threshold Temperature Coefficient	$V_{GS(TH)}/T_J$			-4.4		mV/°C
Drain-to-Source On Resistance	$R_{DS(on)}$	$V_{GS} = 4.5\text{ V}, I_D = 4.3\text{ A}$		50	60	m $\Omega$
Forward Transconductance	$g_{FS}$	$V_{DS} = 10\text{ V}, I_D = 4.0\text{ A}$		5.9		S

### Charges, Capacitances & Gate Resistance

Input Capacitance	$C_{ISS}$	$V_{GS} = 0\text{ V}, f = 1\text{ MHz}, V_{DS} = 10\text{ V}$		250	480	pF
Output Capacitance	$C_{OSS}$			138	200	
Reverse Transfer Capacitance	$C_{RSS}$			52	90	
Total Gate Charge	$Q_{G(TOT)}$	$V_{GS} = 4.5\text{ V}, V_{DS} = 10\text{ V}; I_D = 4.3\text{ A}$ (Note 3)		2.9	4.0	nC
Gate-to-Source Charge	$Q_{GS}$			1.0		
Gate-to-Drain Charge	$Q_{GD}$			1.1		
Gate Resistance	$R_G$			1.5		

### Switching Characteristics, $V_{GS} = 4.5\text{ V}$ (Note 4)

Turn-On Delay Time	$t_{d(ON)}$	$V_{GS} = 4.5\text{ V}, V_{DD} = 10\text{ V},$ $I_D = 4.3\text{ A}, R_G = 10\ \Omega$		7.0	12	ns
Rise Time	$t_r$			17.5	25	
Turn-Off Delay Time	$t_{d(OFF)}$			8.6	15	
Fall Time	$t_f$			3.3	5.0	

### Drain-Source Diode Characteristics

Forward Diode Voltage	$V_{SD}$	$V_{GS} = 0\text{ V}, I_S = 1.6\text{ A}$	$T_J = 25^\circ\text{C}$		0.78	1.2	V
			$T_J = 125^\circ\text{C}$		0.63		
Reverse Recovery Time	$t_{RR}$	$V_{GS} = 0\text{ V}, d_{ISD}/d_t = 100\text{ A}/\mu\text{s},$ $I_S = 1.0\text{ A}$		16.7		ns	
Charge Time	$t_a$			8.2			
Discharge Time	$t_b$			8.5			
Reverse Recovery Charge	$Q_{RR}$			7.0		nC	

3. Pulse Test: pulse width  $\leq 300\ \mu\text{s}$ , duty cycle  $\leq 2\%$

4. Switching characteristics are independent of operating junction temperatures

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

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
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### Off Characteristics

Drain-to-Source Breakdown Voltage	$V_{(BR)DSS}$	$V_{GS} = 0\text{ V}, I_D = 250\ \mu\text{A}$	20			V
Drain-to-Source Breakdown Voltage Temperature Coefficient	$V_{(BR)DSS}/T_J$	$I_D = 250\ \mu\text{A}$ , ref to $25^\circ\text{C}$		22		$\text{mV}/^\circ\text{C}$
Zero Gate Voltage Drain Current	$I_{DSS}$	$V_{GS} = 0\text{ V}, V_{DS} = 16\text{ V}$	$T_J = 25^\circ\text{C}$		1	$\mu\text{A}$
			$T_J = 125^\circ\text{C}$		10	
Gate-to-Source Leakage Current	$I_{GSS}$	$V_{DS} = 0\text{ V}, V_{GS} = \pm 12\text{ V}$			$\pm 100$	nA

### On Characteristics (Note 5)

Gate Threshold Voltage	$V_{GS(TH)}$	$V_{GS} = V_{DS}, I_D = 250\ \mu\text{A}$	0.6		2.0	V
Negative Threshold Temperature Coefficient	$V_{GS(TH)}/T_J$			-2.8		$\text{mV}/^\circ\text{C}$
Drain-to-Source On Resistance	$R_{DS(on)}$	$V_{GS} = 4.5\text{ V}, I_D = 3.4\text{ A}$		70	90	$\text{m}\Omega$
		$V_{GS} = 2.5\text{ V}, I_D = 1.7\text{ A}$		95	120	
Forward Transconductance	$g_{FS}$	$V_{DS} = 10\text{ V}, I_D = 3.4\text{ A}$		6.7		S

