PROBLEMAS PROPUESTOS TEMA 2: SENSORES RESISTIVOS

Problema P.2.10

En una aplicación de medida de temperatura se desea utilizar una RTD de platino. Como la temperatura a medir se encuentra en el entorno de los 100ºC, se prefiere utilizar la relación $R(T) = R_{100} (1 + \alpha_{100} * \Delta T)$, con $\Delta T = T - 100ºC$. ¿Cuál será el valor de α_{100}?

Datos: $R_0 = 100\ \Omega$; $\alpha_0 = 0{,}00385\ \Omega/\Omega/K$.

Problema P.2.11 (Ejercicio de examen, febrero 2007)

Un sensor resistivo de temperatura (RTD) de platino tipo PT1000 tiene un coeficiente de temperatura $\alpha = 0{,}00385ºC^{-1}$. Si se une al circuito de acondicionamiento mediante dos hilos de cobre de 20 metros cada uno, que presentan una resistencia de 45 mΩ/m, calcular el error en la medida que se produce si el sensor se encuentra a 40 ºC.
Indique alguna forma para evitar dicho error.

Problema P.2.12 (Ejercicio de examen, junio 2006)

Si colocamos una resistencia fija en paralelo con un sensor NTC, logramos una variación más lineal de la resistencia del conjunto a costa de una menor sensibilidad. A este proceso lo denominamos "linealización de una NTC". Sin embargo, la respuesta no es totalmente lineal. En la siguiente tabla tenemos los valores de resistencia para distintas temperaturas de un conjunto formado por un sensor NTC Philips de temperatura característica 3528 ºK y resistencia de reposo de 1kΩ y un resistor fijo de valor 403Ω. Calcule el error de linealidad, entendido como la máxima discrepancia en la magnitud de entrada entre la respuesta real y la recta que pasa por los puntos extremos de dicha respuesta que producen la misma salida, expresada como porcentaje del fondo de escala de la magnitud de entrada. Indique la sensibilidad del conjunto, tomando como base para el cálculo la recta hallada.

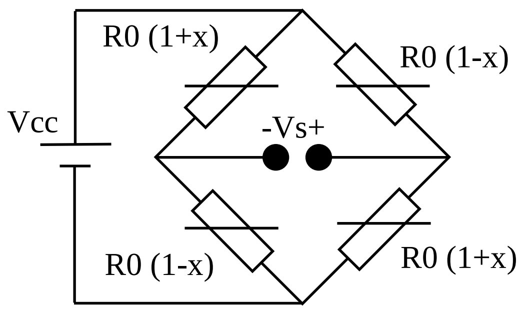
Temperatura [ºC]	20	25	30	35	40	45	50	55	60
Resistencia total [Ω]	303,2	287,2	270,5	253,2	235,6	218,0	200,7	184,0	168

Problema P.2.13

Una célula de carga tiene 4 galgas montadas sobre un soporte de acero, conectadas tal y como se muestran en la figura. Calcular:

a) Tensión de salida si el esfuerzo es de 100 kp/cm2.

b) Si consideramos la tolerancia en las galgas, ¿cuál será el esfuerzo ficticio debido a dicha tolerancia en el peor caso?



DATOS: k= 2; $R_0 = 250\ \Omega$; Tolerancia: 0,3%; $V_{cc} = 10V$; $E_{acero} = 210$ GPa; 1 kp = 9,8 N.

Problema P.2.14

El circuito de la figura representa un termómetro. Utiliza como sensor una PTC de silicio, que se linealiza mediante una resistencia R en paralelo y alimentando el conjunto a corriente constante con la ayuda de una referencia de tensión LT1009. Para que el autocalentamiento provoque un error despreciable, se limita la corriente a través del sensor a 400µA. Calcule:

a) El valor de R para linealizar el sensor entre 0ºC y 50ºC.

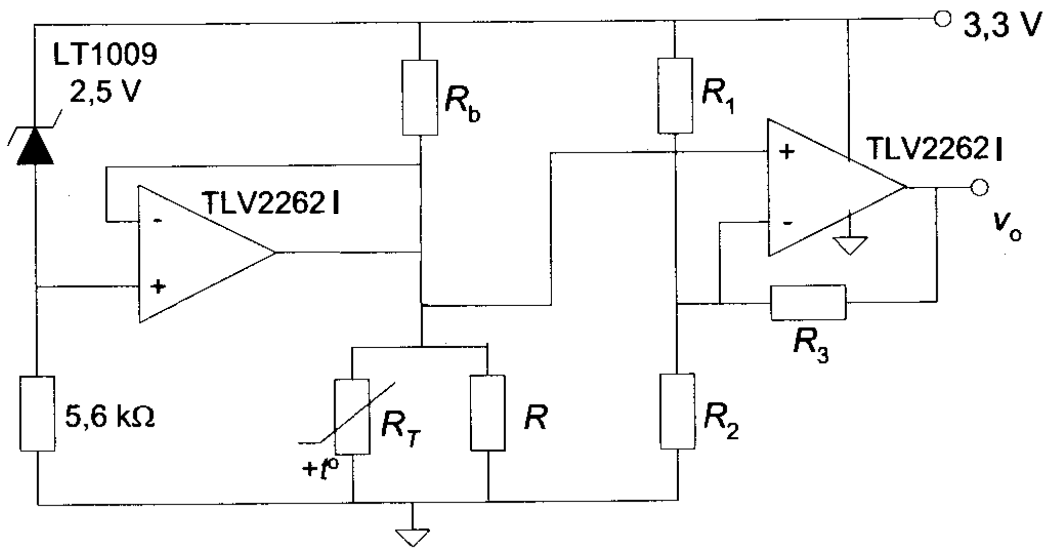
b) El valor de R_B para no sobre pasar el autocalentamiento máximo previsto.

