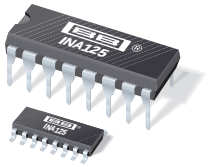
BURR - BROWN®



INA125

INSTRUMENTATION AMPLIFIER With Precision Voltage Reference

FEATURES

- LOW QUIESCENT CURRENT: 460µA
- PRECISION VOLTAGE REFERENCE: 1.24V, 2.5V, 5V or 10V
- SLEEP MODE
- LOW OFFSET VOLTAGE: 250µV max
- LOW OFFSET DRIFT: 2µV/°C max
- LOW INPUT BIAS CURRENT: 20nA max
- HIGH CMR: 100dB min
- LOW NOISE: 38nV/$\sqrt{\text{Hz}}$ at f = 1kHz
- INPUT PROTECTION TO ±40V
- WIDE SUPPLY RANGE
  Single Supply: 2.7V to 36V
  Dual Supply: ±1.35V to ±18V
- 16-PIN DIP AND SO-16 SOIC PACKAGES

APPLICATIONS

- PRESSURE AND TEMPERATURE BRIDGE AMPLIFIERS
- INDUSTRIAL PROCESS CONTROL
- FACTORY AUTOMATION
- MULTI-CHANNEL DATA ACQUISITION
- BATTERY OPERATED SYSTEMS
- GENERAL PURPOSE INSTRUMENTATION

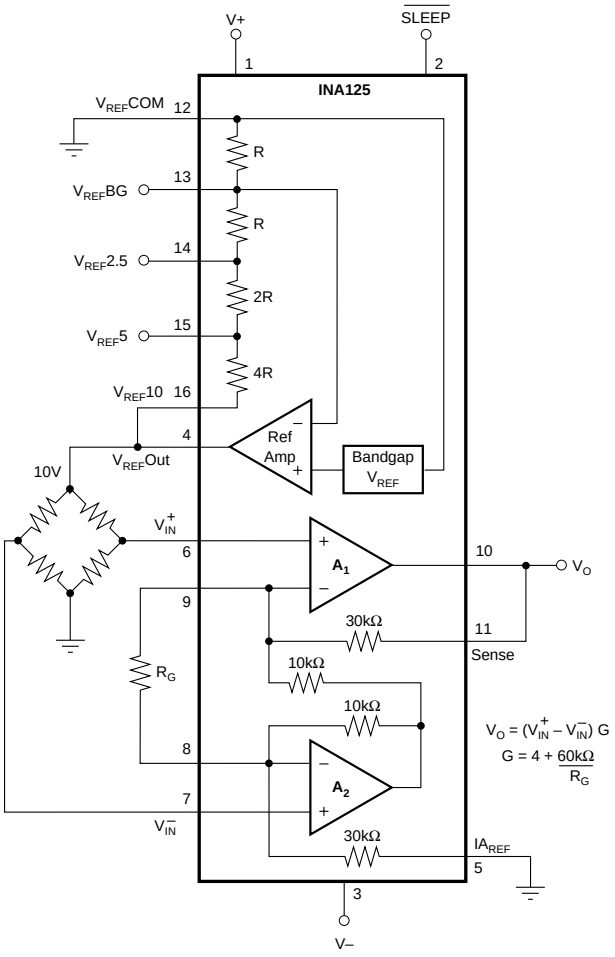
DESCRIPTION

The INA125 is a low power, high accuracy instrumentation amplifier with a precision voltage reference. It provides complete bridge excitation and precision differential-input amplification on a single integrated circuit.

A single external resistor sets any gain from 4 to 10,000. The INA125 is laser-trimmed for low offset voltage (250µV), low offset drift (2µV/°C), and high common-mode rejection (100dB at G = 100). It operates on single (+2.7V to +36V) or dual (±1.35V to ±18V) supplies.

The voltage reference is externally adjustable with pin-selectable voltages of 2.5V, 5V, or 10V, allowing use with a variety of transducers. The reference voltage is accurate to ±0.5% (max) with ±35ppm/°C drift (max). Sleep mode allows shutdown and duty cycle operation to save power.

The INA125 is available in 16-pin plastic DIP and SO-16 surface-mount packages and is specified for the –40°C to +85°C industrial temperature range.



International Airport Industrial Park • Mailing Address: PO Box 11400, Tucson, AZ 85734 • Street Address: 6730 S. Tucson Blvd., Tucson, AZ 85706 • Tel: (520) 746-1111 • Twx: 910-952-1111
Internet: http://www.burr-brown.com/ • FAXLine: (800) 548-6133 (US/Canada Only) • Cable: BBRCORP • Telex: 066-6491 • FAX: (520) 889-1510 • Immediate Product Info: (800) 548-6132

PDS-1361B
Printed in U.S.A., February, 1998

SBOS060

SPECIFICATIONS: $V_S = \pm 15V$

At T_A = +25°C, V_S = ±15V, IA common = 0V, V_{REF} common = 0V, and R_L = 10kΩ, unless otherwise noted.

PARAMETER	CONDITIONS	INA125P, U			INA125PA, UA			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	
INPUT								
Offset Voltage, RTI								
Initial			±50	±250		*	±500	µV
vs Temperature			±0.25	±2		*	±5	µV/°C
vs Power Supply	V_S = ±1.35V to ±18V, G = 4		±3	±20		*	±50	µV/V
Long-Term Stability			±0.2			*		µV/mo
Impedance, Differential			10^{11} || 2			*		Ω || pF
Common-Mode			10^{11} || 9			*		Ω || pF
Safe Input Voltage				±40			*	V
Input Voltage Range			See Text			*		
Common-Mode Rejection	V_{CM} = –10.7V to +10.2V							
	G = 4	78	84		72	*		dB
	G = 10	86	94		80	*		dB
	G = 100	100	114		90	*		dB
	G = 500	100	114		90	*		dB
BIAS CURRENT	V_{CM} = 0V		10	25		*	50	nA
vs Temperature			±60			*		pA/°C
Offset Current			±0.5	±2.5		*	±5	nA
vs Temperature			±0.5			*		pA/°C
NOISE, RTI	R_S = 0Ω							
Voltage Noise, f = 10Hz			40			*		nV/√Hz
f = 100Hz			38			*		nV/√Hz
f = 1kHz			38			*		nV/√Hz
f = 0.1Hz to 10Hz			0.8			*		µVp-p
Current Noise, f = 10Hz			170			*		fA/√Hz
f = 1kHz			56			*		fA/√Hz
f = 0.1Hz to 10Hz			5			*		pAp-p
GAIN								
Gain Equation			4 + 60kΩ/R_G			*		V/V
Range of Gain		4		10,000	*		*	V/V
Gain Error	V_O = –14V to +13.3V							
	G = 4		±0.01	±0.075		*	±0.1	%
	G = 10		±0.03	±0.3		*	±0.5	%
	G = 100		±0.05	±0.5		*	±1	%
	G = 500		±0.1			*		%
Gain vs Temperature								
	G = 4		±1	±15		*	*	ppm/°C
	G > 4[1]		±25	±100		*	*	ppm/°C
Nonlinearity	V_O = –14V to +13.3V							
	G = 4		±0.0004	±0.002		*	±0.004	% of FS
	G = 10		±0.0004	±0.002		*	±0.004	% of FS
	G = 100		±0.001	±0.01		*	*	% of FS
	G = 500		±0.002			*		% of FS
OUTPUT								
Voltage: Positive		(V+)–1.7	(V+)–0.9		*	*		V
Negative		(V–)+1	(V–)+0.4		*	*		V
Load Capacitance Stability			1000			*		pF
Short-Circuit Current			–9/+12			*		mA
VOLTAGE REFERENCE	V_{REF} = +2.5V, +5V, +10V							
Accuracy	I_L = 0		±0.15	±0.5		*	±1	%
vs Temperature	I_L = 0		±18	±35		*	±100	ppm/°C
vs Power Supply, V+	V+ = (V_{REF} + 1.25V) to +36V		±20	±50		*	±100	ppm/V
vs Load	I_L = 0 to 5mA		3	75		*	*	ppm/mA
Dropout Voltage, (V+) – V_{REF}[2]	Ref Load = 2kΩ	1.25	1		*	*		V
Bandgap Voltage Reference			1.24			*		V
Accuracy	I_L = 0		±0.5			*		%
vs Temperature	I_L = 0		±18			*		ppm/°C

SPECIFICATIONS: V_S = ±15V (CONT)

At T_A = +25°C, V_S = ±15V, IA common = 0V, V_{REF} common = 0V, and R_L = 10kΩ, unless otherwise noted.

PARAMETER CONDITIONS		INA125P, U			INA125PA, UA			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	
FREQUENCY RESPONSE								
Bandwidth, –3dB	G = 4		150			*		kHz
	G = 10		45			*		kHz
	G = 100		4.5			*		kHz
	G = 500		0.9			*		kHz
Slew Rate	G = 4, 10V Step		0.2			*		V/µs
Settling Time, 0.01%	G = 4, 10V Step		60			*		µs
	G = 10, 10V Step		83			*		µs
	G = 100, 10V Step		375			*		µs
	G = 500, 10V Step		1700			*		µs
Overload Recovery	50% Overdrive		5			*		µs
POWER SUPPLY								
Specified Operating Voltage			±15			*		V
Specified Voltage Range		±1.35		±18	*		*	V
Quiescent Current, Positive	$I_O = I_{REF}$ = 0mA		460	525		*	*	µA
Negative	$I_O = I_{REF}$ = 0mA		–280	–325		*	*	µA
Reference Ground Current[3]			180			*		µA
Sleep Current ($V_{SLEEP} \le$ 100mV)	R_L = 10kΩ, Ref Load = 2kΩ		±1	±25		*	*	µA
SLEEP MODE PIN[4]								
V_{IH} (Logic high input voltage)		+2.7		V+	*		*	V
V_{IL} (Logic low input voltage)		0		+0.1	*		*	V
I_{IH} (Logic high input current)			15			*		µA
I_{IL} (Logic low input current)			0			*		µA
Wake-up Time[5]			150			*		µs
TEMPERATURE RANGE								
Specification Range		–40		+85	*		*	°C
Operation Range		–55		+125	*		*	°C
Storage Range		–55		+125	*		*	°C
Thermal Resistance, θ_{JA}								
16-Pin DIP			80			*		°C/W
SO-16 Surface-Mount			100			*		°C/W

* Specification same as INA125P, U.

NOTES: (1) Temperature coefficient of the "Internal Resistor" in the gain equation. Does not include TCR of gain-setting resistor, R_G. (2) Dropout voltage is the positive supply voltage minus the reference voltage that produces a 1% decrease in reference voltage. (3) V_{REF}COM pin. (4) Voltage measured with respect to Reference Common. Logic low input selects Sleep mode. (5) IA and Reference, see Typical Performance Curves.

SPECIFICATIONS: V_S = +5V

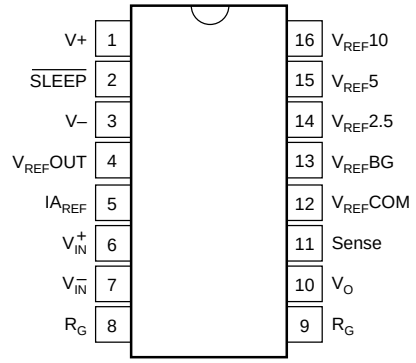
At T_A = +25°C, V_S = +5V, IA common at V_S/2, V_{REF} common = V_S/2, V_{CM} = V_S/2, and R_L = 10kΩ to V_S/2, unless otherwise noted.

PARAMETER	CONDITIONS	INA125P, U			INA125PA, UA			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	
INPUT								
Offset Voltage, RTI								
Initial			±75	±500		*	±750	µV
vs Temperature			±0.25			*		µV/°C
vs Power Supply	V_S = +2.7V to +36V		3	20		*	50	µV/V
Input Voltage Range			See Text			*		
Common-Mode Rejection	V_{CM} = +1.1V to +3.6V							
	G = 4	78	84		72	*		dB
	G = 10	86	94		80	*		dB
	G = 100	100	114		90	*		dB
	G = 500	100	114		90	*		dB
GAIN								
Gain Error	V_O = +0.3V to +3.8V							
	G = 4		±0.01			*		%
OUTPUT								
Voltage, Positive		(V+)–1.2	(V+)–0.8		*	*		V
Negative		(V–)+0.3	(V–)+0.15		*	*		V
POWER SUPPLY								
Specified Operating Voltage			+5			*		V
Operating Voltage Range		+2.7		+36	*		*	V
Quiescent Current	$I_O = I_{REF}$ = 0mA		460	525		*	*	µA
Sleep Current ($V_{SLEEP} \le$ 100mV)	R_L = 10kΩ, Ref Load = 2kΩ		±1	±25		*	*	µA

* Specification same as INA125P, U.

PIN CONFIGURATION

Top View **16-Pin DIP, SO-16**



ELECTROSTATIC DISCHARGE SENSITIVITY

This integrated circuit can be damaged by ESD. Burr-Brown recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

ABSOLUTE MAXIMUM RATINGS[1]

Power Supply Voltage, V+ to V–	36V
Input Signal Voltage	±40V
Output Short Circuit	Continuous
Operating Temperature	–55°C to +125°C
Storage Temperature	–55°C to +125°C
Lead Temperature (soldering, 10s)	+300°C

NOTE: Stresses above these ratings may cause permanent damage.

PACKAGE INFORMATION

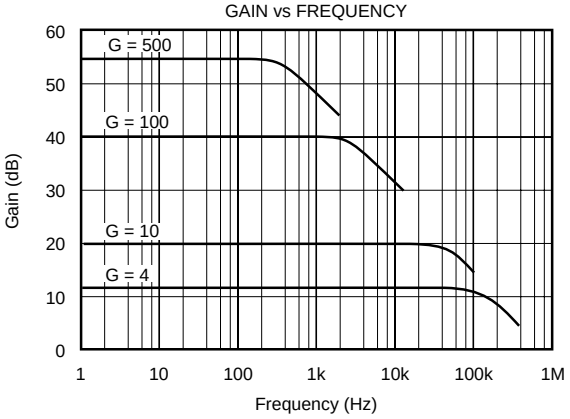
PRODUCT	PACKAGE	PACKAGE DRAWING NUMBER[1]
INA125PA	16-Pin Plastic DIP	180
INA125P	16-Pin Plastic DIP	180
INA125UA	SO-16 Surface-Mount	265
INA125U	SO-16 Surface-Mount	265

NOTES: (1) For detailed drawing and dimension table, please see end of data sheet, or Appendix C of Burr-Brown IC Data Book.

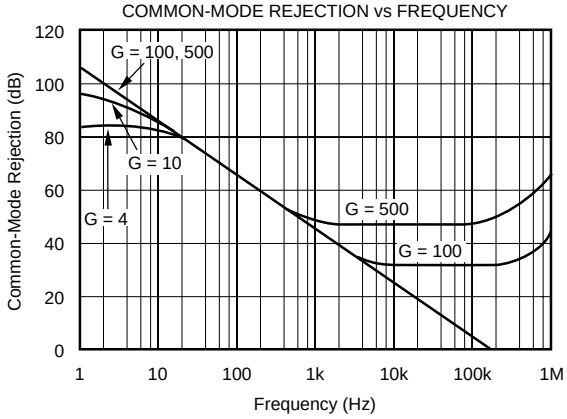
TYPICAL PERFORMANCE CURVES

At T_A = +25°C and V_S = ±15V, unless otherwise noted.

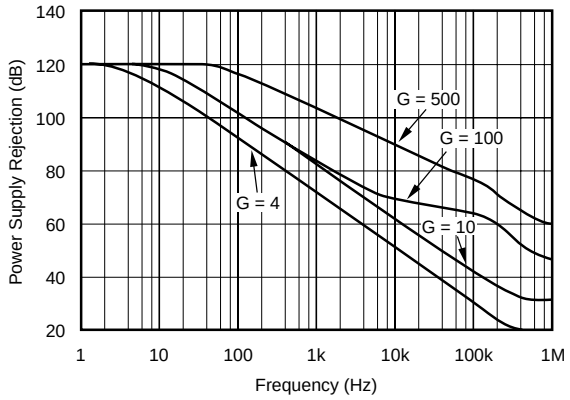
GAIN vs FREQUENCY



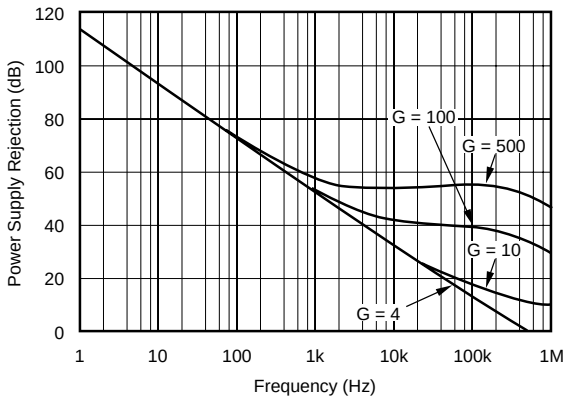
COMMON-MODE REJECTION vs FREQUENCY



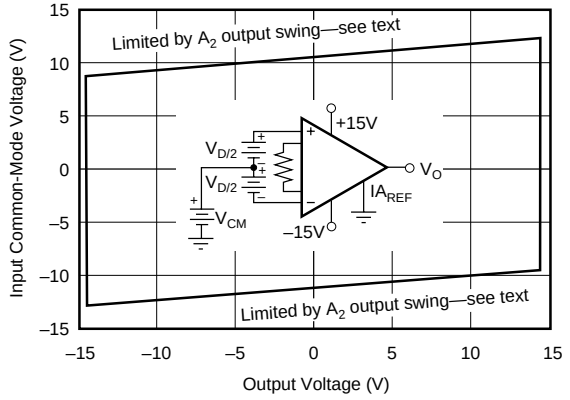
POSITIVE POWER SUPPLY REJECTION vs FREQUENCY



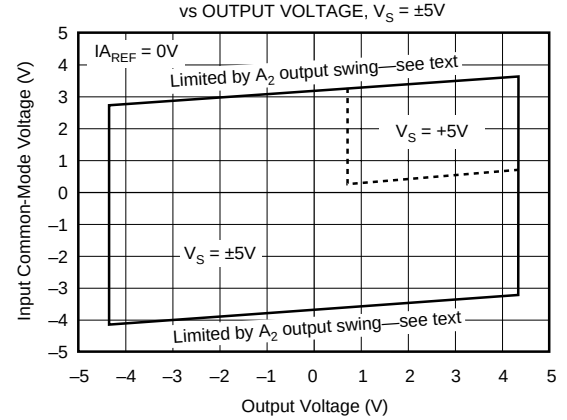
NEGATIVE POWER SUPPLY REJECTION vs FREQUENCY



INPUT COMMON-MODE VOLTAGE vs OUTPUT VOLTAGE, V_S = ±15V



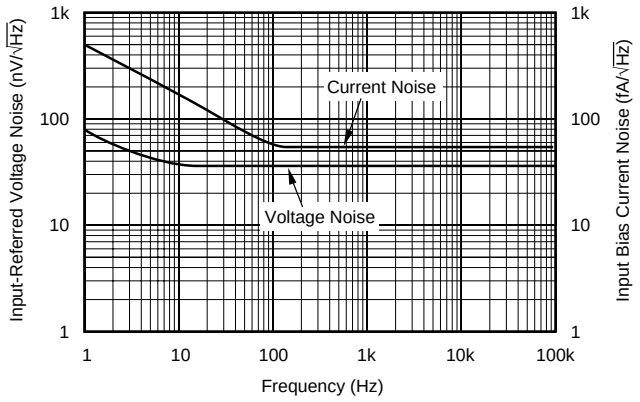
INPUT COMMON-MODE VOLTAGE vs OUTPUT VOLTAGE, V_S = ±5V



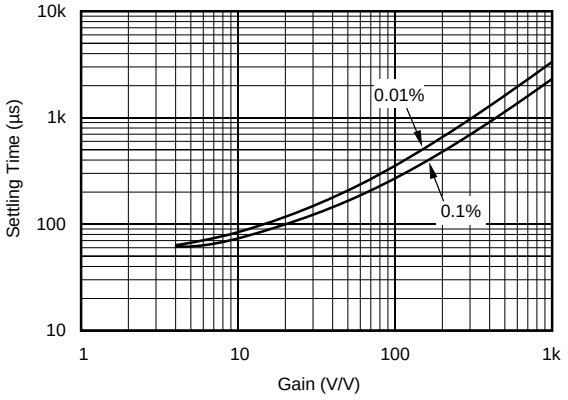
TYPICAL PERFORMANCE CURVES (CONT)

At T_A = +25°C and V_S = ±15V, unless otherwise noted.

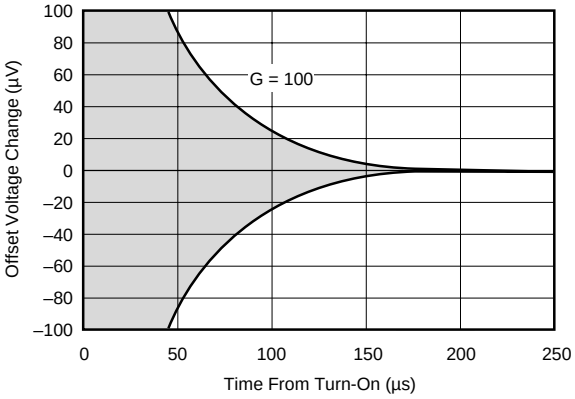
INPUT-REFERRED VOLTAGE AND CURRENT NOISE vs FREQUENCY



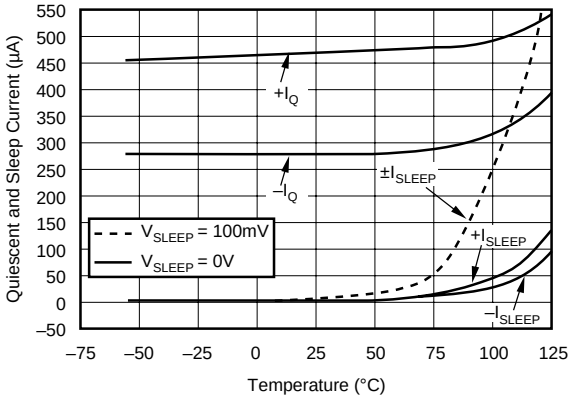
SETTLING TIME vs GAIN



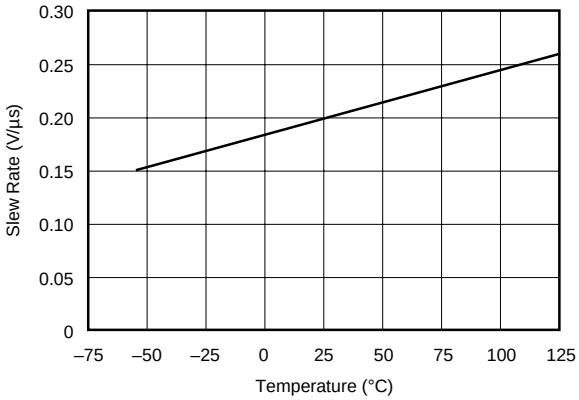
INPUT-REFERRED OFFSET VOLTAGE vs SLEEP TURN-ON TIME



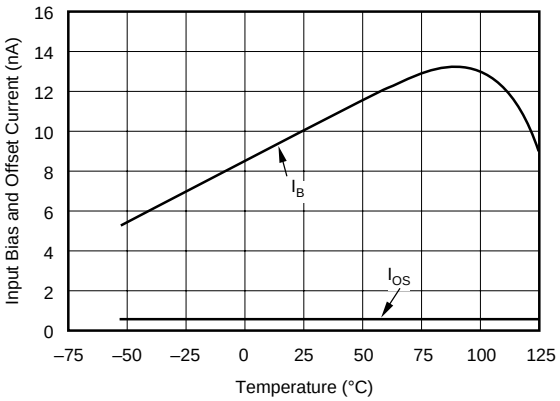
QUIESCENT CURRENT AND SLEEP CURRENT vs TEMPERATURE



SLEW RATE vs TEMPERATURE



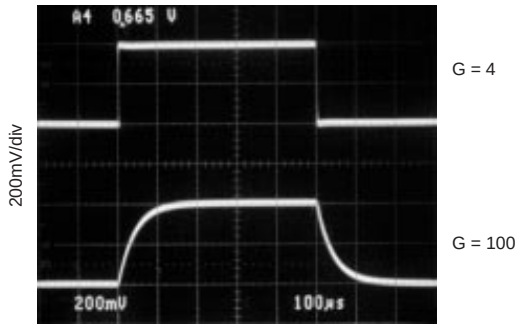
INPUT BIAS AND OFFSET CURRENT vs TEMPERATURE



TYPICAL PERFORMANCE CURVES (CONT)

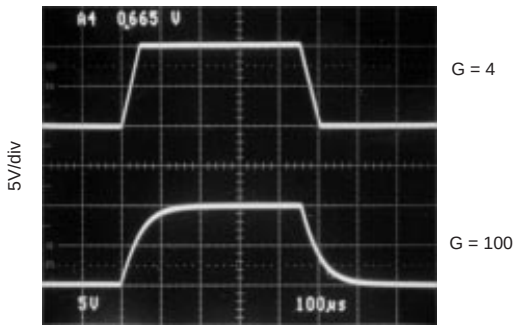
At T_A = +25°C and V_S = ±15V, unless otherwise noted.

SMALL-SIGNAL RESPONSE



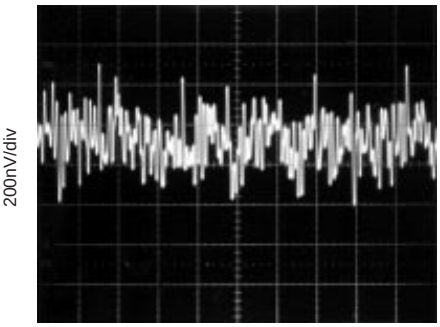
100µs/div

LARGE-SIGNAL RESPONSE



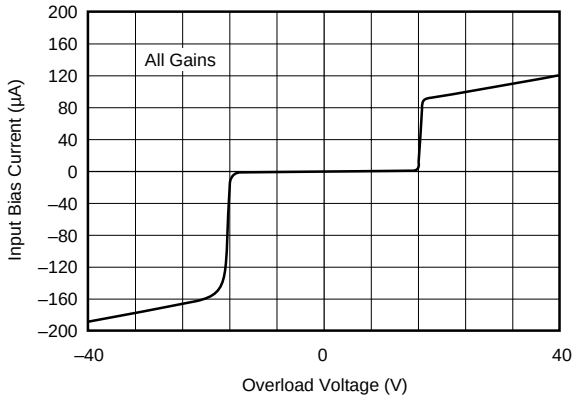
100µs/div

INPUT-REFERRED NOISE, 0.1Hz to 10Hz

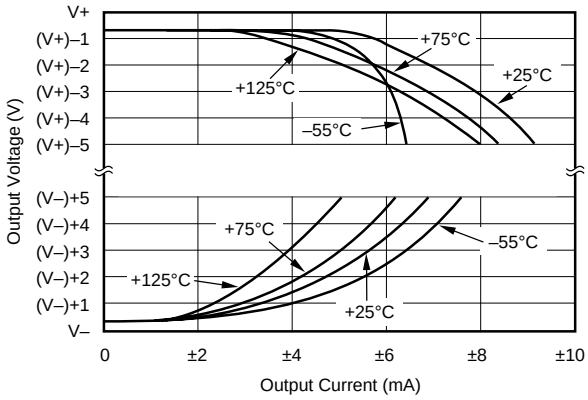


1µs/div

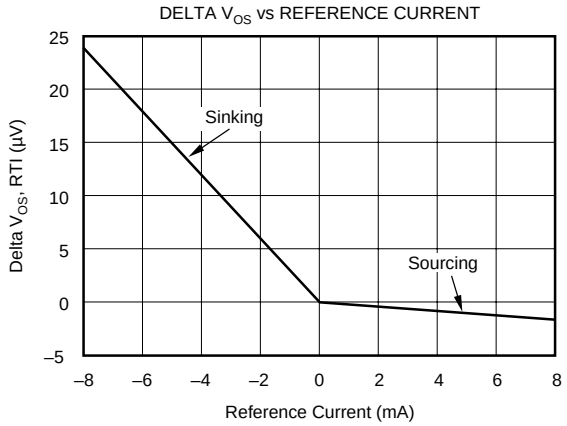
INPUT BIAS CURRENT
vs INPUT OVERLOAD VOLTAGE



OUTPUT VOLTAGE SWING
vs OUTPUT CURRENT



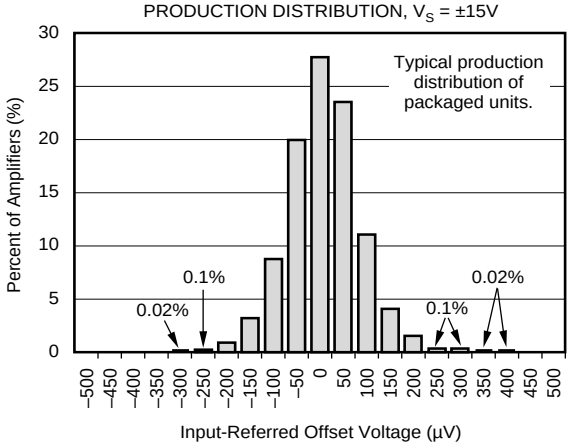
DELTA V_{OS} vs REFERENCE CURRENT



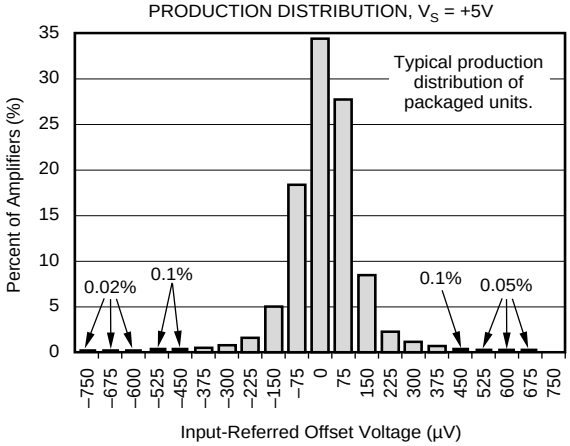
TYPICAL PERFORMANCE CURVES (CONT)

At T_A = +25°C and V_S = ±15V, unless otherwise noted.

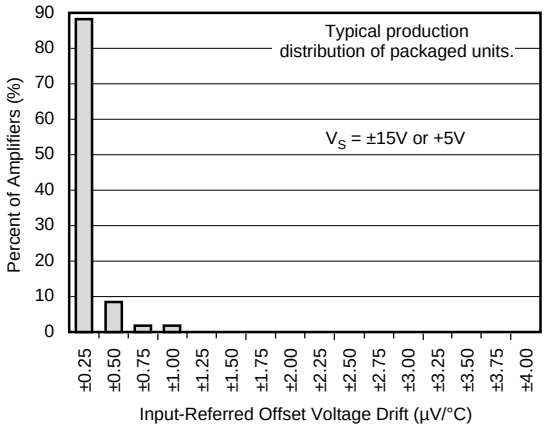
INPUT-REFERRED OFFSET VOLTAGE
PRODUCTION DISTRIBUTION, V_S = ±15V



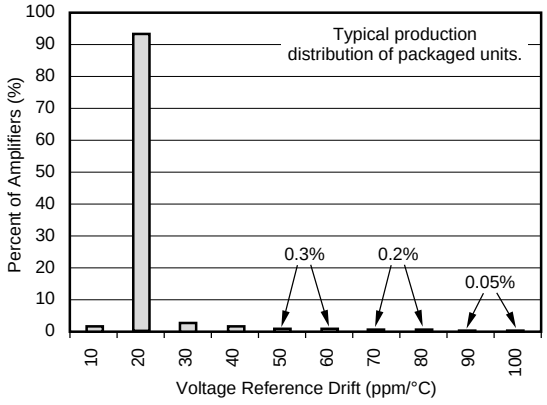
INPUT-REFERRED OFFSET VOLTAGE
PRODUCTION DISTRIBUTION, V_S = +5V



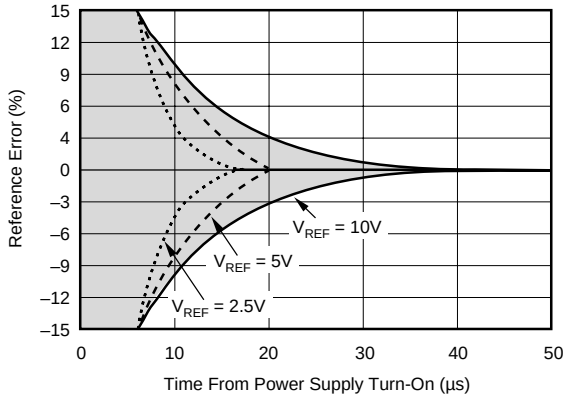
INPUT-REFERRED OFFSET VOLTAGE DRIFT
PRODUCTION DISTRIBUTION



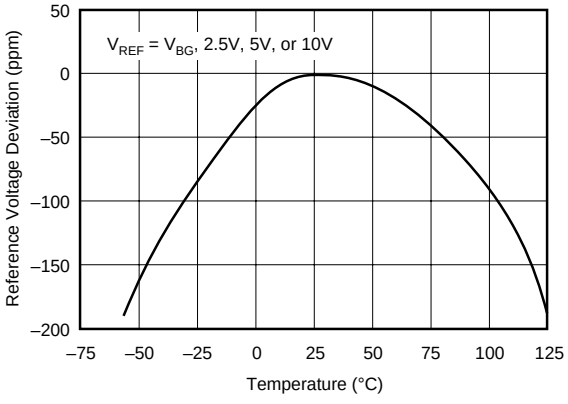
VOLTAGE REFERENCE DRIFT
PRODUCTION DISTRIBUTION



REFERENCE TURN-ON SETTLING TIME



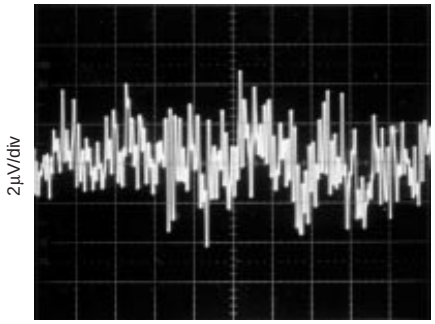
REFERENCE VOLTAGE DEVIATION
vs TEMPERATURE



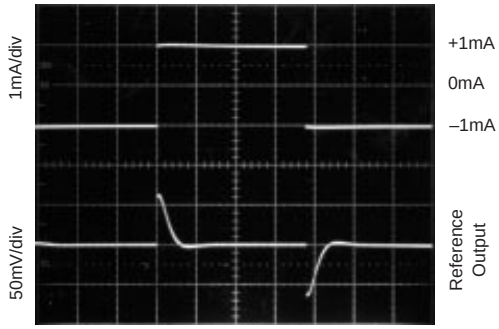
TYPICAL PERFORMANCE CURVES (CONT)

At T_A = +25°C and V_S = ±15V, unless otherwise noted.

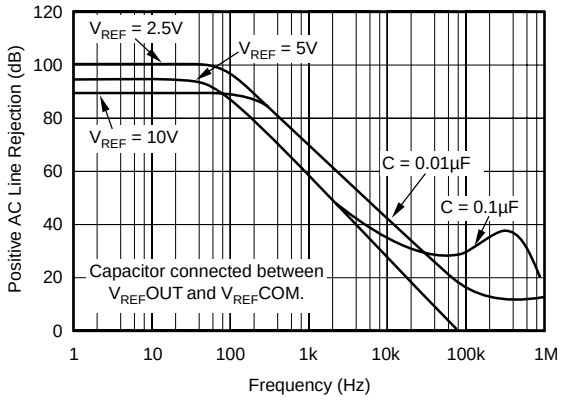
0.1Hz to 10Hz REFERENCE NOISE
V_{REF} = 2.5V, C_L = 100pF



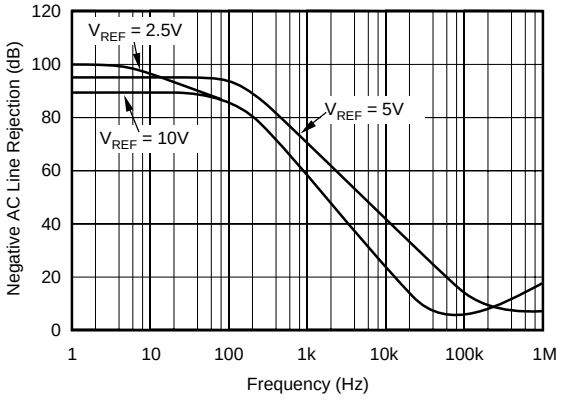
REFERENCE TRANSIENT RESPONSE
V_{REF} = 2.5V, C_L = 100pF



POSITIVE REFERENCE AC LINE REJECTION vs FREQUENCY



NEGATIVE REFERENCE AC LINE REJECTION vs FREQUENCY



APPLICATION INFORMATION

Figure 1 shows the basic connections required for operation of the INA125. Applications with noisy or high impedance power supplies may require decoupling capacitors close to the device pins as shown.

The output is referred to the instrumentation amplifier reference (IA_{REF}) terminal which is normally grounded. This must be a low impedance connection to assure good common-mode rejection. A resistance of 12Ω in series with the IA_{REF} pin will cause a typical device to degrade to approximately 80dB CMR (G = 4).

Connecting $V_{REF}OUT$ (pin 4) to one of the four available reference voltage pins ($V_{REF}BG$, $V_{REF}2.5$, $V_{REF}5$, or $V_{REF}10$) provides an accurate voltage source for bridge applications. For example, in Figure 1 $V_{REF}OUT$ is connected to $V_{REF}10$ thus supplying 10V to the bridge. It is recommended that $V_{REF}OUT$ be connected to one of the reference voltage pins even when the reference is not being utilized to avoid saturating the reference amplifier. Driving the $\overline{SLEEP}$ pin LOW puts the INA125 in a shutdown mode.

SETTING THE GAIN

Gain of the INA125 is set by connecting a single external resistor, R_G, between pins 8 and 9:

$$G = 4 + \frac{60k\Omega}{R_G} \quad (1)$$

Commonly used gains and R_G resistor values are shown in Figure 1.

DESIRED GAIN (V/V)	R_G (Ω)	NEAREST 1% R_G VALUE (Ω)
4	NC	NC
5	60k	60.4k
10	10k	10k
20	3750	3740
50	1304	1300
100	625	619
200	306	309
500	121	121
1000	60	60.4
2000	30	30.1
10000	6	6.04

NC: No Connection.

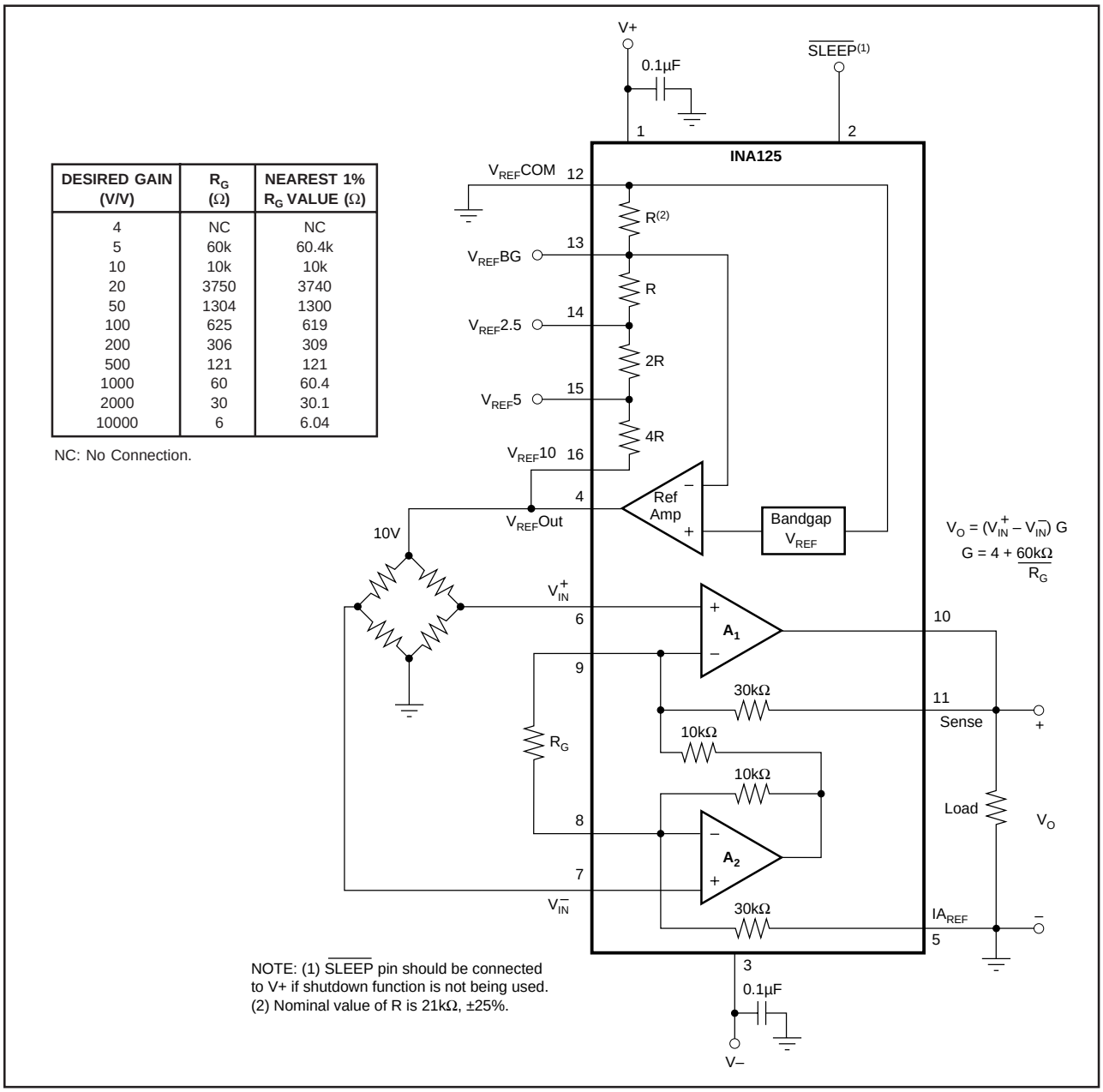


FIGURE 1. Basic Connections.

The 60kΩ term in equation 1 comes from the internal metal film resistors which are laser trimmed to accurate absolute values. The accuracy and temperature coefficient of these resistors are included in the gain accuracy and drift specifications of the INA125.

The stability and temperature drift of the external gain setting resistor, R_G, also affects gain. R_G's contribution to gain accuracy and drift can be directly inferred from the gain equation (1). Low resistor values required for high gain can make wiring resistance important. Sockets add to the wiring resistance, which will contribute additional gain error (possibly an unstable gain error) in gains of approximately 100 or greater.

OFFSET TRIMMING

The INA125 is laser trimmed for low offset voltage and offset voltage drift. Most applications require no external offset adjustment. Figure 2 shows an optional circuit for trimming the output offset voltage. The voltage applied to the IA_{REF} terminal is added to the output signal. The op amp buffer is used to provide low impedance at the IA_{REF} terminal to preserve good common-mode rejection.

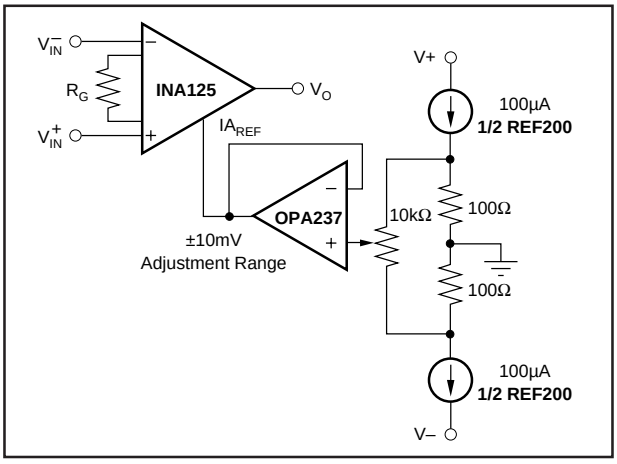


FIGURE 2. Optional Trimming of Output Offset Voltage.

INPUT BIAS CURRENT RETURN

The input impedance of the INA125 is extremely high—approximately $10^{11}\Omega$. However, a path must be provided for the input bias current of both inputs. This input bias current flows out of the device and is approximately 10nA. High input impedance means that this input bias current changes very little with varying input voltage.

Input circuitry must provide a path for this input bias current for proper operation. Figure 3 shows various provisions for an input bias current path. Without a bias current path, the inputs will float to a potential which exceeds the common-mode range, and the input amplifiers will saturate.

If the differential source resistance is low, the bias current return path can be connected to one input (see the thermocouple example in Figure 3). With higher source impedance, using two equal resistors provides a balanced input with possible advantages of lower input offset voltage due to bias current and better high frequency common-mode rejection.

INPUT COMMON-MODE RANGE

The input common-mode range of the INA125 is shown in the typical performance curves. The common-mode range is limited on the negative side by the output voltage swing of A_2, an internal circuit node that cannot be measured on an external pin. The output voltage of A2 can be expressed as:

$$V_{02} = 1.3V_{IN}^- - (V_{IN}^+ - V_{IN}^-)\ (10k\Omega/R_G)$$

(voltages referred to IA_{REF} terminal, pin 5)

The internal op amp A_2 is identical to A_1. Its output swing is limited to approximately 0.8V from the positive supply and 0.25V from the negative supply. When the input common-mode range is exceeded (A_2's output is saturated), A_1 can still be in linear operation, responding to changes in the non-inverting input voltage. The output voltage, however, will be invalid.

PRECISION VOLTAGE REFERENCE

The on-board precision voltage reference provides an accurate voltage source for bridge and other transducer applications or ratiometric conversion with analog-to-digital converters. A reference output of 2.5V, 5V or 10V is available by connecting V_{REF}OUT (pin 4) to one of the V_{REF} pins (V_{REF}2.5, V_{REF}5, or V_{REF}10). Reference voltages are laser-trimmed for low inital error and low temperature drift. Connecting V_{REF}OUT to V_{REF}BG (pin 13) produces the bandgap reference voltage (1.24V ±0.5%) at the reference output.

Positive supply voltage must be 1.25V above the desired reference voltage. For example, with V+ = 2.7V, only the 1.24V reference (V_{REF}BG) can be used. If using dual supplies V_{REF}COM can be connected to V–, increasing the

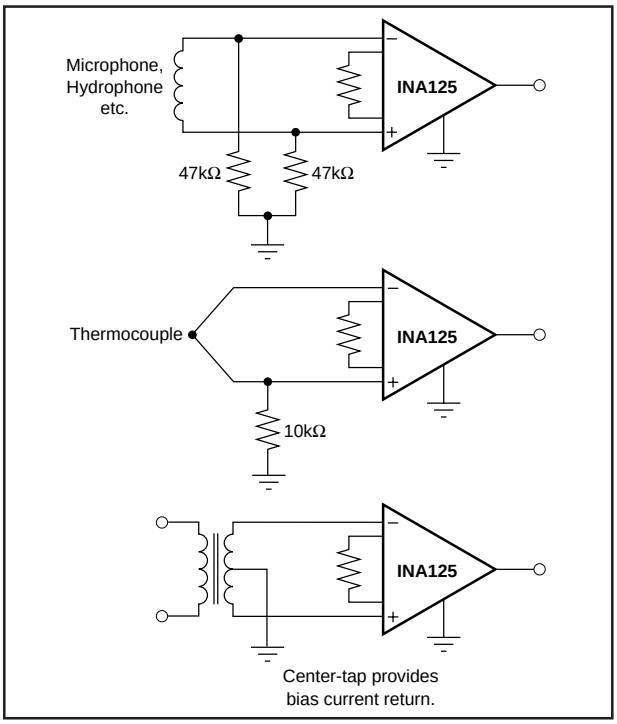


FIGURE 3. Providing an Input Common-Mode Current Path.

amount of supply voltage headroom available to the reference. Approximately 180µA flows out of the V_{REF}COM terminal, therefore, it is recommended that it be connected through a low impedance path to sensor common to avoid possible ground loop problems.

Reference noise is proportional to the reference voltage selected. With V_{REF} = 2.5V, 0.1Hz to 10Hz peak-to-peak noise is approximately 9µVp-p. Noise increases to 36µVp-p for the 10V reference. Output drive capability of the voltage reference is improved by connecting a transistor as shown in Figure 4. The external transistor also serves to remove power from the INA125.

Internal resistors that set the voltage reference output are ratio-trimmed for accurate output voltages (±0.5% max). The absolute resistance values, however, may vary ±25%. Adjustment of the reference output voltage with an external resistor is not recommended because the required resistor value is uncertain.

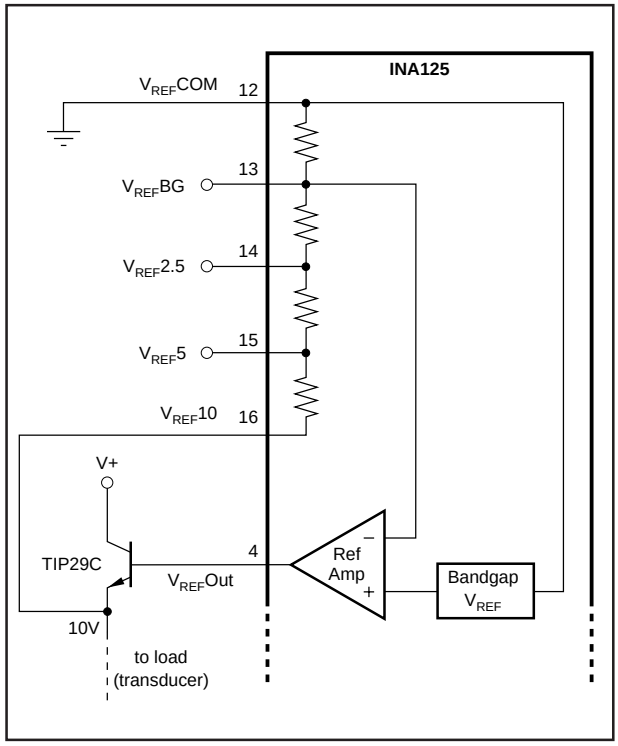


FIGURE 4. Reference Current Boost.

SHUTDOWN

The INA125 has a shutdown option. When the $\overline{\text{SLEEP}}$ pin is LOW (100mV or less), the supply current drops to approximately 1µA and output impedance becomes approximately 80kΩ. Best performance is achieved with CMOS logic. To maintain low sleep current at high temperatures, V_{SLEEP} should be as close to 0V as possible. This should not be a problem if using CMOS logic unless the CMOS gate is driving other currents. Refer to the typical performance curve, "Sleep Current vs Temperature."

A transition region exists when V_{SLEEP} is between 400mV and 2.7V (with respect to V_{REF}COM) where the output is unpredictable. Operation in this region is not recommended. The INA125 achieves high accuracy quickly following wake-up (V_{SLEEP} ≥ 2.7V). See the typical performance curve "Input-Referred Offset Voltage vs Sleep Turn-on Time." If shutdown is not being used, connect the $\overline{\text{SLEEP}}$ pin to V+.

LOW VOLTAGE OPERATION

The INA125 can be operated on power supplies as low as ±1.35V. Performance remains excellent with power supplies ranging from ±1.35V to ±18V. Most parameters vary only slightly throughout this supply voltage range—see typical performance curves. Operation at very low supply voltage requires careful attention to ensure that the common-mode voltage remains within its linear range. See "Input Common-Mode Voltage Range." As previously mentioned, when using the on-board reference with low supply voltages, it may be necessary to connect V_{REF}COM to V– to ensure $V_S - V_{REF} \geq 1.25V$.

SINGLE SUPPLY OPERATION

The INA125 can be used on single power supplies of +2.7V to +36V. Figure 5 shows a basic single supply circuit. The IA_{REF}, V_{REF}COM, and V– terminals are connected to ground. Zero differential input voltage will demand an output voltage of 0V (ground). When the load is referred to ground as shown, actual output voltage swing is limited to approximately 150mV above ground. The typical performance curve "Output Voltage Swing vs Output Current" shows how the output swing varies with output current.

With single supply operation, careful attention should be paid to input common-mode range, output voltage swing of both op amps, and the voltage applied to the IA_{REF} terminal. V_{IN+} and V_{IN-} must both be 1V above ground for linear operation. You cannot, for instance, connect the inverting input to ground and measure a voltage connected to the non-inverting input.

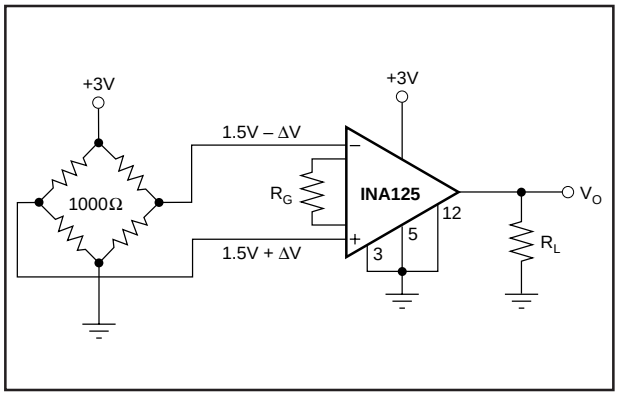
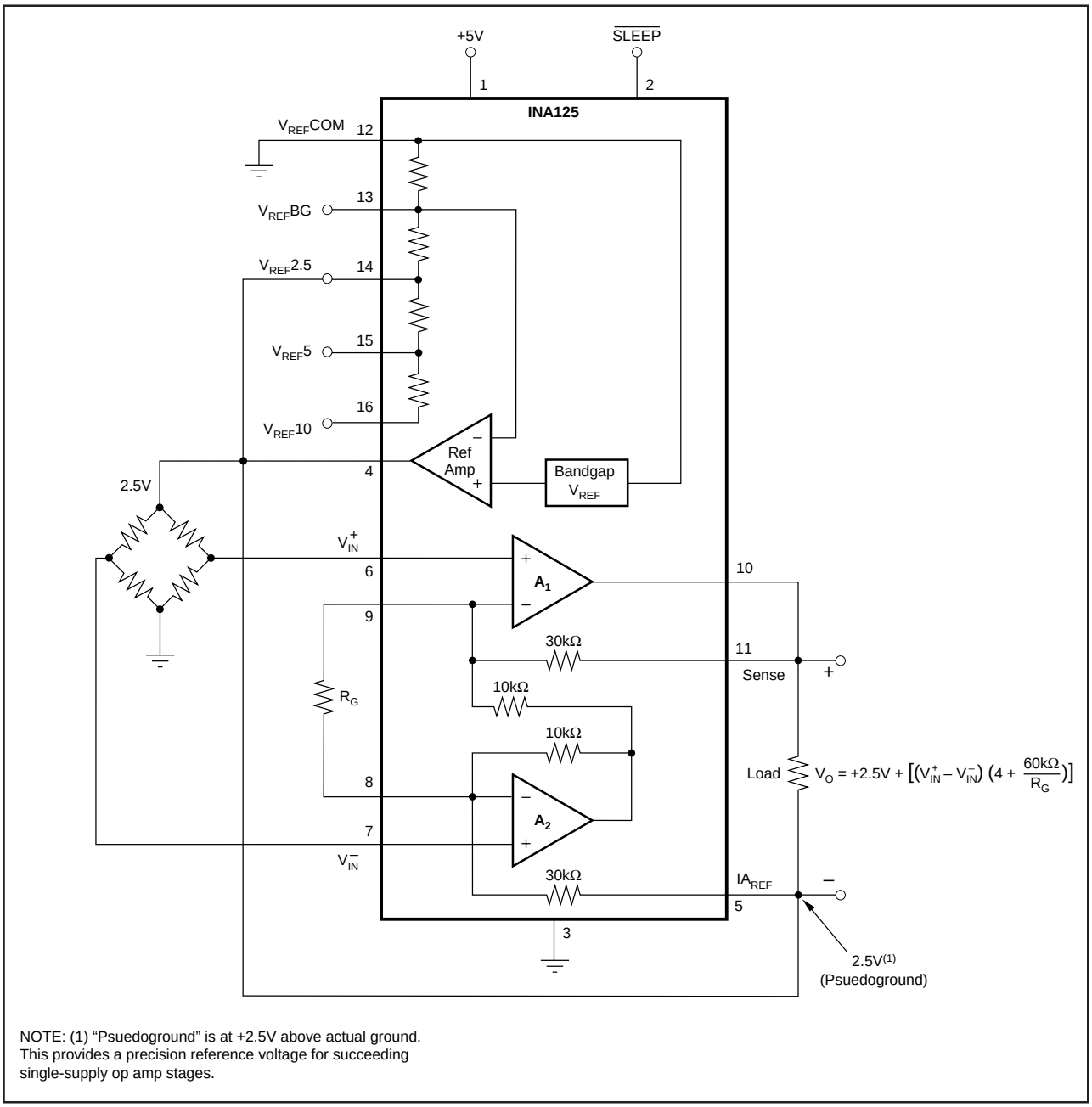


FIGURE 5. Single Supply Bridge Amplifier.

INPUT PROTECTION

The inputs of the INA125 are individually protected for voltage up to ±40V. For example, a condition of –40V on one input and +40V on the other input will not cause damage. Internal circuitry on each input provides low series impedance under normal signal conditions. To provide equivalent protection, series input resistors would contribute excessive noise. If the input is overloaded, the protection circuitry limits the input current to a safe value of approximately 120µA to 190µA. The typical performance curve "Input Bias Current vs Input Overload Voltage" shows this input current limit behavior. The inputs are protected even if the power supplies are disconnected or turned off.



NOTE: (1) "Psuedoground" is at +2.5V above actual ground. This provides a precision reference voltage for succeeding single-supply op amp stages.

FIGURE 6. Psuedoground Bridge Measurement, 5V Single Supply.

