

Integrated limiting circuit for AC voltages.

The invention relates to a limiter circuit for alternating voltages, the circuit comprising two diode groups arranged in series opposition and each group comprising at least one zener diode.

Such a circuit is known from, for example, US 4,700,130 and serves for
5 limiting an applied alternating voltage to a fixed value to protect subsequent circuit sections and circuit elements against excessive voltages.

In the known circuit this is effected in that depending on the polarity of the alternating voltage the zener voltage of one of the two zener diodes is exceeded if the instantaneous value of the alternating voltage exceeds the sum of the zener voltage of one of the
10 diodes and the forward voltage of the second diode. In this way the limiter circuit limits the alternating voltage to this value, the limiter voltage.

In many cases it is desirable to have a signal current which indicates that a limiter current flows in the limiter circuit, *i.e.* the applied alternating voltage is limited to the limiter voltage. By means of this signal current it is possible, for
15 example, to bring into effect further protective measures for the circuit sections following the limiter circuit. This signal current should always flow in the same direction and, if possible, it should not be formed directly by the limiter current, which may assume large values under certain conditions.

It is an object of the invention to modify a limiter circuit of the type
20 defined in the opening paragraph in such a manner that upon activation of the limiter circuit it supplies a signal current which is largely decoupled from the limiter current.

According to the invention this object is achieved in that one diode of each group is constituted by a diode-connected first transistor (TZ_1 , TZ_2), which together with a further transistor (T_1 , T_2) forms a current mirror, the mirrored value of
25 the limiter current flowing through the zener diodes forming a limiter signal current (I_s) which indicates the flow of a limiter current.

This enables a limiter signal current, isolated from the limiter current, to be derived with few additional circuit elements.

Further embodiments of the invention are defined in the subsidiary Claims.

It is very advantageous to employ a limiter circuit in accordance with the invention in the alternating voltage input of a full-wave bridge rectifier, in particular if this alternating voltage input is connected to a two-wire telephone line and the limiter voltage of the limiter circuit has been selected in such a manner that a limiter signal occurs when a ringing signal appears on the telephone line.

Some embodiments of the invention will now be described in more detail, by way of example, with reference to the accompanying drawings. In the drawings

Fig. 1 shows a first embodiment of a limiter circuit in accordance with the invention,

Fig. 2 illustrates diagrammatically the use of a limiter circuit in accordance with the invention in the input branch of a bridge rectifier, and

Fig. 3 shows a second embodiment of a limiter circuit in accordance with the invention.

The limiter circuit shown in Figure 1 comprises two oppositely poled series-connected zener diodes, the diodes being formed by NPN transistors TZ_1 and TZ_2 which are diode-connected by interconnecting their respective bases and collectors. Consequently, each group comprises only one diode.

The limiter voltage is therefore constituted by the sum of the zener voltage of one of the two diode-connected transistors TZ_1 and TZ_2 and the forward voltage of the other diode-connected transistor TZ_2 and TZ_1 , respectively.

This circuit, which is the actual limiter circuit, derives a signal current which indicates that a limiter current flows from A to B, in that a current mirror mirrors the limiter current a limiter signal current, which current mirror is formed by each time one of the two diode-connected transistors in combination with a further transistor.

Such a current mirror is known *per se*, for example from Tietze/Schenk: "Halbleiter-Schaltungstechnik", 8th edition, 1986, page 63.

The first transistors TZ_1 and TZ_2 are diode-connected (by a base-collector interconnection) and form a current mirror with a second transistor T_1 and T_2 in that the bases and the emitters of each transistor pair TZ_1 , T_1 and TZ_2 , T_2 , respectively, are interconnected. A resistor, R_1 and R_2 respectively, is arranged in the emitter line of

each of the further transistors T_1 and T_2 to adjust the current-mirror ratio of the current mirror thus formed.

The collectors of the first transistors TZ_1 and TZ_2 , which operate as zener diodes, are interconnected. Likewise, the collectors of the two further transistors T_1 and T_2 are
5 interconnected.

The limiter circuit of this construction operates as follows. If point A is positive relative to point B and the applied voltage is larger than the sum of the zener voltage of the diode-connected transistor TZ_1 and the forward voltage of the diode-connected transistor TZ_2 , a limiter current will flow from A to B, which current is
10 mirrored in the collector line of the further transistor T_2 with the selected ratio of the current mirror formed by the diode-connected transistor TZ_2 and the further transistor T_2 . This current flows to point B *via* the further transistor T_2 . Conversely, if point B is positive relative to point A and a limiter current flows, *i.e.* the applied voltage exceeds the sum of the zener voltage of the diode-connected transistor TZ_2 and the forward
15 voltage of the diode-connected transistor TZ_1 , the limiter current will be mirrored in the collector line of the further transistor T_1 with the selected ratio of the current mirror formed by the diode-connected transistor TZ_1 and the further transistor T_1 . The mirrored current, which constitutes the limiter signal current, again flows in the same direction, this time to point A *via* the further transistor T_1 .

20 This circuit thus enables a limiter signal current to be obtained which is isolated from the limiter current, which is proportional to but an adjustable factor of, for example, 1000 as small as this limiter current, and which always flows in the same direction independently of the instantaneous value of the alternating voltage applied to points A and B.

