PRE-LIGHTNING INDICATOR FOR HUMAN SAFETY

Abstract:

With manifestation of ever changing global environment lean to carbon footprint evaluation, human being is under threat of lightning mainly in third world country where the proliferation of carbon gas and other particles influence the natural environment more prone to unsafe during lightning phenomenon happens. Every human being is facing huge problem during movement of every step while situation goes in adverse condition. It is necessary proactive and avoid the severe zone by understanding how much ions exists in that zone with the help of relevant device. It will act during this environmental condition and alert to preventive action to move in safe zone where possibility of strike much less.

Introduction:

The Pre Lightning Indicator is a device helps to human being to understand the severity level of the surrounding environmental condition lean to lightning strike. The indicator light will extinguish, the moment ground level will more prone to negative ion produce by atmosphere.

Another thing that can be measured, in addition to the potential gradient, is the current in the atmosphere. The current density is small—about 10 micro microamperes crosses each square meter parallel to the earth. The air is evidently not a perfect insulator, and because of this conductivity, a small current—caused by the electric field we have just been describing—passes from the sky down to the earth.

Air molecules there are an ions—a molecule of oxygen, say, which has acquired an extra electron, or perhaps lost one. These ions do not stay as single molecules; because of their electric field they usually accumulate a few other molecules around them. Each ion then becomes a little lump which, along with other lumps, drifts in the field—moving slowly upward or downward—making the observed current. The ions were produced by the radioactivity of the earth. It was known that the radiation from radioactive materials would make air conducting by ionizing the air molecules. Particles like β-rays coming out of the atomic nuclei are moving so fast that they tear electrons from the atoms, leaving ions behind. This would imply, of course, that if we were to go to higher altitudes, we should find less ionization, because the radioactivity is all in the dirt on the ground.

Theory:

There are negative charges from the cloud; the whole column is full of negative charge. Also, the air is becoming ionized by the rapidly moving charges that produce the leader, so the air becomes a conductor along the path traced out. The moment the leader touches the ground, we have a conducting "wire" that runs all the way up to the cloud and is full of negative charge. Now, at last, the negative charge of the cloud can simply escape and run out. The electrons at the bottom of the leader are the first ones to realize this; they dump out, leaving positive charge behind that attracts more negative charge from higher up in the leader, which in its turn pours out, etc. So finally all the negative charge in a part of the cloud runs out along the column in a rapid and energetic way. So the lightning stroke you *see* runs *upwards* from the ground, In fact, this main stroke—by far the brightest part—is called the *return stroke*. It is what produces the very bright light, and the heat, which by causing a rapid expansion of the air makes the thunder clap.

Sensor:

The air dielectric has been taken into consideration for capturing the flow of ion between to plate which is being influenced by nature of negative ion flowing through it and neutralized the positive ion of ground surface accumulated inside the chamber of sensor. The cavity of the sensor accelerated with positive ion. When it is influenced by negative ion through leader then variation of low current will be experienced by the plate previously biased. This tiny change will be amplified by the very low noise amplifier to amplify the changes happen.

When a ionizing air comes in contact with the sensor, it passes through a positive to negative plate to reach the electrode surface. The first electrode that the negatively ionized air comes in contact with is the positive electrode (PE). The PE is designed to optimize the capture of –ve ion exists in air and to generate a current flow that is proportional to the ion concentration.

To maintain a constant sensitivity with a good linearity, a potential difference exists between –ve and +ve Electrode. The reference electrode's purpose is to anchor the Positive Electrode at the correct potential. In order to maintain a constant potential, no current should flow through it. While the – ion or + ion flow increase in between the electrodes, it changes the constant potential difference and influenced to increase the current. Since the current range is femto ampere and transported to plates the input status (voltages) change of Op Amp. The following basic conception used in this application in more improvise way as well.

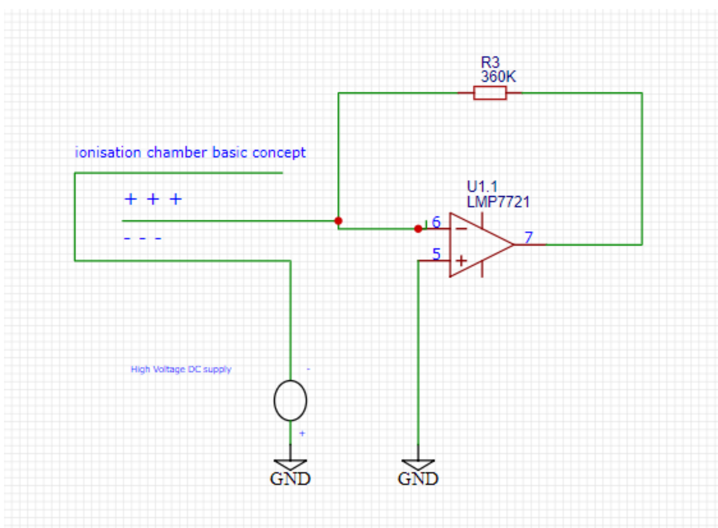


FIG 1

Concept of Circuit Operation:

