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COLLEGE OF ENGINEERING
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"SIMPLE TESTER FOR OPEATIONAL AMPLIFIERS"

A MINI PROJECT REPORT

Submitted by

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In partial fulfillment for the award of the degree of

BACHELOR OF ENGINEERING
IN
ELECTRONICS AND COMMUNICATION

NEW HORIZON COLLEGE OF ENGINEERING

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

CERTIFICATE

Certified that the mini project work entitled “**SIMPLE TESTER FOR OPEATIONAL AMPLIFIERS**” carried out by**, KURAPATI SAI SWATHI (1NH18EC060)** bonafide student of Electronics and Communication Department, New Horizon College of Engineering, Bangalore.

The mini project report has been approved as it satisfies the academic requirements in respect of mini project work prescribed for the said degree.

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KURAPATI SAI SWATHI (1NH18EC060)

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ABSTRACT

Testing before implementation is an important step in the building of a fully functioning circuit. Testing of the basic blocks of a circuit ensure that the design after being implemented is working as per the user's requirements. This testing can be done in various methods and the output of such tester circuits is mostly in binary, that is either high or low. Simple tester circuits revolve around the design where in the output is given by frequencies. If the frequency is matched with the output frequency of its capacitance value, the IC is functioning as per the requirements else the IC is to be replaced. This IC can now be used in larger designs. The circuit implemented here can be used to test two single output operational amplifier's and 1 dual output operational amplifier at once. The output of the circuit is based on the frequency response given by the circuit. The inputs to this circuit is nothing but plugging in the IC to be tested in the slot and completing the conducting paths using switches.

Furthermore, this project revolves around the importance of an operational amplifier characteristic that is slew rate. This project is the simplest and the most optimized version of an IC tester.

CHAPTER 1

INTRODUCTION

Operational amplifiers are a direct coupled amplifier having very high gain. Any operational amplifier has the following features/specifications which are to be met for the proper function of the amplifier. The specifications are listed as follows:

- Open loop gain is the gain of the circuit when there is no feedback path introduced. Ideally it is infinite whereas practically it is very high. Typically, an op-amp has the gain 100000.
- Input impedance is the measure of the opposition to current given by the circuit (resistance and reactance). Ideally it is infinity, thus allowing 0 current into the device. Practically the value is very high (in Mega ohms) thus allowing very little current into the device (in micro amps)
- Output impedance also referred to as source impedance, it is the opposition of the current flow into the load. Ideally it is zero, practically it is very high.
- Common mode rejection ratio of a differential amplifier is a ratio used to depict the ability of the device to reject common mode signals. Ideally this value is infinite, practically it is very high. The higher the value of CMRR the better.
- Difference in the upper and lower frequencies in a continuous band of frequencies is known as band width. It is measured in hertz (Hz) ideally it is infinite, practically it is very high.
- Slew rate can be defined as the rate of change of voltage or current with respect to unit time. It usually expressed in volts/ second or ampere/second. Ideally the value of slew rate is infinite, practically it is very high.

There are two main rules or criteria for any op-amp.

1. The voltage at the input terminals is made same in a closed loop configuration
2. The input terminals draw no current i.e. No current enters the operational amplifier.

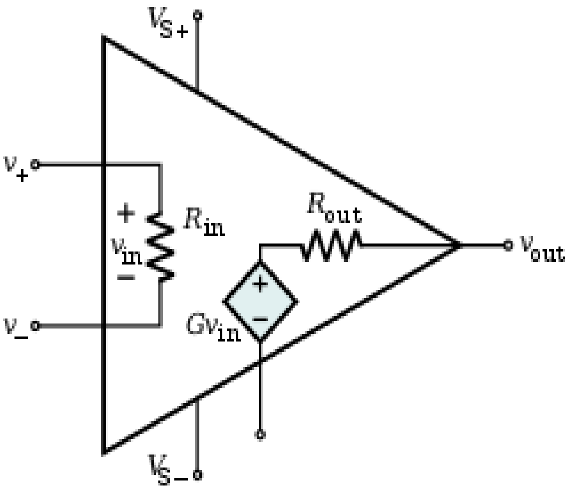


Fig-1.1 operational amplifier

A basic operational amplifier has one or more differential amplifiers followed by a level translator and an output stage. To understand the testing of any IC it is essential to understand the working, internal diagram and the features of the operational amplifier.

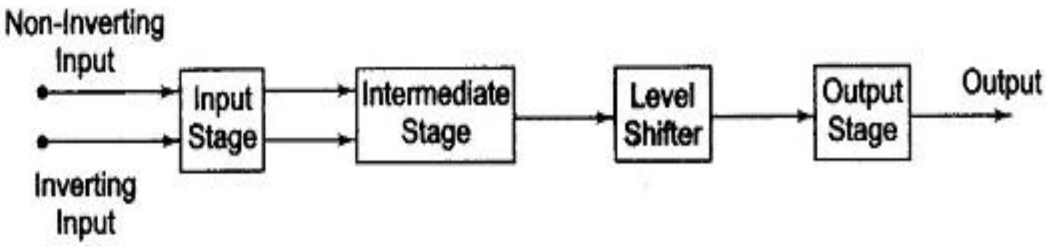


Fig-1.2 Block diagram

- Stage 1: It is also known as the input stage. The input stage is a dual input differential amplifier; it produces a balanced output. This stage is mainly used to provide the required voltage gain of the entire block. It ensures that the input impedance is maintained to be high which is a requirement for the proper functioning of the operational amplifier.
- Stage 2: It is also known as the intermediate stage. It produces an unbalanced output. The input to this block is the output of the previous block that is a balanced input is provided to this stage. This stage usually comprises of a differential amplifier. Since this stage is directly coupled, the DC voltage at the output of this stage is slightly above the ground potential.

