AB44
Operational Amplifier
(Integrator / Differentiator)

Operating Manual

Ver.1.1

An ISO 9001 : 2000 company

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TÜV Rheinland Group

CERTIFICATE

The Certification Body for Quality Management Systems of TÜV Rheinland India Pvt. Ltd.

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TÜV Rheinland Group procedures that

Scientech Technologies Pvt. Ltd.

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Indore – 452 010, Madhya Pradesh, India
Unit-2: 90-91, Electronics Complex, Pardeshi Pura,
Indore – 452 010, Madhya Pradesh, India**

has established and applies a quality management system for

Design, Manufacture of Electronic Test & Measuring Instruments, Training Products for Electrical & Electronics Education and Providing Technology Training

An audit was performed, Report No. 07930

Proof has been furnished that the requirements according to

DIN EN ISO 9001: 2000

are fulfilled.

The certificate is valid until 2010-11-20

Certificate Registration No. **85 100 001 07930**

TÜV NABCB QMS 010

Bangalore, 2007-11-21

The certification Body of
TÜV Rheinland India Pvt. Ltd.

The validity of this certificate is subject to timely completion of Surveillance audits as agreed in the Contract. The Validity of the Certificate can be verified under WWW.tuv.com with the Identification No. 9105027653

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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

AB44 is a compact, ready to use **Operational Amplifier** experimental Board. This is useful for students to study Op-amp as an Integrator and Differentiator. 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)
AB42	Operational Amplifier (Inverting / Non-inverting / Differentiator)
AB43	Operational Amplifier (Adder/Scalar)
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, integrator, differentiator.

Integrator :

A circuit in which the output voltage waveform is the integral of the input voltage waveform is the integrator or the integration amplifier. Such a circuit is obtained by using a basic inverting amplifier configuration if the feedback resistor R_F is replaced by a capacitor C_F as shown in figure1.

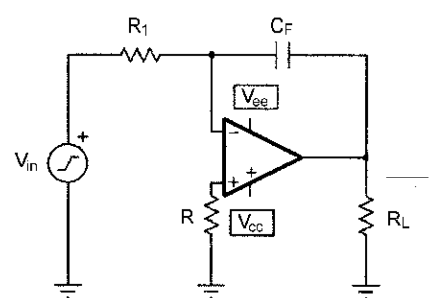


Figure 1

The expression for the output voltage V_{out} is given by :

$$V_{out} = - (l/R_1C_F)\ {}_0\int^t V_{in}\ dt + C$$

Where C is the integration constant and is proportional to the value of the output voltage V_{out} at time t = 0 seconds.

When V_{in} = 0, the integrator of figure 1 works as an open-loop amplifier. This is because the capacitor C_F acts as an open circuit ($X_{CF} = \infty$) to the input offset voltage V_{in}. In other words, the input offset voltage V_{io} and the part of the input current charging capacitor C_F produce the error voltage at the output of the integrator.

Therefore, in the practical op-amp shown in figure 2, to reduce the error voltage at the output, a resistor R_F is connected across the feedback capacitor C_F. Thus, R_F limits the low-frequency gain and hence minimizes the variations in the output voltage.

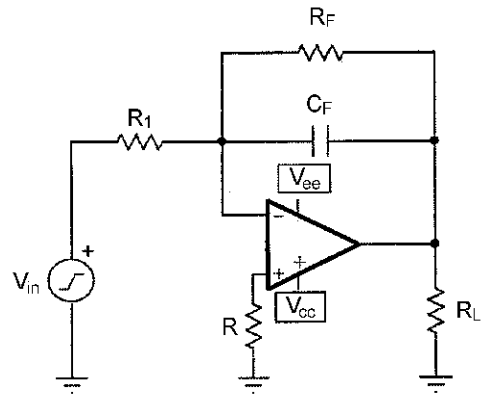


Figure 2

The 0dB frequency i.e. the frequency at which the gain is 0dB is given by :

$$F_b = ½ \pi R_1 C_F$$

Both the stability and the low-frequency roll-off problems can be corrected by the addition of a resistor R_F as shown in the practical integrator. The term stability refers to a constant gain as frequency of an input signal is varied over a certain range. Also low frequency roll-off refers to the rate of decrease in gain at lower frequencies.

