CS5201-3

1.0 A, 3.3 V Fixed Linear Regulator

The CS5201−3 linear regulator provides 1.0 A @ 3.3 V reference at 1.0 A with an output voltage accuracy of ±1.5%.

This regulator is intended for use as a post regulator and microprocessor supply. The fast loop response and low dropout voltage make this regulator ideal for applications where low voltage operation and good transient response are important.

The circuit is designed to operate with dropout voltages less than 1.2 V at 1.0 A output current.

The maximum quiescent current is only 10 mA at full load. Device protection includes overcurrent and thermal shutdown.

The CS5201−3 is pin compatible with the LT1086 family of linear regulators.

The regulator is available in TO−220−3, surface mount D^2, and SOT−223 packages.

Features

- Pb−Free Package is Available
- Output Current to 1.0 A
- Output Accuracy to ±1.5% Overtemperature
- Dropout Voltage (typical) 1.0 V @ 1.0 A
- Fast Transient Response
- Fault Protection
  - ♦ Current Limit
  - ♦ Thermal Shutdown

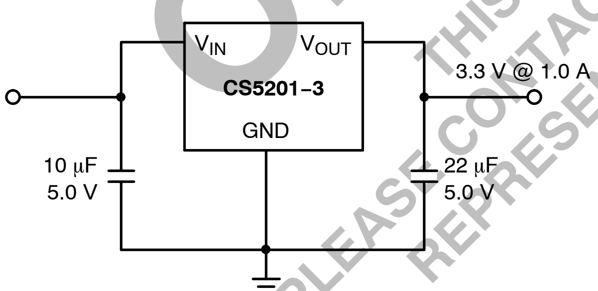

Figure 1. Applications Diagram

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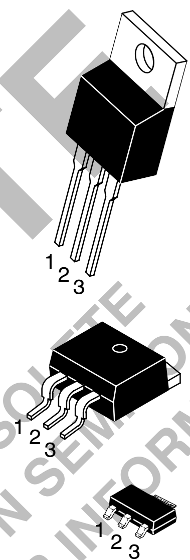


TO−220−3
T SUFFIX
CASE 221A

D²PAK−3
DP SUFFIX
CASE 418AB

SOT−223
ST SUFFIX
CASE 318E

Tab = V_{OUT}
Pin 1. GND
2. V_{OUT}
3. V_{IN}

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 6 of this data sheet.

DEVICE MARKING INFORMATION

See general marking information in the device marking section on page 6 of this data sheet.

MAXIMUM RATINGS

Parameter		Value	Unit
Supply Voltage, V_{IN}		7.0	V
Operating Temperature Range		−40 to +70	°C
Junction Temperature		150	°C
Storage Temperature Range		−60 to +150	°C
Lead Temperature Soldering:	Wave Solder (through hole styles only) (Note 1) Reflow (SMD styles only) (Note 2)	260 Peak 230 Peak	°C °C
ESD Damage Threshold (Human Body Model)		2.0	kV

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. 10 second maximum.
2. 60 second maximum above 183°C.

ELECTRICAL CHARACTERISTICS (C_{IN} = 10 μF, C_{OUT} = 22 μF Tantalum, $V_{OUT} + V_{DROPOUT} < V_{IN} < 7.0$ V, 0°C ≤ T_A ≤ 70°C, T_J ≤ +150°C, unless otherwise specified, $I_{full\ load}$ = 1.0 A)