c) Los valores R_1, R_2 y R_3 para que la salida sea 0,1V a 0ºC y 3,1V a 50ºC.

d) Si la temperatura ambiente puede llegar hasta los 40ºC, calcule el error absoluto debido a la tensión de offset del operacional.

Datos de la PTC: 813,5Ω a 0ºC; 1000Ω a 25ºC y 1211Ω a 50ºC.

Datos de los integrados: Consultar las hojas de características.

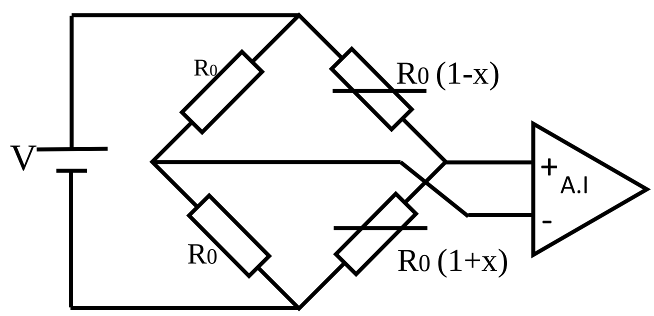


Problema P.2.15

En la figura tenemos un puente con dos sensores en un brazo, cuya salida se amplifica con un amplificador de instrumentación. Calcule:

a) La ganancia del amplificador para que la máxima salida sea de 1V.

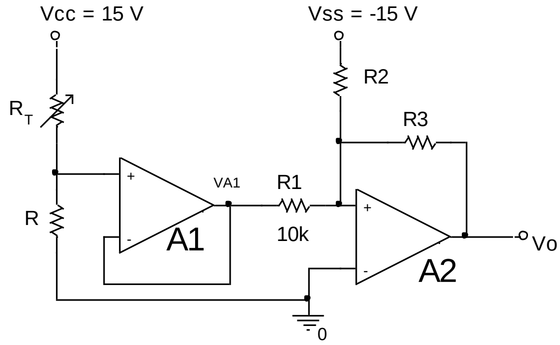
b) El CMRR del amplificador si no se desea tener una tensión en modo común a la salida del circuito superior a $0{,}5 \cdot 10^{-12}$ V.



DATOS: V = 1V; x_{max} = 0,01.

Problema P.2.16 (Ejercicio de examen, septiembre 2004)

La figura representa un circuito de medida de temperatura. En él se utiliza como sensor una RTD de platino (R_T) tipo PT-100. Su coeficiente de temperatura vale 0´004 [(Ω/Ω)/ºC], y la potencia máxima que puede disipar es de 30 mW.



Con el diseño pretendemos medir temperaturas entre 0 ºC y 100 ºC, de forma que la tensión de salida V_0 en milivoltios represente directamente el valor de la temperatura medida.

Se pide:

a) Hallar la expresión teórica de la tensión de salida del operacional A1 (V_{A1}) en función de la temperatura. ¿Es dicha relación lineal? ¿Por qué?

b) Calcular R, atendiendo a las limitaciones de la RTD.

c) Calcular los valores de R_2 y R_3 para que la salida del operacional A2 (V_0) cumpla lo indicado en el enunciado.

d) A la vista de los resultados de los apartados anteriores, indique la función que realiza cada bloque operacional.

e) Realizar una tabla con los valores de R_T, V_{A1} y V_0 en el margen de medida y con un paso de 20ºC. Incluir también el valor de tensión idealmente esperado en la salida en cada caso. Calcular para cada temperatura el error absoluto cometido en mV.

f) Dibujar la curva que relaciona la temperatura de entrada y la tensión de salida (tanto la real como la idealmente esperada). Obtener el error de no-linealidad del sistema.

NOTA: El error de no linealidad es la máxima desviación de la tensión de salida del circuito respecto a la recta que une los puntos extremos de dicha tensión, expresada en porcentaje del fondo de escala (tensión máxima).

