AB42
Operational Amplifier
(Inverting/Non-inverting/Differentiator)

Operating Manual
Ver.1.1

An ISO 9001 : 2000 company

Innovative Technology Ecosystem
94-101, Electronic Complex Pardesipura,
Indore- 452010, India
Tel : 91-731- 2570301/02, 4211100
Fax: 91- 731- 2555643
e mail : info@scientech.bz
Website : www.scientech.bz
Toll free : 1800-103-5050

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TÜV Rheinland Group

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04/11/NABCB/00

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RoHS Compliance

Scientech Products are RoHS Complied.

RoHS Directive concerns with the restrictive use of Hazardous substances (Pb, Cd, Cr, Hg, Br compounds) in electric and electronic equipments.

Scientech products are "Lead Free" and "Environment Friendly".

It is mandatory that service engineers use lead free solder wire and use the soldering irons upto (25 W) that reach a temperature of 450°C at the tip as the melting temperature of the unleaded solder is higher than the leaded solder.

Introduction

AB42 is a compact, ready to use **Operational Amplifier** experimental Board. This is useful for students to study Op-amp as Differential amplifier, Inverting Amplifier, Non-Inverting Amplifier AC inputs. It can be used as stand alone unit with external DC power supply or can be used with **Scientech Analog Lab ST2612** which has built in DC power supply, AC power supply, function generator, modulation generator, continuity tester, toggle switches, and potentiometer.

List of Boards :

Model	**Name**
AB01	Diode characteristics (Si, Zener, LED)
AB02	Transistor characteristics (CB NPN)
AB03	Transistor characteristics (CB PNP)
AB04	Transistor characteristics (CE NPN)
AB05	Transistor characteristics (CE PNP)
AB06	Transistor characteristics (CC NPN)
AB07	Transistor characteristics (CC PNP)
AB08	FET characteristics
AB09	Rectifier Circuits
AB10	Wheatstone bridge
AB11	Maxwell's Bridge
AB12	De Sauty's Bridge
AB13	Schering Bridge
AB14	Darlington Pair
AB15	Common Emitter Amplifier
AB16	Common Collector Amplifier
AB17	Common Base Amplifier
AB18	RC-Coupled Amplifier
AB19	Cascode Amplifier
AB20	Direct Coupled Amplifier
AB21	Class A Amplifier
AB22	Class B Amplifier (Push Pull Emitter Follower)
AB23	Class C Tuned Amplifier
AB24	Transformer Coupled Amplifier
AB25	Phase Locked Loop (FM Demodulator & Frequency Divider / Multiplier)
AB26	FET Amplifier
AB27	Voltage Controlled Oscillator
AB28	Multivibrator (Monostable / Astable)
AB29	F-V and V-F Converter
AB30	V-I and I-V Converter
AB31	Zener Voltage Regulator
AB32	Transistor Series Voltage Regulator
AB33	Transistor Shunt Voltage Regulator
AB35	DC Ammeter
AB37	DC Ammeter (0-2mA)

AB39	Instrumentation Amplifier
AB41	Differential Amplifier (Transistorized)
AB43	Operational Amplifier (Adder/Scalar)
AB44	Operational Amplifier (Integrator/ Differentiator)
AB45	Schmitt Trigger and Comparator
AB49	K Derived Filter
AB51	Active filters (Low Pass and High Pass)
AB52	Active Band Pass Filter
AB54	Tschebyscheff Filter
AB56	Fiber Optic Analog Link
AB57	Owen's Bridge
AB58	Anderson's Bridge
AB59	Maxwell's Inductance Bridge
AB64	RC – Coupled Amplifier with Feedback
AB66	Wien Bridge Oscillators
AB67	Colpitt Oscillator
AB68	Hartley Oscillator
AB80	RLC Series and RLC Parallel Resonance
AB82	Thevenin's and Maximum Power Transfer Theorem
AB83	Reciprocity and Superposition Theorem
AB84	Tellegen's Theorem
AB85	Norton's theorem
AB88	Diode Clipper
AB89	Diode Clampers
AB90	Two port network parameter
AB91	Optical Transducer (Photovoltaic cell)
AB92	Optical Transducer (Photoconductive cell/LDR)
AB93	Optical Transducer (Phototransistor)
AB96	Temperature Transducer (RTD & IC335)
AB97	Temperature Transducer (Thermocouple)
AB101	DSB Modulator and Demodulator
AB102	SSB Modulator and Demodulator
AB106	FM Modulator and Demodulator

and many more…………

Theory

Operational amplifier is a direct-coupled high-gain amplifier usually consisting of one or more differential amplifiers and usually followed by a level translator and an output stage. The output stage is generally a push-pull or push-pull complementary-symmetry pair. An operational amplifier is available as a single integrated circuit package.

