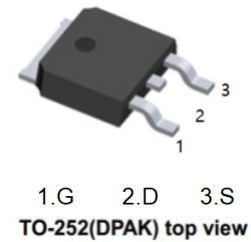


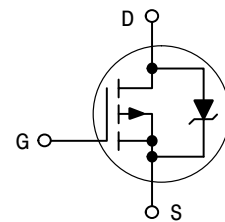
**General Description**

This Power MOSFET is designed to withstand high energy in the avalanche and commutation modes. Designed for low-voltage, high-speed switching applications in power supplies, converters, and power motor controls, these devices are particularly well suited for bridge circuits where diode speed and commutating safe operating areas are critical and offer an additional safety margin against unexpected voltage transients.



**Features**

- $V_{DS}$  (V) = -60V
- $R_{DS(on)} = 150\text{ m}\Omega (V_{GS} = -10V)$
- $I_D = -12A (V_{GS} = -10V)$
- Avalanche Energy Specified
- $I_{DSS}$  and  $V_{DS(on)}$  Specified at Elevated Temperature
- Designed for Low-Voltage, High-Speed Switching Applications and to Withstand High Energy in the Avalanche and Commutation Modes



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

Rating	Symbol	Value	Unit
Drain-to-Source Voltage	$V_{DSS}$	-60	Vdc
Gate-to-Source Voltage	$V_{GS}$	$\pm 20$	Vdc
- Continuous	$V_{GSM}$	$\pm 25$	Vpk
- Non-repetitive ( $t_p \leq 10\text{ ms}$ )			
Drain Current	$I_D$	-12	A dc
- Continuous @ $T_a = 25\text{ }^\circ\text{C}$	$I_{DM}$	-36	A pk
- Single Pulse ( $t_p \leq 10\text{ ms}$ )			
Total Power Dissipation @ $T_a = 25\text{ }^\circ\text{C}$	$P_D$	55	W
Operating and Storage Temperature Range	$T_J, T_{stg}$	-55 to 175	$^\circ\text{C}$
Single Pulse Drain-to-Source Avalanche Energy - Starting $T_J = 25\text{ }^\circ\text{C}$ ( $V_{DD} = 25\text{ Vdc}$ , $V_{GS} = 10\text{ Vdc}$ , Peak $I_L = 12\text{ Apk}$ , $L = 3.0\text{ mH}$ , $R_G = 25\text{ }\Omega$ )	$E_{AS}$	216	mJ
Thermal Resistance	$R_{\theta JC}$	2.73	$^\circ\text{C/W}$
- Junction-to-Case	$R_{\theta JA}$	71.4	
- Junction-to-Ambient (Note 1)	$R_{\theta JA}$	100	
- Junction-to-Ambient (Note 2)			
Maximum Lead Temperature for Soldering Purposes, 1/8 in. from case for 10 seconds	$T_L$	260	$^\circ\text{C}$

Maximum ratings are those values beyond which device damage can occur. Maximum ratings applied to the device are individual stress limit values (not normal operating conditions) and are not valid simultaneously. If these limits are exceeded, device functional operation is not implied, damage may occur and reliability may be affected.

1. When surface mounted to an FR4 board using 1 in pad size (Cu area = 1.127 in<sup>2</sup>).
2. When surface mounted to an FR4 board using the minimum recommended pad size (Cu area = 0.412 in<sup>2</sup>).

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

Characteristic	Symbol	Min	Typ	Max	Unit
<b>OFF CHARACTERISTICS</b>					
Drain-to-Source Breakdown Voltage (Note 3) (V <sub>GS</sub> = 0 Vdc, I <sub>D</sub> = -0.25 mA) (Positive Temperature Coefficient)	V <sub>(BR)DSS</sub>	-60 -	- 67		Vdc mV/°C
Zero Gate Voltage Drain Current (V <sub>GS</sub> = 0 Vdc, V <sub>DS</sub> = -60 Vdc, T <sub>J</sub> = 25°C) (V <sub>GS</sub> = 0 Vdc, V <sub>DS</sub> = -60 Vdc, T <sub>J</sub> = 150°C)	I <sub>DSS</sub>			-10 -100	μAdc
Gate-Body Leakage Current (V <sub>GS</sub> = ± 20 Vdc, V <sub>DS</sub> = 0 Vdc)	I <sub>GSS</sub>			-100	nAdc

