NTB75N03R, NTP75N03R

Power MOSFET
75 Amps, 25 Volts
N-Channel D²PAK, TO-220

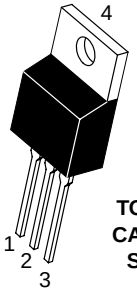
ON Semiconductor®

http://onsemi.com

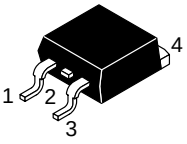
75 AMPERES
25 VOLTS
$R_{DS(on)}$ = 5.6 mΩ (Typ)

Features

- Planar HD3e Process for Fast Switching Performance
- Low $R_{DS(on)}$ to Minimize Conduction Loss
- Low C_{iss} to Minimize Driver Loss
- Low Gate Charge
- Pb−Free Packages are Available



TO−220AB
CASE 221A
STYLE 5



D²PAK
CASE 418B

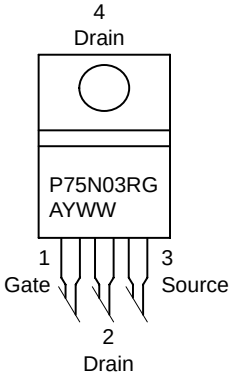
MAXIMUM RATINGS (T_J = 25°C Unless otherwise specified)

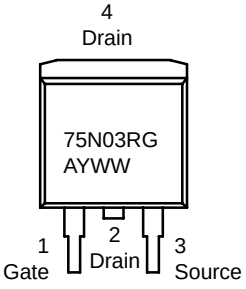
Parameter	Symbol	Value	Unit
Drain−to−Source Voltage	V_{DSS}	25	V_{dc}
Gate−to−Source Voltage − Continuous	V_{GS}	±20	V_{dc}
Thermal Resistance − Junction−to−Case Total Power Dissipation @ T_C = 25°C Drain Current − Continuous @ T_C = 25°C − Single Pulse (t_p = 10 μs)	$R_{\theta JC}$ P_D I_D I_{DM}	1.68 74.4 75 225	°C/W W A A
Thermal Resistance − Junction−to−Ambient (Note 1) Total Power Dissipation @ T_A = 25°C Drain Current − Continuous @ T_A = 25°C	$R_{\theta JA}$ P_D I_D	60 2.08 12.6	°C/W W A
Thermal Resistance − Junction−to−Ambient (Note 2) Total Power Dissipation @ T_A = 25°C Drain Current − Continuous @ T_A = 25°C	$R_{\theta JA}$ P_D I_D	100 1.25 9.7	°C/W W A
Operating and Storage Temperature Range	T_J, T_{stg}	−55 to 150	°C
Single Pulse Drain−to−Source Avalanche Energy − Starting T_J = 25°C (V_{DD} = 30 V_{dc}, V_{GS} = 10 V_{dc}, I_L = 12 A_{pk}, L = 1 mH, R_G = 25 Ω)	E_{AS}	71.7	mJ
Maximum Lead Temperature for Soldering Purposes, 1/8″ from Case for 10 Seconds	T_L	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. When surface mounted to an FR4 board using 1 inch pad size, (Cu Area 1.127 in^2).
2. When surface mounted to an FR4 board using minimum recommended pad size, (Cu Area 0.412 in^2).

MARKING DIAGRAMS & PIN ASSIGNMENTS





xxxxxxx	= Device Code
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 6 of this data sheet.

