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# NTB5412N, NTP5412N

## Power MOSFET 60 Amps, 60 Volts N-Channel D<sup>2</sup>PAK, TO-220

### Features

- Low  $R_{DS(on)}$
- High Current Capability
- Avalanche Energy Specified
- These are Pb-Free Devices

### Applications

- LED Lighting and LED Backlight Drivers
- DC-DC Converters
- DC Motor Drivers
- Power Supplies Secondary Side Synchronous Rectification

### MAXIMUM RATINGS ( $T_J = 25^\circ\text{C}$ Unless otherwise specified)

Parameter			Symbol	Value	Unit
Drain-to-Source Voltage			$V_{DSS}$	60	V
Gate-to-Source Voltage – Continuous			$V_{GS}$	$\pm 20$	V
Gate-to-Source Voltage – Nonrepetitive ( $T_P < 10 \mu\text{s}$ )			$V_{GS}$	$\pm 30$	V
Continuous Drain Current $R_{\theta JC}$ (Note 1)	Steady State	$T_C = 25^\circ\text{C}$	$I_D$	60	A
		$T_C = 100^\circ\text{C}$		44	
Power Dissipation $R_{\theta JC}$ (Note 1)	Steady State	$T_C = 25^\circ\text{C}$	$P_D$	125	W
Pulsed Drain Current	$t_p = 10 \mu\text{s}$		$I_{DM}$	155	A
Operating and Storage Temperature Range			$T_J, T_{stg}$	-55 to 175	$^\circ\text{C}$
Source Current (Body Diode)			$I_S$	60	A
Single Pulse Drain-to-Source Avalanche Energy – Starting $T_J = 25^\circ\text{C}$ ( $V_{DD} = 50 V_{dc}, V_{GS} = 10 V_{dc}, I_{L(pk)} = 60 \text{ A}, L = 0.1 \text{ mH}, R_G = 25 \Omega$ )			$E_{AS}$	180	mJ
Lead Temperature for Soldering Purposes, 1/8" from Case for 10 Seconds			$T_L$	260	$^\circ\text{C}$

### THERMAL RESISTANCE RATINGS

Parameter	Symbol	Max	Unit
Junction-to-Case (Drain) Steady State (Note 1)	$R_{\theta JC}$	1.2	$^\circ\text{C}/\text{W}$
	$R_{\theta JA}$	43.2	

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 sq in pad size, (Cu Area 1.127 sq in [1 oz] including traces).

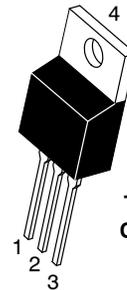
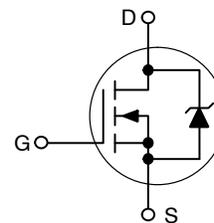


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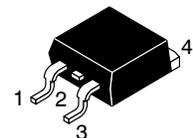
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$V_{(BR)DSS}$	$R_{DS(ON)} \text{ MAX}$	$I_D \text{ MAX}$ (Note 1)
60 V	14 m $\Omega$ @ 10 V	60 A

### N-Channel

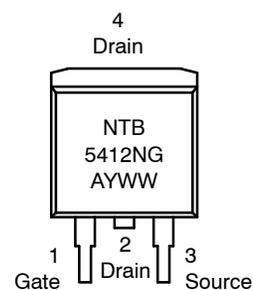
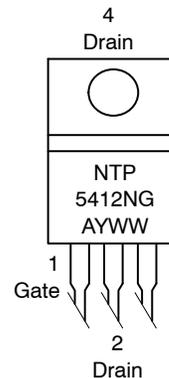


TO-220AB  
CASE 221A  
STYLE 5



D<sup>2</sup>PAK  
CASE 418B  
STYLE 2

### MARKING DIAGRAM & PIN ASSIGNMENT



G = Pb-Free Device  
A = Assembly Location  
Y = Year  
WW = Work Week

### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 5 of this data sheet.

