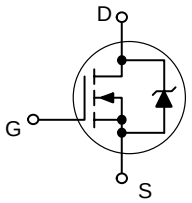
NTB65N02R, NTP65N02R

Power MOSFET
65 A, 24 V N-Channel
TO-220, D²PAK

ON Semiconductor®

http://onsemi.com

$V_{(BR)DSS}$	$R_{DS(on)}$ TYP	I_D MAX
24 V	8.4 mΩ @ 10 V	65 A



Features

- Planar HD3e Process for Fast Switching Performance
- Low R_{DSon} to Minimize Conduction Loss
- Low C_{iss} to Minimize Driver Loss
- Low Gate Charge
- Pb−Free Packages are Available*

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

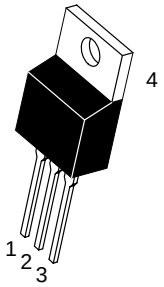
Parameter	Symbol	Value	Unit
Drain−to−Source Voltage	V_{DSS}	25	V_{dc}
Gate−to−Source Voltage − Continuous	V_{GS}	±20	V_{dc}
Thermal Resistance − Junction−to−Case Total Power Dissipation @ T_C = 25°C Drain Current − Continuous @ T_C = 25°C, Chip Continuous @ T_C =25°C, Limited by Package Single Pulse (t_p = 10 μs)	$R_{\theta JC}$ P_D I_D I_D I_{DM}	2.0 62.5 65 58 160	°C/W W A 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	67 1.86 10	°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	120 1.04 7.6	°C/W W A
Operating and Storage Temperature Range	T_J and T_{stg}	−55 to 150	°C
Single Pulse Drain−to−Source Avalanche Energy − Starting T_J = 25°C (V_{DD} = 50 V_{dc}, V_{GS} = 10 V_{dc}, I_L = 11 A_{pk}, L = 1 mH, R_G = 25 Ω)	E_{AS}	60	mJ
Maximum Lead Temperature for Soldering Purposes, 1/8″ from Case for 10 Seconds	T_L	260	°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.

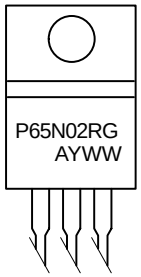
1. When surface mounted to an FR4 board using 1 in. pad size, (Cu Area 1.127 in^2).
2. When surface mounted to an FR4 board using minimum recommended pad size, (Cu Area 0.412 in^2).

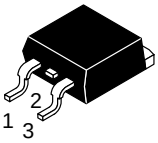
*For additional information on our Pb−Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

MARKING DIAGRAMS

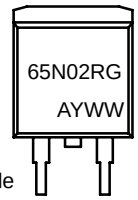


TO−220AB
CASE 221A
STYLE 5





D²PAK
CASE 418AA
STYLE 2



65N02R = Specific Device Code
A = Assembly Location
Y = Year
WW = Work Week
G = Pb−Free Package

PIN ASSIGNMENT

PIN	FUNCTION
1	Gate
2	Drain
3	Source
4	Drain

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 5 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)	$V_{(BR)DSS}$	 24 −	 27.5 25.5	 − −	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}	 − −	 − −	 1.5 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 4.1	 2.0 −	V_{dc} mV/°C
Static Drain−to−Source On−Resistance (Note 3) (V_{GS} = 4.5 V_{dc}, I_D = 15 A_{dc}) (V_{GS} = 10 V_{dc}, I_D = 20 A_{dc}) (V_{GS} = 10 V_{dc}, I_D = 30 A_{dc})	$R_{DS(on)}$	 − − −	 11.2 8.4 8.2	 12.5 10.5 −	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}	−	948	1330	pF
Output Capacitance		C_{oss}	−	456	640	
Transfer Capacitance		C_{rss}	−	160	225	
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)	$t_{d(on)}$	−	7.0	−	ns
Rise Time		t_r	−	53	−	
Turn−Off Delay Time		$t_{d(off)}$	−	14	−	
Fall Time		tf	−	10	−	
Gate Charge	(V_{GS} = 4.5 V_{dc}, I_D = 30 A_{dc}, V_{DS} = 10 V_{dc}) (Note 3)	Q_T	−	9.5	−	nC
		Q_1	−	3.0	−	
		Q_2	−	4.4	−	
SOURCE−DRAIN DIODE CHARACTERISTICS					
Forward On−Voltage	(I_S = 20 A_{dc}, V_{GS} = 0 V_{dc}) (Note 3) (I_S = 30 A_{dc}, V_{GS} = 0 V_{dc}) (I_S = 15 A_{dc}, V_{GS} = 0 V_{dc}, T_J = 125°C)	V_{SD}	 − − −	 0.88 1.10 0.80	 1.2 − −	V_{dc}
Reverse Recovery Time	(I_S = 30 A_{dc}, V_{GS} = 0 V_{dc}, dI_S/dt = 100 A/μs) (Note 3)	t_{rr}	−	29.1	−	ns
		t_a	−	13.6	−	
		t_b	−	15.5	−	
Reverse Recovery Stored Charge		Q_{RR}	−	0.02	−	μC

