3,517,324
COMPLEMENTARY EMITTER FOLLOWER
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3 Claims

ABSTRACT OF THE DISCLOSURE

A current amplifier has a very high input impedance and is easily fabricated as an integrated circuit. It uses resistors having comparatively low values, and a constant current source for base bias.

BACKGROUND OF THE INVENTION

In the prior art it has been very difficult to design an emitter follower which has a very high input impedance, has good linearity, and uses low values of resistance so that the amplifier can be constructed as an integrated circuit.

SUMMARY OF THE INVENTION

It is therefore an object of the invention to provide a complementary emitter follower having a high input impedance, having excellent linearity, and having low values of circuit resistances.

The above and other objects of the invention are accomplished by providing a constant current source as the common emitter to ground and base to ground load of a prior art complementary emitter follower. The invention is further accomplished by arranging the constant current source so that its resistances have low values and can be economically fabricated as an integrated circuit.

BRIEF DESCRIPTION OF THE DRAWING

The invention will be better understood from the drawing in which:

FIG. 1 is a schematic diagram of a prior art complementary emitter follower,

FIG. 2 is a schematic diagram of a complementary emitter follower according to the invention wherein the constant current source is shown symbolically, and

FIG. 3 is a schematic diagram of a complementary emitter follower according to the invention showing all of the discrete components.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In FIG. 1 there is shown a prior art complementary emitter follower. NPN transistor Q2 has its base connected to the input I1. Its collector is connected to a positive supply, whereas its emitter is connected to the base of PNP transistor Q3. Resistor R3 is connected from the base of transistor Q3 to the collector of transistor Q2. The emitter of transistor Q3 is connected to a positive supply through resistor R5. When the input current I1 between the base of transistor Q3 and a common terminal, shown here as ground goes positive, transistor Q3 tends to increase its conductivity. The potential on the base of transistor Q3 therefore raises the base to increase the conductivity of transistor Q2. The output voltage E0 therefore approaches the supply voltage. Since the base to emitter voltage drop of transistor Q3 is approximately the same as the base to emitter voltage drop of transistor Q2, the input voltage will be approximately the same as the output voltage as long as the amplifier is operating unsaturated. The input impedance of the circuit is approximately proportional to the value of resistor R5. In order to increase the input impedance the value of resistance R5 may be raised. However, a limit is reached when R5 no longer passes enough current to drive the base of transistor Q3.

It can therefore be seen that it is desirable to be able to raise the input impedance of the circuit of FIG. 1 and that it would also be desirable to be able to fabricate the amplifier as an integrated circuit.

FIG. 2 shows the invention in its broadest aspects. Resistor R5 of FIG. 1 has been replaced by constant current generator C1. Since a constant current generator has a theoretical infinite impedance, a very high input impedance is obtained.

Although the circuit shown in FIG. 2 is exactly what is needed, its actual reduction to practice as an integrated circuit is extremely difficult to attain because constant current generators usually employ very high values of resistance when the current to be generated is very low. As pointed out above, the use of high values of resistances in integrated circuits is quite uneconomical.

FIG. 3 shows a circuit diagram of a complementary emitter follower using a constant current generator C1 wherein the resistance values are low enough to be fabricated as integrated circuits. Transistor Q3 acts as a diode and serves to keep the voltage at the base of transistor Q2 approximately constant. The conductance of NPN transistor Q2, of course, is dependent upon its base to emitter drop. This base to emitter drop is dependent upon the current passing through resistor R5. As in FIG. 1 when the input voltage on transistor Q3 rises, the output voltage E5 rises with it. When the output voltage E5 rises, the current through transistor Q3 decreases thus reducing the voltage drop across resistor R5, thus increasing the conductance of transistor Q2 and thus tending to keep a constant current through transistor Q3.

The action of the current through transistor Q3 to control, via its voltage drop across resistor R5, the conductance of transistor Q2 constitutes a negative feedback loop. This negative feedback loop helps to provide high input impedance at the base of Q3 and increases the circuit's insensitivity to thermal, supply voltage and transistor gain variations.

In a typical example, the input current is approximately one nanoampere, and the constant current through NPN transistor Q2 is approximately 340 nanoamperes. The current through PNP transistor Q3 is approximately 22 microamperes. The value of R5 is approximately 10 KOh which is economical to fabricate in an integrated circuit.

It is, of course, apparent that it is not essential to the invention to fabricate the circuit as an integrated circuit.

The operation of the invention is the same if discrete components are used. Although the invention has been described in considerable detail with reference to a certain preferred embodiment thereof, it will be understood that variations and modifications can be effected without departing from the spirit and scope of the invention as described herein above and as defined in the appended claims.

I claim:

1. A complementary emitter follower comprising:
(a) an input terminal, an output terminal, and a common terminal,
(b) a first transistor having base, emitter, and collector electrodes, said base electrode being electrically coupled to said input terminal,
(c) a second transistor having base, emitter, and collector electrodes, the base of said second transistor being electrically coupled to the emitter of said first transistor, said output terminal being electrically coupled to the emitter of said second transistor,
(d) a first circuit including a resistance of a predetermined value, said first circuit defining a feedback path between the collector electrode of said second
transistor and said common terminal for conducting current through said resistance and for producing a voltage drop across said resistance, and
e) a second circuit defining a source of substantially constant current connected directly between the base and collector electrodes of said second transistor, and coupled to said resistance for increasing the voltage drop across said resistance.

2. A complementary emitter follower as in claim 1, wherein:

(a) said second circuit comprises a third transistor having base, collector, and emitter electrodes, the emitter-collector path of said third transistor being electrically coupled across the base-collector path of said second transistor, and further comprising:
(b) a fourth transistor having base, emitter, and collector electrodes, said base and collector electrodes being electrically coupled together and to the base of said third transistor.

3. A complementary emitter follower as in claim 2 wherein:

(a) said first, third and fourth transistors are of the NPN type, and said second transistor is of the PNP type, and
(b) said resistance is electrically coupled between the emitter electrode of said third transistor and the emitter electrode of said fourth transistor.

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