# NTB5412N, NTP5412N

## ELECTRICAL CHARACTERISTICS ( $T_J = 25^\circ\text{C}$ Unless otherwise specified)

Characteristics	Symbol	Test Condition	Min	Typ	Max	Unit
<b>OFF CHARACTERISTICS</b>						
Drain-to-Source Breakdown Voltage	$V_{(BR)DSS}$	$V_{DS} = 0\text{ V}, I_D = 250\ \mu\text{A}$	60			V
Drain-to-Source Breakdown Voltage Temperature Coefficient	$V_{(BR)DSS}/T_J$			54.6		mV/°C
Zero Gate Voltage Drain Current	$I_{DSS}$	$V_{GS} = 0\text{ V}$ $V_{DS} = 60\text{ V}$	$T_J = 25^\circ\text{C}$		1.0	$\mu\text{A}$
			$T_J = 150^\circ\text{C}$		100	
Gate-Body Leakage Current	$I_{GSS}$	$V_{DS} = 0\text{ V}, V_{GS} = \pm 20\text{ V}$			$\pm 100$	nA

## ON CHARACTERISTICS (Note 2)

Gate Threshold Voltage	$V_{GS(th)}$	$V_{GS} = V_{DS}, I_D = 250\ \mu\text{A}$	2.0	3.3	4.0	V
Negative Threshold Temperature Coefficient	$V_{GS(th)}/T_J$			6.4		mV/°C
Drain-to-Source On Voltage	$V_{DS(on)}$	$V_{GS} = 10\text{ V}, I_D = 60\text{ A}$		0.7	1.2	V
		$V_{GS} = 10\text{ V}, I_D = 30\text{ A}, 150^\circ\text{C}$		0.75		
Static Drain-to-Source On-Resistance	$R_{DS(on)}$	$V_{GS} = 10\text{ V}, I_D = 30\text{ A}$		11.1	14	m $\Omega$
Forward Transconductance	$g_{FS}$	$V_{GS} = 15\text{ V}, I_D = 30\text{ A}$		58		S

## CHARGES, CAPACITANCES & GATE RESISTANCE

Input Capacitance	$C_{iss}$	$V_{DS} = 25\text{ V}, V_{GS} = 0\text{ V},$ $f = 1\text{ MHz}$		2325	3220	pF
Output Capacitance	$C_{oss}$			440		
Transfer Capacitance	$C_{rss}$			170		
Total Gate Charge	$Q_{G(TOT)}$	$V_{GS} = 0\text{ V}, V_{DS} = 48\text{ V},$ $I_D = 60\text{ A}$		66	85	nC
Threshold Gate Charge	$Q_{G(TH)}$			2.8		
Gate-to-Source Charge	$Q_{GS}$			13.4		
Gate-to-Drain Charge	$Q_{GD}$			31		

## SWITCHING CHARACTERISTICS, $V_{GS} = 10\text{ V}$ (Note 3)

Turn-On Delay Time	$t_{d(on)}$	$V_{GS} = 10\text{ V}, V_{DD} = 48\text{ V},$ $I_D = 60\text{ A}, R_G = 2.5\ \Omega$		14		ns
Rise Time	$t_r$			115		
Turn-Off Delay Time	$t_{d(off)}$			41		
Fall Time	$t_f$			89		

## DRAIN-SOURCE DIODE CHARACTERISTICS

Forward Diode Voltage	$V_{SD}$	$V_{GS} = 0\text{ V}$ $I_S = 60\text{ A}$	$T_J = 25^\circ\text{C}$		1.0	1.2	$V_{dc}$
			$T_J = 125^\circ\text{C}$		0.9		
Reverse Recovery Time	$t_{rr}$	$I_S = 60\text{ A}_{dc}, V_{GS} = 0\text{ V}_{dc},$ $di_S/dt = 100\text{ A}/\mu\text{s}$		75		ns	
Charge Time	$t_a$			54			
Discharge Time	$t_b$			21			
Reverse Recovery Stored Charge	$Q_{RR}$			96			nC

- Pulse Test: Pulse Width  $\leq 300\ \mu\text{s}$ , Duty Cycle  $\leq 2\%$ .
- Switching characteristics are independent of operating junction temperatures.