- **Output Swing Includes Both Supply Rails**
- **Low Noise . . . 12 nV/√Hz Typ at f = 1 kHz**
- **Low Input Bias Current . . . 1 pA Typ**
- **Fully Specified for Both Single-Supply and Split-Supply Operation**
- **Low Power . . . 500 μA Max**
- **Common-Mode Input Voltage Range Includes Negative Rail**
- **Low Input Offset Voltage**
  950 μV Max at T_A = 25°C (TLV226xA)
- **Wide Supply Voltage Range**
  2.7 V to 8 V
- **Macromodel Included**
- **Available in Q-Temp Automotive**
  HighRel Automotive Applications
  Configuration Control / Print Support
  Qualification to Automotive Standards

description

The TLV2262 and TLV2264 are dual and quad low voltage operational amplifiers from Texas Instruments. Both devices exhibit rail-to-rail output performance for increased dynamic range in single or split supply applications. The TLV226x family offers a compromise between the micro-power TLV225x and the ac performance of the TLC227x. It has low supply current for battery-powered applications, while still having adequate ac performance for applications that demand it. This family is fully characterized at 3 V and 5 V and is optimized for low-voltage applications. The noise performance has been dramatically improved over previous generations of CMOS amplifiers. Figure 1 depicts the low level of noise voltage for this CMOS amplifier, which has only 200 μA (typ) of supply current per amplifier.

HIGH-LEVEL OUTPUT VOLTAGE
vs
HIGH-LEVEL OUTPUT CURRENT

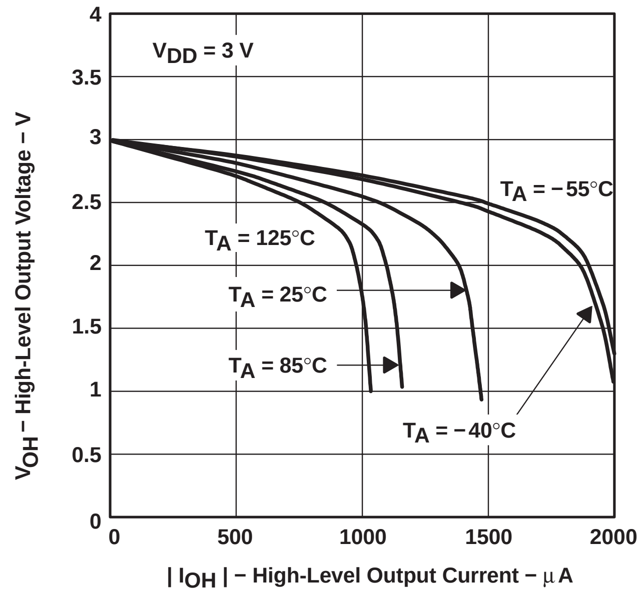


Figure 1

The TLV226x, exhibiting high input impedance and low noise, are excellent for small-signal conditioning for high-impedance sources, such as piezoelectric transducers. Because of the micro-power dissipation levels combined with 3-V operation, these devices work well in hand-held monitoring and remote-sensing applications. In addition, the rail-to-rail output feature with single or split supplies makes this family a great choice when interfacing with analog-to-digital converters (ADCs). For precision applications, the TLV226xA family is available and has a maximum input offset voltage of 950 μV.

The TLV2262/4 also makes great upgrades to the TLV2332/4 in standard designs. They offer increased output dynamic range, lower noise voltage and lower input offset voltage. This enhanced feature set allows them to be used in a wider range of applications. For applications that require higher output drive and wider input voltage range, see the TLV2432 and TLV2442 devices. If your design requires single amplifiers, please see the TLV2211/21/31 family. These devices are single rail-to-rail operational amplifiers in the SOT-23 package. Their small size and low power consumption make them ideal for high density, battery-powered equipment.

TLV2262 AVAILABLE OPTIONS

T_A	V_{IO}max AT 25°C	PACKAGED DEVICES					
		SMALL OUTLINE (D)	CHIP CARRIER (FK)	CERAMIC DIP (JG)	PLASTIC DIP (P)	TSSOP (PW)	CERAMIC FLATPACK (U)
0°C to 70°C	2.5 mV	TLV2262CD	—	—	TLV2262CP	TLV2262CPWLE	—
−40°C to 125°C	950 µV 2.5 mV	TLV2262AID TLV2262ID	— —	— —	TLV2262AIP TLV2262IP	TLV2262AIPWLE —	— —
−40°C to 125°C	950 µV 2.5 mV	TLV2262AQD TLV2262QD	— —	— —	— —	— —	— —
−55°C to 125°C	950 µV 2.5 mV	— —	TLV2262AMFK TLV2262MFK	TLV2262AMJG TLV2262MJG	— —	— —	TLV2262AMU TLV2262MU

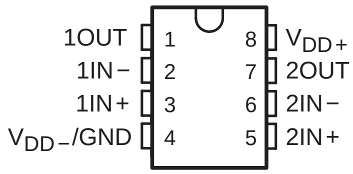
† The D packages are available taped and reeled. Add R suffix to device type (e.g., TLV2262CDR).
‡ The PW package is available only left-end taped and reeled.
§ Chips are tested at 25°C.
¶ For the most current package and ordering information see the Package Option Addendum at the end of this document, or see the TI web site at www.ti.com.

