NCP4569

300 mA CMOS LDO with Shutdown and V_{REF} Bypass

The NCP4569 is a fixed output, high accuracy (typically ±0.5%) CMOS upgrade for older (bipolar) low dropout regulators. Total supply current is typically 50 μA at full load (20 to 60 times lower than in bipolar regulators).

NCP4569 key features include ultra low noise operation (plus optional Bypass input); very low dropout voltage (typically 240 mV at full load), and fast response to step changes in load. Supply current is reduced to 0.05 μA (typical) and V_{OUT} falls to zero when the shutdown input is low.

The NCP4569 incorporates both over–temperature and over–current protection. The NCP4569 is stable with an output capacitor of only 1.0 μF and has a maximum output current of 300 mA.

Features

- Zero Ground Current for Longer Battery Life
- Very Low Dropout Voltage
- Guaranteed 300 mA Output
- High Output Voltage Accuracy
- Standard or Custom Output Voltages
- Power–Saving Shutdown Mode
- Bypass Input for Ultra–Quiet Operation
- Over–Current and Over–Temperature Protection
- Space–Saving Micro–8 Package

Applications

- Battery–Operated Systems
- Portable Computers
- Medical Instruments
- Instrumentation
- Cellular/GSM/PHS Phones
- Linear Post–Regulator for SMPS
- Pagers
- Digital Cameras

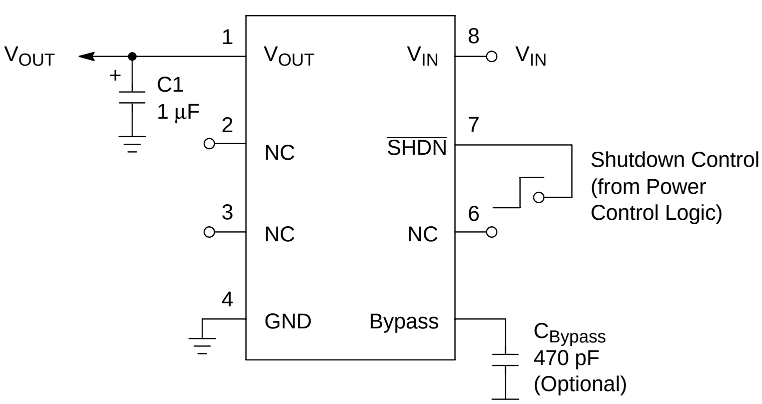

Figure 1. Typical Application

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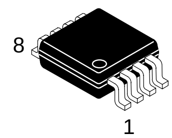
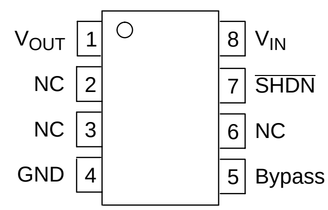


MICRO–8
DM SUFFIX
CASE 846A

PIN CONFIGURATION



(Top View)

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 7 of this data sheet.

ABSOLUTE MAXIMUM RATINGS*

Rating		Symbol	Value	Unit
Input Voltage		–	6.5	V
Output Voltage		–	V_{SS} – 0.3 to V_{IN} + 0.3	–
Power Dissipation		–	Internally Limited (Note 8.)	–
Operating Temperature		T_A	–40 < T_J < 125	°C
Storage Temperature		T_{stg}	–65 to +150	°C
Maximum Voltage on any Pin		–	V_{IN} + 0.3 to – 0.3	V
Lead Temperature (Soldering, 10 Sec.)		–	+300	°C
ESD Withstand Voltage	Human Body Model (Note 1.)	V_{ESD}	>2000	V
Latch–Up Performance (Note 2.)	Positive Negative	$I_{LATCH–UP}$	>500 >500	mA

*Absolute Maximum Ratings indicate device operation limits beyond damage may occur. Device operation beyond the limits listed in Electrical Characteristics is not recommended.

1. Tested to EIA/JESD22–A114–A
2. Tested to EIA/JESD78

ELECTRICAL CHARACTERISTICS (V_{IN} = V_{OUT} + 1.0 V, I_L = 0.1 μA, C_L = 3.3 μF, $\overline{SHDN}$ > V_{IH}, T_A = 25°C, unless otherwise noted. **Boldface** type specifications apply for junction temperatures of –40°C to +125°C.)

