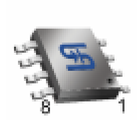
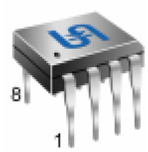
TS2904 Preliminary

Dual Operational Amplifier

SOP-8



DIP-8



Pin assignment:
1. Output
2. Input A (-)
3. Input A (+)
4. Gnd
5. Input B (+)
6. Input B (-)
7. Output B
8. Vcc

Supply Voltage Range 3V to 26V

Dual Channel Amplifier

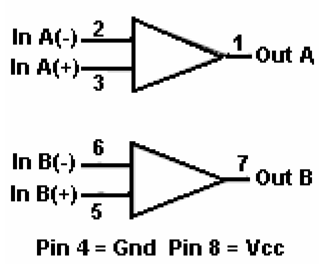
General Description

Utilizing the circuit designs perfected for recently introduced Quad Operational Amplifiers, these dual operational amplifiers have several distinct advantages over standard operational amplifier types in single supply applications. They can operate at supply voltages as low as 3.0 Volts or as high as 26 Volts with quiescent currents about one fifth of those associated with the LM741 (on a pet amplifier basis). The common mode input range includes the negative supply, thereby eliminating the necessity for external biasing components in many applications.
The TS2904 is equivalent to one half of TS2902, and output voltage range also includes the negative supply voltage.
The TS2904 is offered in 8 pin SOP-8 and DIP-8 package.

Features

- ✧ Short circuit protected outputs
- ✧ True differential input stage
- ✧ Single supply operation: 3V to 26V
- ✧ Low input bias currents
- ✧ Internally compensated
- ✧ Common mode range extends to negative supply
- ✧ Single and split supply operation
- ✧ Similar performance to the popular MC1558

Block Diagram



Ordering Information

Part No.	Operating Temp.	Package
TS2904CD	-40 ~ +105 °C	DIP-8
TS2904CS		SOP-8

Absolute Maximum Rating

Supply Voltage	Vcc	26	V
Differential Input Voltage (note 1)	V_{IDR}	26	V
Input Common Mode Voltage Range (note 2)	V_{ICR}	-0.3 to 26	V
Input Forward Current (note 3)	Iif	50	mA
Output Short Circuit Duration	Isc	Continuous	mA
Power Dissipation @ Ta=25 °C		570	mW
Derate above 25 °C	1/Rθja	5.7	mW/ °C
Operating Junction Temperature Range	T_J	0 ~ +125	°C
Storage Temperature Range	T_{STG}	-65 ~ +150	°C

NOTE :
1. Split Power Supplies.
2. For supply. Voltages less than 26V for the TS2904 the absolute maximum input voltage is equal to the supply voltage.
3. This input current will only exist when the voltage is negative at any of the input leads. Normal output states will reestablish when the input voltage returns to a voltage greater than -0.3V.

Electrical Characteristics

(V_{CC} = 5V, Ta=25 ^{o}C; unless otherwise specified.)