PACKAGING INFORMATION

Orderable Device	Status [1]	Package Type	Package Drawing	Pins	Package Qty	Eco Plan [2]	Lead/Ball Finish	MSL Peak Temp [3]
INA125P	ACTIVE	PDIP	N	16	25	Green (RoHS & no Sb/Br)	CU NIPDAU	N / A for Pkg Type
INA125PA	ACTIVE	PDIP	N	16	25	Green (RoHS & no Sb/Br)	CU NIPDAU	N / A for Pkg Type
INA125PAG4	ACTIVE	PDIP	N	16	25	Green (RoHS & no Sb/Br)	CU NIPDAU	N / A for Pkg Type
INA125PG4	ACTIVE	PDIP	N	16	25	Green (RoHS & no Sb/Br)	CU NIPDAU	N / A for Pkg Type
INA125U	ACTIVE	SOIC	D	16	48	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR
INA125U/2K5	ACTIVE	SOIC	D	16	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR
INA125U/2K5E4	ACTIVE	SOIC	D	16	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR
INA125UA	ACTIVE	SOIC	D	16	48	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR
INA125UA/2K5	ACTIVE	SOIC	D	16	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR
INA125UA/2K5E4	ACTIVE	SOIC	D	16	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR
INA125UAG4	ACTIVE	SOIC	D	16	48	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR
INA125UE4	ACTIVE	SOIC	D	16	48	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR

[1] The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

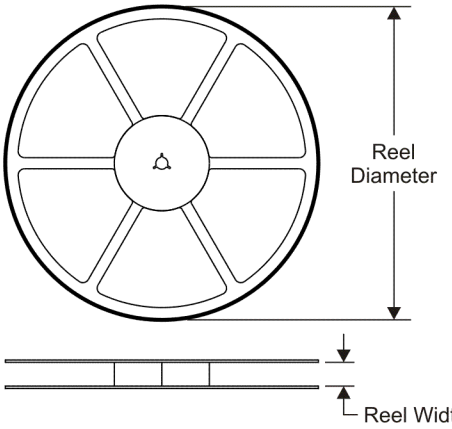
[2] Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been defined.
Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.
Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

[3] MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

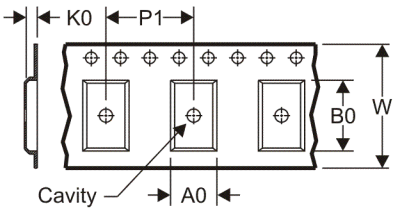
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

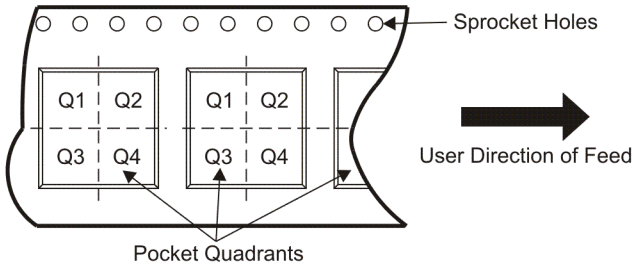


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

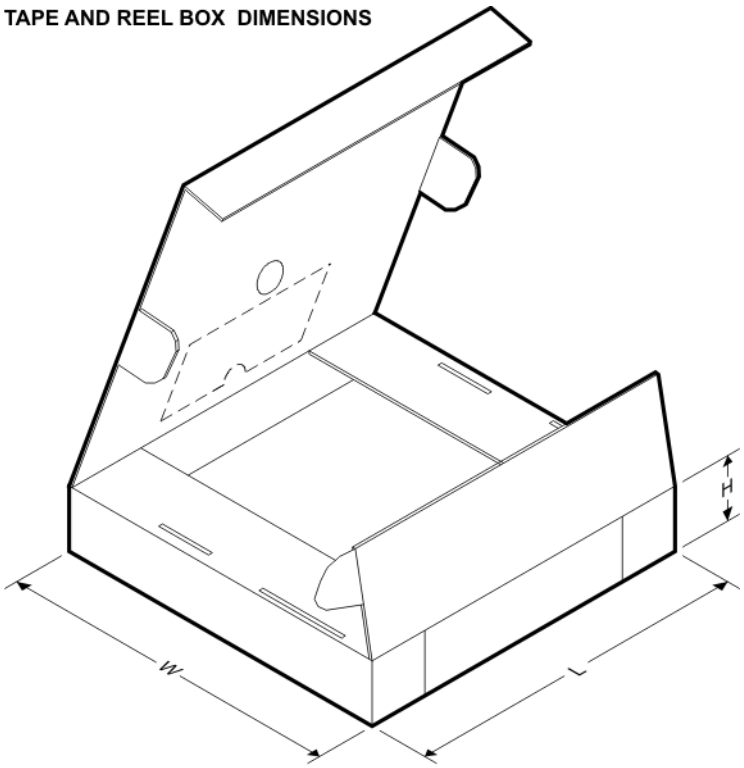
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
INA125U/2K5	SOIC	D	16	2500	330.0	16.4	6.5	10.3	2.1	8.0	16.0	Q1
INA125UA/2K5	SOIC	D	16	2500	330.0	16.4	6.5	10.3	2.1	8.0	16.0	Q1

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
INA125U/2K5	SOIC	D	16	2500	346.0	346.0	33.0
INA125UA/2K5	SOIC	D	16	2500	346.0	346.0	33.0

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

Products		**Applications**	
Amplifiers	amplifier.ti.com	Audio	www.ti.com/audio
Data Converters	dataconverter.ti.com	Automotive	www.ti.com/automotive
DSP	dsp.ti.com	Broadband	www.ti.com/broadband
Clocks and Timers	www.ti.com/clocks	Digital Control	www.ti.com/digitalcontrol
Interface	interface.ti.com	Medical	www.ti.com/medical
Logic	logic.ti.com	Military	www.ti.com/military
Power Mgmt	power.ti.com	Optical Networking	www.ti.com/opticalnetwork
Microcontrollers	microcontroller.ti.com	Security	www.ti.com/security
RFID	www.ti-rfid.com	Telephony	www.ti.com/telephony
RF/IF and ZigBee® Solutions	www.ti.com/lprf	Video & Imaging	www.ti.com/video
		Wireless	www.ti.com/wireless

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265

- **Low Power Consumption**
- **Wide Common-Mode and Differential Voltage Ranges**
- **Low Input Bias and Offset Currents**
- **Output Short-Circuit Protection**
- **Low Total Harmonic Distortion . . . 0.003% Typ**
- **Low Noise**
  V_n = 18 nV/$\sqrt{Hz}$ Typ at f = 1 kHz
- **High Input Impedance . . . JFET Input Stage**
- **Internal Frequency Compensation**
- **Latch-Up-Free Operation**
- **High Slew Rate . . . 13 V/μs Typ**
- **Common-Mode Input Voltage Range Includes V_{CC+}**

description/ordering information

The JFET-input operational amplifiers in the TL07x series are similar to the TL08x series, with low input bias and offset currents and fast slew rate. The low harmonic distortion and low noise make the TL07x series ideally suited for high-fidelity and audio preamplifier applications. Each amplifier features JFET inputs (for high input impedance) coupled with bipolar output stages integrated on a single monolithic chip.

The C-suffix devices are characterized for operation from 0°C to 70°C. The I-suffix devices are characterized for operation from −40°C to 85°C. The M-suffix devices are characterized for operation over the full military temperature range of −55°C to 125°C.

description/ordering information (continued)

ORDERING INFORMATION

T_A	V_{IO}max AT 25°C	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING
0°C to 70°C	10 mV	PDIP (P)	Tube of 50	TL071CP	TL071CP
			Tube of 50	TL072CP	TL072CP
		PDIP (N)	Tube of 25	TL074CN	TL074CN
		SOIC (D)	Tube of 75	TL071CD	TL071C
			Reel of 2500	TL071CDR	
			Tube of 75	TL072CD	TL072C
			Reel of 2500	TL072CDR	
			Tube of 50	TL074CD	TL074C
			Reel of 2500	TL074CDR	
		SOP (NS)	Reel of 2000	TL074CNSR	TL074
		SOP (PS)	Reel of 2000	TL071CPSR	TL071
			Reel of 2000	TL072CPSR	T072
		TSSOP (PW)	Reel of 2000	TL072CPWR	T072
			Tube of 90	TL074CPW	T074
			Reel of 2000	TL074CPWR	
	6 mV	PDIP (P)	Tube of 50	TL071ACP	TL071ACP
			Tube of 50	TL072ACP	TL072ACP
		PDIP (N)	Tube of 25	TL074ACN	TL074ACN
		SOIC (D)	Tube of 75	TL071ACD	071AC
			Reel of 2500	TL071ACDR	
			Tube of 75	TL072ACD	072AC
			Reel of 2500	TL072ACDR	
			Tube of 50	TL074ACD	TL074AC
			Reel of 2500	TL074ACDR	
		SOP (PS)	Reel of 2000	TL072ACPSR	T072A
		SOP (NS)	Reel of 2000	TL074ACNSR	TL074A
	3 mV	PDIP (P)	Tube of 50	TL071BCP	TL071BCP
			Tube of 50	TL072BCP	TL072BCP
		PDIP (N)	Tube of 25	TL074BCN	TL074BCN
		SOIC (D)	Tube of 75	TL071BCD	071BC
			Reel of 2500	TL071BCDR	
			Tube of 75	TL072BCD	072BC
			Reel of 2500	TL072BCDR	
			Tube of 50	TL074BCD	TL074BC
			Reel of 2500	TL074BCDR	
		SOP (NS)	Reel of 2000	TL074BCNSR	TL074B

† Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.

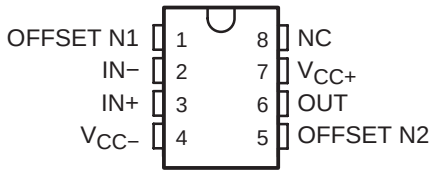
description/ordering information (continued)

ORDERING INFORMATION

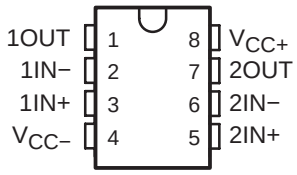
T_A	V_{IO}max AT 25°C	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING
−40°C to 85°C	6 mV	PDIP (P)	Tube of 50	TL071IP	TL071IP
			Tube of 50	TL072IP	TL072IP
		PDIP (N)	Tube of 25	TL074IN	TL074IN
		SOIC (D)	Tube of 75	TL071ID	TL071I
			Reel of 2500	TL071IDR	
			Tube of 75	TL072ID	TL072I
			Reel of 2500	TL072IDR	
			Tube of 50	TL074ID	TL074I
			Reel of 2500	TL074IDR	
−55°C to 125°C	6 mV	CDIP (JG)	Tube of 50	TL072MJGB	TL072MJGB
		CFP (U)	Tube of 150	TL072MUB	TL072MUB
		LCCC (FK)	Tube of 55	TL072MFKB	TL072MFKB
	9 mV	CDIP (J)	Tube of 25	TL074MJB	TL074MJB
		CFP (W)	Tube of 25	TL074MWB	TL074MWB
		LCCC (FK)	Tube of 55	TL074MFKB	TL074MFKB

† Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.

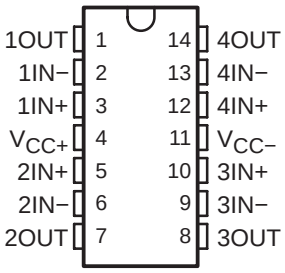
TL071, TL071A, TL071B
D, P, OR PS PACKAGE
(TOP VIEW)



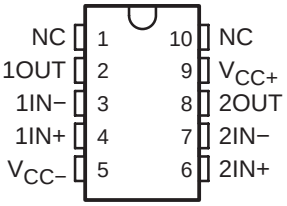
TL072, TL072A, TL072B
D, JG, P, PS, OR PW PACKAGE
(TOP VIEW)



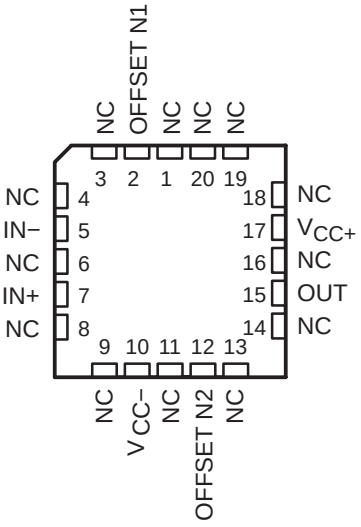
TL074A, TL074B
D, J, N, NS, OR PW PACKAGE
TL074 . . . D, J, N, NS, PW,
OR W PACKAGE
(TOP VIEW)



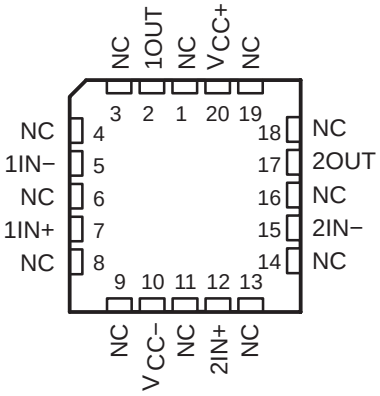
TL072
U PACKAGE
(TOP VIEW)



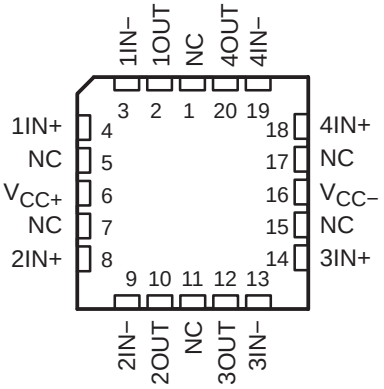
TL071
FK PACKAGE
(TOP VIEW)



TL072
FK PACKAGE
(TOP VIEW)



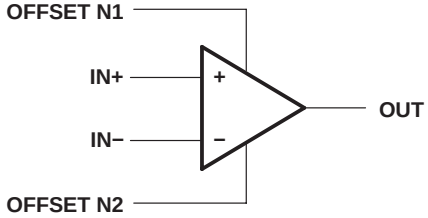
TL074
FK PACKAGE
(TOP VIEW)



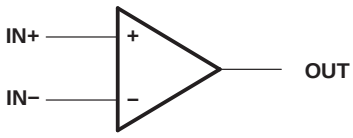
NC − No internal connection

symbols

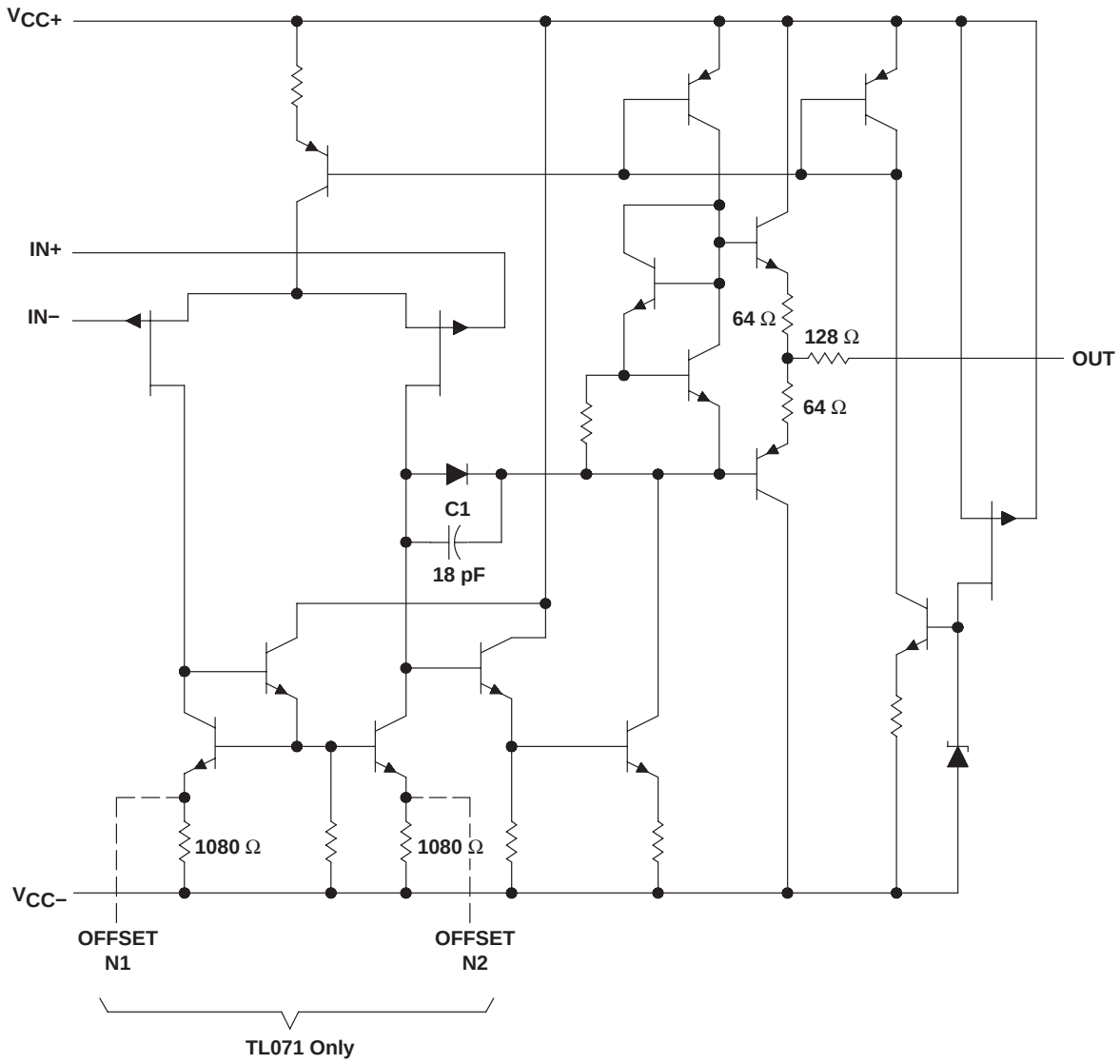
TL071



TL072 (each amplifier)
TL074 (each amplifier)



schematic (each amplifier)



All component values shown are nominal.

COMPONENT COUNT†			
COMPONENT TYPE	TL071	TL072	TL074
Resistors	11	22	44
Transistors	14	28	56
JFET	2	4	6
Diodes	1	2	4
Capacitors	1	2	4
epi-FET	1	2	4

† Includes bias and trim circuitry

absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

Supply voltage (see Note 1):	V_{CC+}	18 V
	V_{CC-}	−18 V
Differential input voltage, V_{ID} (see Note 2)		±30 V
Input voltage, V_I (see Notes 1 and 3)		±15 V
Duration of output short circuit (see Note 4)		Unlimited
Package thermal impedance, θ_{JA} (see Notes 5 and 6):	D package (8 pin)	97°C/W
	D package (14 pin)	86°C/W
	N package	80°C/W
	NS package	76°C/W
	P package	85°C/W
	PS package	95°C/W
	PW package (8 pin)	149°C/W
	PW package (14 pin)	113°C/W
	U package	185°C/W
Package thermal impedance, θ_{JC} (see Notes 7 and 8):	FK package	5.61°C/W
	J package	15.05°C/W
	JG package	14.5°C/W
	W package	14.65°C/W
Operating virtual junction temperature, T_J		150°C
Case temperature for 60 seconds: FK package		260°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds: J, JG, or W package		300°C
Storage temperature range, T_{stg}		−65°C to 150°C

† Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

NOTES:
1. All voltage values, except differential voltages, are with respect to the midpoint between V_{CC+} and V_{CC-}.
2. Differential voltages are at IN+, with respect to IN−.
3. The magnitude of the input voltage must never exceed the magnitude of the supply voltage or 15 V, whichever is less.
4. The output may be shorted to ground or to either supply. Temperature and/or supply voltages must be limited to ensure that the dissipation rating is not exceeded.
5. Maximum power dissipation is a function of $T_J(max)$, θ_{JA}, and T_A. The maximum allowable power dissipation at any allowable ambient temperature is $P_D = (T_J(max) - T_A)/\theta_{JA}$. Operating at the absolute maximum T_J of 150°C can affect reliability.
6. The package thermal impedance is calculated in accordance with JESD 51-7.
7. Maximum power dissipation is a function of $T_J(max)$, θ_{JC}, and T_C. The maximum allowable power dissipation at any allowable case temperature is $P_D = (T_J(max) - T_C)/\theta_{JC}$. Operating at the absolute maximum T_J of 150°C can affect reliability.
8. The package thermal impedance is calculated in accordance with MIL-STD-883.

electrical characteristics, $V_{CC\pm}$ = ±15 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS†	T_A‡	TL071C TL072C TL074C			TL071AC TL072AC TL074AC			TL071BC TL072BC TL074BC			TL071I TL072I TL074I			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage	V_O = 0, R_S = 50 Ω	25°C		3	10		3	6		2	3		3	6	mV
			Full range			13			7.5			5			8	
α_{VIO}	Temperature coefficient of input offset voltage	V_O = 0, R_S = 50 Ω	Full range		18			18			18			18		µV/°C
I_{IO}	Input offset current	V_O = 0	25°C		5	100		5	100		5	100		5	100	pA
			Full range			10			2			2			2	nA
I_{IB}	Input bias current§	V_O = 0	25°C		65	200		65	200		65	200		65	200	pA
			Full range			7			7			7			20	nA
V_{ICR}	Common-mode input voltage range		25°C	±11	−12 to 15		±11	−12 to 15		±11	−12 to 15		±11	−12 to 15		V
V_{OM}	Maximum peak output voltage swing	R_L = 10 kΩ	25°C	±12	±13.5		±12	±13.5		±12	±13.5		±12	±13.5		V
		R_L ≥ 10 kΩ	Full range	±12			±12			±12			±12			
		R_L ≥ 2 kΩ		±10			±10			±10			±10			
A_{VD}	Large-signal differential voltage amplification	V_O = ±10 V, R_L ≥ 2 kΩ	25°C	25	200		50	200		50	200		50	200		V/mV
			Full range	15			25			25			25			
B_1	Unity-gain bandwidth		25°C		3			3			3			3		MHz
r_i	Input resistance		25°C		10^{12}			10^{12}			10^{12}			10^{12}		Ω
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICR}$min, V_O = 0, R_S = 50 Ω	25°C	70	100		75	100		75	100		75	100		dB
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{CC\pm}/\Delta V_{IO}$)	V_{CC} = ±9 V to ±15 V, V_O = 0, R_S = 50 Ω	25°C	70	100		80	100		80	100		80	100		dB
I_{CC}	Supply current (each amplifier)	V_O = 0, No load	25°C		1.4	2.5		1.4	2.5		1.4	2.5		1.4	2.5	mA
V_{O1}/V_{O2}	Crosstalk attenuation	A_{VD} = 100	25°C		120			120			120			120		dB

† All characteristics are measured under open-loop conditions with zero common-mode voltage, unless otherwise specified.
‡ Full range is T_A = 0°C to 70°C for TL07_C,TL07_AC, TL07_BC and is T_A = −40°C to 85°C for TL07_I.
§ Input bias currents of an FET-input operational amplifier are normal junction reverse currents, which are temperature sensitive, as shown in Figure 4. Pulse techniques must be used that maintain the junction temperature as close to the ambient temperature as possible.

electrical characteristics, $V_{CC\pm}$ = ±15 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS†	T_A‡	TL071M TL072M			TL074M			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage	V_O = 0, R_S = 50 Ω	25°C		3	6		3	9	mV
			Full range			9			15	
α_{VIO}	Temperature coefficient of input offset voltage	V_O = 0, R_S = 50 Ω	Full range		18			18		µV/°C
I_{IO}	Input offset current	V_O = 0	25°C		5	100		5	100	pA
			Full range			20			20	nA
I_{IB}	Input bias current‡	V_O = 0	25°C		65	200		65	200	pA
						50			50	nA
V_{ICR}	Common-mode input voltage range		25°C	±11	−12 to 15		±11	−12 to 15		V
V_{OM}	Maximum peak output voltage swing	R_L = 10 kΩ	25°C	±12	±13.5		±12	±13.5		V
		R_L ≥ 10 kΩ	Full range	±12			±12			
		R_L ≥ 2 kΩ		±10			±10			
A_{VD}	Large-signal differential voltage amplification	V_O = ±10 V, R_L ≥ 2 kΩ	25°C	35	200		35	200		V/mV
				15			15			
B_1	Unity-gain bandwidth	T_A = 25°C			3			3		MHz
r_i	Input resistance	T_A = 25°C			10^{12}			10^{12}		Ω
CMRR	Common-mode rejection ratio	V_{IC} = V_{ICR}min, V_O = 0, R_S = 50 Ω	25°C	80	86		80	86		dB
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{CC\pm}/\Delta V_{IO}$)	V_{CC} = ±9 V to ±15 V, V_O = 0, R_S = 50 Ω	25°C	80	86		80	86		dB
I_{CC}	Supply current (each amplifier)	V_O = 0, No load	25°C		1.4	2.5		1.4	2.5	mA
V_{O1}/V_{O2}	Crosstalk attenuation	A_{VD} = 100	25°C		120			120		dB

† Input bias currents of an FET-input operational amplifier are normal junction reverse currents, which are temperature sensitive, as shown in Figure 4. Pulse techniques must be used that will maintain the junction temperature as close to the ambient temperature as possible.

‡ All characteristics are measured under open-loop conditions with zero common-mode voltage, unless otherwise specified. Full range is T_A = −55°C to 125°C.

operating characteristics, $V_{CC\pm}$ = ±15 V, T_A = 25°C

PARAMETER		TEST CONDITIONS		TL07xM			ALL OTHERS			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
SR	Slew rate at unity gain	V_I = 10 V, C_L = 100 pF,	R_L = 2 kΩ, See Figure 1	5	13		8	13		V/μs
t_r	Rise-time overshoot factor	V_I = 20 mV, C_L = 100 pF,	R_L = 2 kΩ, See Figure 1		0.1			0.1		μs
					20%			20%		
V_n	Equivalent input noise voltage	R_S = 20 Ω	f = 1 kHz		18			18		nV/√Hz
			f = 10 Hz to 10 kHz		4			4		μV
I_n	Equivalent input noise current	R_S = 20 Ω,	f = 1 kHz		0.01			0.01		pA/√Hz
THD	Total harmonic distortion	$V_I$rms = 6 V, $R_L \geq$ 2 kΩ, f = 1 kHz	A_{VD} = 1, $R_S \leq$ 1 kΩ,		0.003 %			0.003%		

PARAMETER MEASUREMENT INFORMATION

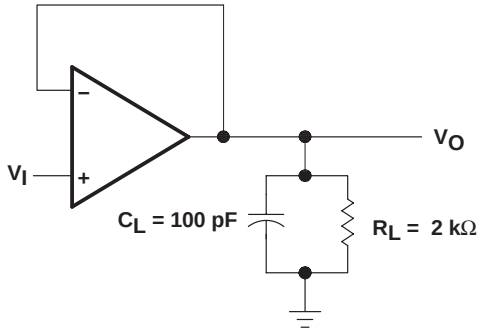


Figure 1. Unity-Gain Amplifier

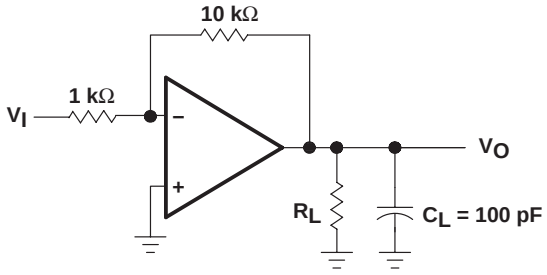


Figure 2. Gain-of-10 Inverting Amplifier

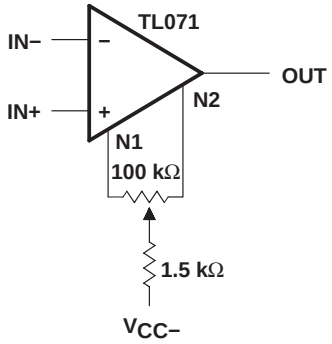


Figure 3. Input Offset-Voltage Null Circuit

TYPICAL CHARACTERISTICS

Table of Graphs

			FIGURE
I_{IB}	Input bias current	vs Free-air temperature	4
V_{OM}	Maximum output voltage	vs Frequency vs Free-air temperature vs Load resistance vs Supply voltage	5, 6, 7 8 9 10
A_{VD}	Large-signal differential voltage amplification	vs Free-air temperature vs Frequency	11 12
	Phase shift	vs Frequency	12
	Normalized unity-gain bandwidth	vs Free-air temperature	13
	Normalized phase shift	vs Free-air temperature	13
CMRR	Common-mode rejection ratio	vs Free-air temperature	14
I_{CC}	Supply current	vs Supply voltage vs Free-air temperature	15 16
P_D	Total power dissipation	vs Free-air temperature	17
	Normalized slew rate	vs Free-air temperature	18
V_n	Equivalent input noise voltage	vs Frequency	19
THD	Total harmonic distortion	vs Frequency	20
	Large-signal pulse response	vs Time	21
V_O	Output voltage	vs Elapsed time	22

TYPICAL CHARACTERISTICS†

INPUT BIAS CURRENT vs FREE-AIR TEMPERATURE

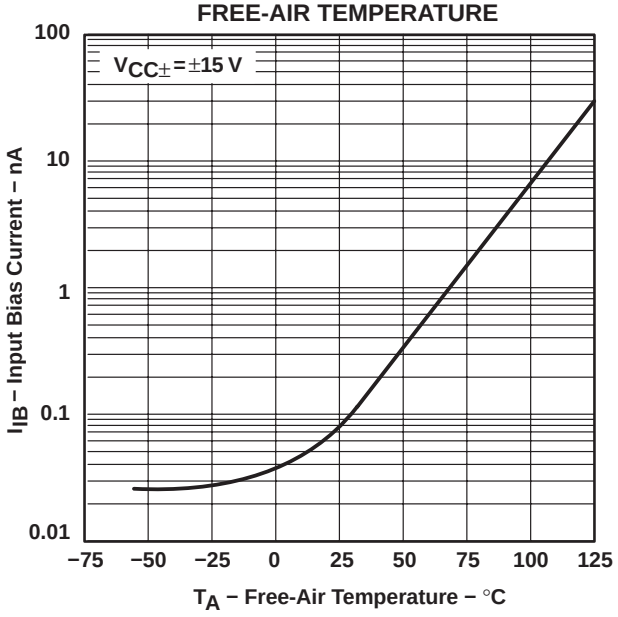


Figure 4

MAXIMUM PEAK OUTPUT VOLTAGE vs FREQUENCY

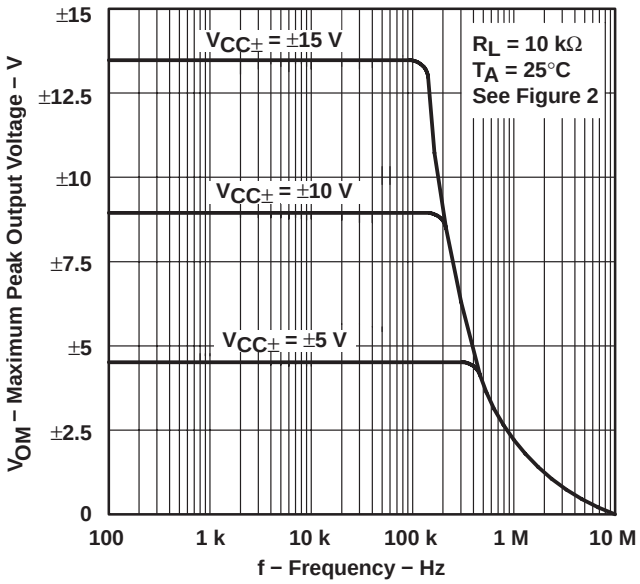


Figure 5

MAXIMUM PEAK OUTPUT VOLTAGE vs FREQUENCY

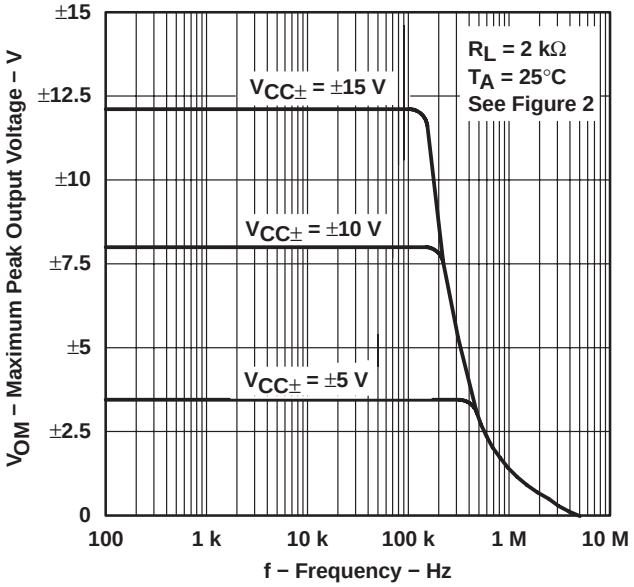


Figure 6

MAXIMUM PEAK OUTPUT VOLTAGE vs FREQUENCY

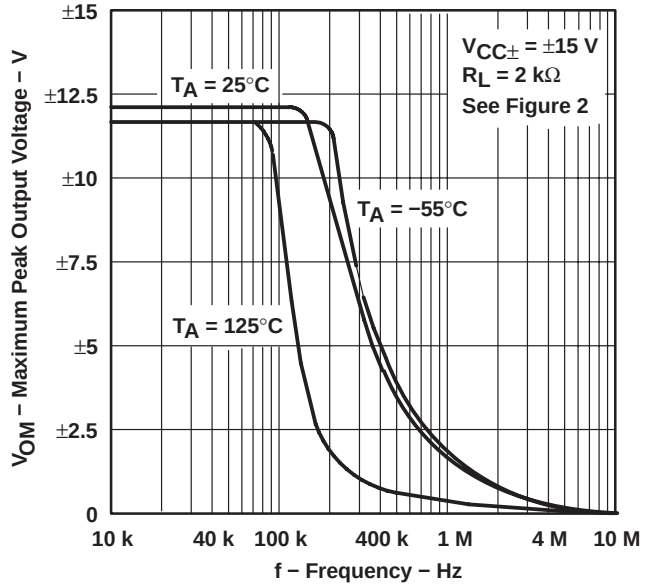


Figure 7

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

TYPICAL CHARACTERISTICS†

MAXIMUM PEAK OUTPUT VOLTAGE vs FREE-AIR TEMPERATURE

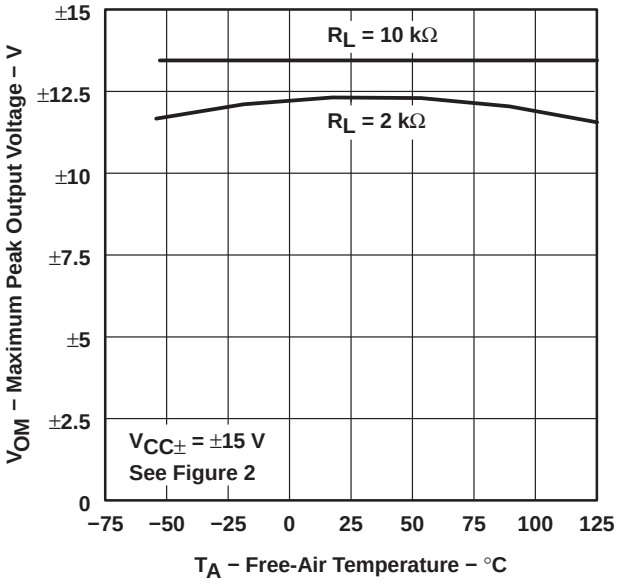


Figure 8

MAXIMUM PEAK OUTPUT VOLTAGE vs LOAD RESISTANCE

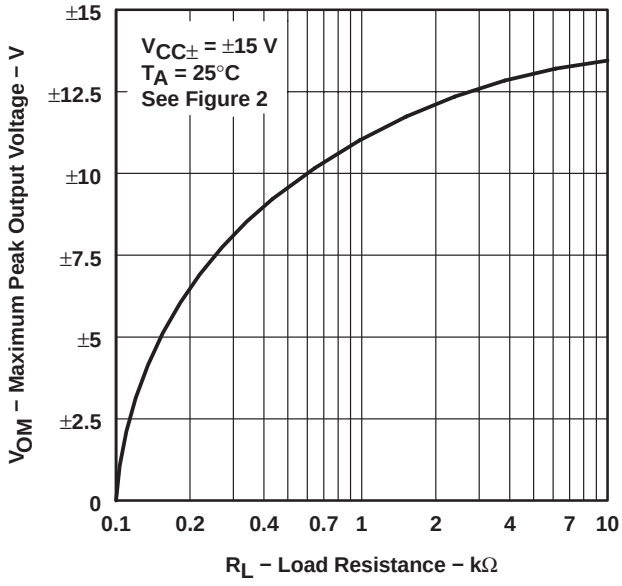


Figure 9

MAXIMUM PEAK OUTPUT VOLTAGE vs SUPPLY VOLTAGE

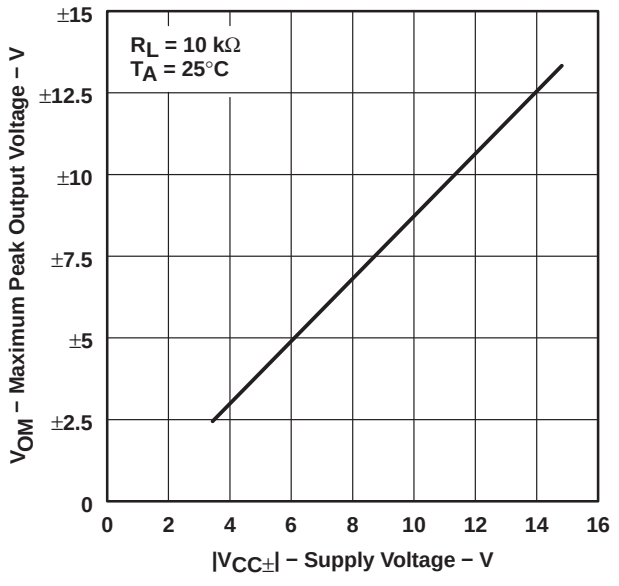


Figure 10

LARGE-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION vs FREE-AIR TEMPERATURE

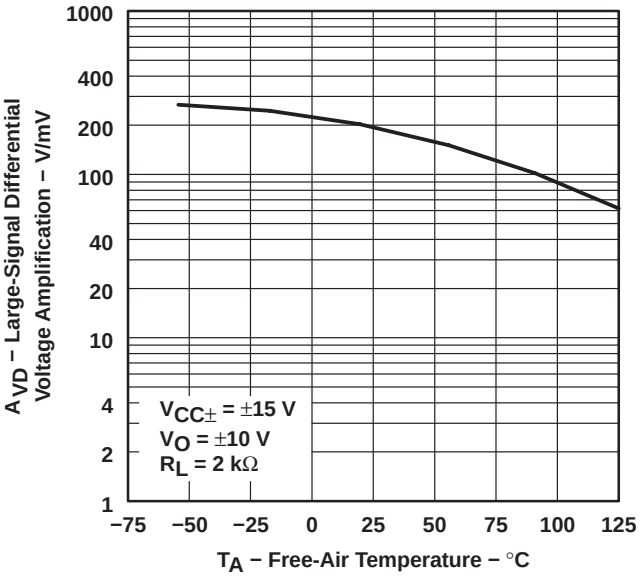


Figure 11

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

TYPICAL CHARACTERISTICS†

LARGE-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION AND PHASE SHIFT vs FREQUENCY

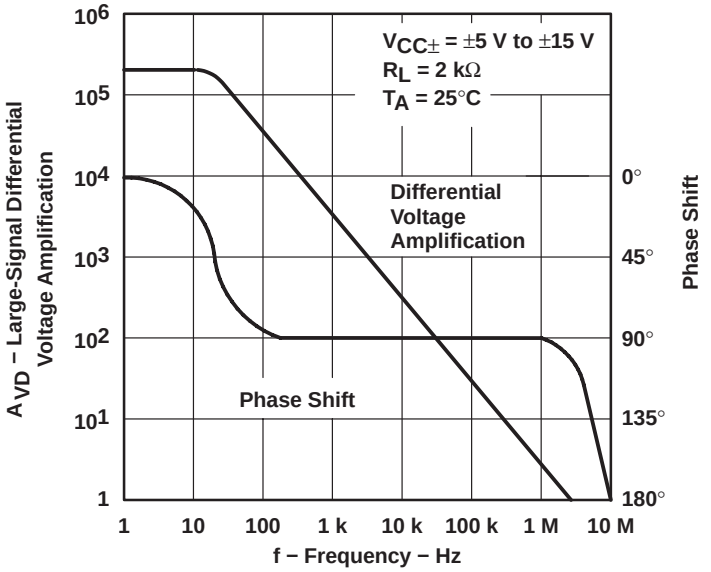


Figure 12

NORMALIZED UNITY-GAIN BANDWIDTH AND PHASE SHIFT vs FREE-AIR TEMPERATURE

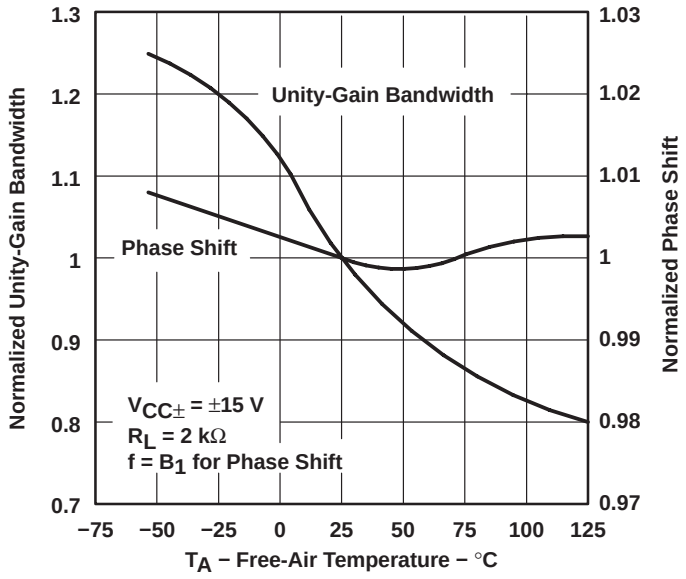


Figure 13

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

TYPICAL CHARACTERISTICS†

COMMON-MODE REJECTION RATIO vs FREE-AIR TEMPERATURE

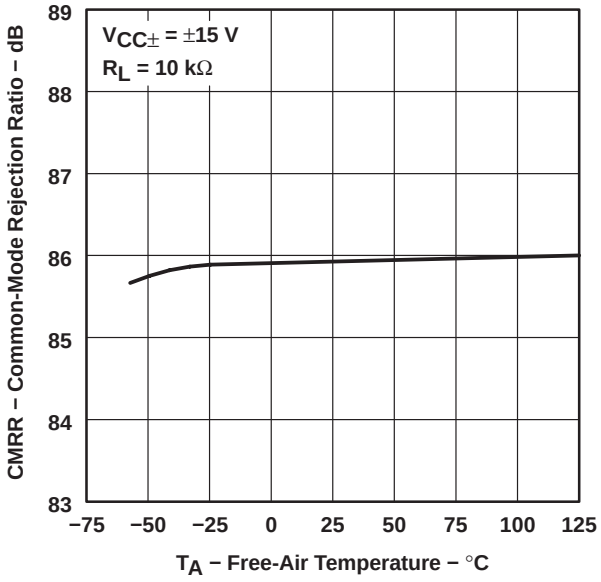


Figure 14

SUPPLY CURRENT PER AMPLIFIER vs SUPPLY VOLTAGE

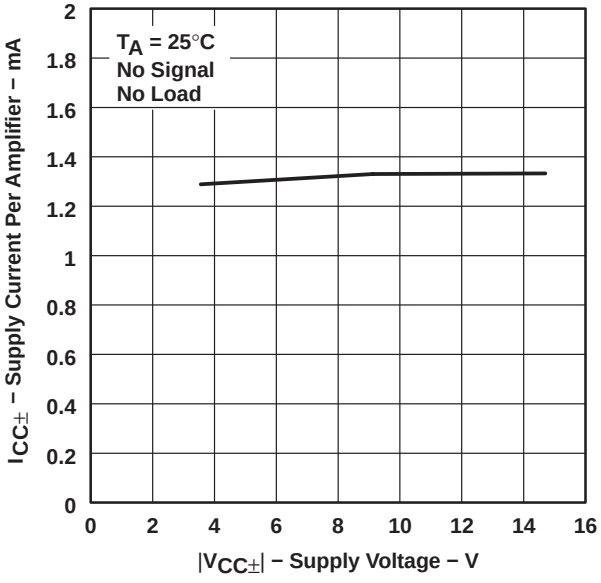


Figure 15

SUPPLY CURRENT PER AMPLIFIER vs FREE-AIR TEMPERATURE

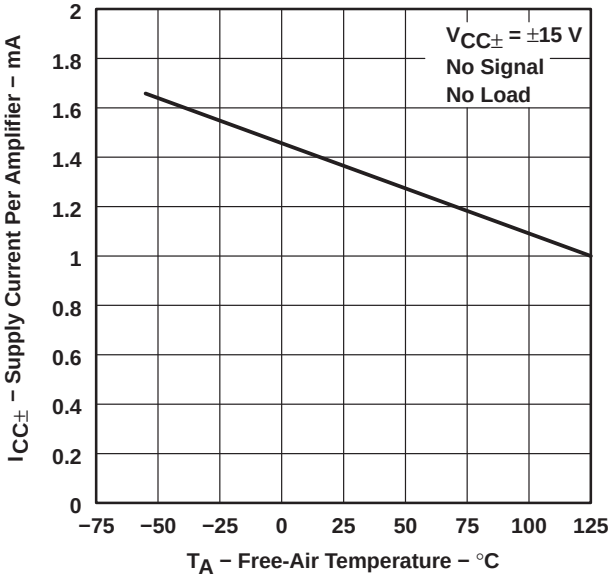


Figure 16

TOTAL POWER DISSIPATION vs FREE-AIR TEMPERATURE

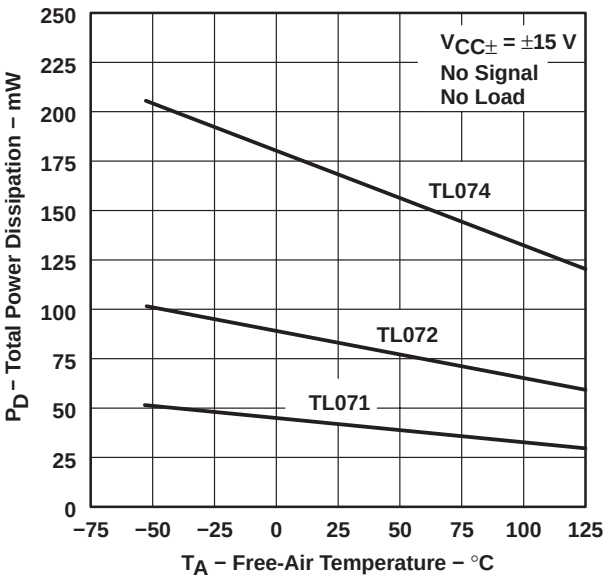


Figure 17

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

TYPICAL CHARACTERISTICS

NORMALIZED SLEW RATE vs FREE-AIR TEMPERATURE

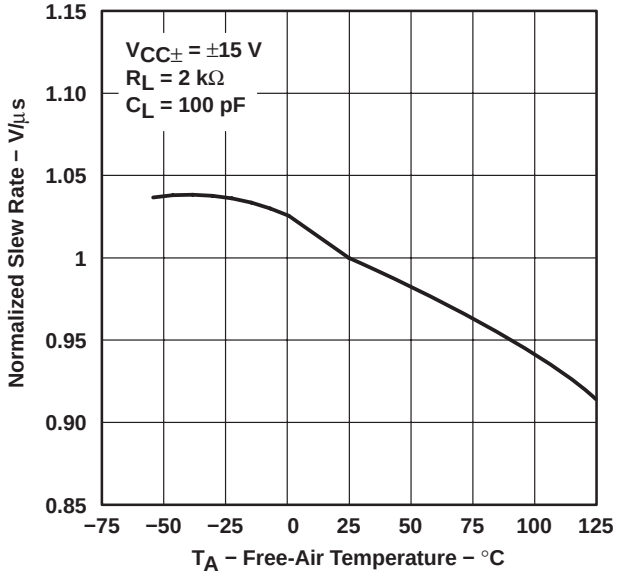


Figure 18

EQUIVALENT INPUT NOISE VOLTAGE vs FREQUENCY

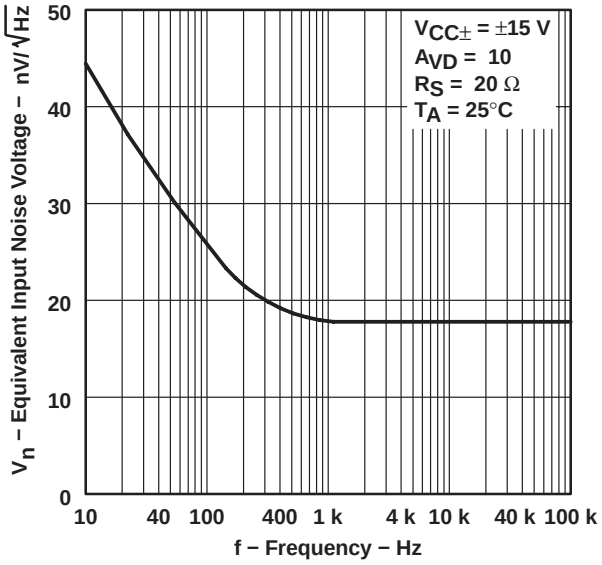


Figure 19

TOTAL HARMONIC DISTORTION vs FREQUENCY

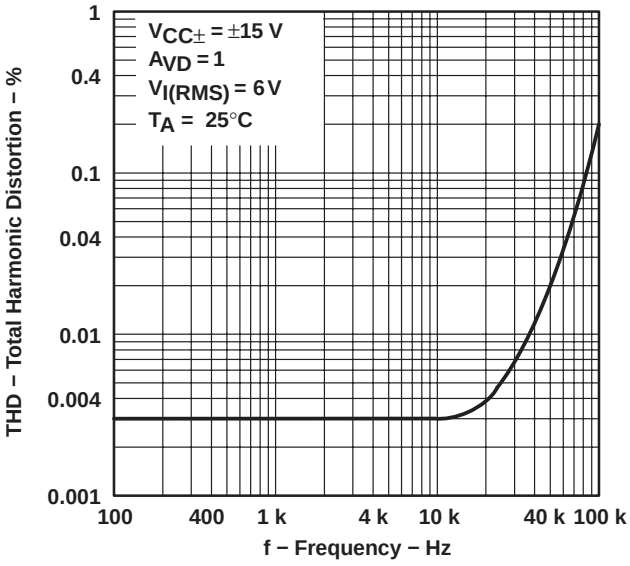


Figure 20

VOLTAGE-FOLLOWER LARGE-SIGNAL PULSE RESPONSE

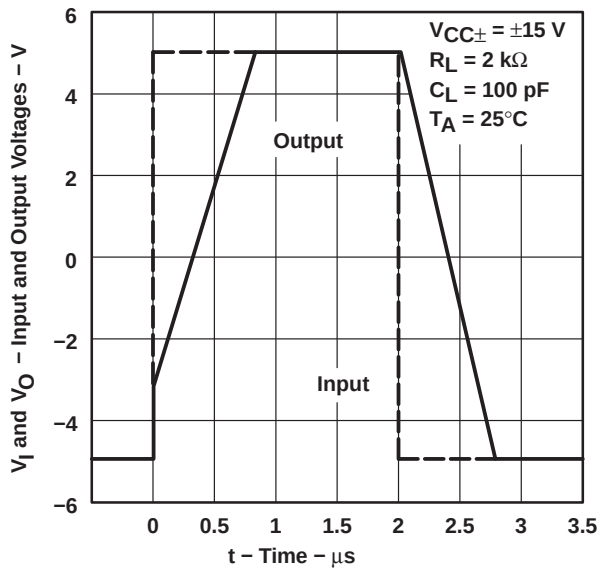


Figure 21

TYPICAL CHARACTERISTICS

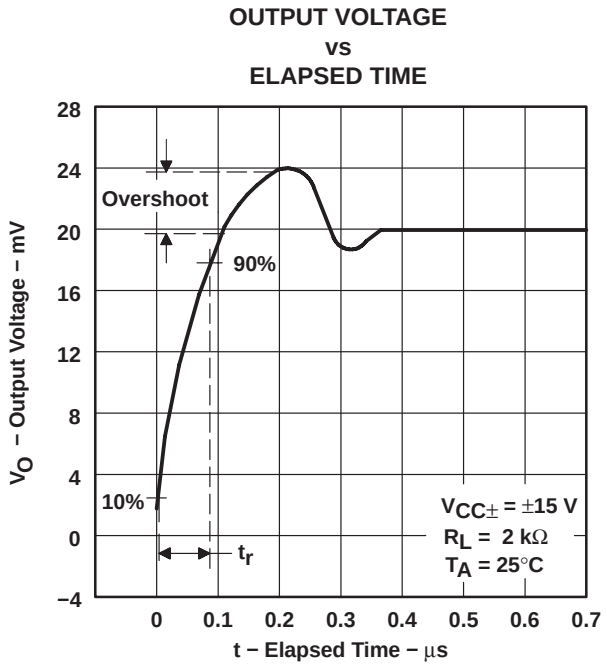


Figure 22

APPLICATION INFORMATION

Table of Application Diagrams

APPLICATION DIAGRAM	PART NUMBER	FIGURE
0.5-Hz square-wave oscillator	TL071	23
High-Q notch filter	TL071	24
Audio-distribution amplifier	TL074	25
100-kHz quadrature oscillator	TL072	26
AC amplifier	TL071	27

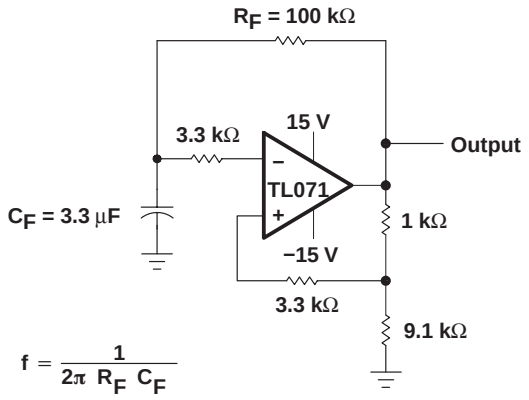


Figure 23. 0.5-Hz Square-Wave Oscillator

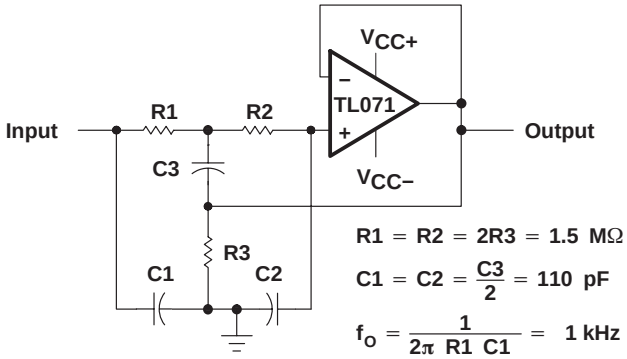


Figure 24. High-Q Notch Filter

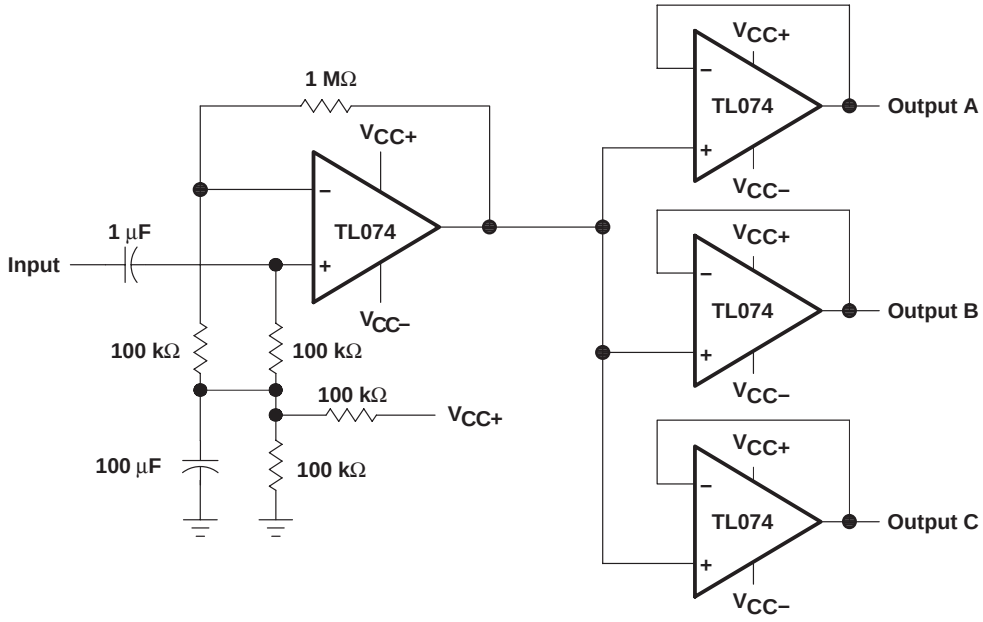
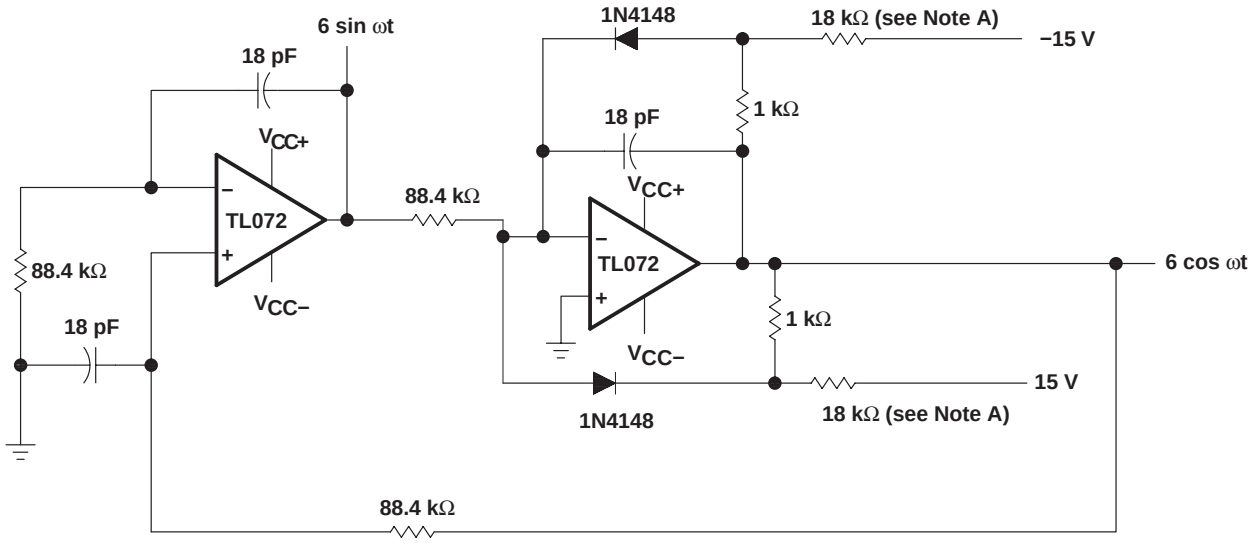


Figure 25. Audio-Distribution Amplifier

APPLICATION INFORMATION



NOTE A: These resistor values may be adjusted for a symmetrical output.