- Stage 3: this stage is also known as the level shifter or the level translator. This stage is mainly used to shift the DC level of the output downward to zero level with respect to ground (reference).
- Stage 4: it is also known as the output stage. It is used to increase the output voltage swing of the final output and to provide a low output impedance. This stage usually comprises of push-pull complementary amplifiers.

A simple tester which is used to test both single and dual output operational amplifier mainly consists of a square wave oscillator. A square wave oscillator is a relaxation oscillator, the output of this is a square wave. This oscillators output is solely dependent on the time constant of the circuit. The rapid charging and discharging of the capacitors drive the operation of the circuit. A basic square wave oscillator is shown as follows

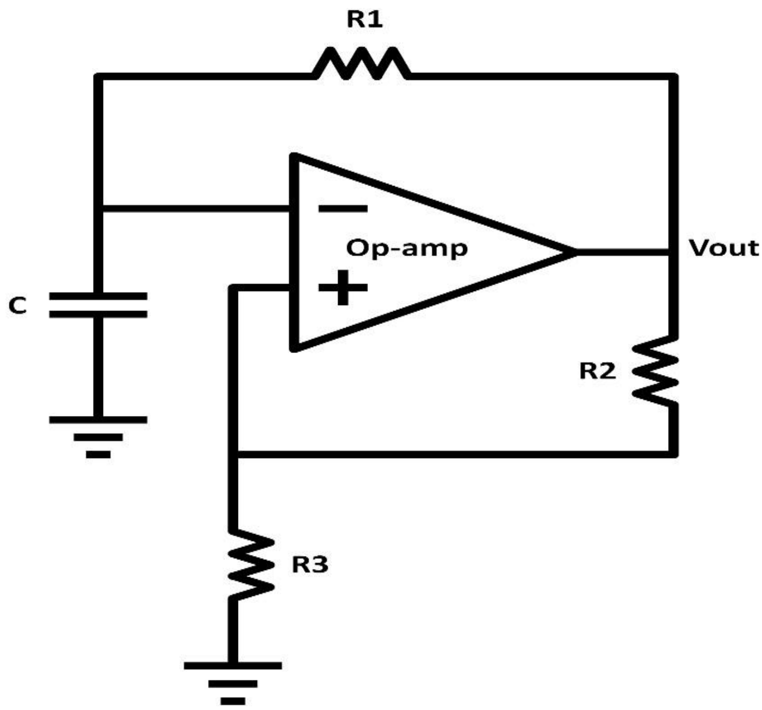


Fig-1.3 Square wave oscillator

CHAPTER 2

LITERATURE SURVEY

Title of the paper	**Author & Year of Publication**	**Outcome**	**Limitation**
Simple tester for operational amplifier	S.C. Dwivedi	This is a simple tester with square-wave oscillator for single and dual operational amplifiers (op-amps)	• Basic tester • Low IQ parts are difficult to test
Conventional Three Op-amp IA with Resistive Feedback	Shodhganga	The three op-amp method uses two additional amplifiers to perform the test faster.	• Stability-Compensation must be correct. • Not usable for DUT's with variable gain/phase • There is always a 1Meg load on the DUT
Research gate	Aduita A Gaonkar 1960	Information about IC'S	Test and IC's implementation
Elector magazine	Dirk Schemacher 2005	The principle of the tester is a triangular voltage is applied to the inverting input of the specimen.	Test equipment

Table – 2.1 Literature survey

CHAPTER 3

EXISTING SYTEM AND PROBLEM STATEMENT

3.1 PROBLEM STATEMENT: -

Earlier there is a tester to test single op-amp. Only few op-amps such as IC741 can be tested using it. This project is to design a tester that tests two single op-amps and one dual op-amp.

3.2 OBJECTIVES: -

- Understanding, designing and implementation of tester for operational amplifier.
- To understand the functionality of IC and diode.
- The sole purpose is to provide isolation and prevent circuit loading.
- Check for errors in operational amplifier prior to its use.

3.3 EXISTING SYSTEM: -

3.3.1 Circuit Diagram and Working:

Circuit is very simple with few components, that can be easily built on breadboard or on PCB. The op-amp LM741has to be placed on right place. The led will flash or blinks if the op-amp is in good condition. If the led remains ON or OFF continuously then the op-amp is said to be faulty.