TLV2264 AVAILABLE OPTIONS

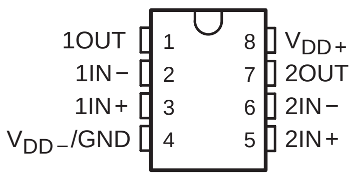
T_A	V_{IO}max AT 25°C	PACKAGED DEVICES					
		SMALL OUTLINE (D)	CHIP CARRIER (FK)	CERAMIC DIP (J)	PLASTIC DIP (N)	TSSOP (PW)	CERAMIC FLATPACK (W)
−40°C to 125°C	950 µV 2.5 mV	TLV2264AID TLV2264ID	— —	— —	TLV2264AIN TLV2264IN	TLV2264AIPWLE —	— —
−40°C to 125°C	950 µV 2.5 mV	TLV2264AQD TLV2264QD	— —	— —	— —	— —	— —
−55°C to 125°C	950 µV 2.5 mV	— —	TLV2264AMFK TLV2264MFK	TLV2264AMJ TLV2264MJ	— —	— —	TLV2264AMW TLV2264MW

† The D packages are available taped and reeled. Add R suffix to device type (e.g., TLV2262IDR).
‡ The PW package is available only left-end taped and reeled.
§ Chips are tested at 25°C.
¶ For the most current package and ordering information see the Package Option Addendum at the end of this document, or see the TI web site at www.ti.com.

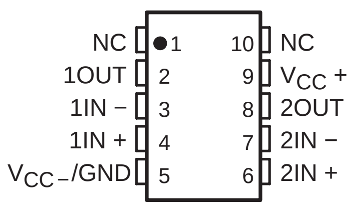
TLV2262C, TLV2262AC
TLV2262I, TLV2262AI
TLV2262Q, TLV2262AQ
D, P, OR PW PACKAGE
(TOP VIEW)



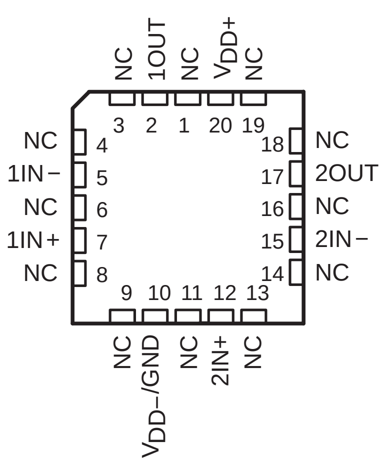
TLV2262M, TLV2262AM
JG PACKAGE
(TOP VIEW)



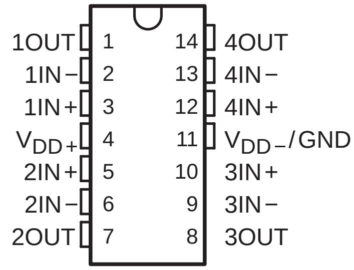
TLV2662M, TLV2262AM
U PACKAGE
(TOP VIEW)



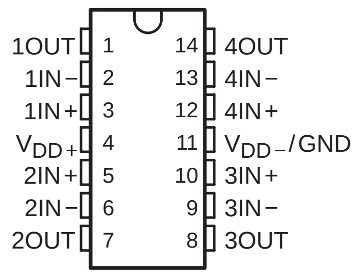
TLV2262M, TLV2262AM
FK PACKAGE
(TOP VIEW)



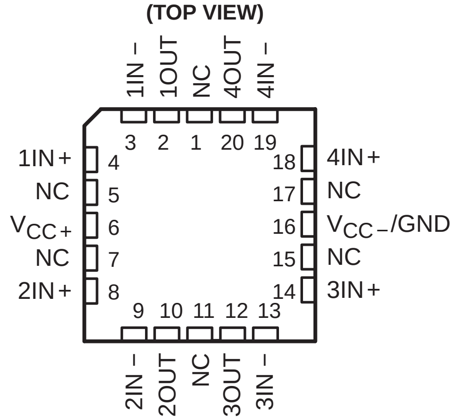
TLV2264I, TLV2264AI
TLV2264Q, TLV2264AQ
D, N, OR PW PACKAGE
(TOP VIEW)