The operational amplifier is a versatile device that can be used to amplify DC as well as AC input signals and was originally designed for performing mathematical operations such as addition, subtraction, multiplication, and integration. Thus the name operational amplifier stems from its original use for these mathematical operations and is abbreviated to op-amp. With the addition of suitable external feedback components, the modern day op-amp can be used for a variety of applications, such as AC and DC signal amplification, active filters, oscillators, comparators, regulator, regulators, and others.

The op-amp may be used as an inverting, non-inverting, or differential amplifier, and that the negative feedback can be used to stabilize the voltage gain and increase the bandwidth of the op-amp circuit.

The Inverting Amplifier :

Figure 1 shows the inverting amplifier in which only one input is applied and that is to the inverting input terminal. The non-inverting input terminal is grounded.

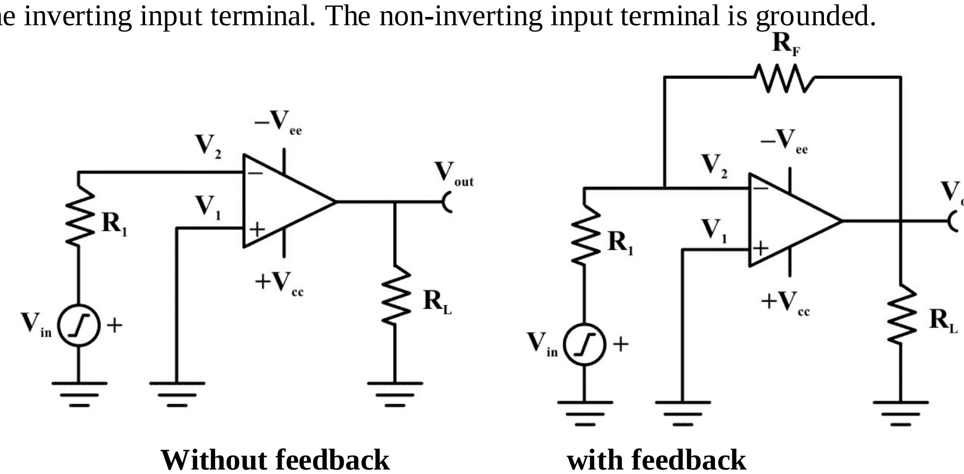


Figure 1

Since $V_1 = 0V$, and $V_2 = V_{in}$

Out put voltage V_{out} is given by

$$V_{out} = -A * V_{in},$$

Where A is Open loop gain.

Also Output voltage of closed loop circuit.

$$V_{out} = -AC_1 * V_{in} = -(Rf / R1) V_{in}. \quad ....(1)$$

Where AC_1 is closed loop gain.

The Non-Inverting Amplifier :

Figure 2 shows the non-inverting amplifier in which only one input is applied and that is to the non-inverting input terminal. The inverting input terminal is grounded.