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

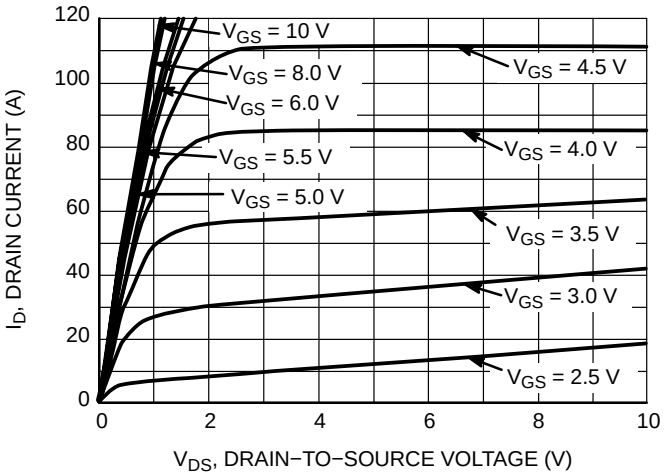


Figure 1. On−Region Characteristics

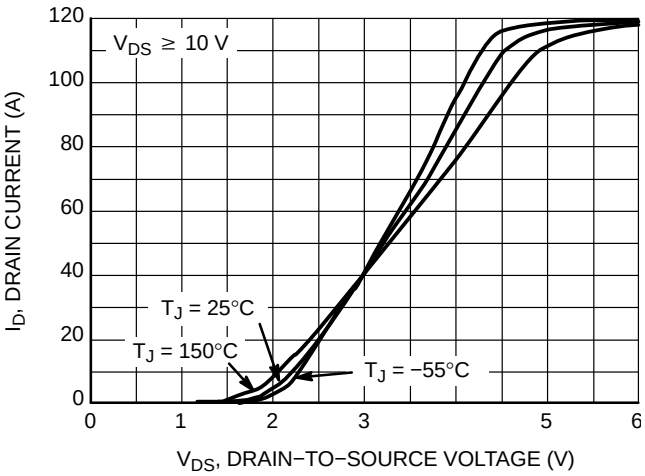


Figure 2. Transfer Characteristics

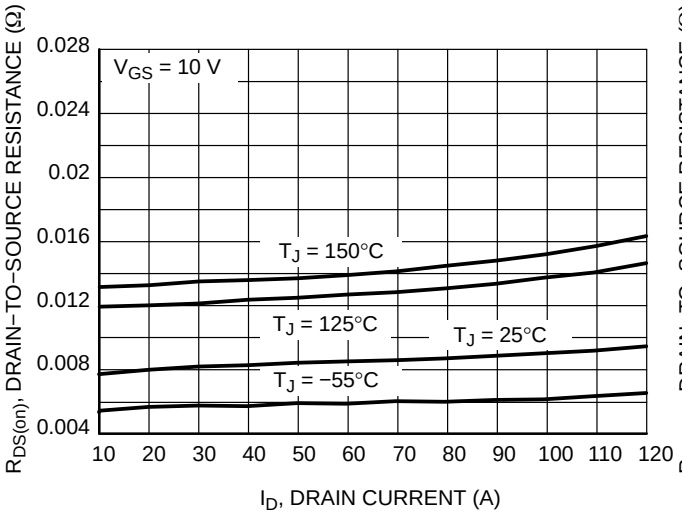


Figure 3. On−Resistance versus Drain Current and Temperature

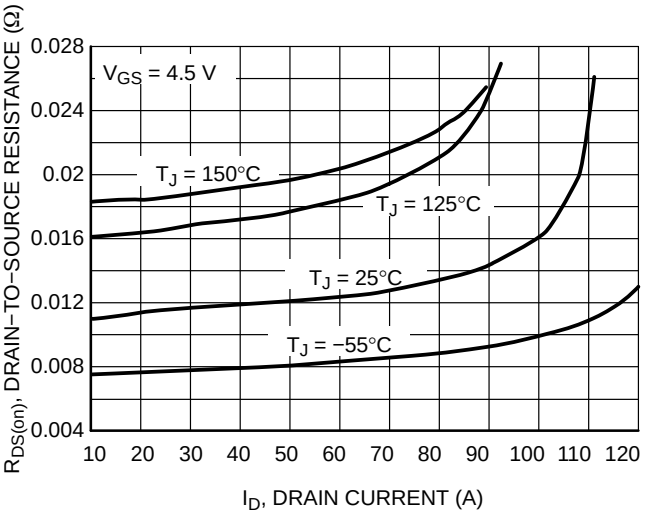


Figure 4. On−Resistance versus Drain Current and Temperature