**ON CHARACTERISTICS (Note 3)**

Gate Threshold Voltage (V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = -250 μAdc) (Negative Temperature Coefficient)	V <sub>GS(th)</sub>	-1.1	-2.0	-3.0	Vdc mV/°C
Static Drain-Source On-State Resistance (V <sub>GS</sub> = -10 Vdc, I <sub>D</sub> = -6.0 Adc)	R <sub>DS(on)</sub>		150	170	mΩ
Drain-to-Source On-Voltage (V <sub>GS</sub> = -10 Vdc, I <sub>D</sub> = -12 Adc) (V <sub>GS</sub> = -10 Vdc, I <sub>D</sub> = -6.0 Adc, T <sub>J</sub> = 150°C)	V <sub>DS(on)</sub>		-1.86 -	-2.6 -2.0	Vdc
Forward Transconductance (V <sub>DS</sub> = 10 Vdc, I <sub>D</sub> = 6.0 Adc)	g <sub>FS</sub>		8.0		Mhos

**DYNAMIC CHARACTERISTICS**

Input Capacitance	(V <sub>DS</sub> = -25 Vdc, V <sub>GS</sub> = 0 Vdc, F = 1.0 MHz)	C <sub>iss</sub>	500	750	pF
Output Capacitance		C <sub>oss</sub>	150	250	
Reverse Transfer Capacitance		C <sub>rss</sub>	50	100	

**SWITCHING CHARACTERISTICS (Notes 3 and 4)**

Turn-On Delay Time	(V <sub>DD</sub> = -30 Vdc, I <sub>D</sub> = -12 A, V <sub>GS</sub> = -10 V, R <sub>G</sub> = 9.1 Ω)	t <sub>d(on)</sub>	10	20	ns
Rise Time		t <sub>r</sub>	45	85	
Turn-Off Delay Time		t <sub>d(off)</sub>	26	40	
Fall Time		t <sub>f</sub>	48	90	
Gate Charge	(V <sub>DS</sub> = -48 Vdc, V <sub>GS</sub> = -10 Vdc, I <sub>D</sub> = -12 A)	Q <sub>T</sub>	15	30	nC
		Q <sub>GS</sub>	4.0		
		Q <sub>GD</sub>	7.0		

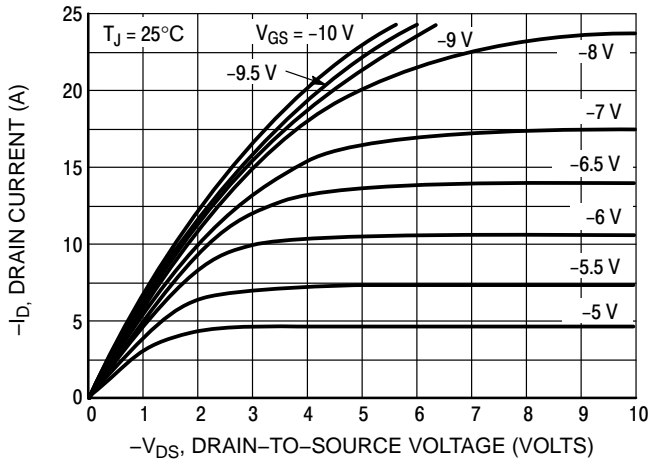
**DRAIN-SOURCE DIODE CHARACTERISTICS (Note 3)**

Diode Forward On-Voltage (I <sub>S</sub> = 12 Adc, V <sub>GS</sub> = 0 V) (I <sub>S</sub> = 12 Adc, V <sub>GS</sub> = 0 V, T <sub>J</sub> = 150°C)	V <sub>SD</sub>		-1.6 -1.3	-2.5 -	Vdc
Reverse Recovery Time (I <sub>S</sub> = 12 A, dI <sub>S</sub> /dt = 100 A/μs, V <sub>GS</sub> = 0 V)	t <sub>rr</sub>		50		ns
	t <sub>a</sub>		40		
	t <sub>b</sub>		10		
Reverse Recovery Stored Charge	Q <sub>RR</sub>		0.10		μC

