

ELECTRONIC CIRCUIT FOR CONVERTING A SIGNAL AND AMPLIFIER
INCORPORATING SAME

The present invention relates in the first instance to
5 an electronic circuit for conversion of an input electric
signal.

It also relates to a power amplifier with cutting out
of the voltage control.

The invention will find its application particularly
10 in the field of the conversion of electric signal levels.

In particular, the amplification of high fidelity
audio signals will be possible by using the present
invention as well as the control of various electrical
equipment, particularly in the field of robotic
15 motorization.

In the field of radio amplification, the present
amplifiers essentially are according to one of the two
following technologies.

The first consists in using two complementary MOSFET
20 (transistor in the field of technology of silicon metal
oxide) mounted with a common source.

Although permitting attaining good results with audio
quality material, such mountings do not permit obtaining
important power gain.

25 A second technology consists in using two MOSFET
transistors both with a N channel arranged in totem pole
mounting.

One of these transistors is mounted with a common
drain and the other is mounted with a common source.

30 This type of mounting is quite successful at present
in the field of high fidelity for class D audio amplifiers
(amplifier with cutout power).

Such a totem pole mounting however has a major drawback as to the control of the transistors.

Thus, the grids of each N channel MOSFET transistor must be controlled by two signals from different sources.

5 Because of this, problems of synchronization of the control signals arise. Given that the simultaneity of their occurrence is impossible to achieve in practice, there are noted current peaks during switching.

10 Thus, it can happen with this mounting that the two transistors will be, for a short time, simultaneously active, which sometimes gives rise to current peaks that can attain several hundreds of amperes.

15 Of course, these large current peaks are damaging both from the standpoint of output of the system and as to its reliability.

 To avoid the presence of current peaks during switching, there is at present used a dead time at the moment of this switching.

20 There are thus avoided current peaks, but other drawbacks arise.

 Thus, the insertion of a dead time leads to distortions in the useful signal.

25 Moreover, the dead time does not solve the problem of intrinsic disequilibrium of the totem pole configuration: the mounting of the transistors is not symmetrical because one is mounted with a common drain and the other with a common source.

30 As a result, present amplifiers do not give complete satisfaction because they do not permit finding a satisfactory compromise, between the output of the system and the reliability obtained during amplification.

In technologies related to those set forth above, there is known from the document FR-A-2.779.293 an output circuit with a transistor which has a voltage higher than a breakdown voltage of two NMOS and PMOS transistors used to
5 construct the output circuit which are connected in series and which have their grids connected to each other. A voltage control circuit is connected to the grids and to the sources of these transistors. The voltage control circuit receives energy from supplies of high and low
10 voltage. The voltage control circuit applies an intermediate reference voltage to the grids of the transistors. Then, in response to an input signal, the voltage control circuit controls the voltages applied to the sources of the transistors.

15 This mounting does not give real progress relative to the totem pole mounting, given that two control signals are still necessary.

Moreover, it relates only to a mounting with a common source.

20 The present invention has for its object to overcome the drawbacks of the present devices and, in the first instance to provide a circuit ensuring both high amplification output and high quality of the obtained signal.

25 One of the principal advantages of the invention is to have a single source of control for the grid so as to avoid the problems of switching.

There will thus not occur, or only slightly occur, the phenomenon of current peaks.

30 Because of this, the losses are considerably reduced at this level without generating distortion as is the case with the insertion of a dead time.

The losses being substantially reduced, it is possible to envisage broad applications with the present invention to obtain very high outputs whilst integrating the device in the form of modules or hybrid circles of small size and hence with a high ratio of power to volume with better dynamic characteristics.

Another advantage of the invention is to provide control means which form the control source for the grids and transistors without having recourse to an insulating transformer.

As a result, there no longer arise the limitations occasioned by the use of an insulating transformer and there is rendered possible an unlimited advance in the cyclic ratio.

It will be understood that the advantages thus set forth permit envisaging multiple uses of the present invention.

Other objects and advantages will become apparent from the description which follows, which is however given only by way of indication and is not limiting of the invention.

According to one aspect of the present invention, there is provided an electronic circuit for the conversion of an input electrical signal, comprising:

- at least two transistors of complementary polarities and mounted in the common drain,
- control means for the transistors adapted to generate a single control signal for the grids of said transistors,
- an output line connected to the sources of said transistors, characterized by the fact

that the control means comprise a buffer circuit adapting a control signal and supplied by a high voltage supply and by a reference voltage supply

and that the reference voltage supply is the output line.

There are set forth hereafter various modifications envisaged for this circuit:

- the complementary transistors may be field effect transistors of the MOS technology, one with a N channel, the other with a P channel.

- the circuit may comprise a modulator of pulse width adapted to convert the input signal into a signal of modulated pulse width usable by the control means.

- the control means may comprise a buffer circuit generating a control signal and supplied by a high voltage supply and a reference voltage supply.

- the reference voltage supply may be the output line.

- the control means may comprise a level translator constituted by a comparator connected at the input to the pulse width modulator such that its input inverter receives the signal (PWM) such that its inverting input receives the (PWM) signal and its non-inverting input receives the reverse of the (PWM) signal, and connected at the output to the input of the buffer circuit.

- the comparator may have a high voltage supply constituted by the high voltage supply and a low voltage supply constituted by the output line.

- the control means may comprise at the output a polarization network connected at the output to a DC generator and to the grids of the transistors.