Characteristic	Test Conditions	Min	Typ	Max	Unit
Fixed Output Voltage					
Reference Voltage (Notes 3 and 4)	$V_{IN} - V_{OUT}$ = 1.5 V; 0 ≤ I_{OUT} ≤ 1.0 A	3.250 (−1.5%)	3.300	3.350 (+1.5%)	V
Line Regulation	2.0 V ≤ $V_{IN} - V_{OUT}$ ≤ 3.7 V; I_{OUT} = 10 mA	–	0.02	0.20	%
Load Regulation (Notes 3 and 4)	$V_{IN} - V_{OUT}$ = 2.0 V; 10 mA ≤ I_{OUT} ≤ 1.0 A	–	0.04	0.4	%
Dropout Voltage (Note 5)	I_{OUT} = 1.0 A	–	1.0	1.2	V
Current Limit	$V_{IN} - V_{OUT}$ = 3.0 V	1.0	3.1	–	A
Quiescent Current	I_{OUT} = 10 mA	–	5.0	10	mA
Thermal Regulation (Note 6)	30 ms Pulse, T_A = 25°C	–	0.002	0.020	%/W
Ripple Rejection (Note 6)	f = 120 Hz; I_{OUT} = 1.0 A; $V_{IN} - V_{OUT}$ = 3.0 V; V_{RIPPLE} = 1.0 V_{PP}	–	80	–	dB
Thermal Shutdown (Note 7)	–	150	180	210	°C
Thermal Shutdown Hysteresis (Note 7)	–	–	25	–	°C

3. Load regulation and output voltage are measured at a constant junction temperature by low duty cycle pulse testing. Changes in output voltage due to temperature changes must be taken into account separately.
4. Specifications apply for an external Kelvin sense connection at a point on the output pin 1/4” from the bottom of the package.
5. Dropout voltage is a measurement of the minimum input/output differential at full load.
6. Guaranteed by design, not 100% tested in production.
7. Thermal shutdown is 100% functionally tested in production.

PACKAGE PIN DESCRIPTION

Package Pin Number			Pin Symbol	Function
TO−220−3	D^2PAK−3	SOT−223		
1	1	1	GND	Ground connection.
2	2	2	V_{OUT}	Regulated output voltage (case).
3	3	3	V_{IN}	Input voltage.