# NTB5412N, NTP5412N

## TYPICAL PERFORMANCE CURVES

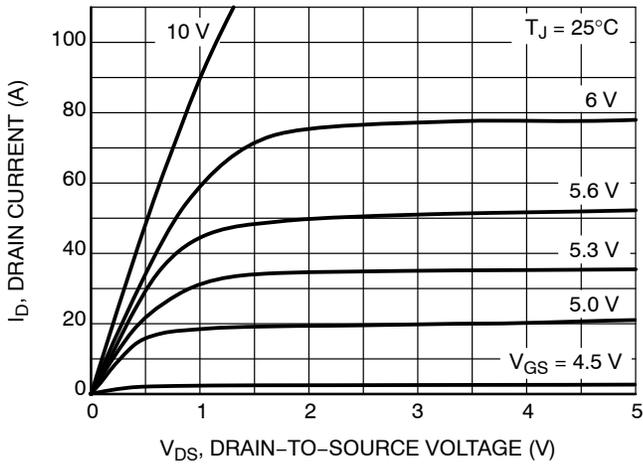


Figure 1. On-Region Characteristics

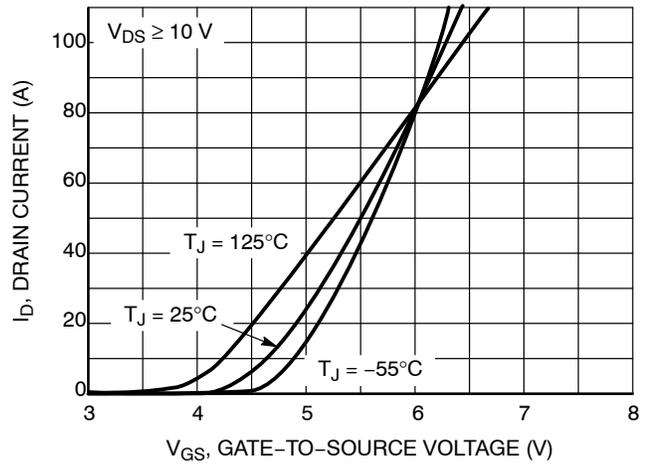


Figure 2. Transfer Characteristics

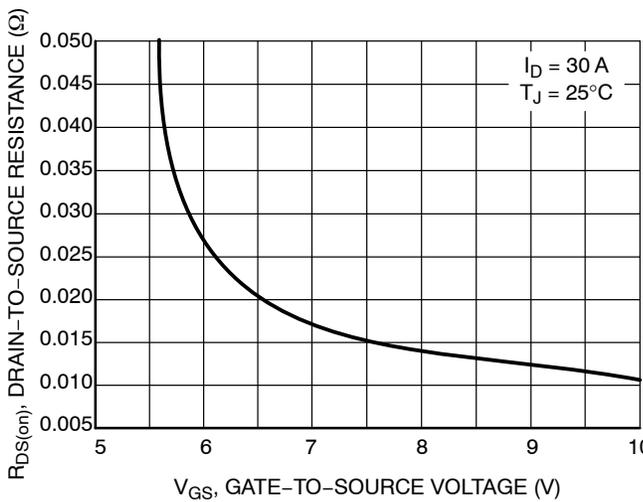


Figure 3. On-Resistance vs. Gate-to-Source Voltage

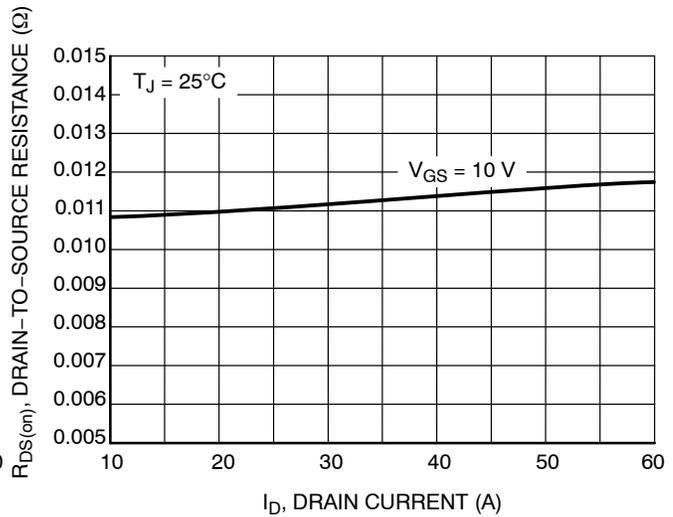


Figure 4. On-Resistance vs. Drain Current and Gate Voltage

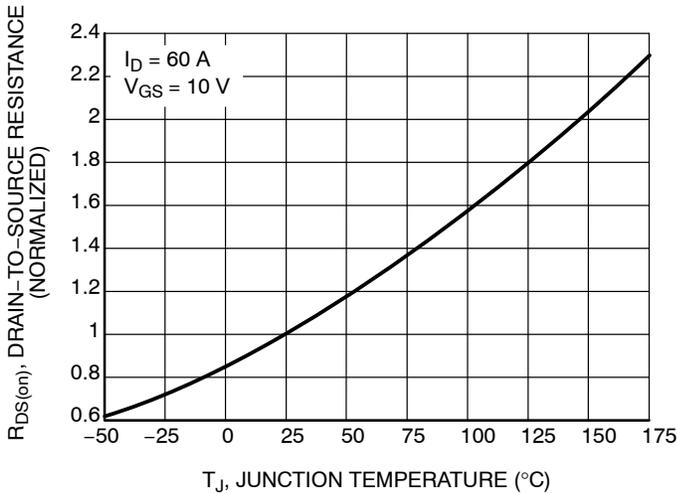