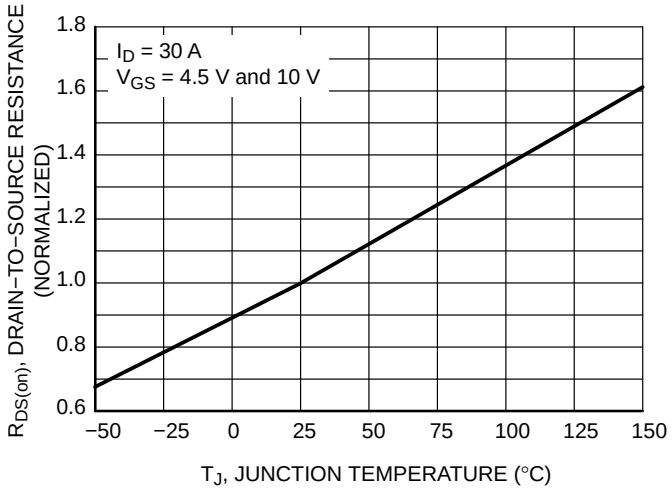


Figure 5. On−Resistance Variation with Temperature

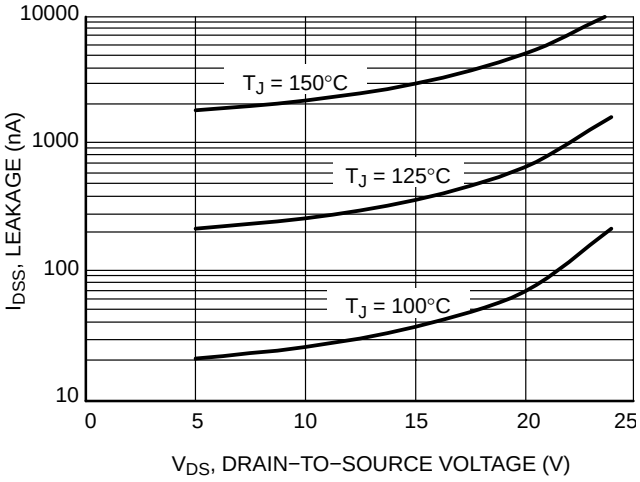


Figure 6. Drain−to−Source Leakage Current versus Voltage

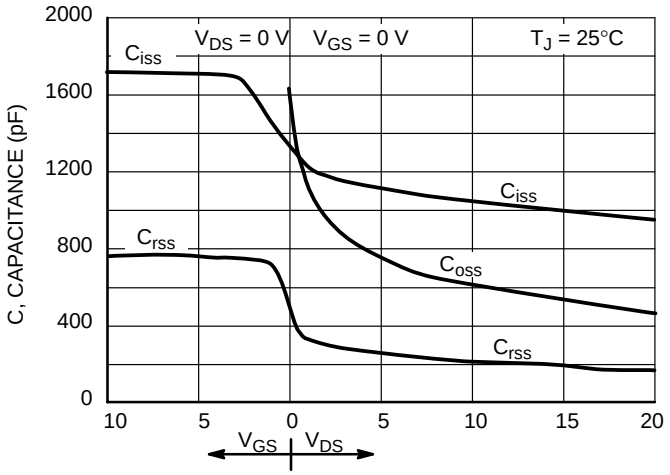


Figure 7. Capacitance Variation

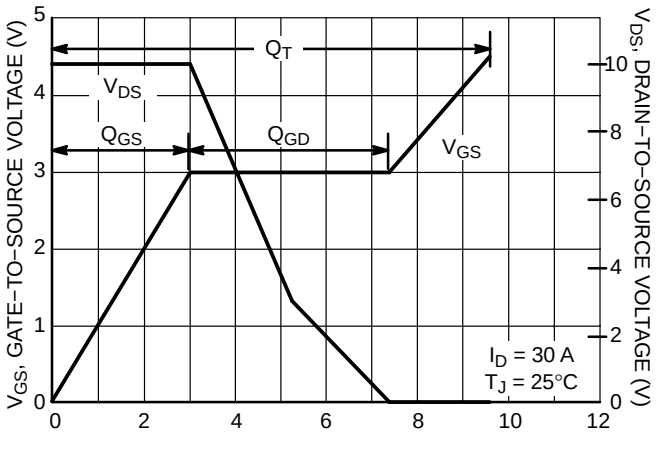


Figure 8. Gate−to−Source and Drain−to−Source Voltage versus Total Charge