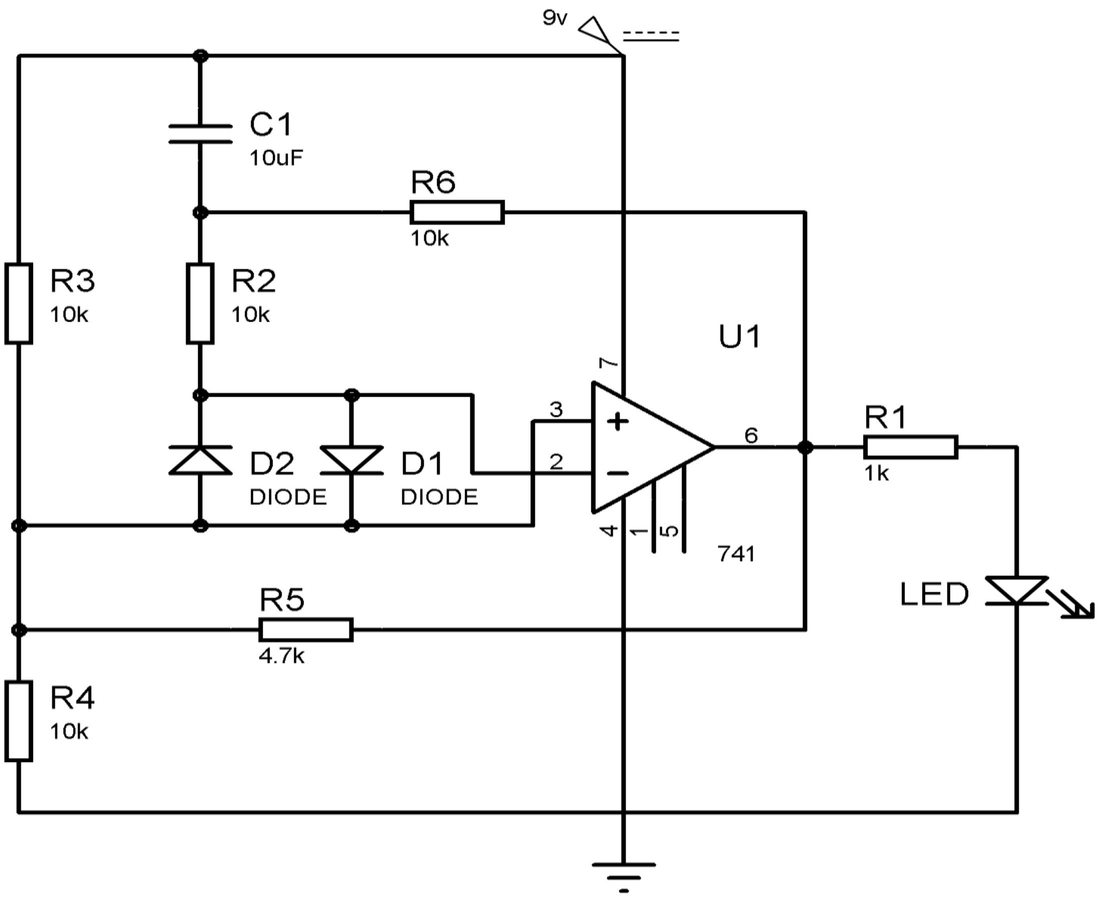


Fig - 3.1 circuit diagram of single op-amp tester

Working of this circuit is simple. If the op-amp is in working condition this circuit generates a square wave at the output, resulting a blinking LED. When the circuit is switched on with the op-amp in its place, initially voltage at non-inverting input (+) is higher than the voltage at inverting input (-) and the output of op-amp is high. So, through R6 resistor the capacitor C1 starts charging. The output becomes low, when C1 charging exceeds the voltage at inverting terminal. As the output goes low, the capacitor C1 starts discharging resulting in lower voltage at inverting terminal than that of the non-inverting terminal. And the output goes high. This-process continuously and produces square wave at the output. This results in LED to blink.

CHAPTER 4

PROPOSED SYSTEM

This is a simple tester for single and dual operational amplifiers (op-amps) with square-wave oscillator. These op-amps are commonly used in different projects. You can use and reuse these, but an op-amp has to be tested before use in new and different projects.

There are many single op-amps available under different names such as NE5534, TL071 and LM741, each having significant differences in slew rate, output drive capabilities and other parameters. You need to compare these parameters to select the most appropriate one for your application. Here is a simple op-amp tester circuit designed to solve these problems.