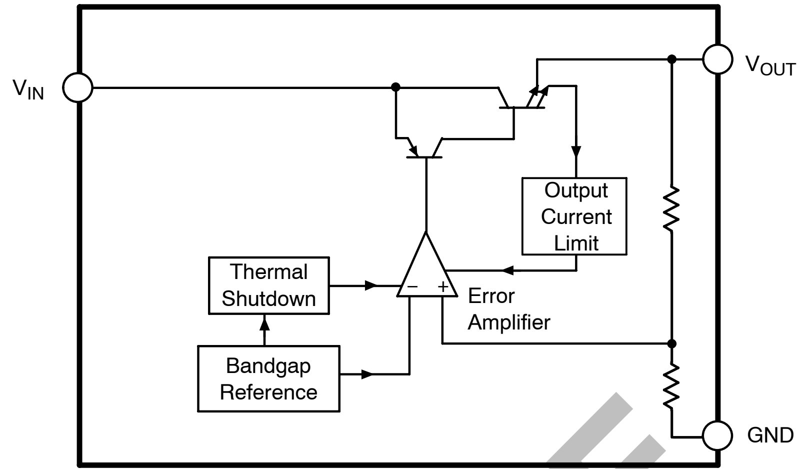


Figure 2. Block Diagram

TYPICAL PERFORMANCE CHARACTERISTICS

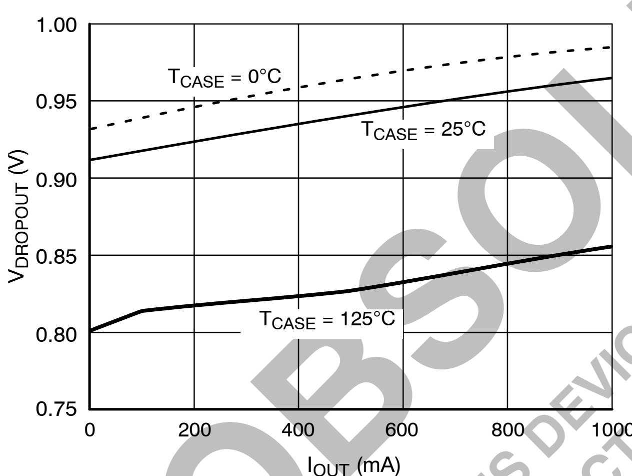


Figure 3. Dropout Voltage vs. Output Current

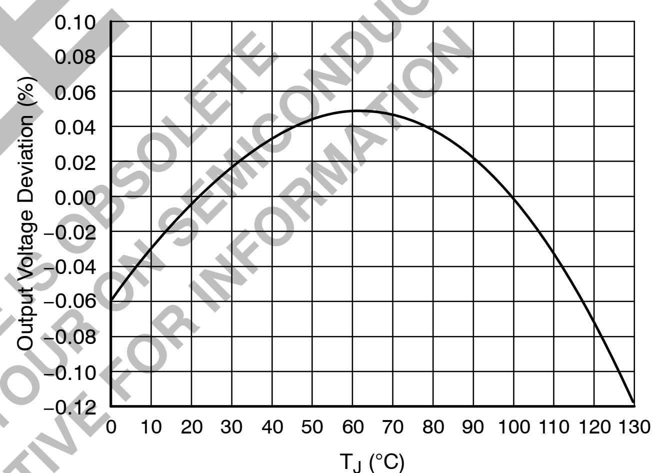


Figure 4. Reference Voltage vs. Temperature

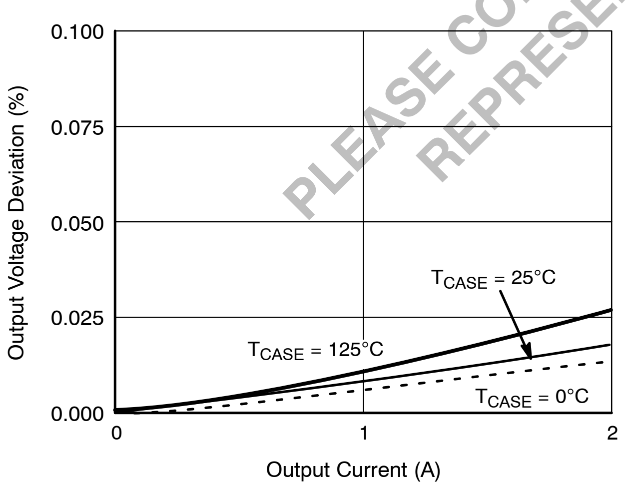


Figure 5. Load Regulation vs. Output Current

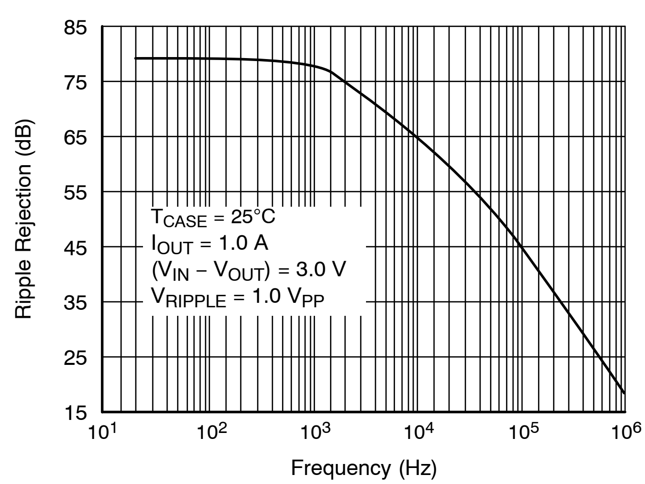
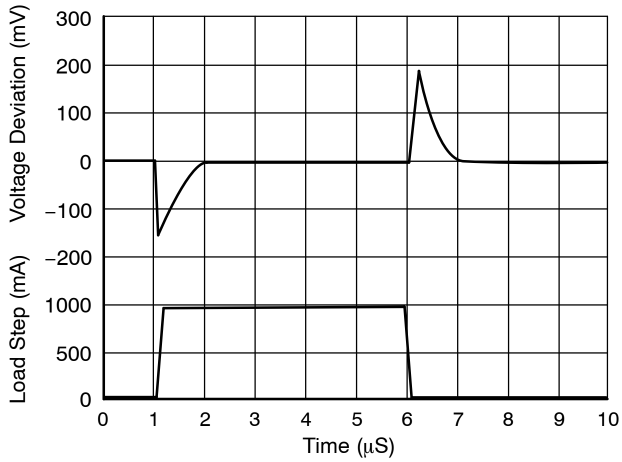