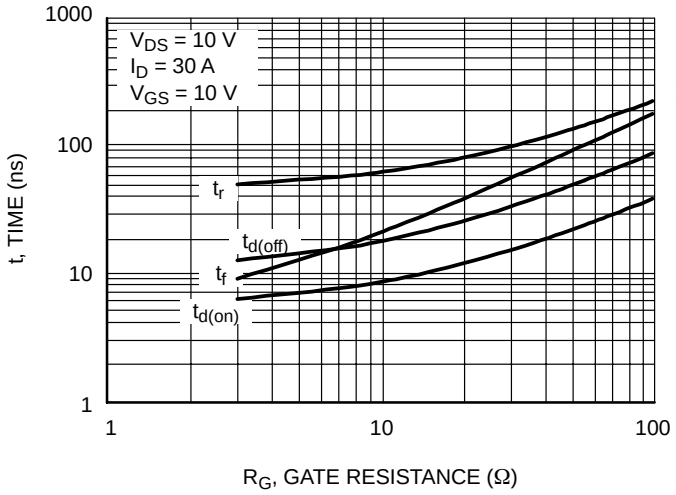


Figure 9. Resistive Switching Time Variation versus Gate Resistance

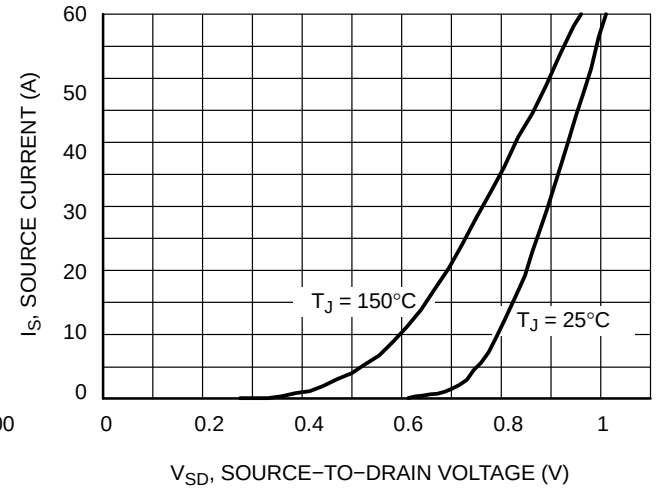


Figure 10. Diode Forward Voltage versus Current

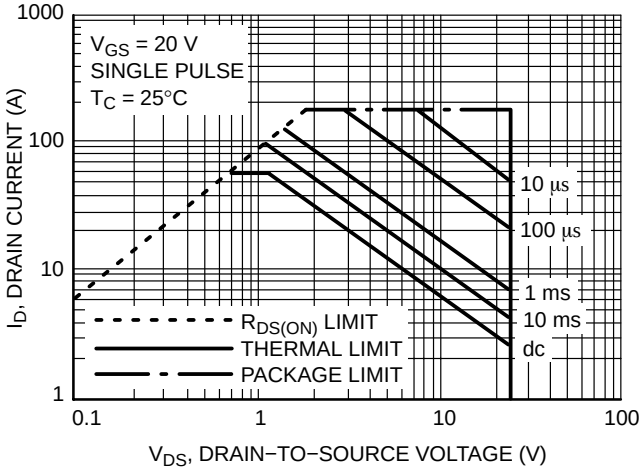


Figure 11. Maximum Rated Forward Biased Safe Operating Area

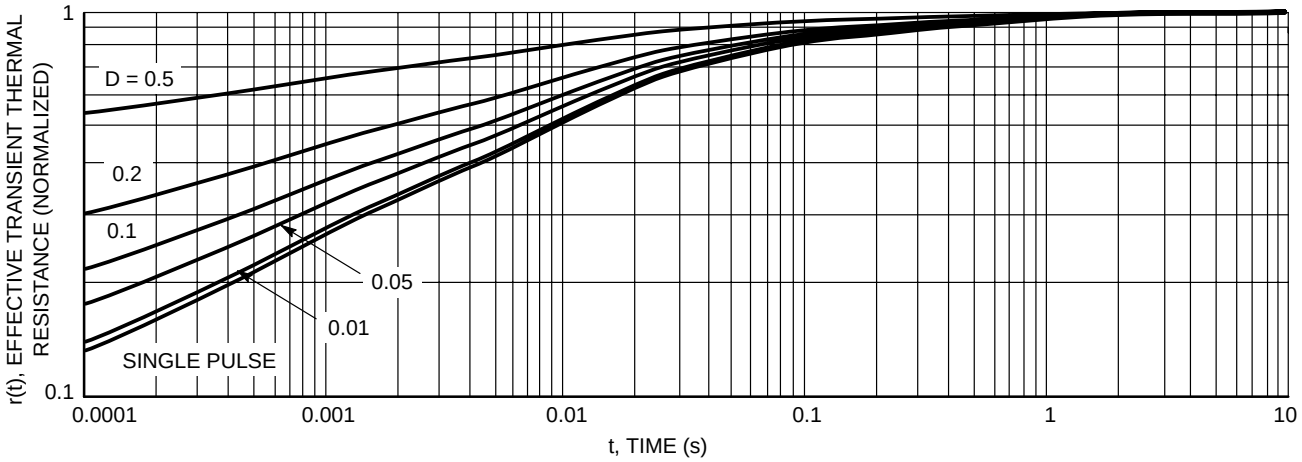


Figure 12. Thermal Response

ORDERING INFORMATION

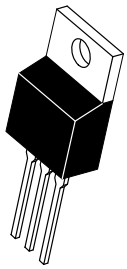
Device	Package	Shipping†
NTB65N02R	D^{2}PAK	50 Units / Rail
NTB65N02RG	D^{2}PAK (Pb−Free)	50 Units / Rail
NTB65N02RT4	D^{2}PAK	800 / Tape & Reel
NTB65N02RT4G	D^{2}PAK (Pb−Free)	800 / Tape & Reel
NTP65N02R	TO−220AB	50 Units / Rail
NTP65N02RG	TO−220AB (Pb−Free)	50 Units / Rail

†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.