4.1 CIRCUIT DIAGRAM: -

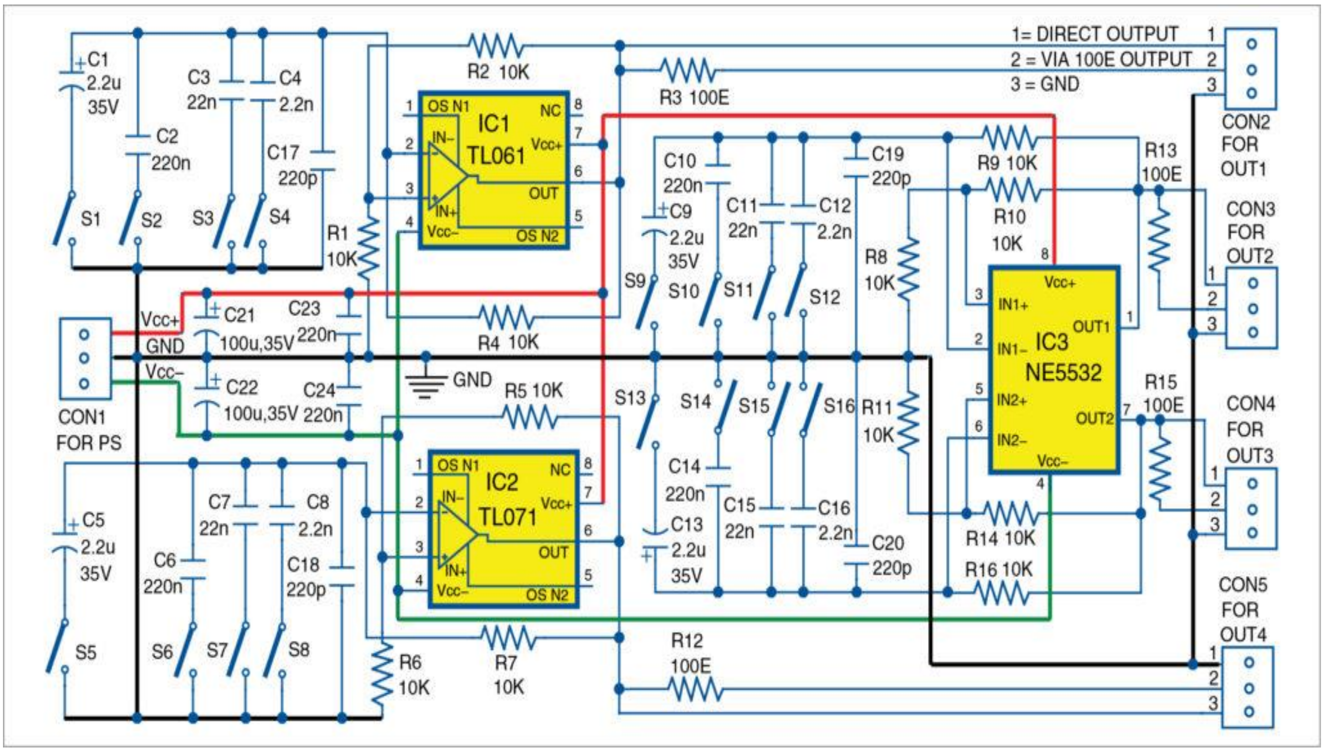


Fig - 4.1 circuit diagram of three op-amp tester

The circuit is built around single op-amps TL061 (IC1) and TL071 (IC2), a dual op-amp NE5532 (IC3), sixteen on/off switches (S1 through S16) and a few extra components. This circuit can be used to test two single op-amps (IC1 and IC2) and one dual op-amp (IC3) conveniently. Sometimes, it can be difficult to choose whether to use two single op-amps or one dual op-amp in a project. In that case you need to compare parameters of the two single op-amps with those of dual op-amp. IC1 and IC2, and IC3 can be of the identical type, such as NE5534 and NE5532, correspondingly.

This circuit gives five test output frequencies on selecting switches S1 through S4. Test output frequencies for IC1 are given in the table below.

When switch is closed	Select capacitor	Value of the capacitor	Approximate test output frequency
S1	C1	2.2μF	30HZ
S2	C2	220nF	300HZ
S3	C3	22nF	3kHZ
S4	C4	2.2nF	33kHZ
None	C5	220pF	330kHZ

Table - 4.1 output frequencies

Use S5 through S8 switches for testing IC2. Use S9 through S16 switches for testing IC3. For IC1 and IC2, the test frequencies can be same.

With the same or different frequencies, IC3 can be tested. Since IC3 is a dual-op-amp, there can be chances where one of the inbuilt op-amps of IC3 is damaged while the other op-amp is operational, and vice-versa. (Note: If the op-amp is damaged, you will not get output frequencies as listed in the table.

This circuit operates with a bipolar power supply. But IC1, IC2 and IC3 have the same power supply lines. Power supply can be symmetrical or non-symmetrical. This will change the limitations of output signals. The circuit operates in full power supply range of the op-amps. Maximum power supply is limited by driving capabilities, op-amps and maximum voltage rating of capacitors used in the tester circuit.

Output frequency of the tests can be changed easily to needs. Driving ability of the op-amps can be tested with external loads. Each op-amp under test has a direct output line as well as output with series resistor of 100 ohms. Op-amps will be unstable if we test them directly with inductive and capacitive loads, so 100-ohm resistors are provided at output.

The circuit does not require any adjustment to operate properly. It can be used to test many op-amps, including faster op-amps such as OPA132 and OPA134 and low-speed op-amps such as LM741 and MC1458.

CHAPTER 5

HARDWARE DESCRIPTION

The components required are as follows:

SL NO	COMPONENTS	NUMBER OF COMPONENTS
1	IC TL061	1
2	IC TL071	1
3	IC NE5532	1
4	10KΩ Resistors	12
5	100Ω Resistors	4
6	2.2μF Capacitors	8
7	220nF Capacitors	2
8	22nF Capacitors	4
9	2.2μF Capacitors	4
10	220pF Capacitors	4
11	100μF Capacitors	2
12	Switches	16
13	3 pin connectors	5
14	Power supply	±5 to ±15
15	Jumper wires	As required

Table - 5.1Components

A detailed explanation about these elements are given as follows for better understanding of the circuit.

5.1 THE LOW POWER JFET OP-AMP:

IC number: TL061

In case the mentioned IC is not available, it can be replaced with the following ICs TL061A, TL061B, TL062, TL062A, TL062B, TL064, TL064A, TL064B.

The low power JFET single output amplifier consists of high speed, high voltage JFET and bipolar junction transistors. This operational amplifier is packed in a monolithic fashion.

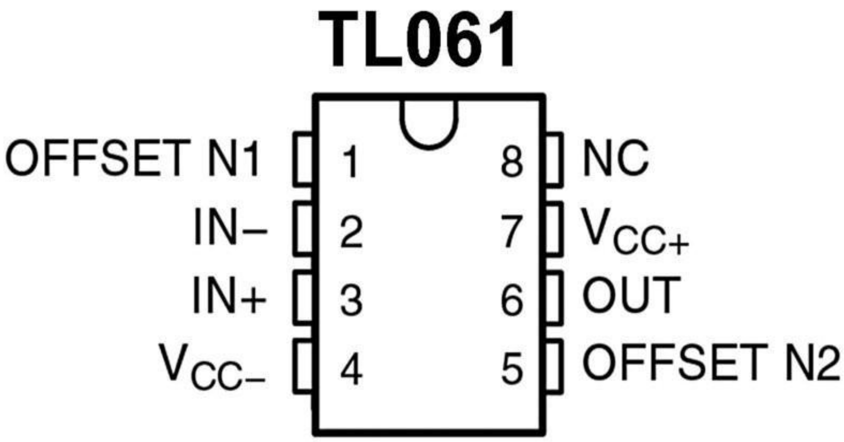


Fig - 5.1 Pin diagram of IC TL061

This operational amplifier as a few extraordinary features such as

- Very low power consumption: 200 µA
- differential voltage ranges and Wide common-mode (up to VCC+)
- Low input bias and offset currents
- Output short-circuit protection
- High input impedance JFET input stage
- Internal frequency compensation