Figure 26. 100-kHz Quadrature Oscillator

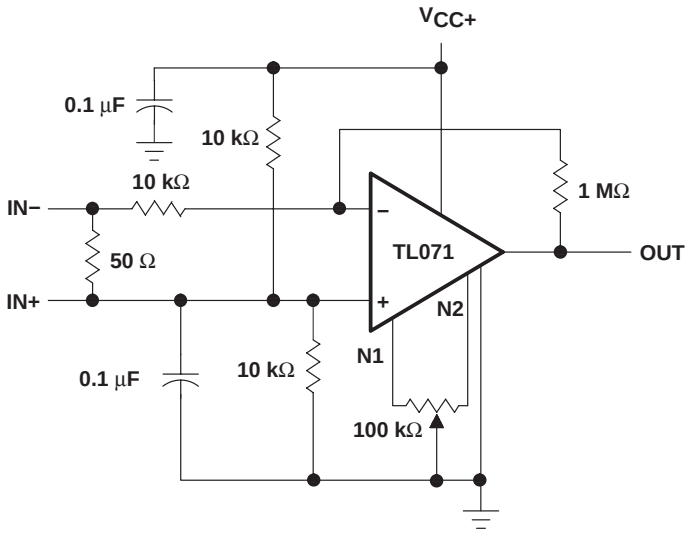


Figure 27. AC Amplifier

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)
8102304HA	OBSOLETE			10		TBD	Call TI	Call TI
81023052A	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	N / A for Pkg Type
8102305HA	ACTIVE	CFP	U	10	1	TBD	A42 SNPB	N / A for Pkg Type
8102305PA	ACTIVE	CDIP	JG	8	1	TBD	A42 SNPB	N / A for Pkg Type
81023062A	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	N / A for Pkg Type
8102306CA	ACTIVE	CDIP	J	14	1	TBD	A42 SNPB	N / A for Pkg Type
8102306DA	ACTIVE	CFP	W	14	1	TBD	A42 SNPB	N / A for Pkg Type
JM38510/11905BPA	ACTIVE	CDIP	JG	8	1	TBD	A42 SNPB	N / A for Pkg Type
JM38510/11906BCA	OBSOLETE	CDIP	J	14		TBD	Call TI	Call TI
TL071ACD	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL071ACDE4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL071ACDG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL071ACDR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL071ACDRE4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL071ACDRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL071ACP	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
TL071ACPE4	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
TL071BCD	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL071BCDE4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL071BCDG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL071BCDR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL071BCDRE4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL071BCDRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL071BCP	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
TL071BCPE4	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
TL071CD	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL071CDE4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL071CDG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL071CDR	ACTIVE	SOIC	D	8	2500	Green (RoHS &	CU NIPDAU	Level-1-260C-UNLIM

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)
						no Sb/Br)		
TL071CDRE4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL071CDRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL071CP	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
TL071CPE4	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
TL071CPSR	ACTIVE	SO	PS	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL071CPSRE4	ACTIVE	SO	PS	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL071CPSRG4	ACTIVE	SO	PS	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL071CPWLE	OBSOLETE	TSSOP	PW	8		TBD	Call TI	Call TI
TL071ID	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL071IDE4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL071IDG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL071IDR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL071IDRE4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL071IDRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL071IJG	OBSOLETE	CDIP	JG	8		TBD	Call TI	Call TI
TL071IP	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
TL071IPE4	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
TL071MFKB	OBSOLETE	LCCC	FK	20		TBD	Call TI	Call TI
TL071MJG	OBSOLETE	CDIP	JG	8		TBD	Call TI	Call TI
TL071MJGB	OBSOLETE	CDIP	JG	8		TBD	Call TI	Call TI
TL072ACD	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL072ACDE4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL072ACDG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL072ACDR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL072ACDRE4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL072ACDRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL072ACJG	OBSOLETE	CDIP	JG	8		TBD	Call TI	Call TI
TL072ACP	ACTIVE	PDIP	P	8	50	Pb-Free	CU NIPDAU	N / A for Pkg Type

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)
						(RoHS)		
TL072ACPE4	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
TL072ACPSR	ACTIVE	SO	PS	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL072ACPSRE4	ACTIVE	SO	PS	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL072ACPSRG4	ACTIVE	SO	PS	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL072BCD	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL072BCDE4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL072BCDG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL072BCDR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL072BCDRE4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL072BCDRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL072BCP	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
TL072BCPE4	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
TL072CD	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL072CDE4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL072CDG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL072CDR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL072CDRE4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL072CDRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL072CP	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
TL072CPE4	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
TL072CPSLE	OBSOLETE	SO	PS	8		TBD	Call TI	Call TI
TL072CPSR	ACTIVE	SO	PS	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL072CPSRE4	ACTIVE	SO	PS	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL072CPSRG4	ACTIVE	SO	PS	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL072CPWR	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL072CPWRE4	ACTIVE	TSSOP	PW	8	2000	Green (RoHS &	CU NIPDAU	Level-1-260C-UNLIM

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)
						no Sb/Br)		
TL072CPWRG4	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL072ID	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL072IDE4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL072IDG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL072IDR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL072IDRE4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL072IDRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL072IP	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
TL072IPE4	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
TL072MFKB	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	N / A for Pkg Type
TL072MJG	ACTIVE	CDIP	JG	8	1	TBD	A42 SNPB	N / A for Pkg Type
TL072MJGB	ACTIVE	CDIP	JG	8	1	TBD	A42 SNPB	N / A for Pkg Type
TL072MUB	ACTIVE	CFP	U	10	1	TBD	A42 SNPB	N / A for Pkg Type
TL074ACD	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL074ACDE4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL074ACDG4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL074ACDR	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL074ACDRE4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL074ACDRG4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL074ACJ	OBSOLETE	CDIP	J	14		TBD	Call TI	Call TI
TL074ACN	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
TL074ACNE4	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
TL074ACNSR	ACTIVE	SO	NS	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL074ACNSRE4	ACTIVE	SO	NS	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL074ACNSRG4	ACTIVE	SO	NS	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL074BCD	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL074BCDE4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)
TL074BCDG4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL074BCDR	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL074BCDRE4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL074BCDRG4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL074BCN	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
TL074BCNE4	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
TL074BCNSR	ACTIVE	SO	NS	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL074BCNSRE4	ACTIVE	SO	NS	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL074BCNSRG4	ACTIVE	SO	NS	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL074CD	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL074CDE4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL074CDG4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL074CDR	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL074CDRE4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL074CDRG4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL074CN	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
TL074CNE4	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
TL074CNSR	ACTIVE	SO	NS	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL074CNSRE4	ACTIVE	SO	NS	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL074CNSRG4	ACTIVE	SO	NS	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL074CPW	ACTIVE	TSSOP	PW	14	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL074CPWE4	ACTIVE	TSSOP	PW	14	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL074CPWG4	ACTIVE	TSSOP	PW	14	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL074CPWLE	OBSOLETE	TSSOP	PW	14		TBD	Call TI	Call TI
TL074CPWR	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL074CPWRE4	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM

Orderable Device	Status [1]	Package Type	Package Drawing	Pins	Package Qty	Eco Plan [2]	Lead/Ball Finish	MSL Peak Temp [3]
TL074CPWRG4	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL074ID	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL074IDE4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL074IDG4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL074IDR	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL074IDRE4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL074IDRG4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL074IJ	OBSOLETE	CDIP	J	14		TBD	Call TI	Call TI
TL074IN	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
TL074INE4	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
TL074MFK	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	N / A for Pkg Type
TL074MFKB	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	N / A for Pkg Type
TL074MJ	ACTIVE	CDIP	J	14	1	TBD	A42 SNPB	N / A for Pkg Type
TL074MJB	ACTIVE	CDIP	J	14	1	TBD	A42 SNPB	N / A for Pkg Type
TL074MWB	ACTIVE	CFP	W	14	1	TBD	A42 SNPB	N / A for Pkg Type

[1] The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

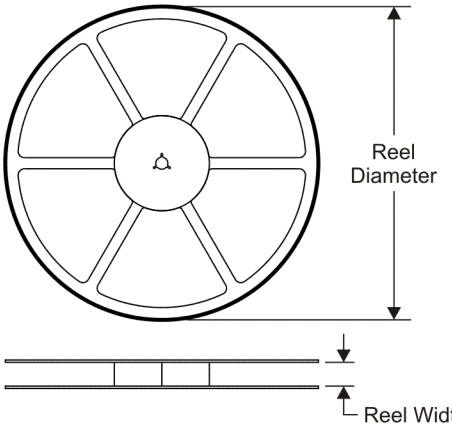
[2] Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been defined.
Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.
Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

[3] MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

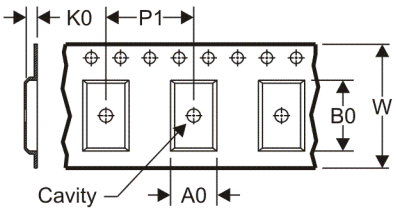
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

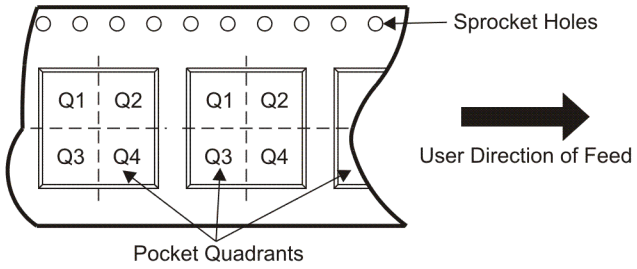


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE

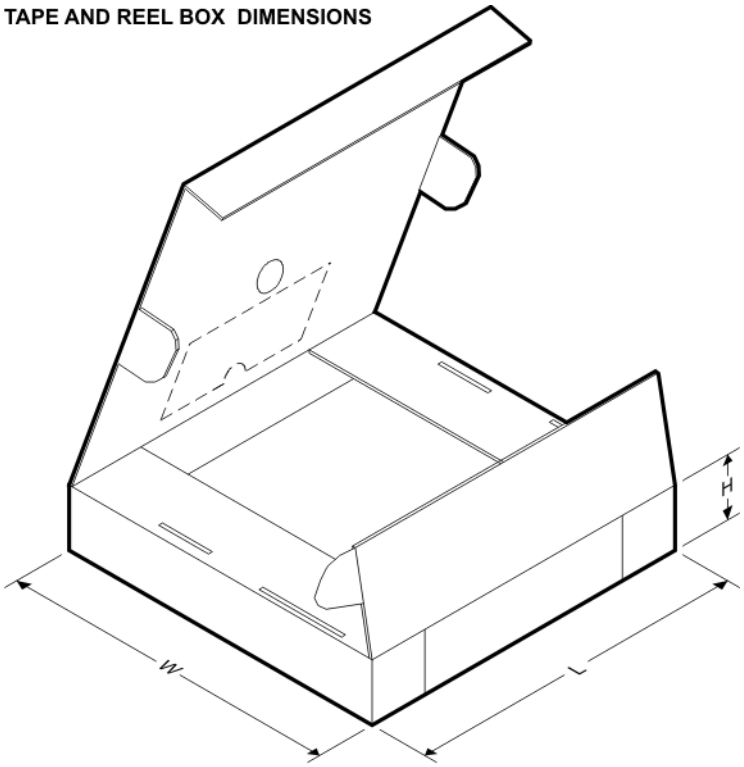


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TL071ACDR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
TL071BCDR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
TL071CDR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
TL071CDR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
TL071CPSR	SO	PS	8	2000	330.0	16.4	8.2	6.6	2.5	12.0	16.0	Q1
TL071IDR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
TL072ACDR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
TL072ACPSR	SO	PS	8	2000	330.0	16.4	8.2	6.6	2.5	12.0	16.0	Q1
TL072BCDR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
TL072CDR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
TL072CDR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
TL072CPSR	SO	PS	8	2000	330.0	16.4	8.2	6.6	2.5	12.0	16.0	Q1
TL072CPWR	TSSOP	PW	8	2000	330.0	12.4	7.0	3.6	1.6	8.0	12.0	Q1
TL072IDR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
TL072IDR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
TL074ACDR	SOIC	D	14	2500	330.0	16.4	6.5	9.0	2.1	8.0	16.0	Q1
TL074ACNSR	SO	NS	14	2000	330.0	16.4	8.2	10.5	2.5	12.0	16.0	Q1
TL074BCDR	SOIC	D	14	2500	330.0	16.4	6.5	9.0	2.1	8.0	16.0	Q1

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TL074BCNSR	SO	NS	14	2000	330.0	16.4	8.2	10.5	2.5	12.0	16.0	Q1
TL074CDR	SOIC	D	14	2500	330.0	16.4	6.5	9.0	2.1	8.0	16.0	Q1
TL074CNSR	SO	NS	14	2000	330.0	16.4	8.2	10.5	2.5	12.0	16.0	Q1
TL074CPWR	TSSOP	PW	14	2000	330.0	12.4	7.0	5.6	1.6	8.0	12.0	Q1
TL074IDR	SOIC	D	14	2500	330.0	16.4	6.5	9.0	2.1	8.0	16.0	Q1

TAPE AND REEL BOX DIMENSIONS

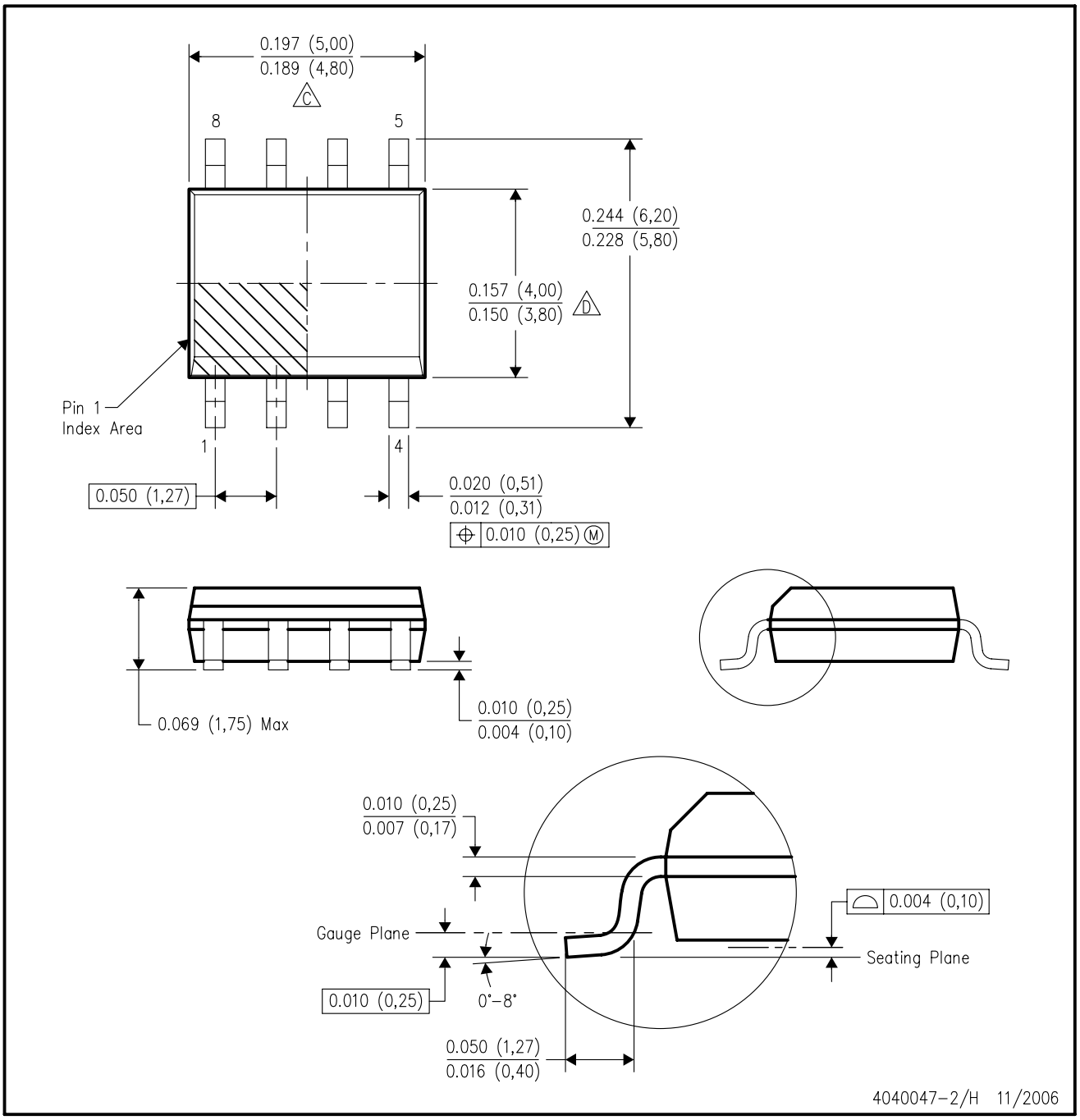


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TL071ACDR	SOIC	D	8	2500	340.5	338.1	20.6
TL071BCDR	SOIC	D	8	2500	340.5	338.1	20.6
TL071CDR	SOIC	D	8	2500	340.5	338.1	20.6
TL071CDR	SOIC	D	8	2500	346.0	346.0	29.0
TL071CPSR	SO	PS	8	2000	346.0	346.0	33.0
TL071IDR	SOIC	D	8	2500	340.5	338.1	20.6
TL072ACDR	SOIC	D	8	2500	340.5	338.1	20.6
TL072ACPSR	SO	PS	8	2000	346.0	346.0	33.0
TL072BCDR	SOIC	D	8	2500	340.5	338.1	20.6
TL072CDR	SOIC	D	8	2500	346.0	346.0	29.0
TL072CDR	SOIC	D	8	2500	340.5	338.1	20.6
TL072CPSR	SO	PS	8	2000	346.0	346.0	33.0

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TL072CPWR	TSSOP	PW	8	2000	346.0	346.0	29.0
TL072IDR	SOIC	D	8	2500	346.0	346.0	29.0
TL072IDR	SOIC	D	8	2500	340.5	338.1	20.6
TL074ACDR	SOIC	D	14	2500	333.2	345.9	28.6
TL074ACNSR	SO	NS	14	2000	346.0	346.0	33.0
TL074BCDR	SOIC	D	14	2500	333.2	345.9	28.6
TL074BCNSR	SO	NS	14	2000	346.0	346.0	33.0
TL074CDR	SOIC	D	14	2500	333.2	345.9	28.6
TL074CNSR	SO	NS	14	2000	346.0	346.0	33.0
TL074CPWR	TSSOP	PW	14	2000	346.0	346.0	29.0
TL074IDR	SOIC	D	14	2500	333.2	345.9	28.6

D (R–PDSO–G8) PLASTIC SMALL–OUTLINE PACKAGE

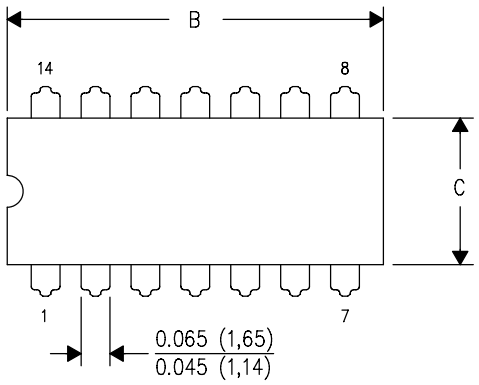


NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed .006 (0,15) per end.
D. Body width does not include interlead flash. Interlead flash shall not exceed .017 (0,43) per side.
E. Reference JEDEC MS–012 variation AA.

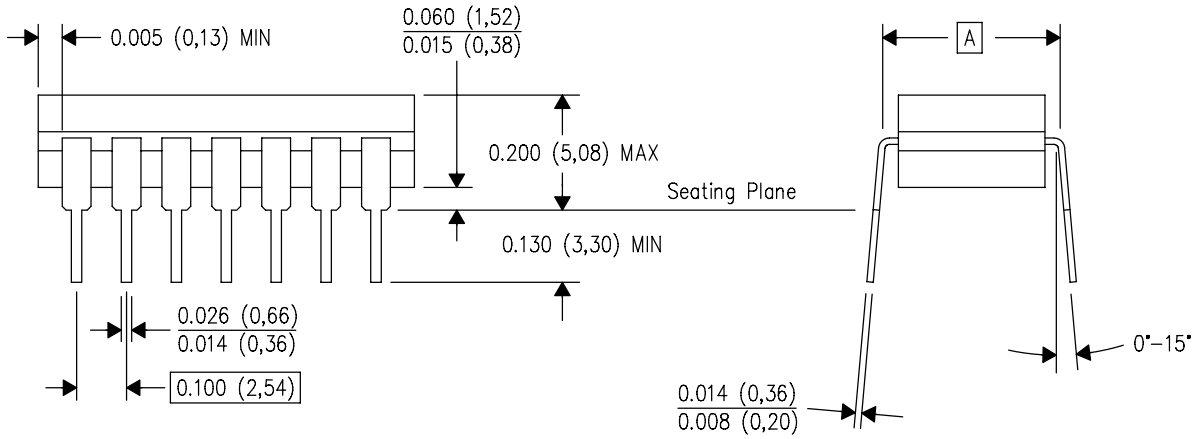
J (R–GDIP–T**)

14 LEADS SHOWN

CERAMIC DUAL IN–LINE PACKAGE



DIM \ PINS **	14	16	18	20
A	0.300 (7,62) BSC	0.300 (7,62) BSC	0.300 (7,62) BSC	0.300 (7,62) BSC
B MAX	0.785 (19,94)	.840 (21,34)	0.960 (24,38)	1.060 (26,92)
B MIN	—	—	—	—
C MAX	0.300 (7,62)	0.300 (7,62)	0.310 (7,87)	0.300 (7,62)
C MIN	0.245 (6,22)	0.245 (6,22)	0.220 (5,59)	0.245 (6,22)



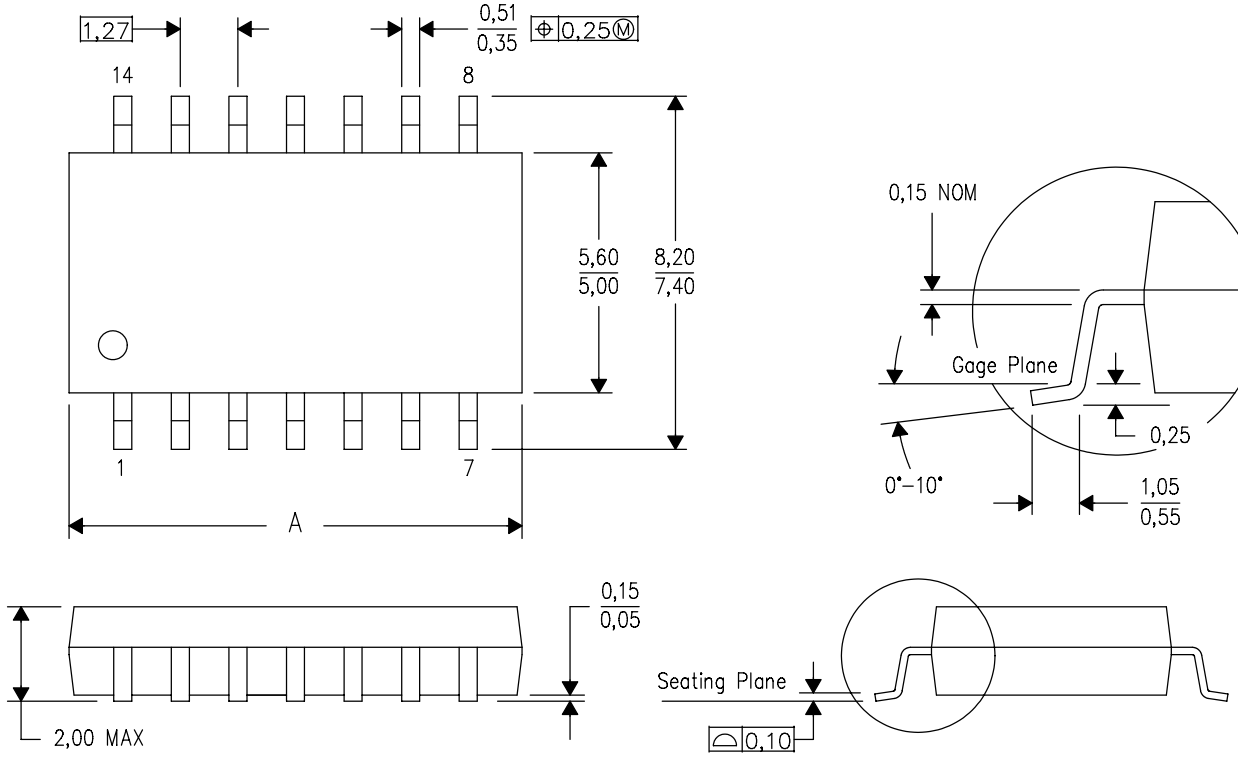
4040083/F 03/03

NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. This package is hermetically sealed with a ceramic lid using glass frit.
D. Index point is provided on cap for terminal identification only on press ceramic glass frit seal only.
E. Falls within MIL STD 1835 GDIP1–T14, GDIP1–T16, GDIP1–T18 and GDIP1–T20.

MECHANICAL DATA

NS (R-PDSO-G)** **PLASTIC SMALL-OUTLINE PACKAGE**

14-PINS SHOWN



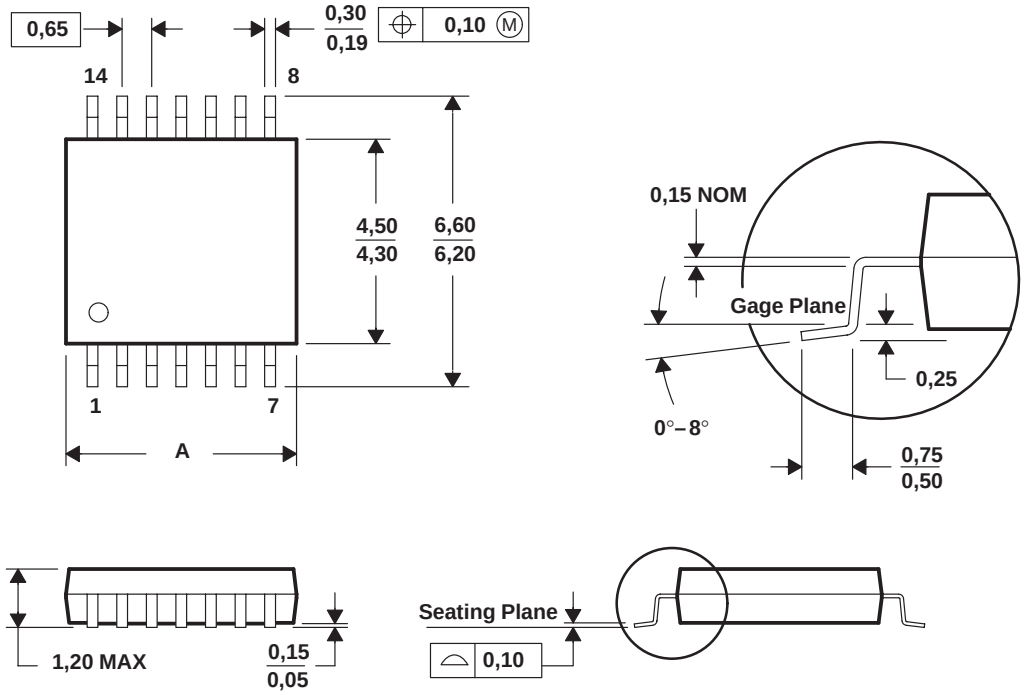
DIM \ PINS **	14	16	20	24
A MAX	10,50	10,50	12,90	15,30
A MIN	9,90	9,90	12,30	14,70

4040062/C 03/03

NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion, not to exceed 0,15.

PW (R-PDSO-G)** **PLASTIC SMALL-OUTLINE PACKAGE**

14 PINS SHOWN



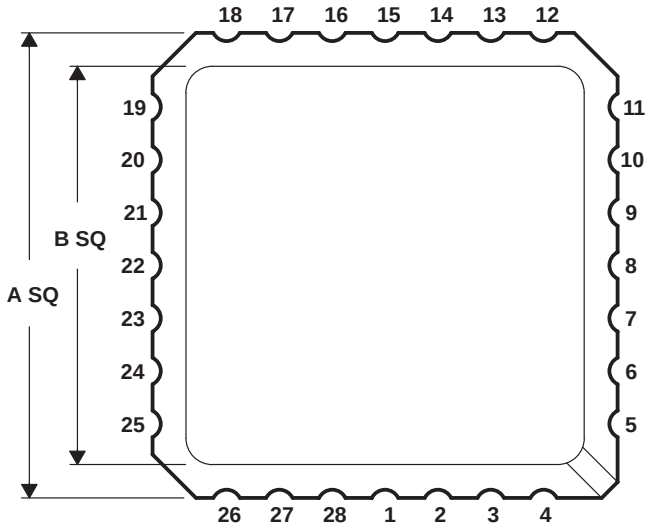
DIM \ PINS **	8	14	16	20	24	28
A MAX	3,10	5,10	5,10	6,60	7,90	9,80
A MIN	2,90	4,90	4,90	6,40	7,70	9,60

4040064/F 01/97

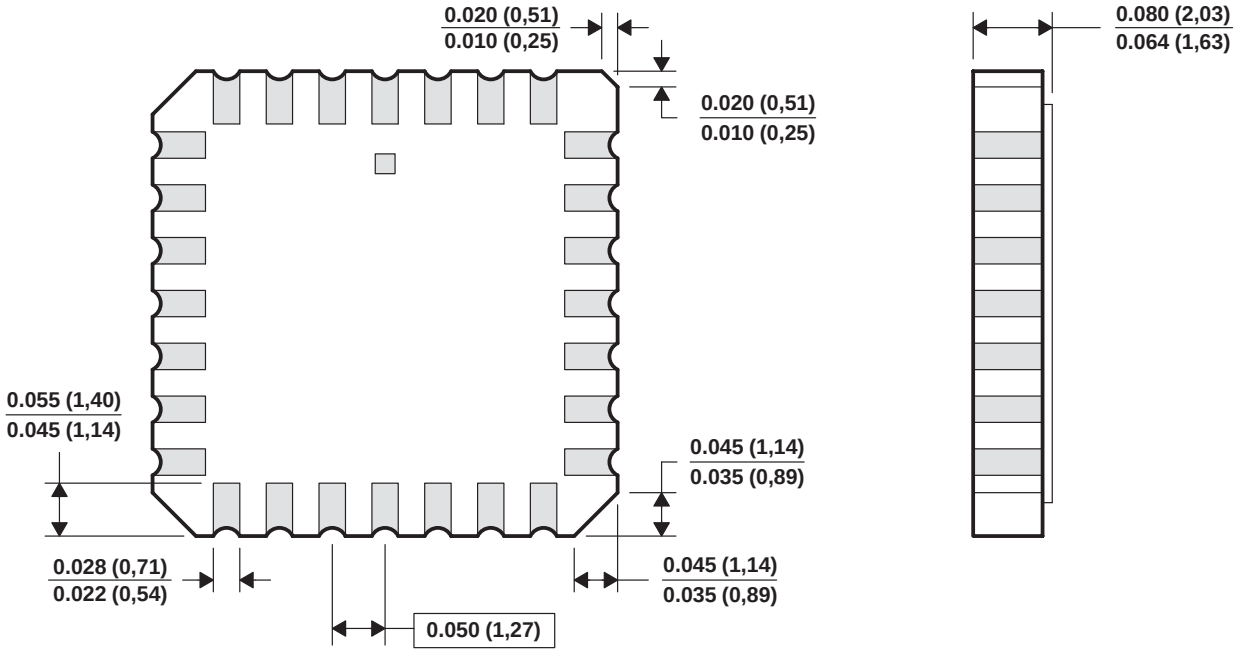
NOTES: A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.
D. Falls within JEDEC MO-153

FK (S-CQCC-N)** **LEADLESS CERAMIC CHIP CARRIER**

28 TERMINAL SHOWN



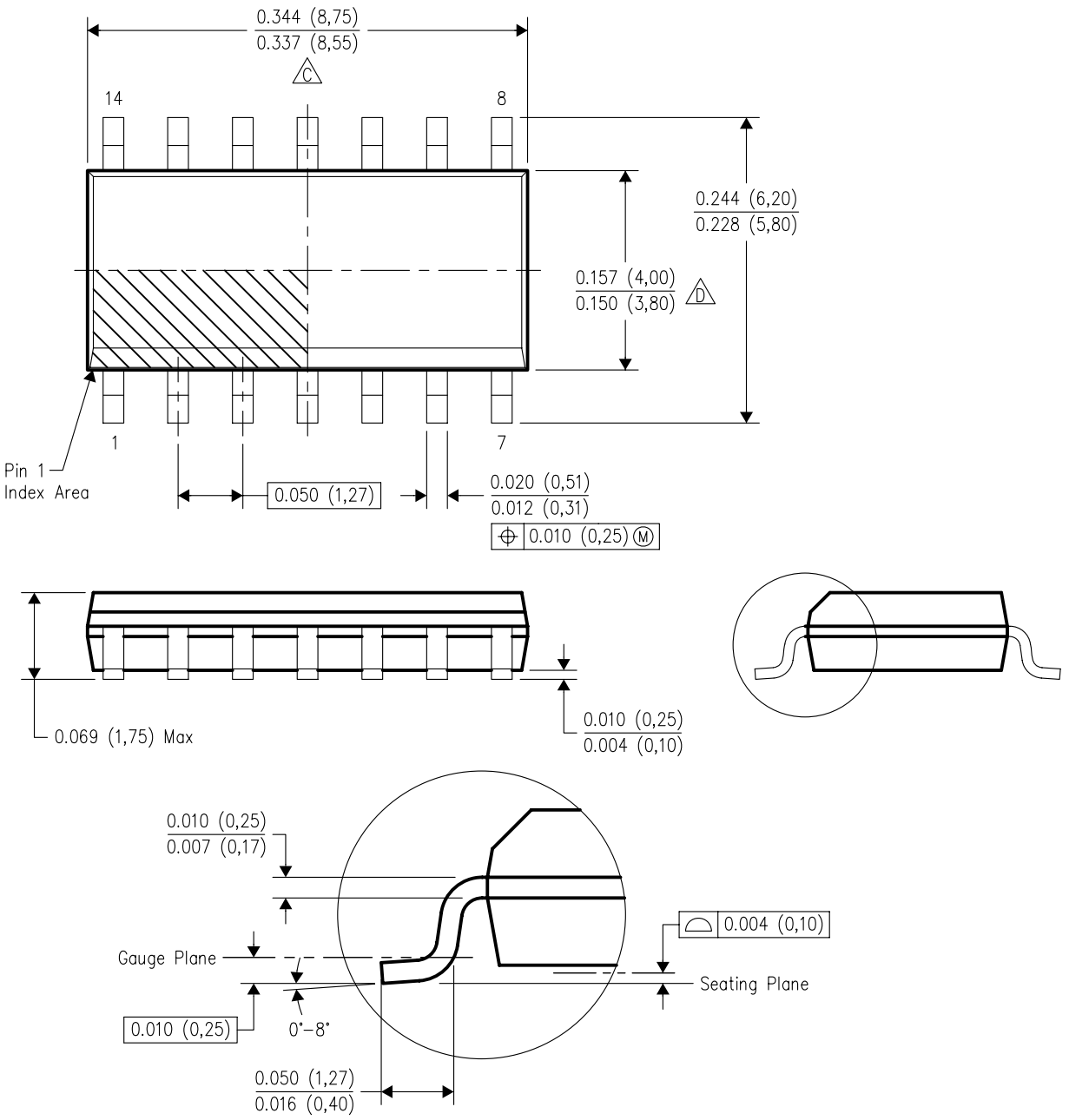
NO. OF TERMINALS **	A		B	
	MIN	MAX	MIN	MAX
20	0.342 (8,69)	0.358 (9,09)	0.307 (7,80)	0.358 (9,09)
28	0.442 (11,23)	0.458 (11,63)	0.406 (10,31)	0.458 (11,63)
44	0.640 (16,26)	0.660 (16,76)	0.495 (12,58)	0.560 (14,22)
52	0.739 (18,78)	0.761 (19,32)	0.495 (12,58)	0.560 (14,22)
68	0.938 (23,83)	0.962 (24,43)	0.850 (21,6)	0.858 (21,8)
84	1.141 (28,99)	1.165 (29,59)	1.047 (26,6)	1.063 (27,0)



4040140/D 10/96

NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. This package can be hermetically sealed with a metal lid.
D. The terminals are gold plated.
E. Falls within JEDEC MS-004

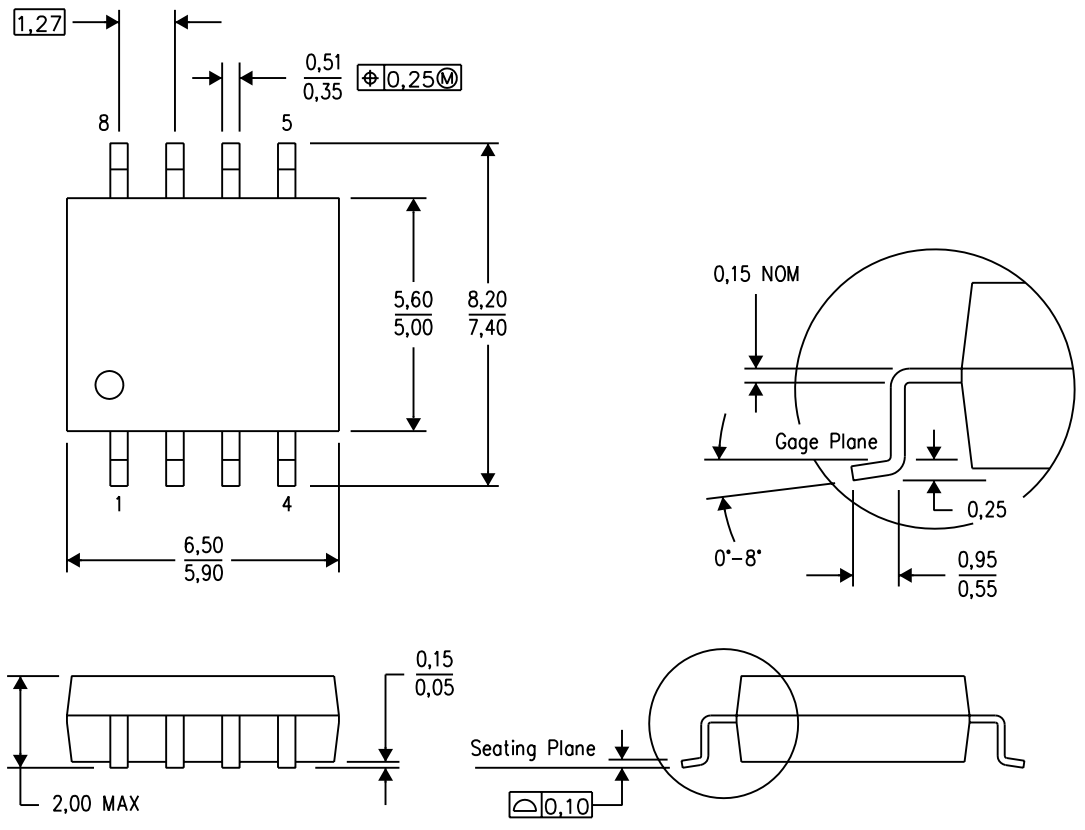
D (R–PDSO–G14) PLASTIC SMALL–OUTLINE PACKAGE



NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed .006 (0,15) per end.
D. Body width does not include interlead flash. Interlead flash shall not exceed .017 (0,43) per side.
E. Reference JEDEC MS–012 variation AB.

MECHANICAL DATA

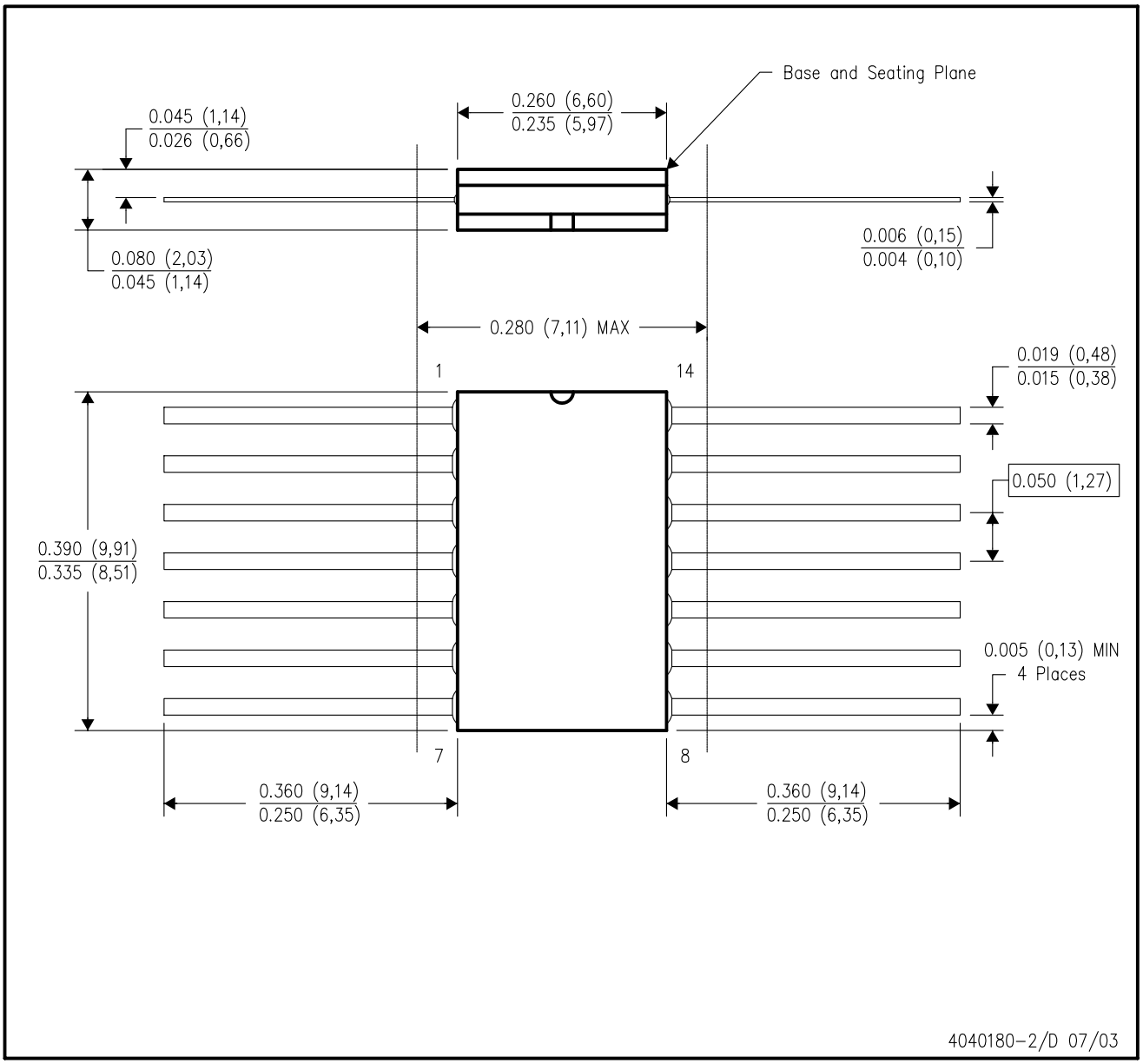
PS (R-PDSO-G8) **PLASTIC SMALL-OUTLINE PACKAGE**



4040063/C 03/03

NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion, not to exceed 0,15.

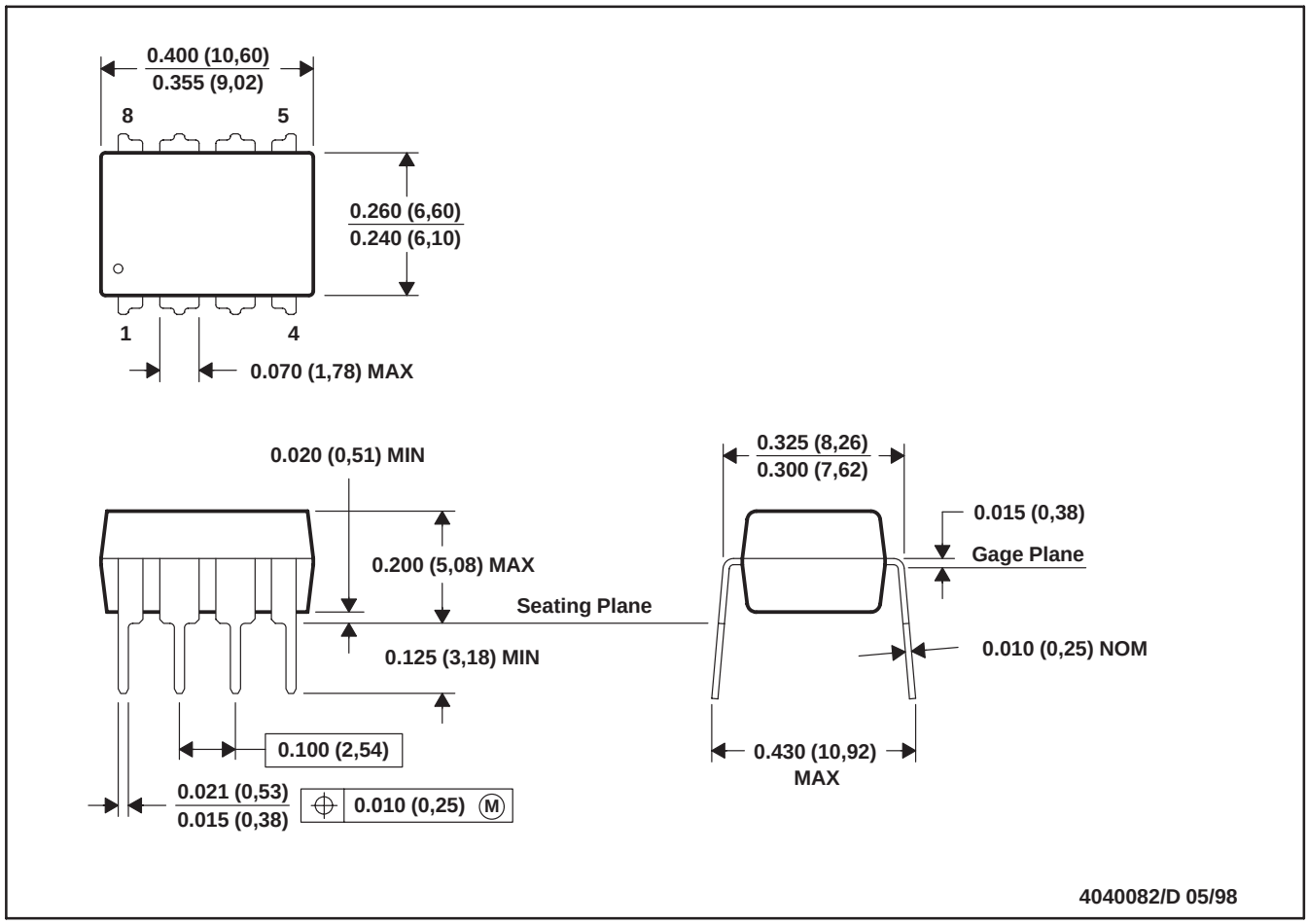
W (R–GDFP–F14) CERAMIC DUAL FLATPACK



NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. This package can be hermetically sealed with a ceramic lid using glass frit.
D. Index point is provided on cap for terminal identification only.
E. Falls within MIL STD 1835 GDFP1–F14 and JEDEC MO–092AB

MPDI001A – JANUARY 1995 – REVISED JUNE 1999

P (R-PDIP-T8) **PLASTIC DUAL-IN-LINE**

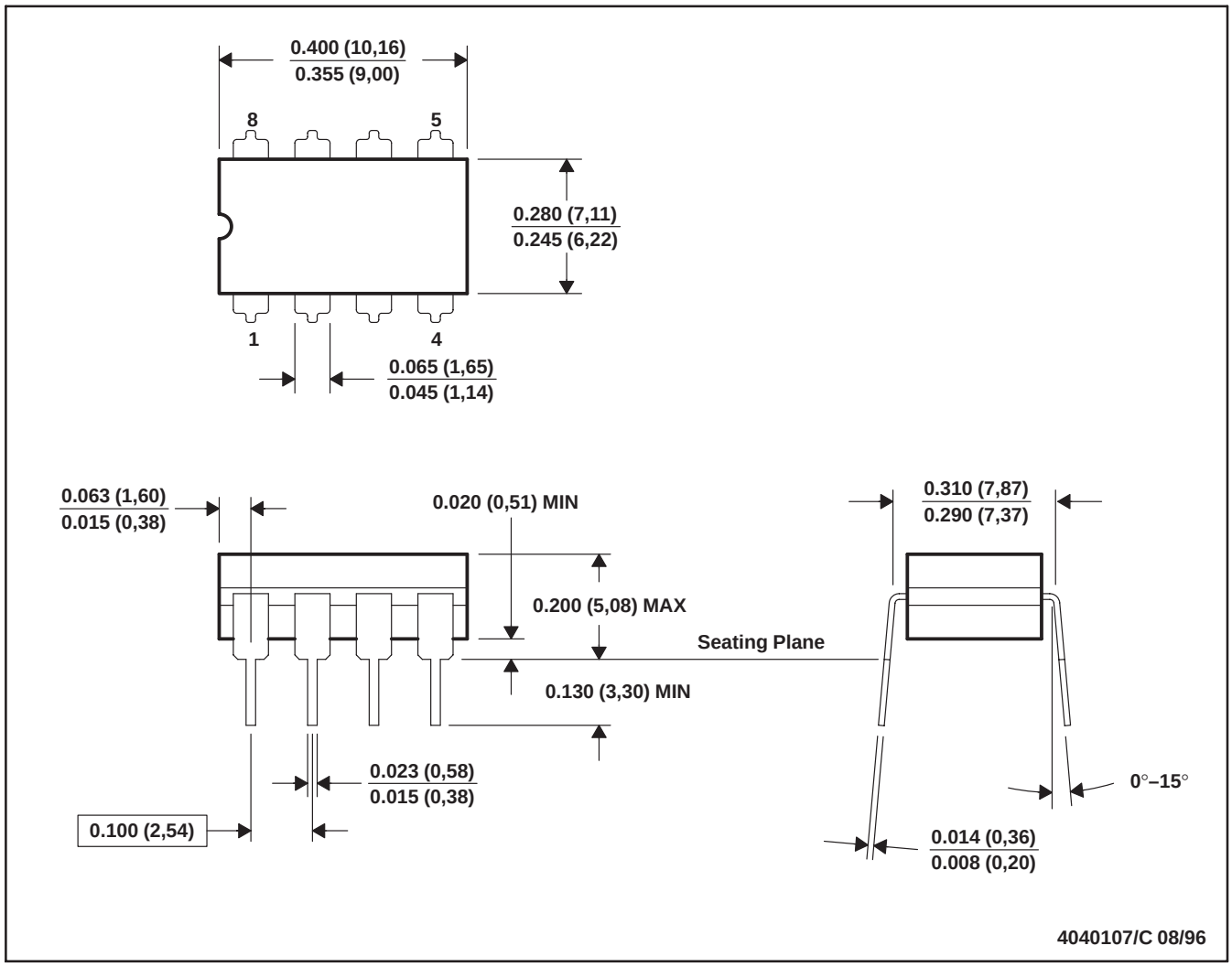


NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Falls within JEDEC MS-001

For the latest package information, go to http://www.ti.com/sc/docs/package/pkg_info.htm

MCER001A – JANUARY 1995 – REVISED JANUARY 1997

JG (R-GDIP-T8) **CERAMIC DUAL-IN-LINE**

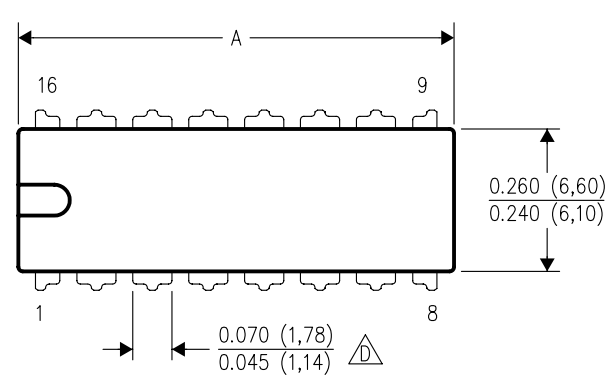


NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. This package can be hermetically sealed with a ceramic lid using glass frit.
D. Index point is provided on cap for terminal identification.
E. Falls within MIL STD 1835 GDIP1-T8

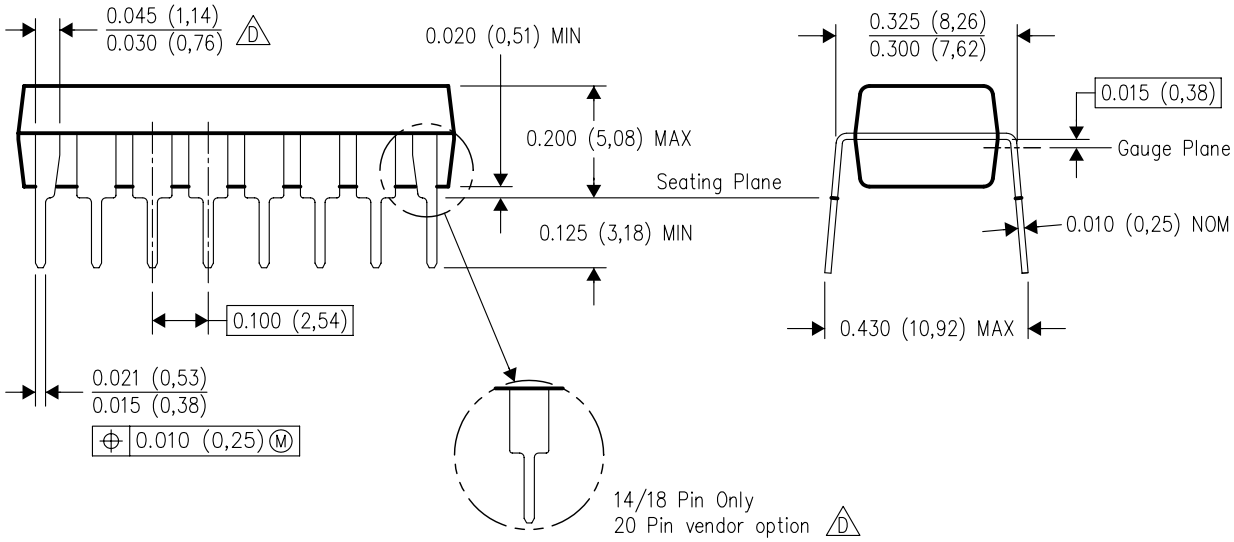
N (R–PDIP–T**)

PLASTIC DUAL–IN–LINE PACKAGE

16 PINS SHOWN



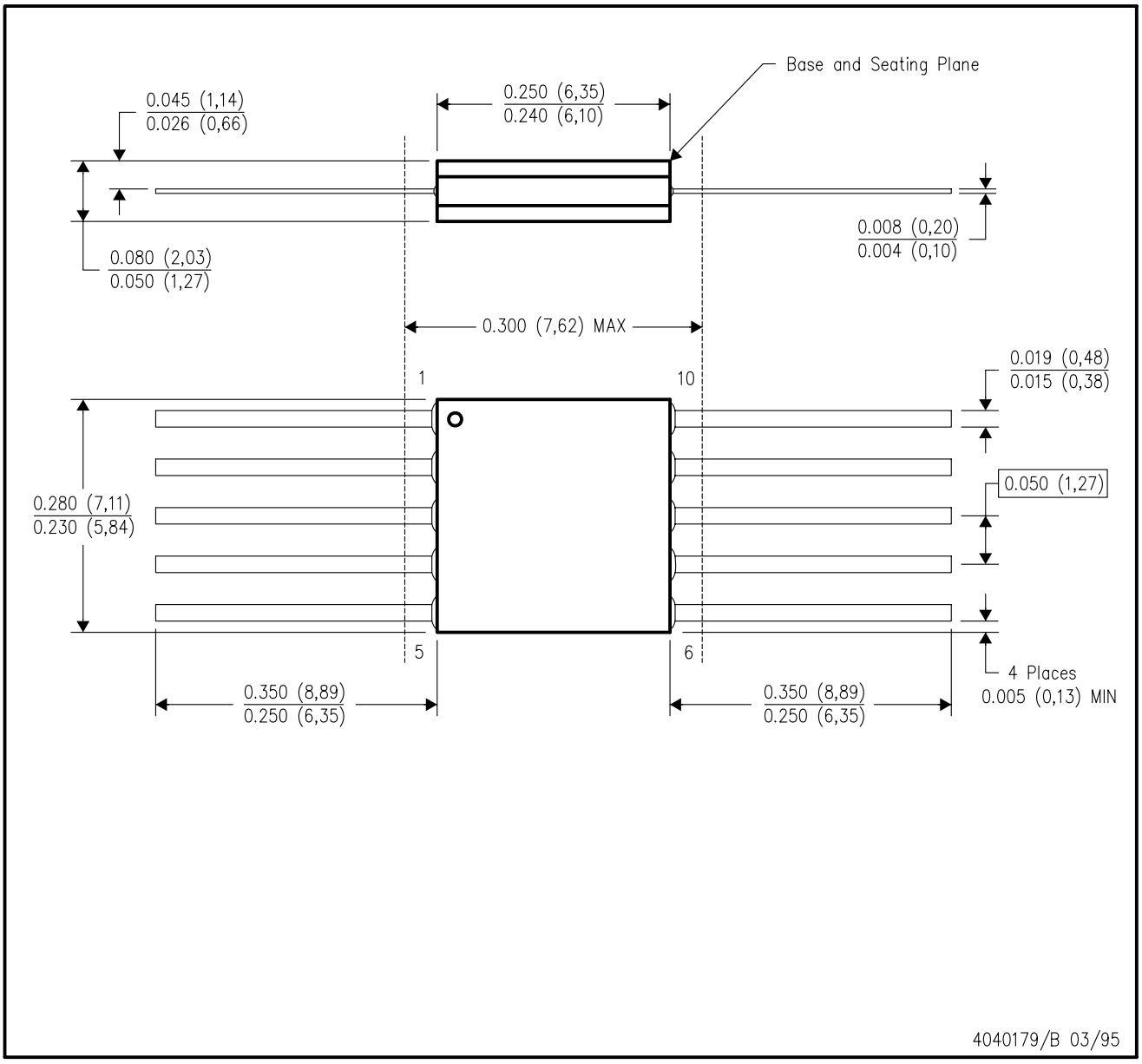
DIM \ PINS **	14	16	18	20
A MAX	0.775 (19,69)	0.775 (19,69)	0.920 (23,37)	1.060 (26,92)
A MIN	0.745 (18,92)	0.745 (18,92)	0.850 (21,59)	0.940 (23,88)
MS–001 VARIATION (C)	AA	BB	AC	AD



4040049/E 12/2002

NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Falls within JEDEC MS–001, except 18 and 20 pin minimum body length (Dim A).
D. The 20 pin end lead shoulder width is a vendor option, either half or full width.

U (S–GDFP–F10) CERAMIC DUAL FLATPACK



NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. This package can be hermetically sealed with a ceramic lid using glass frit.
D. Index point is provided on cap for terminal identification only.
E. Falls within MIL STD 1835 GDFP1–F10 and JEDEC MO–092AA

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

Products		**Applications**	
Amplifiers	amplifier.ti.com	Audio	www.ti.com/audio
Data Converters	dataconverter.ti.com	Automotive	www.ti.com/automotive
DSP	dsp.ti.com	Broadband	www.ti.com/broadband
Clocks and Timers	www.ti.com/clocks	Digital Control	www.ti.com/digitalcontrol
Interface	interface.ti.com	Medical	www.ti.com/medical
Logic	logic.ti.com	Military	www.ti.com/military
Power Mgmt	power.ti.com	Optical Networking	www.ti.com/opticalnetwork
Microcontrollers	microcontroller.ti.com	Security	www.ti.com/security
RFID	www.ti-rfid.com	Telephony	www.ti.com/telephony
RF/IF and ZigBee® Solutions	www.ti.com/lprf	Video & Imaging	www.ti.com/video
		Wireless	www.ti.com/wireless

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265

MC78L00A Series, NCV78L00A

100 mA Positive Voltage Regulators

The MC78L00A Series of positive voltage regulators are inexpensive, easy−to−use devices suitable for a multitude of applications that require a regulated supply of up to 100 mA. Like their higher powered MC7800 and MC78M00 Series cousins, these regulators feature internal current limiting and thermal shutdown making them remarkably rugged. No external components are required with the MC78L00 devices in many applications.