Characteristics	Symbol	Min	Typ	Max	Unit
Input Offset Voltage V_{CC}= 5.0V to 26V, V_{IC}= 0V to Vcc -1.7 V, Vo= 1.4V, R_S= 0Ω $T_{LOW} \le$ Ta $\le T_{HIGH}$	Vio	-- --	2.0 --	5.0 7.0	mV
Average Temperature Coefficient of Input Offset Voltage	△Iio/△T	--	7.0	--	uV/^{o}C
Input Offset Current $T_{LOW} \le$ Ta $\le T_{HIGH}$	Iio	-- --	5.0 --	50 150	nA
Average Temperature Coefficient of input Offset Current	△Iio/△T	--	10	--	pA/^{o}C
Input Bias Current $T_{LOW} \le$ Ta $\le T_{HIGH}$	I_{IB}	-- --	45 50	-250 -500	nA
Input Common-Mode Voltage Range (Note1) V_{CC} = 26 V V_{CC} = 26 V, $T_{LOW} \le$ Ta $\le T_{HIGH}$	V_{ICR}	0 0	-- --	24.3 24	V
Differential Input Voltage Range	V_{IDR}	--	--	V_{CC}	V
Large Signal Open-Loop Voltage Gain R_L = 2.0K, V_{CC} =15V, For Large V_O Swing, $T_{LOW} \le$ Ta $\le T_{HIGH}$	A_{VOL}	25 15	100 --	-- --	V/mV
Channel Separation 1.0 KHz to 20KHz	--	--	-120	--	dB
Common Mode Rejection Ratio $R_S \le$ 10 kΩ	CMRR	50	70	--	dB
Power Supply Rejection Ratio	PSRR	50	100	--	dB
Output Voltage Range, RL = 2KΩ	V_{OR}	0	--	3.3	V
Output Voltage -- High Limit V_{CC} = 26 V, R_L = 2 kΩ V_{CC} = 26 V, R_L = 10 kΩ	V_{OH}	26 27	-- 28	-- --	V
Output Voltage -- Low Limit V_{CC} = 5.0 V, R_L = 10 kΩ	V_{OL}	--	5.0	20	mV
Output Source Current V_{ID}=+1.0V,V_{CC}=15V	I_{O+}	20	40	--	mA
Output Sink Current V_{ID} = -1.0 V, V_{CC} = 15 V V_{ID} = -1.0 V, V_O = 200 mV	I_{O-}	10 12	20 50	-- --	mA uA
Output Short Circuit to Ground (Note 2)	I_{OS}	--	40	60	mA
Power Supply Current , V_{CC} = 26V, V_O = 0 V, R_L = ∞ V_{CC} = 5.0V, V_O = 0 V, R_L = ∞	I_{CC}	-- --	1.5 0.7	3.0 1.2	mA

Notes :

1. The input common mode voltage or either input signal voltage should not be allowed to go negative by more than 0.3 V. The upper end of the common mode voltage range is Vcc 17V, but either or both inputs can go to +26V.
2. Short circuits from the output to Vcc can cause excessive heating and eventual destruction. Destructive dissipation can recruit from simultaneous shorts on all amplifiers.

Circuit Description

The TS2904 made using two internally compensated, two-stage operational amplifiers. The first stage performs not only the first stage gain function but also performs the level shifting and transconductance reduction functions. By reducing the transconductance, a smaller compensation capacitor (only 5.0pF) can be employed, thus saving chip area. Another feature of this input stage is that the input common mode range can include the negative supply or ground, in single supply operation, without saturating either the input devices or the differential to single-ended converter. The second stage consists of a standard current source load amplifier stage.

Each amplifier is biased from an internal-voltage regulator, and which has a low temperature coefficient thus giving each amplifier good temperature characteristics as well as excellent power supply rejection.