### Charges, Capacitances & Gate Resistance

Input Capacitance	$C_{ISS}$	$V_{GS} = 0\text{ V}, f = 1\text{ MHz}, V_{DS} = 10\text{ V}$		144	275	$\text{pF}$
Output Capacitance	$C_{OSS}$			67	125	
Reverse Transfer Capacitance	$C_{RSS}$			22	40	
Total Gate Charge	$Q_{G(TOT)}$	$V_{GS} = 4.5\text{ V}, V_{DS} = 10\text{ V}; I_D = 3.4\text{ A}$		2.1	5.0	$\text{nC}$
Threshold Gate Charge	$Q_{G(TH)}$			0.11		
Gate-to-Source Charge	$Q_{GS}$			0.42		
Gate-to-Drain Charge	$Q_{GD}$			0.7		

### Switching Characteristics, $V_{GS} = 4.5\text{ V}$ (Note 6)

Turn-On Delay Time	$t_{d(ON)}$	$V_{GS} = 4.5\text{ V}, V_{DD} = 16\text{ V},$ $I_D = 3.4\text{ A}, R_G = 10\ \Omega$		4.8	10	ns
Rise Time	$t_r$			13.6	25	
Turn-Off Delay Time	$t_{d(OFF)}$			9.0	20	
Fall Time	$t_f$			1.9	5.0	

### Drain-Source Diode Characteristics

Forward Diode Voltage	$V_{SD}$	$V_{GS} = 0\text{ V}, I_S = 1.7\text{ A}$	$T_J = 25^\circ\text{C}$		0.8	1.15	V
			$T_J = 150^\circ\text{C}$		0.63		
Reverse Recovery Time	$t_{RR}$	$V_{GS} = 0\text{ V}, d_{ISD}/d_t = 100\text{ A}/\mu\text{s},$ $I_S = 1.0\text{ A}$		12		ns	
Charge Time	$t_a$			8.0			
Discharge Time	$t_b$			4.0			
Reverse Recovery Charge	$Q_{RR}$			5.0			nC

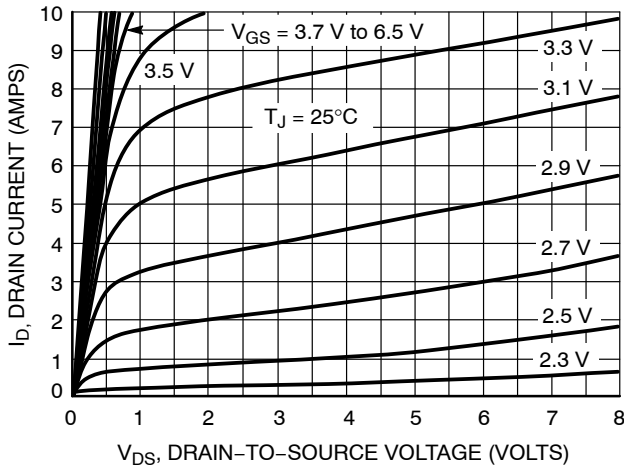
5. Pulse Test: pulse width  $\leq 300\ \mu\text{s}$ , duty cycle  $\leq 2\%$

6. Switching characteristics are independent of operating junction temperatures

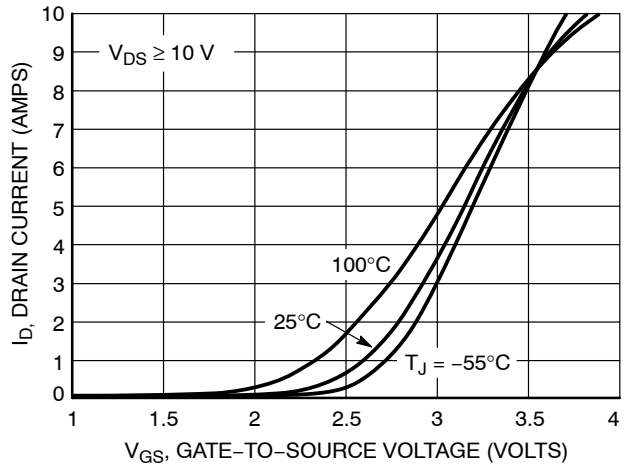
# NTLGD3502N

## TYPICAL MOSFET I N-CHANNEL PERFORMANCE CURVES

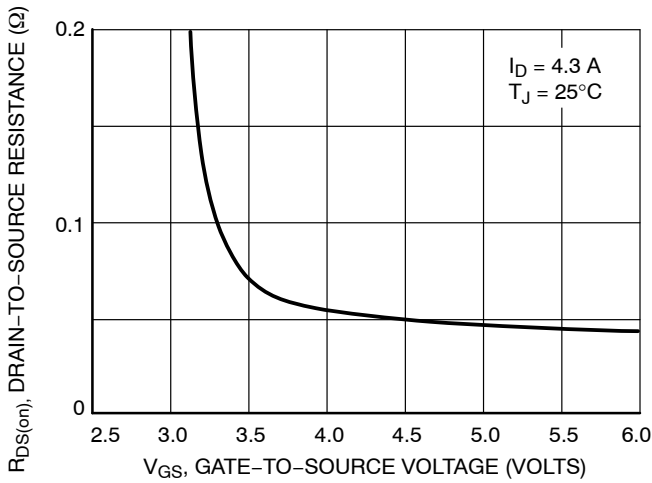
( $T_J = 25^\circ\text{C}$  unless otherwise noted)