ELECTRICAL CHARACTERISTICS (T_J = 25°C Unless otherwise specified)

Characteristics		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Drain−to−Source Breakdown Voltage (Note 3) (V_{GS} = 0 V_{dc}, I_D = 250 μA_{dc}) Temperature Coefficient (Positive)		$V_{(br)DSS}$	 25 –	 28 20.5	 – –	V_{dc} mV/°C
Zero Gate Voltage Drain Current (V_{DS} = 20 V_{dc}, V_{GS} = 0 V_{dc}) (V_{DS} = 20 V_{dc}, V_{GS} = 0 V_{dc}, T_J = 150°C)		I_{DSS}	 – –	 – –	 1.0 10	μA_{dc}
Gate−Body Leakage Current (V_{GS} = ±20 V_{dc}, V_{DS} = 0 V_{dc})		I_{GSS}	 –	 –	 ±100	nA_{dc}
ON CHARACTERISTICS (Note 3)						
Gate Threshold Voltage (Note 3) (V_{DS} = V_{GS}, I_D = 250 μA_{dc}) Threshold Temperature Coefficient (Negative)		$V_{GS(th)}$	 1.0 –	 1.5 4.0	 2.0 –	V_{dc} mV/°C
Static Drain−to−Source On−Resistance (Note 3) (V_{GS} = 4.5 V_{dc}, I_D = 20 A_{dc}) (V_{GS} = 10 V_{dc}, I_D = 20 A_{dc})		$R_{DS(on)}$	 – –	 8.1 5.6	 13 8.0	mΩ
Forward Transconductance (Note 3) (V_{DS} = 10 V_{dc}, I_D = 15 A_{dc})		g_{FS}	 –	 27	 –	Mhos
DYNAMIC CHARACTERISTICS						
Input Capacitance	(V_{DS} = 20 V_{dc}, V_{GS} = 0 V, f = 1 MHz)	C_{iss}	–	1333	–	pF
Output Capacitance		C_{oss}	–	600	–	
Transfer Capacitance		C_{rss}	–	218	–	
SWITCHING CHARACTERISTICS (Note 4)						
Turn−On Delay Time	(V_{GS} = 10 V_{dc}, V_{DD} = 10 V_{dc}, I_D = 30 A_{dc}, R_G = 3 Ω)	$t_{d(on)}$	–	6.9	–	ns
Rise Time		t_r	–	1.3	–	
Turn−Off Delay Time		$t_{d(off)}$	–	18.4	–	
Fall Time		t_f	–	5.5	–	
Gate Charge	(V_{GS} = 5 V_{dc}, I_D = 30 A_{dc}, V_{DS} = 10 V_{dc}) (Note 3)	Q_T	–	13.2	–	nC
		Q_1	–	3.3	–	
		Q_2	–	6.2	–	
SOURCE−DRAIN DIODE CHARACTERISTICS						
Forward On−Voltage	(I_S = 20 A_{dc}, V_{GS} = 0 V_{dc}) (Note 3) (I_S = 20 A_{dc}, V_{GS} = 0 V_{dc}, T_J = 125°C)	V_{SD}	 – –	 0.86 0.73	 1.2 –	V_{dc}
Reverse Recovery Time	(I_S = 35 A_{dc}, V_{GS} = 0 V_{dc}, dI_S/dt = 100 A/μs) (Note 3)	t_{rr}	–	15.6	–	ns
		t_a	–	13.8	–	
		t_b	–	1.78	–	
Reverse Recovery Stored Charge		Q_{RR}	–	0.004	–	μC

3. Pulse Test: Pulse Width = 300 μs, Duty Cycle = 2%.
4. Switching characteristics are independent of operating junction temperatures.