These devices offer a substantial performance advantage over the traditional zener diode−resistor combination, as output impedance and quiescent current are substantially reduced.

Features

- Wide Range of Available, Fixed Output Voltages
- Low Cost
- Internal Short Circuit Current Limiting
- Internal Thermal Overload Protection
- No External Components Required
- Complementary Negative Regulators Offered (MC79L00A Series)
- Pb−Free Packages are Available
- NCV Prefix for Automotive and Other Applications Requiring Site and Control Changes

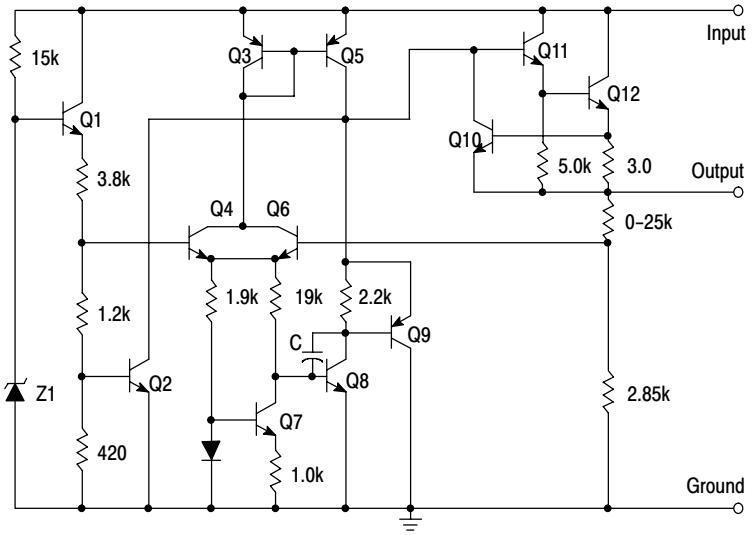


Figure 1. Representative Schematic Diagram

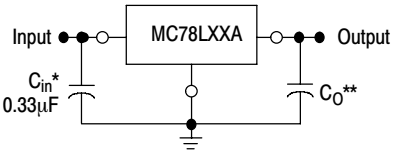


Figure 2. Standard Application

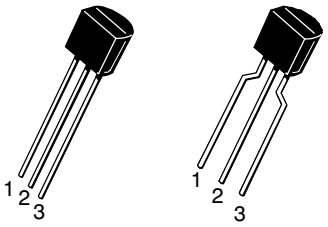
A common ground is required between the input and the output voltages. The input voltage must remain typically 2.0 V above the output voltage even during the low point on the input ripple voltage.

* C_{in} is required if regulator is located an appreciable distance from power supply filter.

** C_O is not needed for stability; however, it does improve transient response.

ON Semiconductor®

http://onsemi.com



STRAIGHT LEAD BULK PACK

BENT LEAD TAPE & REEL AMMO PACK

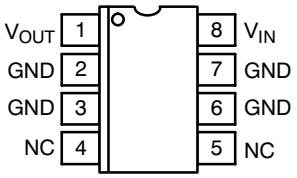
TO−92
P SUFFIX
CASE 029

Pin: 1. Output
2. Ground
3. Input

SOIC−8*
D SUFFIX
CASE 751

*SOIC−8 is an internally modified SO−8 package. Pins 2, 3, 6, and 7 are electrically common to the die attach flag. This internal lead frame modification decreases package thermal resistance and increases power dissipation capability when appropriately mounted on a printed circuit board. SOIC−8 conforms to all external dimensions of the standard SO−8 package.

PIN CONNECTIONS



(Top View)

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 9 of this data sheet.

DEVICE MARKING INFORMATION

See general marking information in the device marking section on page 15 of this data sheet.

MAXIMUM RATINGS (T_A = +125°C, unless otherwise noted.)

Rating	Symbol	Value	Unit
Input Voltage (2.6 V−8.0 V) (12 V−18 V) (24 V)	V_I	30 35 40	Vdc
Storage Temperature Range	T_{stg}	−65 to +150	°C
Operating Junction Temperature Range	T_J	−40 to +150	°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.

*This device series contains ESD protection and exceeds the following tests:
Human Body Model 2000 V per MIL−STD−883, Method 3015
Machine Model Method 200 V

ELECTRICAL CHARACTERISTICS (V_I = 10 V, I_O = 40 mA, C_I = 0.33 μF, C_O = 0.1 μF, −40°C < T_J < +125°C (for MC78LXXAB, NCV78L05A), 0°C < T_J < +125°C (for MC78LXXAC), unless otherwise noted.)

Characteristics	Symbol	MC78L05AC, AB, NCV78L05A			Unit
		Min	Typ	Max	
Output Voltage (T_J = +25°C)	V_O	4.8	5.0	5.2	Vdc
Line Regulation (T_J = +25°C, I_O = 40 mA) 7.0 Vdc ≤ V_I ≤ 20 Vdc 8.0 Vdc ≤ V_I ≤ 20 Vdc	Reg_{line}	 – –	 55 45	 150 100	mV
Load Regulation (T_J = +25°C, 1.0 mA ≤ I_O ≤ 100 mA) (T_J = +25°C, 1.0 mA ≤ I_O ≤ 40 mA)	Reg_{load}	 – –	 11 5.0	 60 30	mV
Output Voltage (7.0 Vdc ≤ V_I ≤ 20 Vdc, 1.0 mA ≤ I_O ≤ 40 mA) (V_I = 10 V, 1.0 mA ≤ I_O ≤ 70 mA)	V_O	 4.75 4.75	 – –	 5.25 5.25	Vdc
Input Bias Current (T_J = +25°C) (T_J = +125°C)	I_{IB}	 – –	 3.8 –	 6.0 5.5	mA
Input Bias Current Change (8.0 Vdc ≤ V_I ≤ 20 Vdc) (1.0 mA ≤ I_O ≤ 40 mA)	ΔI_{IB}	 – –	 – –	 1.5 0.1	mA
Output Noise Voltage (T_A = +25°C, 10 Hz ≤ f ≤ 100 kHz)	V_n	–	40	–	μV
Ripple Rejection (I_O = 40 mA, f = 120 Hz, 8.0 Vdc ≤ V_I ≤ 18 V, T_J = +25°C)	RR	41	49	–	dB
Dropout Voltage (T_J = +25°C)	$V_I - V_O$	–	1.7	–	Vdc

NOTE: NCV78L05A: T_{low} = −40°C, T_{high} = +125°C. Guaranteed by design. NCV prefix is for automotive and other applications requiring site and change control.

ELECTRICAL CHARACTERISTICS (V_I = 14 V, I_O = 40 mA, C_I = 0.33 μF, C_O = 0.1 μF, −40°C < T_J < +125°C (for MC78LXXAB), 0°C < T_J < +125°C (for MC78LXXAC), unless otherwise noted.)

Characteristics	Symbol	MC78L08AC, AB			Unit
		Min	Typ	Max	
Output Voltage (T_J = +25°C)	V_O	7.7	8.0	8.3	Vdc
Line Regulation (T_J = +25°C, I_O = 40 mA) 10.5 Vdc ≤ V_I ≤ 23 Vdc 11 Vdc ≤ V_I ≤ 23 Vdc	Reg_{line}	 – –	 20 12	 175 125	mV
Load Regulation (T_J = +25°C, 1.0 mA ≤ I_O ≤ 100 mA) (T_J = +25°C, 1.0 mA ≤ I_O ≤ 40 mA)	Reg_{load}	 – –	 15 8.0	 80 40	mV
Output Voltage (10.5 Vdc ≤ V_I ≤ 23 Vdc, 1.0 mA ≤ I_O ≤ 40 mA) (V_I = 14 V, 1.0 mA ≤ I_O ≤ 70 mA)	V_O	 7.6 7.6	 – –	 8.4 8.4	Vdc
Input Bias Current (T_J = +25°C) (T_J = +125°C)	I_{IB}	 – –	 3.0 –	 6.0 5.5	mA
Input Bias Current Change (11 Vdc ≤ V_I ≤ 23 Vdc) (1.0 mA ≤ I_O ≤ 40 mA)	ΔI_{IB}	 – –	 – –	 1.5 0.1	mA
Output Noise Voltage (T_A = +25°C, 10 Hz ≤ f ≤ 100 kHz)	V_n	–	60	–	μV
Ripple Rejection (I_O = 40 mA, f = 120 Hz, 12 V ≤ V_I ≤ 23 V, T_J = +25°C)	RR	37	57	–	dB
Dropout Voltage (T_J = +25°C)	$V_I - V_O$	–	1.7	–	Vdc

ELECTRICAL CHARACTERISTICS (V_I = 15 V, I_O = 40 mA, C_I = 0.33 μF, C_O = 0.1 μF, −40°C < T_J < +125°C (for MC78LXXAB), 0°C < T_J < +125°C (for MC78LXXAC), unless otherwise noted.)

Characteristics	Symbol	MC78L09AC, AB			Unit
		Min	Typ	Max	
Output Voltage (T_J = +25°C)	V_O	8.6	9.0	9.4	Vdc
Line Regulation (T_J = +25°C, I_O = 40 mA) 11.5 Vdc ≤ V_I ≤ 24 Vdc 12 Vdc ≤ V_I ≤ 24 Vdc	Reg_{line}	 – –	 20 12	 175 125	mV
Load Regulation (T_J = +25°C, 1.0 mA ≤ I_O ≤ 100 mA) (T_J = +25°C, 1.0 mA ≤ I_O ≤ 40 mA)	Reg_{load}	 – –	 15 8.0	 90 40	mV
Output Voltage (11.5 Vdc ≤ V_I ≤ 24 Vdc, 1.0 mA ≤ I_O ≤ 40 mA) (V_I = 15 V, 1.0 mA ≤ I_O ≤ 70 mA)	V_O	 8.5 8.5	 – –	 9.5 9.5	Vdc
Input Bias Current (T_J = +25°C) (T_J = +125°C)	I_{IB}	 – –	 3.0 –	 6.0 5.5	mA
Input Bias Current Change (11 Vdc ≤ V_I ≤ 23 Vdc) (1.0 mA ≤ I_O ≤ 40 mA)	ΔI_{IB}	 – –	 – –	 1.5 0.1	mA
Output Noise Voltage (T_A = +25°C, 10 Hz ≤ f ≤ 100 kHz)	V_n	–	60	–	μV
Ripple Rejection (I_O = 40 mA, f = 120 Hz, 13 V ≤ V_I ≤ 24 V, T_J = +25°C)	RR	37	57	–	dB
Dropout Voltage (T_J = +25°C)	$V_I - V_O$	–	1.7	–	Vdc

ELECTRICAL CHARACTERISTICS (V_I = 19 V, I_O = 40 mA, C_I = 0.33 μF, C_O = 0.1 μF, −40°C < T_J < +125°C (for MC78LXXAB), 0°C < T_J < +125°C (for MC78LXXAC), unless otherwise noted.)

Characteristics	Symbol	MC78L12AC, AB			Unit
		Min	Typ	Max	
Output Voltage (T_J = +25°C)	V_O	11.5	12	12.5	Vdc
Line Regulation (T_J = +25°C, I_O = 40 mA) 14.5 Vdc ≤ V_I ≤ 27 Vdc 16 Vdc ≤ V_I ≤ 27 Vdc	Reg_{line}	 – –	 120 100	 250 200	mV
Load Regulation (T_J = +25°C, 1.0 mA ≤ I_O ≤ 100 mA) (T_J = +25°C, 1.0 mA ≤ I_O ≤ 40 mA)	Reg_{load}	 – –	 20 10	 100 50	mV
Output Voltage (14.5 Vdc ≤ V_I ≤ 27 Vdc, 1.0 mA ≤ I_O ≤ 40 mA) (V_I = 19 V, 1.0 mA ≤ I_O ≤ 70 mA)	V_O	 11.4 11.4	 – –	 12.6 12.6	Vdc
Input Bias Current (T_J = +25°C) (T_J = +125°C)	I_{IB}	 – –	 4.2 –	 6.5 6.0	mA
Input Bias Current Change (16 Vdc ≤ V_I ≤ 27 Vdc) (1.0 mA ≤ I_O ≤ 40 mA)	ΔI_{IB}	 – –	 – –	 1.5 0.1	mA
Output Noise Voltage (T_A = +25°C, 10 Hz ≤ f ≤ 100 kHz)	V_n	–	80	–	μV
Ripple Rejection (I_O = 40 mA, f = 120 Hz, 15 V ≤ V_I ≤ 25 V, T_J = +25°C)	RR	37	42	–	dB
Dropout Voltage (T_J = +25°C)	$V_I - V_O$	–	1.7	–	Vdc

ELECTRICAL CHARACTERISTICS (V_I = 23 V, I_O = 40 mA, C_I = 0.33 μF, C_O = 0.1 μF, −40°C < T_J < +125°C (for MC78LXXAB), 0°C < T_J < +125°C (for MC78LXXAC), unless otherwise noted.)

Characteristics	Symbol	MC78L15AC, AB / NCV78L15A			Unit
		Min	Typ	Max	
Output Voltage (T_J = +25°C)	V_O	14.4	15	15.6	Vdc
Line Regulation (T_J = +25°C, I_O = 40 mA) 17.5 Vdc ≤ V_I ≤ 30 Vdc 20 Vdc ≤ V_I ≤ 30 Vdc	Reg_{line}	 – –	 130 110	 300 250	mV
Load Regulation (T_J = +25°C, 1.0 mA ≤ I_O ≤ 100 mA) (T_J = +25°C, 1.0 mA ≤ I_O ≤ 40 mA)	Reg_{load}	 – –	 25 12	 150 75	mV
Output Voltage (17.5 Vdc ≤ V_I ≤ 30 Vdc, 1.0 mA ≤ I_O ≤ 40 mA) (V_I = 23 V, 1.0 mA ≤ I_O ≤ 70 mA)	V_O	 14.25 14.25	 – –	 15.75 15.75	Vdc
Input Bias Current (T_J = +25°C) (T_J = +125°C)	I_{IB}	 – –	 4.4 –	 6.5 6.0	mA
Input Bias Current Change (20 Vdc ≤ V_I ≤ 30 Vdc) (1.0 mA ≤ I_O ≤ 40 mA)	ΔI_{IB}	 – –	 – –	 1.5 0.1	mA
Output Noise Voltage (T_A = +25°C, 10 Hz ≤ f ≤ 100 kHz)	V_n	–	90	–	μV
Ripple Rejection (I_O = 40 mA, f = 120 Hz, 18.5 V ≤ V_I ≤ 28.5 V, T_J = +25°C)	RR	34	39	–	dB
Dropout Voltage (T_J = +25°C)	$V_I - V_O$	–	1.7	–	Vdc

ELECTRICAL CHARACTERISTICS (V_I = 27 V, I_O = 40 mA, C_I = 0.33 μF, C_O = 0.1 μF, 0°C < T_J < +125°C, unless otherwise noted.)

Characteristics	Symbol	MC78L18AC			Unit
		Min	Typ	Max	
Output Voltage (T_J = +25°C)	V_O	17.3	18	18.7	Vdc
Line Regulation (T_J = +25°C, I_O = 40 mA) 21.4 Vdc ≤ V_I ≤ 33 Vdc 20.7 Vdc ≤ V_I ≤ 33 Vdc 22 Vdc ≤ V_I ≤ 33 Vdc 21 Vdc ≤ V_I ≤ 33 Vdc	Reg_{line}	 – –	 45 35	 325 275	mV
Load Regulation (T_J = +25°C, 1.0 mA ≤ I_O ≤ 100 mA) (T_J = +25°C, 1.0 mA ≤ I_O ≤ 40 mA)	Reg_{load}	 – –	 30 15	 170 85	mV
Output Voltage (21.4 Vdc ≤ V_I ≤ 33 Vdc, 1.0 mA ≤ I_O ≤ 40 mA) (20.7 Vdc ≤ V_I ≤ 33 Vdc, 1.0 mA ≤ I_O ≤ 40 mA) (V_I = 27 V, 1.0 mA ≤ I_O ≤ 70 mA) (V_I = 27 V, 1.0 mA ≤ I_O ≤ 70 mA)	V_O	 17.1 17.1	 – –	 18.9 18.9	Vdc
Input Bias Current (T_J = +25°C) (T_J = +125°C)	I_{IB}	 – –	 3.1 –	 6.5 6.0	mA
Input Bias Current Change (22 Vdc ≤ V_I ≤ 33 Vdc) (21 Vdc ≤ V_I ≤ 33 Vdc) (1.0 mA ≤ I_O ≤ 40 mA)	ΔI_{IB}	 – –	 – –	 1.5 0.1	mA
Output Noise Voltage (T_A = +25°C, 10 Hz ≤ f ≤ 100 kHz)	V_n	–	150	–	μV
Ripple Rejection (I_O = 40 mA, f = 120 Hz, 23 V ≤ V_I ≤ 33 V, T_J = +25°C)	RR	33	48	–	dB
Dropout Voltage (T_J = +25°C)	$V_I - V_O$	–	1.7	–	Vdc

ELECTRICAL CHARACTERISTICS (V_I = 33 V, I_O = 40 mA, C_I = 0.33 μF, C_O = 0.1 μF, 0°C < T_J < +125°C, unless otherwise noted.)

Characteristics	Symbol	MC78L24AC			Unit
		Min	Typ	Max	
Output Voltage (T_J = +25°C)	V_O	23	24	25	Vdc
Line Regulation	Reg_{line}				mV
(T_J = +25°C, I_O = 40 mA)					
27.5 Vdc ≤ V_I ≤ 38 Vdc		–	–	–	
28 Vdc ≤ V_I ≤ 80 Vdc		–	50	300	
27 Vdc ≤ V_I ≤ 38 Vdc		–	60	350	
Load Regulation	Reg_{load}				mV
(T_J = +25°C, 1.0 mA ≤ I_O ≤ 100 mA)		–	40	200	
(T_J = +25°C, 1.0 mA ≤ I_O ≤ 40 mA)		–	20	100	
Output Voltage	V_O				Vdc
(28 Vdc ≤ V_I ≤ 38 Vdc, 1.0 mA ≤ I_O ≤ 40 mA)					
(27 Vdc ≤ V_I ≤ 38 Vdc, 1.0 mA ≤ I_O ≤ 40 mA)		22.8	–	25.2	
(28 Vdc ≤ V_I = 33 Vdc, 1.0 mA ≤ I_O ≤ 70 mA)					
(27 Vdc ≤ V_I ≤ 33 Vdc, 1.0 mA ≤ I_O ≤ 70 mA)		22.8	–	25.2	
Input Bias Current	I_{IB}				mA
(T_J = +25°C)		–	3.1	6.5	
(T_J = +125°C)		–	–	6.0	
Input Bias Current Change	ΔI_{IB}				mA
(28 Vdc ≤ V_I ≤ 38 Vdc)		–	–	1.5	
(1.0 mA ≤ I_O ≤ 40 mA)		–	–	0.1	
Output Noise Voltage (T_A = +25°C, 10 Hz ≤ f ≤ 100 kHz)	V_n	–	200	–	μV
Ripple Rejection (I_O = 40 mA, f = 120 Hz, 29 V ≤ V_I ≤ 35 V, T_J = +25°C)	RR	31	45	–	dB
Dropout Voltage (T_J = +25°C)	$V_I - V_O$	–	1.7	–	Vdc

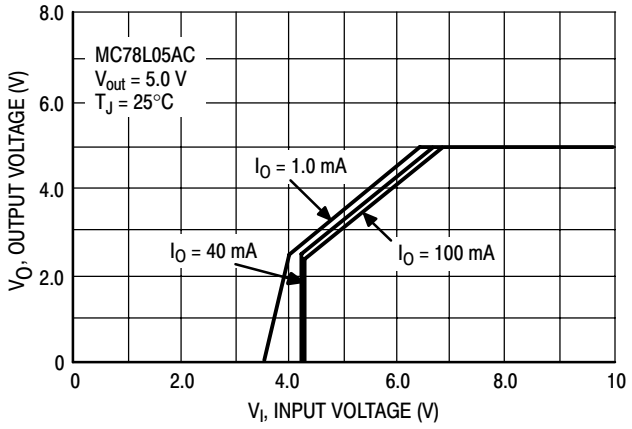


Figure 3. Dropout Characteristics

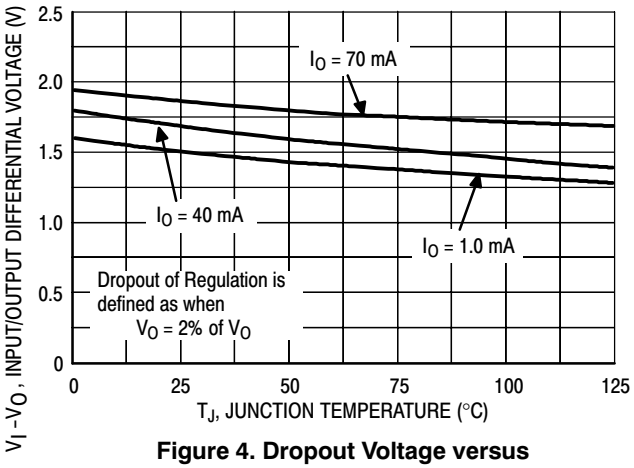


Figure 4. Dropout Voltage versus Junction Temperature

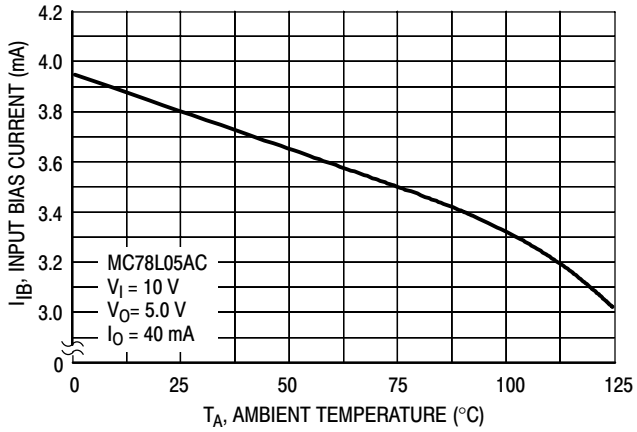


Figure 5. Input Bias Current versus Ambient Temperature

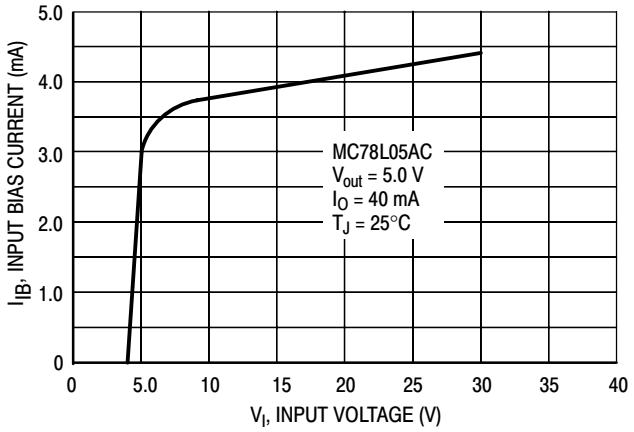


Figure 6. Input Bias Current versus Input Voltage

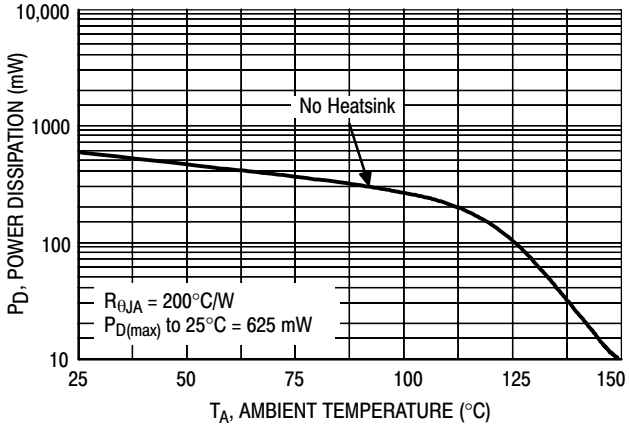


Figure 7. Maximum Average Power Dissipation versus Ambient Temperature – TO−92 Type Package

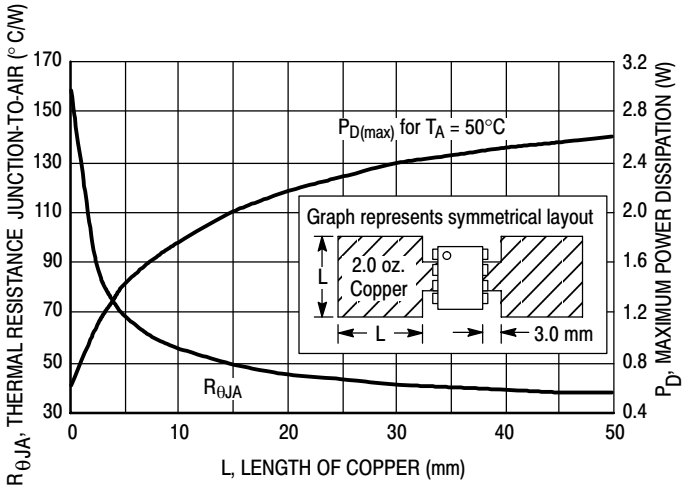


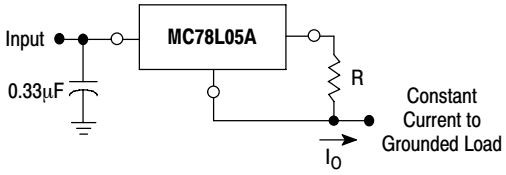
Figure 8. SOIC−8 Thermal Resistance and Maximum Power Dissipation versus P.C.B. Copper Length

APPLICATIONS INFORMATION

Design Considerations

The MC78L00A Series of fixed voltage regulators are designed with Thermal Overload Protection that shuts down the circuit when subjected to an excessive power overload condition. Internal Short Circuit Protection limits the maximum current the circuit will pass.

In many low current applications, compensation capacitors are not required. However, it is recommended that the regulator input be bypassed with a capacitor if the regulator is connected to the power supply filter with long wire lengths, or if the output load capacitance is large. The input bypass capacitor should be selected to provide good high−frequency characteristics to insure stable operation under all load conditions. A 0.33 μF or larger tantalum, mylar, or other capacitor having low internal impedance at high frequencies should be chosen. The bypass capacitor should be mounted with the shortest possible leads directly across the regulators input terminals. Good construction techniques should be used to minimize ground loops and lead resistance drops since the regulator has no external sense lead. Bypassing the output is also recommended.



The MC78L00 regulators can also be used as a current source when connected as above. In order to minimize dissipation the MC78L05C is chosen in this application. Resistor R determines the current as follows:

$$I_O = \frac{5.0\ V}{R} + I_B$$

I_{IB} = 3.8 mA over line and load changes

For example, a 100 mA current source would require R to be a 50 Ω, 1/2 W resistor and the output voltage compliance would be the input voltage less 7 V.

Figure 9. Current Regulator

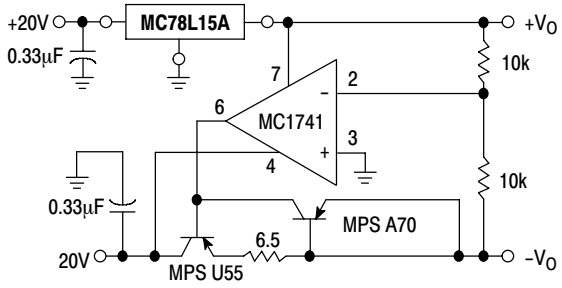


Figure 10. ± 15 V Tracking Voltage Regulator

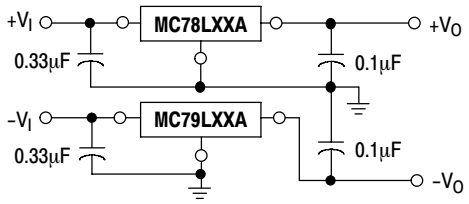


Figure 11. Positive and Negative Regulator

ORDERING INFORMATION

Device	Output Voltage	Operating Temperature Range	Package	Shipping†
MC78L05ABD	5.0 V	T_J = −40° to +125°C	SOIC−8	98 Units/Rail
MC78L05ABDG			SOIC−8	98 Units/Rail
MC78L05ABDR2			SOIC−8	2500 Tape & Reel
MC78L05ABDR2G			SOIC−8 (Pb−Free)	2500 Tape & Reel
NCV78L05ABDR2*			SOIC−8	2500 Tape & Reel
NCV78L05ABDR2G*			SOIC−8 (Pb−Free)	2500 Tape & Reel
MC78L05ABP			TO−92	2000 Units/Bag
MC78L05ABPG			TO−92 (Pb−Free)	2000 Units/Bag
NCV78L05ABPG*			TO−92 (Pb−Free)	2000 Units/Bag
MC78L05ABPRA			TO−92	2000 Tape & Reel
MC78L05ABPRAG			TO−92 (Pb−Free)	2000 Tape & Reel
NCV78L05ABPRAG*			TO−92 (Pb−Free)	2000 Tape & Reel
MC78L05ABPRE			TO−92	2000 Tape & Reel
MC78L05ABPREG			TO−92 (Pb−Free)	2000 Tape & Reel
NCV78L05ABPREG*			TO−92 (Pb−Free)	2000 Tape & Reel
MC78L05ABPRM			TO−92	2000 Ammo Pack
MC78L05ABPRMG			TO−92 (Pb−Free)	2000 Ammo Pack
NCV78L05ABPRMG*			TO−92 (Pb−Free)	2000 Ammo Pack
NCV78L05ABPRPG*			TO−92 (Pb−Free)	2000 Ammo Pack
MC78L05ACD	5.0 V	T_J = 0° to +125°C	SOIC−8	98 Units/Rail
MC78L05ACDG			SOIC−8 (Pb−Free)	98 Units/Rail
MC78L05ACDR2			SOIC−8	2500 Tape & Reel
MC78L05ACDR2G			SOIC−8 (Pb−Free)	2500 Tape & Reel
MC78L05ACP			TO−92	2000 Units/Bag
MC78L05ACPG			TO−92 (Pb−Free)	2000 Units/Bag
MC78L05ACPRA			TO−92	2000 Tape & Reel
MC78L05ACPRAG			TO−92 (Pb−Free)	2000 Tape & Reel
MC78L05ACPRE			TO−92	2000 Tape & Reel
MC78L05ACPREG			TO−92 (Pb−Free)	2000 Tape & Reel
MC78L05ACPRM			TO−92	2000 Ammo Pack
MC78L05ACPRMG			TO−92 (Pb−Free)	2000 Ammo Pack
MC78L05ACPRP			TO−92	2000 Ammo Pack
MC78L05ACPRPG			TO−92 (Pb−Free)	2000 Ammo Pack

*NCV78L05A: T_{low} = −40°C, T_{high} = +125°C. Guaranteed by design. NCV prefix is for automotive and other applications requiring site and change control.
†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.

ORDERING INFORMATION (continued)

Device	Output Voltage	Operating Temperature Range	Package	Shipping†
MC78L08ABD	8.0 V	T_J = −40° to +125°C	SOIC−8	98 Units/Rail
MC78L08ABDG			SOIC−8 (Pb−Free)	98 Units/Rail
MC78L08ABDR2			SOIC−8	2500 Tape & Reel
MC78L08ABDR2G			SOIC−8 (Pb−Free)	2500 Tape & Reel
NCV78L08ABDR2*			SOIC−8	2500 Tape & Reel
NCV78L08ABDR2G*			SOIC−8 (Pb−Free)	2500 Tape & Reel
MC78L08ABP			TO−92	2000 Units/Bag
MC78L08ABPG			TO−92 (Pb−Free)	2000 Units/Bag
MC78L08ABPRA			TO−92	2000 Tape & Reel
MC78L08ABPRAG			TO−92 (Pb−Free)	2000 Tape & Reel
MC78L08ABPRP			TO−92	2000 Ammo Pack
MC78L08ABPRPG			TO−92 (Pb−Free)	2000 Ammo Pack
MC78L08ACD		T_J = 0° to +125°C	SOIC−8	98 Units/Rail
MC78L08ACDG			SOIC−8 (Pb−Free)	98 Units/Rail
MC78L08ACDR2			SOIC−8	2500 Tape & Reel
MC78L08ACDR2G			SOIC−8 (Pb−Free)	2500 Tape & Reel
MC78L08ACP			TO−92	2000 Units/Bag
MC78L08ACPG			TO−92 (Pb−Free)	2000 Units/Bag
MC78L08ACPRA			TO−92	2000 Tape & Reel
MC78L08ACPRAG			TO−92 (Pb−Free)	2000 Tape & Reel
MC78L08ACPRE			TO−92	2000 Tape & Reel
MC78L08ACPREG			TO−92 (Pb−Free)	2000 Tape & Reel
MC78L08ACPRP			TO−92	2000 Ammo Pack
MC78L08ACPRPG			TO−92 (Pb−Free)	2000 Ammo Pack

ORDERING INFORMATION (continued)(continued)

Device	Output Voltage	Operating Temperature Range	Package	Shipping†
MC78L09ABD	9.0 V	T_J = −40° to +125°C	SOIC−8	98 Units/Rail
MC78L09ABDG			SOIC−8 (Pb−Free)	98 Units/Rail
MC78L09ABDR2			SOIC−8	2500 Tape & Reel
MC78L09ABDR2G			SOIC−8 (Pb−Free)	2500 Tape & Reel
MC78L09ABPRA			TO−92	2000 Tape & Reel
MC78L09ABPRAG			TO−92 (Pb−Free)	2000 Tape & Reel
MC78L09ABPRP			TO−92	2000 Ammo Pack
MC78L09ABPRPG			TO−92 (Pb−Free)	2000 Ammo Pack
MC78L09ACD	9.0 V	T_J = 0° to +125°C	SOIC−8	98 Units/Rail
MC78L09ACDG			SOIC−8 (Pb−Free)	98 Units/Rail
MC78L09ACDR2			SOIC−8	2500 Tape & Reel
MC78L09ACDR2G			SOIC−8 (Pb−Free)	2500 Tape & Reel
MC78L09ACP			TO−92	2000 Units/Bag
MC78L09ACPG			TO−92 (Pb−Free)	2000 Units/Bag

†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.

ORDERING INFORMATION (continued)

Device	Output Voltage	Operating Temperature Range	Package	Shipping†
MC78L12ABD	12 V	T_J = −40° to +125°C	SOIC−8	98 Units/Rail
MC78L12ABDG			SOIC−8 (Pb−Free)	98 Units/Rail
MC78L12ABDR2			SOIC−8	2500 Tape & Reel
MC78L12ABDR2G			SOIC−8 (Pb−Free)	2500 Tape & Reel
NCV78L12ABDG*			SOIC−8 (Pb−Free)	98 Units/Rail
NCV78L12ABDR2*			SOIC−8	2500 Tape & Reel
NCV78L12ABDR2G*			SOIC−8 (Pb−Free)	2500 Tape & Reel
MC78L12ABP			TO−92	2000 Units/Bag
MC78L12ABPG			TO−92 (Pb−Free)	2000 Units/Bag
MC78L12ABPRP			TO−92	2000 Ammo Pack
MC78L12ABPRPG			TO−92 (Pb−Free)	2000 Ammo Pack
NCV78L12ABPG*			TO−92 (Pb−Free)	2000 Units/Bag
MC78L12ACD		T_J = 0° to +125°C	SOIC−8	98 Units/Rail
MC78L12ACDG			SOIC−8 (Pb−Free)	98 Units/Rail
MC78L12ACDR2			SOIC−8	2500 Tape & Reel
MC78L12ACDR2G			SOIC−8 (Pb−Free)	2500 Tape & Reel
MC78L12ACP			TO−92	2000 Units/Bag
MC78L12ACPG			TO−92 (Pb−Free)	2000 Units/Bag
MC78L12ACPRA			TO−92	2000 Tape & Reel
MC78L12ACPRAG			TO−92 (Pb−Free)	2000 Tape & Reel
MC78L12ACPRE			TO−92	2000 Tape & Reel
MC78L12ACPREG			TO−92 (Pb−Free)	2000 Tape & Reel
MC78L12ACPRM			TO−92	2000 Ammo Pack
MC78L12ACPRMG			TO−92 (Pb−Free)	2000 Ammo Pack
MC78L12ACPRP			TO−92	2000 Ammo Pack
MC78L12ACPRPG			TO−92 (Pb−Free)	2000 Ammo Pack

*NCV78L12A: T_{low} = −40°C, T_{high} = +125°C. Guaranteed by design. NCV prefix is for automotive and other applications requiring site and change control.
†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.

ORDERING INFORMATION (continued)

Device	Output Voltage	Operating Temperature Range	Package	Shipping†
MC78L15ABD	15 V	T_J = −40° to +125°C	SOIC−8	98 Units/Rail
MC78L15ABDG			SOIC−8 (Pb−Free)	98 Units/Rail
MC78L15ABDR2			SOIC−8	2500 Tape & Reel
MC78L15ABDR2G			SOIC−8 (Pb−Free)	2500 Tape & Reel
NCV78L15ABDR2G*			SOIC−8 (Pb−Free)	2500 Tape & Reel
MC78L15ABP			TO−92	2000 Units/Bag
MC78L15ABPG			TO−92 (Pb−Free)	2000 Units/Bag
MC78L15ABPRA			TO−92	2000 Tape & Reel
MC78L15ABPRAG			TO−92 (Pb−Free)	2000 Tape & Reel
MC78L15ABPRP			TO−92	2000 Ammo Pack
MC78L15ABPRPG			TO−92 (Pb−Free)	2000 Ammo Pack
MC78L15ACD		T_J = 0° to +125°C	SOIC−8	98 Units/Rail
MC78L15ACDG			SOIC−8 (Pb−Free)	98 Units/Rail
MC78L15ACDR2			SOIC−8	2500 Tape & Reel
MC78L15ACDR2G			SOIC−8 (Pb−Free)	2500 Tape & Reel
MC78L15ACP			TO−92	2000 Units/Bag
MC78L15ACPG			TO−92 (Pb−Free)	2000 Units/Bag
MC78L15ACPRA			TO−92	2000 Tape & Reel
MC78L15ACPRAG			TO−92 (Pb−Free)	2000 Tape & Reel
MC78L15ACPRP			TO−92	2000 Ammo Pack
MC78L15ACPRPG			TO−92 (Pb−Free)	2000 Ammo Pack

*NCV78L15A: T_{low} = −40°C, T_{high} = +125°C. Guaranteed by design. NCV prefix is for automotive and other applications requiring site and change control.
†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.

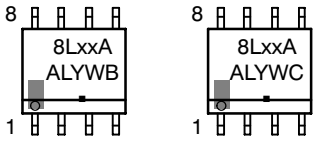
ORDERING INFORMATION (continued)

Device	Output Voltage	Operating Temperature Range	Package	Shipping†
MC78L18ABP	18 V	T_J = −40° to +125°C	TO−92	2000 Units/Bag
MC78L18ABPG			TO−92 (Pb−Free)	2000 Units/Bag
MC78L18ACP		T_J = 0° to +125°C	TO−92	2000 Units/Bag
MC78L18ACPG			TO−92 (Pb−Free)	2000 Units/Bag
MC78L18ACPRA			TO−92	2000 Tape & Reel
MC78L18ACPRAG			TO−92 (Pb−Free)	2000 Tape & Reel
MC78L18ACPRM			TO−92	2000 Ammo Pack
MC78L18ACPRMG			TO−92 (Pb−Free)	2000 Ammo Pack
MC78L18ACPRP			TO−92	2000 Ammo Pack
MC78L18ACPRPG			TO−92 (Pb−Free)	2000 Ammo Pack
MC78L24ABP	24 V	T_J = −40° to +125°C	TO−92	2000 Units/Bag
MC78L24ABPG			TO−92 (Pb−Free)	2000 Units/Bag
NCV78L24ABPRPG*			TO−92 (Pb−Free)	2000 Units/Bag
MC78L24ACP		T_J = 0° to +125°C	TO−92	2000 Units/Bag
MC78L24ACPG			TO−92 (Pb−Free)	2000 Units/Bag
MC78L24ACPRA			TO−92	2000 Tape & Reel
MC78L24ACPRAG			TO−92 (Pb−Free)	2000 Tape & Reel
MC78L24ACPRP			TO−92	2000 Ammo Pack
MC78L24ACPRPG			TO−92 (Pb−Free)	2000 Ammo Pack

†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.

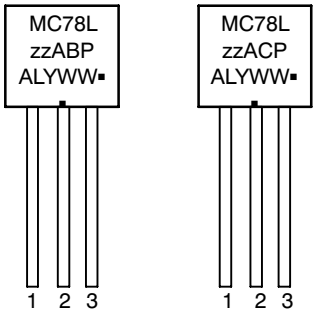
MARKING DIAGRAMS

SOIC−8
D SUFFIX
CASE 751



xx = 05, 08, 09, 12, or 15
A = Assembly Location
L = Wafer Lot
Y = Year
W = Work Week
B, C = Temperature Range
▪ = Pb−Free Package

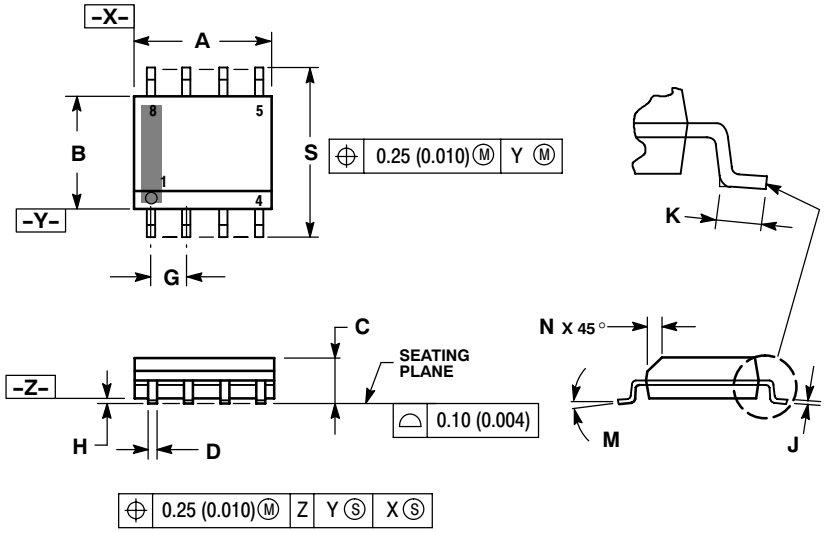
TO−92
P SUFFIX
CASE 029



zz = 05, 08, 09, 12, 15, 18 or 24
A = Assembly Location
L = Wafer Lot
Y = Year
WW = Work Week
▪ = Pb−Free Package
(Note: Microdot may be in either location)

PACKAGE DIMENSIONS

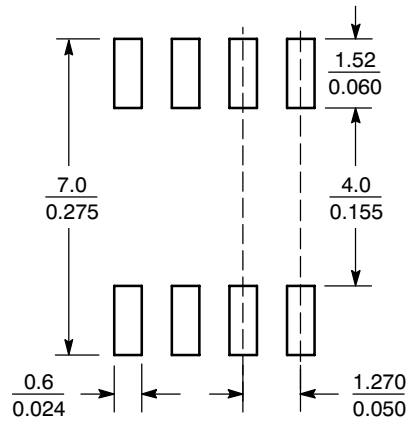
SOIC−8 NB
D SUFFIX
CASE 751−07
ISSUE AJ



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.
6. 751−01 THRU 751−06 ARE OBSOLETE. NEW STANDARD IS 751−07.

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	4.80	5.00	0.189	0.197
B	3.80	4.00	0.150	0.157
C	1.35	1.75	0.053	0.069
D	0.33	0.51	0.013	0.020
G	1.27 BSC		0.050 BSC	
H	0.10	0.25	0.004	0.010
J	0.19	0.25	0.007	0.010
K	0.40	1.27	0.016	0.050
M	0 °	8 °	0 °	8 °
N	0.25	0.50	0.010	0.020
S	5.80	6.20	0.228	0.244

SOLDERING FOOTPRINT*

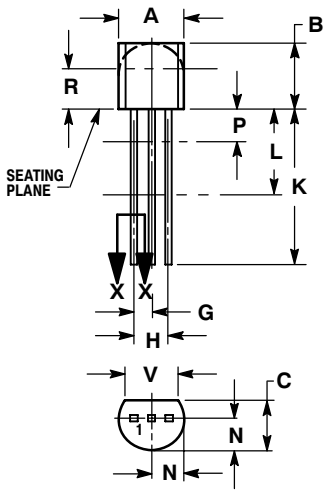


SCALE 6:1 (mm / inches)

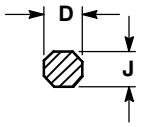
*For additional information on our Pb−Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

PACKAGE DIMENSIONS

TO−92 (TO−226)
P SUFFIX
CASE 29−11
ISSUE AM



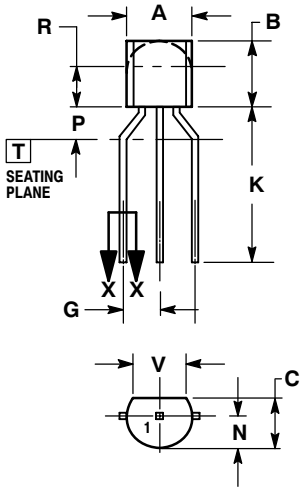
STRAIGHT LEAD
BULK PACK



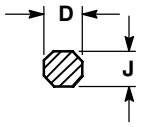
SECTION X−X

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. CONTOUR OF PACKAGE BEYOND DIMENSION R IS UNCONTROLLED.
4. LEAD DIMENSION IS UNCONTROLLED IN P AND BEYOND DIMENSION K MINIMUM.

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.175	0.205	4.45	5.20
B	0.170	0.210	4.32	5.33
C	0.125	0.165	3.18	4.19
D	0.016	0.021	0.407	0.533
G	0.045	0.055	1.15	1.39
H	0.095	0.105	2.42	2.66
J	0.015	0.020	0.39	0.50
K	0.500	---	12.70	---
L	0.250	---	6.35	---
N	0.080	0.105	2.04	2.66
P	---	0.100	---	2.54
R	0.115	---	2.93	---
V	0.135	---	3.43	---



BENT LEAD
TAPE & REEL
AMMO PACK



SECTION X−X

NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. CONTOUR OF PACKAGE BEYOND DIMENSION R IS UNCONTROLLED.
4. LEAD DIMENSION IS UNCONTROLLED IN P AND BEYOND DIMENSION K MINIMUM.

	MILLIMETERS	
DIM	MIN	MAX
A	4.45	5.20
B	4.32	5.33
C	3.18	4.19
D	0.40	0.54
G	2.40	2.80
J	0.39	0.50
K	12.70	---
N	2.04	2.66
P	1.50	4.00
R	2.93	---
V	3.43	---

PUBLICATION ORDERING INFORMATION

LITERATURE FULFILLMENT:
Literature Distribution Center for ON Semiconductor
P.O. Box 5163, Denver, Colorado 80217 USA
Phone: 303−675−2175 or 800−344−3860 Toll Free USA/Canada
Fax: 303−675−2176 or 800−344−3867 Toll Free USA/Canada
Email: orderlit@onsemi.com

N. American Technical Support: 800−282−9855 Toll Free USA/Canada
Europe, Middle East and Africa Technical Support:
Phone: 421 33 790 2910
Japan Customer Focus Center
Phone: 81−3−5773−3850

ON Semiconductor Website: **www.onsemi.com**

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

For additional information, please contact your loca
Sales Representative

MC79L00A Series

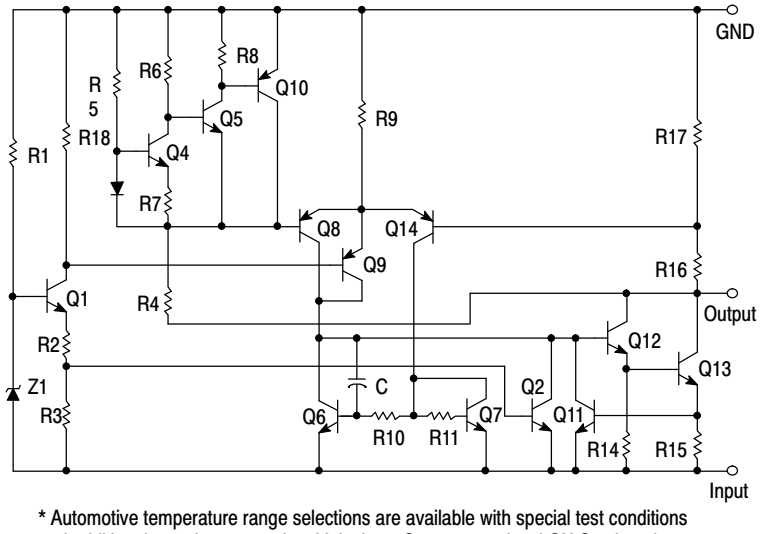
100 mA Negative Voltage Regulators

The MC79L00A Series negative voltage regulators are inexpensive, easy−to−use devices suitable for numerous applications requiring up to 100 mA. Like the higher powered MC7900 Series negative regulators, this series features thermal shutdown and current limiting, making them remarkably rugged. In most applications, no external components are required for operation.

The MC79L00A devices are useful for on−card regulation or any other application where a regulated negative voltage at a modest current level is needed. These regulators offer substantial advantage over the common resistor/Zener diode approach.

Features

- No External Components Required
- Internal Short Circuit Current Limiting
- Internal Thermal Overload Protection
- Low Cost
- Complementary Positive Regulators Offered (MC78L00 Series)
- Pb−Free Packages are Available



* Automotive temperature range selections are available with special test conditions and additional tests in 5, 12 and 15 V devices. Contact your local ON Semiconductor sales office for information.

Figure 1. Representative Schematic Diagram

ON Semiconductor®

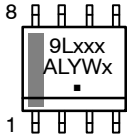
http://onsemi.com

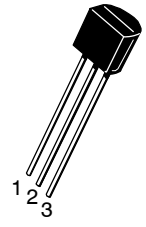
THREE−TERMINAL LOW CURRENT NEGATIVE FIXED VOLTAGE REGULATORS

MARKING DIAGRAMS

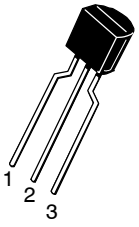
SOIC−8
D SUFFIX
CASE 751

Pin 1. V_{out}
2. V_{in}
3. V_{in}
4. NC
5. GND
6. V_{in}
7. V_{in}
8. NC





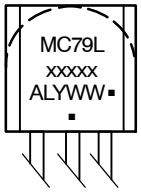
STRAIGHT LEAD
BULK PACK



BENT LEAD
TAPE & REEL
AMMO PACK

TO−92
P SUFFIX
CASE 29

Pin 1. Ground
2. Input
3. Output



xxx	= Specific Device Code
A	= Assembly Location
L	= Wafer Lot
Y	= Year
W, WW	= Work Week
y	= B or C
▪	= Pb−Free Package

(Note: Microdot may be in either location)

ORDERING INFORMATION

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

MAXIMUM RATINGS (T_A = +25°C, unless otherwise noted.)

Rating	Symbol	Value	Unit
Input Voltage (–5 V) (–12, –15, –18 V) (–24 V)	V_I	–30 –35 –40	Vdc
Power Dissipation Case 29 (TO–92 Type) T_A = 25°C Thermal Resistance, Junction–to–Ambient Thermal Resistance, Junction–to–Case Case 751 (SOIC–8 Type) (Note 1) T_A = 25°C Thermal Resistance, Junction–to–Ambient Thermal Resistance, Junction–to–Case	 PD $R_{\theta JA}$ $R_{\theta JC}$ PD $R_{\theta JA}$ $R_{\theta JC}$	 Internally Limited 160 83 Internally Limited 180 45	 W °C/W °C/W W °C/W °C/W
Storage Temperature Range	T_{stg}	–65 to +150	°C
Junction Temperature	T_J	+150	°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. SOIC–8 Junction–to–Ambient Thermal Resistance is for minimum recommended pad size. Refer to Figure 9 for Thermal Resistance variation versus pad size.

*This device series contains ESD protection and exceeds the following tests:
Human Body Model 2000 V per MIL_STD_883, Method 3015
Machine Model Method 200 V.

ELECTRICAL CHARACTERISTICS (V_I = –10 V, I_O = 40 mA, C_I = 0.33 μF, C_O = 0.1 μF, –40°C < T_J +125°C (for MC79LXXAB), 0°C < T_J < +125°C (for MC79LXXAC)).

Characteristics	Symbol	MC79L05AC, AB			Unit
		Min	Typ	Max	
Output Voltage (T_J = +25°C)	V_O	–4.8	–5.0	–5.2	Vdc
Input Regulation (T_J = +25°C) –7.0 Vdc ≥ V_I ≥ –20 Vdc –8.0 Vdc ≥ V_I ≥ –20 Vdc	Reg_{line}	 – –	 – –	 150 100	mV
Load Regulation T_J = +25°C, 1.0 mA ≤ I_O ≤ 100 mA 1.0 mA ≤ I_O ≤ 40 mA	Reg_{load}	 – –	 – –	 60 30	mV
Output Voltage –7.0 Vdc ≥ V_I ≥ –20 Vdc, 1.0 mA ≤ I_O ≤ 40 mA V_I = –10 Vdc, 1.0 mA ≤ I_O ≤ 70 mA	V_O	 –4.75 –4.75	 – –	 –5.25 –5.25	Vdc
Input Bias Current (T_J = +25°C) (T_J = +125°C)	I_{IB}	 – –	 – –	 6.0 5.5	mA
Input Bias Current Change –8.0 Vdc ≥ V_I ≥ –20 Vdc 1.0 mA ≤ I_O ≤ 40 mA	I_{IB}	 – –	 – –	 1.5 0.1	mA
Output Noise Voltage (T_A = +25°C, 10 Hz ≤ f ≤ 100 kHz)	V_n	–	40	–	μV
Ripple Rejection (–8.0 ≥ V_I ≥ –18 Vdc, f = 120 Hz, T_J = +25°C)	RR	41	49	–	dB
Dropout Voltage (I_O = 40 mA, T_J = +25°C)	$\|V_I–V_O\|$	–	1.7	–	Vdc

ELECTRICAL CHARACTERISTICS (V_I = −19 V, I_O = 40 mA, C_I = 0.33 μF, C_O = 0.1 μF, −40°C < T_J +125°C (for MC79LXXAB), 0°C < T_J < +125°C (for MC79LXXAC)).

Characteristics	Symbol	MC79L12AC, AB			Unit
		Min	Typ	Max	
Output Voltage (T_J = +25°C)	V_O	−11.5	−12	−12.5	Vdc
Input Regulation (T_J = +25°C) −14.5 Vdc ≥ V_I ≥ −27 Vdc −16 Vdc ≥ V_I ≥ −27 Vdc	Reg_{line}	 – –	 – –	 250 200	mV
Load Regulation T_J = +25°C, 1.0 mA ≤ I_O ≤ 100 mA 1.0 mA ≤ I_O ≤ 40 mA	Reg_{load}	 – –	 – –	100 50	mV
Output Voltage −14.5 Vdc ≥ V_I ≥ −27 Vdc, 1.0 mA ≤ I_O ≤ 40 mA V_I = −19 Vdc, 1.0 mA ≤ I_O ≤ 70 mA	V_O	−11.4 −11.4	 – –	−12.6 −12.6	Vdc
Input Bias Current (T_J = +25°C) (T_J = +125°C)	I_{IB}	 – –	 – –	 6.5 6.0	mA
Input Bias Current Change −16 Vdc ≥ V_I ≥ −27 Vdc 1.0 mA ≤ I_O ≤ 40 mA	I_{IB}	 – –	 – –	1.5 0.2	mA
Output Noise Voltage (T_A = +25°C, 10 Hz ≤ f ≤ 100 kHz)	V_n	–	80	–	μV
Ripple Rejection (−15 ≤ V_I ≤ −25 Vdc, f = 120 Hz, T_J = +25°C)	RR	37	42	–	dB
Dropout Voltage (I_O = 40 mA, T_J = +25°C)	$\|V_I–V_O\|$	–	1.7	–	Vdc

ELECTRICAL CHARACTERISTICS (V_I = −23 V, I_O = 40 mA, C_I = 0.33 μF, C_O = 0.1 μF, −40°C < T_J +125°C (for MC79LXXAB), 0°C < T_J < +125°C (for MC79LXXAC)).

Characteristics	Symbol	MC79L15AC, AB			Unit
		Min	Typ	Max	
Output Voltage (T_J = +25°C)	V_O	−14.4	−15	−15.6	Vdc
Input Regulation (T_J = +25°C) −17.5 Vdc ≥ V_I ≥ −30 Vdc −20 Vdc ≥ V_I ≥ −30 Vdc	Reg_{line}	 – –	 – –	 300 250	mV
Load Regulation T_J = +25°C, 1.0 mA ≤ I_O ≤ 100 mA 1.0 mA ≤ I_O ≤ 40 mA	Reg_{load}	 – –	 – –	 150 75	mV
Output Voltage −17.5 Vdc ≥ V_I ≥ −Vdc, 1.0 mA ≤ I_O ≤ 40 mA V_I = −23 Vdc, 1.0 mA ≤ I_O ≤ 70 mA	V_O	 −14.25 −14.25	 – –	 −15.75 −15.75	Vdc
Input Bias Current (T_J = +25°C) (T_J = +125°C)	I_{IB}	 – –	 – –	 6.5 6.0	mA
Input Bias Current Change −20 Vdc ≥ V_I ≥ −30 Vdc 1.0 mA ≤ I_O ≤ 40 mA	ΔI_{IB}	 – –	 – –	 1.5 0.1	mA
Output Noise Voltage (T_A = +25°C, 10 Hz ≤ f ≤ 100 kHz)	V_N	–	90	–	μV
Ripple Rejection (−18.5 ≤ V_I ≤ −28.5 Vdc, f = 120 Hz)	RR	34	39	–	dB
Dropout Voltage I_O = 40 mA, T_J = +25°C	$\|V_I–V_O\|$	–	1.7	–	Vdc

ELECTRICAL CHARACTERISTICS (V_I = −27 V, I_O = 40 mA, C_I = 0.33 μF, C_O = 0.1 μF, −40°C < T_J +125°C (for MC79LXXAB), 0°C < T_J < +125°C (for MC79LXXAC), unless otherwise noted).