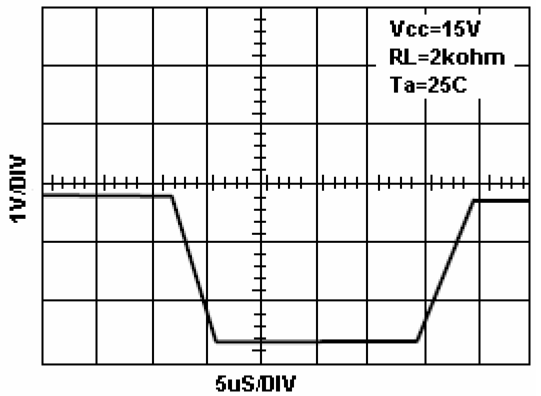


Figure 1. large signal voltage follower response

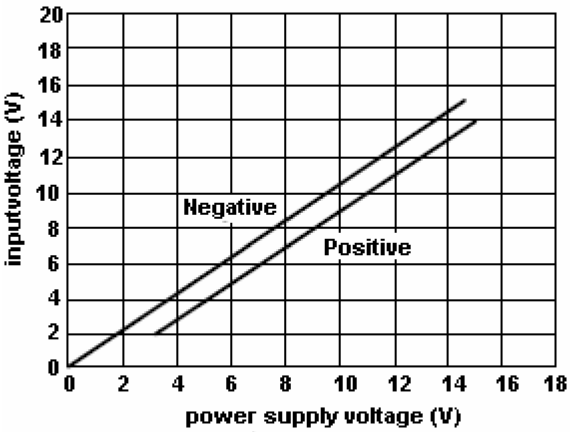


Figure 2. input voltage range

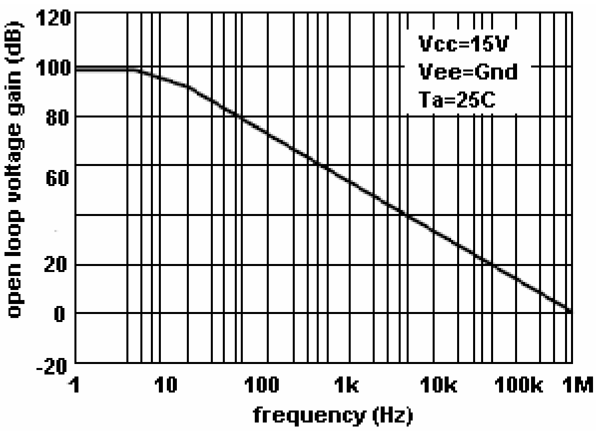


Figure 3. large singal open loop voltage gain

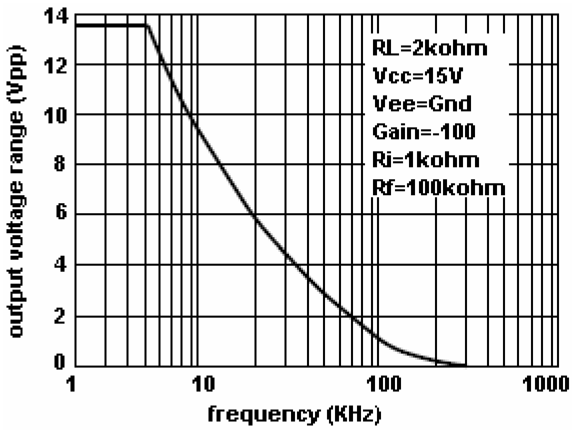


Figure 4. larger signal frequency response

Circuit Description

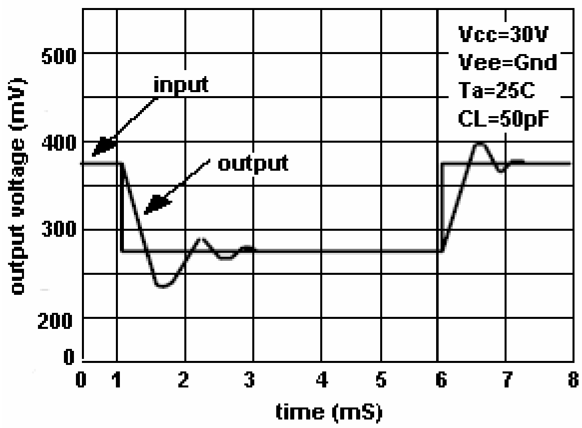


Figure 5. small signal voltage follower pulse response (noninverting)