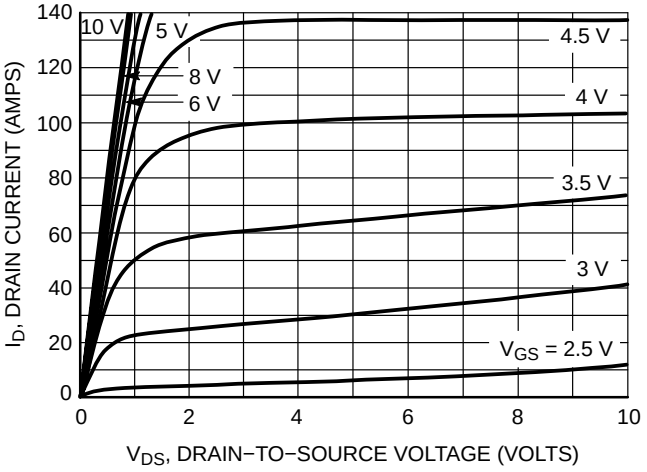


Figure 1. On−Region Characteristics

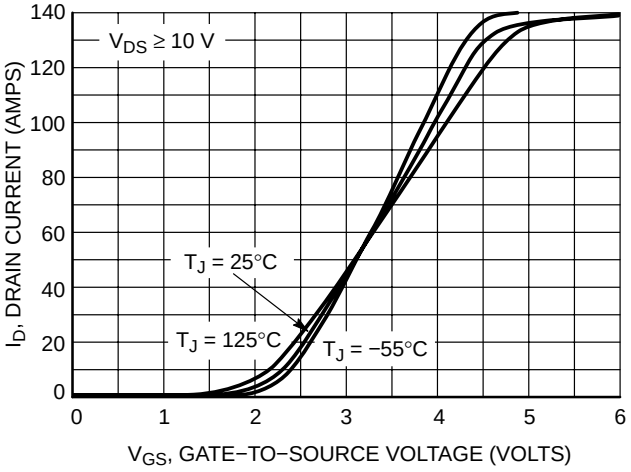


Figure 2. Transfer Characteristics

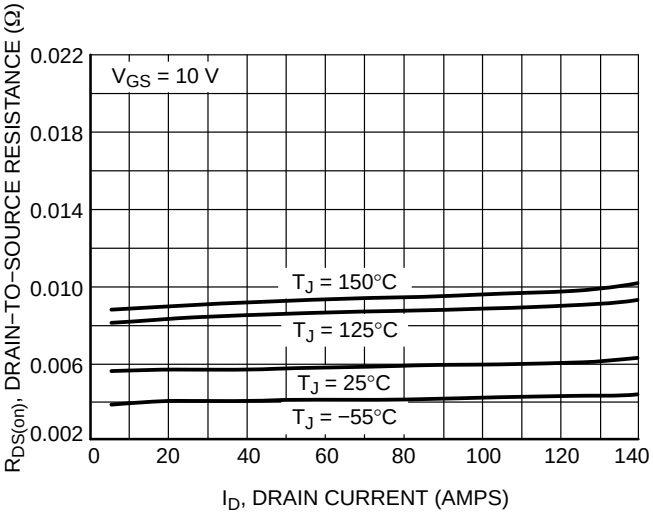


Figure 3. On−Resistance versus Drain Current and Temperature

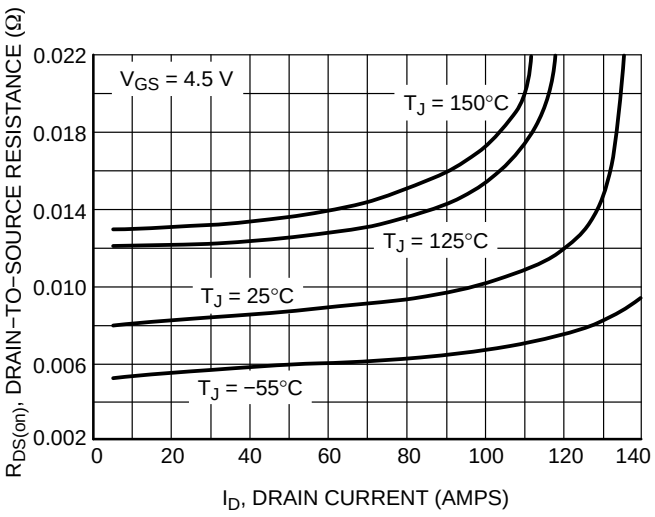


Figure 4. On−Resistance versus Drain Current and Temperature

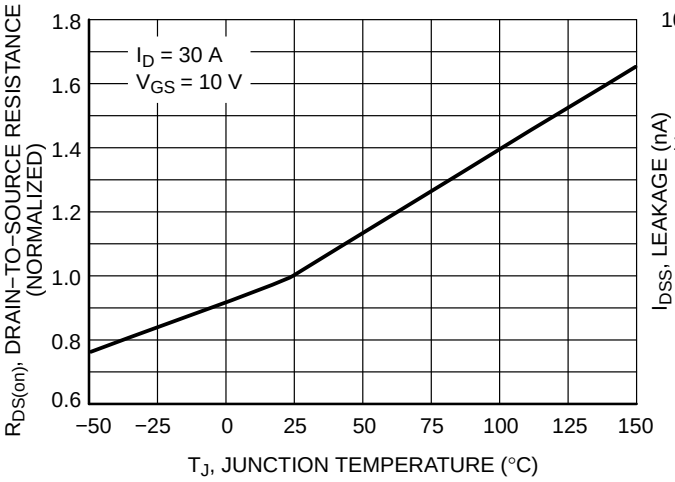


Figure 5. On−Resistance Variation with Temperature

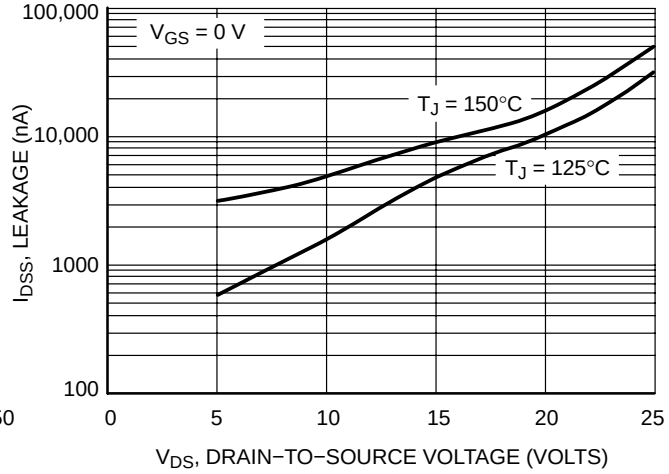


Figure 6. Drain−to−Source Leakage Current versus Voltage

POWER MOSFET SWITCHING

Switching behavior is most easily modeled and predicted by recognizing that the power MOSFET is charge controlled. The lengths of various switching intervals (Δt) are determined by how fast the FET input capacitance can be charged by current from the generator.

The published capacitance data is difficult to use for calculating rise and fall because drain−gate capacitance varies greatly with applied voltage. Accordingly, gate charge data is used. In most cases, a satisfactory estimate of average input current ($I_{G(AV)}$) can be made from a rudimentary analysis of the drive circuit so that

$t = Q/I_{G(AV)}$

During the rise and fall time interval when switching a resistive load, V_{GS} remains virtually constant at a level known as the plateau voltage, V_{SGP}. Therefore, rise and fall times may be approximated by the following:

$t_r = Q_2 \times R_G/(V_{GG} - V_{GSP})$