The gain limiting frequency F_a is given by :

$$F_a = ½ \pi R_F C_F$$

Generally, the value of f_a and in turn R_1C_F and R_FC_F values should be selected such that $F_a < F_b$. For example, if $F_a = F_b/10$, then $R_F = 10 R_1$. In fact, the input signal will be integrated properly if the time period T of the signal is larger than or equal to $R_F C_F$. That is,

$$T \geq R_F C_F \qquad \text{where } R_F C_F = ½\pi F_a$$

A workable integrator can be designed by implementing the following steps :

1. Select F_a equals to the maximum frequency of the input signals to be integrated. Then, assuming a value of $C_F < 1\mu F$, calculate the value of R_F.

2. Choose $F_b = 10 F_a$ and calculate the value of $R_1 = R_F / 10$.

The integrator is most commonly used in analog computers and analog to digital and signal-wave shaping circuits.

Differentiator :

Figure 3 shows the differentiator or differentiation amplifier. As its name implies, the circuit performs the mathematical operation of differentiator; that is the output waveform is the derivative of the input waveform. The differentiator may be constructed from a basic inverting amplifier if an input resistor R_1 is replaced by a capacitor C1.

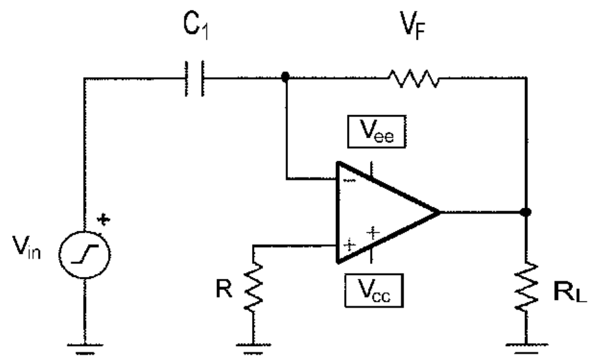


Figure 3

The expression for the output voltage is given by :

$$V_{out} = - R_F C_1 * dV_{in} / d_t$$

Thus the output V_o is equal to the R_F C_1 times the negative instantaneous rate of change of the input voltage V_{in} with time.

The differentiator performs the reverse of the integrator's function. However, the differentiator of figure 3 will not do this because it has some practical problem. The gain of the circuit (R_F / X_{c1}) increases with increase in frequency at a rate of 20dB / decade. This makes the circuit unusable. Also, the input impedance X_{c1} decreases with increase in frequency, which makes the circuit very susceptible to high-frequency noise. When amplified, this noise can completely override the differentiated output signal.

The frequency at which the gain is 0dB is given by :

$$F_a = ½ \pi R_F C_1$$

Both the stability and the high-frequency noise problems can be corrected by the addition of two components: R_1 and C_F, as shown in figure 4. This circuit is a practical differentiator.

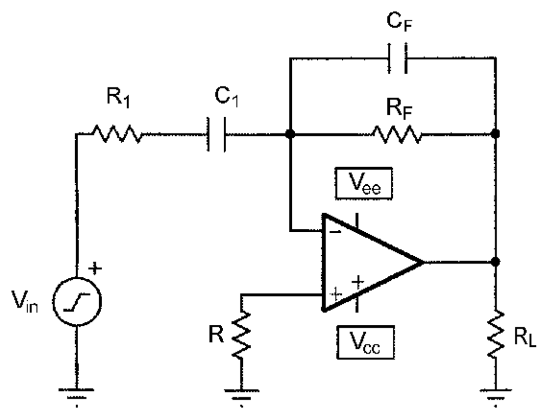


Figure 4

The gain limiting frequency F_b is given by

$$F_b = ½ \pi R_1C_1$$

Generally, the value of F_b and in turn R_1C_1 and R_F C_F values should be selected such that

$$F_a < F_b < F_c$$

Where F_c is unity gain bandwidth

The input signal will be differentiated properly if the time period T of the input signal is larger than or equal to R_F C_1. That is,

$$T \geq R_F C_1$$

A workable differentiator can be designed by implementing the following steps :

1. Select F_a equals to the highest frequency of the input signals to be differentiated. Then, assuming a value of C_1<1µF, calculate the value of R_F.