Characteristics	Symbol	MC79L18AC			Unit
		Min	Typ	Max	
Output Voltage (T_J = +25°C)	V_O	−17.3	−18	−18.7	Vdc
Input Regulation (T_J = +25°C) −20.7 Vdc ≥ V_I ≥ −33 Vdc −21.4 Vdc ≥ V_I ≥ −33 Vdc −22 Vdc ≥ V_I ≥ −33 Vdc −21 Vdc ≥ V_I ≥ −33 Vdc	Reg_{line}	 – – – –	 – – – –	 325 – – 275	mV
Load Regulation T_J = +25°C, 1.0 mA ≤ I_O ≤ 100 mA 1.0 mA ≤ I_O ≤ 40 mA	Reg_{load}	 – –	 – –	 170 85	mV
Output Voltage −20.7 Vdc ≥ V_I ≥ −33 Vdc, 1.0 mA ≤ I_O ≤ 40 mA −21.4 Vdc ≥ V_I ≥ −33 Vdc, 1.0 mA ≤ I_O ≤ 40 mA V_I = −27 Vdc, 1.0 mA ≤ I_O ≤ 70 mA	V_O	 −17.1 – −17.1	 – – –	 −18.9 – −18.9	Vdc
Input Bias Current (T_J = +25°C) (T_J = +125°C)	I_{IB}	 – –	 – –	 6.5 6.0	mA
Input Bias Current Change −21 Vdc ≥ V_I ≥ −33 Vdc −27 Vdc ≥ V_I ≥ −33 Vdc 1.0 mA ≤ I_O ≤ 40 mA	I_{IB}	 – – –	 – – –	 1.5 – 0.1	mA
Output Noise Voltage (T_A = +25°C, 10 Hz ≤ f ≤ 100 kHz)	V_n	–	150	–	μV
Ripple Rejection (−23 ≤ V_I ≤ −33 Vdc, f = 120 Hz, T_J = +25°C)	RR	33	48	–	dB
Dropout Voltage I_O = 40 mA, T_J = +25°C	$\|V_I - V_O\|$	–	1.7	–	Vdc

ELECTRICAL CHARACTERISTICS (V_I = −33 V, I_O = 40 mA, C_I = 0.33 μF, C_O = 0.1 μF, −40°C < T_J +125°C (for MC79LXXAB), 0°C < T_J < +125°C (for MC79LXXAC), unless otherwise noted).

Characteristics	Symbol	MC79L24AC			Unit
		Min	Typ	Max	
Output Voltage (T_J = +25°C)	V_O	−23	−24	−25	Vdc
Input Regulation (T_J = +25°C) −27 Vdc ≥ V_I ≥ −38 Vdc −27.5 Vdc ≥ V_I ≥ −38 Vdc −28 Vdc ≥ V_I ≥ −38 Vdc	Reg_{line}	 – – –	 – – –	 350 – 300	mV
Load Regulation T_J = +25°C, 1.0 mA ≤ I_O ≤ 100 mA 1.0 mA ≤ I_O ≤ 40 mA	Reg_{load}	 – –	 – –	 200 100	mV
Output Voltage −27 Vdc ≥ V_I ≥ −38 V, 1.0 mA ≤ I_O ≤ 40 mA −28 Vdc ≥ V_I ≥ −38 Vdc, 1.0 mA ≤ I_O ≤ 40 mA V_I = −33 Vdc, 1.0 mA ≤ I_O ≤ 70 mA	V_O	 −22.8 – −22.8	 – – –	 −25.2 – −25.2	Vdc
Input Bias Current (T_J = +25°C) (T_J = +125°C)	I_{IB}	 – –	 – –	 6.5 6.0	mA
Input Bias Current Change −28 Vdc ≥ V_I ≥ −38 Vdc 1.0 mA ≤ I_O ≤ 40 mA	ΔI_{IB}	 – –	 – –	 1.5 0.1	mA
Output Noise Voltage (T_A = +25°C, 10 Hz ≤ f ≤ 100 kHz)	V_n	–	200	–	μV
Ripple Rejection (−29 ≤ V_I ≤ −35 Vdc, f = 120 Hz, T_J = +25°C)	RR	31	47	–	dB
Dropout Voltage I_O = 40 mA, T_J = +25°C	$\|V_I - V_O\|$	–	1.7	–	Vdc

APPLICATIONS INFORMATION

Design Considerations

The MC79L00A Series of fixed voltage regulators are designed with Thermal Overload Protections that shuts down the circuit when subjected to an excessive power overload condition, Internal Short Circuit Protection that limits the maximum current the circuit will pass.

In many low current applications, compensation capacitors are not required. However, it is recommended that the regulator input be bypassed with a capacitor if the regulator is connected to the power supply filter with long wire length, or if the output load capacitance is large. An input bypass capacitor should be selected to provide good high−frequency characteristics to insure stable operation under all load conditions. A 0.33 μF or larger tantalum, mylar, or other capacitor having low internal impedance at high frequencies should be chosen. The bypass capacitor should be mounted with the shortest possible leads directly across the regulator's input terminals. Normally good construction techniques should be used to minimize ground loops and lead resistance drops since the regulator has no external sense lead. Bypassing the output is also recommended.

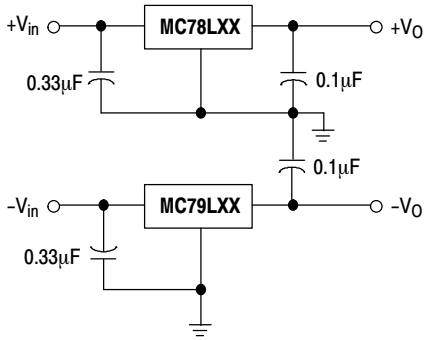
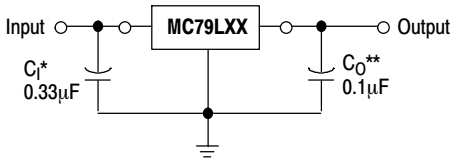


Figure 2. Positive and Negative Regulator



A common ground is required between the input and the output voltages. The input voltage must remain typically 2.0 V above the output voltage even during the low point on the ripple voltage.

* C_I is required if regulator is located an appreciable distance from the power supply filter

** C_O improves stability and transient response.

Figure 3. Standard Application

TYPICAL CHARACTERISTICS

(T_A = +25°C, unless otherwise noted.)

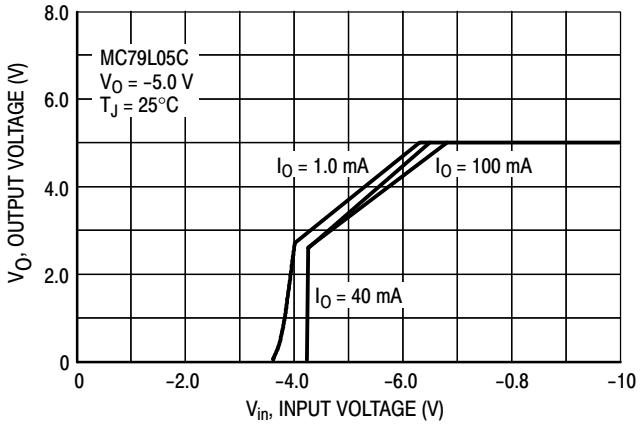


Figure 4. Dropout Characteristics

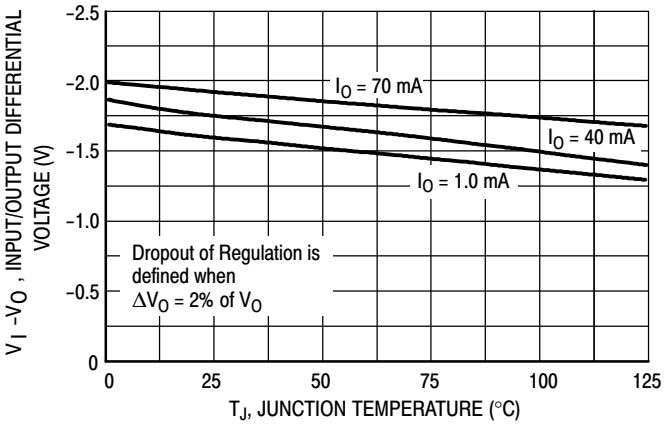


Figure 5. Dropout Voltage versus Junction Temperature

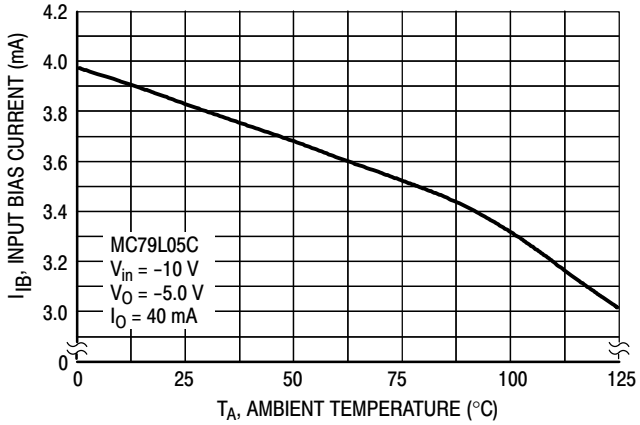


Figure 6. Input Bias Current versus Ambient Temperature

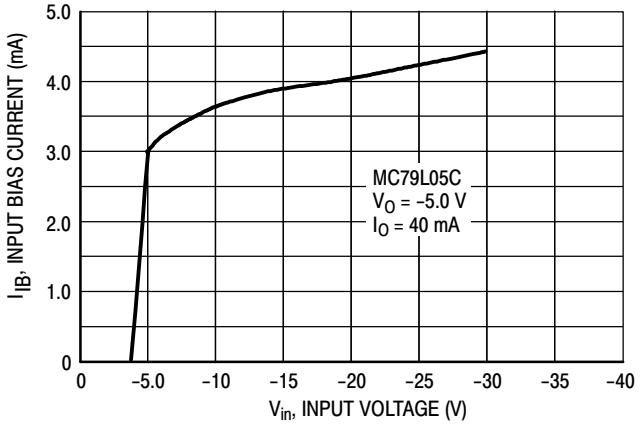


Figure 7. Input Bias Current versus Input Voltage

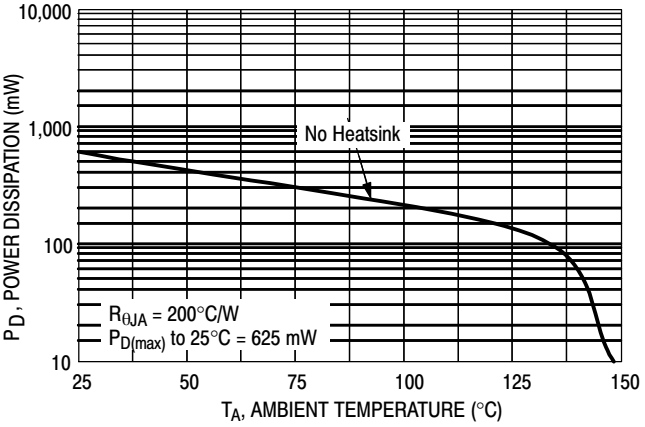


Figure 8. Maximum Average Power Dissipation versus Ambient Temperature (TO−92)

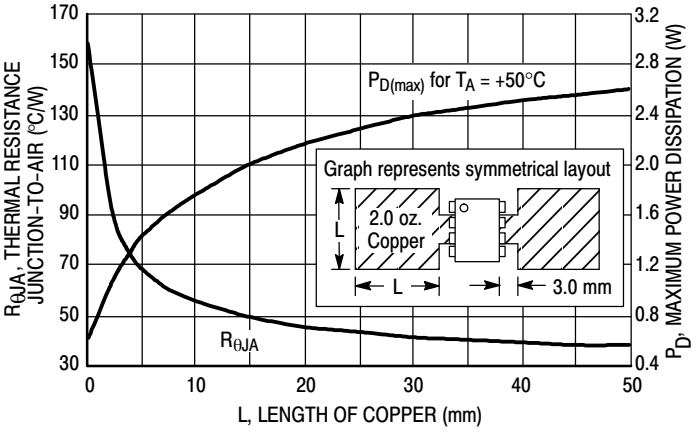


Figure 9. SOP−8 Thermal Resistance and Maximum Power Dissipation versus P.C.B. Copper Length

ORDERING INFORMATION

Device	Nominal Voltage	Operating Temperature Range	Package	Shipping†
MC79L05ABD	−5.0 V	TJ = −40° to +125°C	SOIC−8	98 Units / Rail
MC79L05ABDG			SOIC−8 (Pb−Free)	98 Units / Rail
MC79L05ABDR2			SOIC−8	2500 / Tape & Reel
MC79L05ABDR2G			SOIC−8 (Pb−Free)	2500 / Tape & Reel
MC79L05ABP			TO−92	2000 Units / Bag
MC79L05ABPG			TO−92 (Pb−Free)	2000 Units / Bag
MC79L05ABPRA			TO−92	2000 / Tape & Reel
MC79L05ABPRAG			TO−92 (Pb−Free)	2000 / Tape & Reel
MC79L05ACD		TJ = 0° to +125°C	SOIC−8	98 Units / Rail
MC79L05ACDG			SOIC−8 (Pb−Free)	98 Units / Rail
MC79L05ACDR2			SOIC−8	2500 / Tape & Reel
MC79L05ACDR2G			SOIC−8 (Pb−Free)	2500 / Tape & Reel
MC79L05ACP			TO−92	2000 Units / Bag
MC79L05ACPG			TO−92 (Pb−Free)	2000 Units / Bag
MC79L05ACPRA			TO−92	2000 / Tape & Reel
MC79L05ACPRAG			TO−92 (Pb−Free)	2000 / Tape & Reel
MC79L05ACPRM			TO−92	2000 / Tape & Ammo Box
MC79L05ACPRMG			TO−92 (Pb−Free)	2000 / Tape & Ammo Box
MC79L05ACPRP			TO−92	2000 / Tape & Ammo Box
MC79L05ACPRPG			TO−92 (Pb−Free)	2000 / Tape & Ammo Box
MC79L12ABD	−12 V	TJ = −40° to +125°C	SOIC−8	98 Units / Rail
MC79L12ABDG			SOIC−8 (Pb−Free)	98 Units / Rail
MC79L12ABDR2			SOIC−8	2500 / Tape & Reel
MC79L12ABDR2G			SOIC−8 (Pb−Free)	2500 / Tape & Reel
MC79L12ABP			TO−92	2000 Units / Bag
MC79L12ABPG			TO−92 (Pb−Free)	2000 Units / Bag
MC79L12ABPRA			TO−92	2000 / Tape & Reel
MC79L12ABPRAG			TO−92 (Pb−Free)	2000 / 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.

ORDERING INFORMATION

Device	Nominal Voltage	Operating Temperature Range	Package	Shipping†
MC79L12ACD	−12 V	TJ = 0° to +125°C	SOIC−8	98 Units / Rail
MC79L12ACDG			SOIC−8 (Pb−Free)	98 Units / Rail
MC79L12ACDR2			SOIC−8	2500 / Tape & Reel
MC79L12ACDR2G			SOIC−8 (Pb−Free)	2500 / Tape & Reel
MC79L12ACP			TO−92	2000 Units / Bag
MC79L12ACPG			TO−92 (Pb−Free)	2000 Units / Bag
MC79L12ACPRA			TO−92	2000 / Tape & Reel
MC79L12ACPRAG			TO−92 (Pb−Free)	2000 / Tape & Reel
MC79L12ACPRP			TO−92	2000 / Tape & Ammo Box
MC79L12ACPRPG			TO−92 (Pb−Free)	2000 / Tape & Ammo Box
MC79L15ABD	−15 V	TJ = −40° to +125°C	SOIC−8	98 Units / Rail
MC79L15ABDG			SOIC−8 (Pb−Free)	98 Units / Rail
MC79L15ABDR2			SOIC−8	2500 / Tape & Reel
MC79L15ABDR2G			SOIC−8 (Pb−Free)	2500 / Tape & Reel
MC79L15ABP			TO−92	2000 Units / Bag
MC79L15ABPG			TO−92 (Pb−Free)	2000 Units / Bag
MC79L15ABPRP			TO−92	2000 / Tape & Ammo Box
MC79L15ABPRPG			TO−92 (Pb−Free)	2000 / Tape & Ammo Box
MC79L15ACD		TJ = 0° to +125°C	SOIC−8	98 Units / Rail
MC79L15ACDG			SOIC−8 (Pb−Free)	98 Units / Rail
MC79L15ACDR2			SOIC−8	2500 / Tape & Reel
MC79L15ACDR2G			SOIC−8 (Pb−Free)	2500 / Tape & Reel
MC79L15ACP			TO−92	2000 Units / Bag
MC79L15ACPG			TO−92 (Pb−Free)	2000 Units / Bag
MC79L15ACPRA			TO−92	2000 / Tape & Reel
MC79L15ACPRAG			TO−92 (Pb−Free)	2000 / Tape & Reel
MC79L15ACPRE			TO−92	2000 / Tape & Reel
MC79L15ACPREG			TO−92 (Pb−Free)	2000 / Tape & Reel
MC79L15ACPRP			TO−92	2000 / Tape & Ammo Box
MC79L15ACPRPG			TO−92 (Pb−Free)	2000 / Tape & Ammo Box

†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.

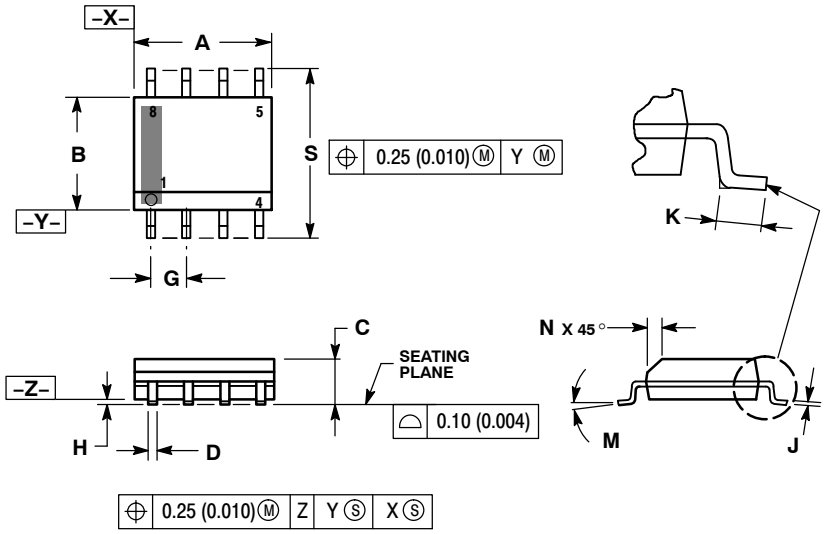
ORDERING INFORMATION

Device	Nominal Voltage	Operating Temperature Range	Package	Shipping†
MC79L18ABPRP	−18 V	TJ = −40° to +125°C	TO−92	2000 / Tape & Ammo Box
MC79L18ABPRPG			TO−92 (Pb−Free)	2000 / Tape & Ammo Box
MC79L18ACP		TJ = 0° to +125°C	TO−92	2000 Units / Bag
MC79L18ACPG			TO−92 (Pb−Free)	2000 Units / Bag
MC79L24ABP	−24 V	TJ = −40° to +125°C	TO−92	2000 Units / Bag
MC79L24ABPG			TO−92 (Pb−Free)	2000 Units / Bag
MC79L24ACP		TJ = 0° to +125°C	TO−92	2000 Units / Bag
MC79L24ACPG			TO−92 (Pb−Free)	2000 Units / Bag
MC79L24ACPRM			TO−92	2000 / Tape & Ammo Box
MC79L24ACPRMG			TO−92 (Pb−Free)	2000 / Tape & Ammo Box
MC79L24ACPRP			TO−92	2000 / Tape & Ammo Box
MC79L24ACPRPG			TO−92 (Pb−Free)	2000 / Tape & Ammo Box

†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

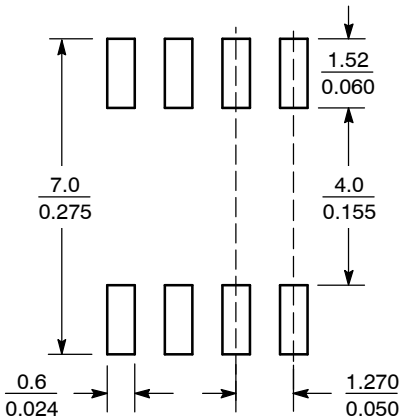
SOIC−8
CASE 751−07
ISSUE AJ



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.
6. 751−01 THRU 751−06 ARE OBSOLETE. NEW STANDARD IS 751−07.

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	4.80	5.00	0.189	0.197
B	3.80	4.00	0.150	0.157
C	1.35	1.75	0.053	0.069
D	0.33	0.51	0.013	0.020
G	1.27 BSC		0.050 BSC	
H	0.10	0.25	0.004	0.010
J	0.19	0.25	0.007	0.010
K	0.40	1.27	0.016	0.050
M	0 °	8 °	0 °	8 °
N	0.25	0.50	0.010	0.020
S	5.80	6.20	0.228	0.244

SOLDERING FOOTPRINT*

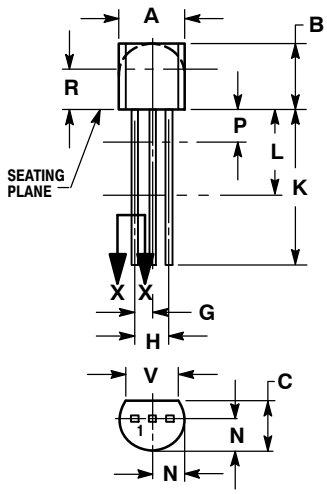


SCALE 6:1 (mm / inches)

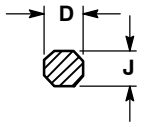
*For additional information on our Pb−Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

PACKAGE DIMENSIONS

TO−92 (TO−226)
CASE 29−11
ISSUE AM



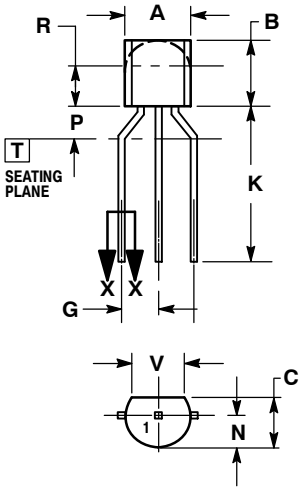
STRAIGHT LEAD
BULK PACK



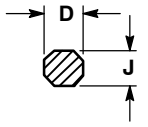
SECTION X−X

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. CONTOUR OF PACKAGE BEYOND DIMENSION R IS UNCONTROLLED.
4. LEAD DIMENSION IS UNCONTROLLED IN P AND BEYOND DIMENSION K MINIMUM.

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.175	0.205	4.45	5.20
B	0.170	0.210	4.32	5.33
C	0.125	0.165	3.18	4.19
D	0.016	0.021	0.407	0.533
G	0.045	0.055	1.15	1.39
H	0.095	0.105	2.42	2.66
J	0.015	0.020	0.39	0.50
K	0.500	---	12.70	---
L	0.250	---	6.35	---
N	0.080	0.105	2.04	2.66
P	---	0.100	---	2.54
R	0.115	---	2.93	---
V	0.135	---	3.43	---



BENT LEAD
TAPE & REEL
AMMO PACK



SECTION X−X

NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. CONTOUR OF PACKAGE BEYOND DIMENSION R IS UNCONTROLLED.
4. LEAD DIMENSION IS UNCONTROLLED IN P AND BEYOND DIMENSION K MINIMUM.

	MILLIMETERS	
DIM	MIN	MAX
A	4.45	5.20
B	4.32	5.33
C	3.18	4.19
D	0.40	0.54
G	2.40	2.80
J	0.39	0.50
K	12.70	---
N	2.04	2.66
P	1.50	4.00
R	2.93	---
V	3.43	---

PUBLICATION ORDERING INFORMATION

LITERATURE FULFILLMENT:
Literature Distribution Center for ON Semiconductor
P.O. Box 5163, Denver, Colorado 80217 USA
Phone: 303−675−2175 or 800−344−3860 Toll Free USA/Canada
Fax: 303−675−2176 or 800−344−3867 Toll Free USA/Canada
Email: orderlit@onsemi.com

N. American Technical Support: 800−282−9855 Toll Free USA/Canada
Europe, Middle East and Africa Technical Support:
Phone: 421 33 790 2910
Japan Customer Focus Center
Phone: 81−3−5773−3850

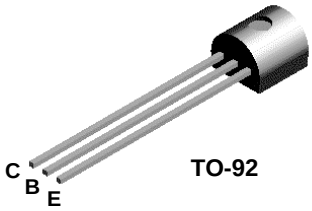
ON Semiconductor Website: **www.onsemi.com**

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

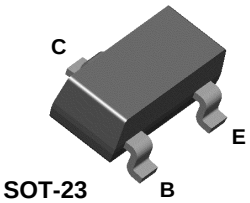
For additional information, please contact your loca
Sales Representative

FAIRCHILD
SEMICONDUCTOR TM

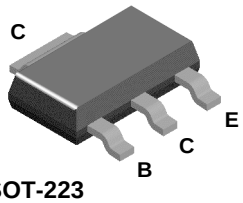
2N3904 MMBT3904 PZT3904



TO-92



SOT-23
Mark: 1A



SOT-223

NPN General Purpose Amplifier

This device is designed as a general purpose amplifier and switch. The useful dynamic range extends to 100 mA as a switch and to 100 MHz as an amplifier.

Absolute Maximum Ratings*

T_A = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	40	V
V_{CBO}	Collector-Base Voltage	60	V
V_{EBO}	Emitter-Base Voltage	6.0	V
I_C	Collector Current - Continuous	200	mA
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

T_A = 25°C unless otherwise noted

Symbol	Characteristic	Max			Units
		2N3904	*MMBT3904	**PZT3904	
P_D	Total Device Dissipation Derate above 25°C	625 5.0	350 2.8	1,000 8.0	mW mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	83.3			°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	200	357	125	°C/W

*Device mounted on FR-4 PCB 1.6" X 1.6" X 0.06."

**Device mounted on FR-4 PCB 36 mm X 18 mm X 1.5 mm; mounting pad for the collector lead min. 6 cm^2.

NPN General Purpose Amplifier
(continued)

Electrical Characteristics
T_A = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage	I_C = 1.0 mA, I_B = 0	40		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	I_C = 10 μA, I_E = 0	60		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	I_E = 10 μA, I_C = 0	6.0		V
I_{BL}	Base Cutoff Current	V_{CE} = 30 V, V_{EB} = 3V		50	nA
I_{CEX}	Collector Cutoff Current	V_{CE} = 30 V, V_{EB} = 3V		50	nA
ON CHARACTERISTICS*					
h_{FE}	DC Current Gain	I_C = 0.1 mA, V_{CE} = 1.0 V I_C = 1.0 mA, V_{CE} = 1.0 V I_C = 10 mA, V_{CE} = 1.0 V I_C = 50 mA, V_{CE} = 1.0 V I_C = 100 mA, V_{CE} = 1.0 V	40 70 100 60 30	 300 	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	I_C = 10 mA, I_B = 1.0 mA I_C = 50 mA, I_B = 5.0 mA		0.2 0.3	V V
$V_{BE(sat)}$	Base-Emitter Saturation Voltage	I_C = 10 mA, I_B = 1.0 mA I_C = 50 mA, I_B = 5.0 mA	0.65	0.85 0.95	V V
SMALL SIGNAL CHARACTERISTICS					
f_T	Current Gain - Bandwidth Product	I_C = 10 mA, V_{CE} = 20 V, f = 100 MHz	300		MHz
C_{obo}	Output Capacitance	V_{CB} = 5.0 V, I_E = 0, f = 1.0 MHz		4.0	pF
C_{ibo}	Input Capacitance	V_{EB} = 0.5 V, I_C = 0, f = 1.0 MHz		8.0	pF
NF	Noise Figure	I_C = 100 μA, V_{CE} = 5.0 V, R_S =1.0kΩ,f=10 Hz to 15.7kHz		5.0	dB
SWITCHING CHARACTERISTICS					
t_d	Delay Time	V_{CC} = 3.0 V, V_{BE} = 0.5 V, I_C = 10 mA, I_{B1} = 1.0 mA		35	ns
t_r	Rise Time			35	ns
t_s	Storage Time	V_{CC} = 3.0 V, I_C = 10mA I_{B1} = I_{B2} = 1.0 mA		200	ns
t_f	Fall Time			50	ns

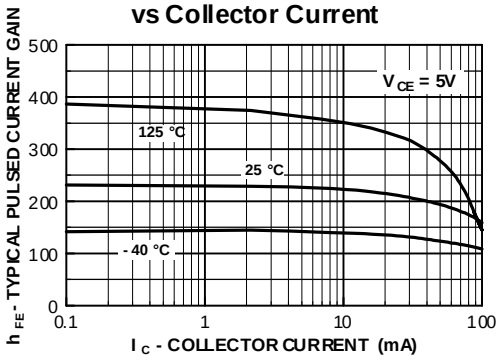
*Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%

Spice Model

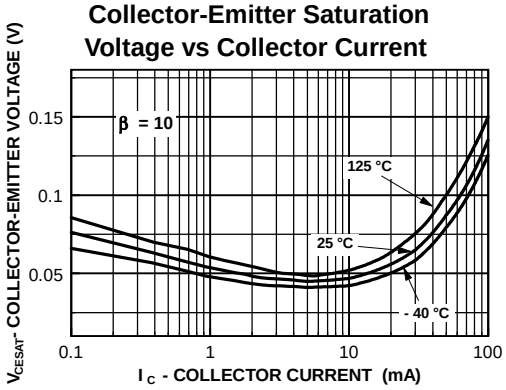
NPN (Is=6.734f Xti=3 Eg=1.11 Vaf=74.03 Bf=416.4 Ne=1.259 Ise=6.734 Ikf=66.78m Xtb=1.5 Br=.7371 Nc=2 Isc=0 Ikr=0 Rc=1 Cjc=3.638p Mjc=.3085 Vjc=.75 Fc=.5 Cje=4.493p Mje=.2593 Vje=.75 Tr=239.5n Tf=301.2p Itf=.4 Vtf=4 Xtf=2 Rb=10)

Typical Characteristics

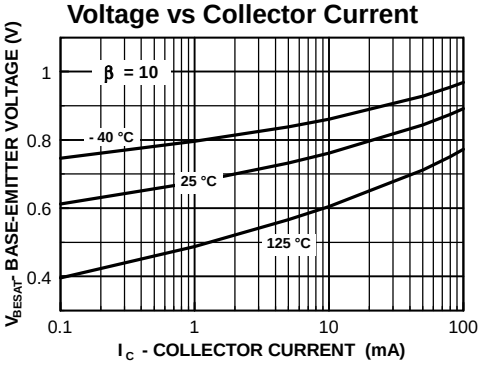
Typical Pulsed Current Gain vs Collector Current



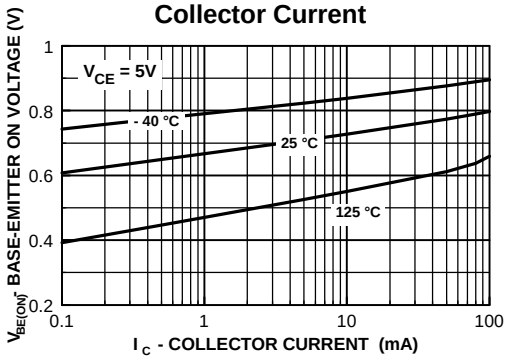
Collector-Emitter Saturation Voltage vs Collector Current



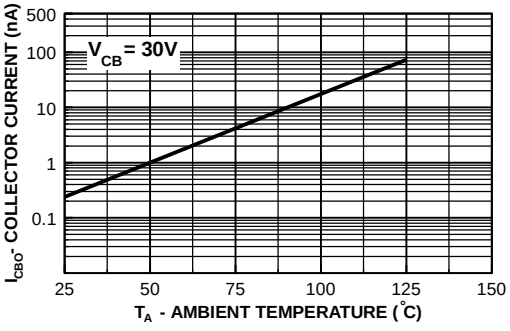
Base-Emitter Saturation Voltage vs Collector Current



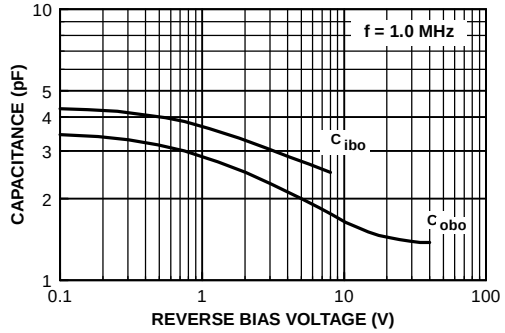
Base-Emitter ON Voltage vs Collector Current



Collector-Cutoff Current vs Ambient Temperature

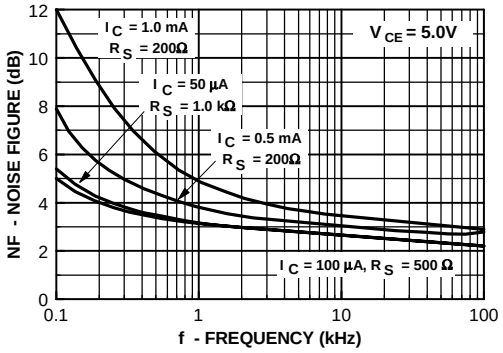


Capacitance vs Reverse Bias Voltage

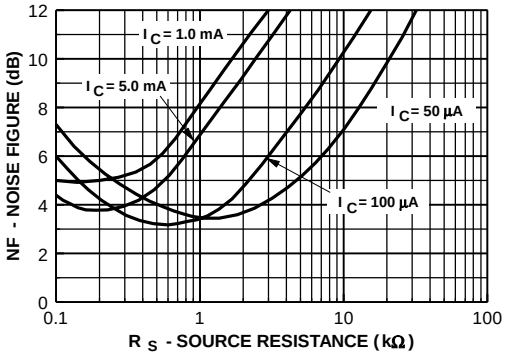


Typical Characteristics (continued)

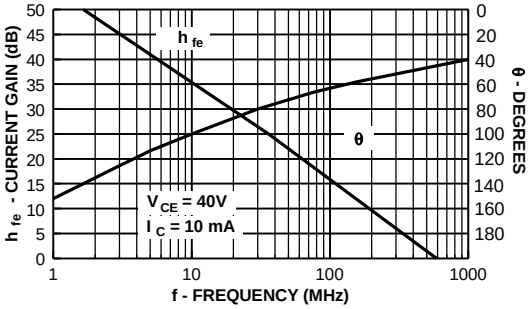
Noise Figure vs Frequency



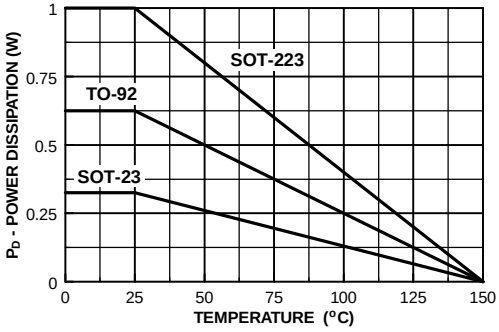
Noise Figure vs Source Resistance



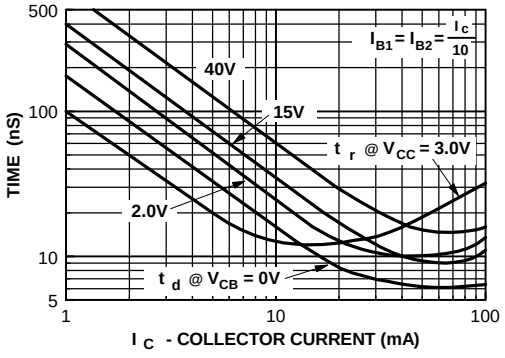
Current Gain and Phase Angle vs Frequency



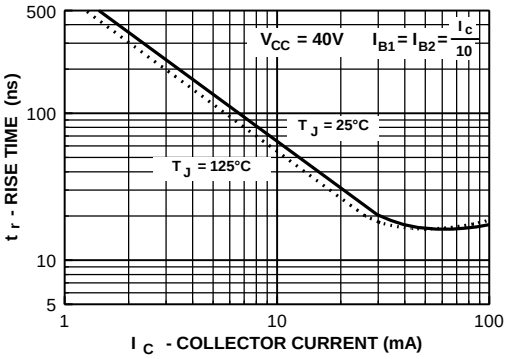
Power Dissipation vs Ambient Temperature



Turn-On Time vs Collector Current

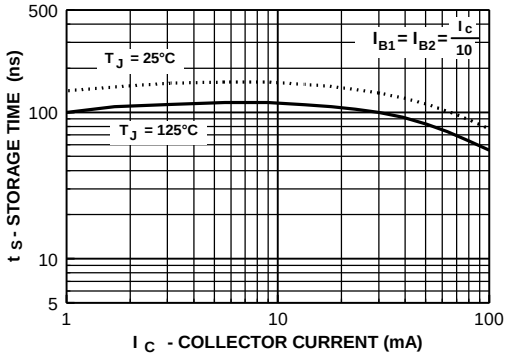


Rise Time vs Collector Current

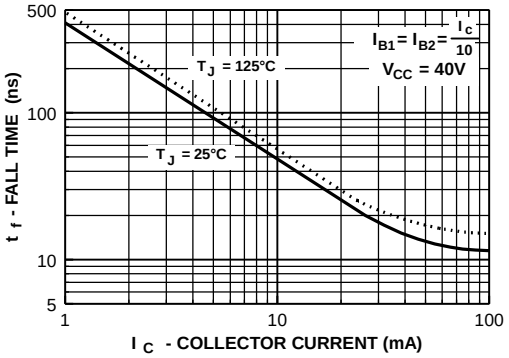


Typical Characteristics (continued)

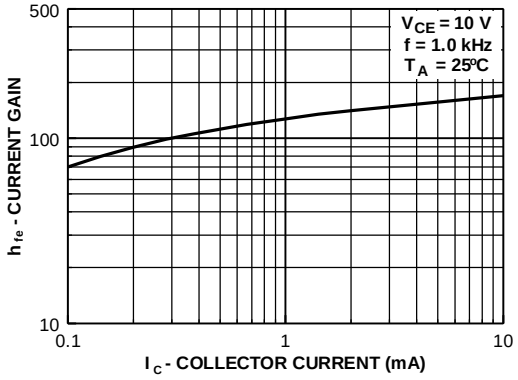
Storage Time vs Collector Current



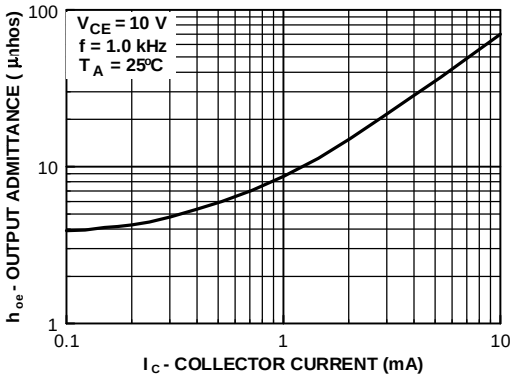
Fall Time vs Collector Current



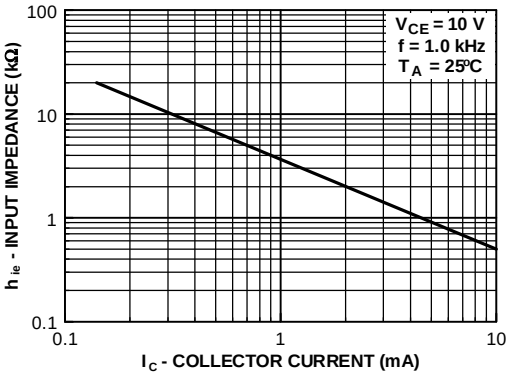
Current Gain



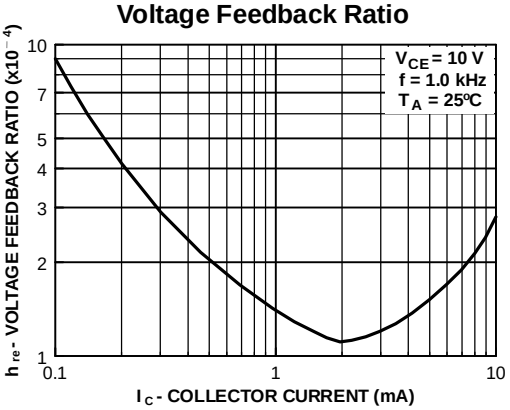
Output Admittance



Input Impedance



Voltage Feedback Ratio



Test Circuits

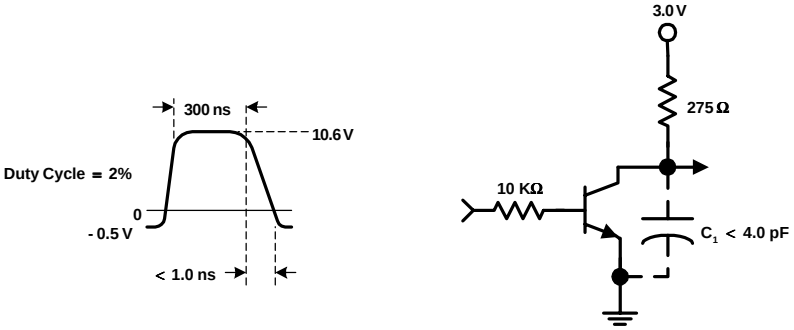


FIGURE 1: Delay and Rise Time Equivalent Test Circuit

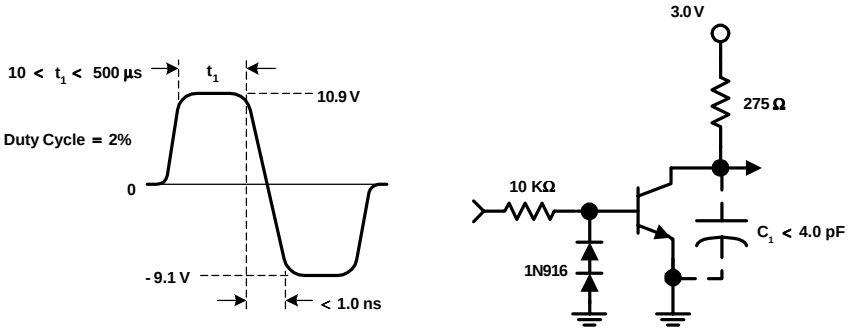


FIGURE 2: Storage and Fall Time Equivalent Test Circuit

TRADEMARKS

The following are registered and unregistered trademarks Fairchild Semiconductor owns or is authorized to use and is not intended to be an exhaustive list of all such trademarks.

ACEx™
Bottomless™
CoolFET™
CROSSVOLT™
DOME™
E^2CMOS^{TM}
EnSigna™
FACT™
FACT Quiet Series™
FAST®
FASTr™
GlobalOptoisolator™
GTO™
HiSeC™
ISOPLANAR™
MICROWIRE™
OPTOLOGIC™
OPTOPLANAR™
PACMAN™
POP™
PowerTrench®
QFET™
QS™
QT Optoelectronics™
Quiet Series™
SILENT SWITCHER®
SMART START™
SuperSOT™-3
SuperSOT™-6
SuperSOT™-8
SyncFET™
TinyLogic™
UHC™
VCX™

DISCLAIMER

FAIRCHILD SEMICONDUCTOR RESERVES THE RIGHT TO MAKE CHANGES WITHOUT FURTHER NOTICE TO ANY PRODUCTS HEREIN TO IMPROVE RELIABILITY, FUNCTION OR DESIGN. FAIRCHILD DOES NOT ASSUME ANY LIABILITY ARISING OUT OF THE APPLICATION OR USE OF ANY PRODUCT OR CIRCUIT DESCRIBED HEREIN; NEITHER DOES IT CONVEY ANY LICENSE UNDER ITS PATENT RIGHTS, NOR THE RIGHTS OF OTHERS.

LIFE SUPPORT POLICY

FAIRCHILD'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF FAIRCHILD SEMICONDUCTOR CORPORATION.
As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, or (c) whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in significant injury to the user.

2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

PRODUCT STATUS DEFINITIONS

Definition of Terms

Datasheet Identification	Product Status	Definition
Advance Information	Formative or In Design	This datasheet contains the design specifications for product development. Specifications may change in any manner without notice.
Preliminary	First Production	This datasheet contains preliminary data, and supplementary data will be published at a later date. Fairchild Semiconductor reserves the right to make changes at any time without notice in order to improve design.
No Identification Needed	Full Production	This datasheet contains final specifications. Fairchild Semiconductor reserves the right to make changes at any time without notice in order to improve design.
Obsolete	Not In Production	This datasheet contains specifications on a product that has been discontinued by Fairchild semiconductor. The datasheet is printed for reference information only.

1N4001, 1N4002, 1N4003, 1N4004, 1N4005, 1N4006, 1N4007

1N4004 and 1N4007 are Preferred Devices

Axial Lead Standard Recovery Rectifiers

This data sheet provides information on subminiature size, axial lead mounted rectifiers for general−purpose low−power applications.

Features

- Shipped in plastic bags, 1000 per bag
- Available Tape and Reeled, 5000 per reel, by adding a “RL” suffix to the part number
- Available in Fan−Fold Packaging, 3000 per box, by adding a “FF” suffix to the part number
- Pb−Free Packages are Available

Mechanical Characteristics

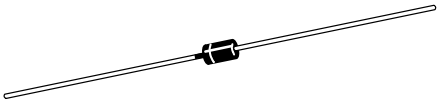
- Case: Epoxy, Molded
- Weight: 0.4 gram (approximately)
- Finish: All External Surfaces Corrosion Resistant and Terminal Leads are Readily Solderable
- Lead and Mounting Surface Temperature for Soldering Purposes: 260°C Max. for 10 Seconds, 1/16 in. from case
- Polarity: Cathode Indicated by Polarity Band

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

ON Semiconductor®

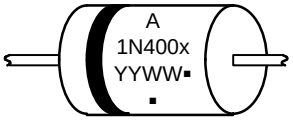
http://onsemi.com

LEAD MOUNTED RECTIFIERS 50−1000 VOLTS DIFFUSED JUNCTION



CASE 59−10
AXIAL LEAD
PLASTIC

MARKING DIAGRAM



A = Assembly Location
1N400x = Device Number
x = 1, 2, 3, 4, 5, 6 or 7
YY = Year
WW = Work Week
▪ = Pb−Free Package
(Note: Microdot may be in either location)

ORDERING INFORMATION

See detailed ordering and shipping information on page 4 of this data sheet.

Preferred devices are recommended choices for future use and best overall value.

MAXIMUM RATINGS

Rating	Symbol	1N4001	1N4002	1N4003	1N4004	1N4005	1N4006	1N4007	Unit
†Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	50	100	200	400	600	800	1000	V
†Non−Repetitive Peak Reverse Voltage (halfwave, single phase, 60 Hz)	V_{RSM}	60	120	240	480	720	1000	1200	V
†RMS Reverse Voltage	$V_{R(RMS)}$	35	70	140	280	420	560	700	V
†Average Rectified Forward Current (single phase, resistive load, 60 Hz, T_A = 75°C)	I_O	1.0							A
†Non−Repetitive Peak Surge Current (surge applied at rated load conditions)	I_{FSM}	30 (for 1 cycle)							A
Operating and Storage Junction Temperature Range	T_J T_{stg}	−65 to +175							°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.

ELECTRICAL CHARACTERISTICS†

Rating	Symbol	Typ	Max	Unit
Maximum Instantaneous Forward Voltage Drop, (i_F = 1.0 Amp, T_J = 25°C)	v_F	0.93	1.1	V
Maximum Full−Cycle Average Forward Voltage Drop, (I_O = 1.0 Amp, T_L = 75°C, 1 inch leads)	$V_{F(AV)}$	−	0.8	V
Maximum Reverse Current (rated DC voltage) (T_J = 25°C) (T_J = 100°C)	I_R	 0.05 1.0	 10 50	μA
Maximum Full−Cycle Average Reverse Current, (I_O = 1.0 Amp, T_L = 75°C, 1 inch leads)	$I_{R(AV)}$	−	30	μA

†Indicates JEDEC Registered Data

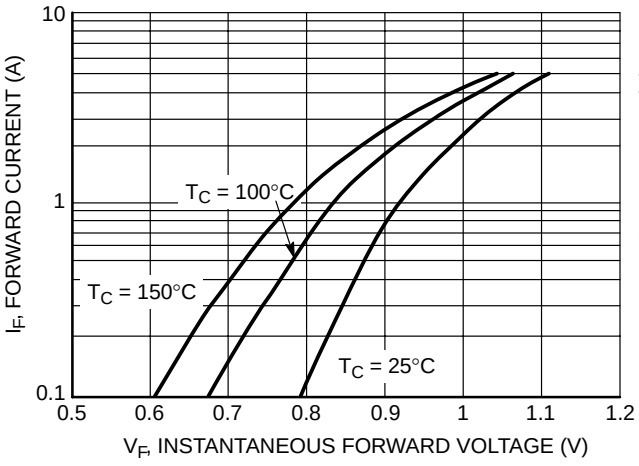


Figure 1. Typical Forward Voltage

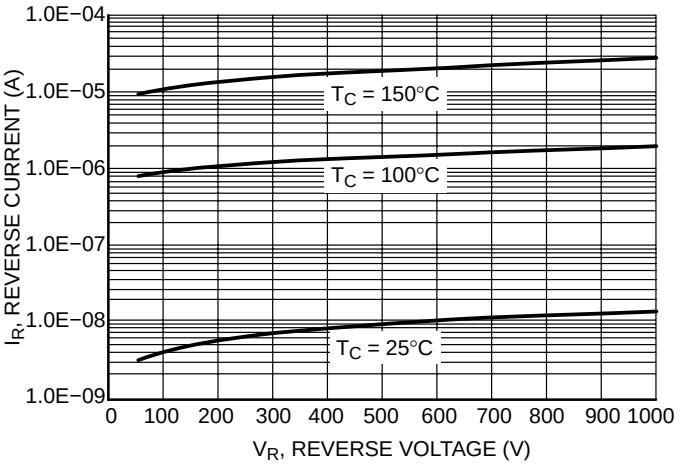


Figure 2. Typical Reverse Current

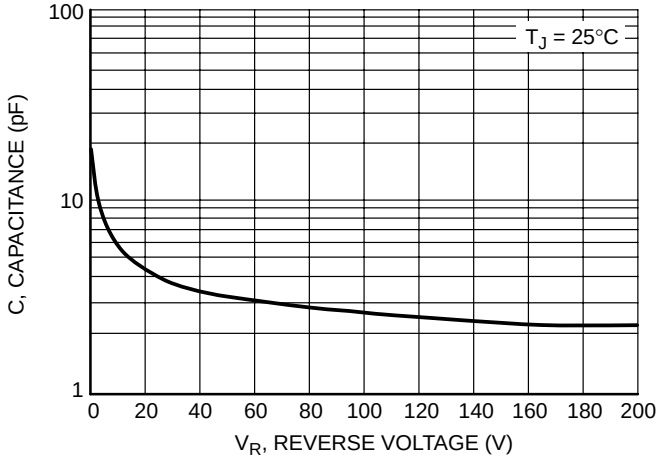


Figure 3. Typical Capacitance

ORDERING INFORMATION

Device	Package	Shipping†
1N4001	Axial Lead*	1000 Units/Bag
1N4001G	Axial Lead* (Pb−Free)	1000 Units/Bag
1N4001FF	Axial Lead*	3000 Units/Box
1N4001FFG	Axial Lead* (Pb−Free)	3000 Units/Box
1N4001RL	Axial Lead*	5000/Tape & Reel
1N4001RLG	Axial Lead* (Pb−Free)	5000/Tape & Reel
1N4002	Axial Lead*	1000 Units/Bag
1N4002G	Axial Lead* (Pb−Free)	1000 Units/Bag
1N4002FF	Axial Lead*	3000 Units/Box
1N4002FFG	Axial Lead* (Pb−Free)	3000 Units/Box
1N4002RL	Axial Lead*	5000/Tape & Reel
1N4002RLG	Axial Lead* (Pb−Free)	5000/Tape & Reel
1N4003	Axial Lead*	1000 Units/Bag
1N4003G	Axial Lead* (Pb−Free)	1000 Units/Bag
1N4003FF	Axial Lead*	3000 Units/Box
1N4003FFG	Axial Lead* (Pb−Free)	3000 Units/Box
1N4003RL	Axial Lead*	5000/Tape & Reel
1N4003RLG	Axial Lead* (Pb−Free)	5000/Tape & Reel
1N4004	Axial Lead*	1000 Units/Bag
1N4004G	Axial Lead* (Pb−Free)	1000 Units/Bag
1N4004FF	Axial Lead*	3000 Units/Box
1N4004FFG	Axial Lead* (Pb−Free)	3000 Units/Box
1N4004RL	Axial Lead*	5000/Tape & Reel
1N4004RLG	Axial Lead* (Pb−Free)	5000/Tape & Reel
1N4005	Axial Lead*	1000 Units/Bag
1N4005G	Axial Lead* (Pb−Free)	1000 Units/Bag
1N4005FF	Axial Lead*	3000 Units/Box
1N4005FFG	Axial Lead* (Pb−Free)	3000 Units/Box
1N4005RL	Axial Lead*	5000/Tape & Reel
1N4005RLG	Axial Lead* (Pb−Free)	5000/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.
*This package is inherently Pb−Free.

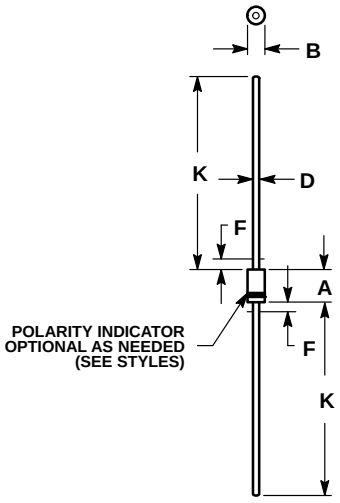
ORDERING INFORMATION

Device	Package	Shipping†
1N4006	Axial Lead*	1000 Units/Bag
1N4006G	Axial Lead* (Pb−Free)	1000 Units/Bag
1N4006FF	Axial Lead*	3000 Units/Box
1N4006FFG	Axial Lead* (Pb−Free)	3000 Units/Box
1N4006RL	Axial Lead*	5000/Tape & Reel
1N4006RLG	Axial Lead* (Pb−Free)	5000/Tape & Reel
1N4007	Axial Lead*	1000 Units/Bag
1N4007G	Axial Lead* (Pb−Free)	1000 Units/Bag
1N4007FF	Axial Lead*	3000 Units/Box
1N4007FFG	Axial Lead* (Pb−Free)	3000 Units/Box
1N4007RL	Axial Lead*	5000/Tape & Reel
1N4007RLG	Axial Lead* (Pb−Free)	5000/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.
*This package is inherently Pb−Free.

PACKAGE DIMENSIONS

AXIAL LEAD
CASE 59−10
ISSUE U



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. ALL RULES AND NOTES ASSOCIATED WITH JEDEC DO−41 OUTLINE SHALL APPLY
4. POLARITY DENOTED BY CATHODE BAND.
5. LEAD DIAMETER NOT CONTROLLED WITHIN F DIMENSION.

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.161	0.205	4.10	5.20
B	0.079	0.106	2.00	2.70
D	0.028	0.034	0.71	0.86
F	−−−	0.050	−−−	1.27
K	1.000	−−−	25.40	−−−

PUBLICATION ORDERING INFORMATION

LITERATURE FULFILLMENT:
Literature Distribution Center for ON Semiconductor
P.O. Box 61312, Phoenix, Arizona 85082−1312 USA
Phone: 480−829−7710 or 800−344−3860 Toll Free USA/Canada
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

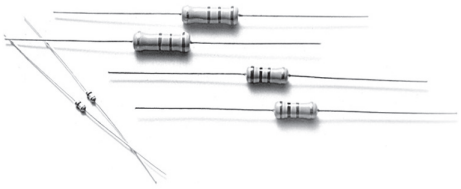
For additional information, please contact your local Sales Representative.

1N4001/D

Carbon Film Resistors

CFR Type

Normal & Miniature Style [CFR Series]



INTRODUCTION

The CFR Series Carbon Film Resistors are manufactured by coating a homogeneous film of pure carbon on high grade ceramic rods. After a helical groove has been cut in the resistive layer, tinned connecting leads of electrolytic copper are welded to the end-caps. The resistors are coated with layers of tan color lacquer.

FEATURES

Power Rating	1/6W, 1/4W, 1/2W, 1W, 2W, 3W
Resistance Tolerance	±2%, ±5%
T.C.R.	see Table 1

DERATING CURVE

For resistors operated in ambient temperatures above 70°C, power rating must be derated in accordance with the curve below.

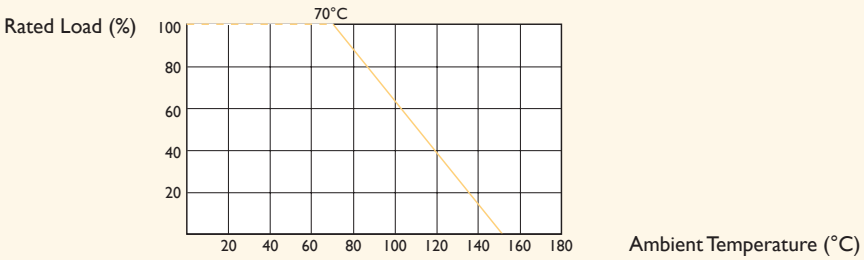
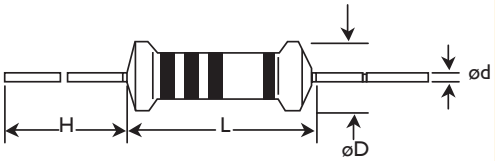


TABLE 1 TEMPERATURE COEFFICIENT

STYLE	Max. Value of Temp. Coefficient ppm/°C		
	under 100KΩ	100KΩ ~ 1MΩ	1MΩ ~ 10MΩ
CFR100, CFR200, CFR2WS, CFR3WS	±350	-500	-1500
CFR-12, CFR-25, CFR-50, CFR25S, CFR50S, CFR1WS	+350 - 500	-700	-1500

DIMENSIONS

Unit : mm



STYLE		DIMENSION			
Normal	Miniature	L	øD	H	ød
CFR-12	CFR25S	3.4±0.3	1.9±0.2	28±2.0	0.45±0.05
CFR-25	CFR50S	6.3±0.5	2.4±0.2	28±2.0	0.55±0.05
CFR-50	CFR1WS	9.0±0.5	3.3±0.3	26±2.0	0.55±0.05
CFR100	CFR2WS	11.5±1.0	4.5±0.5	35±2.0	0.8±0.05
CFR200	CFR3WS	15.5±1.0	5.0±0.5	33±2.0	0.8±0.05

Note :

ELECTRICAL CHARACTERISTICS

STYLE	CFR-12	CFR25S	CFR-25	CFR50S	CFR-50	CFR1WS	CFR100	CFR2WS	CFR200	CFR3WS
Power Rating at 70 °C	1/6W	1/4W		1/2W		1W		2W		3W
Maximum Working Voltage	150V	200V	250V	300V	350V	400V	500V			
Maximum Overload Voltage	300V	400V	500V	600V	700V	800V	1000V			
Dielectric Withstanding Voltage	300V	400V	500V			700V	1000V			
Resistance Range	1Ω ~ 10MΩ & 0Ω for E24 series value									
Operating Temp. Range	-55°C to + 155°C									
Temperature Coefficient	see Table 1									

* Below or over this resistance range on request.