$t_f = Q_2 \times R_G/V_{GSP}$

where

V_{GG} = the gate drive voltage, which varies from zero to V_{GG}

R_G = the gate drive resistance

and Q_2 and V_{GSP} are read from the gate charge curve.

During the turn−on and turn−off delay times, gate current is not constant. The simplest calculation uses appropriate values from the capacitance curves in a standard equation for voltage change in an RC network. The equations are:

$t_{d(on)} = R_G C_{iss} \ln [V_{GG}/(V_{GG} - V_{GSP})]$

$t_{d(off)} = R_G C_{iss} \ln (V_{GG}/V_{GSP})$

The capacitance (C_{iss}) is read from the capacitance curve at a voltage corresponding to the off−state condition when calculating $t_{d(on)}$ and is read at a voltage corresponding to the on−state when calculating $t_{d(off)}$.

At high switching speeds, parasitic circuit elements complicate the analysis. The inductance of the MOSFET source lead, inside the package and in the circuit wiring which is common to both the drain and gate current paths, produces a voltage at the source which reduces the gate drive current. The voltage is determined by Ldi/dt, but since di/dt is a function of drain current, the mathematical solution is complex. The MOSFET output capacitance also complicates the mathematics. And finally, MOSFETs have finite internal gate resistance which effectively adds to the resistance of the driving source, but the internal resistance is difficult to measure and, consequently, is not specified.