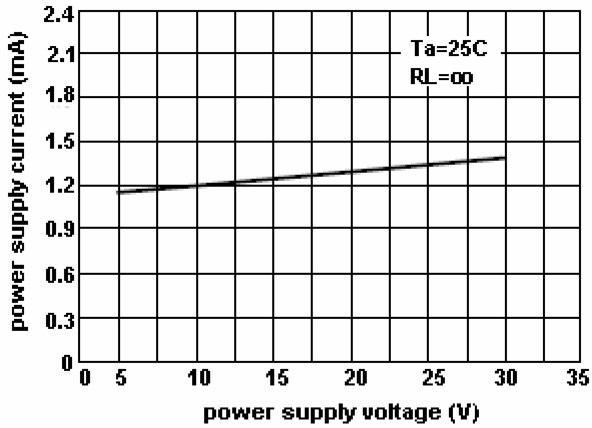


Figure 6. power supply current vs supply voltage

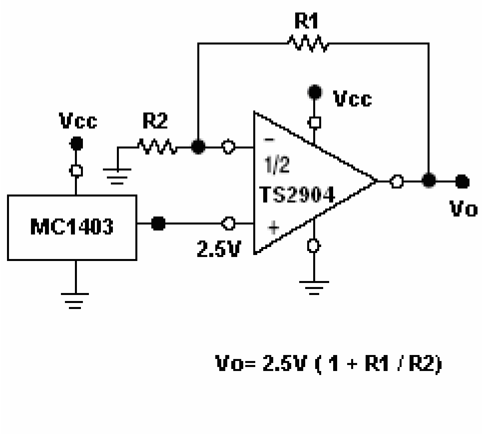


Figure 7. voltage reference

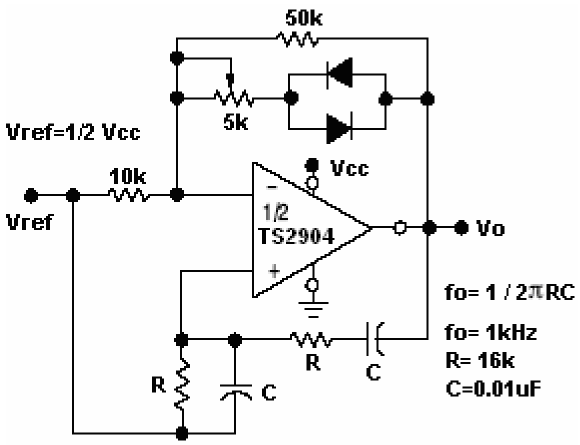


Figure 8. wien bridge oscillator

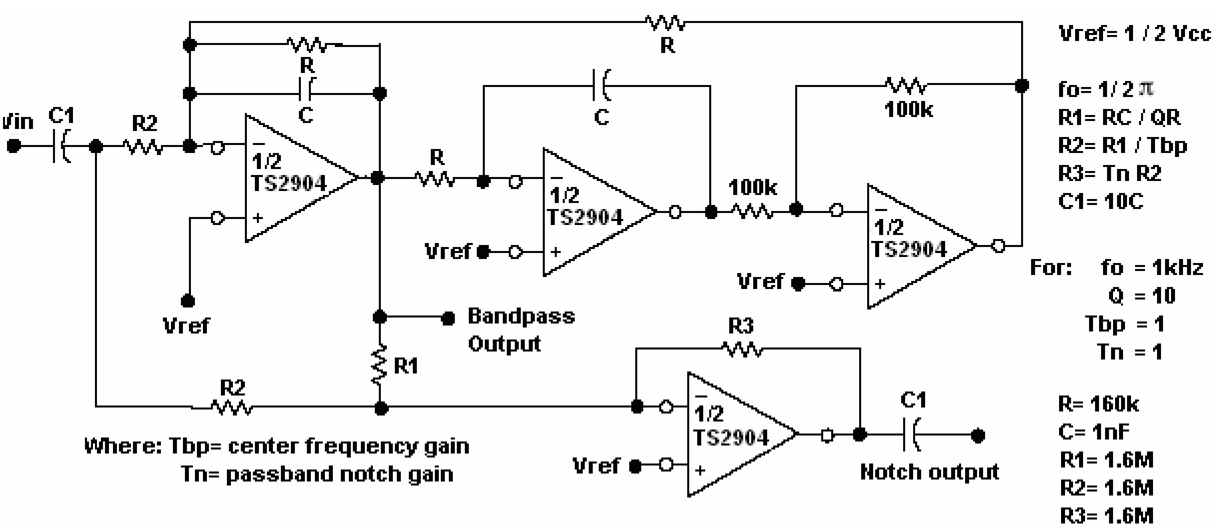


Figure 9. bi-quad filter

Electrical Characteristics Curve

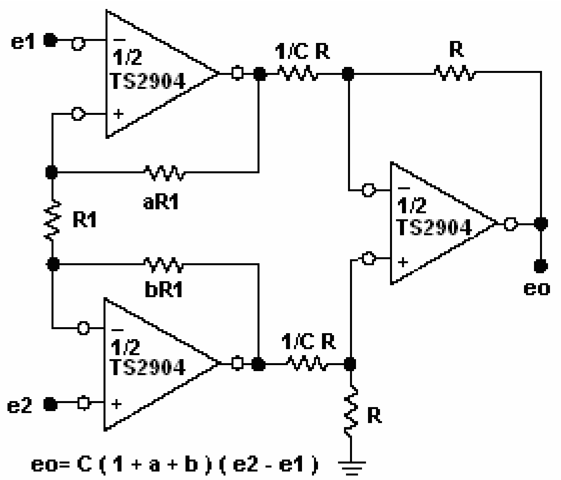