ENVIRONMENTAL CHARACTERISTICS

PERFORMANCE TEST	TEST METHOD		APPRAISE
Short Time Overload	JIS-C-5202 5.5	2.5 Times RCWV for 5 Seconds	±(0.75%+0.05Ω)
Dielectric Withstanding Voltage	JIS-C-5202 5.7	in V-Block for 60 Seconds	by Type
Temperature Coefficient	JIS-C-5202 5.2	55°C to +155°C	by Type
Insulation Resistance	JIS-C-5202 5.6	in V-Block	>1000MΩ
Solderability	JIS-C-5202 6.5	260°C ±5°C for 5 ±0.5 Seconds	95% Min. Coverage
Resistance to Solvent	JIS-C-5202 6.9	IPA for 1 Min. with Ultrasonic	No deterioration of Coatings and Markings
Terminal Strength	JIS-C-5202 6.1	Direct load for 10 Sec. In the Direction of the Terminal Leads	≧2.5kg (24.5N)
Pulse Overload	JIS-C-5202 5.8	4 Times RCWV 10000 Cycles (1 Sec. On, 25 Sec. off)	±1.0%+0.05Ω
Load Life in Humidity	JIS-C-5202 7.9	40±2°C , 90~95% RH at RCWV for 1,000 Hrs. (1.5 Hrs. on , 0.5 Hrs. off)	±3%+0.05Ω
Load Life	JIS-C-5202 7.10	70°C at RCWV for 1,000 Hrs. (1.5 Hrs. on 0.5 Hrs. off)	±3%+0.05Ω
Temperature Cycling	JIS-C-5202 7.4	-55°C→Room Temp.→+155°C→Room Temp. for 5 Cycles	±1%+0.05Ω
Resistance to Soldering Heat	JIS-C-5202 6.4	350°C ±10°C for 3±0.5 Seconds	±1%+0.05Ω

* Rated Continuous Working Voltage (RCWV)= $\sqrt{\text{Power Rating} \times \text{Resistance Value}}$

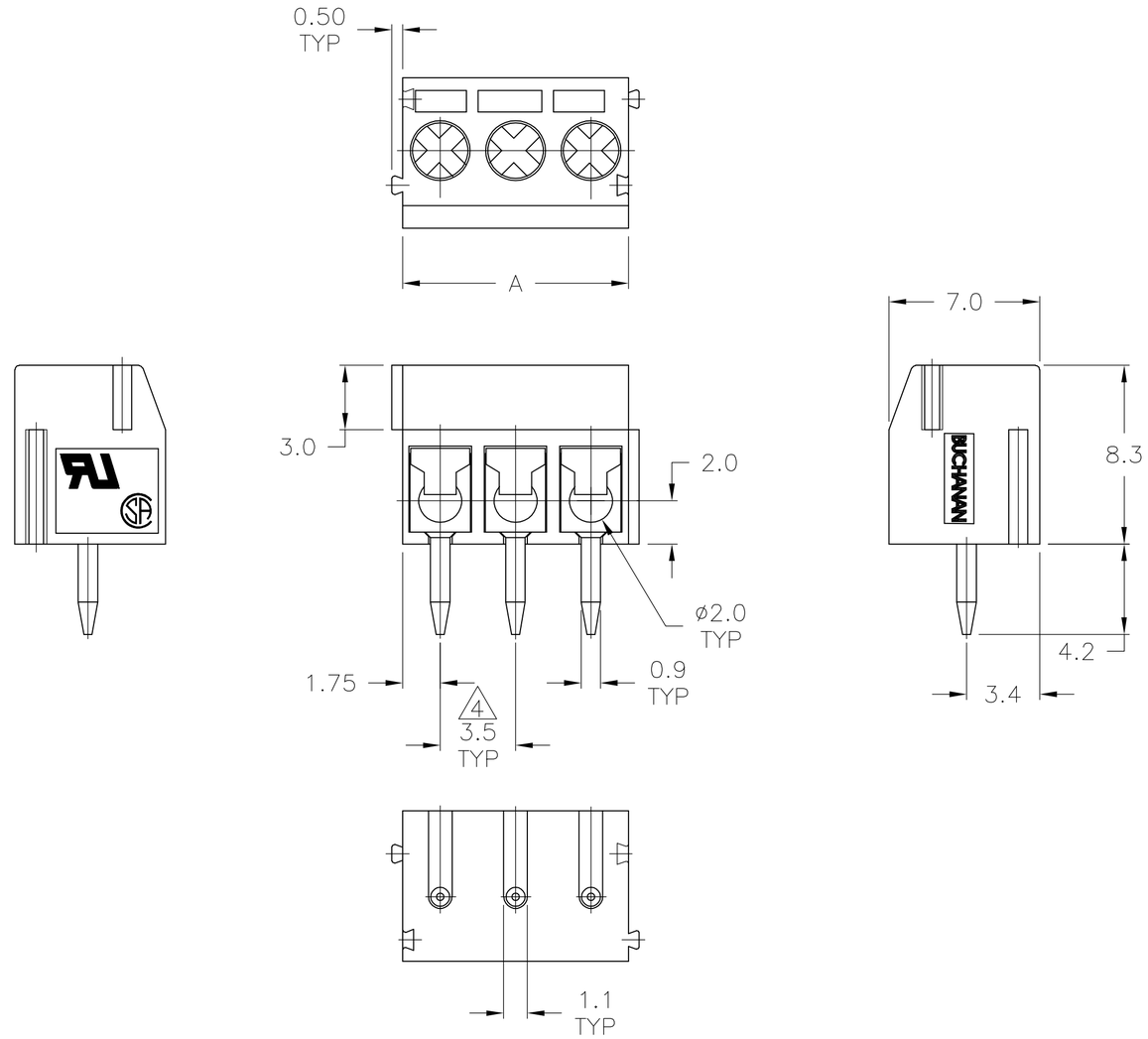
LOC	DIST
FT	0

REVISIONS

P	LTR	DESCRIPTION	DATE	DWN	APVD
	02	REVISED PER ECO-07-005217	3/6/07	SS	CR

1. ALL DIMENSIONS ARE IN MM.
2. RECOMMENDED PC BOARD HOLE DIAMETER: 1.20-1.40.
3. BUCHANAN LOGO TO APPEAR ON HOUSING LOCATION OPTIONAL WHERE SPACE PERMITS.

4 NON CUMULATIVE



HOUSING COLOR	DIM A	NO OF POSN	PART NUMBER
BLACK	42.00	12	4-1776275-2
BLACK	28.00	8	3-1776275-8
BLUE	84.00	24	2-1776275-4
BLUE	80.50	23	2-1776275-3
BLUE	77.00	22	2-1776275-2
BLUE	73.50	21	2-1776275-1
BLUE	70.00	20	2-1776275-0
BLUE	66.50	19	1-1776275-9
BLUE	28.00	18	1-1776275-8
BLUE	59.50	17	1-1776275-7
BLUE	56.00	16	1-1776275-6
BLUE	52.50	15	1-1776275-5
BLUE	49.00	14	1-1776275-4
BLUE	45.50	13	1-1776275-3
BLUE	42.00	12	1-1776275-2
BLUE	38.50	11	1-1776275-1
BLUE	35.00	10	1-1776275-0
BLUE	31.50	9	1776275-9
BLUE	28.00	8	1776275-8
BLUE	24.50	7	1776275-7
BLUE	21.00	6	1776275-6
BLUE	17.50	5	1776275-5
BLUE	14.00	4	1776275-4
BLUE	10.50	3	1776275-3
BLUE	7.00	2	1776275-2

THIS DRAWING IS A CONTROLLED DOCUMENT.

DIMENSIONS: mm

TOLERANCES UNLESS OTHERWISE SPECIFIED:
0 PLC ± -
1 PLC ± 0.3
2 PLC ± 0.25
3 PLC ± -
4 PLC ± -
ANGLES ± -

MATERIAL -
FINISH -

DWN S SCHLEGEL 5/5/05
CHK C RICHARD 5/5/05
APVD C RICHARD 5/5/05
PRODUCT SPEC -
APPLICATION SPEC -
WEIGHT -

tyco Electronics
Tyco Electronics Corporation
Harrisburg, Pa 17105-3608

NAME
TERMINAL BLOCK, PCB MOUNT, STRAIGHT SIDE WIRE ENTRY, W/ INTERLOCK, 3.5mm PITCH, HIGH TEMP

SIZE	CAGE CODE	DRAWING NO	RESTRICTED TO
A2	00779	C-1776275	-

CUSTOMER DRAWING | SCALE 4:1 | SHEET 1 OF 2 | REV 02

1776275

LOC	DIST
FT	0

REVISIONS

P	LTR	DESCRIPTION	DATE	DWN	APVD
	—	SEE SHEET 1	–	—	—

1. APPLICATION AND FEATURES:

1–1. STANDARD SIZES ARE 2 AND 3 WAY–BLOCKS, BUT EVERY NUMBER OF CONTACT CAN BE COMBINED, BY SIMPLY PLUGGING THEM TOGETHER AND CAN BE ORDERED AS REQUIRED.
1–2. WITH WIRE GUARD FOR WIRE PROTECTION SO THAT THE SCREW DOESN'T PRESS DIRECTLY ON THE WIRE.

2. TECHNICAL DATA:

2–1. MATERIAL:
2–1–1. HOUSING: NYON 6.6, UL 94 V–O, SEE TABLE.
2–1–2. METAL HOUSING: BRASS(Cu Zn) Cu, Tin plated.
2–1–3. WIRE GUARD: STAINLESS STEEL.
2–1–4. SCREW: STEEL GALVANIZED AND CHROMATIZED, M2.6.

2–2. ELECTRICAL:

2–2–1. CURRENT RATING: RATING: 7 AMPS/WAY MAX.
2–2–2. CONTACT RESISTANCE: 20mohm (MAX).
2–2–3. INSULATION RESISTANCE: 5000Mohm/1000V.
2–2–4. WITHSTANDING VOLTAGE: 1500 VAC/MIN.
2–2–5. OPERATION VOLTAGE: 250 VAC.
2–2–6. WIRE RANGE: 18–26 AWG.

2.3. MECHANICAL:

2–3–1. TORQUE: 4 Kg.cm (MAX).
2–3–3. OPERATING TEMPERATURE: –55°C to +105°C.
2–3–4. SOLDERABILITY: 95% COVERAGE (MIN).

THIS DRAWING IS A CONTROLLED DOCUMENT.

DIMENSIONS: mm

TOLERANCES UNLESS OTHERWISE SPECIFIED:
0 PLC ± –
1 PLC ± 0.3
2 PLC ± 0.25
3 PLC ± –
4 PLC ± –
ANGLES ± –

MATERIAL –
FINISH –

DWN S SCHLEGEL 5/5/05
CHK C RICHARD 5/5/05
APVD C RICHARD 5/5/05
PRODUCT SPEC —
APPLICATION SPEC —
WEIGHT —

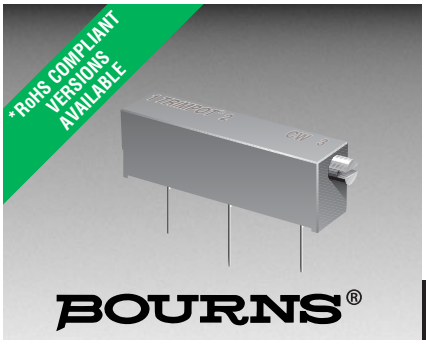
tyco Electronics
Tyco Electronics Corporation
Harrisburg, Pa 17105–3608

NAME
TERMINAL BLOCK, PCB MOUNT, STRAIGHT
SIDE WIRE ENTRY, W/ INTERLOCK,
3.5mm PITCH, HIGH TEMP

SIZE	CAGE CODE	DRAWING NO	RESTRICTED TO
A2	00779	C-1776275	—

CUSTOMER DRAWING | SCALE 4:1 | SHEET 2 OF 2 | REV 02

1776275



Features

- 3/4 " Rectangular / Multiturn Cermet / Industrial / Sealed
- Low PC board profile - only 1/4 " high
- Panel mount option available
- Transparent housing available, can be set visually without hook-up and instrumentation ("P" style only)
- RoHS compliant* version available

3006 - Trimpot® Trimming Potentiometer

Electrical Characteristics

Standard Resistance Range
.....10 to 5 megohms
(see standard resistance table)
Resistance Tolerance .....±10 % std.
(tighter tolerance available)
Absolute Minimum Resistance
.....1.0 % or 2 ohms max.
(whichever is greater)
Contact Resistance Variation
.....1.0 % or 1 ohm max.
(whichever is greater)
Adjustability
Voltage.....±0.01 %
Resistance.....±0.05 %
Resolution.....Infinite
Insulation Resistance .....500 vdc.
1,000 megohms min.
Dielectric Strength
Sea Level.....1,000 vac
80,000 Feet.....250 vac
Adjustment Angle .....15 turns nom.

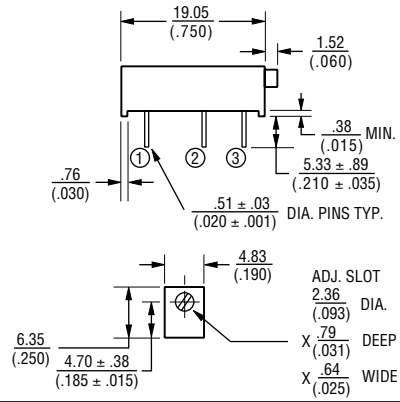
Environmental Characteristics

Power Rating (400 volts max.)
70 °C .....0.75 watt
125 °C .....0 watt
Temperature Range ....-55 °C to +125 °C
Temperature Coefficient ....±100 ppm/°C
Seal Test.....85 °C Fluorinert†
Humidity.....MIL-STD-202 Method 103
96 hours
(3 % ΔTR, 20 Megohms IR)
Vibration.....20 G (2 % ΔTR; 2 % ΔVR)
Shock.....50 G (2 % ΔTR; 2 % ΔVR)
Load Life ...1,000 hours 0.75 watt 70 °C
(4 % ΔTR)
Rotational Life.....200 cycles
(3 % ΔTR; 1 % or 1 ohm,
whichever is greater, CRV)

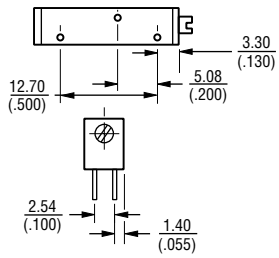
Physical Characteristics

Torque .....5.0 oz-in. max.
Mechanical Stops .....Wiper idles
Terminals.....Solderable pins
Weight .....0.04 oz.
Marking .....Manufacturer's
trademark, resistance code,
terminal numbers, date code,
manufacturer's model number
and style
Wiper .....50 % (Actual TR) ±10 %
Flammability.....U.L. 94V-0
Standard Packaging.....25 pcs. per tube
Adjustment Tool.....H-90

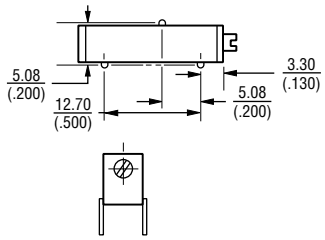
Common Dimensions



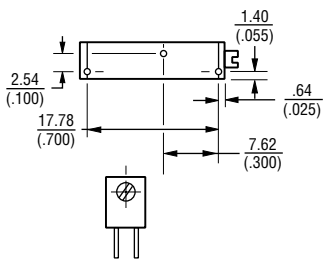
3006P



3006W



3006Y



TOLERANCES: ± 0.25 (.010) EXCEPT WHERE NOTED

DIMENSIONS ARE: MM / (INCHES)

How To Order

3006 P - 1 - 103 Z LF

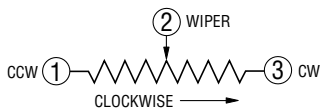
Model
Style
Standard or Modified Product Indicator
-1 = Standard Product
-7 = Transparent Housing
Resistance Code
Optional Suffix Letter
Z = Panel Mount (Factory Installed)
Terminations
LF = 100 % Tin-plated (RoHS compliant)
Blank = 90 % Tin / 10 % Lead-plated (Standard)

Consult factory for other available options.

Standard Resistance Table

Resistance (Ohms)	Resistance Code
10	100
20	200
50	500
100	101
200	201
500	**501**
1,000	**102**
2,000	**202**
5,000	**502**
10,000	**103**
20,000	**203**
25,000	**253**
50,000	**503**
100,000	**104**
200,000	**204**
250,000	254
500,000	504
1,000,000	105
2,000,000	205

Popular distribution values listed in boldface.
Special resistances available.



REV. 10/04

*RoHS Directive 2002/95/EC Jan 27 2003 including Annex.
†"Fluorinert" is a registered trademark of 3M Co.
Specifications are subject to change without notice.
Customers should verify actual device performance in their specific applications.

Multilayer ceramic capacitors are available in a variety of physical sizes and configurations, including leaded devices and surface mounted chips. Leaded styles include molded and conformally coated parts with axial and radial leads. However, the basic capacitor element is similar for all styles. It is called a chip and consists of formulated dielectric materials which have been cast into thin layers, interspersed with metal electrodes alternately exposed on opposite edges of the laminated structure. The entire structure is fired at high temperature to produce a monolithic block which provides high capacitance values in a small physical volume. After firing, conductive terminations are applied to opposite ends of the chip to make contact with the exposed electrodes. Termination materials and methods vary depending on the intended use.

TEMPERATURE CHARACTERISTICS

Ceramic dielectric materials can be formulated with a wide range of characteristics. The EIA standard for ceramic dielectric capacitors (RS-198) divides ceramic dielectrics into the following classes:

Class I: Temperature compensating capacitors, suitable for resonant circuit application or other applications where high Q and stability of capacitance characteristics are required. Class I capacitors have predictable temperature coefficients and are not affected by voltage, frequency or time. They are made from materials which are not ferro-electric, yielding superior stability but low volumetric efficiency. Class I capacitors are the most stable type available, but have the lowest volumetric efficiency.

Class II: Stable capacitors, suitable for bypass or coupling applications or frequency discriminating circuits where Q and stability of capacitance characteristics are not of major importance. Class II capacitors have temperature characteristics of ± 15% or less. They are made from materials which are ferro-electric, yielding higher volumetric efficiency but less stability. Class II capacitors are affected by temperature, voltage, frequency and time.

Class III: General purpose capacitors, suitable for by-pass coupling or other applications in which dielectric losses, high insulation resistance and stability of capacitance characteristics are of little or no importance. Class III capacitors are similar to Class II capacitors except for temperature characteristics, which are greater than ± 15%. Class III capacitors have the highest volumetric efficiency and poorest stability of any type.

KEMET leaded ceramic capacitors are offered in the three most popular temperature characteristics:

C0G: Class I, with a temperature coefficient of 0 ± 30 ppm per degree C over an operating temperature range of - 55°C to + 125°C (Also known as “NP0”).

X7R: Class II, with a maximum capacitance change of ± 15% over an operating temperature range of - 55°C to + 125°C.

Z5U: Class III, with a maximum capacitance change of + 22% - 56% over an operating temperature range of + 10°C to + 85°C.

Specified electrical limits for these three temperature characteristics are shown in Table 1.

SPECIFIED ELECTRICAL LIMITS

Parameter	Temperature Characteristics		
	C0G	X7R	Z5U
Dissipation Factor: Measured at following conditions. C0G – 1 kHz and 1 vrms if capacitance >1000pF 1 MHz and 1 vrms if capacitance ≤ 1000 pF X7R – 1 kHz and 1 vrms* or if extended cap range 0.5 vrms Z5U – 1 kHz and 0.5 vrms	0.10%	2.5% (3.5% @ 25V)	4.0%
Dielectric Stength: 2.5 times rated DC voltage.	Pass Subsequent IR Test		
Insulation Resistance (IR): At rated DC voltage, whichever of the two is smaller	1,000 MΩ–µF or 100 GΩ	1,000 MΩ–µF or 100 GΩ	1,000 MΩ–µF or 10 GΩ
Temperature Characteristics: Range, °C Capacitance Change without DC voltage	-55 to +125 0 ± 30 ppm/°C	-55 to +125 ± 15%	+ 10 to +85 +22%,-56%

* MHz and 1 vrms if capacitance ≤ 100 pF on military product.

Table I

ELECTRICAL CHARACTERISTICS

The fundamental electrical properties of multilayer ceramic capacitors are as follows:

Polarity: Multilayer ceramic capacitors are not polar, and may be used with DC voltage applied in either direction.

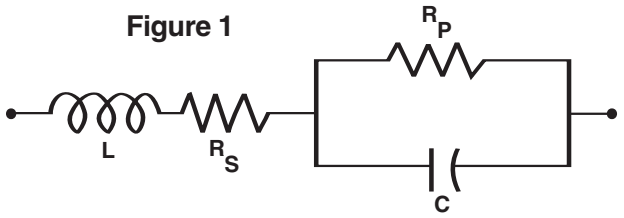
Rated Voltage: This term refers to the maximum continuous DC working voltage permissible across the entire operating temperature range. Multilayer ceramic capacitors are not extremely sensitive to voltage, and brief applications of voltage above rated will not result in immediate failure. However, reliability will be reduced by exposure to sustained voltages above rated.

Capacitance: The standard unit of capacitance is the farad. For practical capacitors, it is usually expressed in microfarads (10^{-6} farad), nanofarads (10^{-9} farad), or picofarads (10^{-12} farad). Standard measurement conditions are as follows:

Class I (up to 1,000 pF):	1MHz and 1.2 VRMS maximum.
Class I (over 1,000 pF):	1kHz and 1.2 VRMS maximum.
Class II:	1 kHz and 1.0 ± 0.2 VRMS.
Class III:	1 kHz and 0.5 ± 0.1 VRMS.

Like all other practical capacitors, multilayer ceramic capacitors also have resistance and inductance. A simplified schematic for the equivalent circuit is shown in Figure 1. Other significant electrical characteristics resulting from these additional properties are as follows:

Figure 1



C = Capacitance **R_S = Equivalent Series Resistance (ESR)**

L = Inductance **R_P = Insulation Resistance (IR)**

Impedance: Since the parallel resistance (Rp) is normally very high, the total impedance of the capacitor is:

$$Z = \sqrt{R_S^2 + (X_C - X_L)^2}$$

Where **Z = Total Impedance**

RS = Equivalent Series Resistance

X_C = Capacitive Reactance = $\frac{1}{2\pi fC}$

X_L = Inductive Reactance = $2\pi fL$

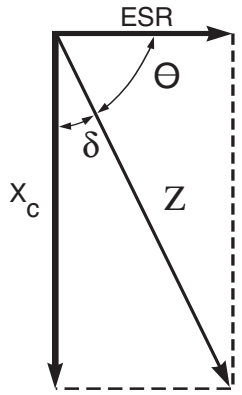
The variation of a capacitor's impedance with frequency determines its effectiveness in many applications.

Dissipation Factor: Dissipation Factor (DF) is a measure of the losses in a capacitor under AC application. It is the ratio of the equivalent series resistance to the capacitive reactance, and is usually expressed in percent. It is usually measured simultaneously with capacitance, and under the same conditions. The vector diagram in Figure 2 illustrates the relationship between DF, ESR, and impedance. The reciprocal of the dissipation factor is called the "Q", or quality factor. For convenience, the "Q" factor is often used for very low values of dissipation factor. DF is sometimes called the "loss tangent" or "tangent δ", as derived from this diagram.

Figure 2

$$DF = \frac{ESR}{X_C}$$

$$X_C = \frac{1}{2\pi fC}$$



Insulation Resistance: Insulation Resistance (IR) is the DC resistance measured across the terminals of a capacitor, represented by the parallel resistance (Rp) shown in Figure 1. For a given dielectric type, electrode area increases with capacitance, resulting in a decrease in the insulation resistance. Consequently, insulation resistance is usually specified as the "RC" (IR x C) product, in terms of ohm-farads or megohm-microfarads. The insulation resistance for a specific capacitance value is determined by dividing this product by the capacitance. However, as the nominal capacitance values become small, the insulation resistance calculated from the RC product reaches values which are impractical. Consequently, IR specifications usually include both a minimum RC product and a maximum limit on the IR calculated from that value. For example, a typical IR specification might read "1,000 megohm-microfarads or 100 gigohms, whichever is less."

Insulation Resistance is the measure of a capacitor to resist the flow of DC leakage current. It is sometimes referred to as "leakage resistance." The DC leakage current may be calculated by dividing the applied voltage by the insulation resistance (Ohm's Law).

Dielectric Withstanding Voltage: Dielectric withstanding voltage (DWV) is the peak voltage which a capacitor is designed to withstand for short periods of time without damage. All KEMET multilayer ceramic capacitors will withstand a test voltage of 2.5 x the rated voltage for 60 seconds.

KEMET specification limits for these characteristics at standard measurement conditions are shown in Table 1 on page 4. Variations in these properties caused by changing conditions of temperature, voltage, frequency, and time are covered in the following sections.

TABLE 1
EIA TEMPERATURE CHARACTERISTIC CODES FOR CLASS I DIELECTRICS

Significant Figure of Temperature Coefficient		Multiplier Applied to Temperature Coefficient		Tolerance of Temperature Coefficient *	
PPM per Degree C	Letter Symbol	Multi-plier	Number Symbol	PPM per Degree C	Letter Symbol
0.0	C	-1	0	±30	G
0.3	B	-10	1	±60	H
0.9	A	-100	2	±120	J
1.0	M	-1000	3	±250	K
1.5	P	-100000	4	±500	L
2.2	R	+1	5	±1000	M
3.3	S	+10	6	±2500	N
4.7	T	+100	7		
7.5	U	+1000	8		
		+10000	9		

** These symetrical tolerances apply to a two-point measurement of temperature coefficient: one at 25°C and one at 85°C. Some deviation is permitted at lower temperatures. For example, the PPM tolerance for C0G at -55°C is +30 / -72 PPM.*

TABLE 2
EIA TEMPERATURE CHARACTERISTIC CODES FOR CLASS II & III DIELECTRICS

Low Temperature Rating		High Temperature Rating		Maximum Capacitance Shift	
Degree Celcius	Letter Symbol	Degree Celcius	Number Symbol	Percent	Letter Symbol
+10C	Z	+45C	2	±1.0%	A
-30C	Y	+65C	4	±1.5%	B
-55C	X	+85C	5	±2.2%	C
		+105C	6	±3.3%	D
		+125C	7	±4.7%	E
		+150C	8	±7.5%	F
		+200C	9	±10.0%	P
				±15.0%	R
				±22.0%	S
				+22/-33%	T
				+22/-56%	U
				+22/-82%	V

EFFECT OF TEMPERATURE

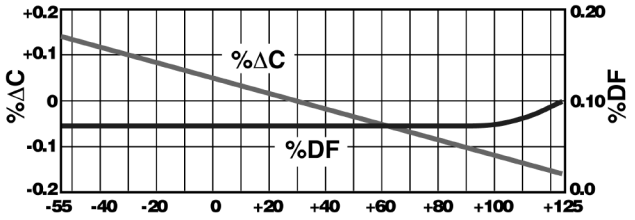


Figure 3. Temperature °C
Capacitance & DF vs Temperature - C0G

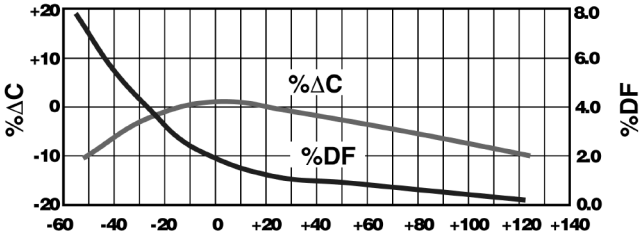


Figure 4. Temperature °C
Capacitance & DF vs Temperature - X7R

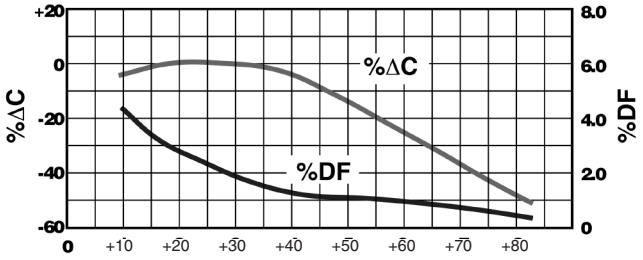


Figure 5. Temperature °C
Capacitance & DF vs Temperature - Z5U

EFFECT OF APPLIED VOLTAGE

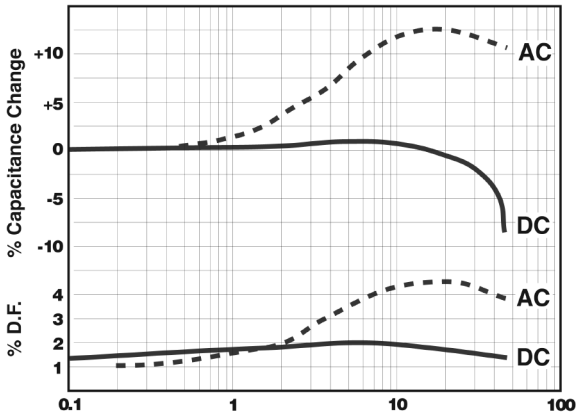


Figure 6. AC or DC Volts Applied
Typical Effects of 1000 Hz AC and DC Voltage Level on Capacitance and Dissipation Factor - X7R
Note: C0G Dielectric capacitance and dissipation factor are stable with voltage.

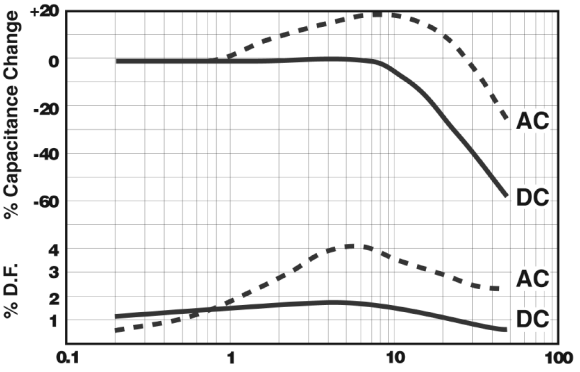


Figure 7. AC or DC Volts Applied
Typical Effects of 1000 Hz AC and DC Voltage Level on Capacitance and Dissipation Factor - Z5U
Note: C0G Dielectric capacitance and dissipation factor are stable with voltage.

Effect of Temperature: Both capacitance and dissipation factor are affected by variations in temperature. The maximum capacitance change with temperature is defined by the temperature characteristic. However, this only defines a "box" bounded by the upper and lower operating temperatures and the minimum and maximum capacitance values. Within this "box", the variation with temperature depends upon the specific dielectric formulation. Typical curves for KEMET capacitors are shown in Figures 3, 4, and 5. These figures also include the typical change in dissipation factor for KEMET capacitors.

Insulation resistance decreases with temperature. Typically, the insulation resistance at maximum rated temperature is 10% of the 25°C value.

Effect of Voltage: Class I ceramic capacitors are not affected by variations in applied AC or DC voltages. For Class II and III ceramic capacitors, variations in voltage affect only the capacitance and dissipation factor. The application of DC voltage higher than 5 vdc reduces both the capacitance and dissipation factor. The application of AC voltages up to 10-20 Vac tends to increase both capacitance and dissipation factor. At higher AC voltages, both capacitance and dissipation factor begin to decrease.

Typical curves showing the effect of applied AC and DC voltage are shown in Figure 6 for KEMET X7R capacitors and Figure 7 for KEMET Z5U capacitors.

Effect of Frequency: Frequency affects both capacitance and dissipation factor. Typical curves for KEMET multilayer ceramic capacitors are shown in Figures 8 and 9.

The variation of impedance with frequency is an important consideration in the application of multilayer ceramic capacitors. Total impedance of the capacitor is the vector of the capacitive reactance, the inductive reactance, and the ESR, as illustrated in Figure 2. As frequency increases, the capacitive reactance decreases. However, the series inductance (L) shown in Figure 1 produces inductive reactance, which increases with frequency. At some frequency, the impedance ceases to be capacitive and becomes inductive. This point, at the bottom of the V-shaped impedance versus frequency curves, is the self-resonant frequency. At the self-resonant frequency, the reactance is zero, and the impedance consists of the ESR only.

Typical impedance versus frequency curves for KEMET multilayer ceramic capacitors are shown in Figures 10, 11, and 12. These curves apply to KEMET capacitors in chip form, without leads. Lead configuration and lead length have a significant impact on the series inductance. The lead inductance is approximately 10nH/inch, which is large compared to the inductance of the chip. The effect of this additional inductance is a decrease in the self-resonant frequency, and an increase in impedance in the inductive region above the self-resonant frequency.

Effect of Time: The capacitance of Class II and III dielectrics change with time as well as with temperature, voltage and frequency. This change with time is known as "aging." It is caused by gradual realignment of the crystalline structure of the ceramic dielectric material as it is cooled below its Curie temperature, which produces a loss of capacitance with time. The aging process is predictable and follows a logarithmic decay. Typical aging rates for C0G, X7R, and Z5U dielectrics are as follows:

C0G	None
X7R	2.0% per decade of time
Z5U	5.0% per decade of time

Typical aging curves for X7R and Z5U dielectrics are shown in Figure 13.

The aging process is reversible. If the capacitor is heated to a temperature above its Curie point for some period of time, de-aging will occur and the capacitor will regain the capacitance lost during the aging process. The amount of de-aging depends on both the elevated temperature and the length of time at that temperature. Exposure to 150°C for one-half hour or 125°C for two hours is usually sufficient to return the capacitor to its initial value.

Because the capacitance changes rapidly immediately after de-aging, capacitance measurements are usually delayed for at least 10 hours after the de-aging process, which is often referred to as the "last heat." In addition, manufacturers utilize the aging rates to set factory test limits which will bring the capacitance within the specified tolerance at some future time, to allow for customer receipt and use. Typically, the test limits are adjusted so that the capacitance will be within the specified tolerance after either 1,000 hours or 100 days, depending on the manufacturer and the product type.

POWER DISSIPATION

Power dissipation has been empirically determined for two representative KEMET series: C052 and C062. Power dissipation capability for various mounting configurations is shown in Table 3. This table was extracted from Engineering Bulletin F-2013, which provides a more detailed treatment of this subject.

Note that no significant difference was detected between the two sizes in spite of a 2 to 1 surface area ratio. Due to the materials used in the construction of multilayer ceramic capacitors, the power dissipation capability does not depend greatly on the surface area of the capacitor body, but rather on how well heat is conducted out of the capacitor lead wires. Consequently, this power dissipation capability is applicable to other leaded multilayer styles and sizes.

TABLE 3
POWER DISSIPATION CAPABILITY
(Rise in Celsius degrees per Watt)

Mounting Configuration	Power Dissipation of C052 & C062
1.00" leadwires attached to binding post of GR-1615 bridge (excellent heat sink)	90 Celsius degrees rise per Watt ±10%
0.25" leadwires attached to binding post of GR-1615 bridge	55 Celsius degrees rise per Watt ±10%
Capacitor mounted flush to 0.062" glass-epoxy circuit board with small copper traces	77 Celsius degrees rise per Watt ±10%
Capacitor mounted flush to 0.062" glass-epoxy circuit board with four square inches of copper land area as a heat sink	53 Celsius degrees rise per Watt ±10%

As shown in Table 3, the power dissipation capability of the capacitor is very sensitive to the details of its use environment. The temperature rise due to power dissipation should not exceed 20°C. Using that constraint, the maximum permissible power dissipation may be calculated from the data provided in Table 3.

It is often convenient to translate power dissipation capability into a permissible AC voltage rating. Assuming a sinusoidal wave form, the RMS "ripple voltage" may be calculated from the following formula:

$$E = Z \times \sqrt{\frac{P_{MAX}}{R}}$$

Where E = RMS Ripple Voltage (volts)

P = Power Dissipation (watts)

Z = Impedance

R = ESR

The data necessary to make this calculation is included in Engineering Bulletin F-2013. However, the following criteria must be observed:

1. The temperature rise due to power dissipation should be limited to 20°C.
2. The peak AC voltage plus the DC voltage must not exceed the maximum working voltage of the capacitor.

Provided that these criteria are met, multilayer ceramic capacitors may be operated with AC voltage applied without need for DC bias.

RELIABILITY

A well constructed multilayer ceramic capacitor is extremely reliable and, for all practical purposes, has an infinite life span when used within the maximum voltage and temperature ratings. Capacitor failure may be induced by sustained operation at voltages that exceed the rated DC voltage, voltage spikes or transients that exceed the dielectric withstanding voltage, sustained operation at temperatures above the maximum rated temperature, or the excessive temperature rise due to power dissipation.

Failure rate is usually expressed in terms of percent per 1,000 hours or in FITS (failure per billion hours). Some KEMET series are qualified under U.S. military established reliability specifications MIL-PRF-20, MIL-PRF-123, MIL-PRF-39014, and MIL-PRF-55681. Failure rates as low as 0.001% per 1,000 hours are available for all capacitance / voltage ratings covered by these specifications. These specifications and accompanying Qualified Products List should be consulted for details.

For series not covered by these military specifications, an internal testing program is maintained by KEMET Quality Assurance. Samples from each week's production are subjected to a 2,000 hour accelerated life test at 2 x rated voltage and maximum rated temperature. Based on the results of these tests, the average failure rate for all non-military series covered by this test program is currently 0.06% per 1,000 hours at maximum rated conditions. The failure rate would be much lower at typical use conditions. For example, using MIL-HDBK-217D this failure rate translates to 0.9 FITS at 50% rated voltage and 50°C.

Current failure rate details for specific KEMET multilayer ceramic capacitor series are available on request.

MISAPPLICATION

Ceramic capacitors, like any other capacitors, may fail if they are misapplied. Typical misapplications include exposure to excessive voltage, current or temperature. If the dielectric layer of the capacitor is damaged by misapplication the electrical energy of the circuit can be released as heat, which may damage the circuit board and other components as well.

If potential for misapplication exists, it is recommended that precautions be taken to protect personnel and equipment during initial application of voltage. Commonly used precautions include shielding of personnel and sensing for excessive power drain during board testing.

STORAGE AND HANDLING

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature – reels may soften or warp, and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40° C, and maximum storage humidity not exceed 70% relative humidity. In addition, temperature fluctuations should be minimized to avoid condensation on the parts, and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability, chip stock should be used promptly, preferably within 1.5 years of receipt.

EFFECT OF FREQUENCY

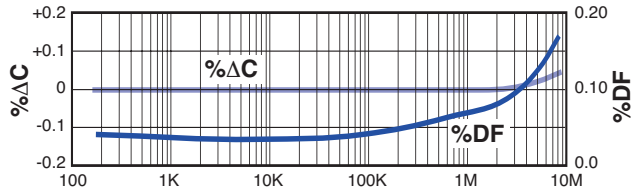


Figure 8. Frequency - Hertz
Capacitance & DF vs Frequency - C0G

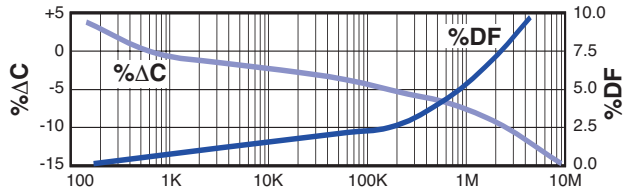


Figure 9. Frequency - Hertz
Capacitance & DF vs Frequency - X7R & Z5U

EFFECT OF TIME (hours)

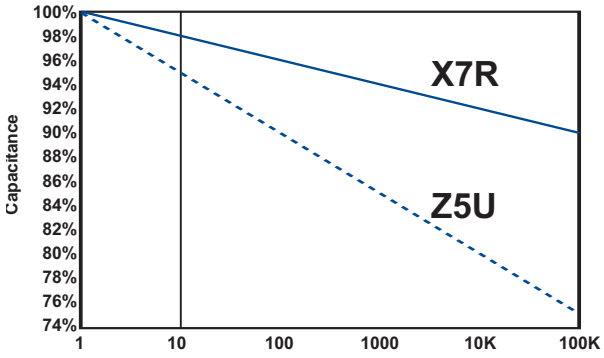


Figure 13. Typical Aging Rates for X7R & Z5U

IMPEDANCE VS FREQUENCY

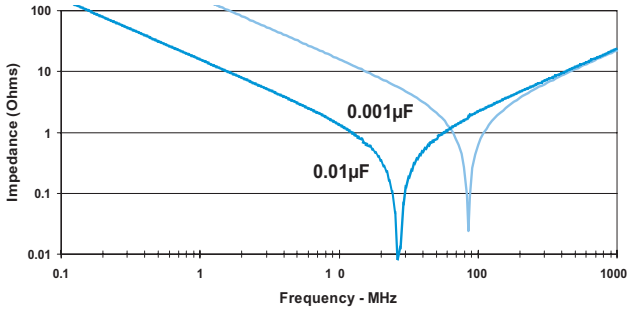


Figure 10. Impedance vs Frequency
for C0G Dielectric

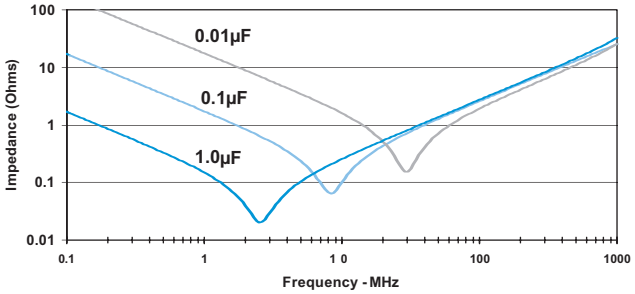


Figure 11. Impedance vs Frequency
for X7R Dielectric

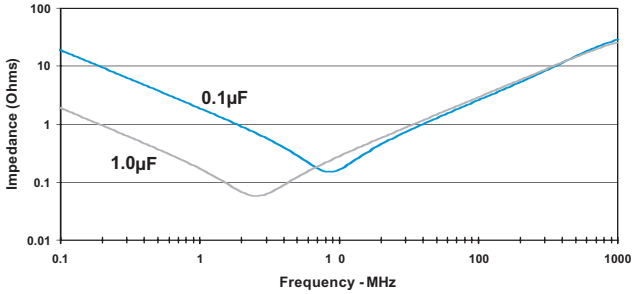


Figure 12. Impedance vs Frequency
for Z5U Dielectric

GENERAL SPECIFICATIONS

Working Voltage:
Axial (WVDC)
C0G 50, 100, 200
X7R 25, 50, 100, 200, 250
Z5U 50, 100
Radial (WVDC)
C0G 50, 100, 200, 500, 1k, 1.5k, 2k, 2.5k, 3k
X7R 25, 50, 100, 200, 250, 500, 1k, 1.5k, 2k, 2.5k, 3k
Z5U 50, 100

Temperature Characteristics:
C0G 0 ±30 PPM / °C from -55°C to +125°C (1)
X7R ± 15% from -55°C to +125°C
Z5U + 22%, -56% from +10°C to +85°C

Capacitance Tolerance:
C0G ±0.5pF, ±1%, ±2%, ±5%, ±10%, ±20%
X7R ±10%, ±20%, +80% / -20%
Z5U ±20%, 80% / -20%

Construction:
Epoxy encapsulated – meets flame test requirements of UL Standard 94V-0.
High-temperature solder – meets EIA RS-198, Method 302, Condition B (260°C for 10 seconds)

Lead Material:
Standard: 100% matte tin (Sn) with nickel (Ni) underplate and steel core ("TA" designation).
Alternative 1: 60% Tin (Sn)/40% Lead (Pb) finish with copper-clad steel core ("HA" designation).
Alternative 2: 60% Tin (Sn)/40% Lead (Pb) finish with 100% copper core (available with "HA" termination code with c-spec)

Solderability:
EIA RS-198, Method 301, Solder Temperature: 230°C ±5°C. Dwell time in solder = 7 ± ½ seconds.

Terminal Strength:
EIA RS-198, Method 303, Condition A (2.2kg)

ELECTRICAL

Capacitance @ 25°C:
Within specified tolerance and following test conditions.
C0G – >1000pF with 1.0 vrms @ 1 kHz
≤ 1000pF with 1.0 vrms @ 1 MHz
X7R – with 1.0 vrms @ 1 kHz (Referee Time: 1,000 hours)
Z5U – with 1.0 vrms @ 1 kHz

Dissipation Factor @25°C:
Same test conditions as capacitance.
C0G – 0.10% maximum
X7R – 2.5% maximum (3.5% for 25V)
Z5U – 4.0% maximum

Insulation Resistance @25°C:
EIA RS-198, Method 104, Condition A <1kV
C0G – 100 GΩ or 1000 MΩ – µF, whichever is less.
≤500V test @ rated voltage, >500V test @ 500V
X7R – 100 GΩ or 1000 MΩ – µF, whichever is less.
≤500V test @ rated voltage, >500V test @ 500V
Z5U – 10 GΩ or 1000 MΩ – µF, whichever is less.

Dielectric Withstanding Voltage:
EIA RS-198, Method 103
≤250V test @ 250% of rated voltage for 5 seconds with current limited to 50mA.
500V test @ 150% of rated voltage for 5 seconds with current limited to 50mA.
≥1000V test @ 120% of rated voltage for 5 seconds with current limited to 50mA.

ENVIRONMENTAL

Vibration:
EIA RS-198, Method 304, Condition D (10-2000Hz; 20g)
Shock:
EIA RS-198, Method 305, Condition I (100g)

Life Test:
EIA RS-198, Method 201, Condition D.
<200V
C0G – 200% of rated voltage @ +125°C
X7R – 200% of rated voltage @ +125°C
Z5U – 200% of rated voltage @ +85°C
>500V
C0G – rated voltage @ +125°C
X7R – rated voltage @ +125°C

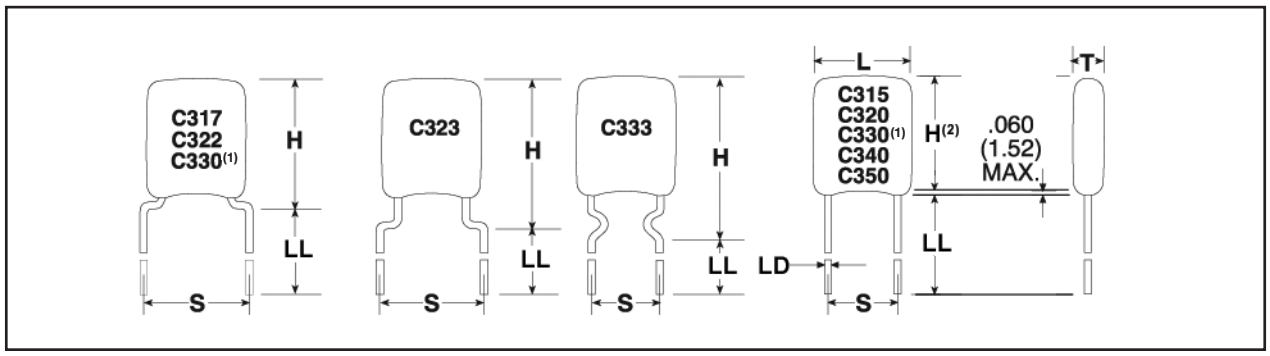
Post Test Limits @ 25°C are:
Capacitance Change:
C0G (≤ 200V) – ±3% or 0.25pF, whichever is greater.
C0G (≥ 500V) – ±3% or 0.50pF, whichever is greater.
X7R – ± 20% of initial value (2)
Z5U – ± 30% of initial value (2)
Dissipation Factor:
C0G – 0.10% maximum
X7R – 2.5% maximum (3.5% for 25V)
Z5U – 4.0% maximum
Insulation Resistance:
C0G – 10 GΩ or 100 MΩ – µF, whichever is less.
>1kV tested @ 500V.
X7R – 10 GΩ or 100 MΩ – µF, whichever is less.
>1kV tested @ 500V.
Z5U – 1 GΩ or 100 MΩ – µF, whichever is less.

Moisture Resistance:
EIA RS-198, Method 204, Condition A (10 cycles without applied voltage).
Post Test Limits @ 25°C are:
Capacitance Change:
C0G (≤ 200V) – ±3% or ±0.25pF, whichever is greater.
C0G (≥ 500V) – ±3% or ± 0.50pF, whichever is greater.
X7R – ± 20% of initial value (2)
Z5U – ± 30% of initial value (2)
Dissipation Factor:
C0G – 0.10% maximum
X7R – 2.5% maximum (3.5% for 25V)
Z5U – 4.0% maximum
Insulation Resistance:
C0G – 10 GΩ or 100 MΩ – µFwhichever is less.
≤500V test @ rated voltage, >500V test @ 500V.
X7R – 10 GΩ or 100 MΩ – µF, whichever is less.
≤500V test @ rated voltage, >500V test @ 500V.
Z5U – 1k MΩ or 100 MΩ – µF, whichever is less.

Thermal Shock:
EIA RS-198, Method 202, Condition B (C0G & X7R: -55°C to 125°C); Condition A (Z5U: -55°C to 85°C)

(1) +53 PPM -30 PPM/ °C from +25°C to -55°C, + 60 PPM below 10pF.
(2) X7R and Z5U dielectrics exhibit aging characteristics; therefore, it is highly recommended that capacitors be deaged for 2 hours at 150°C and stabilized at room temperature for 48 hours before capacitance measurements are made.

STANDARD LEAD CONFIGURATION OUTLINE DRAWINGS



Drawings are not to scale. See table below for dimensions. See page 16 for optional lead configurations.
(1) Lead configuration depends on capacitance value. (2) H dimensions does not include meniscus.

DIMENSIONS INCHES (MILLIMETERS)

Case Size	L Max.	H. Max.	Standard T Max.	High Voltage T Max.	S(1) ±.030 (.78)	LD +.004(.10) -.001(.025)	LL Min.
C315	0.150 (3.81)	0.210 (5.33)	0.100 (2.54)	0.150 (3.81)	0.100 (2.54)	0.020 (.51)	0.276 (7.00)
C317	0.150 (3.81)	0.230 (5.84)	0.100 (2.54)	0.150 (3.81)	0.200 (5.08)	0.020 (.51)	0.276 (7.00)
C320	0.200 (5.08)	0.260 (6.60)	0.125 (3.18)(2)	0.200 (5.08)	0.100 (2.54)	0.020 (.51)	0.276 (7.00)
C322	0.200 (5.08)	0.260 (6.60)	0.125 (3.18)	0.200 (5.08)	0.200 (5.08)	0.020 (.51)	0.276 (7.00)
C323	0.200 (5.08)	0.320 (8.13)	0.125 (3.18)	0.200 (5.08)	0.200 (5.08)	0.020 (.51)	0.276 (7.00)
C330	0.300 (7.62)	0.360 (9.14)	0.150 (3.81)	0.250 (6.35)	0.200 (5.08)	0.020 (.51)	0.276 (7.00)
C333	0.300 (7.62)	0.390 (9.91)	0.150 (3.81)	0.250 (6.35)	0.200 (5.08)	0.020 (.51)	0.276 (7.00)
C340	0.400 (10.16)	0.460 (11.68)	0.150 (3.81)	0.270 (6.86)	0.200 (5.08)	0.020 (.51)	0.276 (7.00)
C350	0.500 (12.70)	0.560 (14.22)	0.200 (5.08)	0.270 (6.86)	0.400 (10.16)	0.025 (.64)	0.276 (7.00)

Note: 1 inch = 25.4mm.
Note (1): Measured at seating plane.
Note (2): Thickness = 0.16" (4.064mm) for C320 from 4.7 - 10.0µF.

ORDERING INFORMATION

C 320 C 102 M 1 R 5 T A

CERAMIC

CASE SIZE
See Table Above

SPECIFICATION
C – Standard

CAPACITANCE PICOFARAD CODE
Expressed in picofarads (pF). First two digits represent significant figures. Third digit specifies number of zeros. Use 9 for 1.0 thru 9.9 pF. Example 2.2pF = 229

CAPACITANCE TOLERANCE
C0G: C – ±0.25pF; D – ±0.5pF; F – ±1%; G – ±2%; J – ±5%,
X7R: K – ±10%; M – ±20%; P – 0, -100%; Z – -20,+80%
Z5U: M – ±20%; P – 0, -100%; Z – -20,+80%

RATED VOLTAGE (DC)

3 – 25	D – 1000
5 – 50	F – 1500
1 – 100	G – 2000
2 – 200	Z – 2500
A – 250	H – 3000
C – 500	

DIELECTRIC
EIA Designation
G – C0G (NP0) - Ultra Stable
R – X7R - Stable
U – Z5U - General Purpose

INTERNAL CONSTRUCTION
5 – Multilayer

LEAD MATERIAL
T – 100% Tin (Sn)
H – 60/40% Tin/Lead (SnPb)

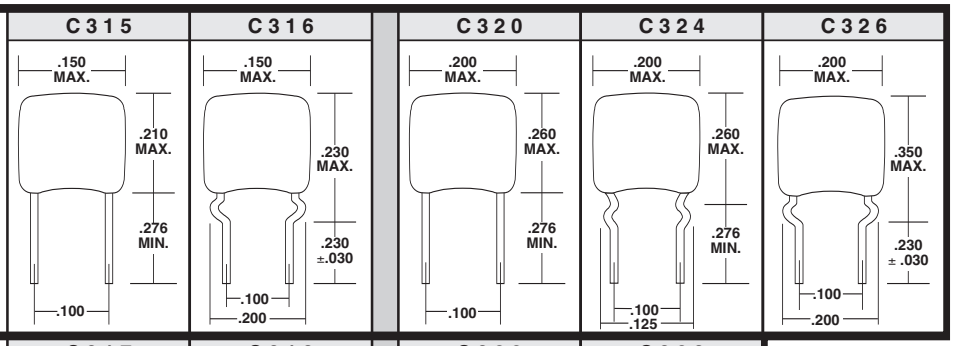
FAILURE RATE
A – Not Applicable

For packaging information, see pages 47 and 48.

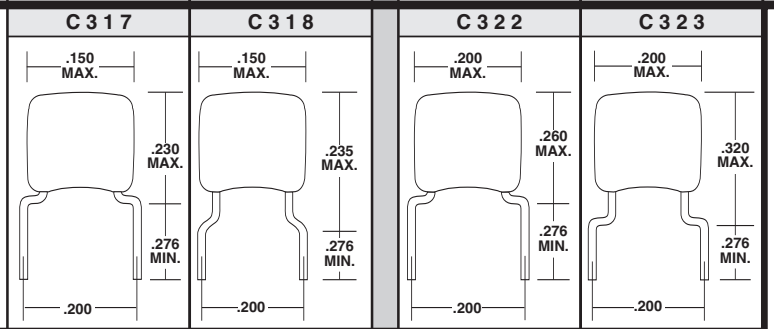
OPTIONAL CONFIGURATIONS BY LEAD SPACING

The preferred lead wire configurations are shown on page 15. However, additional configurations are available. All available options, including those on page 15, are shown below grouped by lead spacing.

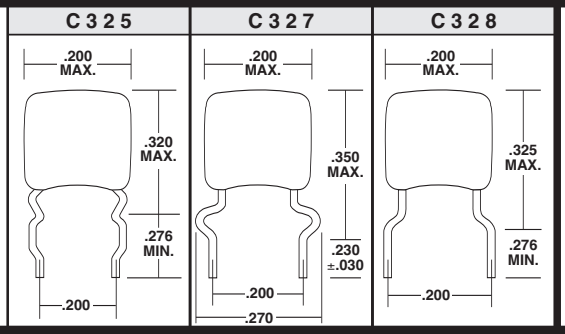
Lead Spacing .100" ± .030



Lead Spacing .200" ± .030

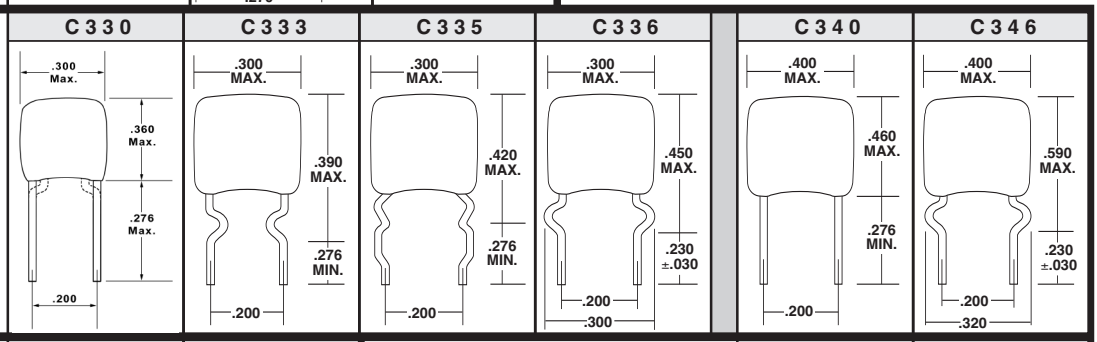


Lead Spacing .200" ± .030

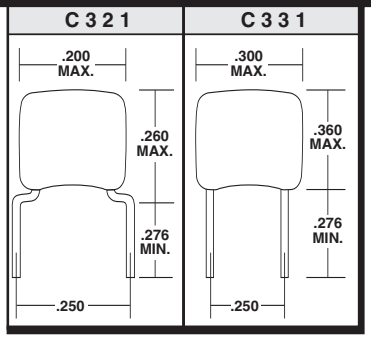


Lead Spacing .200" ± .030

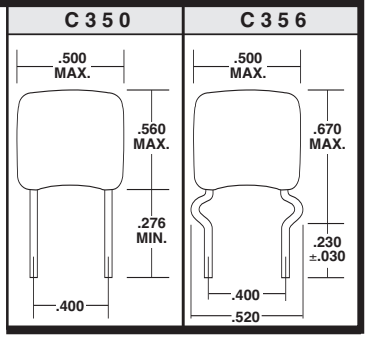
Note: C330 configuration depends on capacitance. See part number tables for specifics.



Lead Spacing .250" ± .030 (Available in bulk only)

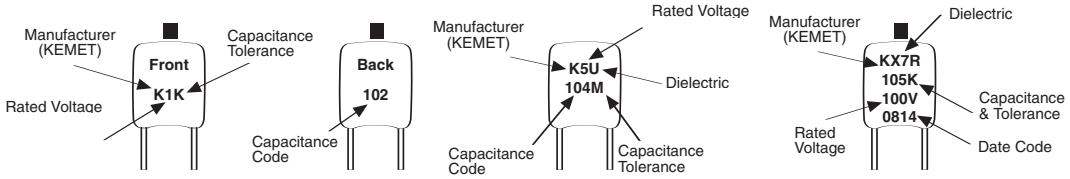


Lead Spacing .400" ± .030



Note: Non-standard lead lengths are available in bulk only.

CAPACITOR MARKINGS



RATINGS & PART NUMBER REFERENCE: ULTRA-STABLE TEMPERATURE CHARACTERISTICS — C0G/NP0

Cap	Cap Code	Cap Tol	Style	C31X					C32X							C33X									C34X							C35X						
			WVDC	50	100	200	500	1k	50	100	200	500	1k	1.5k	2k	50	100	200	500	1k	1.5k	2k	2.5k	3k	50	100	200	500	1k	2k	3k	50	100	200	500	1k	2k	3k
1.0pF	109	C,D																																			
1.1	119	C,D																																			
1.2	129	C,D																																			
1.3	139	C,D																																			
1.5	159	C,D																																			
1.6	169	C,D																																			
1.8	189	C,D																																			
2.0	209	C,D																																			
2.2	229	C,D																																			
2.4	249	C,D																																			
2.7	279	C,D																																			
3.0	309	C,D																																			
3.3	339	C,D																																			
3.6	369	C,D																																			
3.9	399	C,D																																			
4.3	439	C,D																																			
4.7	479	C,D																																			
5.1	519	C,D																																			
5.6	569	C,D																																			
6.2	629	C,D																																			
6.8	689	C,D																																			
7.5	759	C,D																																			
8.2	829	C,D																																			
9.1	919	C,D																																			
10	100	F,G,J																																			
11	110	F,G,J																																			
12	120	F,G,J																																			
13	130	F,G,J																																			
15	150	F,G,J																																			
16	160	F,G,J																																			
18	180	F,G,J																																			
20	200	F,G,J																																			
22	220	F,G,J																																			
24	240	F,G,J																																			
27	270	F,G,J																																			
30	300	F,G,J																																			
33	330	F,G,J																																			
36	360	F,G,J																																			
39	390	F,G,J																																			
43	430	F,G,J																																			
47	470	F,G,J																																			
51	510	F,G,J																																			
56	560	F,G,J																																			
62	620	F,G,J																																			
68	680	F,G,J																																			
75	750	F,G,J																																			
82	820	F,G,J																																			
91	910	F,G,J																																			

For packaging information, see pages 47 and 48.