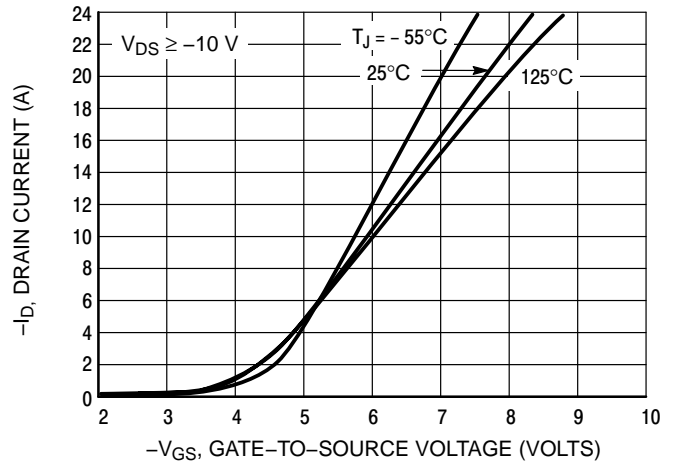
3. Indicates Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2%.

4. Switching characteristics are independent of operating junction temperature.

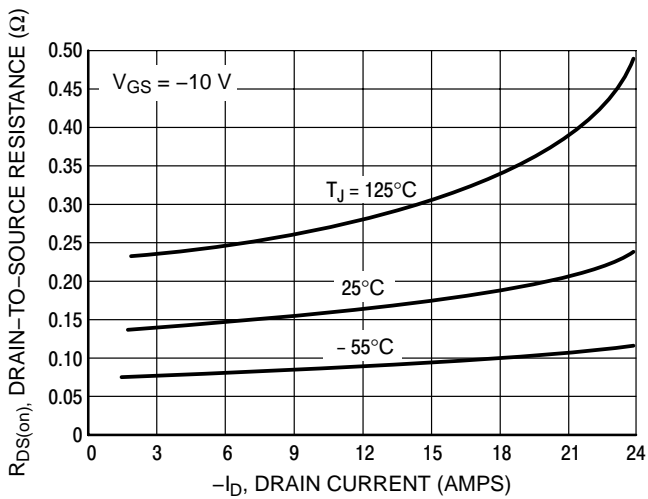
**TYPICAL PERFORMANCE CURVES** ( $T_J = 25^\circ\text{C}$  unless otherwise noted)