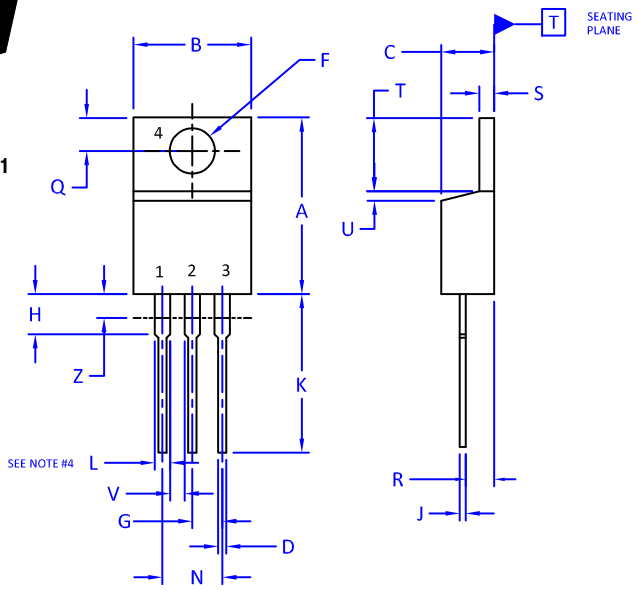
MECHANICAL CASE OUTLINE
PACKAGE DIMENSIONS

TO−220
CASE 221A
ISSUE AK

DATE 13 JAN 2022



SCALE 1:1



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 2009.
2. CONTROLLING DIMENSION: INCHES
3. DIMENSION Z DEFINES A ZONE WHERE ALL BODY AND LEAD IRREGULARITIES ARE ALLOWED.
4. MAX WIDTH FOR F102 DEVICE = 1.35MM

	INCHES		MILLIMETERS	
DIM	MIN.	MAX.	MIN.	MAX.
A	0.570	0.620	14.48	15.75
B	0.380	0.415	9.66	10.53
C	0.160	0.190	4.07	4.83
D	0.025	0.038	0.64	0.96
F	0.142	0.161	3.60	4.09
G	0.095	0.105	2.42	2.66
H	0.110	0.161	2.80	4.10
J	0.014	0.024	0.36	0.61
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	1.41
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 1:
PIN 1. BASE
2. COLLECTOR
3. EMITTER
4. COLLECTOR

STYLE 2:
PIN 1. BASE
2. EMITTER
3. COLLECTOR
4. EMITTER

STYLE 3:
PIN 1. CATHODE
2. ANODE
3. GATE
4. ANODE

STYLE 4:
PIN 1. MAIN TERMINAL 1
2. MAIN TERMINAL 2
3. GATE
4. MAIN TERMINAL 2

STYLE 5:
PIN 1. GATE
2. DRAIN
3. SOURCE
4. DRAIN

STYLE 6:
PIN 1. ANODE
2. CATHODE
3. ANODE
4. CATHODE

STYLE 7:
PIN 1. CATHODE
2. ANODE
3. CATHODE
4. ANODE

STYLE 8:
PIN 1. CATHODE
2. ANODE
3. EXTERNAL TRIP/DELAY
4. ANODE

STYLE 9:
PIN 1. GATE
2. COLLECTOR
3. EMITTER
4. COLLECTOR

STYLE 10:
PIN 1. GATE
2. SOURCE
3. DRAIN
4. SOURCE

STYLE 11:
PIN 1. DRAIN
2. SOURCE
3. GATE
4. SOURCE

STYLE 12:
PIN 1. MAIN TERMINAL 1
2. MAIN TERMINAL 2
3. GATE
4. NOT CONNECTED

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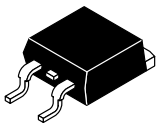
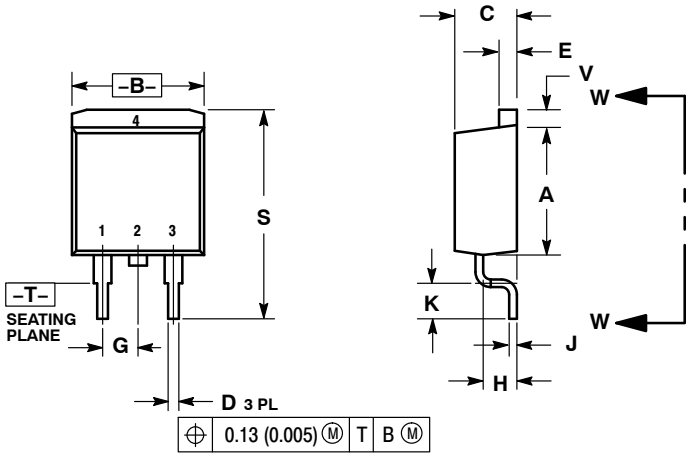
DESCRIPTION:	**TO−220**	**PAGE 1 OF 1**