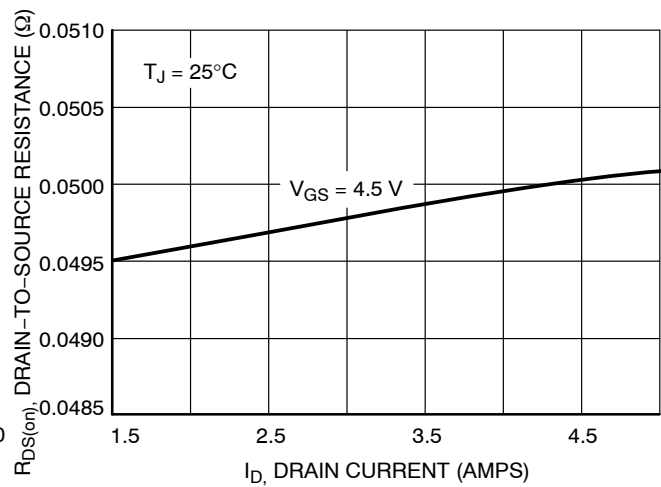
**Figure 1. On-Region Characteristics**



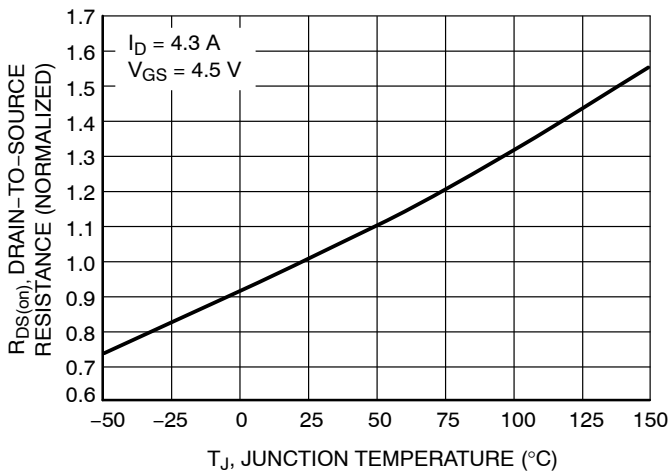
**Figure 2. Transfer Characteristics**



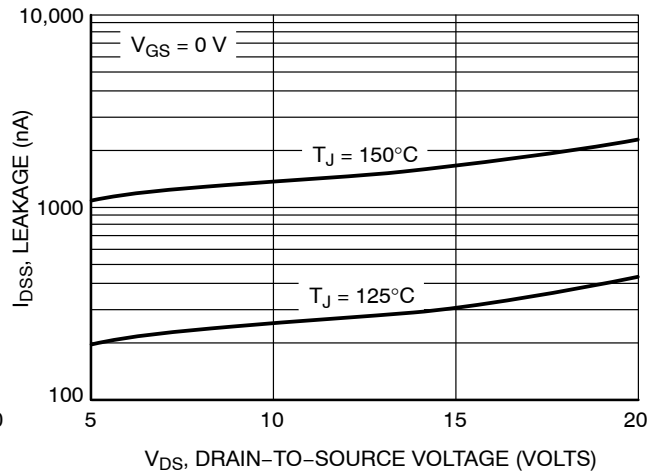
**Figure 3. On-Resistance vs. Gate-to-Source Voltage**