2. Choose F_b = 10 F_a and calculate the value of R_1 and C_F so that $R_1C_1 = R_FC_F$.

Experiment 1

Objective :

Study of Operational Amplifier as an Integrating Amplifier/Integrator

Equipments Needed :

1. Analog board of **AB44.**

2. DC Power Supplies +12V and -12V from external source or **ST2612 Analog Lab**.

3. Oscilloscope

4. 2mm. Patch Cords.

Circuit diagram :

Circuit used to study Integrating Amplifier is shown in figure 5.

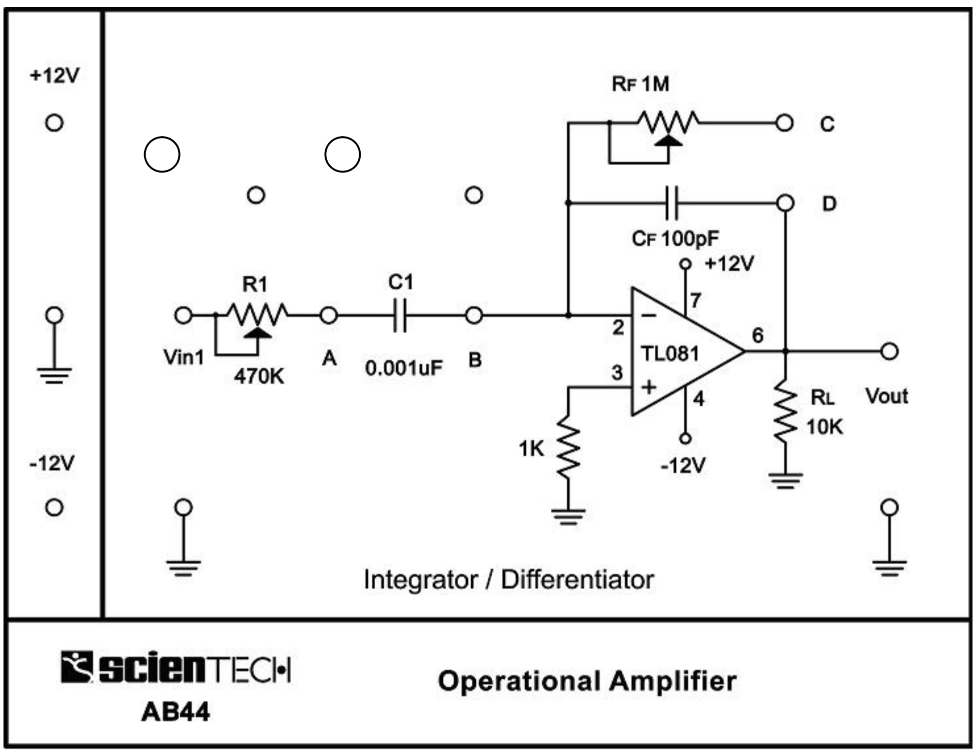


Figure 5

Procedure :

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

1. Select F_a = 10K, the maximum frequency of the input signals to be integrated.

2. As C_F < 1µF i.e. 100 P_F, calculate the value of R_F.

3. Choose $F_b = 10F_a$ and calculate the value of $R_1 = R_F /10$.

4. Use potentiometer R_1 and R_F set the above calculated values of R_1 and R_F.

5. Connect a patch cord between test point A, B and C, D.

6. Apply an input voltage of $1V_{pp}$ at the test point V_{in} l.

7. Measure and trace the output waveform at the test point V_{out}.

8. Vary the frequency of input signal and observe its effect on the output waveform.

9. Repeat the above procedure for different maximum frequencies of input signal. 10K, 50K, 100K etc.

Experiment 2

Objective :

Study of Operational Amplifier as a Differentiating Amplifier/Differentiator

Equipments Needed :

1. Analog Board of **AB44.**
2. DC Power Supplies +12V and -12 from external source or **ST2612 Analog Lab**.
3. Cathode Ray Oscilloscope
4. Function Generator
5. 2mm. Patch Cords

Circuit diagram :

Circuit used to study Differentiating Amplifier Circuit is shown in figure 6.