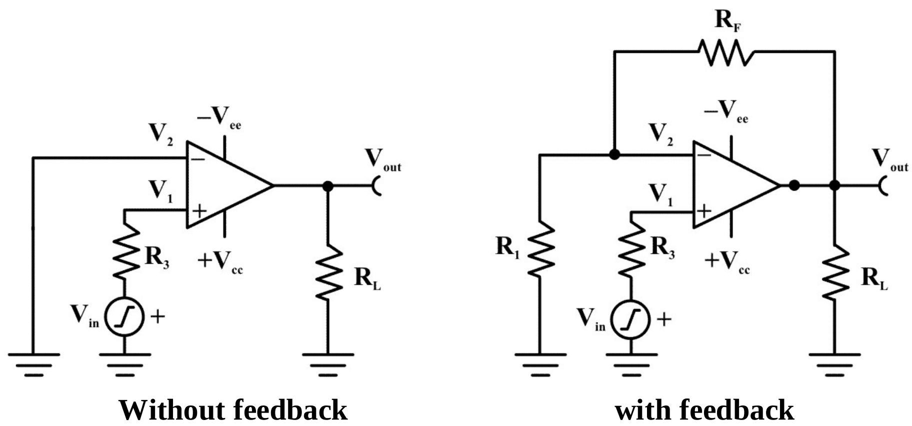


Figure 2

Since V1 = V_{in}, and V2 = 0V, Output voltage V_{out} is given by

$$V_{out} = A * V_{in},$$

Where A is Open loop gain.

Also Output voltage

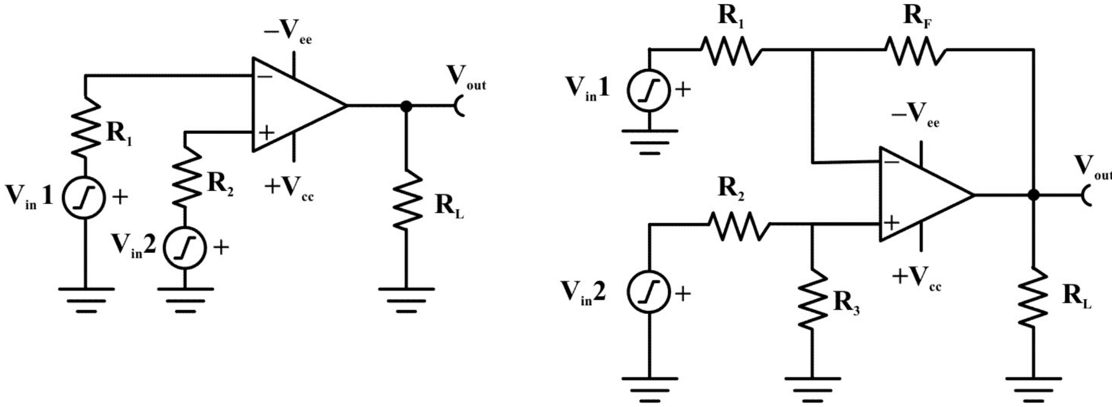
$$V_{out} = -AC_l * V_{in} = (1+Rf / R1)\ V_{in}.................................(2)$$

Where AC_1 is closed loop gain.

The Differential Amplifier :

Since the op-amp amplifies the difference between the two input signals, this is called the differential amplifier.

Figure 3 shows the differential amplifier in which input signals $V_{in}1$ and $V_{in}2$ are applied to the positive and the negative input terminals. The source resistance R1 and R2 are normally negligible compared to the input resistance Ri. Therefore the voltage drop across these resistors can be assumed to be zero.



Without feedback **With feedback**

Figure 3

Output voltage V_{out} for differential amplifier is given by

$$V_{out} = A\ (V_{in}l - V_{in}2),$$

Where A is the open loop voltage gain.

Also $V_{out} = Rf/Rl\ (V_{in}l - V_{in}2)$ ....(3)

If R1 = R2 and Rf = R3 for closed loop circuit.

Input offset voltage :

Input offset voltage Vio is the differential input voltage that exists between two input terminals of an op-amp without any external inputs applied. In other words, it is the amount of the input voltage that should be applied between two input terminals in order to force the output voltage to zero.

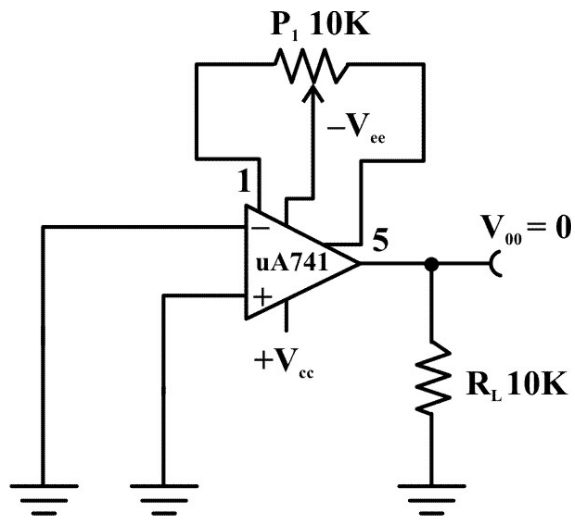


Figure 4

Common Mode Rejection Ratio :