Characteristics	Test Conditions	Symbol	Min	Typ	Max	Unit
Input Operating Voltage	–	V_{IN}	–	–	**6.0**	V
Maximum Output Current	–	I_{OUTMAX}	**300**	–	–	mA
Output Voltage	Note 3.	V_{OUT}	– **V_R – 2.5%**	V_R ± 0.5% –	– **V_R + 2.5%**	V
V_{OUT} Temperature Coefficient	Note 4.	$\Delta V_{OUT}/\Delta T$	–	**40**	–	ppm/°C
Line Regulation	(V_R + 1.0 V) ≤ V_{IN} ≤ 6.0 V	$\Delta V_{OUT}/\Delta V_{IN}$	–	0.05	**0.35**	%
Load Regulation	I_L = 0.1 mA to I_{OUTMAX}	$\Delta V_{OUT}/V_{OUT}$	–	0.5	**2.0**	%
Dropout Voltage	I_L = 0.1 mA I_L = 100 mA I_L = 300 mA Note 6.	$V_{IN} – V_{OUT}$	– – –	20 80 240	**30** **160** **480**	mV
Supply Current	$\overline{SHDN}$ = V_{IH}	I_{SS1}	–	50	**90**	μA
Shutdown Supply Current	$\overline{SHDN}$ = 0 V	I_{SS2}	–	0.05	**0.5**	μA
Power Supply Rejection Ratio	F_{RE} ≤ 1.0 kHz	PSRR	–	60	–	dB
Output Short Circuit Current	V_{OUT} = 0 V	I_{OUTSC}	–	550	650	mA
Thermal Regulation	Note 7.	$\Delta V_{OUT}/\Delta P_D$	–	0.04	–	V/W
Output Noise	F = 1.0 kHz, C_{OUT} = 1.0 μF, R_{LOAD} = 50 Ω	eN	–	260	–	$nV/\sqrt{Hz}$

$\overline{SHDN}$ Input

Characteristics	Test Conditions	Symbol	Min	Typ	Max	Unit
$\overline{SHDN}$ Input High Threshold	–	V_{IH}	**45**	–	–	$\%V_{IN}$
$\overline{SHDN}$ Input Low Threshold	–	V_{IL}	–	–	**15**	$\%V_{IN}$

3. V_R is the regulator output voltage setting.
4. $T_C V_{OUT} = \dfrac{(V_{OUTMAX} - V_{OUTMIN}) \times 10^6}{V_{OUT} \times \Delta T}$
5. Regulation is measured at a constant junction temperature using low duty cycle pulse testing. Load regulation is tested over a load range from 0.1 mA to the maximum specified output current. Changes in output voltage due to heating effects are covered by the thermal regulation specification.
6. Dropout voltage is defined as the input to output differential at which the output voltage drops 2% below its nominal value measured at a 1.0 V differential.
7. Thermal Regulation is defined as the change in output voltage at a time T after a change in power dissipation is applied, excluding load or line regulation effects. Specifications are for a current pulse equal to I_{LMAX} at V_{IN} = 6.0 V for T = 10 msec.
8. The maximum allowable power dissipation is a function of ambient temperature, the maximum allowable junction temperature, and the thermal resistance from junction–to–air (i.e. T_A, T_J, θ_{JA}). Exceeding the maximum allowable power dissipation causes the device to initiate thermal shutdown. Please see *Thermal Considerations* section of this data sheet for more details.

DETAILED DESCRIPTION

The NCP4569 is a precision regulator available in fixed voltages. Unlike the bipolar regulators, the NCP4569 supply current does not increase with load current. In addition, V_{OUT} remains stable and within regulation at very low load currents (an important consideration in RTC and CMOS RAM battery backup applications). NCP4569 pin functions are detailed below.

PIN DESCRIPTION

Pin Number	Symbol	Description
1	V_{OUT}	Regulated voltage output.
2	NC	No connect.
3	NC	No connect.
4	GND	Ground terminal.
5	Bypass	Reference bypass input. Connecting a 470 pF to this input further reduces output noise.
6	NC	No connect.
7	$\overline{SHDN}$	Shutdown control input. The regulator is fully enabled when a logic high is applied to this input. The regulator enters shutdown when a logic low is applied to this input. During shutdown, output voltage falls to zero and supply current is reduced to 0.05 μA (typical).
8	V_{IN}	Unregulated supply input.