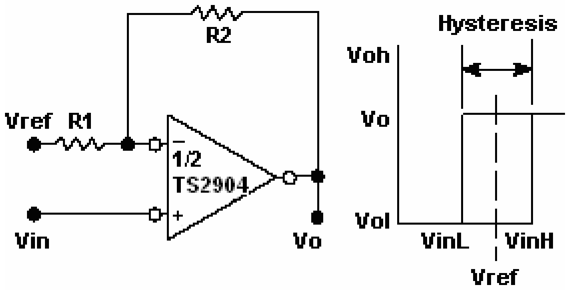


Figure 10. high impedance differential amplifier

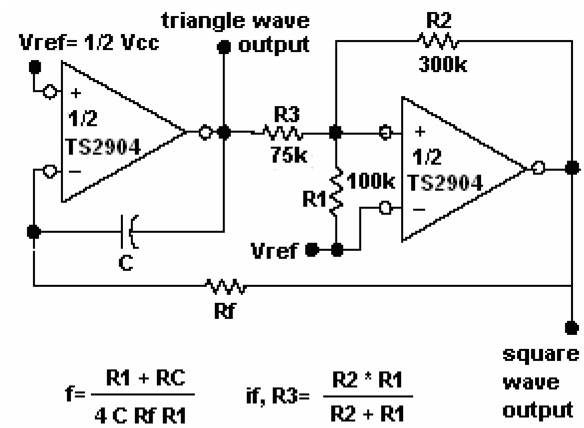


VinL= R1 / (R1 + R2) * (Vol - Vref) + Vref

VinH= R1 / (R1 + R2) * (Voh - Vref) + Vref

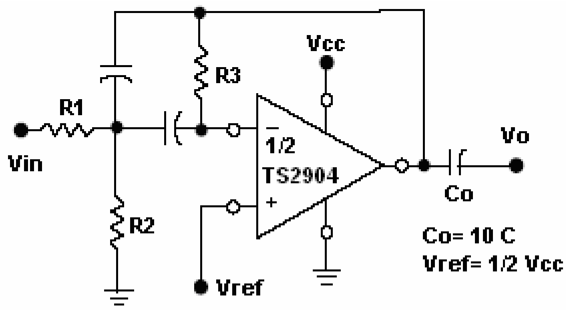
H= R1 / (R1 + R2) * (Voh - Vol)

Figure 11. comparator with hysteresis



$$f = \frac{R1 + RC}{4\,C\,Rf\,R1} \qquad \text{if, } R3 = \frac{R2 * R1}{R2 + R1}$$