Figure 6. Ripple Rejection vs. Frequency



$C_{OUT} = C_{IN} = 22\ \mu F$ Tantalum

Figure 7. Transient Response

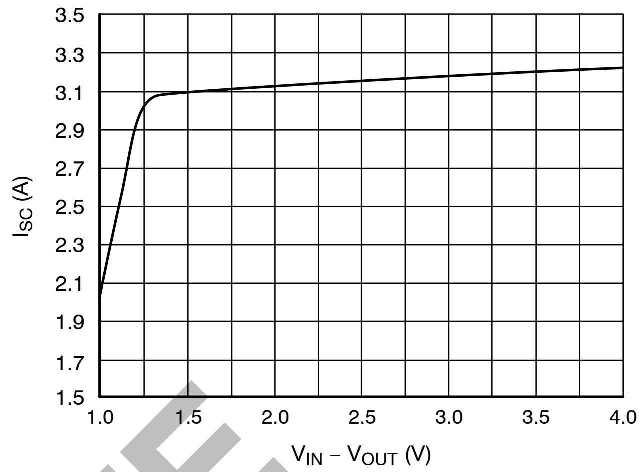


Figure 8. Short Circuit Current vs. $V_{IN} - V_{OUT}$

APPLICATIONS INFORMATION

The CS5201−3 linear regulator provides a fixed 3.3 V output voltage at currents up to 1.0 A. The regulator is protected against overcurrent conditions and includes thermal shutdown.

The CS5201−3 has a composite PNP−NPN output transistor and requires an output capacitor for stability. A detailed procedure for selecting this capacitor is included in the Stability Considerations section.

Stability Considerations

The output compensation capacitor helps determine three main characteristics of a linear regulator: startup delay, load transient response, and loop stability.

The capacitor value and type is based on cost, availability, size and temperature constraints. A tantalum or aluminum electrolytic capacitor is best, since a film or ceramic capacitor with almost zero ESR can cause instability. The aluminum electrolytic capacitor is the least expensive solution. However, when the circuit operates at low temperatures, both the value and ESR of the capacitor will vary considerably. The capacitor manufacturer's data sheet provides this information.

A 22 µF tantalum capacitor will work for most applications, but with high current regulators such as the CS5201−3 the transient response and stability improve with higher values of capacitance. The majority of applications for this regulator involve large changes in load current so the output capacitor must supply the instantaneous load current. The ESR of the output capacitor causes an immediate drop in output voltage given by:

$$\Delta V = \Delta I \times ESR$$

For microprocessor applications it is customary to use an output capacitor network consisting of several tantalum and ceramic capacitors in parallel. This reduces the overall ESR and reduces the instantaneous output voltage drop under transient load conditions. The output capacitor network should be as close to the load as possible for the best results.

Protection Diodes

When large external capacitors are used with a linear regulator it is sometimes necessary to add protection diodes. If the input voltage of the regulator gets shorted, the output capacitor will discharge into the output of the regulator. The discharge current depends on the value of the capacitor, the output voltage and the rate at which V_{IN} drops. In the CS5201−3 linear regulator, the discharge path is through a large junction and protection diodes are not usually needed. If the regulator is used with large values of output capacitance and the input voltage is instantaneously shorted to ground, damage can occur. In this case, a diode connected as shown in Figure 9 is recommended.