Figure 2 shows a typical application circuit. The regulator is enabled any time the shutdown input ($\overline{SHDN}$) is at or above V_{IH}, and shutdown (disabled) when $\overline{SHDN}$ is at or below V_{IL}. $\overline{SHDN}$ may be controlled by a CMOS logic gate, or I/O port of a microcontroller. If the $\overline{SHDN}$ input is not required, it should be connected directly to the input supply. While in shutdown, supply current decreases to 0.05 μA (typical), V_{OUT} falls to zero.

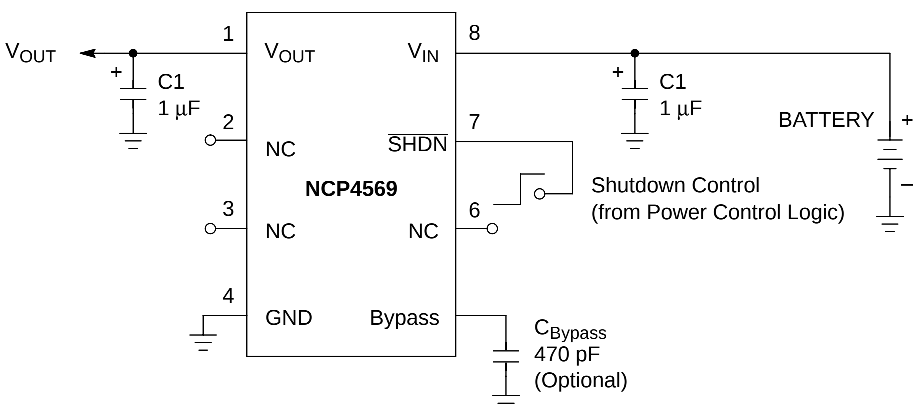


Figure 2. Typical Application Circuit

Bypass Input

A 470 pF capacitor connected from the Bypass input to ground reduces noise present on the internal reference, which in turn significantly reduces output noise. If output noise is not a concern, this input may be left unconnected. Larger capacitor values may be used, but results in a longer time period to rated output voltage when power is initially applied.

Output Capacitor

A 1.0 μF (min) capacitor from V_{OUT} to ground is recommended. The output capacitor should have an effective series resistance of 5.0 Ω or less, and a resonant frequency above 1.0 MHz. A 1.0 μF capacitor should be connected from V_{IN} to GND if there is more than 10 inches of wire between the regulator and the AC filter capacitor, or if a battery is used as the power source. Aluminum electrolytic or tantalum capacitor types can be used. (Since many aluminum electrolytic capacitors freeze at approximately –30°C, solid tantalums are recommended for applications operating below –25°C.) When operating from sources other than batteries, supply–noise rejection and transient response can be improved by increasing the value of the input and output capacitors and employing passive filtering techniques.

Thermal Considerations

Thermal Shutdown

Integrated thermal protection circuitry shuts the regulator off when die temperature exceeds 150°C. The regulator remains off until the die temperature drops to approximately 140°C.

Power Dissipation

The amount of power the regulator dissipates is primarily a function of input and output voltage, and output current. The following equation is used to calculate worst case *actual* power dissipation:

$$P_D \approx (V_{INMAX} - V_{OUTMIN}) I_{LOADMAX}$$

Where : P_D = worst case actual power dissipation
V_{INMAX} = maximum voltage on V_{IN}
V_{OUTMIN} = minimum regulator output voltage
$I_{LOADMAX}$ = maximum output (load) current

(eq. 1)

The maximum *allowable* power dissipation (Equation 2) is a function of the maximum ambient temperature (T_{AMAX}), the maximum allowable die temperature (125°C), and the thermal resistance from junction–to–air (θ_{JA}). The Micro–8 package has a θ_{JA} of approximately **200°C/Watt**; both when mounted on a single layer FR4 dielectric copper clad PC board.

$$P_{DMAX} = \frac{(T_{JMAX} - T_{AMAX})}{\theta_{JA}}$$

Where all terms are previously defined. (eq. 2)

Equation 1 can be used in conjunction with Equation 2 to ensure regulator thermal operation is within limits. For example:

GIVEN : V_{INMAX} = 3.0 V ± 10%
V_{OUTMIN} = 2.7 V − 2.5%
I_{LOAD} = 250 mA
T_{AMAX} = 55°C

Micro−8 Package

FIND : 1. Actual power dissipation.
2. Maximum allowable dissipation.