Data sheets list the common-mode rejection ratio (CMRR). It is defined as the ratio of differential voltage gain to common-mode voltage gain. Generally, the CMRR value is very large and is therefore usually specified in decibels (dB), where

$$CMRR\ (dB) = 20 \log (A_D/A_{CM})$$

The CMRR can also be expressed as the ratio of the change in the offset voltage to the total change in common-mode voltage. Thus

$$CMRR = V_{io}/ V_{CM} \text{ or } CMRR\ (dB) = 20 \log (V_{io}/V_{cm})$$

CMRR is a measure of the degree of matching between two input terminals; that is, the larger the value of CMRR (dB), the better is the matching between the two input terminals and the smaller is the output common-mode voltage.

Frequency Response :

The gain of the op-amp is a complex number that is a function of frequency. Therefore, at a given frequency the gain will have a specific magnitude as well as a phase angle. This means that variation in operating frequency will cause variation in gain magnitude and its phase angle.

The manner in which the gain of the op-amp responds to different frequency is called the frequency response. A graph of the magnitude of gain versus frequency is called the frequency response plot.

Experiment 1

Objective :
Study of Operational amplifier as a Differential amplifier

Equipments Needed :

1. Analog board of **AB42.**
2. DC power supplies +12V and -12V from external source or **ST2612 Analog Lab**.
3. Variable DC supplies (+5V and +12V)
4. Digital multi-meter.
5. 2 mm. patch cords.

Circuit diagram :

Circuit used to study Differential amplifier circuit is shown in figure 5.

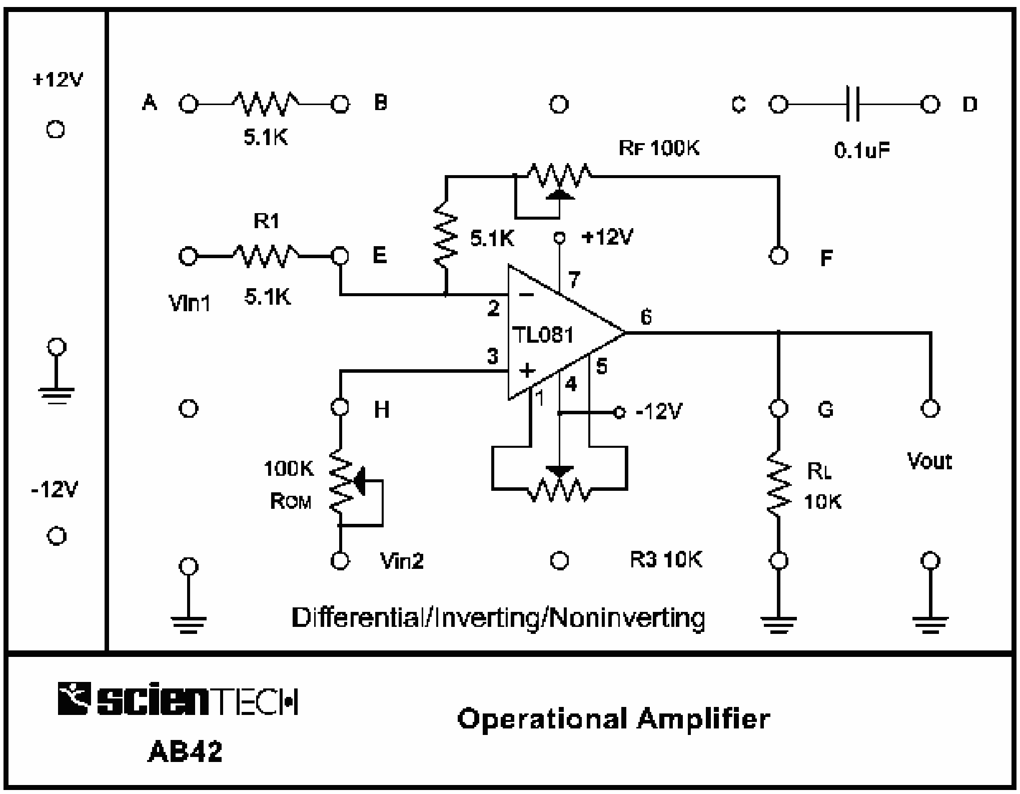


Figure 5

Procedure :

- Connect +12V, -12V DC power supplies at their indicated position from external source or **ST2612 Analog Lab**.