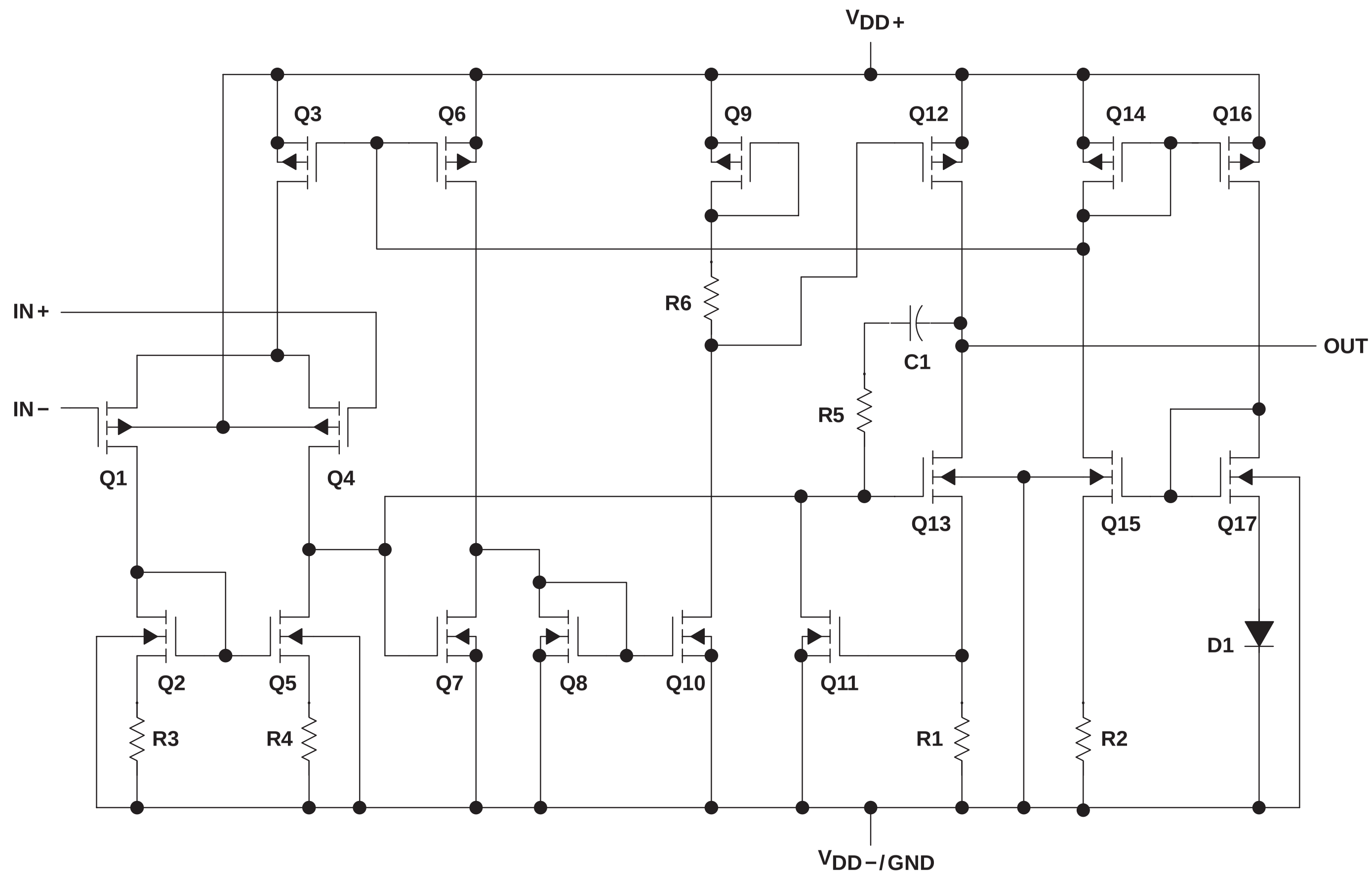
TLV2264M, TLV2264AM
J OR W PACKAGE
(TOP VIEW)



TLV2264M, TLV2264AM
FK PACKAGE
(TOP VIEW)



equivalent schematic (each amplifier)



ACTUAL DEVICE COMPONENT COUNT†		
COMPONENT	TLV2252	TLV2254
Transistors	38	76
Resistors	28	54
Diodes	9	18
Capacitors	3	6

† Includes both amplifiers and all ESD, bias, and trim circuitry

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

Supply voltage, V_{DD} (see Note 1) . . . . 16 V
Differential input voltage, V_{ID} (see Note 2) . . . . $\pm V_{DD}$
Input voltage range, V_I (any input, see Note 1) . . . . V_{DD-} −0.3 V to V_{DD+}
Input current, I_I (each input) . . . . ±5 mA
Output current, I_O . . . . ±50 mA
Total current into V_{DD+} . . . . ±50 mA
Total current out of V_{DD-} . . . . ±50 mA
Duration of short-circuit current (at or below) 25°C (see Note 3) . . . . unlimited
Continuous total power dissipation . . . . See Dissipation Rating Table
Operating free-air temperature range, T_A: I suffix . . . . −40°C to 125°C
Q suffix . . . . −40°C to 125°C
M suffix . . . . −55°C to 125°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 V_{DD-}.
2. Differential voltages are at the noninverting input with respect to the inverting input. Excessive current flows when input is brought below V_{DD-} − 0.3 V.
3. The output may be shorted to either supply. Temperature and/or supply voltages must be limited to ensure that the maximum dissipation rating is not exceeded.

DISSIPATION RATING TABLE

PACKAGE	$T_A \le 25°C$ POWER RATING	DERATING FACTOR ABOVE $T_A = 25°C$	$T_A = 85°C$ POWER RATING	$T_A = 125°C$ POWER RATING
D−8	725 mW	5.8 mW/°C	377 mW	145 mW
D−14	950 mW	7.6 mW/°C	494 mW	190 mW
FK	1375 mW	11.0 mW/°C	715 mW	275 mW
J	1375 mW	11.0 mW/°C	715 mW	275 mW
JG	1050 mW	8.4 mW/°C	—	210 mW
N	1150 mW	9.2 mW/°C	598 mW	—
P	1000 mW	8.0 mW/°C	520 mW	200 mW
PW−8	525 mW	4.2 mW/°C	273 mW	105 mW
PW−14	700 mW	5.6 mW/°C	364 mW	—
U	700 mW	5.5 mW/°C	—	150 mW
W	700 mW	5.5 mW/°C	370 mW	150 mW

recommended operating conditions

	I SUFFIX		Q SUFFIX		M SUFFIX		UNIT
	MIN	MAX	MIN	MAX	MIN	MAX	
Supply voltage, $V_{DD\pm}$ (see Note 1)	2.7	8	2.7	8	2.7	8	V
Input voltage range, V_I	V_{DD-}	V_{DD+} −1.3	V_{DD-}	V_{DD+} −1.3	V_{DD-}	V_{DD+} −1.3	V
Common-mode input voltage, V_{IC}	V_{DD-}	V_{DD+} −1.3	V_{DD-}	V_{DD+} −1.3	V_{DD-}	V_{DD+} −1.3	V
Operating free-air temperature, T_A	−40	125	−40	125	−55	125	°C

NOTE 1: All voltage values, except differential voltages, are with respect to V_{DD-}.