Actual power dissipation :

$$P_D \approx (V_{INMAX} - V_{OUTMIN}) I_{LOADMAX}$$
$$= [(3.0 \times 1.1) - (2.7 \times .975)]\ 250 \times 10^{-3}$$
$$= \underline{167\ mW}$$

Maximum allowable power dissipation :

$$P_{DMAX} = \frac{(T_{JMAX} - T_{AMAX})}{\theta_{JA}}$$
$$= \frac{(125 - 55)}{200}$$
$$= \underline{350\ mW}$$

In this example, the NCP4569 dissipates a maximum of only 167 mW; far below the allowable limit of 350 mW. In a similar manner, Equation 1 and Equation 2 can be used to calculate maximum current and/or input voltage limits.

Layout Considerations

The primary path of heat conduction out of the package is via the package leads. Therefore, layouts having a ground plane, wide traces at the pads, and wide power supply bus lines combine to lower θ_{JA} and, therefore, increase the maximum allowable power dissipation limit.

TYPICAL CHARACTERISTICS

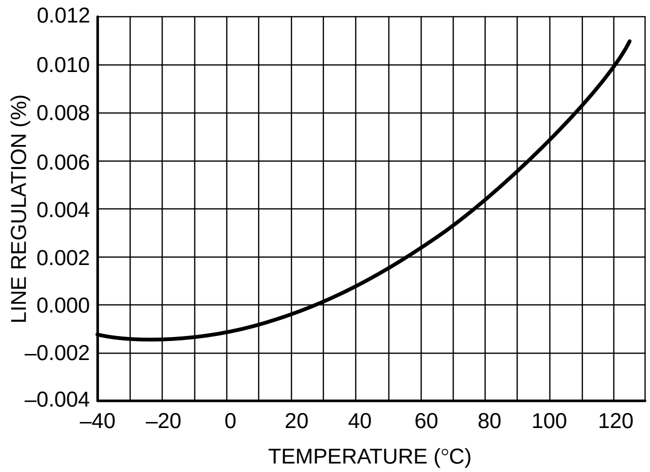


Figure 3. Line Regulation