1. Set the value of feedback resistance R_F equals to 10K with the help of potentiometer observing its value at socket's 'E' and 'F'.
2. Set the value of resistance R_{OM} equals to 10 K with the help of potentiometer observing its value at socket's 'H' and 'V_{in}2'.
3. Connect a patch cord between test point B & H; and F & G, V_{in}2 & ground to configure a Differential Amplifier.
4. Switch ON the power supplies.
5. Connect the +5V supply at socket 'V_{in}1'; that is inverting input for Op-amp. Keep this supply at constant +5V.
6. Connect the Variable +12V supply at socket 'A'; that is noninverting input for op-amp. Set the supply voltage at 1V.
7. Calculate the value of output by using Eq.3;
$$V_{out} = Rf/R1\ (V_{in}l - V_{in}2)$$
8. Where Vin1 is the input at socket 'A' noninverting terminal, and Vin2 is the input at socket 'Vin1' inverting terminal.
9. Connect the multimeter's probes at socket 'V_{out}' and Ground.
10. Note the output voltage and verify the difference between calculated and measured output voltage.
11. Increase the input voltage at noninverting terminal (socket 'A') with the margin of 1V up to 10 V whilst keeping input voltage at inverting terminal at constant +5V.
12. Repeat the above steps from 7 to 10.

- The Differential output of two AC signal can be observe

1. If the inputs which are given in the input terminals are at same frequency and have 180° phase shift.
2. Then the difference between both signal will appear at the output
3. It is difficult to get the inputs which have same frequency, thus this bridges are used at measuring the differential voltage at AC Bridges.

Note :

1. Try to make given circuits on the bread board strip given on the Analog Board to practice and understand its connections.

Observation Table :

S. No.	V_{IN1}	V_{IN2}	V_{OUT} (Calculated)	V_{OUT} (Measured)

Conclusion : The calculated and measured output are almost the same.

Experiment 2

Objective :

Study of Operational amplifier as an Inverting amplifier

Equipments Needed :

1. Analog board of **AB42.**
2. DC power supplies +12V and -12V
3. Function generator
4. Oscilloscope
5. Digital multi-meter.
6. 2 mm. patch cords.

Circuit diagram :

Circuit used to study Inverting amplifier circuit is shown in figure 6.