- Latch-up free operation
- High slew rate: 3.5 V/µs

5.1.1 PIN DISCRIPTION:

PIN NUMBER	NAME OF THE PIN	FUNCTION OF THE PIN
1	Offset null-1	Used to nullify
2	Inverting input	Input pin
3	Non inverting input	Input pin
4	GND	grounded
5	Offset null-2	Used to nullify
6	output	Output pin
7	Vcc	Supply Voltage (5-18) V
8	No connection	

Table - 5.2 pin description of IC TL061

5.1.2 INTERNAL CIRCUIT DIAGRAM:

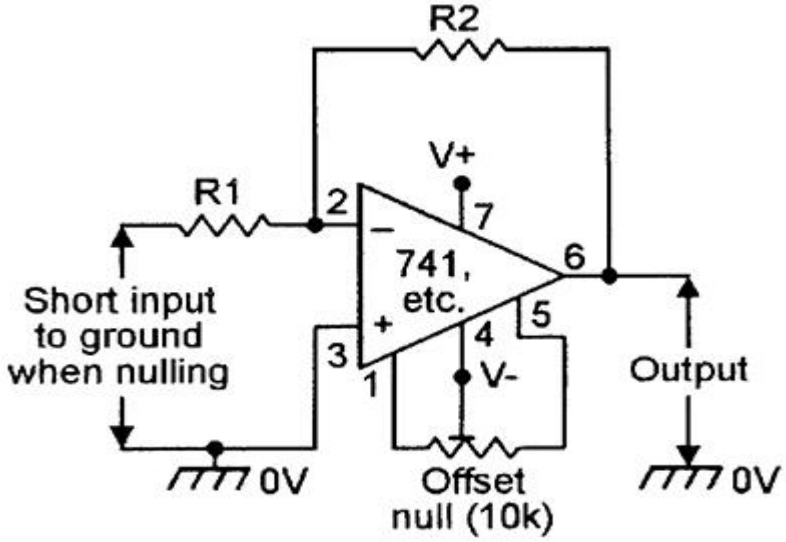


Fig - 5.2 internal circuit diagram of TL061

5.2 THE LOW NOISE JFET OP-AMP:

IC number: TL071

In case the mentioned IC is not available, it can be replaced with the following ICs TL071A, TL071B, TL072, TL072A, TL072B, TL074, TL074A, TL074B.

These ICs have relatively low input bias current and low offset currents. In addition to this the IC offers a high slew rate. Due to the low harmonic distortion and high noise cancelation this IC finds its application in audio preamplifiers and high fidelity. The design of this operational amplifier is fabricated into a monolithic chip.

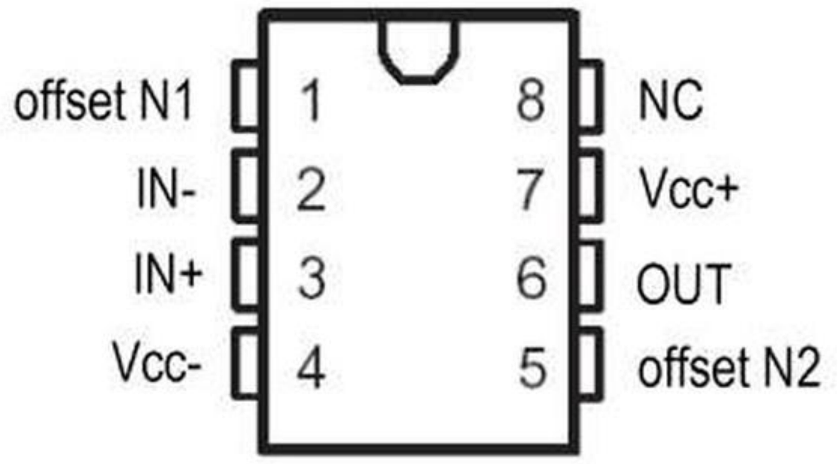


Fig - 5.3 pin diagram of IC TL071

- Low Power Consumption
- Wide Common-Mode and Differential Voltage Ranges
- Low Input Bias and Offset Currents
- Output Short-Circuit Protection
- Low Total Harmonic Distortion typical value ranges up to 0.003%
- High Input Impedance offered by the JFET Input Stage
- Internal Frequency Compensation
- Latch-Up-Free Operation
- High Slew Rate is typically 13 V/µs

5.2.1 PIN DISCRIPTION:

PIN NUMBER	NAME OF THE PIN	FUNCTION OF THE PIN
1	Offset null-1	Used to nullify
2	Inverting input	Input pin
3	Non inverting input	Input pin