Figure 5. On-Resistance Variation with Temperature

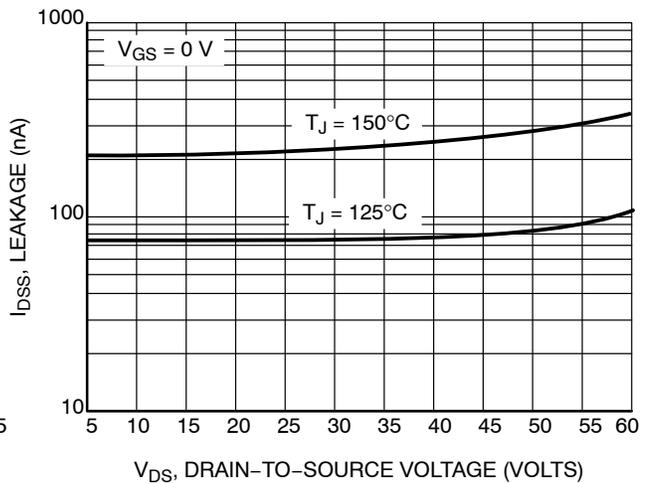


Figure 6. Drain-to-Source Leakage Current vs. Voltage

# NTB5412N, NTP5412N

## TYPICAL PERFORMANCE CURVES

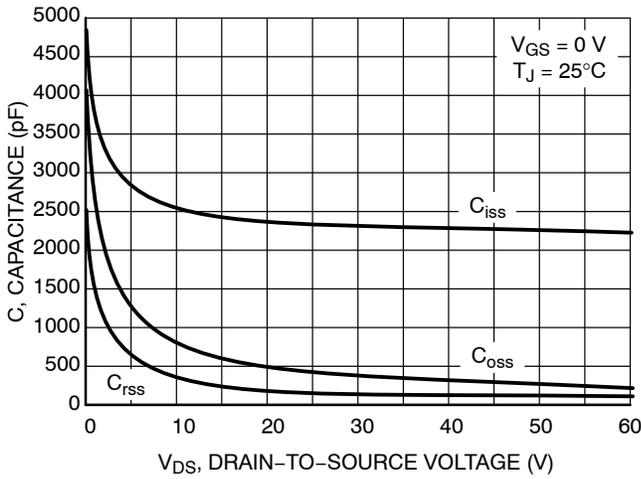


Figure 7. Capacitance Variation

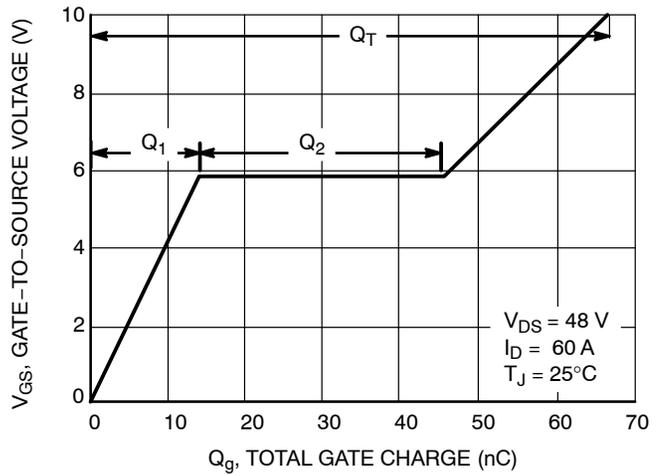


Figure 8. Gate-to-Source Voltage vs. Total Charge

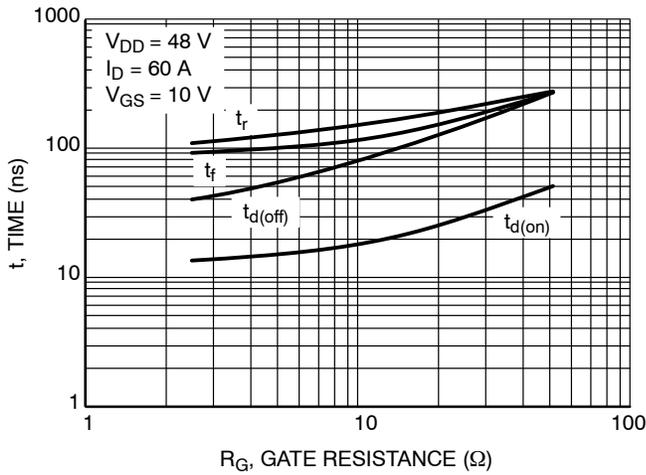


Figure 9. Resistive Switching Time Variation vs. Gate Resistance