The resistive switching time variation versus gate resistance (Figure 9) shows how typical switching performance is affected by the parasitic circuit elements. If the parasitics were not present, the slope of the curves would maintain a value of unity regardless of the switching speed. The circuit used to obtain the data is constructed to minimize common inductance in the drain and gate circuit loops and is believed readily achievable with board mounted components. Most power electronic loads are inductive; the data in the figure is taken with a resistive load, which approximates an optimally snubbed inductive load. Power MOSFETs may be safely operated into an inductive load; however, snubbing reduces switching losses.

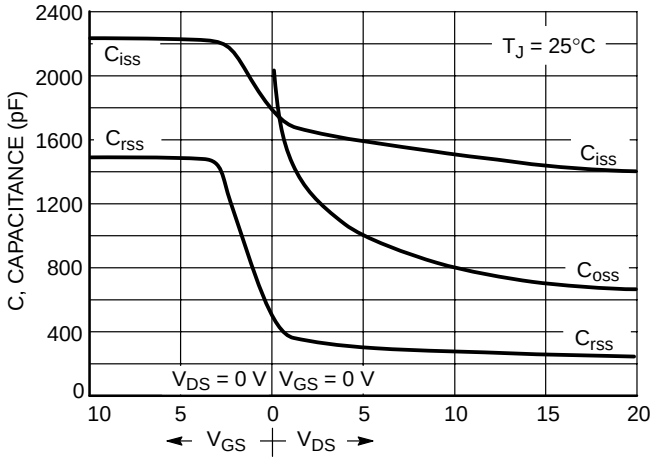


Figure 7. Capacitance Variation

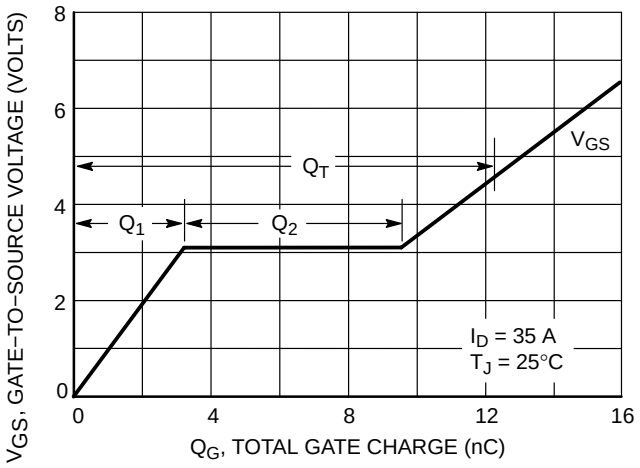


Figure 8. Gate−To−Source and Drain−To−Source Voltage versus Total Charge

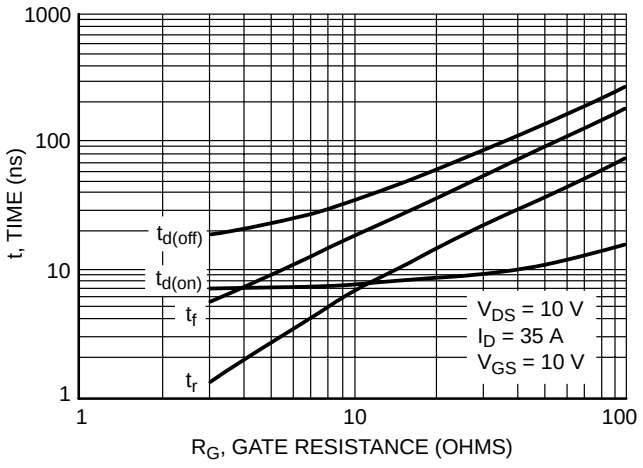


Figure 9. Resistive Switching Time Variation versus Gate Resistance

DRAIN−TO−SOURCE DIODE CHARACTERISTICS

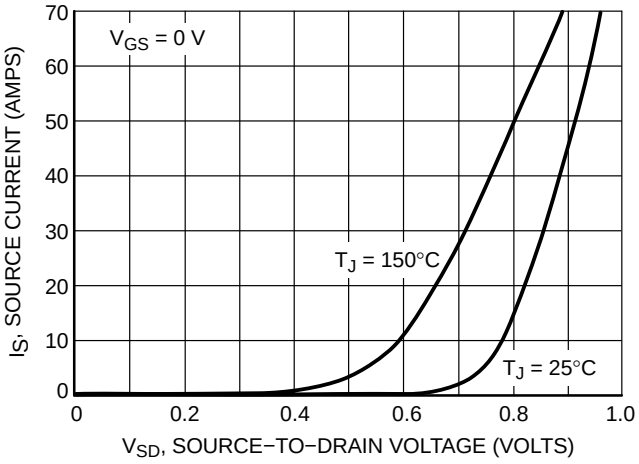


Figure 10. Diode Forward Voltage versus Current

SAFE OPERATING AREA

The Forward Biased Safe Operating Area curves define the maximum simultaneous drain−to−source voltage and drain current that a transistor can handle safely when it is forward biased. Curves are based upon maximum peak junction temperature and a case temperature (T_C) of 25°C. Peak repetitive pulsed power limits are determined by using the thermal response data in conjunction with the procedures discussed in AN569, “Transient Thermal Resistance − General Data and Its Use.”

Switching between the off−state and the on−state may traverse any load line provided neither rated peak current (I_{DM}) nor rated voltage (V_{DSS}) is exceeded and the transition time (t_r,t_f) do not exceed 10 μs. In addition the total power averaged over a complete switching cycle must not exceed $(T_{J(MAX)} − T_C)/(R_{\theta JC})$.

A Power MOSFET designated E−FET can be safely used in switching circuits with unclamped inductive loads. For reliable operation, the stored energy from circuit inductance dissipated in the transistor while in avalanche must be less than the rated limit and adjusted for operating conditions differing from those specified. Although industry practice is to rate in terms of energy, avalanche energy capability is not a constant. The energy rating decreases non−linearly with an increase of peak current in avalanche and peak junction temperature.

Although many E−FETs can withstand the stress of drain−to−source avalanche at currents up to rated pulsed current (I_{DM}), the energy rating is specified at rated continuous current (I_D), in accordance with industry custom. The energy rating must be derated for temperature as shown in the accompanying graph (Figure 12). Maximum energy at currents below rated continuous I_D can safely be assumed to equal the values indicated.