TLV2262I electrical characteristics at specified free-air temperature, V_{DD} = 3 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS		T_A†	TLV2262I MIN	TLV2262I TYP	TLV2262I MAX	TLV2262AI MIN	TLV2262AI TYP	TLV2262AI MAX	UNIT
V_{IO}	Input offset voltage	$V_{DD\pm}$ = ±1.5 V, V_O = 0,	V_{IC} = 0, R_S = 50 Ω	25°C		300	2500		300	950	μV
				Full range			3000			1500	
α_{VIO}	Temperature coefficient of input offset voltage			25°C to 85°C		2			2		μV/°C
	Input offset voltage long-term drift (see Note 4)			25°C		0.003			0.003		μV/mo
I_{IO}	Input offset current			25°C		0.5	60		0.5	60	pA
				85°C			150			150	
				Full range			800			800	
I_{IB}	Input bias current			25°C		1	60		1	60	pA
				85°C			150			150	
				Full range			800			800	
V_{ICR}	Common-mode input voltage range	R_S = 50 Ω,	$\|V_{IO}\|$ ≤5 mV	25°C	0 to 2	−0.3 to 2.2		0 to 2	−0.3 to 2.2		V
				Full range	0 to 1.7			0 to 1.7			
V_{OH}	High-level output voltage	I_{OH} = −20 μA		25°C		2.99			2.99		V
		I_{OH} = −100 μA		25°C	2.85			2.85			
				Full range	2.825			2.825			
		I_{OH} = −400 μA		25°C	2.7			2.7			
				Full range	2.65			2.65			
V_{OL}	Low-level output voltage	V_{IC} = 1.5 V,	I_{OL} = 50 μA	25°C		10			10		mV
		V_{IC} = 1.5 V,	I_{OL} = 500 μA	25°C		100			100		
				Full range			150			150	
		V_{IC} = 1.5 V,	I_{OL} = 1 mA	25°C		200			200		
				Full range			300			300	
A_{VD}	Large-signal differential voltage amplification	V_{IC} = 1.5 V, V_O = 1 V to 2 V	R_L = 50 kΩ‡	25°C	60	100		60	100		V/mV
				Full range	30			30			
			R_L = 1 MΩ‡	25°C		100			100		
$r_{i(d)}$	Differential input resistance			25°C		10^{12}			10^{12}		Ω
$r_{i(c)}$	Common-mode input resistance			25°C		10^{12}			10^{12}		Ω
$c_{i(c)}$	Common-mode input capacitance	f = 10 kHz,	P package	25°C		8			8		pF
z_o	Closed-loop output impedance	f = 100 kHz,	A_V = 10	25°C		270			270		Ω
CMRR	Common-mode rejection ratio	V_{IC} = 0 to 1.7 V, V_O = 1.5 V,	R_S = 50 Ω	25°C	65	75		65	77		dB
				Full range	60			60			
k_{SVR}	Supply voltage rejection ratio ($\Delta V_{DD}/\Delta V_{IO}$)	V_{DD} = 2.7 V to 8 V, V_{IC} = V_{DD}/2,	No load	25°C	80	95		80	100		dB
				Full range	80			80			

† Full range is − 40°C to 125°C.
‡ Referenced to 1.5 V

NOTE 4: Typical values are based on the input offset voltage shift observed through 500 hours of operating life test at T_A = 150°C extrapolated to T_A = 25°C using the Arrhenius equation and assuming an activation energy of 0.96 eV.

TLV2262I electrical characteristics at specified free-air temperature, V_{DD} = 3 V (unless otherwise noted) (continued)

PARAMETER		TEST CONDITIONS		T_A†	TLV2262I			TLV2262AI			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
I_{DD}	Supply current	V_O = 1.5 V,	No load	25°C		400	500		400	500	µA
				Full range			500			500	

† Full range is − 40°C to 125°C.