4	GND	grounded
5	Offset null-2	Used to nullify
6	output	Output pin
7	Vcc	Supply Voltage (5-18) V
8	No connection	

Table - 5.3 pin description of IC TL071

5.2.2 INTERNAL CIRCUIT DIAGRAM:

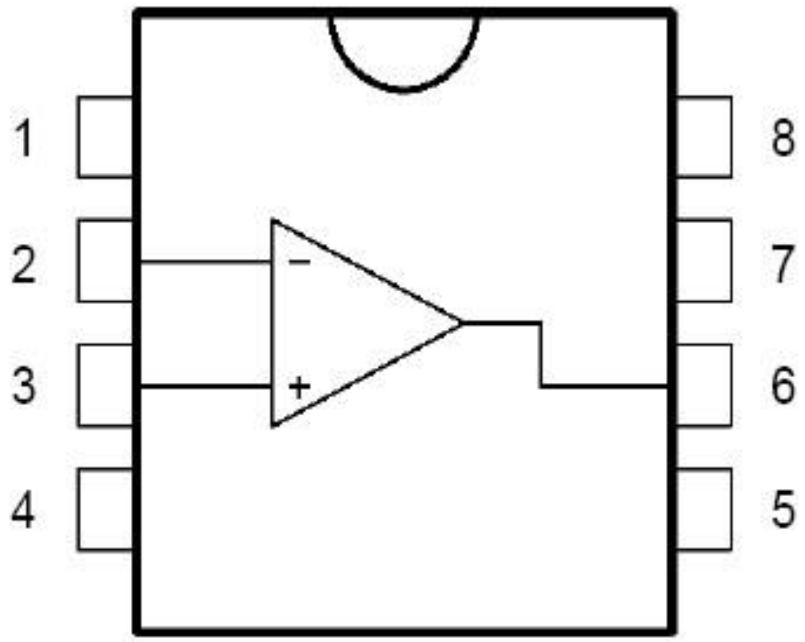


Fig - 5.4 internal circuit diagram of IC TL071

5.3 THE DUAL LOW NOISE JFET OP-AMP:

IC number: NE5532

In case the mentioned IC is not available, it can be replaced with the following ICs can be used NE5532, NE5532A, SE5532, SE5532A.

The ICs of this family give high performance as they are a combination of the excellent dc and ac characteristics. A few of the extraordinary characteristics provided by them include low distortion, high slew rate, high unity gain, low noise, high output driving capability. The design also involves input protection (diodes) and output protection (short circuit).

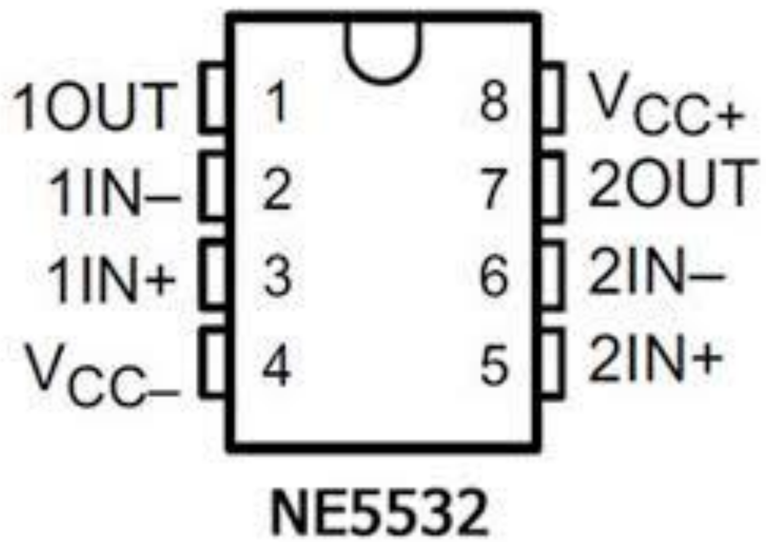


Fig - 5.5 Pin diagram of IC NE5532

- The equivalent Input Noise Voltage is typically 5 nV/√Hz when measured at 1 kHz
- The unity-Gain Bandwidth is typically 10 MHz
- The common-Mode Rejection Ratio is typically 100 dB.
- The dc Voltage Gain is typically 100 V/mV
- Peak-to-Peak Output Voltage Swing is typically 32 V when measured With VCC = 18 V and RL = 600 Ω
- The Slew Rate offered by this IC is typically 9 V/µs
- Power Supply-Voltage Ranges from ±3 V to ±20 V

5.3.2 PIN DESCRIPTION:

PIN NUMBER	NAME OF THE PIN	FUNCTION OF THE PIN
1	Output_1	Output pin
2	Inverting input_1	Input pin
3	Non inverting input_1	Input pin
4	GND	grounded
5	Non inverting input_2	Input pin
6	Inverting input_2	Input pin
7	Output_2	Output pin
8	Vcc	Supply Voltage (5-18) V

Table - 5.4 pin description of IC NE5532

5.3.3 INTERNAL CIRCUIT DIAGRAM:

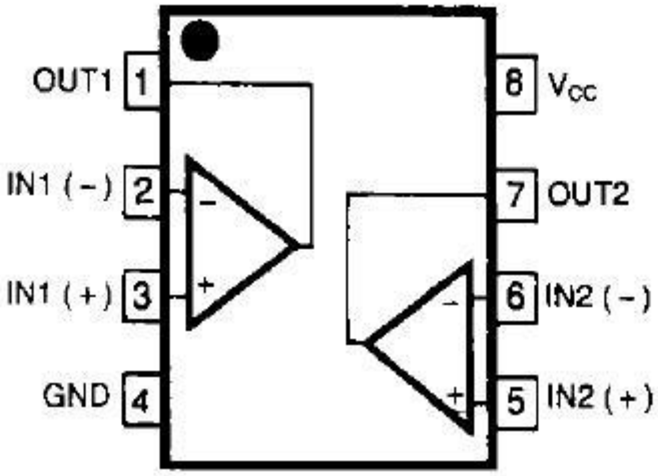


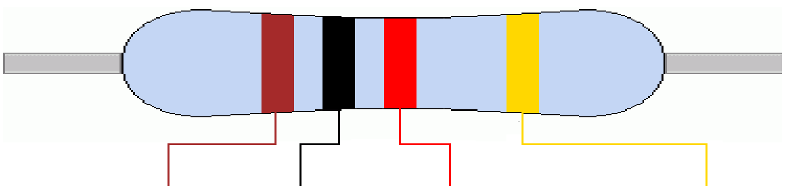
Fig - 5.6 internal circuit diagram of IC NE5532

5.4 RESISTORS:

Resistors used in circuit are 10kΩ and 100Ω. Resistor is a two-terminal device which is used in an electric circuit and provides predefined resistance to the flow of current in the circuit. The resistance of a resistor can be linear or non-linear depending on the application used. The resistance of a linear resistor is self-determined of the applied voltage. But the resistance of a non-linear resistor changes upon the applied voltage. Resistors made of semi-conductor are non-linear. However, resistors can also be used to control the amount of voltage provided to part of a circuit and to help create timing circuits.