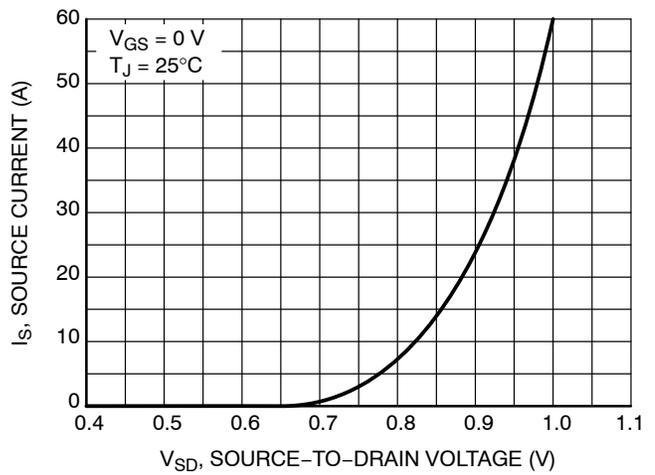


Figure 10. Diode Forward Voltage vs. Current

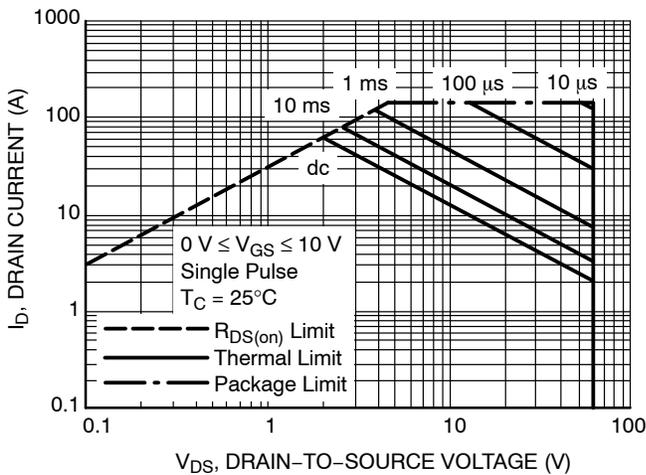


Figure 11. Maximum Rated Forward Biased Safe Operating Area

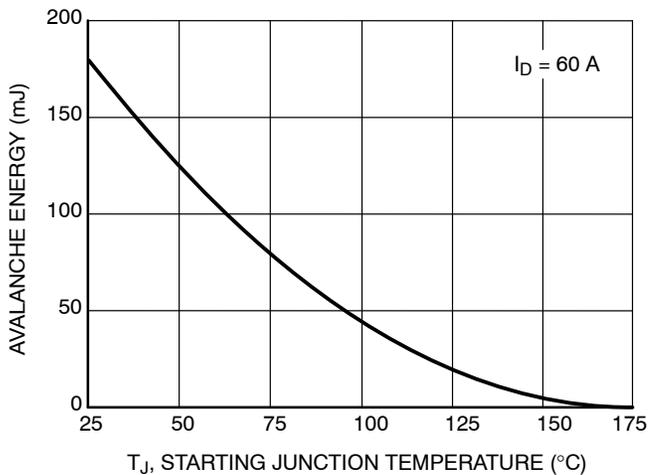
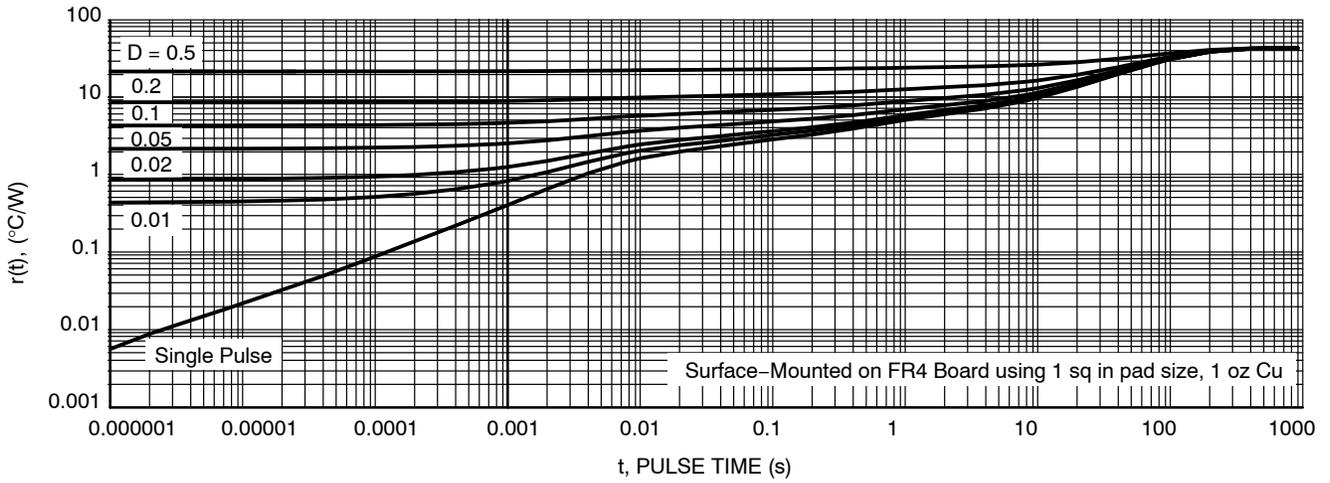


Figure 12. Maximum Avalanche Energy vs. Starting Junction Temperature

# NTB5412N, NTP5412N

## TYPICAL PERFORMANCE CURVES



**Figure 13. Thermal Response**

### ORDERING INFORMATION

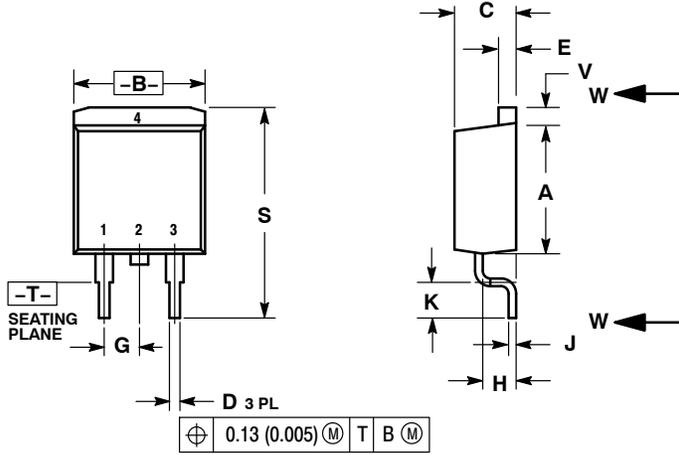