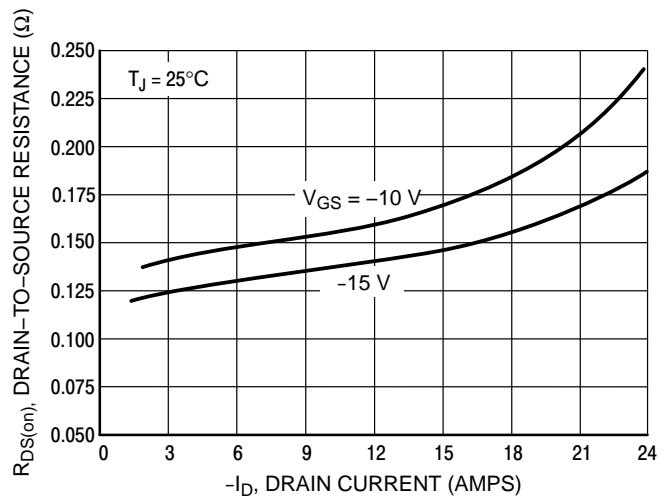
**Figure 1. On-Region Characteristics**



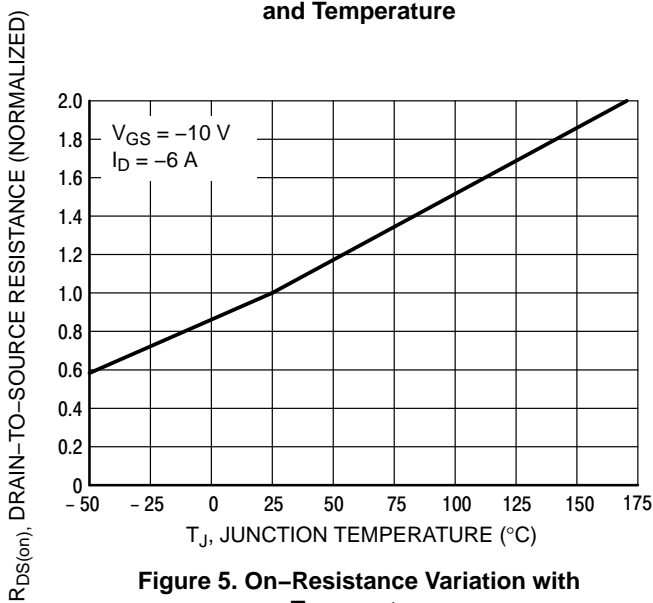
**Figure 2. Transfer Characteristics**



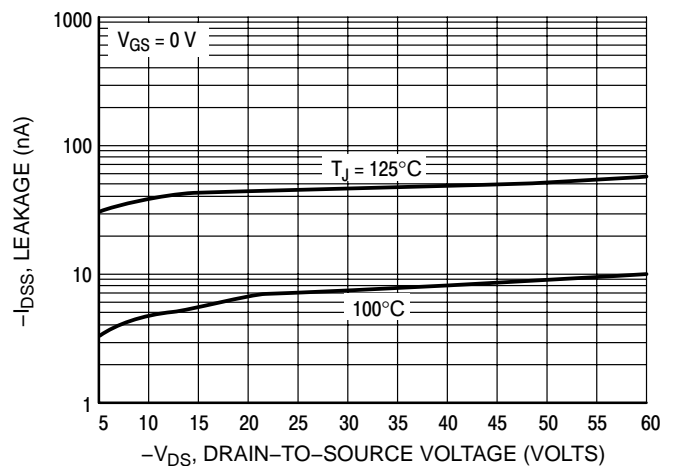
**Figure 3. On-Resistance versus Drain Current and Temperature**



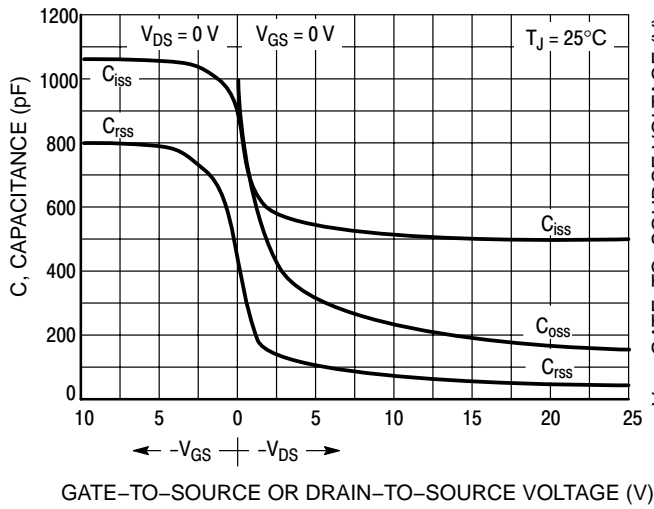
**Figure 4. On-Resistance versus Drain Current and Gate Voltage**



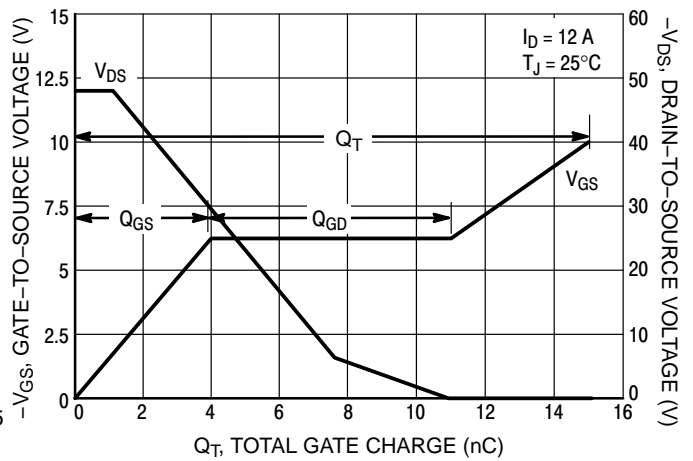
**Figure 5. On-Resistance Variation with Temperature**