RATINGS & PART NUMBER REFERENCE:
ULTRA-STABLE TEMPERATURE CHARACTERISTICS —C0G/NPO CONT.

Cap	Cap Code	Cap Tol	C31X					C32X							C33X									C34X							C35X						
			WVDC					WVDC							WVDC									WVDC							WVDC						
			50	100	200	500	1k	50	100	200	500	1k	1.5k	2k	50	100	200	500	1k	1.5k	2k	2.5k	3k	50	100	200	500	1k	2k	3k	50	100	200	500	1k	2k	3k
100	101	F G J	■	■	■	■		■	■	■	■	■	■	■				■	■	■	■	■	■				■	■	■	■						■	
110	111	F G J	■	■	■	■		■	■	■	■	■	■	■				■	■	■	■	■	■				■	■	■	■						■	
120	121	F G J	■	■	■	■		■	■	■	■	■	■	■				■	■	■	■	■	■				■	■	■	■						■	
130	131	F G J	■	■	■	■		■	■	■	■	■	■	■				■	■	■	■	■	■				■	■	■	■						■	
150	151	F G J	■	■	■	■		■	■	■	■	■	■	■				■	■	■	■	■	■				■	■	■	■						■	
160	161	F G J	■	■	■	■		■	■	■	■	■	■	■				■	■	■	■	■	■				■	■	■	■						■	
180	181	F G J	■	■	■	■		■	■	■	■	■	■	■				■	■	■	■	■	■				■	■	■	■						■	
200	201	F G J	■	■	■			■	■	■	■	■	■	■				■	■	■	■	■	■				■	■	■	■						■	
220	221	F G J	■	■	■			■	■	■	■	■	■	■				■	■	■	■	■	■				■	■	■	■				■	■	■	
240	241	F G J	■	■	■			■	■	■	■	■	■	■				■	■	■	■	■	■				■	■	■	■				■	■	■	
270	271	F G J	■	■	■			■	■	■	■	■	■	■				■	■	■	■	■	■				■	■	■	■				■	■	■	
300	301	F G J	■	■	■			■	■	■	■	■	■	■				■	■	■	■	■	■				■	■	■	■				■	■	■	
330	331	F G J	■	■	■			■	■	■	■	■	■	■				■	■	■	■	■	■				■	■	■	■				■	■	■	
360	361	F G J	■	■	■			■	■	■	■	■	■	■				■	■	■	■	■	■				■	■	■	■				■	■	■	
390	391	F G J	■	■	■			■	■	■	■	■	■	■				■	■	■	■	■	■				■	■	■	■				■	■	■	
430	431	F G J	■	■	■			■	■	■	■	■	■	■				■	■	■	■	■	■				■	■	■	■				■	■	■	
470	471	F G J	■	■	■			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■				■	■	■	■				■	■	■	
510	511	F G J	■	■	■			■	■	■	■	■	■		■	■	■	■	■	■	■	■	■				■	■	■	■				■	■	■	
560	561	F G J	■	■	■			■	■	■	■	■	■		■	■	■	■	■	■	■	■	■				■	■	■	■				■	■	■	
620	621	F G J	■	■	■			■	■	■	■	■	■		■	■	■	■	■	■	■	■					■	■	■	■				■	■	■	
680	681	F G J	■	■	■			■	■	■	■	■	■		■	■	■	■	■	■	■	■					■	■	■	■				■	■	■	■
750	751	F G J	■	■				■	■	■	■	■			■	■	■	■	■	■	■						■	■	■	■				■	■	■	■
820	821	F G J	■	■				■	■	■	■	■			■	■	■	■	■	■	■						■	■	■	■				■	■	■	■
910	911	F G J	■	■				■	■	■	■	■			■	■	■	■	■	■	■						■	■	■	■				■	■	■	■
1000	102	F G J	■	■				■	■	■	■	■			■	■	■	■	■	■	■						■	■	■	■				■	■	■	■
1100	112	F G J	■					■	■	■	■	■			■	■	■	■	■	■	■						■	■	■	■				■	■	■	■
1200	122	F G J	■					■	■	■	■	■			■	■	■	■	■	■	■						■	■	■	■				■	■	■	■
1300	132	F G J	■					■	■	■	■	■			■	■	■	■	■	■	■						■	■	■					■	■	■	■
1500	152	F G J	■					■	■	■	■	■			■	■	■	■	■	■							■	■	■					■	■	■	■
1600	162	F G J	■					■	■	■	■	■			■	■	■	■	■	■							■	■	■					■	■	■	■
1800	182	F G J						■	■	■	■	■			■	■	■	■	■	■							■	■	■					■	■	■	■
2000	202	F G J						■	■	■	■				■	■	■	■	■	■							■	■	■					■	■	■	■
2200	222	F G J						■	■	■	■				■	■	■	■	■								■	■	■					■	■	■	
2400	242	F G J						■	■	■	■				■	■	■	■									■	■	■					■	■	■	
2700	272	F G J						■	■	■	■				■	■	■	■									■	■	■					■	■	■	
3000	302	F G J						■	■	■	■				■	■	■	■									■	■	■					■	■	■	
3300	332	F G J						■	■	■	■				■	■	■	■									■	■	■					■	■	■	
3600	362	F G J						■	■	■					■	■	■	■									■	■	■					■	■	■	
3900	392	F G J						■	■						■	■	■	■									■	■	■					■	■	■	
4300	432	F G J						■	■						■	■	■	■									■	■	■					■	■	■	
4700	472	F G J						■	■						■	■	■	■									■	■	■					■	■	■	
5100	512	F G J						■	■						■	■	■	■									■	■	■					■	■	■	
5600	562	F G J						■	■						■	■	■	■									■	■	■					■	■	■	
6200	622	F G J						■	■						■	■	■	■									■	■	■					■	■		
6800	682	F G J						■							■	■	■	■									■	■	■					■	■		
7500	752	F G J						■							■	■	■										■	■	■					■	■		
8200	822	F G J						■							■	■	■										■	■	■					■	■		
9100	912	F G J						■							■	■	■										■	■	■					■	■		
.010uF	103	F G J						■							■	■	■										■	■	■					■	■		
.012	123	F G J						■							■	■	■										■	■	■					■	■		
.015	153	F G J													■	■	■										■	■	■					■	■		
.018	183	F G J													■	■	■																	■	■		
.022	223	F G J													■	■																		■	■		
.027	273	F G J													■	■																		■	■		
.033	333	F G J																																■	■		
.039	393	F G J																																■	■		
.047	473	F G J																																■	■		
.056	563	F G J																																■	■		
.068	683	F G J																																■	■		
.082	823	F G J																																■	■		
.10	104	F G J																																■	■		
.12	124	F G J																																■	■		

For packaging information, see pages 47 and 48.

RATINGS & PART NUMBER REFERENCE: STABLE TEMPERATURE CHARACTERISTICS - X7R

		Style	C31X							C32X									C33X									
	Cap	Cap	WVDC							WVDC									WVDC									
Cap	Code	Tol	25	50	100	200	250	500	1k	25	50	100	200	250	500	1k	1.5k	2k	25	50	100	200	250	500	1k	1.5k	2k	2.5k	3k
10pF	100	K,M,P,Z																											
12	120	K,M,P,Z																											
15	150	K,M,P,Z																											
18	180	K,M,P,Z																											
22	220	K,M,P,Z																											
27	270	K,M,P,Z																											
33	330	K,M,P,Z																											
39	390	K,M,P,Z																											
47	470	K,M,P,Z																											
56	560	K,M,P,Z																											
68	680	K,M,P,Z																											
82	820	K,M,P,Z																											
100	101	K,M,P,Z																											
120	121	K,M,P,Z																											
150	151	K,M,P,Z																											
180	181	K,M,P,Z																											
220	221	K,M,P,Z																											
270	271	K,M,P,Z																											
330	331	K,M,P,Z																											
390	391	K,M,P,Z																											
470	471	K,M,P,Z																											
560	561	K,M,P,Z																											
680	681	K,M,P,Z																											
820	821	K,M,P,Z																											
1000	102	K,M,P,Z																											
1200	122	K,M,P,Z																											
1500	152	K,M,P,Z																											
1800	182	K,M,P,Z																											
2200	222	K,M,P,Z																											
2700	272	K,M,P,Z																											
3300	332	K,M,P,Z																											
3900	392	K,M,P,Z																											
4700	472	K,M,P,Z																											
5600	562	K,M,P,Z																											
6800	682	K,M,P,Z																											
8200	822	K,M,P,Z																											
.010uF	103	K,M,P,Z																											
.012	123	K,M,P,Z																											
.015	153	K,M,P,Z																											
.018	183	K,M,P,Z																											
.022	223	K,M,P,Z																											
.027	273	K,M,P,Z																											
.033	333	K,M,P,Z																											
.039	393	K,M,P,Z																											
.047	473	K,M,P,Z																											
.056	563	K,M,P,Z																											
.068	683	K,M,P,Z																											
.082	823	K,M,P,Z																											
.10	104	K,M,P,Z																											
.12	124	K,M,P,Z																											
.15	154	K,M,P,Z																											
.18	184	K,M,P,Z																				1	1						
.22	224	K,M,P,Z																				1	1						
.27	274	K,M,P,Z																				1	1						
.33	334	K,M,P,Z																				1	1						
.39	394	K,M,P,Z																			1	1	1						
.47	474	K,M,P,Z																			1	1	1						
.56	564	K,M,P,Z																			1	1	1						
.68	684	K,M,P,Z																			1	1	1						
.82	824	K,M,P,Z																			1	1	1						
1.0	105	K,M,P,Z																			1	1	1						
1.2	125	K,M,P,Z																	1	1	1	1	1						
1.5	155	K,M,P,Z																	1	1									
1.8	185	K,M,P,Z																	1	1									
2.2	225	K,M,P,Z																	1	1									
2.7	275	K,M,P,Z																											
3.3	335	K,M,P,Z																											
3.9	395	K,M,P,Z																											
4.7	475	K,M,P,Z								2	2																		
5.6	565	K,M,P,Z								2																			
6.8	685	K,M,P,Z								2																			
10.0	106	K,M,P,Z								2																			

(1) Requires straight leads (all other C33X's require bent leads)

(2) Thickness max = 0.160" (4.064mm)

For packaging information, see pages 47 and 48.

RATINGS & PART NUMBER REFERENCE: STABLE TEMPERATURE CHARACTERISTICS - X7R

		Style	C34X									C35X								
	Cap	Cap	WVDC									WVDC								
Cap	Code	Tol	25	50	100	200	250	500	1k	2k	3k	25	50	100	200	250	500	1k	2k	3k
10pF	100	K,M,P,Z																		
12	120	K,M,P,Z																		
15	150	K,M,P,Z																		
18	180	K,M,P,Z																		
22	220	K,M,P,Z																		
27	270	K,M,P,Z																		
33	330	K,M,P,Z																		
39	390	K,M,P,Z																		
47	470	K,M,P,Z																		
56	560	K,M,P,Z																		
68	680	K,M,P,Z																		
82	820	K,M,P,Z																		
100	101	K,M,P,Z																		
120	121	K,M,P,Z																		
150	151	K,M,P,Z																		
180	181	K,M,P,Z																		
220	221	K,M,P,Z																		
270	271	K,M,P,Z																		
330	331	K,M,P,Z																		
390	391	K,M,P,Z																		
470	471	K,M,P,Z																		
560	561	K,M,P,Z																		
680	681	K,M,P,Z																		
820	821	K,M,P,Z																		
1000	102	K,M,P,Z																		
1200	122	K,M,P,Z																		
1500	152	K,M,P,Z																		
1800	182	K,M,P,Z																		
2200	222	K,M,P,Z																		
2700	272	K,M,P,Z																		
3300	332	K,M,P,Z																		
3900	392	K,M,P,Z																		
4700	472	K,M,P,Z																		
5600	562	K,M,P,Z																		
6800	682	K,M,P,Z																		
8200	822	K,M,P,Z																		
.010uF	103	K,M,P,Z																		
.012	123	K,M,P,Z																		
.015	153	K,M,P,Z																		
.018	183	K,M,P,Z																		
.022	223	K,M,P,Z																		
.027	273	K,M,P,Z																		
.033	333	K,M,P,Z																		
.039	393	K,M,P,Z																		
.047	473	K,M,P,Z																		
.056	563	K,M,P,Z																		
.068	683	K,M,P,Z																		
.082	823	K,M,P,Z																		
.10	104	K,M,P,Z																		
.12	124	K,M,P,Z																		
.15	154	K,M,P,Z																		
.18	184	K,M,P,Z																		
.22	224	K,M,P,Z																		
.27	274	K,M,P,Z																		
.33	334	K,M,P,Z																		
.39	394	K,M,P,Z																		
.47	474	K,M,P,Z																		
.56	564	K,M,P,Z																		
.68	684	K,M,P,Z																		
.82	824	K,M,P,Z																		
1.0	105	K,M,P,Z																		
1.2	125	K,M,P,Z																		
1.5	155	K,M,P,Z																		
1.8	185	K,M,P,Z																		
2.2	225	K,M,P,Z																		
2.7	275	K,M,P,Z																		
3.3	335	K,M,P,Z																		
3.9	395	K,M,P,Z																		
4.7	475	K,M,P,Z																		
5.6	565	K,M,P,Z																		
6.8	685	K,M,P,Z																		
10	106	K,M,P,Z																		

For packaging information, see pages 47 and 48.

RATINGS & PART NUMBER REFERENCE
GENERAL PURPOSE TEMPERATURE CHARACTERISTIC — Z5U

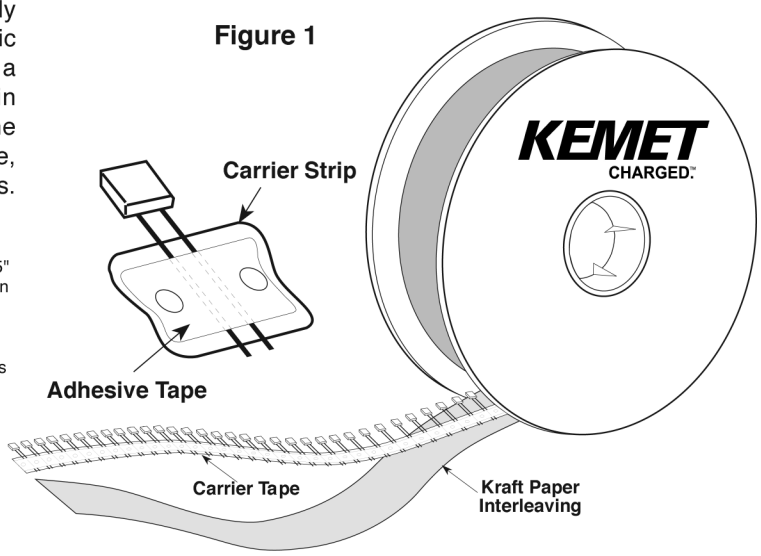
Cap	Cap Code	Cap Tol	Style	C31X			C32X			C33X			C34X			C35X		
				WVDC			WVDC			WVDC			WVDC			WVDC		
				50	100	200	50	100	200	50	100	200	50	100	200	50	100	200
1000pF	102	M,P,Z																
1200	122	M,P,Z																
1500	152	M,P,Z																
1800	182	M,P,Z																
2200	222	M,P,Z																
2700	272	M,P,Z																
3300	332	M,P,Z																
3900	392	M,P,Z																
4700	472	M,P,Z																
5600	562	M,P,Z																
6800	682	M,P,Z																
8200	822	M,P,Z																
.010uF	103	M,P,Z																
.012	123	M,P,Z																
.015	153	M,P,Z																
.018	183	M,P,Z																
.022	223	M,P,Z																
.027	273	M,P,Z																
.033	333	M,P,Z																
.039	393	M,P,Z																
.047	473	M,P,Z																
.056	563	M,P,Z																
.068	683	M,P,Z																
.082	823	M,P,Z																
.10	104	M,P,Z																
.12	124	M,P,Z																
.15	154	M,P,Z																
.18	184	M,P,Z										1						
.22	224	M,P,Z										1						
.27	274	M,P,Z										1						
.33	334	M,P,Z										1						
.39	394	M,P,Z									1	1						
.47	474	M,P,Z									1	1						
.56	564	M,P,Z									1							
.68	684	M,P,Z									1							
.82	824	M,P,Z									1							
1.0	105	M,P,Z									1							
1.2	125	M,P,Z								1								
1.5	155	M,P,Z								1								
1.8	185	M,P,Z								1								
2.2	225	M,P,Z								1								
2.7	275	M,P,Z																
3.3	335	M,P,Z																
3.9	395	M,P,Z																
4.7	475	M,P,Z																
5.6	565	M,P,Z																
6.8	685	M,P,Z																

1 Requires straight leads (all other C33x's require bent leads)

For packaging information, see pages 47 and 48.

Ceramic Radial
Lead Tape and Reel Packaging

KEMET offers standard reeling of Molded and Conformally Coated Radial Leaded Ceramic Capacitors for automatic insertion per EIA specification RS-468. Parts are taped to a tagboard carrier strip, and wound on a reel as shown in Figure 1. Kraft paper interleaving is inserted between the layers of capacitors on the reel. Ammopack is also available, with the same lead tape configuration and package quantities.



(Note: Non-standard lead lengths available in bulk only.)

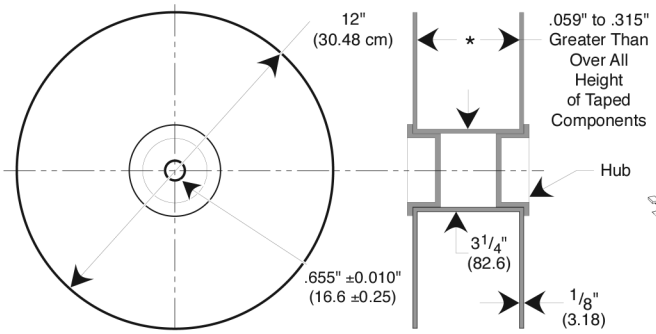


Figure 3: Standard Reel

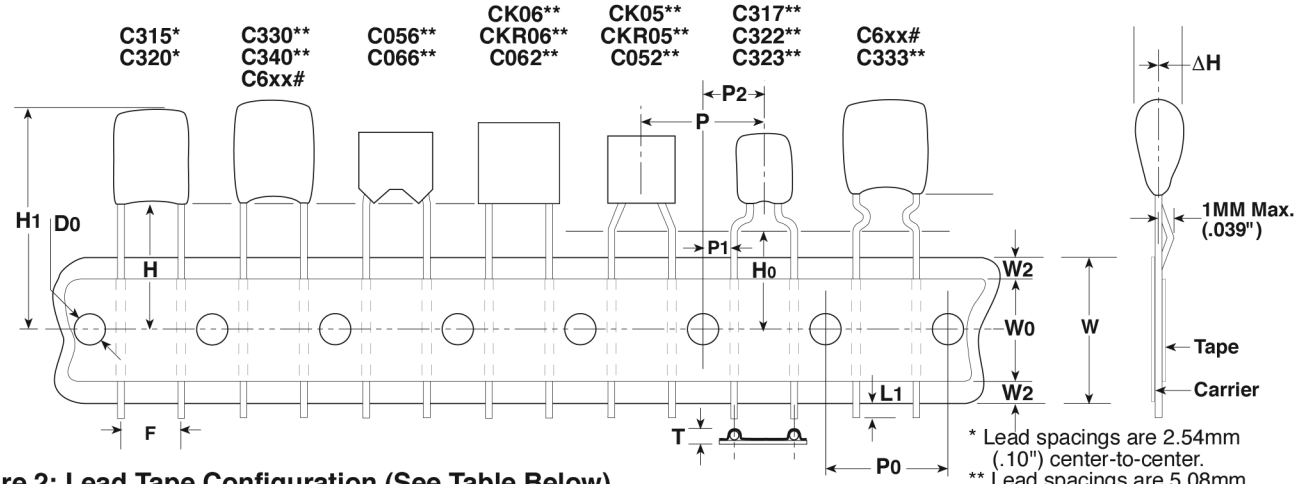


Figure 2: Lead Tape Configuration (See Table Below)

* Lead spacings are 2.54mm (.10") center-to-center.
** Lead spacings are 5.08mm (.20") center-to-center.
# See page 22 for exact lead configuration for Series.

Ceramic Radial Tape and Reel Dimensions in Millimeters (Inches)

Dimension	Symbol	Nominal mm (inch)		Tolerance mm (inch)		Dimension	Symbol	Nominal mm (inch)		Tolerance mm (inch)	
Sprocket Hole Diameter	Do	4.0 (.157)		± 0.2 (.008)		Height to Seating Plane (formed leads) (2)	H0	7301 16.0 (.630)	7303 18.0 (.709)	7301 ±0.5 (.020)	7303 Minimum
Sprocket Hole Pitch	P0	12.7 (.500)		± 0.3 (.012)		Component Alignment	Δh	4.0 (.157)		±0.2 (.008)	
Component Pitch	P	12.7 (.500)		± 0.3 (.012)		Lead Protrusion	L1	1.0 (.039)		Maximum	
Lead Spacing (1)	F	5.08 (.20)	2.54 (.10)	+0.6 -0.2 (+.024 -.008)		Composite Tape Thickness	t	0.7 (.051)		±0.2 (.008)	
Sprocket Hole Center to Lead Center (1)	P1	3.81 (.150)	5.08 (.200)	± 0.7 (.028)		Overall Tape and Lead Thickness	T	1.5 (.059)		Maximum	
Sprocket Hole Center to Component Center	P2	6.35 (.250)		± 1.3 (.051)		Carrier Tape Width	W	18.0 (.709)		+1.0 - 0.5 (+.039 -.020)	
Height to Seating Plane (straight leads) (2)	H	7301 16.0 (.630)	7303 18.0 (.709)	7301 ±0.5 (.020)	7303 Minimum	Hold-Down Tape Width	W0	5.0 (.197)		Minimum	
Component Height Above Tape Center	H1	32.2 (1.27)		Maximum		Hold-Down Tape Location	W2	3.0 (.118)		Maximum	

(1) Measured at the egress from the carrier tape, on the component side.
(2) Determined by a 4 digit suffix placed at the end of the part number, as follows:
7301 = Recommended for parts with formed leads. Example: C322C104K5R5CA7301
7303 = Recommended for parts with straight leads. Example: C320C104K5R5CA7303

CERAMIC PACKAGING

KEMET Series	Military Style	Military Specification	Standard (1) Bulk Quantity	Ammo Pack Quantity Maximum	Maximum Reel Quantity	Reel Size
C114C-K-G	CK12, CC75	MIL-C-11015/	200/Box		5000	12"
C124C-K-G	CK13, CC76	MIL-PRF-20	200/Box		5000	12"
C192C-K-G	CK14, CC77		100/Box		3000	12"
C202C-K	CK15		25/Box		500	12"
C222C-K	CK16		10/Tray		300	12"
C052C-K-G	CK05, CC05		100/Bag	2000	2000	12"
C062C-K-G	CK06, CC06		100/Bag	1500	1500	12"
C114G	CCR75	MIL-PRF-20	200/Box		5000	12"
C124G	CCR76		200/Box		5000	12"
C192G	CCR77		100/Box		3000	12"
C202G	CC78-CCR78		25/Box		500	12"
C222G	CC79-CCR79		10/Tray		300	12"
C052/56G	CCR05		100/Bag		1700	12"
C062/66G	CCR06		100/Bag		1500	12"
C512G	CC07-CCR07		Footnote (2)		N/A	N/A
C522G	CC08-CCR08		Footnote (2)		N/A	N/A
C114T	CKR11	MIL-PRF-39014	200/Box		5000	12"
C124T	CKR12		200/Box		5000	12"
C192T	CKR14		100/Box		3000	12"
C202T	CKR15		25/Box		500	12"
C222T	CKR16		10/Tray		300	12"
C052/56T	CKR05		100/Bag		1700	12"
C062/66T	CKR06		100/Bag		1500	12"
C31X			500/Bag	2500	2500	12"
C32X			500/Bag	2500	2500	12"
C33X			250/Bag	1500	1500	12"
C340			100/Bag	1000	1000	12"
C350			50/Bag	N/A	500	12"
C410			300/Box	4000	5000	12"
C412			200/Box	4000	5000	12"
C420			300/Box	4000	5000	12"
C430			200/Box	2000	2500	12"
C440			200/Box	2000	2500	12"
C512	N/A	N/A	Footnote (2)		N/A	N/A
C522	N/A	N/A	Footnote (2)		N/A	N/A
C617			250/Bag		1000	12"
C622/C623			100/Bag		500	12"
C627/C628			100/Bag		500	12"
C630/C631			100/Bag		500	12"
C637/C638			50/Bag		500	12"
C640/C641			50/Bag		500	12"
C642/C643			50/Bag		500	12"
C647/C648			50/Bag		500	12"
C657/C658			50/Bag		500	12"
C667/C668			50/Bag		500	12"

NOTE: (1) Standard packaging refers to number of pieces per bag, tray or vial.
(2) Quantity varies. For further details, please consult the factory.

Section 3: Introduction

Foreword

AVX offers a broad line of solid Tantalum capacitors in a wide range of sizes, styles, and ratings to meet any design needs. This catalog combines into one source AVX's leaded tantalum capacitor information from its worldwide tantalum operations.

The TAP/TEP is rated for use from -55°C to +85°C at rated voltage and up to +125°C with voltage derating. There are three preferred wire forms to choose from which are available on tape and reel, and in bulk for hand insertion.

Four sizes of molded axials, the TAR series, are also available. The TAR is fully marked and available on tape and reel for high speed insertion. The TAA is a hermetically sealed series also with four case sizes available.

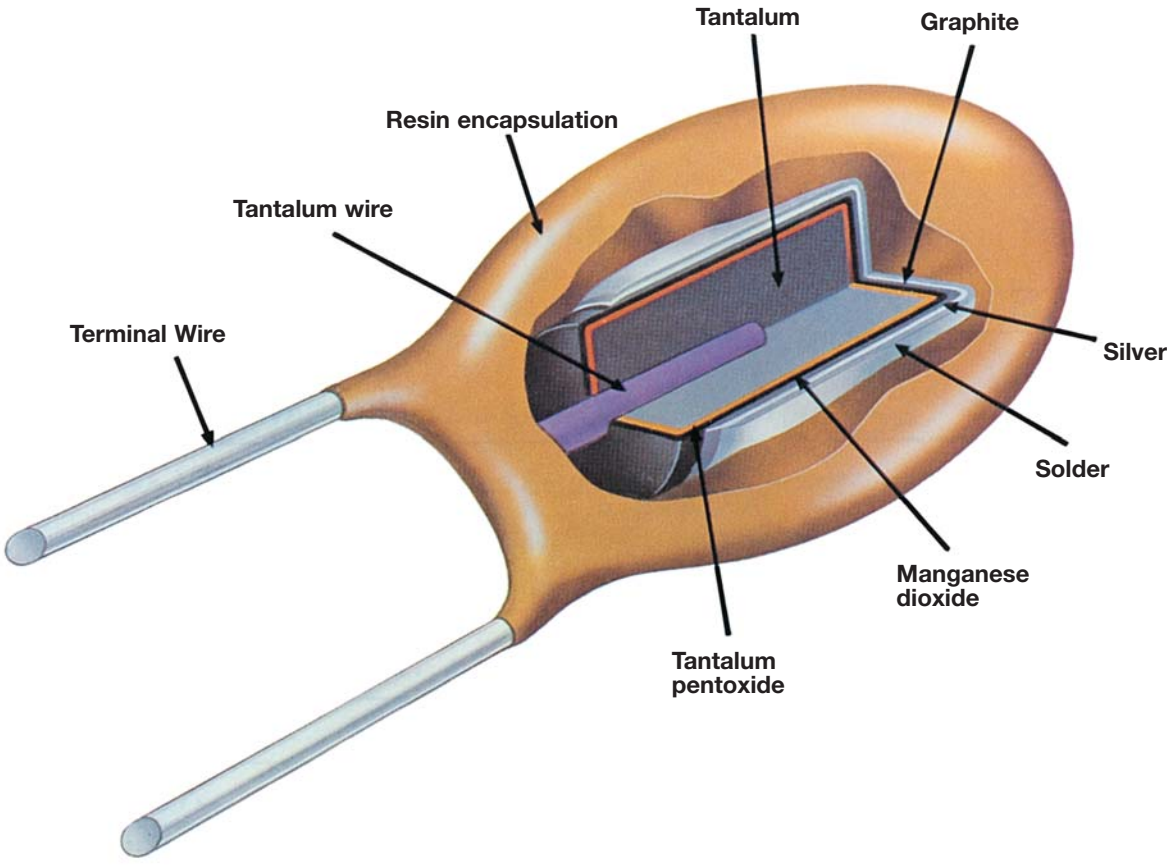
AVX has a complete tantalum applications service available for use by all our customers. With the capability to prototype and mass produce solid tantalum capacitors in special configurations, almost any design need can be fulfilled. And if the customer requirements are outside our standard testing, AVX will work with you to define and implement a test or screening plan.

AVX is determined to become the world leader in tantalum capacitor technology and has made, and is continuing to make, significant investments in equipment and research to reach that end. We believe that the investment has paid off with the devices shown on the following pages.

Dipped Radial Capacitors

SOLID TANTALUM RESIN DIPPED SERIES TAP/TEP

The TAP/TEP resin dipped series of miniature tantalum capacitors is available for individual needs in both commercial and professional applications. From computers to automotive to industrial, AVX has a dipped radial for almost any application.

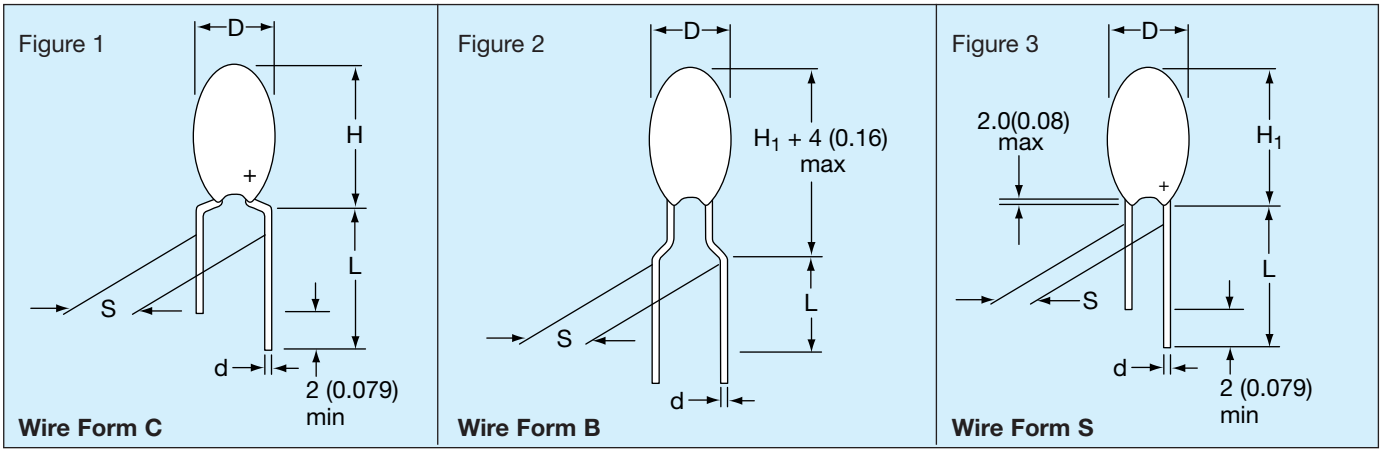


Dipped Radial Capacitors

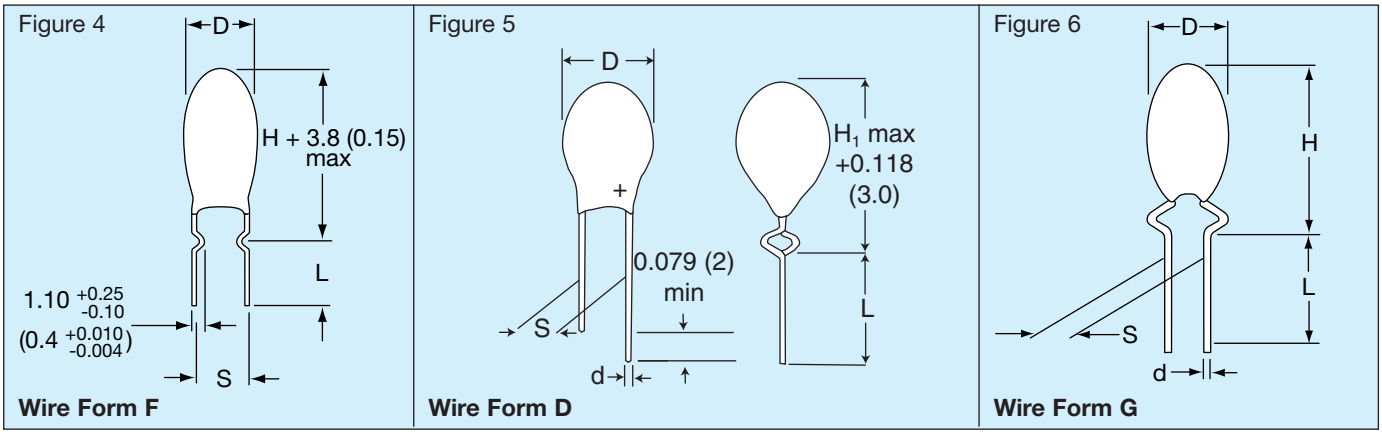
Wire Form Outline

SOLID TANTALUM RESIN DIPPED TAP/TEP

Preferred Wire Forms



Non-Preferred Wire Forms (Not recommended for new designs)



DIMENSIONS

millimeters (inches)

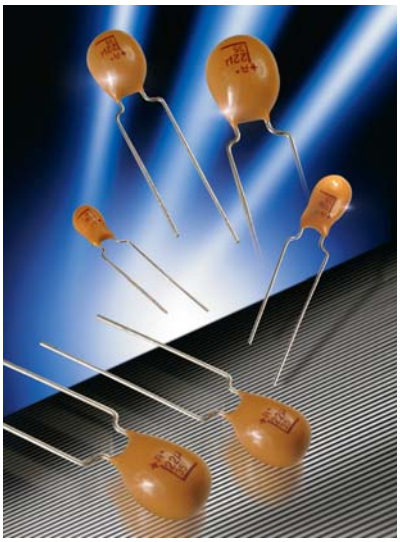
Wire Form	Figure	Case Size	L (see note 1)	S	d	Packaging Suffixes Available*
Preferred Wire Forms						
C	Figure 1	A - R*	16.0±4.00 (0.630±0.160)	5.00±1.00 (0.200±0.040)	0.50±0.05 (0.020±0.002)	CCS Bulk CRW Tape/Reel CRS Tape/Ammo
B	Figure 2	A - J*	16.0±4.00 (0.630±0.160)	5.00±1.00 (0.200±0.040)	0.50±0.05 (0.020±0.002)	BRW Tape/Reel BRS Tape/Ammo
S	Figure 3	A - J*	16.0±4.00 (0.630±0.160)	2.50±0.50 (0.100±0.020)	0.50±0.05 (0.020±0.002)	SCS Bulk SRW Tape/Reel SRS Tape/Ammo
Non-Preferred Wire Forms (Not recommended for new designs)						
F	Figure 4	A - R	3.90±0.75 (0.155±0.030)	5.00±0.50 (0.200±0.020)	0.50±0.05 (0.020±0.002)	FCS Bulk
D	Figure 5	A - H*	16.0±4.00 (0.630±0.160)	2.50±0.75 (0.100±0.020)	0.50±0.05 (0.020±0.002)	DCS Bulk DTW Tape/Reel DTS Tape/Ammo
G	Figure 6	A - J	16.0±4.00 (0.630±0.160)	3.18±0.50 (0.125±0.020)	0.50±0.05 (0.020±0.002)	GSB Bulk
H	Similar to Figure 1	A - R	16.0±4.00 (0.630±0.160)	6.35±1.00 (0.250±0.040)	0.50±0.05 (0.020±0.002)	HSB Bulk

Notes: (1) Lead lengths can be supplied to tolerances other than those above and should be specified in the ordering information.
(2) For D, H, and H_1 dimensions, refer to individual product on following pages.
* For case size availability in tape and reel, please refer to pages 87-88.

Dipped Radial Capacitors

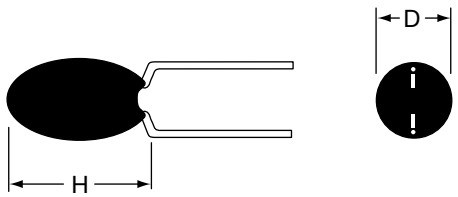
TAP Series

SOLID TANTALUM RESIN DIPPED CAPACITORS



TAP is a professional grade device manufactured with a flame retardant coating and featuring low leakage current and impedance, very small physical sizes and exceptional temperature stability. It is designed and conditioned to operate to +125°C (see page 122 for voltage derating above 85°C) and is available loose or taped and reeled for auto insertion. The 15 case sizes with wide capacitance and working voltage ranges means the TAP can accommodate almost any application.

MAXIMUM CASE DIMENSIONS: millimeters (inches)



Wire	C, F, G, H	B, S, D	
Case	H	*H_1	D
A	8.50 (0.330)	7.00 (0.280)	4.50 (0.180)
B	9.00 (0.350)	7.50 (0.300)	4.50 (0.180)
C	10.0 (0.390)	8.50 (0.330)	5.00 (0.200)
D	10.5 (0.410)	9.00 (0.350)	5.00 (0.200)
E	10.5 (0.410)	9.00 (0.350)	5.50 (0.220)
F	11.5 (0.450)	10.0 (0.390)	6.00 (0.240)
G	11.5 (0.450)	10.0 (0.390)	6.50 (0.260)
H	12.0 (0.470)	10.5 (0.410)	7.00 (0.280)
J	13.0 (0.510)	11.5 (0.450)	8.00 (0.310)
K	14.0 (0.550)	12.5 (0.490)	8.50 (0.330)
L	14.0 (0.550)	12.5 (0.490)	9.00 (0.350)
M	14.5 (0.570)	13.0 (0.510)	9.00 (0.350)
N	16.0 (0.630)		9.00 (0.350)
P	17.0 (0.670)		10.0 (0.390)
R	18.5 (0.730)		10.0 (0.390)

HOW TO ORDER

TAP	475	M	035	SCS
Type	**Capacitance Code** pF code: 1st two digits represent significant figures, 3rd digit represents multiplier (number of zeros to follow)	**Capacitance Tolerance** K = ±10% M = ±20% (For J = ±5% tolerance, please consult factory)	**Rated DC Voltage**	**Suffix indicating wire form and packaging** (see page 80)

Dipped Radial Capacitors

TAP Series

TECHNICAL SPECIFICATIONS

Technical Data:		All technical data relate to an ambient temperature of +25°C						
Capacitance Range:		0.1 µF to 330 µF						
Capacitance Tolerance:		±20%; ±10% (±5% consult your AVX representative for details)						
Rated Voltage DC (V_R)	≦+85°C:	6.3	10	16	20	25	35	50
Category Voltage (V_C)	≦+125°C:	4	6.3	10	13	16	23	33
Surge Voltage (V_S)	≦+85°C:	8	13	20	26	33	46	65
	≦+125°C:	5	9	12	16	21	28	40
Temperature Range:		-55°C to +125°C						
Environmental Classification:		55/125/56 (IEC 68-2)						
Dissipation Factor:		≦0.04 for C_R 0.1-1.5µF						
		≦0.06 for C_R 2.2-6.8µF						
		≦0.08 for C_R 10-68µF						
		≦0.10 for C_R 100-330µF						
Reliability:		1% per 1000 hrs. at 85°C with 0.1Ω/V series impedance, 60% confidence level.						
Qualification:		CECC 30201 - 032						

Capacitance Range (letter denotes case size)

Capacitance		Rated voltage DC (V_R)						
µF	Code	6.3V	10V	16V	20V	25V	35V	50V
0.1	104						A	A
0.15	154						A	A
0.22	224						A	A
0.33	334						A	A
0.47	474						A	A
0.68	684						A	B
1.0	105				A	A	A	C
1.5	155			A	A	A	A	D
2.2	225		A	A	A	A	B	E
3.3	335	A	A	A	B	B	C	F
4.7	475	A	A	B	C	C	E	G
6.8	685	A	B	C	D	D	F	H
10	106	B	C	D	E	E	F	J
15	156	C	D	E	F	F	H	K
22	226	D	E	F	H	H	K	L
33	336	E	F	F	J	J	M	
47	476	F	G	J	K	M	N	
68	686	G	H	L	N	N		
100	107	H	K	N	N			
150	157	K	N	N				
220	227	M	P	R				
330	337	P	R					

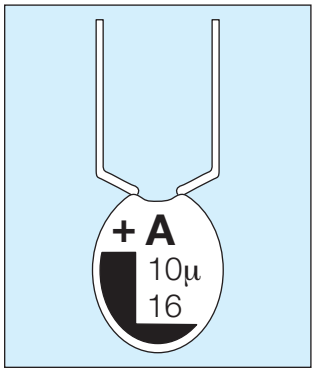
Values outside this standard range may be available on request.
AVX reserves the right to supply capacitors to a higher voltage rating, in the same case size, than that ordered.

MARKING

Polarity, capacitance, rated DC voltage, and an "A" (AVX logo) are laser marked on the capacitor body which is made of flame retardant gold epoxy resin with a limiting oxygen index in excess of 30 (ASTM-D-2863).

- Polarity
- Capacitance
- Voltage
- AVX logo

- Tolerance code:
  ±20% = Standard (no marking)
  ±10% = "K" on reverse side of unit
  ±5% = "J" on reverse side of unit



Dipped Radial Capacitors

TAP Series

RATINGS AND PART NUMBER REFERENCE

AVX Part No.	Case Size	Capacitance µF	DCL (µA) Max.	DF % Max.	ESR Max. (Ω) @ 100 kHz
6.3 volt @ 85°C (4 volt @ 125°C)					
TAP 335(*)006	A	3.3	0.5	6	13.0
TAP 475(*)006	A	4.7	0.5	6	10.0
TAP 685(*)006	A	6.8	0.5	6	8.0
TAP 106(*)006	B	10	0.5	8	6.0
TAP 156(*)006	C	15	0.8	8	5.0
TAP 226(*)006	D	22	1.1	8	3.7
TAP 336(*)006	E	33	1.7	8	3.0
TAP 476(*)006	F	47	2.4	8	2.0
TAP 686(*)006	G	68	3.4	8	1.8
TAP 107(*)006	H	100	5.0	10	1.6
TAP 157(*)006	K	150	7.6	10	0.9
TAP 227(*)006	M	220	11.0	10	0.9
TAP 337(*)006	P	330	16.6	10	0.7
10 volt @ 85°C (6.3 volt @ 125°C)					
TAP 225(*)010	A	2.2	0.5	6	13.0
TAP 335(*)010	A	3.3	0.5	6	10.0
TAP 475(*)010	A	4.7	0.5	6	8.0
TAP 685(*)010	B	6.8	0.5	6	6.0
TAP 106(*)010	C	10	0.8	8	5.0
TAP 156(*)010	D	15	1.2	8	3.7
TAP 226(*)010	E	22	1.7	8	2.7
TAP 336(*)010	F	33	2.6	8	2.1
TAP 476(*)010	G	47	3.7	8	1.7
TAP 686(*)010	H	68	5.4	8	1.3
TAP 107(*)010	K	100	8.0	10	1.0
TAP 157(*)010	N	150	12.0	10	0.8
TAP 227(*)010	P	220	17.6	10	0.6
TAP 337(*)010	R	330	20.0	10	0.5
16 volt @ 85°C (10 volt @ 125°C)					
TAP 155(*)016	A	1.5	0.5	4	10.0
TAP 225(*)016	A	2.2	0.5	6	8.0
TAP 335(*)016	A	3.3	0.5	6	6.0
TAP 475(*)016	B	4.7	0.6	6	5.0
TAP 685(*)016	C	6.8	0.8	6	4.0
TAP 106(*)016	D	10	1.2	8	3.2
TAP 156(*)016	E	15	1.9	8	2.5
TAP 226(*)016	F	22	2.8	8	2.0
TAP 336(*)016	F	33	4.2	8	1.6
TAP 476(*)016	J	47	6.0	8	1.3
TAP 686(*)016	L	68	8.7	8	1.0
TAP 107(*)016	N	100	12.8	10	0.8
TAP 157(*)016	N	150	19.2	10	0.6
TAP 227(*)016	R	220	20.0	10	0.5
20 volt @ 85°C (13 volt @ 125°C)					
TAP 105(*)020	A	1.0	0.5	4	10.0
TAP 155(*)020	A	1.5	0.5	4	9.0
TAP 225(*)020	A	2.2	0.5	6	7.0
TAP 335(*)020	B	3.3	0.5	6	5.5
TAP 475(*)020	C	4.7	0.7	6	4.5
TAP 685(*)020	D	6.8	1.0	6	3.6
TAP 106(*)020	E	10	1.6	8	2.9
TAP 156(*)020	F	15	2.4	8	2.3
TAP 226(*)020	H	22	3.5	8	1.8

AVX Part No.	Case Size	Capacitance µF	DCL (µA) Max.	DF % Max.	ESR Max. (Ω) @ 100 kHz
20 volt @ 85°C (13 volt @ 125°C) continued					
TAP 336(*)020	J	33	5.2	8	1.4
TAP 476(*)020	K	47	7.5	8	1.2
TAP 686(*)020	N	68	10.8	8	0.9
TAP 107(*)020	N	100	16.0	10	0.6
25 volt @ 85°C (16 volt @ 125°C)					
TAP 105(*)025	A	1.0	0.5	4	10.0
TAP 155(*)025	A	1.5	0.5	4	8.0
TAP 225(*)025	A	2.2	0.5	6	6.0
TAP 335(*)025	B	3.3	0.6	6	5.0
TAP 475(*)025	C	4.7	0.9	6	4.0
TAP 685(*)025	D	6.8	1.3	6	3.1
TAP 106(*)025	E	10	2.0	8	2.5
TAP 156(*)025	F	15	3.0	8	2.0
TAP 226(*)025	H	22	4.4	8	1.5
TAP 336(*)025	J	33	6.6	8	1.2
TAP 476(*)025	M	47	9.4	8	1.0
TAP 686(*)025	N	68	13.6	8	0.8
35 volt @ 85°C (23 volt @ 125°C)					
TAP 104(*)035	A	0.1	0.5	4	26.0
TAP 154(*)035	A	0.15	0.5	4	21.0
TAP 224(*)035	A	0.22	0.5	4	17.0
TAP 334(*)035	A	0.33	0.5	4	15.0
TAP 474(*)035	A	0.47	0.5	4	13.0
TAP 684(*)035	A	0.68	0.5	4	10.0
TAP 105(*)035	A	1.0	0.5	4	8.0
TAP 155(*)035	A	1.5	0.5	4	6.0
TAP 225(*)035	B	2.2	0.6	6	5.0
TAP 335(*)035	C	3.3	0.9	6	4.0
TAP 475(*)035	E	4.7	1.3	6	3.0
TAP 685(*)035	F	6.8	1.9	6	2.5
TAP 106(*)035	F	10	2.8	8	2.0
TAP 156(*)035	H	15	4.2	8	1.6
TAP 226(*)035	K	22	6.1	8	1.3
TAP 336(*)035	M	33	9.2	8	1.0
TAP 476(*)035	N	47	10.0	8	0.8
50 volt @ 85°C (33 volt @ 125°C)					
TAP 104(*)050	A	0.1	0.5	4	26.0
TAP 154(*)050	A	0.15	0.5	4	21.0
TAP 224(*)050	A	0.22	0.5	4	17.0
TAP 334(*)050	A	0.33	0.5	4	15.0
TAP 474(*)050	A	0.47	0.5	4	13.0
TAP 684(*)050	B	0.68	0.5	4	10.0
TAP 105(*)050	C	1.0	0.5	4	8.0
TAP 155(*)050	D	1.5	0.6	4	6.0
TAP 225(*)050	E	2.2	0.8	6	3.5
TAP 335(*)050	F	3.3	1.3	6	3.0
TAP 475(*)050	G	4.7	1.8	6	2.5
TAP 685(*)050	H	6.8	2.7	6	2.0
TAP 106(*)050	J	10	4.0	8	1.6
TAP 156(*)050	K	15	6.0	8	1.2
TAP 226(*)050	L	22	8.8	8	1.0

(*) Insert capacitance tolerance code; M for ±20%, K for ±10% and J for ±5%

NOTE: Voltage ratings are minimum values. AVX reserves the right to supply higher voltage ratings in the same case size.

Dipped Radial Capacitors

Tape and Reel Packaging

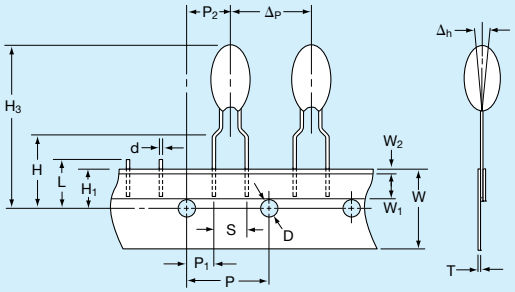
SOLID TANTALUM RESIN DIPPED TAP/TEP

TAPE AND REEL PACKAGING FOR AUTOMATIC COMPONENT INSERTION

TAP/TEP types are all offered on radial tape, in reel or 'ammo' pack format for use on high speed radial automatic insertion equipment, or preforming machines.

The tape format is compatible with EIA 468A standard for component taping set out by major manufacturers of radial automatic insertion equipment.

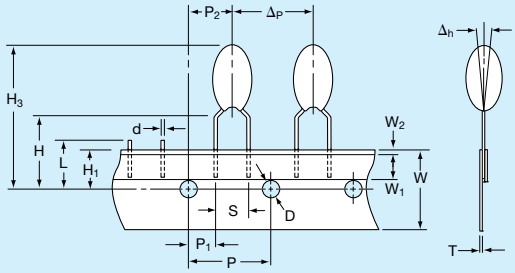
TAP/TEP – available in three formats. See page 88 for dimensions.



'B' wires for normal automatic insertion on 5mm pitch.

BRW suffix for reel
BRS suffix for 'ammo' pack

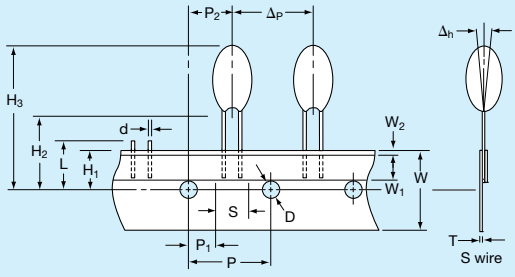
Available in case sizes A - J



'C' wires for preforming.

CRW suffix for reel
CRS suffix for 'ammo' pack

Available in case sizes A - R



'S' and 'D' wire for special applications, automatic insertion on 2.5mm pitch.

SRW, DTW suffix for reel
SRS, DTS suffix for 'ammo' pack
Available in case sizes A - J

Dipped Radial Capacitors

Tape and Reel Packaging

SOLID TANTALUM RESIN DIPPED TAP/TEP

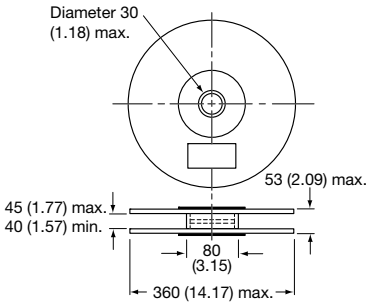
DIMENSIONS:

millimeters (inches)

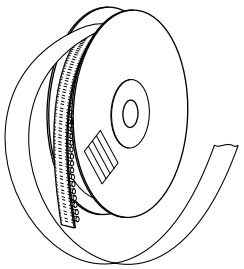
Description	Code	Dimension
Feed hole pitch	P	12.7 ± 0.30 (0.500 ± 0.010)
Hole center to lead	P_1	3.85 ± 0.70 (0.150 ± 0.030) to be measured at bottom of clench
		5.05 ± 1.00 (0.200 ± 0.040) for S wire
Hole center to component center	P_2	6.35 ± 0.40 (0.250 ± 0.020)
Change in pitch	Δp	± 1.00 (± 0.040)
Lead diameter	d	0.50 ± 0.05 (0.020 ± 0.003)
Lead spacing	S	See wire form table
Component alignment	Δh	0 ± 2.00 (0 ± 0.080)
Feed hole diameter	D	4.00 ± 0.20 (0.150 ± 0.008)
Tape width	W	18.0 + 1.00 - 0.50 (0.700 + 0.040 - 0.020)
Hold down tape width	W_1	6.00 (0.240) min.
Hold down tape position	W_2	1.00 (0.040) max.
Lead wire clench height	H	16.0 ± 0.50 (0.630 ± 0.020) 19.0 ± 1.00 (0.750 ± 0.040) on request
Hole position	H_1	9.00 ± 0.50 (0.350 ± 0.020)
Base of component height	H_2	18.0 (0.700) min. (S wire only)
Component height	H_3	32.25 (1.300) max.
Length of snipped lead	L	11.0 (0.430) max.
Total tape thickness	T	0.70 ± 0.20 (0.030 ± 0.001)
		Carrying card 0.50 ± 0.10 (0.020 ± 0.005)

REEL CONFIGURATION AND DIMENSIONS:

millimeters (inches)



Manufactured from cardboard with plastic hub.



Holding tape outside. Positive terminal leading.

PACKAGING QUANTITIES

For Reels

Style	Case size	No. of pieces
TAP TEP	A	1500
	B, C, D	1250
	E, F	1000
	G, H, J	750
	K, L, M, N, P, R	500

For 'Ammo' pack

Style	Case size	No. of pieces
TAP TEP	A, B, C, D	3000
	E, F, G	2500
	H, J	2000
	K, L, M, N, P, R	1000

For bulk products

Style	Case size	No. of pieces
TAP TEP	A to H	1000
	J to L	500
	M to R	100

AMMO PACK DIMENSIONS

millimeters (inches) max.

Height 360 (14.17), width 360 (14.17), thickness 60 (2.36)

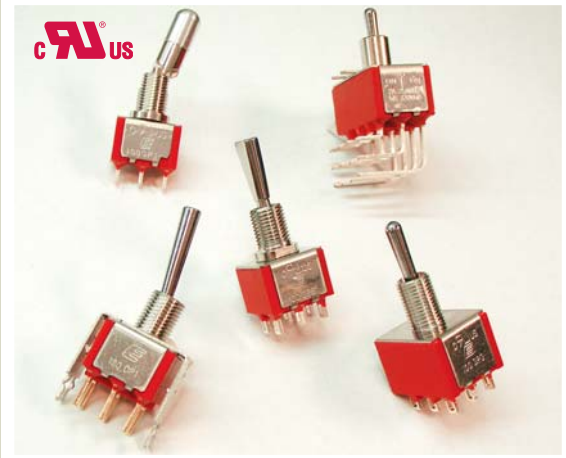
GENERAL NOTES

Resin dipped tantalum capacitors are only available taped in the range of case sizes and in the modular quantities by case size as indicated.

Packaging quantities on tape may vary by ±1%.

SERIES 100 SWITCHES

TOGGLE SWITCHES - MINIATURE



FEATURES & BENEFITS

- Up to 4 poles available
- Variety of switching functions
- Miniature
- Multiple actuator & bushing options

APPLICATIONS/MARKETS

- Telecommunications
- Instrumentation
- Networking
- Medical equipment

SPECIFICATIONS

Contact Rating:	See contact material options
Life Expectancy:	40,000 make-and-break cycles at full load
Contact Resistance:	100 mΩ max. typical initial @ 2-4 VDC 100 mA for both silver and gold plated contacts
Insulation Resistance:	1,000 MΩ min.
Dielectric Strength:	1,000 V RMS @ sea level
Operating Temperature:	-30° C to 85° C

MATERIALS

Case:	Diallyl Phthalate (DAP)
Toggle Handle:	Brass, chrome plated
Switch Support:	Brass or steel, tin plated
Bushing:	Brass, nickel plated
Housing:	Stainless steel
Contacts / Terminals:	Silver or gold plated copper alloy

HOW TO ORDER

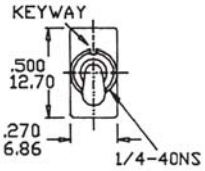
SERIES	MODEL NO.	ACTUATOR	BUSHING	TERMINATION	CONTACT MATERIAL	SEAL	HARDWARE
100	SP1 SP2* SP3 SP4* SP5* DP1 DP2* DP3 DP4* DP5* DP6 DP7* DP8* 3P1 3P2* 3P3 3P4* 3P5* 4P1 4P2* 4P3 4P4* 4P5* 4P6 4P7* 4P8*	T1† T2 T3 T4 T5 T6 T7 T8 T9 K1 K2 † Optional Toggle Cap (T1 Only): T100-1 = White T100-2 = Black	B1 B2 B3 B4 B5 B6 B8 B9 B11 B12 B13 B15 B16 B25** B26**	M1 M2 M3 M5 M6 M61 M7 M71 VS2 VS3 VS5* M64* VS21* VS31*	Q = Silver R = Gold	E = Epoxy Sealed at Base of Terminal	H = Hardware

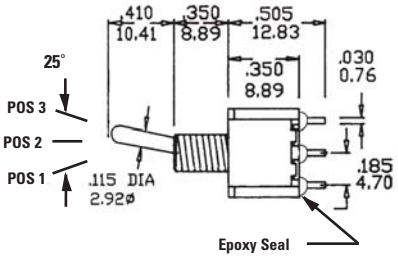
Example Ordering Number
100–SP1–T4–B2–M1–R–E

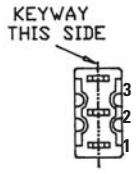
Notes: * Not available with the K1 and K2 actuator options.
** Available only with the K1 and K2 actuator options.

Specifications subject to change without notice.