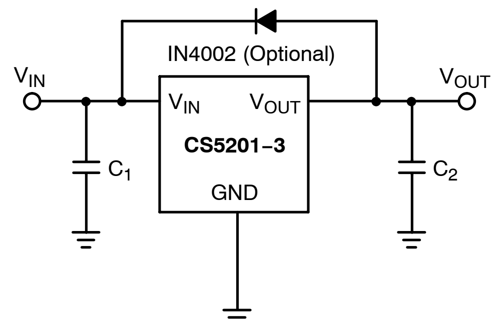


Figure 9. Protection Diode Scheme for Large Output Capacitors

Output Voltage Sensing

Since the CS5201−3 is a three terminal regulator, it is not possible to provide true remote load sensing. Load regulation is limited by the resistance of the conductors connecting the regulator to the load. For best results the regulator should be connected as shown in Figure 10.

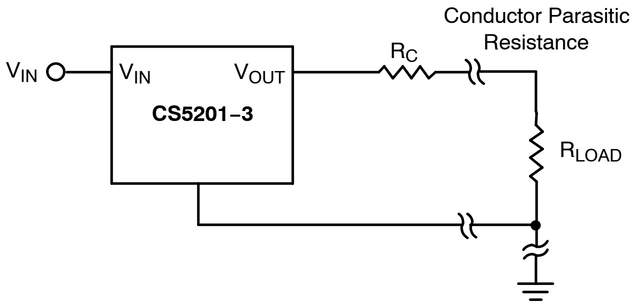


Figure 10. Conductor Parasitic Resistance Effects Can Be Minimized With the Above Grounding Scheme For Fixed Output Regulators

Calculating Power Dissipation and Heatsink Requirements

The CS5201−3 linear regulator includes thermal shutdown and current limit circuitry to protect the device. High power regulators such as these usually operate at high junction temperatures so it is important to calculate the power dissipation and junction temperatures accurately to ensure that an adequate heatsink is used.

The case is connected to V_{OUT} on the CS5201−3, electrical isolation may be required for some applications. Thermal compound should always be used with high current regulators such as these.

The thermal characteristics of an IC depend on the following four factors:

1. Maximum Ambient Temperature T_A (°C)
2. Power dissipation P_D (Watts)
3. Maximum junction temperature T_J (°C)
4. Thermal resistance junction to ambient $R_{\theta JA}$ (°C/W)

These four are related by the equation

$$T_J = T_A + P_D \times R_{\theta JA} \quad (1)$$

The maximum ambient temperature and the power dissipation are determined by the design while the maximum junction temperature and the thermal resistance depend on the manufacturer and the package type.

The maximum power dissipation for a regulator is:

$$P_{D(max)} = \{V_{IN(max)} - V_{OUT(min)}\} I_{OUT(max)} + V_{IN(max)} I_Q \quad (2)$$

where:

$V_{IN(max)}$ is the maximum input voltage,

$V_{OUT(min)}$ is the minimum output voltage,

$I_{OUT(max)}$ is the maximum output current, for the application

I_Q is the maximum quiescent current at $I_{OUT(max)}$.

A heatsink effectively increases the surface area of the package to improve the flow of heat away from the IC and into the surrounding air.

Each material in the heat flow path between the IC and the outside environment has a thermal resistance. Like series electrical resistances, these resistances are summed to determine $R_{\theta JA}$, the total thermal resistance between the junction and the surrounding air.

1. Thermal Resistance of the junction−to−case, $R_{\theta JC}$ (°C/W)
2. Thermal Resistance of the case to heatsink, $R_{\theta CS}$ (°C/W)
3. Thermal Resistance of the heatsink to the ambient air, $R_{\theta SA}$ (°C/W)

These are connected by the equation:

$$R_{\theta JA} = R_{\theta JC} + R_{\theta CS} + R_{\theta SA} \quad (3)$$

The value for $R_{\theta JA}$ is calculated using equation (3) and the result can be substituted in equation (1).