Device	Package	Shipping <sup>†</sup>
NTP5412NG	TO-220AB (Pb-Free)	50 Units / Rail
NTB5412NT4G	D <sup>2</sup> PAK (Pb-Free)	800 / Tape & Reel

<sup>†</sup>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.

# NTB5412N, NTP5412N

## PACKAGE DIMENSIONS

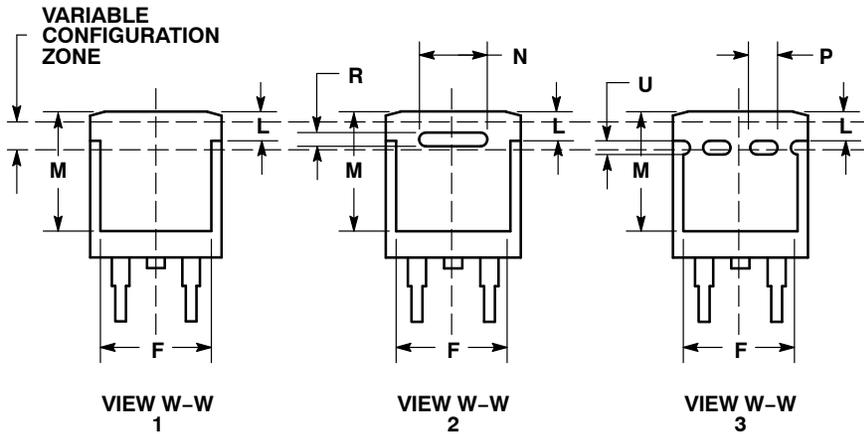
**D<sup>2</sup>PAK 3**  
CASE 418B-04  
ISSUE K



**NOTES:**

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. 418B-01 THRU 418B-03 OBSOLETE, NEW STANDARD 418B-04.