Design of the amplifier is illustrated in the circuit diagram in Figure 1. The first stage comprises a unity gain current to voltage amplifier with a zero-resistance front-end, followed by the second stage, a (approximate) gain of twenty inverting amplifier. The input signal is presented via a 500MΩ Input Resistor to the inverting input of U1, LMP7721 device. This resistor is only used for testing purposes to measure the minimum current readable by the amplifier. Once the amplifier is tested, this resistor is removed, enabling a direct zero-resistance connection between the input terminal and the amplifier. A precision resistor of 500MΩ is connected as the Feedback Resistor to provide roughly 1010 current/voltage transfer function. However, the voltage gain of the amplifier remains unity.

Schematic:

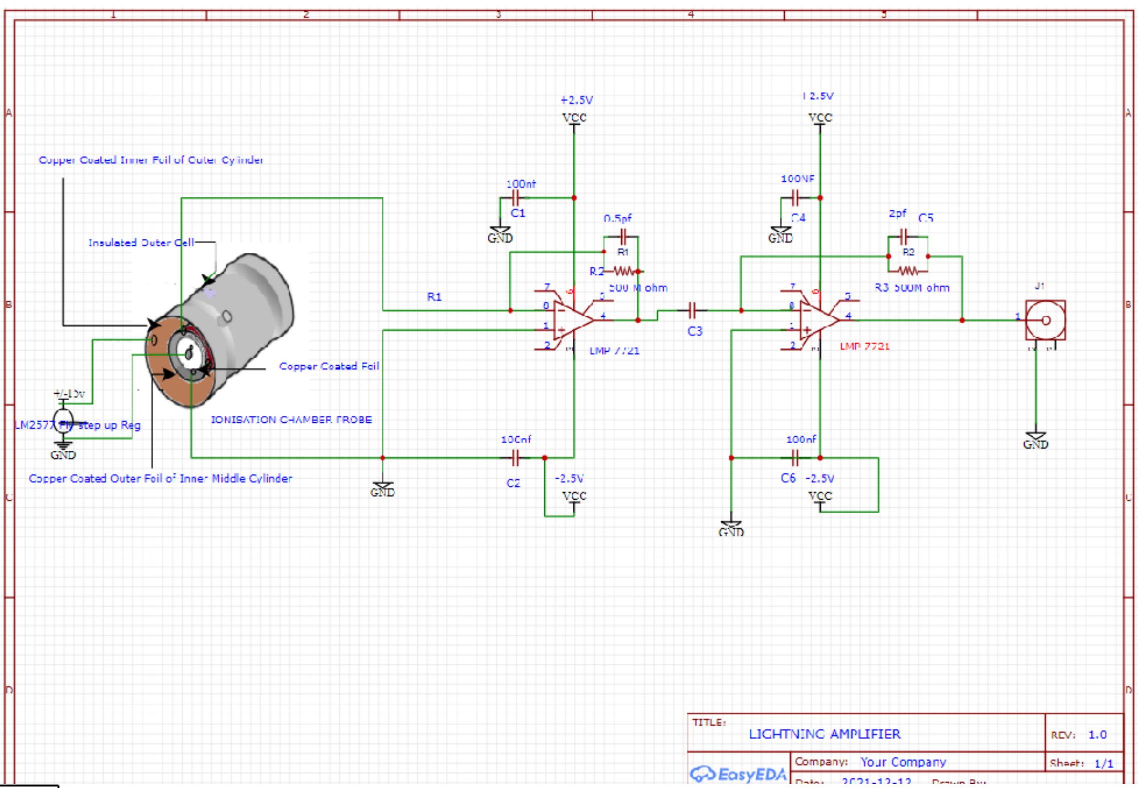


FIG 2

Output from the current/voltage pre-amplifier is passed on to a second amplification stage, comprising of the U2 (LMP7721) via C3, which removes the DC voltage presented at the output of U1 from the input current. U2 has a feedback resistor, R3, which can be of any value close to around 1MΩ (an optimal value for our application was found to be 997KΩ), however a higher resistance than 1.1MΩ was found to be unsatisfactory. This stage yields a voltage gain of prevents coupling of the amplifier to mains noise and also acts as a pseudo-cut-off for the high frequency content of input signal. A successive power supply filtering scheme is adopted for the amplifier power rails by means of numerous 10nF and 100nF capacitors at the power rail employed in the circuit. In addition, a notch filter design can also be devised at this stage for elimination of mains and high-frequency noise components.