Fig - 5.7 resistors

Colour coding is used in resistors to calculate the magnitude of the resistance in ohms. Colour coding is a process widely used in determining the values of the resistors. The colour bands on the resistor are of utmost significance while determining the value of the resistors. Each colour has a resistance value along with a tolerance value as shown in the figure mentioned below.



	Band 1	Band 2	Band 3	Multiplier	Tolerance
Black	0	0	0	1	-
Brown	1	1	1	10	±1%
Red	2	2	2	100	±2%
Orange	3	3	3	1000	-
Yellow	4	4	4	10 000	-
Green	5	5	5	100 000	±0.5%
Blue	6	6	6	1 000 000	±0.25%
Violet	7	7	7	10 000 000	±0.1%
Gray	8	8	8	100 000 000	±0.05%
White	9	9	9	1000 000 000	-
Gold				0.1	±5%
Silver				0.01	±10%
None					±20%

Fig - 5.8 colour coding of resistors

The colour code for 10k ohm will be: brown, black, orange, gold

The colour code for 100 ohm will be: brown, black, brown, gold

CAPACITORS:

Capacitors used in this circuit are 2.2µf, 220nf, 22nf, 2.2µf, 220pf, 100Mf. A capacitor is a component that has the ability (capacity) to store energy in an electric field. It is an inactive electronic module with two terminals. The charge that capacitor hold is known as capacitance. Capacitors are devices which store & hold electrical charge. Further uses include power conditioning, electronic noise filtering, decoupling or signal coupling and remote sensing. Because of its wide-ranging applications, capacitors are used in a wide range of industries and have become a vigorous part of everyday life.

Fig - 5.9 capacitors

5.6 SWITCHES:

A switch is an element which controls the open-ness or closed-ness of an electric circuit. They let control over current flow in a circuit (without having to actually get in there and manually cut or splice the wires). Switches are the critical components in any circuit which requires user interaction or control. Electrical switches work according to an elementary design. Generally, the most common switches are the on/off toggle ones. Electric circuits work when electricity can move in a nonstop loop. The electricity slashes off once the circle is broken. This is where the switch comes in. when it is off, toggle on/off circuit breaks the current. The loop completes itself when it's in" on" position.

Fig - 5.10 switches

5.7 BREADBOARD:

The breadboard is a circuit construction system that is designed to allow the rapid creation of circuits without the need for soldering or making permanent connections. Leaded components are inserted into holes comprising metal grips that gently clamp onto the lead and breadboards almost always have common rows whereby the holes in a row are electrically connected together. Breadboards allow components to be inserted and removed easily. To use a bread board, you just push the pins of jumper wires into the holes. The holes have springs in them to keep the components from falling out. The trick, however, is to put the pins into the right holes so that you get the circuit you want. Some of the holes in breadboards are connected together and it is important to know which.

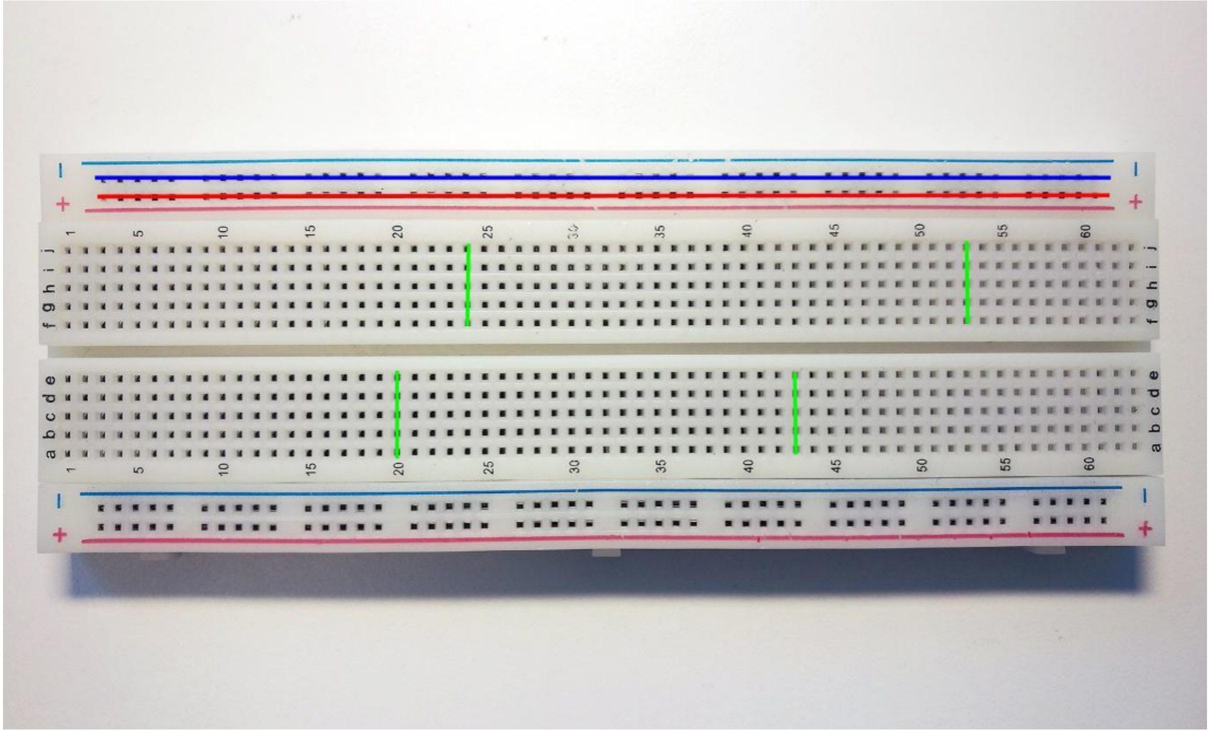


Fig - 5.11 breadboard

5.8 3-PIN CONNECTOR:

3 Pin Wire to Board connector are used commonly for connecting Wires to Boards. It can be for Power Supply or connecting any other peripheral like Motor to the Board. There is a distance of standard 2.54mm between two mounting pins, so that this connector can be mounted easily on general purpose PCBs.