The value for $R_{\theta JC}$ is 3.5°C/W for a given package type based on an average die size. For a high current regulator such as the CS5201−3 the majority of the heat is generated in the power transistor section. The value for $R_{\theta SA}$ depends on the heatsink type, while $R_{\theta CS}$ depends on factors such as package type, heatsink interface (is an insulator and thermal grease used?), and the contact area between the heatsink and the package. Once these calculations are complete, the maximum permissible value of $R_{\theta JA}$ can be calculated and the proper heatsink selected. For further discussion on heatsink selection, see application note "Thermal Management," document number AND8036/D, available through the Literature Distribution Center or via our website at http://onsemi.com.

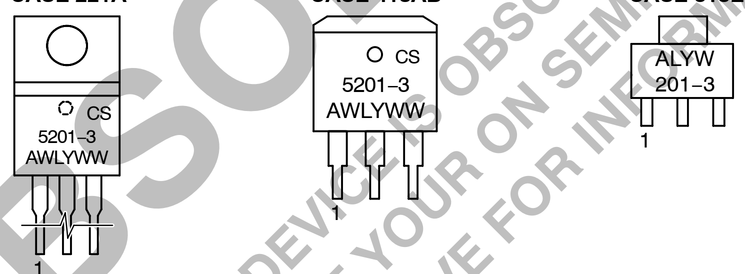
ORDERING INFORMATION

Device	Type*	Package	Shipping†
CS5201−3GT3	1.0 A, 3.3 V Output	TO−220−3, STRAIGHT	50 Units / Rail
CS5201−3GDP3	1.0 A, 3.3 V Output	D^2PAK−3	50 Units / Rail
CS5201−3GDPR3	1.0 A, 3.3 V Output	D^2PAK−3	750 / Tape & Reel
CS5201−3GDPR3G	1.0 A, 3.3 V Output	D^2PAK−3 (Pb−Free)	750 / Tape & Reel
CS5201−3GST3	1.0 A, 3.3 V Output	SOT−223	80 Units / Rail
CS5201−3GSTR3	1.0 A, 3.3 V Output	SOT−223	2500 / Tape & Reel

*Consult your local sales representative for other fixed output voltage versions.
†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.

MARKING DIAGRAMS

TO−220−3 T SUFFIX CASE 221A | **D^2PAK−3 DP SUFFIX CASE 418AB** | **SOT−223 ST SUFFIX CASE 318E**



A = Assembly Location
WL, L = Wafer Lot
YY, Y = Year
WW, W = Work Week

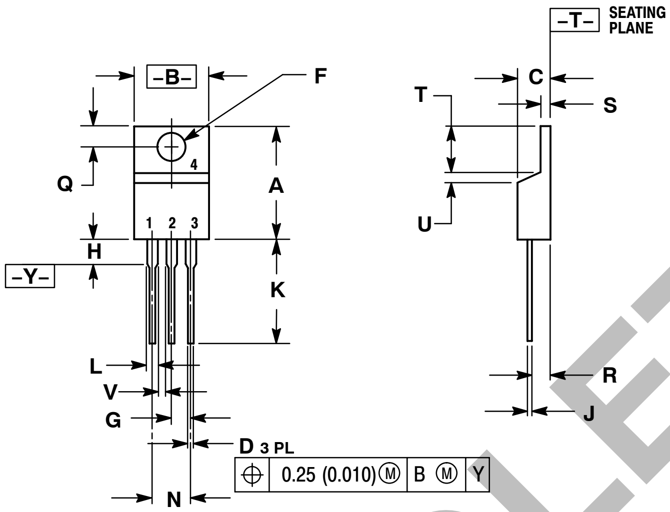
PACKAGE THERMAL DATA

Parameter		TO−220 THREE LEAD	D^2PAK 3−PIN	SOT−223	Unit
$R_{\theta JC}$	Typical	3.5	3.5	15	°C/W
$R_{\theta JA}$	Typical	50	10−50*	156	°C/W