Device Functional Modes

Compensating Input Capacitance

The high-input resistance of the LMP7721 allows the use of large feedback and source resistor values without losing gain accuracy due to loading. However, the circuit will be especially sensitive to its layout when these large-value resistors are used.

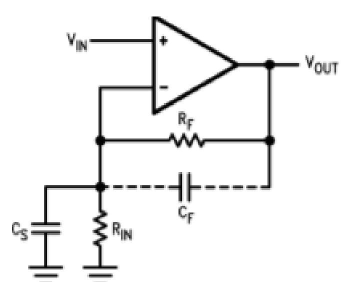
Every amplifier has some capacitance between each input and AC ground, and also some differential capacitance between the inputs. When the feedback network around an amplifier is resistive, this input capacitance (along with any additional capacitance due to circuit board traces, the socket, etc.) and the feedback resistors create a pole in the feedback path. This pole can cause gain "peaking" or outright oscillations.

Device Functional Modes

In the General Operational Amplifier circuit, Figure 45 the frequency of this pole is:

$$fp = \frac{1}{2\pi Cs\ Rp}$$

where: • CS is the total capacitance at the inverting input, including amplifier input capacitance and any stray capacitance from the circuit board traces. • RP is the parallel combination of RF and RIN



The typical input capacitance of the LMP7721 is about 11pF. This formula, as well as all formulas derived below, apply to inverting and non-inverting op amp configurations. When the feedback resistors are smaller than a few kΩ, the frequency of the feedback pole will be quite high, since CS is generally less than 15 pF. If the frequency of the feedback pole is much higher than the “ideal” closed-loop bandwidth (the nominal closed-loop bandwidth in the absence of CS), the pole will have a negligible effect on stability, as it will add only a small amount of phase shift. However, if the feedback pole is less than approximately 6 to 10 times the “ideal” −3 dB frequency, a feedback capacitor, CF, should be connected between the output and the inverting input of the op amp. This condition can also be stated in terms of the amplifier's low-frequency noise gain: To maintain stability a feedback capacitor will probably be needed if

$$\left(\frac{R_F}{R_{IN}} + 1 \right) \leq \sqrt{6 \times 2\pi \times GBW \times R_F \times C_S}$$

where

$$\left(\frac{R_F}{R_{IN}} + 1 \right)$$

is the amplifier's low-frequency noise gain and GBW is the amplifier's gain bandwidth product. An amplifier's lowfrequency noise gain is represented by the formula

$$\left(\frac{R_F}{R_{IN}} + 1 \right) \geq 2\sqrt{GBW \times R_F \times C_S}$$

regardless of whether the amplifier is being used in inverting or non-inverting mode. Note that a feedback capacitor is more likely to be needed when the noise gain is low and/or the feedback resistor is large. If the above condition is met (indicating a feedback capacitor will probably be needed), and the noise gain is large enough that:

$$\left(\frac{R_F}{R_{IN}} + 1 \right) \geq 2\sqrt{GBW \times R_F \times C_S}$$

the following value of feedback capacitor is recommended:

$$C_F = \frac{C_S}{2\left(\frac{R_F}{R_{IN}} + 1 \right)}$$

If

$$\left(\frac{R_F}{R_{IN}} + 1 \right) < 2\sqrt{GBW \times R_F \times C_S}$$

the feedback capacitor should be:

$$C_F = \sqrt{\frac{C_S}{GBW \times R_F}}$$

Note that these capacitor values are usually significant smaller than those given by the older, more conservative formula:

$$C_F = \frac{C_S R_{IN}}{R_F}$$

Conclusion:

Design and development of a very sensitive, low-noise and low-cost amplifier have been carried out which is found to work at an input current dynamic range of ~2 x 10-14 to 1 x 10-13 amperes, with a lowest measured current limit of around 25 femto-amperes with low-noise content. The amplifier was incorporated in an application study by investigating its response to very low current sources, such as ionization currents and on the basis of this, a technique was developed to measure ultra-low currents within the constant potential difference and small change of ionization current existing between two plates.