**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**

# NTLGD3502N

## TYPICAL MOSFET I N-CHANNEL PERFORMANCE CURVES

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

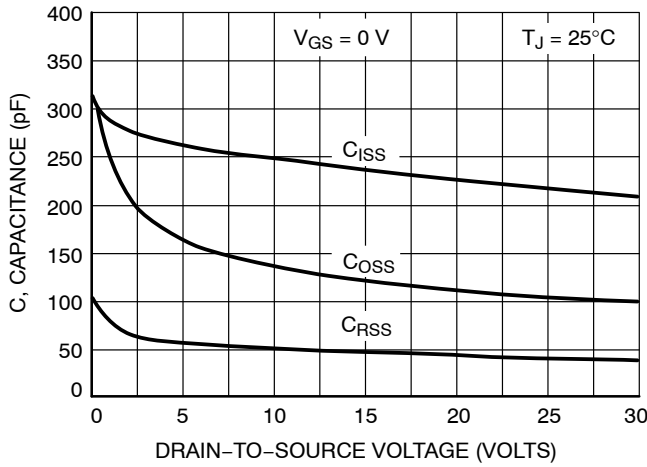


Figure 7. Capacitance Variation

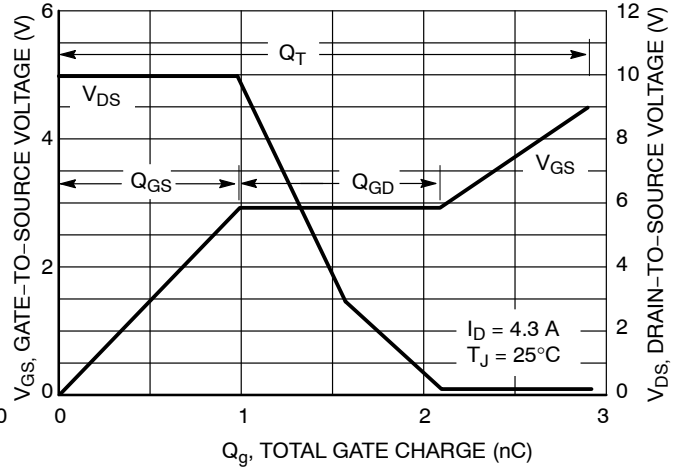


Figure 8. Gate-to-Source and Drain-to-Source Voltage vs. Total Charge

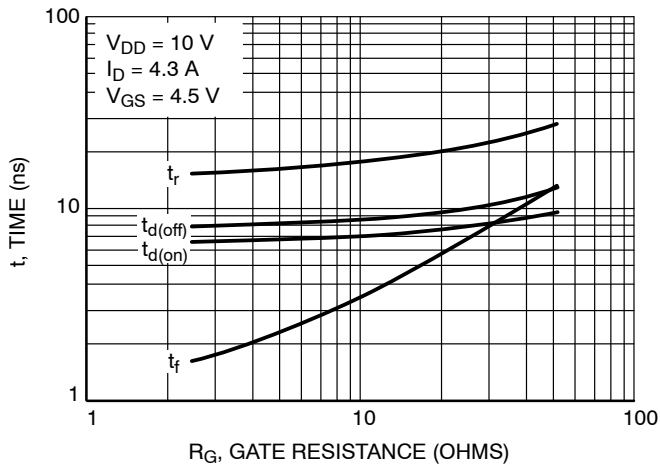


Figure 9. Resistive Switching Time Variation vs. Gate Resistance

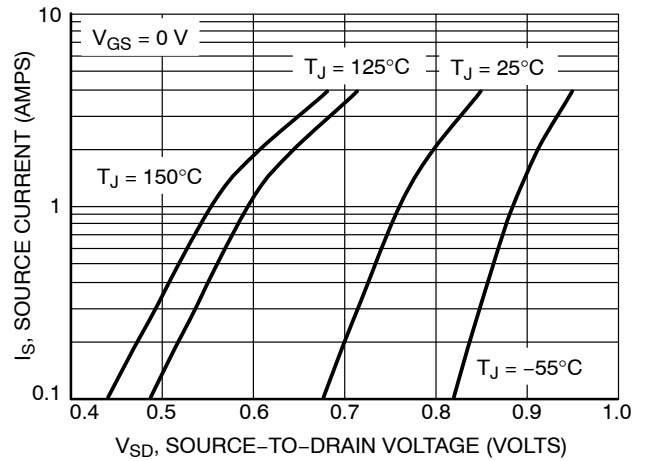


Figure 10. Diode Forward Voltage vs. Current

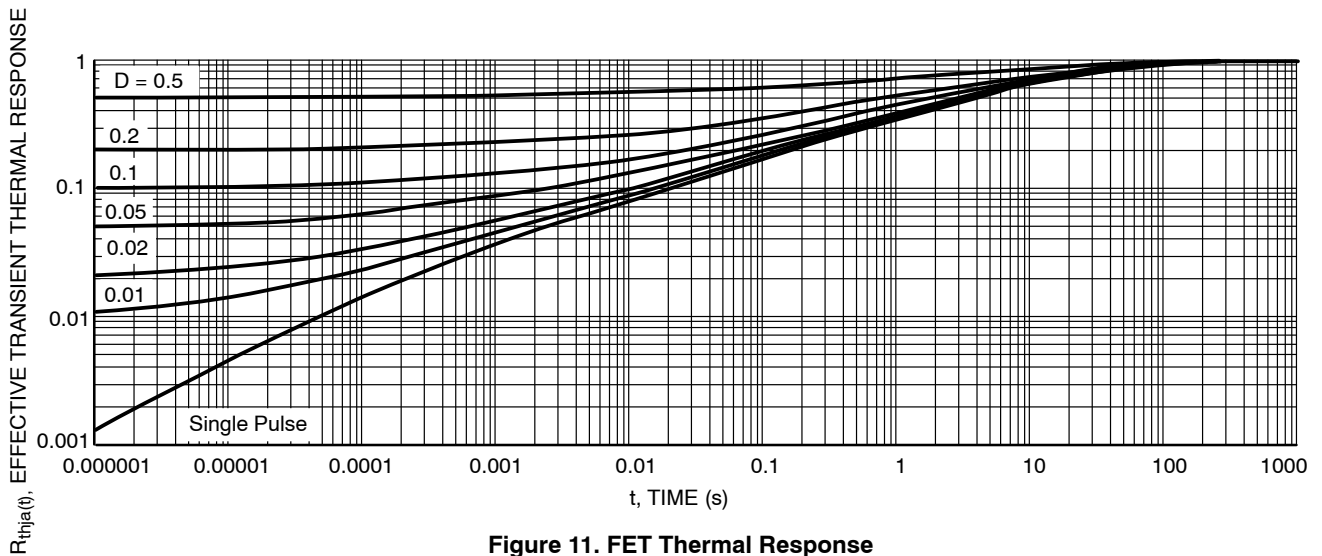


Figure 11. FET Thermal Response