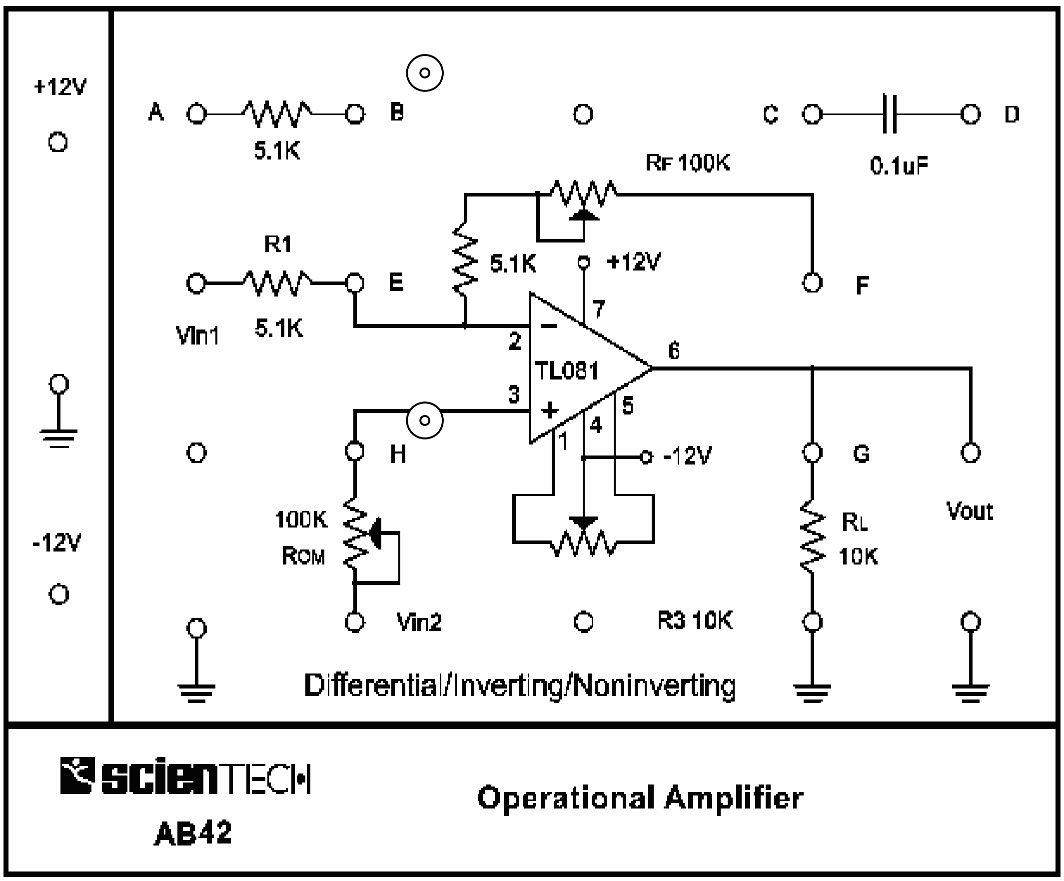


Figure 6

Procedure :

- Connect +12V, -12V DC power supplies at their indicated position from external source or **ST2612 Analog Lab**.

1. Set the value of feedback resistance R_F equals to 10K with the help of potentiometer R_F observing its value at sockets 'E' and 'F'.
2. Set the value of resistance R_{OM} equals to 5 K with the help of potentiometer R_{OM} observing its value at socket 'H' and 'V_{in}2'.
3. Connect a patch cord between sockets 'F' & 'G'; and 'Vin2' & ground to configure the Inverting amplifier.
4. Connect Function generator's probe at the socket 'V_{in}l'; to apply $1V_{pp}$, 1 KHz, sine wave signal at input.
5. Observe the input amplitude on oscilloscope CHII.
6. Calculate the output for the given value of input using Eq.1

$$V_{out} = - (Rf / R1)\ V_{in.}$$

7. Observe the output waveform between socket 'V_{out}' and Ground on oscilloscope CHI.
8. Note the output voltage and Verify the difference between calculated and measured output voltage
9. Note the phase shift between the output and input waveform.
10. Repeat the above procedure for different value of feedback resistance R_F.
11. Repeat the above procedure for different value of input voltage 'Vin'.

Note : To see the phase shift between input and output signal its necessary to connect both, input and output signal at the oscilloscope channels.

Observation Table :

S. No.	V_{IN}	R_F	R_F /R1	V_{OUT} (Calculated)	Phase shift (φ)	V_{OUT} (Measured)

Conclusion :

1. The calculated and measured output is almost the same.
2. The Phase shift between input and output signal is 180°

Experiment 3

Objective :
Study of Operational amplifier as a Non-inverting amplifier

Equipments Needed :

1. Analog board of **AB42.**
2. DC power supplies +12V and -12V
3. Oscilloscope
4. Function generator
5. Digital multi-meter.
6. 2 mm. patch cords.

Circuit diagram :

Circuit used to study non-inverting circuit is shown in figure 7.