D²PAK 3
CASE 418B–04
ISSUE L

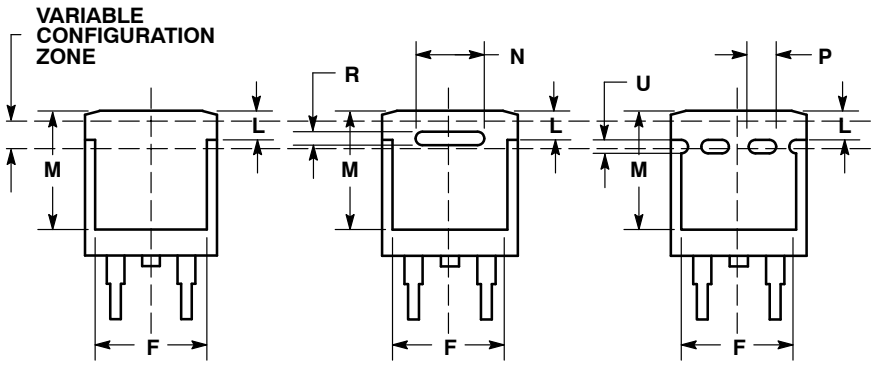
DATE 17 FEB 2015

SCALE 1:1



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

STYLE 1:
PIN 1. BASE
2. COLLECTOR
3. EMITTER
4. COLLECTOR

STYLE 2:
PIN 1. GATE
2. DRAIN
3. SOURCE
4. DRAIN

STYLE 3:
PIN 1. ANODE
2. CATHODE
3. ANODE
4. CATHODE

STYLE 4:
PIN 1. GATE
2. COLLECTOR
3. EMITTER
4. COLLECTOR

STYLE 5:
PIN 1. CATHODE
2. ANODE
3. CATHODE
4. ANODE

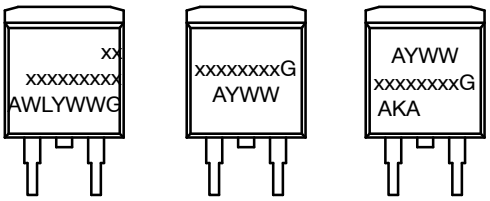
STYLE 6:
PIN 1. NO CONNECT
2. CATHODE
3. ANODE
4. CATHODE

MARKING INFORMATION AND FOOTPRINT ON PAGE 2

D²PAK 3
CASE 418B−04
ISSUE L

DATE 17 FEB 2015

GENERIC
MARKING DIAGRAM*

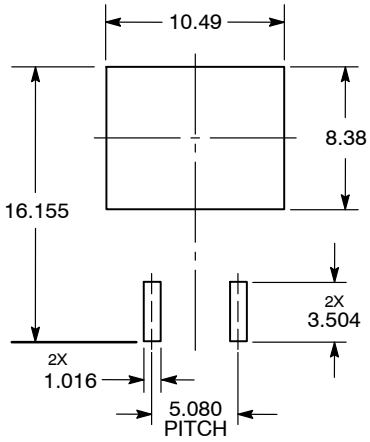


IC **Standard** **Rectifier**

xx	= Specific Device Code
A	= Assembly Location
WL	= Wafer Lot
Y	= Year
WW	= Work Week
G	= Pb−Free Package
AKA	= Polarity Indicator

*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.

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.

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DESCRIPTION:	**D²PAK 3**		**PAGE 2 OF 2**

PUBLICATION ORDERING INFORMATION

LITERATURE FULFILLMENT:
Email Requests to: orderlit@onsemi.com

onsemi Website: www.onsemi.com

TECHNICAL SUPPORT
North American Technical Support:
Voice Mail: 1 800−282−9855 Toll Free USA/Canada
Phone: 011 421 33 790 2910

Europe, Middle East and Africa Technical Support:
Phone: 00421 33 790 2910
For additional information, please contact your local Sales Representative

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