# NTLGD3502N

## TYPICAL MOSFET II N-CHANNEL PERFORMANCE CURVES

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

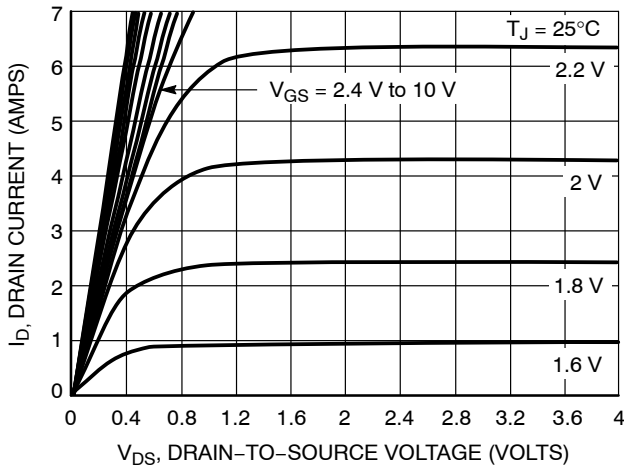


Figure 12. On-Region Characteristics

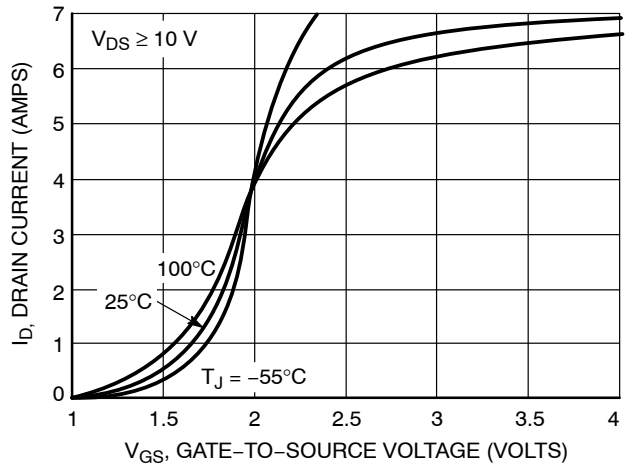


Figure 13. Transfer Characteristics

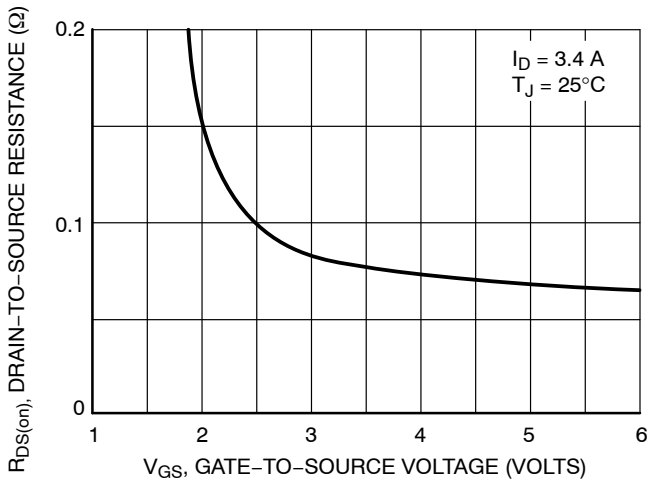


Figure 14. On-Resistance vs. Gate-to-Source Voltage

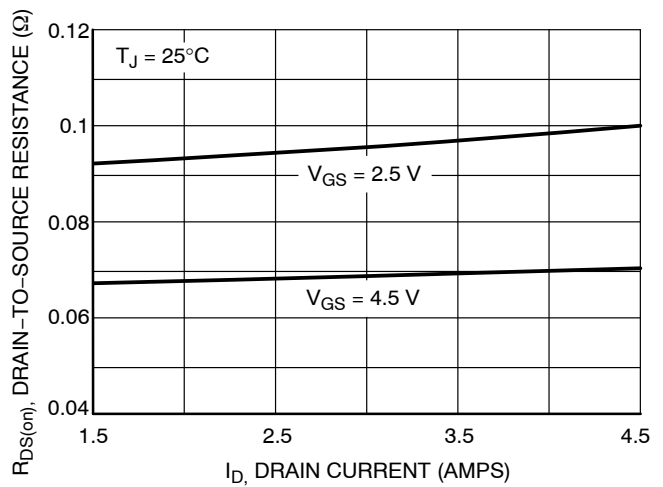


Figure 15. On-Resistance vs. Drain Current and Gate Voltage

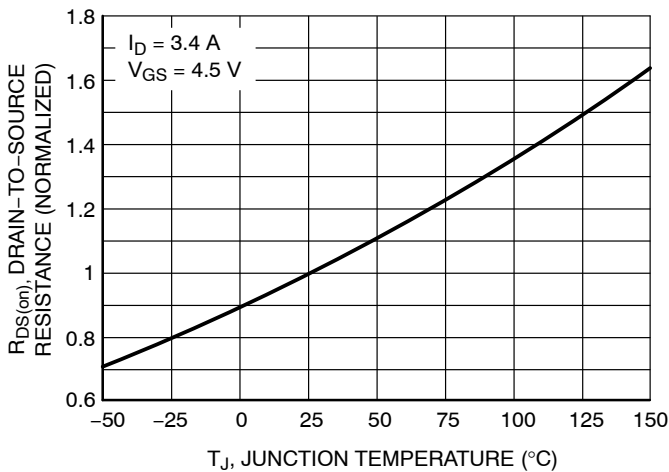


Figure 16. On-Resistance Variation with Temperature

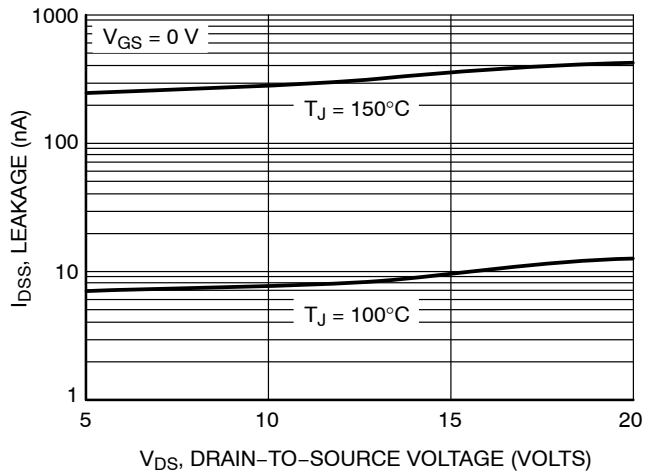


Figure 17. Drain-to-Source Leakage Current vs. Voltage