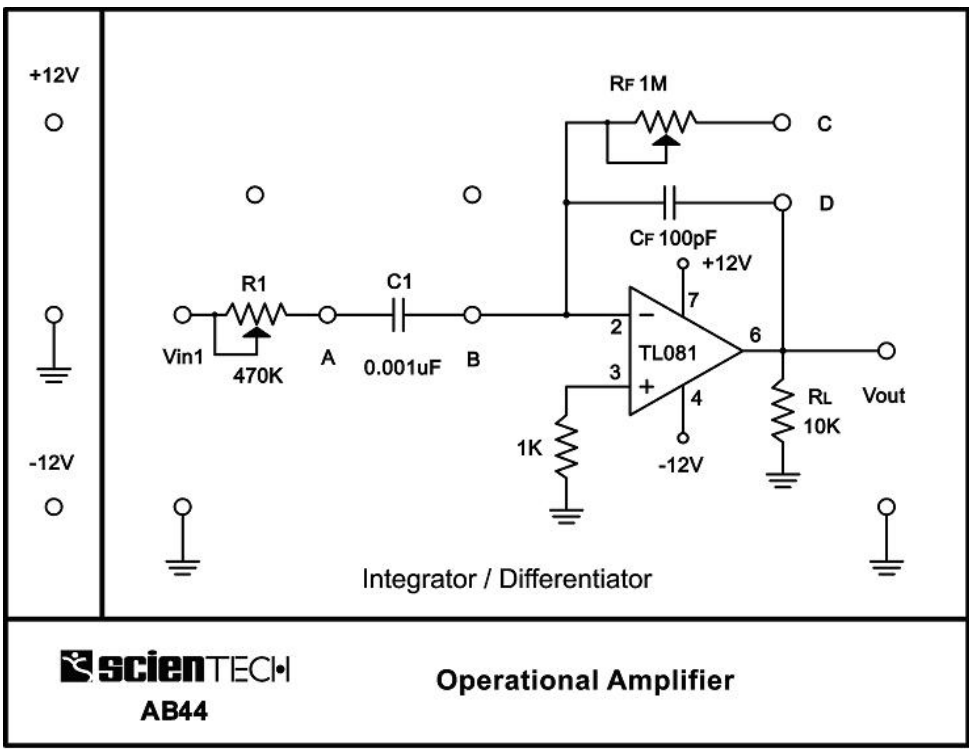


Figure 6

Procedure :

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

1. Select F_a = 100Hz, the maximum frequency of the input signals to be differentiated.

2. As C_1 = .001µF, calculate the value of R_F using relation

$$F_{max} = Fa = ½ \pi R_F C_1.$$

3. Choose $F_b = 10F_a$ and calculate the value of R_1 using the relation $F_b = ½ \pi R_1 C_1$

4. Use potentiometer R_1 and R_F to set the above calculated values of R_1 and R_F.

5. Connect a patch cord between test point C, D

6. Apply sine, square, triangular wave one by one of 1 V_{pp} at the test point V_{in} l.

7. Measure and trace the output waveform at the test point V_{out}.

8. Vary the frequency of input signal for a maximum of 1K, 10K & 100K and observe its effect on the output waveform.

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+}**

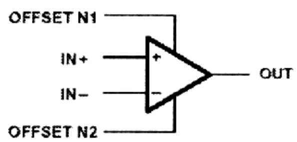
description

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.