SPDT





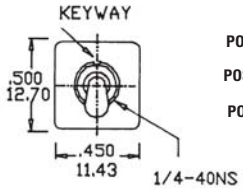


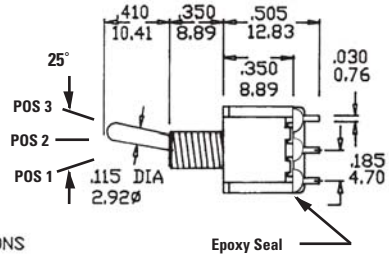
SCHEMATIC

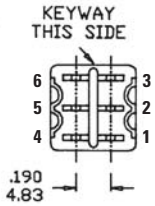
Model No.	POS 1	POS 2	POS 3
SP-1	ON	NONE	ON
SP-2	ON	NONE	(ON)
SP-3	ON	OFF	ON
SP-4	(ON)	OFF	(ON)
SP-5	ON	OFF	(ON)
Term. Comm.	2-3	OPEN	2-1

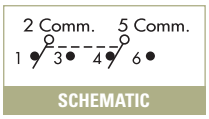
( ) = Momentary

DPDT







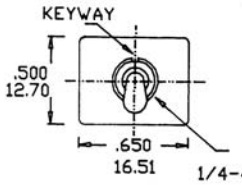


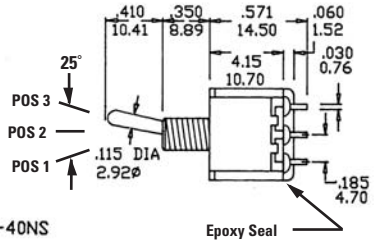
SCHEMATIC

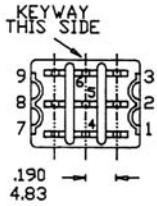
Model No.	POS 1	POS 2	POS 3
DP-1	ON	NONE	ON
DP-2	ON	NONE	(ON)
DP-3	ON	OFF	ON
DP-4	(ON)	OFF	(ON)
DP-5	ON	OFF	(ON)
DP-7	ON	ON	(ON)
DP-8	(ON)	ON	(ON)
Term. Comm.	2-3, 5-6	OPEN	2-1, 5-4
DP-6	ON	ON	ON
Term. Comm.	2-3, 5-6	2-3, 5-4	2-1, 5-4

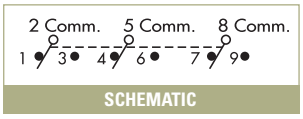
( ) = Momentary

3PDT







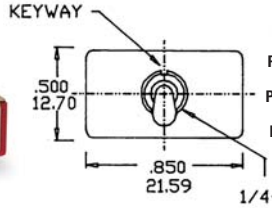


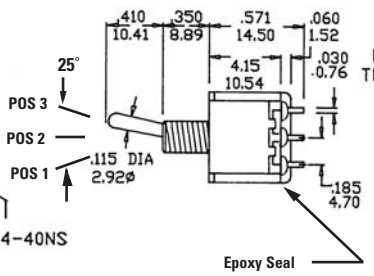
SCHEMATIC

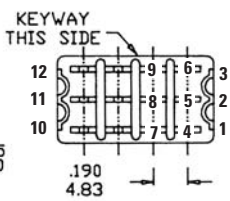
Model No.	POS 1	POS 2	POS 3
3P-1	ON	NONE	ON
3P-2	ON	NONE	(ON)
3P-3	ON	OFF	ON
3P-4	(ON)	OFF	(ON)
3P-5	ON	OFF	(ON)
Term. Comm.	2-3, 5-6 8-9	OPEN	2-1, 5-4 8-7

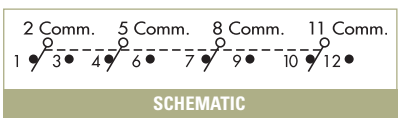
( ) = Momentary

4PDT









SCHEMATIC

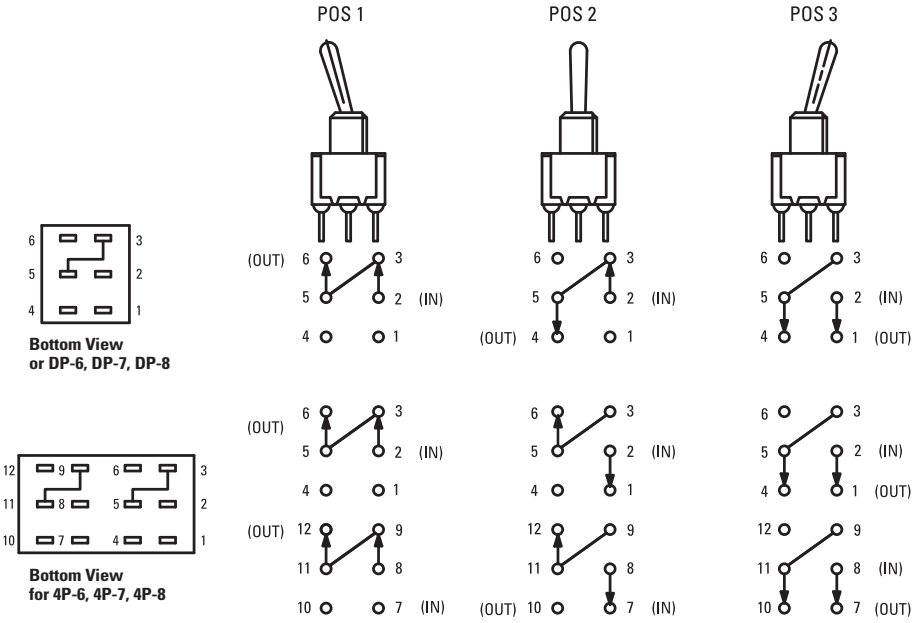
Model No.	POS 1	POS 2	POS 3
4P-1	ON	NONE	ON
4P-2	ON	NONE	(ON)
4P-3	ON	OFF	ON
4P-4	(ON)	OFF	(ON)
4P-5	ON	OFF	(ON)
4P-7	ON	ON	(ON)
4P-8	(ON)	ON	(ON)
Term. Comm.	2-3, 5-6 8-9 11-12	OPEN	2-1, 5-4 8-7 11-10
4P-6	ON	ON	ON
Term. Comm.	2-3, 5-6 8-9 11-12	2-3, 5-4 8-9 11-10	2-1, 5-4 8-7 11-10

( ) = Momentary

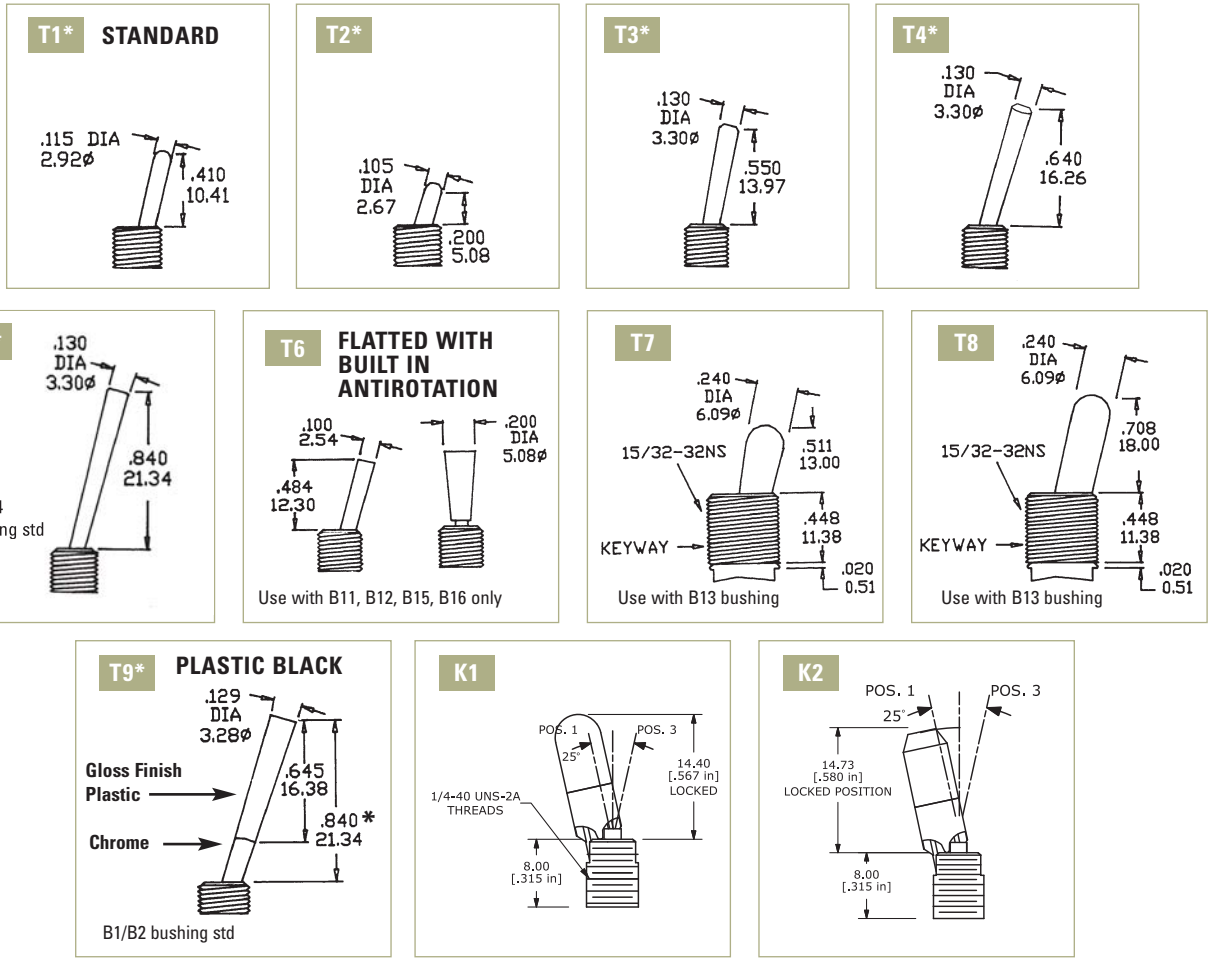
SERIES 100 SWITCHES

TOGGLE SWITCHES - MINIATURE

3 - WAY WIRING DIAGRAM SCHEMATICS



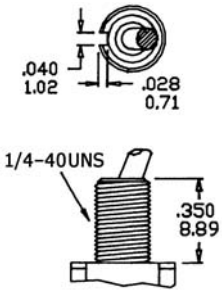
ACTUATOR OPTIONS



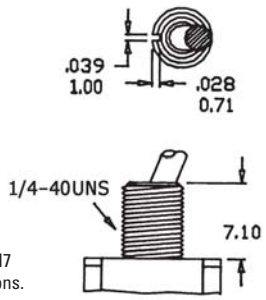
*Add .070 (1.78) for B3, B4 bushings, subtract .020 (0.51) for B6 bushing.

BUSHING OPTIONS

B1 THD STD
B2 NON-THD

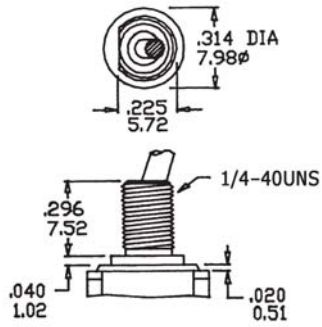


B3 THD STD
B4 NON-THD

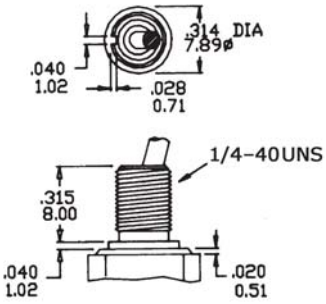


B4 is standard for M6, M7 and VS termination options.

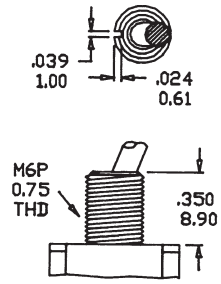
B5 HIGH TORQUE



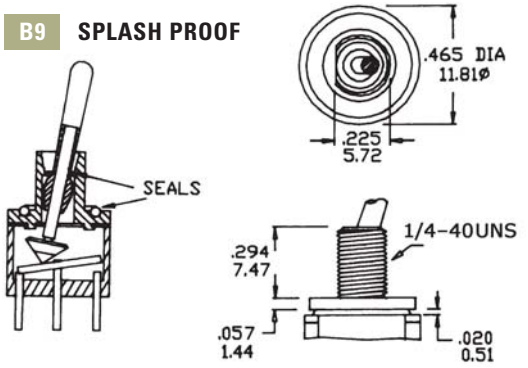
B6 HIGH TORQUE



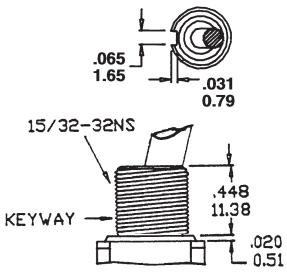
B8 METRIC THD



B9 SPLASH PROOF

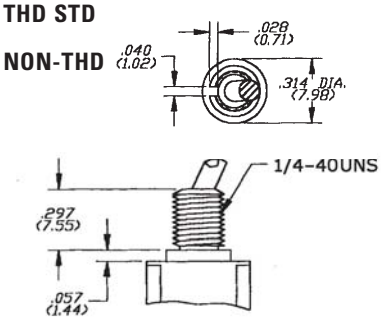


B13



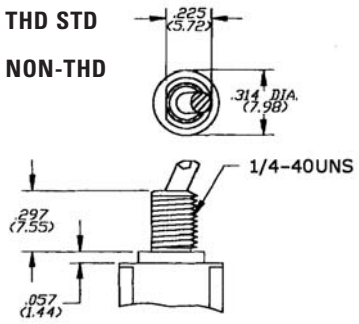
Use with T7 and T8 actuators only

B11 THD STD
B12 NON-THD



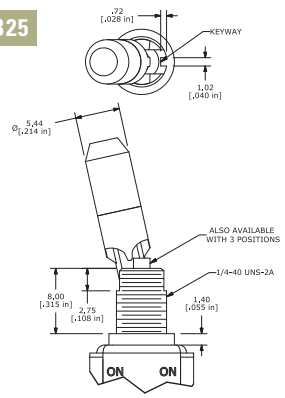
Use with T6 actuator only

B15 THD STD
B16 NON-THD

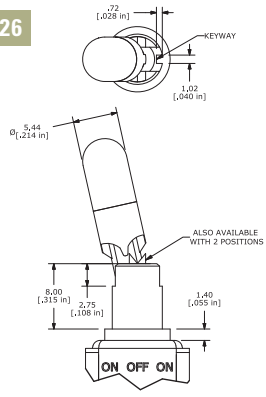


Use with T6 actuator only

B25



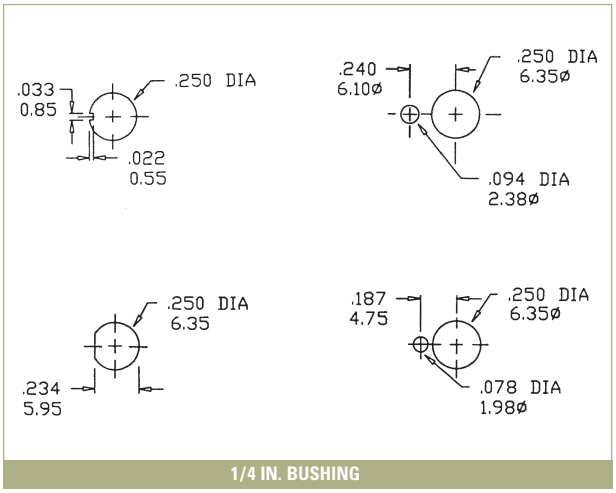
B26



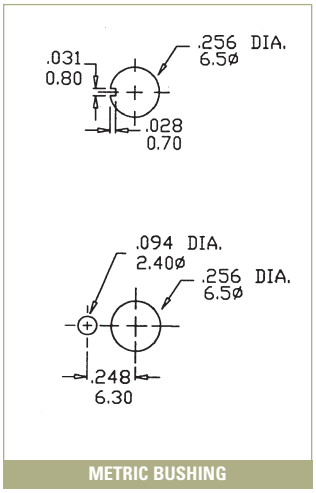
SERIES 100 SWITCHES

TOGGLE SWITCHES - MINIATURE

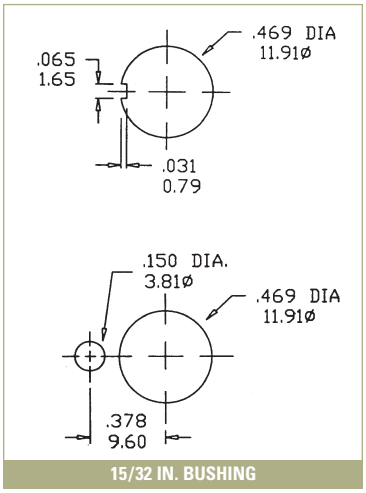
BUSHING OPTIONS - PANEL MOUNTING



1/4 IN. BUSHING



METRIC BUSHING

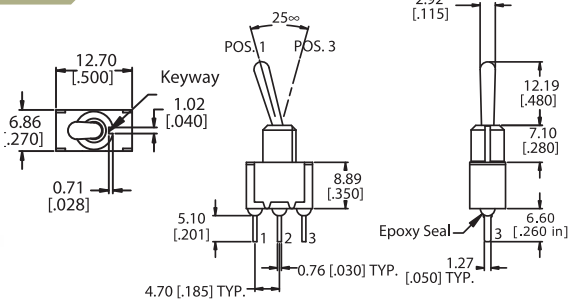


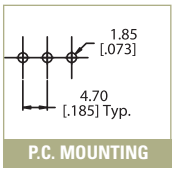
15/32 IN. BUSHING

TERMINATION OPTIONS

M2

SPDT

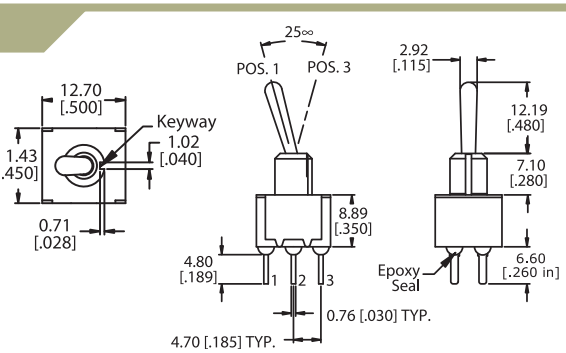


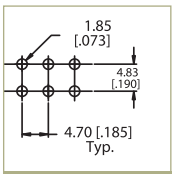


P.C. MOUNTING

M2

DPDT

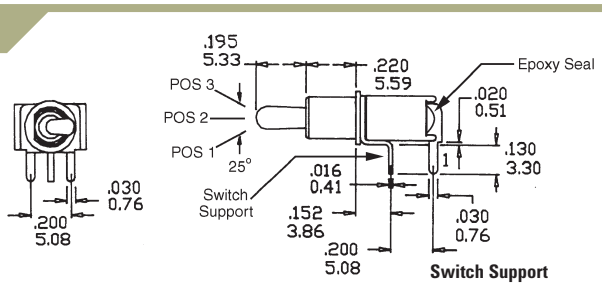




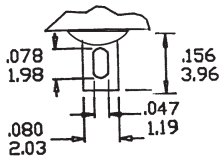
P.C. MOUNTING

M6

SPDT

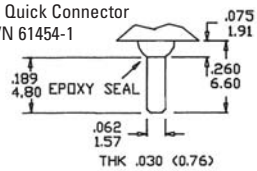


M1 SOLDER LUG



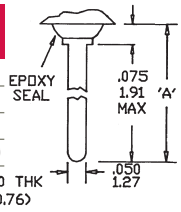
M3 QUICK CONNECT

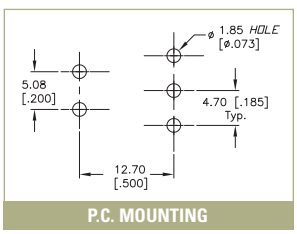
Mating Quick Connector
Amp P/N 61454-1



M5 WIRE WRAP

Option Code	Dim. 'A'
M51	.750 (18.7)
M52	.964 (24.48)
M53	.425 (10.80)
M54	1.062 (26.97)

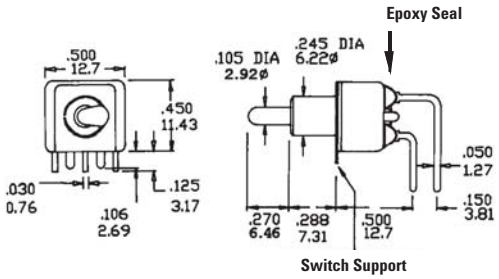


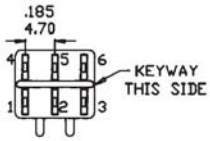


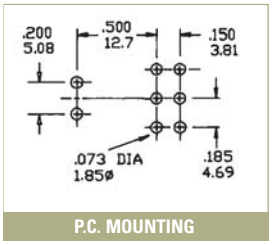
P.C. MOUNTING

M6

DPDT



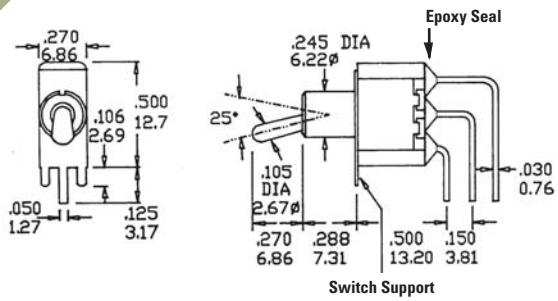


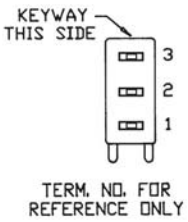


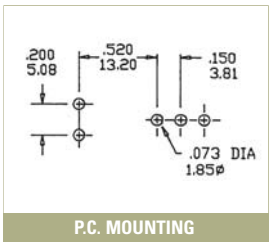
P.C. MOUNTING

M7

SPDT



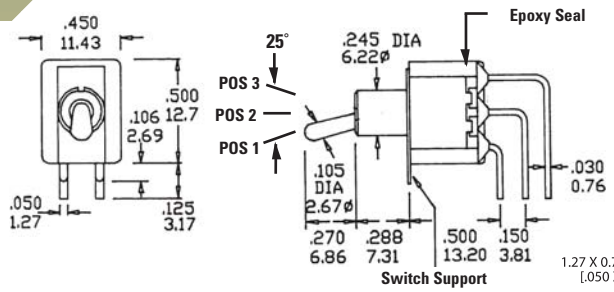


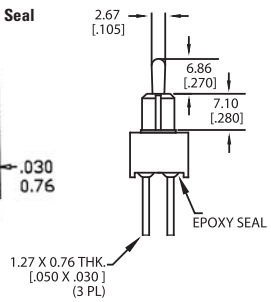


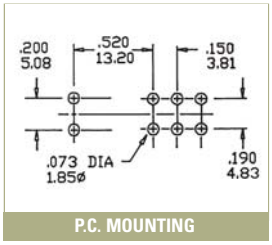
P.C. MOUNTING

M7

DPDT



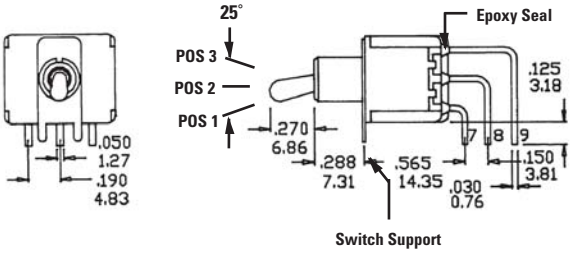


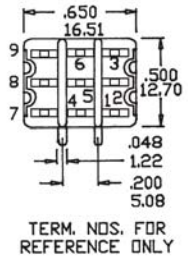


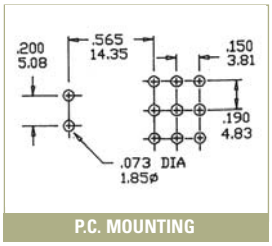
P.C. MOUNTING

M7

3PDT



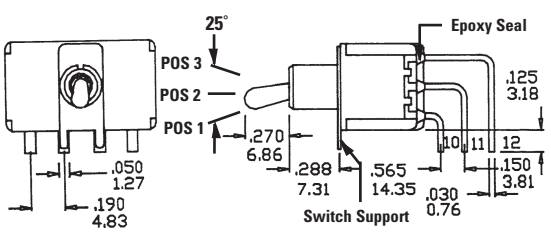


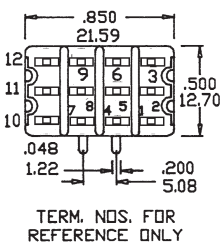


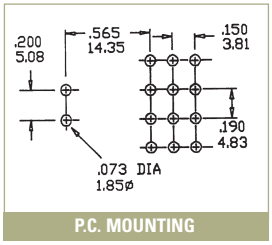
P.C. MOUNTING

M7

4PDT







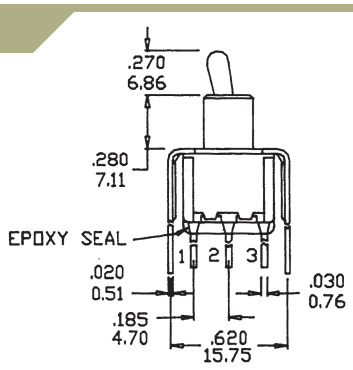
P.C. MOUNTING

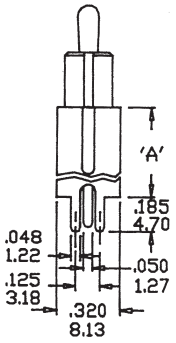
SERIES 100 SWITCHES

TOGGLE SWITCHES - MINIATURE

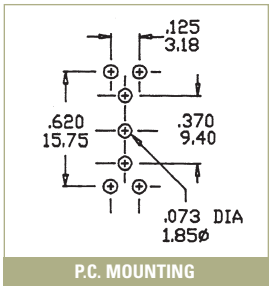
VS2-VS3

SPDT





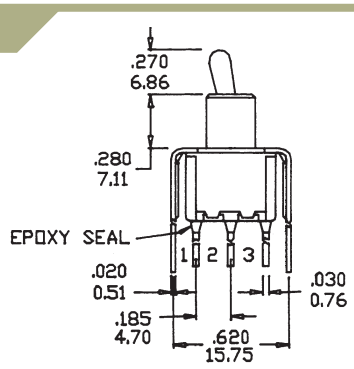
Option Code	Dim. 'A'
VS2	.460 (11.68)
VS3	.630 (16.00)

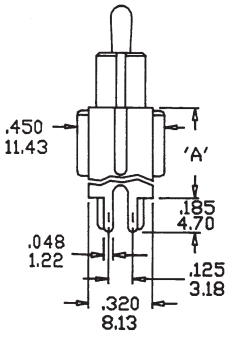


P.C. MOUNTING

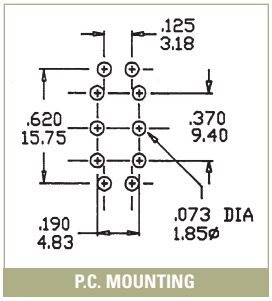
VS2-VS3

DPDT





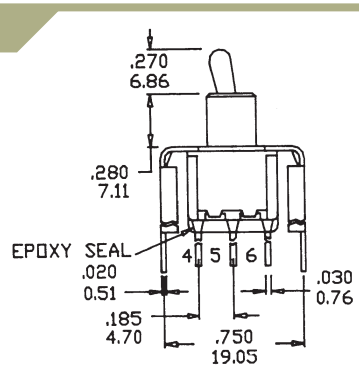
Option Code	Dim. 'A'
VS2	.460 (11.68)
VS3	.630 (16.00)

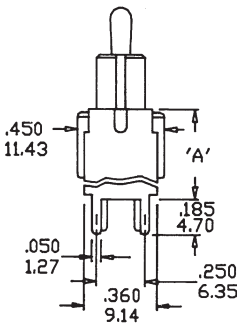


P.C. MOUNTING

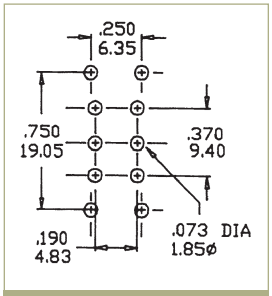
VS5

DPDT





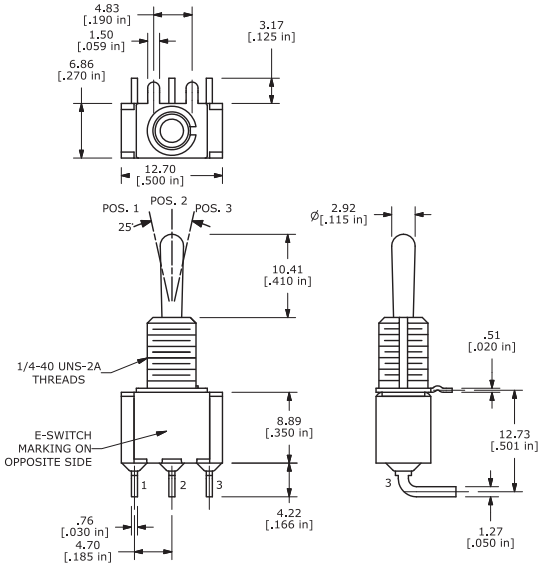
Option Code	Dim. 'A'
VS5	.630 (16.00)

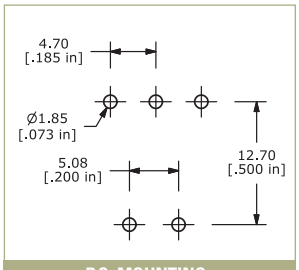


P.C. MOUNTING

M61

SPDT

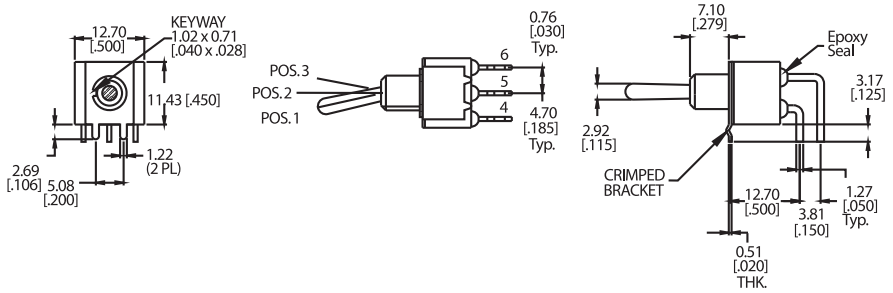


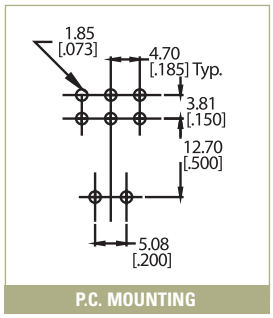


P.C. MOUNTING

M61

DPDT

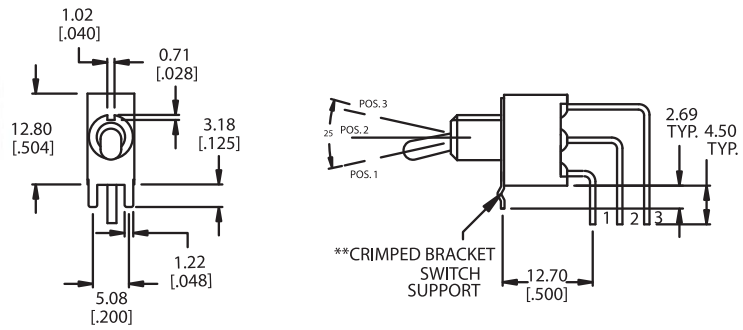


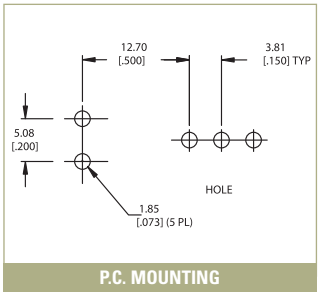


P.C. MOUNTING

M71

SPDT

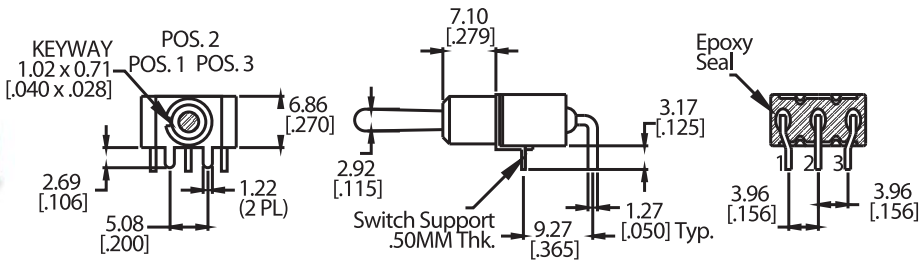


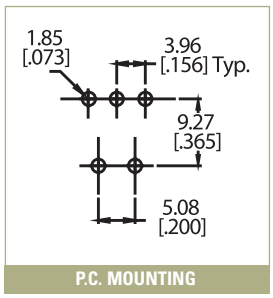


P.C. MOUNTING

M64

SPDT





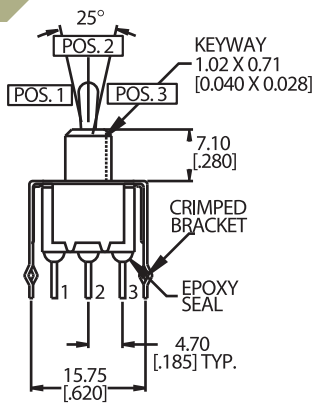
P.C. MOUNTING

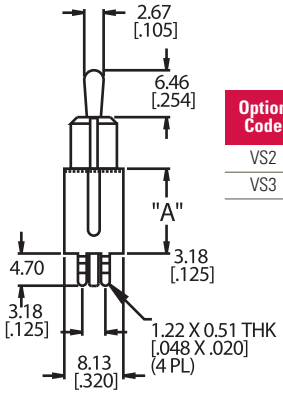
SERIES 100 SWITCHES

TOGGLE SWITCHES - MINIATURE

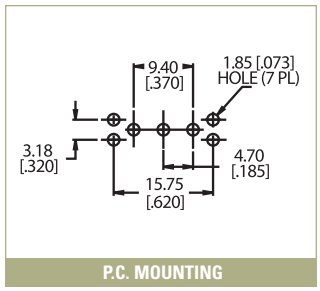
VS21-VS31

SPDT





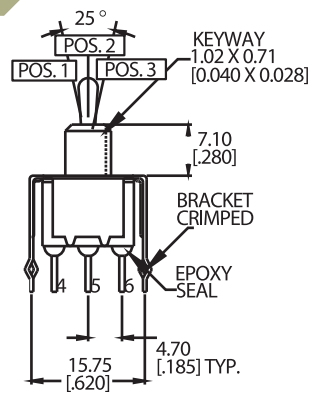
Option Code	Dim. 'A'
VS2	.460 (11.68)
VS3	.630 (16.00)

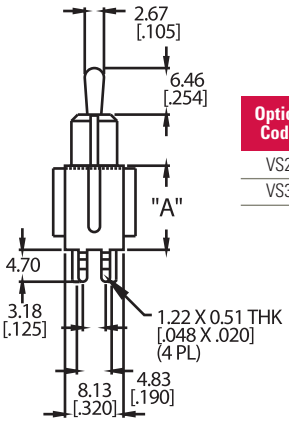


P.C. MOUNTING

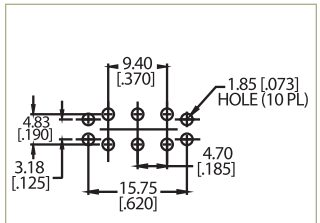
VS21-VS31

DPDT





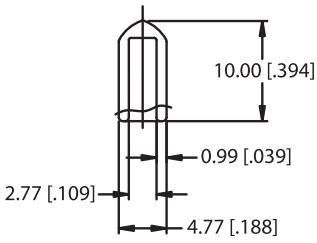
Option Code	Dim. 'A'
VS2	.460 (11.68)
VS3	.630 (16.00)



P.C. MOUNTING

OPTIONAL TOGGLE CAP

Use with T1
T100-1 WHITE
T100-2 BLACK



CONTACT MATERIAL OPTIONS

Q

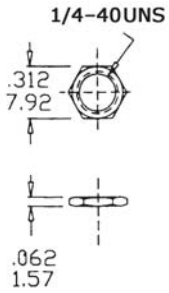
Fixed Terminal:	Silver plated over copper alloy
Moving Contact:	Silver plated over copper alloy
Rating:	5 Amps with resistive load @ 120VAC or 28VDC; 2 Amps with resistive load @ 250VAC

R

Fixed Terminal:	Copper alloy with gold plate over nickel plate
Moving Contact:	Copper alloy with gold plate over nickel plate
Rating:	0.4 Volt-Amps (VA) max. @ 20V max. (AC or DC)

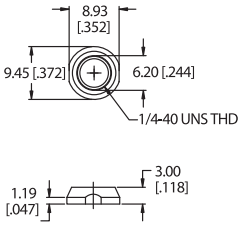
HARDWARE

HDW2 1/4 IN. NUTS

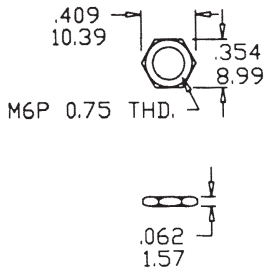


Supplied standard with
B1, B3, B5, B6 and B9 options

HDW3 BLIND DRESSNUT

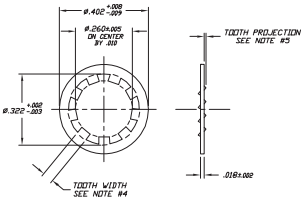


HDW6 METRIC NUT



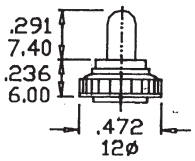
Supplied standard with B8
metric bushing

HDW11 LOCK WASHER



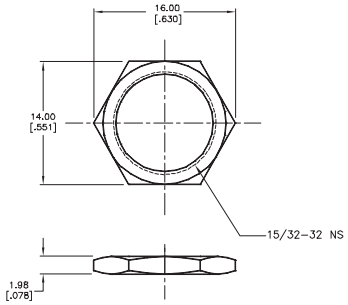
Supplied standard with B1/B3
bushing

Optional Rubber Hood Sealing E1



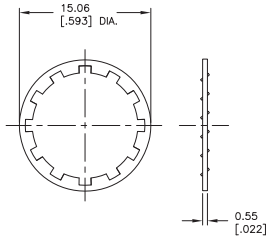
E1= Inch (Std.) for actuator T1, T2 and bushings
B1, B3, B5, B6 Optional rubber boot sealing

HDW4 15/32 IN. NUTS



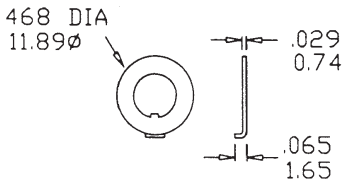
Supplied standard with B13 bushing

HDW12 LOCK WASHER



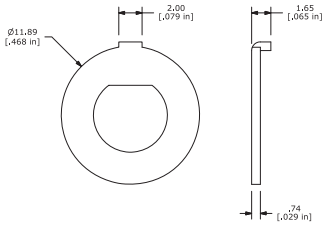
Supplied standard with B13 bushing

HDW15 LOCKING RING



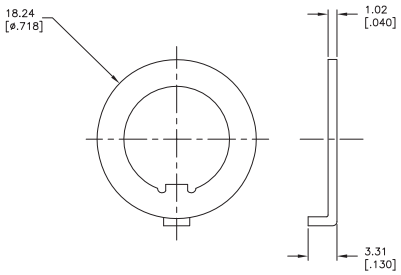
Supplied standard

HDW16 LOCKING RING



Supplied with B5 bushing

HDW17 LOCKING RING



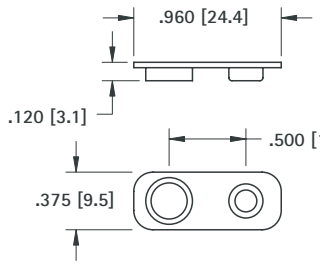
Supplied with B13 bushing

PROTECTIVE BATTERY CAP

- Protects 9 Volt batteries and battery packs when they are not in use
- Snap-fits onto battery contacts
- Both male and female contacts are covered, minimizing physical damage which can occur during battery handling, shipping and storage
- Shields the battery contacts and reduces the potential of a short circuit between battery poles
- Protects sensitive electronic equipment, systems and circuits, cap prevents unwanted electrical discharges
- Protects the battery contacts from damage due to dust, dirt and contamination

MATERIAL:
Impact Resistant Polypropylene, Black

CAT. NO. 96

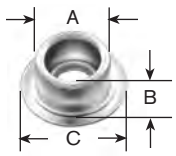


BATTERY SNAP-ONS

For most electronic applications requiring a quick connect and disconnect of circuit. Commonly used with 9 Volt or other batteries designed with snap fasteners. Ideal for temporary or permanent means of connecting without soldering. Can be cascaded together for multiple connections.

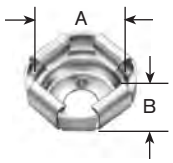
SOCKET OR STUD ONLY

FIG. 1



Stud only

FIG. 2



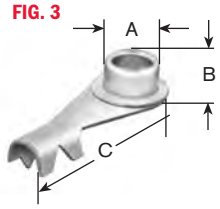
Socket only

CAT. NO.	FIG NO.	A	B	C	HOLE	SIZE	MATERIAL
261*	1	.225 (5.7)	.135 (3.4)	.312 (7.9)	.093 (2.4)	Junior	Steel, Nickel Plate
269*	2	.205 (5.2)	.156 (4.0)	–	–		
262	1	.283 (7.2)	.143 (3.6)	.425 (10.8)	.125 (3.2)	Senior	Brass, Nickel Plate
270	2	.265 (6.7)	.156 (4.0)	–	–		

*Use Jr. Socket and stud for standard 9 Volt Battery

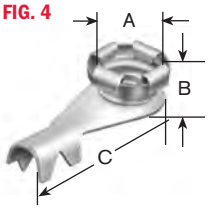
SOCKET OR STUD W/CRIMP LUG

FIG. 3



Stud w/Crimp Lug

FIG. 4



Socket w/Crimp Lug

CAT. NO.	FIG NO.	A	B	C	SIZE	MATERIAL
263*	3	.225 (5.7)	.170 (4.3)	.790 (20.1)	Junior	Stud: Steel, Nickel Plate Lug: Brass, Tin Plate
271*	4	.205 (5.2)	.200 (5.1)	.790 (20.1)		
264	3	.283 (7.2)	.185 (4.7)	.840 (21.3)	Senior	Stud: Brass, Nickel Plate Lug: Brass, Tin Plate
272	4	.265 (6.7)	.185 (4.7)	.835 (21.2)		

*Use Jr. Socket and stud for standard 9 Volt Battery

DIMENSIONS ARE FOR REFERENCE ONLY

DUAL 9 VOLT BATTERY STRAP

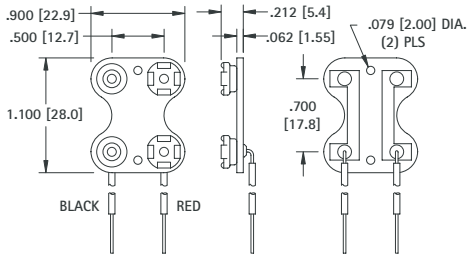
This dual battery strap is pre-wired for connecting two 9 Volt batteries. Base made from fibre material with steel, nickel plated contacts. Wires have tinned copper conductors, PVC insulation and the ends are stripped for easy connection. Wires meet UL/CSA #1061 requirements.

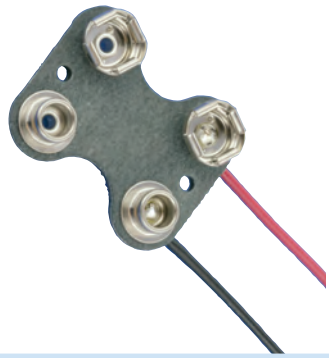
SPECIFICATIONS
Contacts: Steel, Nickel Plate
Wire: #22 AWG, 7/30 Prebond
End Strip: .375 (9.5) Long, Tinned

CAT. NO.	*LEAD LENGTH
227	7.00 (177.8)

*Tolerance on lead length +/-.250 (6.4)

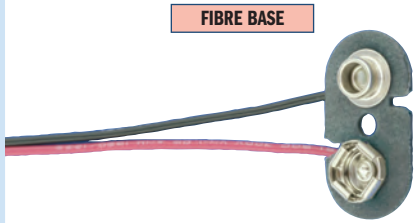
PARALLEL





PREMIUM 9 VOLT BATTERY STRAPS

FIBRE BASE



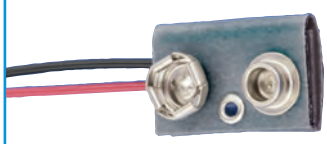
CAT. NO.	*LEAD LENGTH
68	NONE
72-4	4.00 (101.6)
72	7.00 (177.8)
72-8	8.00 (203.2)

Base Size:
1.025 (26.0) × .535 (13.6)
.062 (1.57) thick
Contacts: Steel, Nickel Plate
Wire: #22 AWG, 7/30 Prebond
End Strip: .375 (9.5) Long, Tinned

*Tolerance on lead length +/-.250 (6.4)

FIBRE COVER

- Fully Insulated
- Flexible assembly

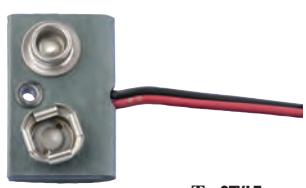


I - STYLE

Cover Size:
.900 (22.9) × .575 (14.6)
Contacts: Steel., Nickel Plate
Wire: #22 AWG, 7/30 Prebond
End Strip: .375 (9.5) Long, Tinned

CAT. NO.	*LEAD LENGTH
83-4	4.00 (101.6)
83	6.50 (165.1)
83-8	8.00 (203.2)

*Tolerance on lead length +/-.250 (6.4)



T - STYLE

Cover Size:
.900 (22.9) × .575 (14.6)
Contacts: Steel., Nickel Plate
Wire: #22 AWG, 7/30 Prebond
End Strip: .375 (9.5) Long, Tinned

CAT. NO.	*LEAD LENGTH
85-4	4.00 (101.6)
85-6	6.50 (165.1)
85-8	8.00 (203.2)

*Tolerance on lead length +/-.250 (6.4)

Tel (718) 956-8900 • Fax (718) 956-9040
(800) 221-5510 • kec@keyelco.com
KEYSTONE®
RoHS COMPLIANT ~ ISO 9001 CERTIFIED
www.keyelco.com
31-07 20th Road – Astoria, NY 11105-2017

SHIELDED 9 VOLT BATTERY STRAPS

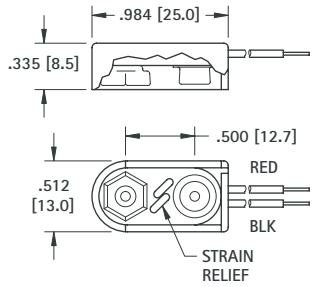
- Insulates and shields 9 Volt battery snap-on connector contacts
- Assures safe secure use, reduces the potential of short circuits and prevents tampering with battery contacts
- Protects circuits, prevents unwanted electrical discharge due to unintended grounding
- Protects battery contacts from dust, dirt, and physical damage
- Ideal for rugged applications, made of high impact molded plastic with integral wire lead strain relief

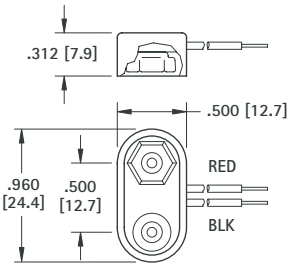
Modifications available with different wire lengths.

84-4
84-6
84-8

SPECIFICATIONS
Base: ABS
Male/Female Contacts: Brass, Nickel Plate
Wires (Red & Black): #26 AWG, Tinned, .187 (4.8) end strip, UL/CSA1007

*Tolerance on lead length +/-.250 (6.4)





81-4
81-6
81-8

I STYLE MOLDED CAT. NO.	*LEAD LENGTH	T STYLE MOLDED CAT. NO.
84-4	4.00 (101.6)	81-4
84-6	6.00 (152.4)	81-6
84-8	8.00 (203.2)	81-8

PREMIUM 9 VOLT BATTERY STRAPS

• Fully Assembled • Rigid Assembly • Ideal for rugged applications, made of high impact molded plastic with integral wire lead strain relief

Rigidly constructed. Nickel plate, male and female contacts. Female contacts are spring temper. Accepts numerous insertions to meet U.L. approved standards. Provides excellent mechanical strength and low contact resistance. Wires have tinned copper conductors, PVC insulation and the ends are stripped for easy connection.

Wires are rated to 176°F (80°C) and 300V and meet UL/CSA #1061/#1007 requirements.

Modifications available with different wire lengths.

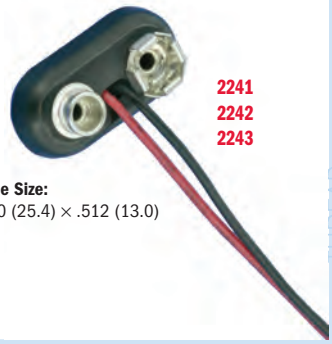
2238
2239
2240

Base Size:
1.062 (27.0) × .512 (13.0)

SPECIFICATIONS
Contacts: Phosphor Bronze, Nickel Plate
Wire: #26 AWG, 7/34
End Strip: .250 (6.4) Long, Tinned
Base: Polyethylene

*Tolerance on lead length +/-.250 (6.4)

I STYLE MOLDED CAT. NO.	*LEAD LENGTH	T STYLE MOLDED CAT. NO.
2238	4.00 (101.6)	2241
2239	6.00 (152.4)	2242
2240	8.00 (203.2)	2243



2241
2242
2243

Base Size:
1.00 (25.4) × .512 (13.0)

ECONOMY 9 VOLT BATTERY STRAPS

• Fully Assembled • Rigid Assembly

When product cost is of the utmost importance these economy battery straps will suit your needs. Brass contacts, nickel plated with vinyl or ABS covering. Wires have tinned copper conductors, PVC insulation and the ends are stripped for easy connection. Wires meet UL/CSA #1007 requirements.

Modifications available with different wire lengths

232-M
233-M
234-M

Molded ABS Base Size:
.984 (25.0) × .469 (11.9)
(Strain Relief)

SPECIFICATIONS
Contacts: Brass, Nickel Plate
Wire: #26 AWG, 7/34
End Strip: .250 (6.4) Long, Tinned

*Tolerance on lead length +/-.250 (6.4)

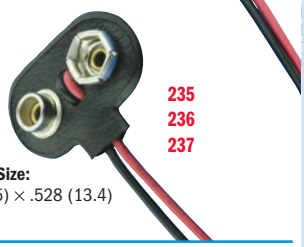
235-M
236-M
237-M

Molded ABS Base Size:
.965 (25.0) × .469 (11.9)
(Strain Relief)

232
233
234

Vinyl Base Size:
1.125 (31.8) × .530 (13.5)

I STYLE MOLDED CAT. NO.	I STYLE VINYL CAT. NO.	*LEAD LENGTH	T STYLE MOLDED CAT. NO.	T STYLE VINYL CAT. NO.
232-M	232	4.00 (101.6)	235-M	235
233-M	233	6.00 (152.4)	236-M	236
234-M	234	8.00 (203.2)	237-M	237



235
236
237

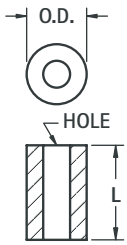
Vinyl Base Size:
1.000 (24.5) × .528 (13.4)

ROUND CLEAR HOLE SPACERS

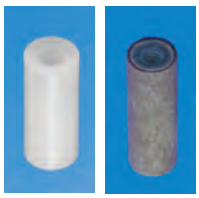
CLEAR HOLE	O.D.	L LENGTH	BRASS CAT. NO.	ALUMINUM CAT. NO.
.120 (3.0) For #4	.250 (6.4)	.125 (3.2)	1909	2036
		.250 (6.4)	1454A	3457
		.375 (9.5)	1454B	3458
		.500 (12.7)	1454C	3459
		.625 (15.9)	1919	2314
		.750 (19.1)	1454D	3460
		.875 (22.2)	1920	3402
		1.000 (25.4)	1454E	3461
		1.500 (38.1)	1924	3462
		2.000 (50.8)	1925	3463
.140 (3.5) For #6	.250 (6.4)	.125 (3.2)	1934	3403
		.250 (6.4)	1457A	3464
		.375 (9.5)	1457B	3465
		.500 (12.7)	1457C	3466
		.625 (15.9)	1935	3429
		.750 (19.1)	1457D	3467
		.875 (22.2)	1936	3438
		1.000 (25.4)	1457E	3468
		1.500 (38.1)	1937	3469
		2.000 (50.8)	1938	3470
.171 (4.3) For #8	.250 (6.4)	.125 (3.2)	1942	4258
		.250 (6.4)	1480	3471
		.375 (9.5)	1481	3472
		.500 (12.7)	1482	3473
		.625 (15.9)	2032	4259
		.750 (19.1)	1483	3474
		.875 (22.2)	2033	4260
		1.000 (25.4)	1484	3475
		1.500 (38.1)	2034	3476
		2.000 (50.8)	2035	3477
.196 (5.0) For #10	.312 (7.9)	.250 (6.4)	1662	4261
		.375 (9.5)	1663	4262
		.500 (12.7)	1664	4263
		.625 (15.9)	1665	4264
		.750 (19.1)	1666	4265
		.875 (22.2)	1667	4266
		1.000 (25.4)	1668	4267
		1.500 (38.1)	1669	4268
		2.000 (50.8)	1672	4269

MATERIAL:
Brass: ASTM-B16, Nickel Plate (QQ-N-290)
Aluminum: ASTM B211, Clear Iridite (MIL-C-5541)
Nylon: Nylon 6/6, UL Rated 94V-2
Phenolic: PBE Grade Natural Color Phenolic

BRASS | ALUMINUM



NYLON | PHENOLIC



NYLON CAT. NO.	PHENOLIC CAT. NO.	L LENGTH	O.D.	CLEAR HOLE
875	—	.125 (3.2)	.250 (6.4)	.120 (3.0) For #4
876	360	.250 (6.4)		
877	361	.375 (9.5)		
878	362	.500 (12.7)		
879	—	.625 (15.9)		
880	363	.750 (19.1)		
881	—	.875 (22.2)		
882	364	1.000 (25.4)		
779	365	1.500 (38.1)		
—	366	2.000 (50.8)		
883	—	.125 (3.2)	.250 (6.4)	.140 (3.5) For #6
884	367	.250 (6.4)		
885	368	.375 (9.5)		
886	369	.500 (12.7)		
887	—	.625 (15.9)		
888	370	.750 (19.1)		
889	—	.875 (22.2)		
890	371	1.000 (25.4)		
789	372	1.500 (38.1)		
—	373	2.000 (50.8)		
891	—	.125 (3.2)	.250 (6.4)	.171 (4.3) For #8
892	1490	.250 (6.4)		
893	1491	.375 (9.5)		
894	1492	.500 (12.7)		
895	—	.625 (15.9)		
896	1493	.750 (19.1)		
897	—	.875 (22.2)		
898	1494	1.000 (25.4)		
799	374	1.500 (38.1)		
—	375	2.000 (50.8)		
790	453	.250 (6.4)	.312 (7.9)	.196 (5.0) For #10
791	454	.375 (9.5)		
792	455	.500 (12.7)		
793	—	.625 (15.9)		
794	456	.750 (19.1)		
795	—	.875 (22.2)		
796	457	1.000 (25.4)		
797	458	1.500 (38.1)		
—	459	2.000 (50.8)		

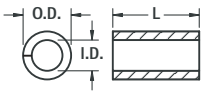
ALUMINUM ECONOMY SPACERS

- Made of flat strip aluminum and rolled on precision equipment.
- Assures maximum bearing surface, square ends.

Aluminum:
5052-H34 per QQ-A-250/8b

- Tight Joint on Outside Diameter

SPACER FOR	I.D.	O.D. REF.
# 4	.120 (3.0)	.167 (4.3)
# 6	.148 (3.8)	.193 (4.9)
# 8	.176 (4.5)	.232 (5.9)

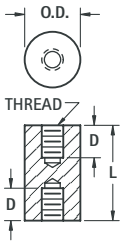


L LENGTH	SCREW CLEARANCE # 4 CAT. NO.	# 6 CAT. NO.	# 8 CAT. NO.
.187 (4.7)	397	—	—
.250 (6.4)	398	405	412
.312 (7.9)	399	406	413
.375 (9.5)	400	407	414
.437 (11.1)	401	408	415
.500 (12.7)	402	409	416
.625 (15.9)	403	410	417

L LENGTH	SCREW CLEARANCE # 4 CAT. NO.	# 6 CAT. NO.	# 8 CAT. NO.
.750 (19.1)	418	425	432
.875 (22.2)	419	426	433
1.000 (25.4)	420	427	434
1.250 (31.8)	421	428	435
1.500 (38.1)	422	429	436
1.750 (44.5)	—	430	437
2.000 (50.8)	—	—	438

CERAMIC STANDOFFS

- Ideal for very high temperature conditions
- Commercial and military types available
- Military types meet MIL-1-010, NL # clearly marked
- Exceptional strength in compression and tension
- Withstands very high voltage without flashover
- Special sizes available upon request



MATERIAL: Grade L5 Ceramic

COMMERCIAL

CAT. NO.	L LENGTH	O.D.	T THREAD	D DEPTH
7710	.250 (6.4)	.250 (6.4)	6-32	THRU
7711	.500 (12.7)	.250 (6.4)	6-32	.156 (4.0)
7712	.375 (9.5)	.375 (9.5)	6-32	.156 (4.0)
7713	.500 (12.7)	.375 (9.5)	6-32	.156 (4.0)
7714	.500 (12.7)	.500 (12.7)	6-32	.140 (3.6)
7715	.750 (19.1)	.500 (12.7)	6-32	.250 (6.4)
7716	1.000 (25.4)	.500 (12.7)	6-32	.375 (9.5)
7717	1.500 (38.1)	.500 (12.7)	6-32	.562 (14.3)
7718	2.500 (63.5)	.500 (12.7)	6-32	.500 (12.7)
7719	2.500 (63.5)	.750 (19.1)	1/4 - 20	.750 (19.1)
7720	4.000 (101.6	.750 (19.1)	1/4 - 20	.750 (19.1)

MILITARY

CAT. NO.	L LENGTH	O.D.	T THREAD	D DEPTH	NL #
7661	.500 (12.7)	.375 (9.5)	6-32	.156 (4.0)	NL523W01-004
7662	.625 (15.9)	.375 (9.5)	6-32	.250 (6.4)	NL523W01-005
7663	.625 (15.9)	.500 (12.7)	8-32	.187 (4.7)	NL523W02-005
7664	.750 (19.1)	.375 (9.5)	6-32	.250 (6.4)	NL523W01-006
7665	.750 (19.1)	.500 (12.7)	8-32	.250 (6.4)	NL523W02-006
7666	1.000 (25.4)	.375 (9.5)	6-32	.375 (9.5)	NL523W01-008
7667	1.000 (25.4)	.500 (12.7)	8-32	.375 (9.5)	NL523W02-008
7668	1.000 (25.4)	.750 (19.1)	10-32	.375 (9.5)	NL523W03-008
7669	1.250 (31.8)	.375 (9.5)	6-32	.375 (9.5)	NL523W01-010
7670	1.250 (31.8)	.500 (12.7)	8-32	.375 (9.5)	NL523W02-010
7671	1.250 (31.8)	1.000 (25.4)	1/4 - 20	.437 (11.1)	NL523W04-010
7672	1.500 (38.1)	.375 (9.5)	6-32	.375 (9.5)	NL523W01-012
7673	1.500 (38.1)	.500 (12.7)	8-32	.375 (9.5)	NL523W02-012
7674	1.500 (38.1)	.750 (19.1)	10-32	.375 (9.5)	NL523W03-012
7675	1.500 (38.1)	1.000 (25.4)	1/4 - 20	.500 (12.7)	NL523W04-012
7676	2.000 (50.8)	.375 (9.5)	6-32	.375 (9.5)	NL523W01-016
7677	2.000 (50.8)	.500 (12.7)	8-32	.375 (9.5)	NL523W02-016
7678	2.000 (50.8)	.750 (19.1)	10-32	.375 (9.5)	NL523W03-016

Tel (718) 956-8900 • Fax (718) 956-9040
(800) 221-5510 • kec@keyelco.com
KEYSTONE®
RoHS COMPLIANT ~ ISO 9001 CERTIFIED
www.keyelco.com
31-07 20th Road - Astoria, NY 11105-2017