# NTLGD3502N

## TYPICAL MOSFET II N-CHANNEL PERFORMANCE CURVES

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

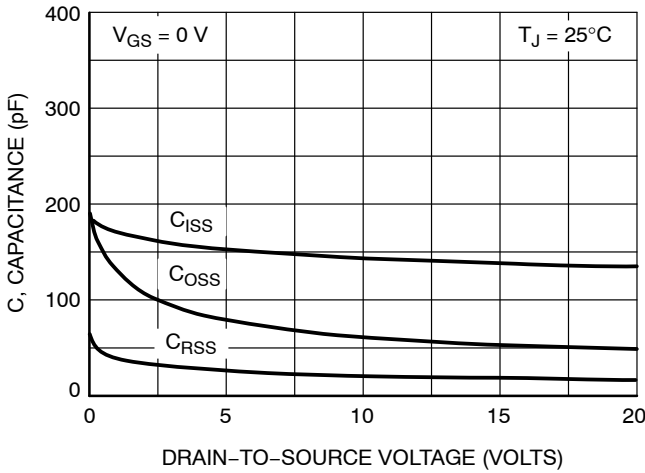


Figure 18. Capacitance Variation

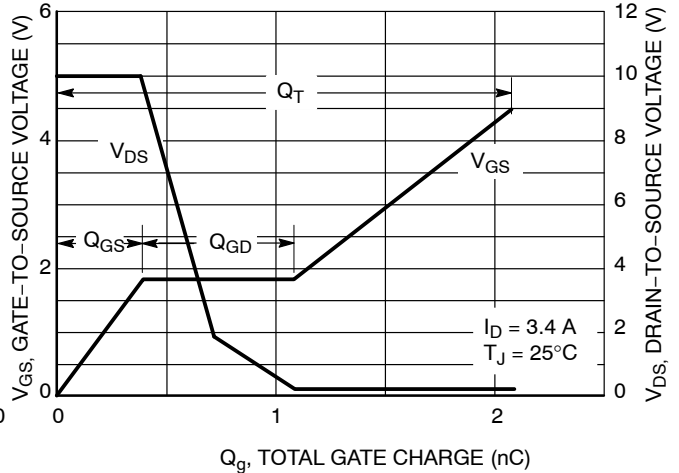


Figure 19. Gate-to-Source and Drain-to-Source Voltage vs. Total Charge

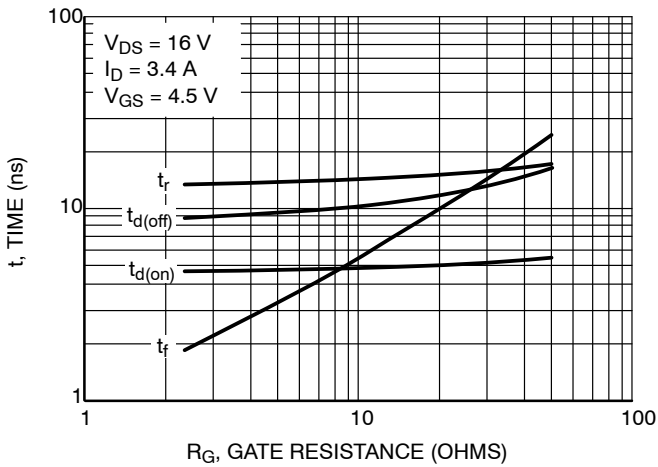


Figure 20. Resistive Switching Time Variation vs. Gate Resistance

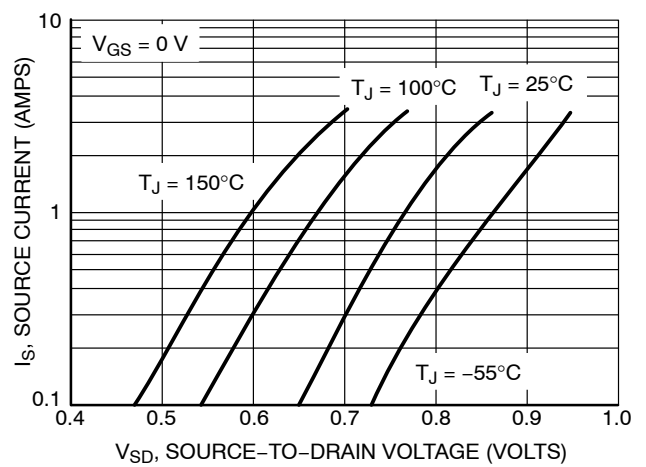


Figure 21. Diode Forward Voltage vs. Current

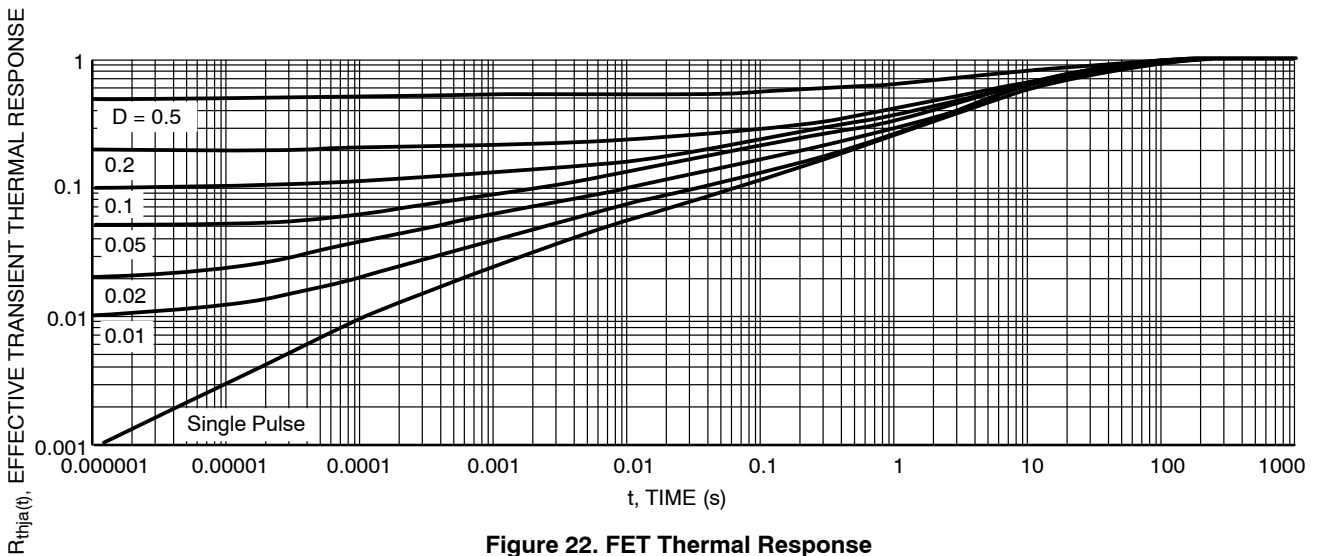


Figure 22. FET Thermal Response