* Depending on thermal properties of substrate. $R_{\theta JA} = R_{\theta JC} + R_{\theta CA}$

PACKAGE DIMENSIONS

TO−220
THREE LEAD
T SUFFIX
CASE 221A−08
ISSUE AA



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

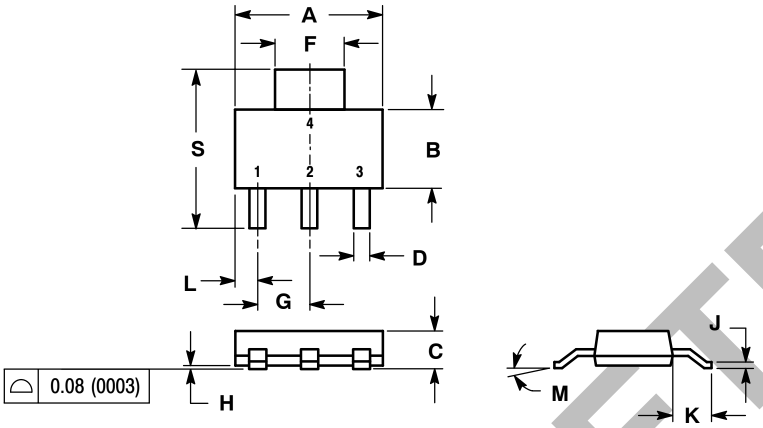
DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	0.560	0.625	14.23	15.87
B	0.380	0.420	9.66	10.66
C	0.140	0.190	3.56	4.82
D	0.025	0.035	0.64	0.89
F	0.139	0.155	3.53	3.93
G	0.100 BSC		2.54 BSC	
H	---	0.280	---	7.11
J	0.012	0.045	0.31	1.14
K	0.500	0.580	12.70	14.73
L	0.045	0.060	1.15	1.52
N	0.200 BSC		5.08 BSC	
Q	0.100	0.135	2.54	3.42
R	0.080	0.115	2.04	2.92
S	0.020	0.055	0.51	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	---

D²PAK−3
DP SUFFIX
CASE 418AB−01
ISSUE O

For D²PAK Outline and Dimensions – Contact Factory

PACKAGE DIMENSIONS

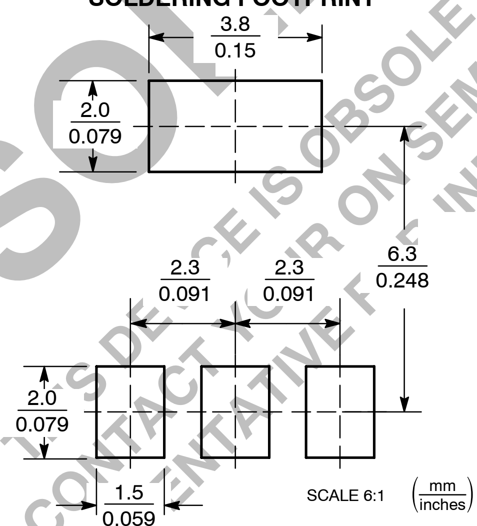
SOT−223
ST SUFFIX
CASE 318E−04
ISSUE K



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.249	0.263	6.30	6.70
B	0.130	0.145	3.30	3.70
C	0.060	0.068	1.50	1.75
D	0.024	0.035	0.60	0.89
F	0.115	0.126	2.90	3.20
G	0.087	0.094	2.20	2.40
H	0.0008	0.0040	0.020	0.100
J	0.009	0.014	0.24	0.35
K	0.060	0.078	1.50	2.00
L	0.033	0.041	0.85	1.05
M	0°	10°	0°	10°
S	0.264	0.287	6.70	7.30

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.

PUBLICATION ORDERING INFORMATION

LITERATURE FULFILLMENT:
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