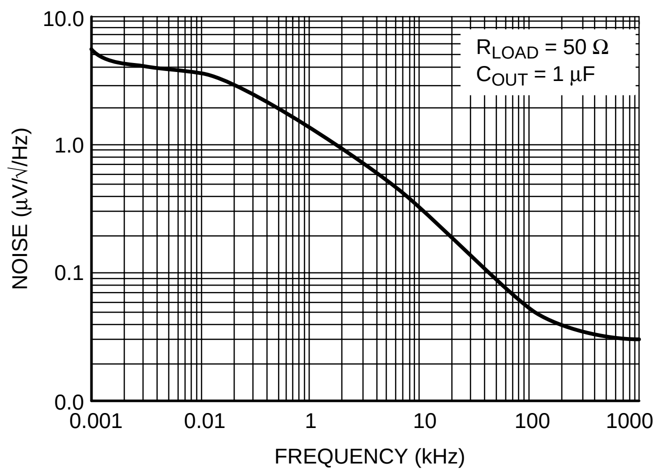


Figure 4. Output Noise

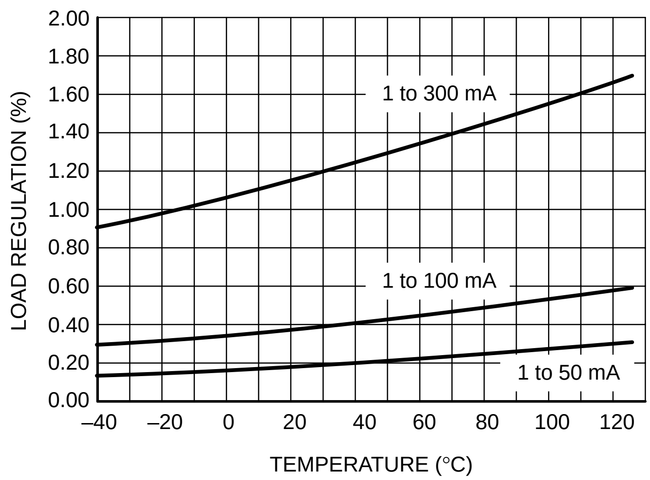


Figure 5. Load Regulation

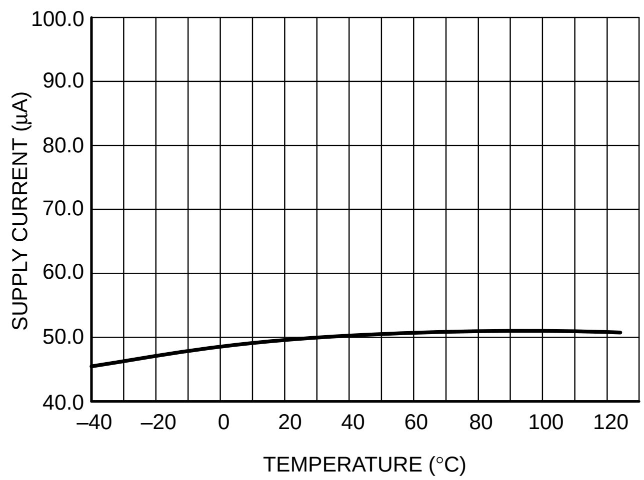


Figure 6. Supply Current

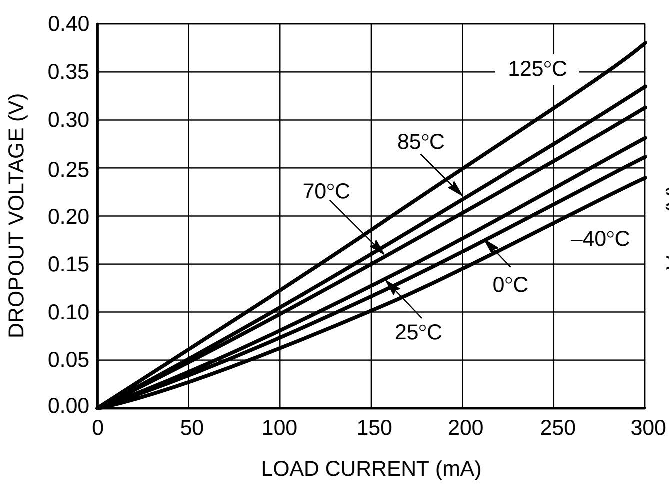


Figure 7. Dropout Voltage vs. Load Current

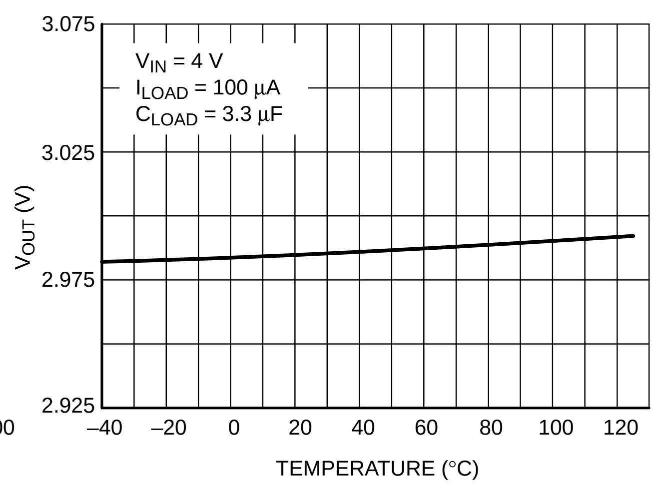


Figure 8. V_{OUT} vs. Temperature

TYPICAL CHARACTERISTICS

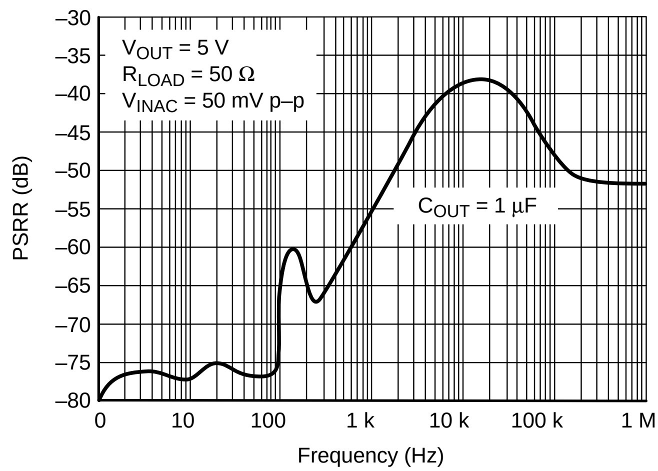
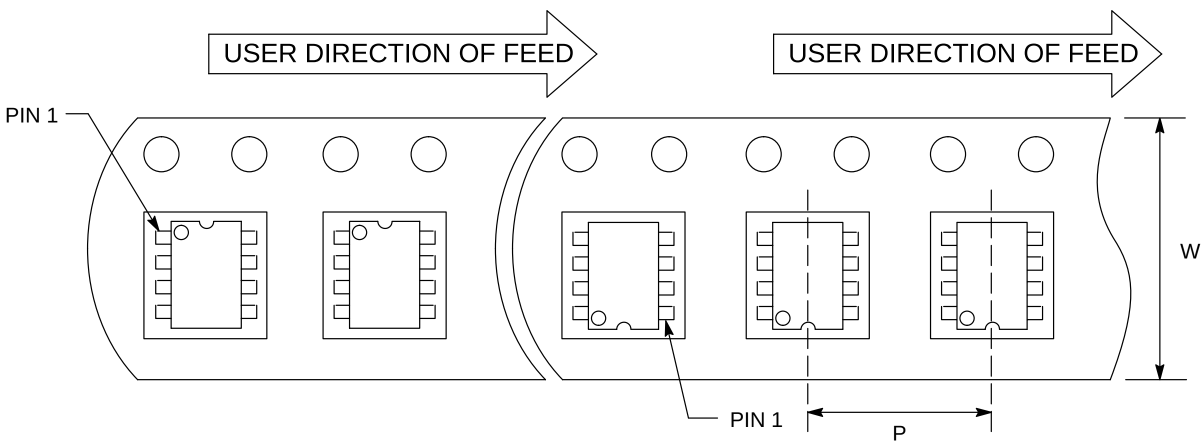


Figure 9. Power Supply Rejection Ratio

Component Taping Orientation for Micro–8 Devices



Standard Reel Component Orientation for TR Suffix Device

Reverse Reel Component Orientation for RT Suffix Device

Carrier Tape, Number of Components Per Reel and Reel Size

Package	Carrier Width (W)	Pitch (P)	Part Per Full Reel	Reel Size
Micro–8	12 mm	8 mm	2500	13 inches

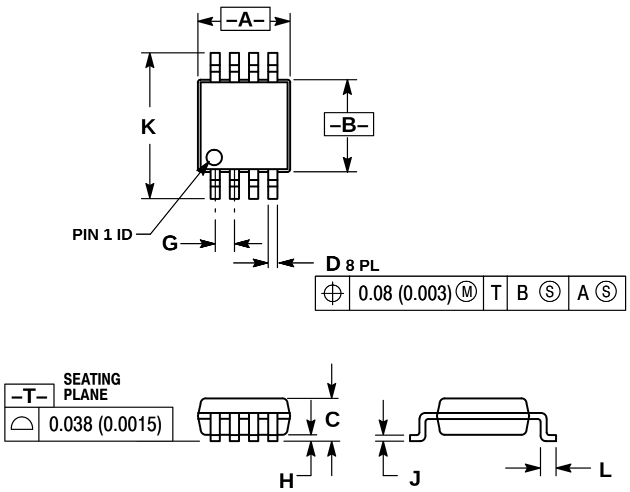
ORDERING INFORMATION

Device	Output Voltage (V)*	Package	Junction Temperature Range	Shipping
NCP4569DM25R2	2.5	Micro–8	–40°C to + 125°C	2500 Tape & Reel
NCP4569DM28R2	2.8			
NCP4569DM30R2	3.0			
NCP4569DM33R2	3.3			
NCP4569DM50R2	5.0			

*Other output voltages available. Please contact ON Semiconductor for details.

PACKAGE DIMENSIONS

MICRO–8
DM SUFFIX
CASE 846A–02
ISSUE E



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION A DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH, PROTRUSIONS OR GATE BURRS SHALL NOT EXCEED 0.15 (0.006) PER SIDE.
4. DIMENSION B DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION. INTERLEAD FLASH OR PROTRUSION SHALL NOT EXCEED 0.25 (0.010) PER SIDE.

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	2.90	3.10	0.114	0.122
B	2.90	3.10	0.114	0.122
C	---	1.10	---	0.043
D	0.25	0.40	0.010	0.016
G	0.65 BSC		0.026 BSC	
H	0.05	0.15	0.002	0.006
J	0.13	0.23	0.005	0.009
K	4.75	5.05	0.187	0.199
L	0.40	0.70	0.016	0.028

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