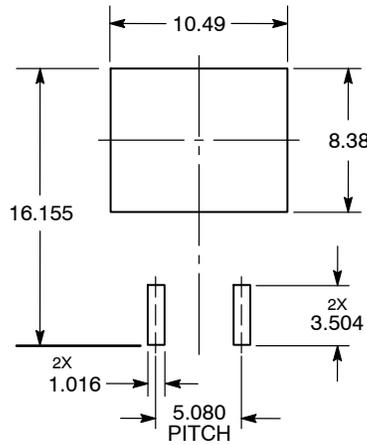
DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.340	0.380	8.64	9.65
B	0.380	0.405	9.65	10.29
C	0.160	0.190	4.06	4.83
D	0.020	0.035	0.51	0.89
E	0.045	0.055	1.14	1.40
F	0.310	0.350	7.87	8.89
G	0.100 BSC		2.54 BSC	
H	0.080	0.110	2.03	2.79
J	0.018	0.025	0.46	0.64
K	0.090	0.110	2.29	2.79
L	0.052	0.072	1.32	1.83
M	0.280	0.320	7.11	8.13
N	0.197 REF		5.00 REF	
P	0.079 REF		2.00 REF	
R	0.039 REF		0.99 REF	
S	0.575	0.625	14.60	15.88
V	0.045	0.055	1.14	1.40



**STYLE 2:**

1. GATE
2. DRAIN
3. SOURCE
4. DRAIN

**SOLDERING FOOTPRINT\***



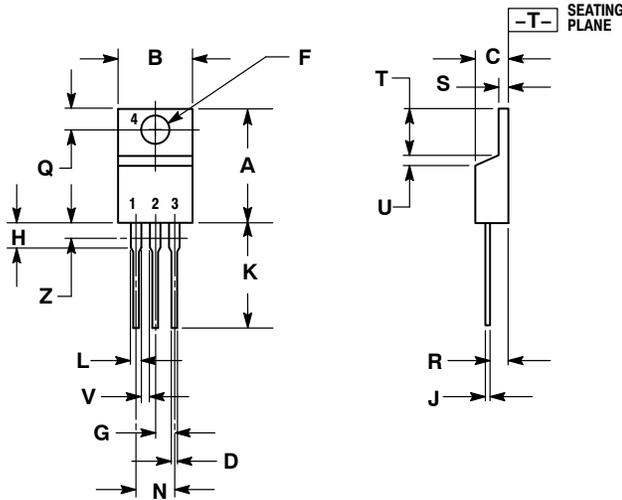
DIMENSIONS: MILLIMETERS

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

# NTB5412N, NTP5412N

## PACKAGE DIMENSIONS

TO-220  
CASE 221A-09  
ISSUE AF



NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION Z DEFINES A ZONE WHERE ALL BODY AND LEAD IRREGULARITIES ARE ALLOWED.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.570	0.620	14.48	15.75
B	0.380	0.405	9.66	10.28
C	0.160	0.190	4.07	4.82
D	0.025	0.035	0.64	0.88
F	0.142	0.161	3.61	4.09
G	0.095	0.105	2.42	2.66
H	0.110	0.155	2.80	3.93
J	0.014	0.025	0.36	0.64
K	0.500	0.562	12.70	14.27
L	0.045	0.060	1.15	1.52
N	0.190	0.210	4.83	5.33
Q	0.100	0.120	2.54	3.04
R	0.080	0.110	2.04	2.79
S	0.045	0.055	1.15	1.39
T	0.235	0.255	5.97	6.47
U	0.000	0.050	0.00	1.27
V	0.045	---	1.15	---
Z	---	0.080	---	2.04

STYLE 5:

1. GATE
2. DRAIN
3. SOURCE
4. DRAIN

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