Figure 12. function generator



Given: fo= center frequency
A(fo)= gain at center frequency

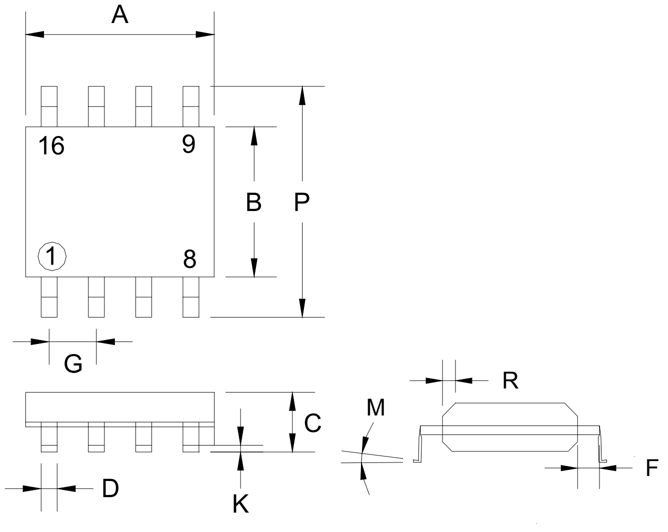
Choose value fo, C
Then: R3= Q / π fo C
R1= R3 / 2A(fo)
R2= R1 * R2 / 4Q2 *R1 - R3

For less than 10% error from operational amplifier,
Qo fo / BW < 0.1
Where fo and BW are expressed in Hz

If source impendance varies, filter may be preceded with Voltage follower buffer stabilize filter parameters

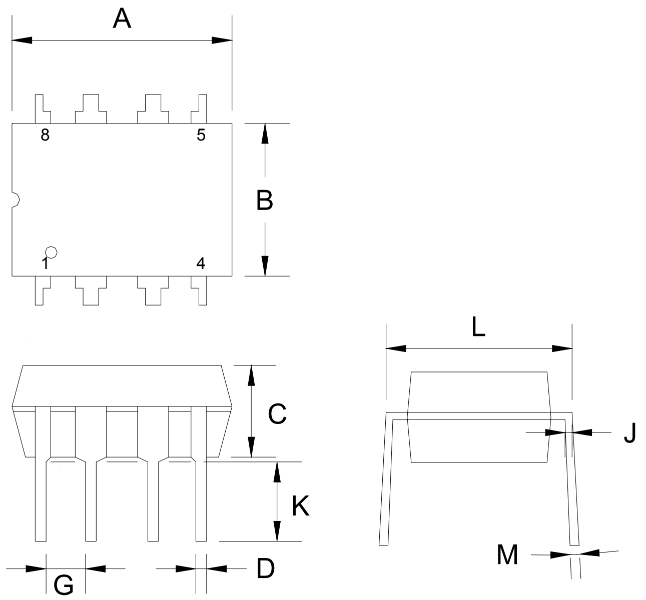
Figure 13. multiple feedback bandpass filter

SOP-8 Mechanical Drawing



SOP-8 DIMENSION				
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.80	5.00	0.189	0.196
B	3.80	4.00	0.150	0.157
C	1.35	1.75	0.054	0.068
D	0.35	0.49	0.014	0.019
F	0.40	1.25	0.016	0.049
G	1.27 (typ)		0.05 (typ)	
K	0.10	0.25	0.004	0.009
M	0^o	7^o	0^o	7^o
P	5.80	6.20	0.229	0.244
R	0.25	0.50	0.010	0.019

DIP-8 Mechanical Drawing



SOP-8 DIMENSION				
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	9.07	9.32	0.357	0.367
B	6.22	6.48	0.245	0.255
C	3.18	4.45	0.125	0.135
D	0.35	0.55	0.019	0.020
G	2.54 (typ)		0.10 (typ)	
J	0.29	0.31	0.011	0.012
K	3.25	3.35	0.128	0.132
L	7.75	8.00	0.305	0.315
M	-	10^o	-	10^o