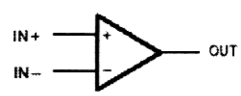
The C-suffix devices are characterized for operation from 0°C to 70°C. The I-suffix devices are characterized for operation from −40°C to 85°C. The Q-suffix devices are characterized for operation from −40°C to 125°C. The M-suffix devices are characterized for operation over the full military temperature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

symbols

TL081



TL082 (EACH AMPLIFIER)
TL084 (EACH AMPLIFIER)



AVAILABLE OPTIONS

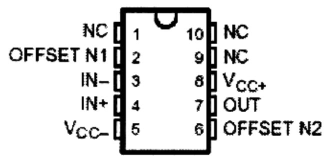
T_A	V_{IO}max AT 25°C	PACKAGED DEVICES										CHIP FORM (Y)
		SMALL OUTLINE (D008)	SMALL OUTLINE (D014)	CHIP CARRIER (FK)	CERAMIC DIP (J)	CERAMIC DIP (JG)	PLASTIC DIP (N)	PLASTIC DIP (P)	TSSOP (PW)	FLAT PACK (U)	FLAT PACK (W)	
0°C to 70°C	15 mV 6 mV 3 mV	TL081CD TL081ACD TL081BCD	—	—	—	—	—	TL081CP 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).

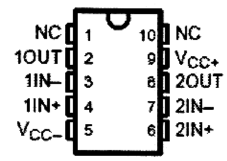
TL081, TL081A, TL081B, TL082, TL082A, TL082B
TL082Y, TL084, TL084A, TL084B, TL084Y
JFET-INPUT OPERATIONAL AMPLIFIERS

SLOS081E – FEBRUARY 1977 – REVISED FEBRUARY 1999

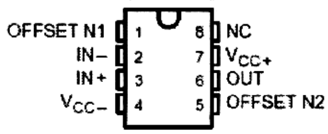
TL081M
U PACKAGE
(TOP VIEW)



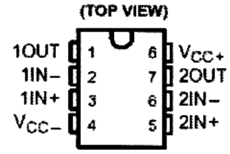
TL082M
U PACKAGE
(TOP VIEW)



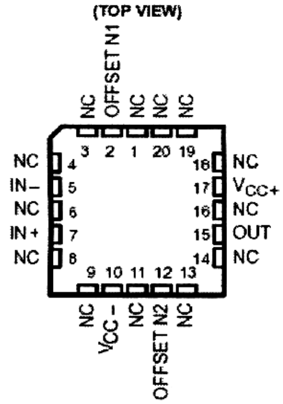
TL081, TL081A, TL081B
D, JG, P, OR PW PACKAGE
(TOP VIEW)



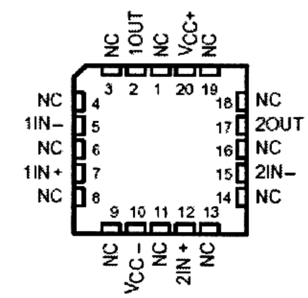
TL082, TL082A, TL082B
D, JG, P, OR PW PACKAGE
(TOP VIEW)



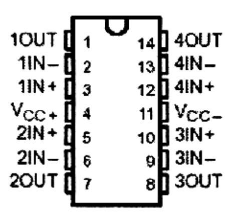
TL081M . . . FK PACKAGE
(TOP VIEW)



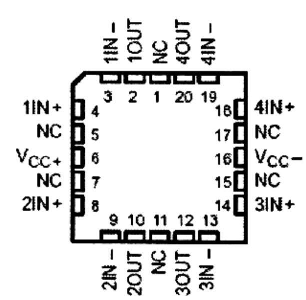
TL082M . . . FK PACKAGE
(TOP VIEW)



TL084, TL084A, TL084B
D, J, N, PW, OR W PACKAGE
(TOP VIEW)



TL084M . . . FK PACKAGE
(TOP VIEW)



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) .... 2 Nos.
2. 2 mm Patch Cord (Black) .... 3 Nos.
3. 2 mm Patch Cord (Blue) .... 4 Nos.
4. e-Manual...1 No.

Updated 18-02-2009