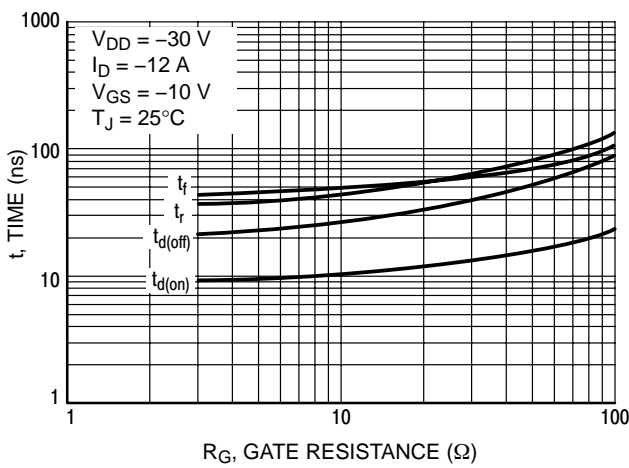
**Figure 6. Drain-To-Source Leakage Current versus Voltage**



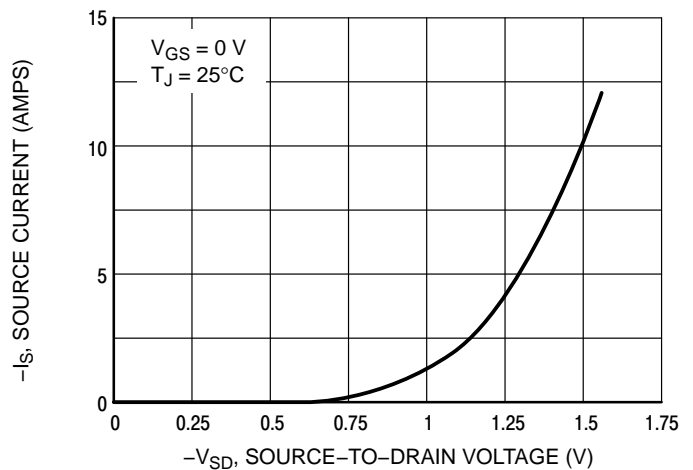
**Figure 7. Capacitance Variation**



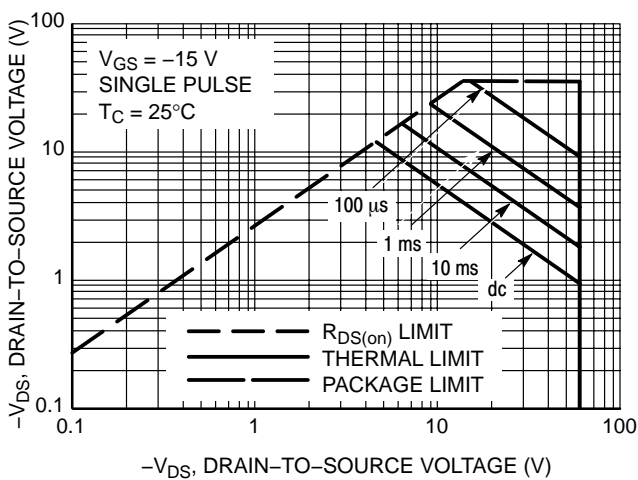
**Figure 8. Gate-To-Source and Drain-To-Source Voltage versus Total Charge**



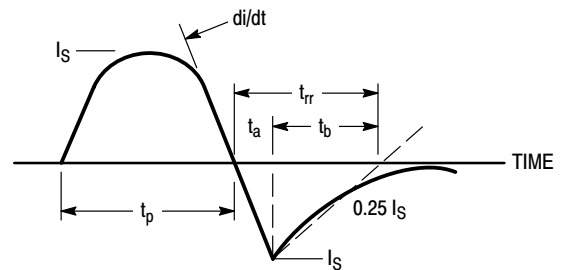
**Figure 9. Resistive Switching Time Variation versus Gate Resistance**