SAFE OPERATING AREA

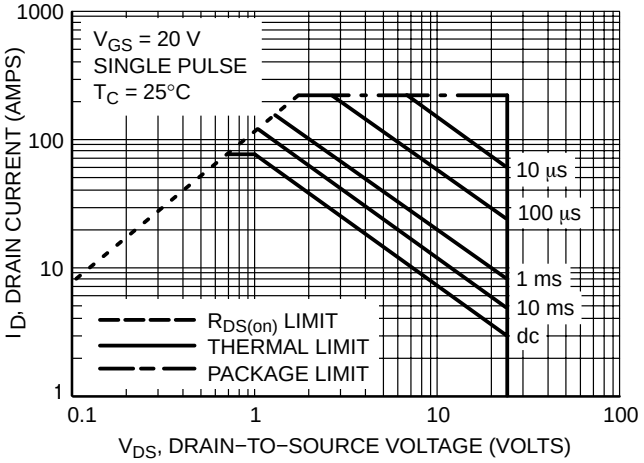


Figure 11. Maximum Rated Forward Biased Safe Operating Area

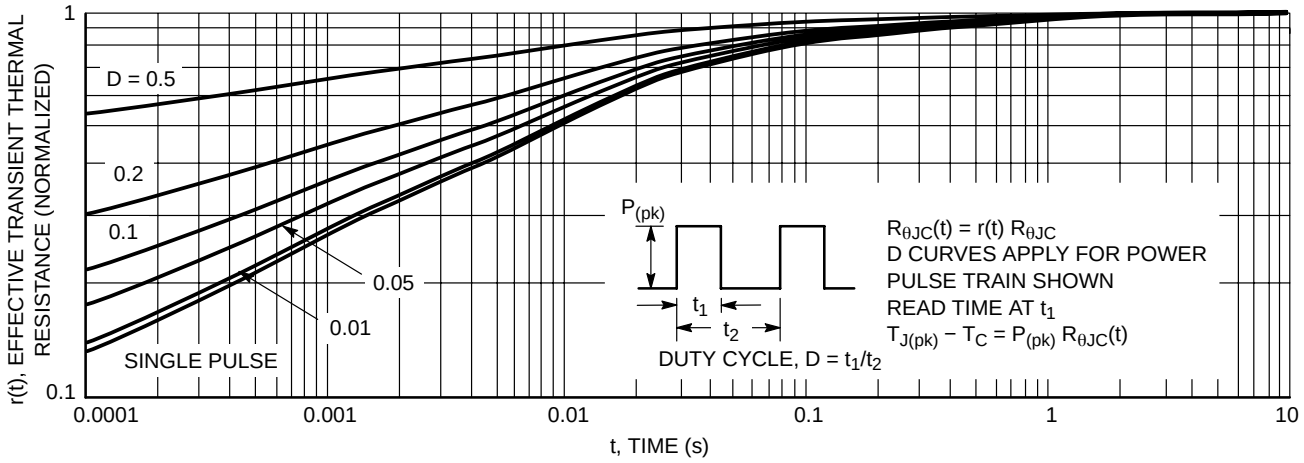


Figure 12. Thermal Response

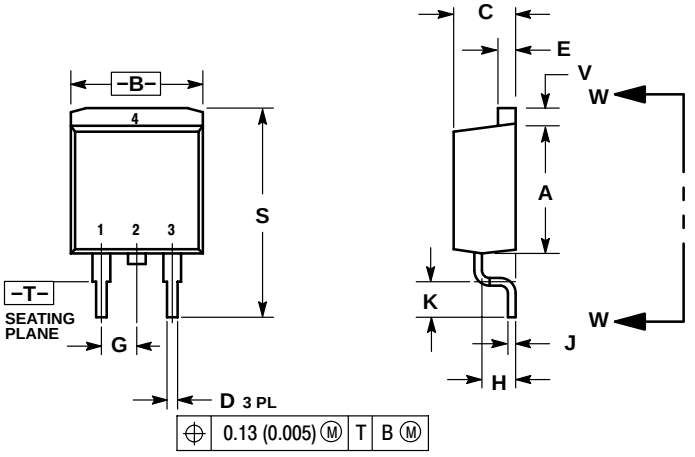
ORDERING INFORMATION

Device	Package	Shipping†
NTP75N03R	TO−220AB	50 Units / Rail
NTB75N03R	D^2PAK	50 Units / Rail
NTB75N03RG	D^2PAK (Pb−Free)	50 Units / Rail
NTB75N03RT4	D^2PAK	800 Tape & Reel
NTB75N03RT4G	D^2PAK (Pb−Free)	800 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.