# MECHANICAL CASE OUTLINE

## PACKAGE DIMENSIONS

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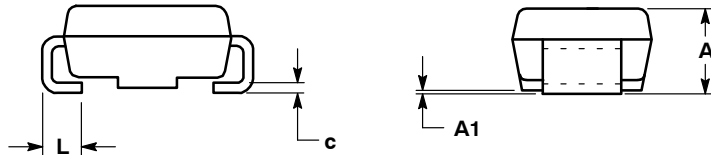
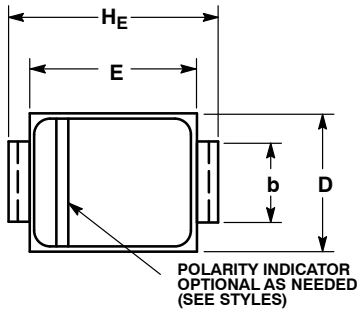


STYLE 1    STYLE 2

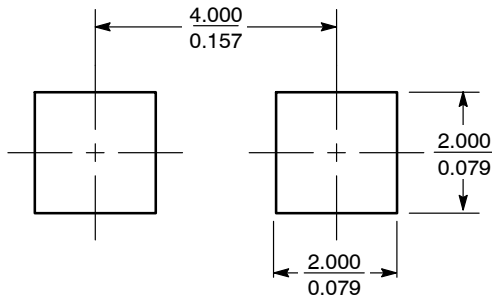
SCALE 1:1

### SMA CASE 403D ISSUE H

DATE 23 SEP 2015



#### SOLDERING FOOTPRINT\*



SCALE 8:1 (mm/inches)

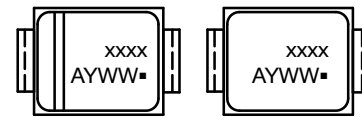
\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

#### NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION b SHALL BE MEASURED WITHIN DIMENSION L.

DIM	MILLIMETERS			INCHES		
	MIN	NOM	MAX	MIN	NOM	MAX
A	1.97	2.10	2.20	0.078	0.083	0.087
A1	0.05	0.10	0.20	0.002	0.004	0.008
b	1.27	1.45	1.63	0.050	0.057	0.064
c	0.15	0.28	0.41	0.006	0.011	0.016
D	2.29	2.60	2.92	0.090	0.103	0.115
E	4.06	4.32	4.57	0.160	0.170	0.180
HE	4.83	5.21	5.59	0.190	0.205	0.220
L	0.76	1.14	1.52	0.030	0.045	0.060

#### GENERIC MARKING DIAGRAM\*



STYLE 1

STYLE 2

- xxxx = Specific Device Code
- A = Assembly Location
- Y = Year
- WW = Work Week
- = Pb-Free Package

\*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.

STYLE 1:  
PIN 1. CATHODE (POLARITY BAND)  
2. ANODE

STYLE 2:  
NO POLARITY

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<b>DESCRIPTION:</b>	<b>SMA</b>	<b>PAGE 1 OF 1</b>

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