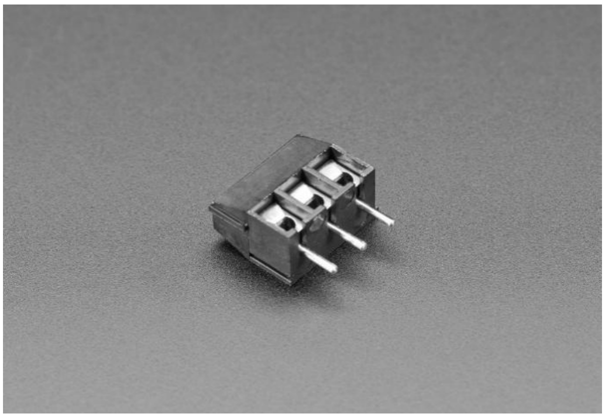


Fig - 5.12 3 pin connector

5.9 JUMPER WIRES:

A jumper wire is an electrical wire that has a connector or pin at each end which is usually used to interconnect the components of a breadboard or other prototype or test circuit, internally or with other equipment or components, without soldering. Individual jump wires are fitted by introducing the connector ends into the slots provided in a breadboard, the header connector of a circuit board, or a piece of test equipment.

The types of jumper wires:

The jumper wires are typically of three types:

The difference between the three types are based on their end of the wire. Basically, the male tip has a protruding end which is used to plug into things whereas, the females do not have protruding ends and cannot be used to plug into things.

- **The male-to-male:**
  This is the most common type of jumper wire that is being used often. Our project also involves the use of this type of jumper wires. Especially while connecting two ports on a breadboard a male-to-male wire is useful.

- **Male-to-female:**

The male to female jumper wire is useful in connecting female header pin of any board to a development board having a male connector.

- **Female-to-female:**

This jumper wire is very much handy for making wire hardness on PCB's.

Fig - 5.13 female-female jumper wires

Fig - 5.14 male-male jumper wires

Fig - 5.15 male-female jumper wires

CHAPTER 6

RESULT AND DISSCUSSION

The result of this project was demonstrated successfully. By testing it on various ICs such as LM741, MC1458, OPA132, OPA134.

Usually testers work with certain frequencies. The output frequency of a tester depends upon its capacitance value.

So, the output of the tester around 30hz frequency will be in working condition in accordance with its 2.2micro farad capacitance value

Similarly, at some particular capacitance values the output frequency of a tester shows that the tester is working

In this project we could see 5 different frequencies where a tester could probably work better under its capacitance values

If the frequency gets mismatch then we could find that the component is not in working condition.

CHAPTER 7

ADVANTAGES AND APPLICATIONS

7.1 ADVANTAGES:

The circuit operates in full power supply range of the op-amps. Maximum power supply is limited by op-amps, maximum voltage rating of capacitors used in the tester circuit and driving capabilities of op-amps.

Output frequency of the tests can be changed easily and to a large scale according to needs.

Driving capability of the op-amps can be tested with external loads. For that, each op-amp under test has a direct output line as well as output with series resistor of 100 ohms.

Op-amps will be unstable if you test them directly with capacitive and inductive loads, so 100-ohm resistors are provided at output.

7.2 APPLICATIONS

- amplifier circuits
- voltage follower circuits
- current to voltage changer
- voltage to current changer

CHAPTER 8

CONCLUSION AND FUTURE SCOPE

8.1 CONCLUSION:

IC3 can be tested at the same or different frequencies. Since IC3 is a dual-op-amp, there can be cases where one of the inbuilt op-amps of IC3 is operational while the other op-amp is damaged, and vice-versa.

This project's goal was to design a simple IC tester kit that allows the designer to check the working status of the IC before introducing it in a larger design. We have given our full efforts to make this mini project a successful tester.

8.2 FUTURE SCOPE:

Advances in process and packaging technologies will enable more integration within smaller packages, allowing increased functionality and performance.

Amplifiers will begin to integrate other functions, again within very small packages. Advances in package material sets will allow even tighter parametric specifications.

REFERENCES

[1]D. W. Bliss, P. A. Parker, A. R. Margetts, "Simultaneous transmission and reception for improved wireless network performance", *Statistical Signal Processing 2007 IEEE/SP 14th Workshop on*, pp. 478-482, 2007.

[2]https://www.google.com/search?q=Simple+Tester+For+operational+Amplifie&oq=Simple+Tester+For+operational+Amplifie&aqs=chrome..69i57j69i59.936j0j1&sourceid=chrome&ie=UTF-8

[3]https://bestengineeringprojects.com/operational-amplifier-741-tester/

[4]https://www.electronicsforu.com/electronics-projects/simple-tester-for-operational-amplifiers-2

[5] https://circuitdigest.com/electronic-circuits/opamp-lm741-tester-circuit

[6] https://www.ti.com/product/TL061

[7] https://www.ti.com/product/TL071

[8] https://www.ti.com/product/NE5532

Author – Title:

S.C. Dwivedi - Simple tester for operational amplifier

Shodhganga - Conventional Three Op-amp IA with Resistive Feedback

Aduita A Gaonkar 1960 - Research gate

Dirk Schemacher 2005 - Elector magazine