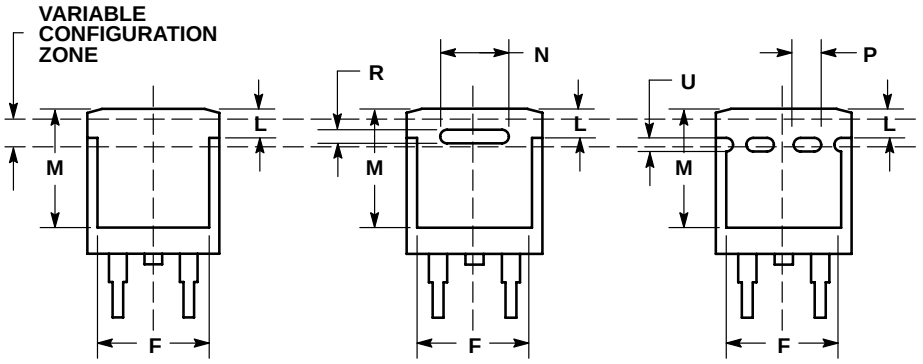
PACKAGE DIMENSIONS

D²PAK
CASE 418B−04
ISSUE J



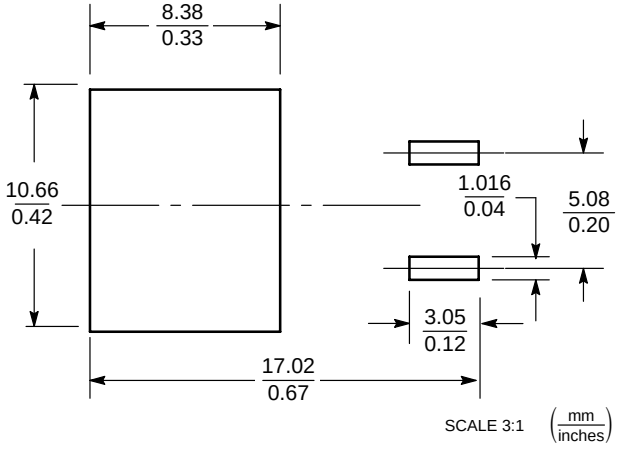
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. 418B−01 THRU 418B−03 OBSOLETE, NEW STANDARD 418B−04.

	INCHES		MILLIMETERS	
DIM	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



VIEW W−W 1 | VIEW W−W 2 | VIEW W−W 3

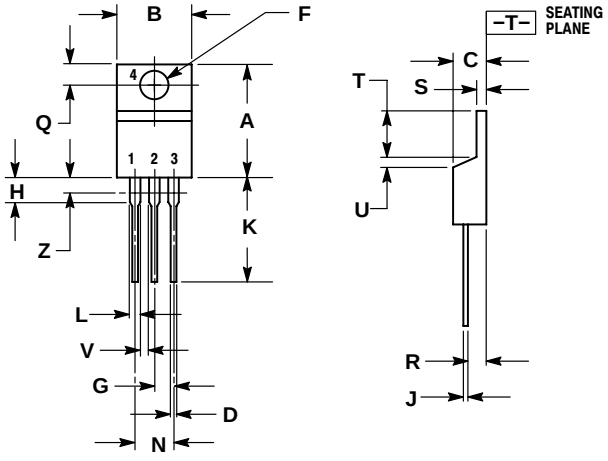
SOLDERING FOOTPRINT*



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

PACKAGE DIMENSIONS

TO−220
CASE 221A−09
ISSUE AA



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.

	INCHES		MILLIMETERS	
DIM	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	0.147	3.61	3.73
G	0.095	0.105	2.42	2.66
H	0.110	0.155	2.80	3.93
J	0.018	0.025	0.46	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:
PIN 1. GATE
2. DRAIN
3. SOURCE
4. DRAIN

PUBLICATION ORDERING INFORMATION

LITERATURE FULFILLMENT:
Literature Distribution Center for ON Semiconductor
P.O. Box 61312, Phoenix, Arizona 85082−1312 USA
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Fax: 480−829−7709 or 800−344−3867 Toll Free USA/Canada
Email: orderlit@onsemi.com

N. American Technical Support: 800−282−9855 Toll Free USA/Canada

Japan: ON Semiconductor, Japan Customer Focus Center
2−9−1 Kamimeguro, Meguro−ku, Tokyo, Japan 153−0051
Phone: 81−3−5773−3850

ON Semiconductor Website: http://onsemi.com

Order Literature: http://www.onsemi.com/litorder

For additional information, please contact your local Sales Representative.

NTB75N03R/D