TLV2262I operating characteristics at specified free-air temperature, V_{DD} = 3 V

PARAMETER		TEST CONDITIONS		T_A†	TLV2262I			TLV2262AI			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
SR	Slew rate at unity gain	V_O = 1.1 V to 1.9 V, C_L = 100 pF‡	R_L = 50 kΩ‡,	25°C	0.35	0.55		0.35	0.55		V/µs
				Full range	0.3			0.3			
V_n	Equivalent input noise voltage	f = 10 Hz		25°C		43			43		nV/√Hz
		f = 1 kHz		25°C		12			12		
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage	f = 0.1 Hz to 1 Hz		25°C		0.6			0.6		µV
		f = 0.1 Hz to 10 Hz		25°C		1			1		
I_n	Equivalent input noise current			25°C		0.6			0.6		fA /√Hz
THD + N	Total harmonic distortion plus noise	V_O = 0.5 V to 2.5 V, f = 20 kHz, R_L = 50 kΩ‡	A_V = 1	25°C		0.03%			0.03%		
			A_V = 10			0.05%			0.05%		
	Gain-bandwidth product	f = 1 kHz, C_L = 100 pF‡	R_L = 50 kΩ‡,	25°C		0.67			0.67		MHz
B_{OM}	Maximum output-swing bandwidth	$V_{O(PP)}$ = 1 V, R_L = 50 kΩ‡,	A_V = 1, C_L = 100 pF‡	25°C		395			395		kHz
t_s	Settling time	A_V = −1, Step = 1 V to 2 V, R_L = 50 kΩ‡, C_L = 100 pF‡	To 0.1%	25°C		5.6			5.6		µs
			To 0.01%			12.5			12.5		
ϕ_m	Phase margin at unity gain	R_L = 50 kΩ‡,	C_L = 100 pF‡	25°C		55°			55°		
	Gain margin			25°C		11			11		dB

† Full range is − 40°C to 125°C.
‡ Referenced to 1.5 V

2.5V Reference

FEATURES

- Maximum Initial Tolerance: 0.2%
- *Guaranteed* Temperature Stability
- Maximum 0.6Ω Dynamic Impedance
- Wide Operating Current Range
- Directly Interchangeable with LM136 for Improved Performance
- No Adjustments Needed for Minimum Temperature Coefficient
- Available in 8-Lead SO and MSOP Packages and 3-Lead TO-92 Package

APPLICATIONS

- Reference for 5V Systems
- 8-Bit A/D and D/A Reference
- Digital Voltmeters
- Current Loop Measurement and Control Systems
- Power Supply Monitor

DESCRIPTION

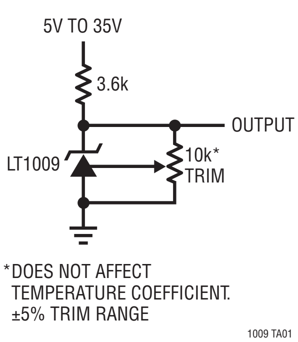
The LT®1009 is a precision trimmed 2.5V shunt regulator diode featuring a maximum initial tolerance of only ±5mV. The low dynamic impedance and wide operating current range enhances its versatility. The 0.2% reference tolerance is achieved by on-chip trimming which not only minimizes the initial voltage tolerance but also minimizes the temperature drift.

Even though no adjustments are needed with the LT1009, a third terminal allows the reference voltage to be adjusted ±5% to calibrate out system errors. In many applications, the LT1009 can be used as a pin-to-pin replacement of the LM136 and the external trim network eliminated.

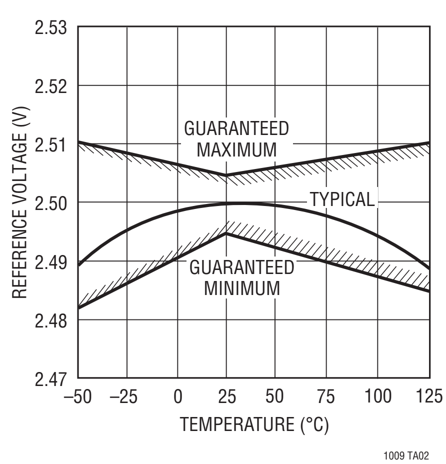
For a lower drift 2.5V reference, see the LT1019 data sheet.

TYPICAL APPLICATION

2.5V Reference



Output Voltage



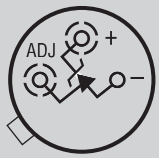
ABSOLUTE MAXIMUM RATINGS (Note 1)

Reverse Current 20mA
Forward Current..10mA
Storage Temperature Range...................–65°C to 150°C
Lead Temperature (Soldering, 10 sec) .... 300°C

Operating Temperature Range
LT1009/LT1009C .... 0°C to 70°C
LT1009I .... –40°C to 85°C
LT1009M **(OBSOLETE)** .... –55°C to 125°C