25 The current mirror ratio, *i.e.* the factor by which the limiter signal current I_s is smaller than the limiter current, can be adjusted either by means of the resistors R_1 and R_2 in the emitter lines of the two further transistors T_1 and T_2 or by an appropriate choice of the (emitter/base) area ratio of the transistors TZ_1 , T_1 and TZ_2 , T_2 of each respective current mirror. The two resistors R_1 and R_2 at the same time prevent the two
30 further transistors T_1 and T_2 from acting as zener diodes.

Fig. 2 shows the use of a limiter circuit BGS as shown in Fig. 1 in the input branch of a bridge rectifier BGR. Such a circuit is employed, for example, in the input circuit of electronic telephone sets connected to two-wire lines in order to detect

the arrival of a ringing current and to produce a ringing signal. When a ringing current appears on the line the applied voltage will exceed the preset limiter voltage and the limiter circuit BGS will be activated, *i.e.* a limiter signal current I_s will flow which always has the same direction regardless of the instantaneous value of the alternating
5 voltage. This limiter signal current I_s can be now employed to produce a ringing signal in the electronic telephone set.

Fig. 3 finally shows a further embodiment of a limiter circuit in accordance with the invention. In this case each of the oppositely poled series-connected groups of zener diodes comprises at least two diodes, namely TZ_1 and TZ_{11} in the one
10 group and TZ_2 and TZ_{21} in the other group, of which each time one diode, *i.e.* TZ_{11} in the one group and TZ_{21} in the other group, should operate as a zener diode. In a manner as shown in Fig. 1 the diode TZ_1 or TZ_{11} , which need not necessarily operate as a zener diode, together with a respective further transistor T_1 or T_2 each form a current mirror, which mirrors a limiter current in the collector lines of the further tran-
15 sistors T_1 and T_2 , as already described above with reference to Fig. 1, in such a way that it always flows in the same direction.

In this circuit the collectors of the diode-connected transistors TZ_1 and TZ_2 are not connected to each other but to the emitter of the respective other diode-connected transistor TZ_2 and TZ_1 . In this circuit the limiter voltage is therefore given by
20 the sum of the zener voltages of the diodes TZ_{11} and TZ_{12} and the forward voltages of the diodes TZ_2 , TZ_{21} and TZ_{22} for one polarity of the applied alternating voltage and the sum of the zener voltages of the diodes TZ_{21} and TZ_{22} and the forward voltages of the diodes TZ_1 , TZ_{11} and TZ_{12} for the other polarity.

In the current mirrors in this embodiment the current-mirror ratio is not
25 adjusted by means of resistors arranged in the emitter lines of the further transistors T_1 and T_2 but, as already stated hereinbefore, by means of the emitter/base area ratio of the transistors TZ_1 and T_1 , and of TZ_2 and T_2 , respectively.

The circuit elements used in an integrated version of the limiter circuit in accordance with the invention may be replaced by equivalent elements in conformity
30 with the fabrication method used for the fabrication of the integrated circuit. For example, the zener diodes used in the embodiment shown in Fig. 3 may be realised directly by diode structures instead of by transistor structures. Likewise, the conductivity types of the circuit elements may be reversed.

CLAIMS:

1. A limiter circuit for alternating voltages, the circuit comprising two diode groups arranged in series opposition and each group comprising at least one zener diode,
characterized in that
- 5 one diode of each group is constituted by a diode-connected first transistor (TZ_1 , TZ_2), which together with a further transistor (T_1 , T_2) forms a current mirror, the mirrored value of the limiter current flowing through the first transistors forming a limiter signal current (I_S) which indicates the flow of a limiter current.
2. A limiter circuit as claimed in Claim 1,
10 characterized by
a connection between the collectors of the two further transistors (T_1 , T_2), on which connection the limiter signal current (I_S) is available.
3. A limiter circuit as claimed in Claim 2,
characterized in that
- 15 each group comprises only one diode-connected transistor operating as a zener diode, which is constituted by each time one of the first transistors (TZ_1 , TZ_2), and the collectors of said two transistors are interconnected (Fig. 1).
4. A limiter circuit as claimed in Claim 2,
characterized in that
- 20 each group comprises a plurality of zener diodes and the collector of the first transistor (TZ_1 , TZ_2) of each group has been connected to the emitter of the first transistor (TZ_2 , TZ_1) of each time the other group (Fig. 3).
5. A limiter circuit as claimed in any one of the preceding Claims,
characterized in that
- 25 the current-mirror ratio of the current mirror formed is adjusted by a resistor (R_1 , R_2) arranged in the emitter line of the further transistor (T_1 , T_2).
6. A limiter circuit as claimed in Claim 4,
characterized in that



the current-mirror ratio of the current mirror formed is adjusted by the emitter-base area ratio of the first (TZ_1 , TZ_2) and the second (T_1 , T_2) transistors relative to each other.

7. A limiter circuit as claimed in any one of the preceding Claims,

5 characterized in that

the current-mirror ratio of the current mirror formed is adjusted in such a way that the limiter signal current is of the order of magnitude of 10^{-6} A.

8. The use of a limiter circuit as claimed in any one of the preceding Claims in the alternating voltage input of a full-wave rectifier bridge.

10 9. The use of a limiter circuit as claimed in Claim 8,
characterized in that

the alternating voltage input of the bridge rectifier is connected to a two-wire telephone line and the limiter voltage of the limiter circuit has been selected in such a way that a limiter signal current (I_S) is produced when a ringing signal appears on the telephone

15 line.