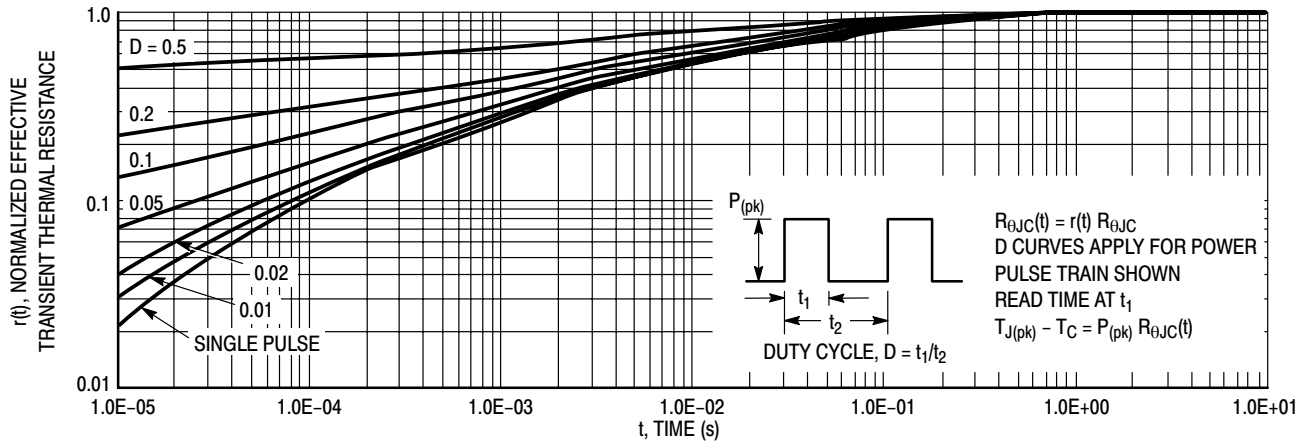
**Figure 10. Diode Forward Voltage versus Current**



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

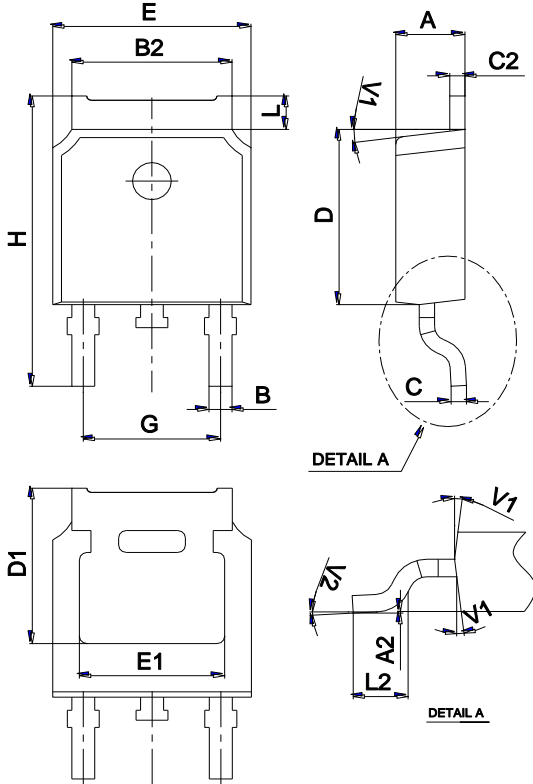


**Figure 12. Diode Reverse Recovery Waveform**



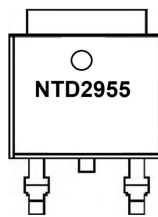
**Figure 13. Thermal Response**

**Package Mechanical Data TO-252**



Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	2.10		2.50	0.083		0.098
A2	0		0.10	0		0.004
B	0.66		0.86	0.026		0.034
B2	5.18		5.48	0.202		0.216
C	0.40		0.60	0.016		0.024
C2	0.44		0.58	0.017		0.023
D	5.90		6.30	0.232		0.248
D1	5.30REF			0.209REF		
E	6.40		6.80	0.252		0.268
E1	4.63			0.182		
G	4.47		4.67	0.176		0.184
H	9.50		10.70	0.374		0.421
L	1.09		1.21	0.043		0.048
L2	1.35		1.65	0.053		0.065
V1		7°			7°	
V2	0°		6°	0°		6°

**Marking**



**Ordering information**

Order code	Package	Baseqty	Deliverymode
NTD2955T4G	TO-252	2500	Tape and reel