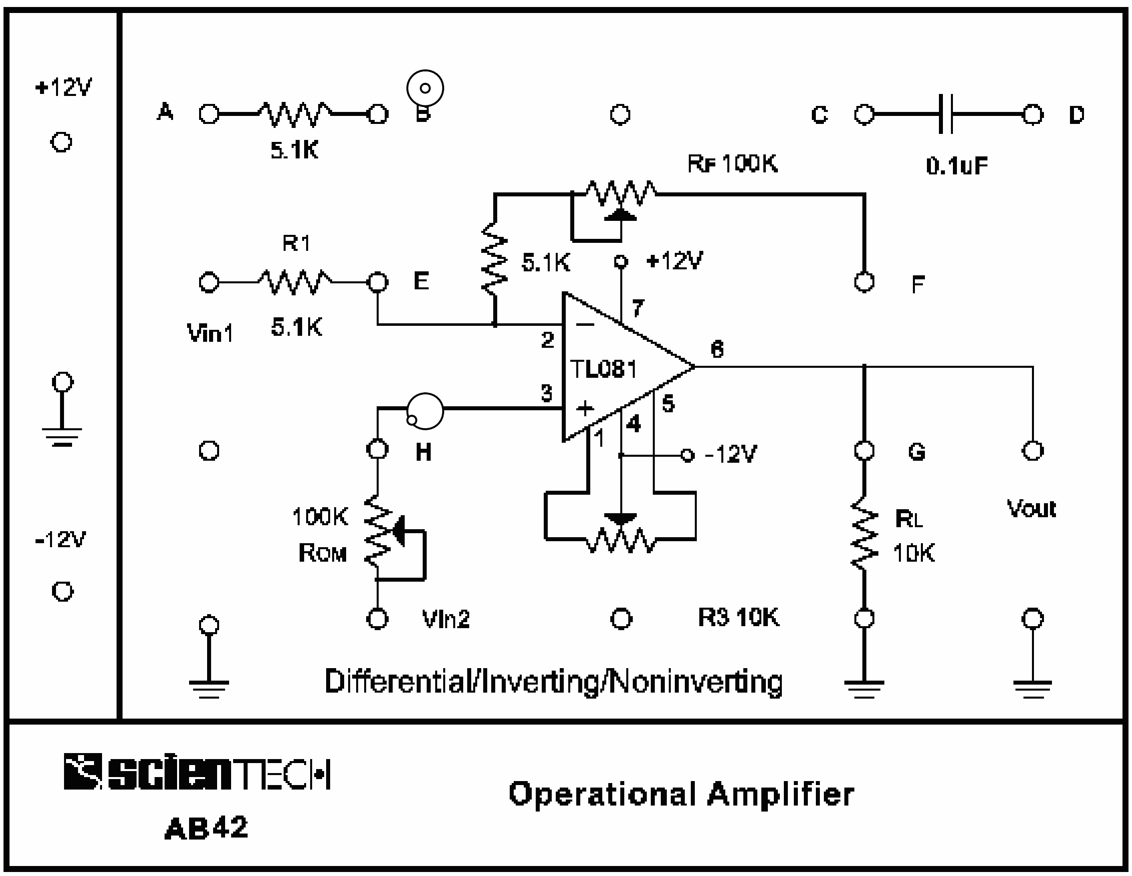


Figure 7

Procedure :

- Connect +12V, -12V DC power supplies at their indicated position from external source or **ST2612 Analog Lab**.

1. Set the value of feedback resistance R_F equals to 10K with the help of potentiometer R_F observing its value at sockets 'E' and 'F'.
2. Connect a patch cord between sockets 'F' & 'G'; and 'Vin1' & ground to configure the Noninverting amplifier.
3. Connect Function generator's probe at the socket 'H'; to apply $1V_{pp}$, 1 KHz, sine wave signal at noninverting input terminal.
4. Observe the input amplitude on oscilloscope CHII.
5. Calculate the output for the given value of input using equation 2
$$V_{out} = (1+Rf / R1)\, V_{in}$$
6. Observe the output waveform between socket 'V_{out}' and Ground on oscilloscope CH I.
7. Note the output voltage and Verify the difference between calculated and measured output voltage
8. Note the phase shift between the output and input waveform.
9. Repeat the above procedure for different value of feedback resistance R_F.
10. Repeat the above procedure for different value of input voltage 'Vin'.

Note : To see the phase shift between input and output signal its necessary to connect both input and output signal at the oscilloscope channels.