PIN CONFIGURATION

BOTTOM VIEW

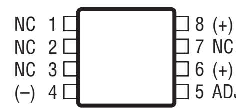


H PACKAGE
3-LEAD TO-46 METAL CAN

T_{JMAX} = 150°C, θ_{JA} = 440°C/W, θ_{JC} = 80°C/W

OBSOLETE PACKAGE
Consider the MS8, S8 or Z Packages for Alternate Source

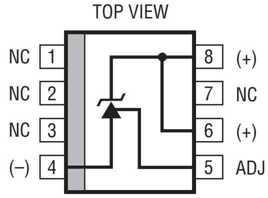
TOP VIEW



MS8 PACKAGE
8-LEAD PLASTIC MSOP

T_{JMAX} = 150°C, θ_{JA} = 250°C/W

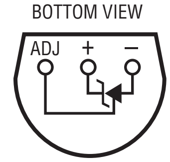
TOP VIEW



S8 PACKAGE
8-LEAD PLASTIC SO

T_{JMAX} = 150°C, θ_{JA} = 190°C/W

BOTTOM VIEW



Z PACKAGE
3-LEAD PLASTIC TO-92

T_{JMAX} = 100°C, θ_{JA} = 160°C/W

ORDER INFORMATION

LEAD FREE FINISH	TAPE AND REEL	PART MARKING	PACKAGE DESCRIPTION	TEMPERATURE RANGE
LT1009MH#PBF	LT1009MH#TRPBF		3-Lead TO-46 Metal Can	–55°C to 125°C
LT1009CH#PBF	LT1009CH#TRPBF		3-Lead TO-46 Metal Can	0°C to 70°C
LT1009CMS8#PBF	LT1009CMS8#TRPBF	LTQZ	8-Lead Plastic MSOP	0°C to 70°C
LT1009S8#PBF	LT1009S8#TRPBF	1009	8-Lead Plastic SO	0°C to 70°C
LT1009IS8#PBF	LT1009IS8#TRPBF	1009I	8-Lead Plastic SO	–40°C to 85°C
LT1009CZ#PBF	LT1009CZ#TRPBF		3-Lead Plastic TO-92	0°C to 70°C
LT1009IZ#PBF	LT1009IZ#TRPBF		3-Lead Plastic TO-92	–40°C to 85°C

ORDER INFORMATION

LEAD BASED FINISH	TAPE AND REEL	PART MARKING	PACKAGE DESCRIPTION	TEMPERATURE RANGE
LT1009MH	LT1009MH#TR		3-Lead TO-46 Metal Can	–55°C to 125°C
LT1009CH	LT1009CH#TR		3-Lead TO-46 Metal Can	0°C to 70°C
LT1009CMS8	LT1009CMS8#TR	LTQZ	8-Lead Plastic MSOP	0°C to 70°C
LT1009S8	LT1009S8#TR	1009	8-Lead Plastic SO	0°C to 70°C
LT1009IS8	LT1009IS8#TR	1009I	8-Lead Plastic SO	–40°C to 85°C
LT1009CZ	LT1009CZ#TR		3-Lead Plastic TO-92	0°C to 70°C
LT1009IZ	LT1009IZ#TR		3-Lead Plastic TO-92	–40°C to 85°C

Consult LTC Marketing for parts specified with wider operating temperature ranges.

For more information on lead free part marking, go to: http://www.linear.com/leadfree/
For more information on tape and reel specifications, go to: http://www.linear.com/tapeandreel/

AVAILABLE OPTIONS

TEMPERATURE	ACCURACY (%)	TEMPERATURE COEFFICIENT (ppm/°C)	PACKAGE STYLE			
			TO-46 (H) OBSOLETE	MSOP-8 (MS8)	SO-8 (S8)	TO-92 (Z)
0°C to 70°C	0.20 0.40	25 25	LT1009CH	LT1009CMS8	LT1009S8	LT1009CZ
–40°C to 85°C	0.20 0.40	35 35			LT1009IS8	LT1009IZ
–55°C to 125°C	0.20	35	LT1009MH			

ELECTRICAL CHARACTERISTICS

The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications are at T_A = 25°C.

SYMBOL	PARAMETER	CONDITIONS		LT100M MIN	LT100M TYP	LT100M MAX	LT1009I MIN	LT1009I TYP	LT1009I MAX	LT1009/LT1009C MIN	LT1009/LT1009C TYP	LT1009/LT1009C MAX	UNITS
V_Z	Reverse Breakdown Voltage	T_A = 25°C, I_R = 1mA H, Z Pkg MS, S Pkg		2.495	2.500	2.505	2.495 2.49	2.500 2.50	2.505 2.51	2.495 2.49	2.500 2.50	2.505 2.51	V V
$\frac{\Delta V_Z}{\Delta I_R}$	Reverse Breakdown Change with Current	400μA ≤ I_R ≤ 10mA	 ●		2.6 3.0	6 10		2.6 3.0	10 12		2.6 3.0	10 12	mV mV
r_Z	Reverse Dynamic Impedance	I_R = 1mA	 ●		0.2 0.4	0.6 1.0		0.2 0.4	1.0 1.4		0.2 0.4	1.0 1.4	Ω Ω
	Temperature Stability	T_{MIN} ≤ T_A ≤ T_{MAX}	●			15			15		1.8	4	mV
$\frac{\Delta V_Z}{\Delta Temp}$	Average Temperature Coefficient (Notes 2, 3)	0°C ≤ T_A ≤ 70°C –40°C ≤ T_A ≤ 85°C –55°C ≤ T_A ≤ 125°C			15 25	25 35		15	25 35		15	25	ppm/°C ppm/°C ppm/°C
$\frac{\Delta V_Z}{\Delta Time}$	Long-Term Stability	T_A = 25°C ±0.1°C, I_R = 1mA			20			20			20		ppm/kHr

Note 1: Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. Exposure to any Absolute Maximum Rating condition for extended periods may affect device reliability and lifetime.

Note 2: Guaranteed by Design.

Note 3: Average temperature coefficient is defined as the total voltage change divided by the specified temperature change.