Observation Table :

S. No.	V_{IN}	R_F	$1+(R_F/R1)$	V_{OUT} (Calculated)	Phase Shift (φ)	V_{OUT} (Measured)

Conclusion :

1. The calculated and measured output is almost the same.

2. The Phase shift between input and output signal is 0°.

Data Sheet

TL081, TL081A, TL081B, TL082, TL082A, TL082B TL082Y, TL084, TL084A, TL084B, TL084Y JFET-INPUT OPERATIONAL AMPLIFIERS

SLOS081E – FEBRUARY 1977 – REVISED FEBRUARY 1999

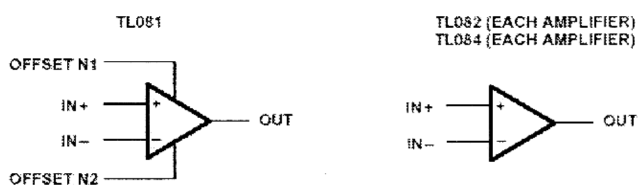
- **Low Power Consumption**
- **Wide Common-Mode and Differential Voltage Ranges**
- **Low Input Bias and Offset Currents**
- **Output Short-Circuit Protection**
- **Low Total Harmonic Distortion . . . 0.003% Typ**
- **High Input Impedance . . . JFET-Input Stage**
- **Latch-Up-Free Operation**
- **High Slew Rate . . . 13 V/μs Typ**
- **Common-Mode Input Voltage Range Includes V_{CC+}**

description

The TL08x JFET-input operational amplifier family is designed to offer a wider selection than any previously developed operational amplifier family. Each of these JFET-input operational amplifiers incorporates well-matched, high-voltage JFET and bipolar transistors in a monolithic integrated circuit. The devices feature high slew rates, low input bias and offset currents, and low offset voltage temperature coefficient. Offset adjustment and external compensation options are available within the TL08x family.

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 Q-suffix devices are characterized for operation from –40°C to 125°C. The M-suffix devices are characterized for operation over the full military temperature range of –55°C to 125°C.

symbols



AVAILABLE OPTIONS

T_A	V_{IO}max AT 25°C	PACKAGED DEVICES										CHIP FORM (Y)
		SMALL OUTLINE (D008)	SMALL OUTLINE (D014)	CHIP CARRIER (FK)	CERAMIC DIP (J)	CERAMIC DIP (JG)	PLASTIC DIP (N)	PLASTIC DIP (P)	TSSOP (PW)	FLAT PACK (U)	FLAT PACK (W)	
0°C to 70°C	15 mV 6 mV 3 mV	TL081CD TL081ACD TL081BCD	—	—	—	—	—	TL081CP TL081ACP TL081BCP	TL081CPW	—	—	—
	15 mV 6 mV 3 mV	TL082CD TL082ACD TL082BCD	—	—	—	—	—	TL082CP TL082ACP TL082BCP	TL082CPW	—	—	TL082Y
	15 mV 6 mV 3 mV	—	TL084CD TL084ACD TL084BCD	—	—	—	TL084CN TL084ACN TL084BCN	—	TL084CPW	—	—	TL084Y
–40°C to 85°C	6 mV 6 mV 6 mV	TL081ID TL082ID TL084ID	TL084ID	—	—	—	TL084IN	TL081IP TL082IP	—	—	—	—
–40°C to 125°C	9 mV	—	TL084QD	—	—	—	—	—	—	—	—	—
–55°C to 125°C	6 mV 6 mV 9 mV	—	—	TL081MFK TL082MFK TL084MFK	TL084MJ	TL081MJG TL082MJG	—	—	—	TL081MU TL082MU	TL084MW	—

The D package is available taped and reeled. Add R suffix to the device type (e.g., TL081CDR).

Warranty

1. We guarantee the product against all manufacturing defects for 24 months from the date of sale by us or through our dealers. Consumables like dry cell etc. are not covered under warranty.
2. The guarantee will become void, if
   - **a)** The product is not operated as per the instruction given in the operating manual.
   - **b)** The agreed payment terms and other conditions of sale are not followed.
   - **c)** The customer resells the instrument to another party.
   - **d)** Any attempt is made to service and modify the instrument.
3. The non-working of the product is to be communicated to us immediately giving full details of the complaints and defects noticed specifically mentioning the type, serial number of the product and date of purchase etc.
4. The repair work will be carried out, provided the product is dispatched securely packed and insured. The transportation charges shall be borne by the customer.

For any Technical Problem Please Contact us at **service@scientech.bz**

List of Accessories

1. 2 mm Patch Cords (Red) 16"... 2 Nos.
2. 2 mm Patch Cord (Blue) 16" .... 3 Nos.
3. 2 mm Patch Cord (Blue) 16" .... 3 Nos.
4. e-Manual...1 No.

Updated 07-05-2009