- the connection between the grids of the transistors, at the output of the polarization network, may be effected by a passive level adaptation network.

- its may comprise a filter for filtering the output signal.

A power amplifier with cutting out of the voltage control may also be provided, characterized by the fact that it includes a circuit according to embodiments of the invention described above.

The accompanying drawings are given by way of indicative and non-limiting examples. They represent a preferred embodiment according to the invention. They permit easy comprehension of the invention.

5 Figure 1 is a general operating scheme of the electronic circuit shown here.

Figure 2 is a preferred embodiment of this circuit according to one example.

10 The amplifier provided by the present invention is of the D class type, with cutting out of the voltage control.

The circuit in its embodiment comprises at least two transistors ensuring the conversion of the input signal level In.

15 Although field effect transistors of the MOS (Metal Oxide Silicon) technology are particularly envisaged, the invention is not limited at this level and other types of transistors (bipolar, IGBT, quantum for example) could be used.

20 There will be described hereafter the preferred embodiment in which the transistors are field effect of the MOS technology, hereinafter called MOSFET.

In a known manner with respect to D class amplifiers, the signal to be amplified is received in the circuit at a pulse width modulator 1.

25 As shown in Figure 1, the modulator 1 generates a square signal with pulse width modulation (PWM).

30 In the case of the invention, this PWM signal and its PWM complement obtained by any known inversion means constitute the input of the control means shown at 2 in Figure 1.

Schematically, this figure illustrates that, with the PWM and PWM signals as well as, thanks to high and low

voltage supplies V_1 and V_2 , the control means 2 form at the output a control signal 13.

The control signal 13 ensures control of the grids of the two transistors designated at 4 and 5.

5 Possibly, a passive network 3 connects the two grids so as to provide a new adaptation.

The transistors 4, 5 are of complementary polarities.

In the case of MOSFET, one is of the N 4 channel type and the other of the P 5 channel type.

10 The power supply is constituted between a high voltage V_p connected to the drain of the transistor 4 and the ground G, connected to the drain of the transistor 5.

At the output, a filter 6 is desirable. As at present in an audio application, it is a low pass filter of
15 capacito-inductive composition.

It will be noted that, according to the invention, the signal 13 is the only control signal of the grids of the transistors 4, 5. There is thus solved the problem of switching peaks, mentioned previously.

20 Moreover, it will be seen that the output line 14 is connected to the transistor sources 4, 5.

The output signal obtained by this circuit is indicated in Figure 1 by the term "out".

There will be described hereafter more precisely the
25 particular mode of embodiment of the invention shown in Figure 2.

A preferred example of the control means 2 is shown there.

Within the control means 2, a buffer circuit
30 permits the formation of a compatible control signal.

It receives at the input a signal of modulated pulse width. Its supply is constituted by a high voltage source V_1 and a reference voltage.

5 In a manner characteristic of the invention, the reference voltage is taken on the output line 14. The buffer circuit 10 is thus connected to the node N1 common to the two sources of transistors 4, 5.

At the output of the buffer circuit 10, a polarization network 12 is present. It permits fixing the static
10 operating point of the circuit.

At its output, the node N2 connects the grids of the transistors 4, 5. The generator 11 delivers to them a DC electrical signal and emplaces the low voltage V_2 of the control supply. Another advantage of the circuit provided
15 here is, according to a preferred modification, the use of a transistor of a particular design.

To this end, the control means 2 comprise, upstream of the buffer circuit 10, a comparator 9 as shown in Figure 2.

As shown, the supply of the comparator 9 will be
20 similar to or derived from that of the buffer circuit 10, between a high voltage V_1 and the reference voltage constituted by the output line 14.

The inverting and non-inverting inputs of the comparator receive respectively the signals PWM and PWM.

25 The use of such a network to form the translation of the level is advantageous relative to the use of an insulating transformer because it permits unlimited excursion of the cyclic ratio.

It will be noted that the circuit according to the
30 invention and the amplifier including it can have a particularly reduced size with regard to the possibilities of amplification that are offered.

Figure 2 also shows an embodiment of the filter 6.

REFERENCES

1. Pulse width modulator
2. Control means
- 5 3. Network for connection of grids
4. Transistor
5. Transistor
6. Filter
- 7, 8. Inputs of the control means
- 10 9. Comparator
10. Buffer
11. Generator
12. Polarization network
13. Control signal
- 15 14. Output line
- in: input signal
- out: output signal
- V₁: high voltage of control supply
- V₂: low voltage of control supply
- 20 V_p: high voltage of the power source
- G: ground power
- N1: node 1
- N2: node 2
- PWM: pulse width modulated signal

CLAIMS

1. Electronic circuit for the conversion of an input electrical signal, comprising:

- at least two transistors of complementary polarities and mounted with a common drain,

- control means for the transistors adapted to generate a single control signal for the grids of said transistors,

- an output line connected to the sources of said transistors, characterized by the fact

that the control means comprise a buffer circuit adapting a control signal and supplied by a high voltage supply and by a reference voltage supply

and that the reference voltage supply is the output line.

2. Circuit according to claim 1, characterized by the fact

that it comprises a pulse width modulator adapted to convert the input signal into a pulse width modulated (PWM) signal usable by the control means.

3. Circuit according to any one of claims 1 or 2, characterized by the fact

that the control means comprise a level translator constituted by a comparator connected at the input to the pulse width modulator such that its inverting input receives the PWM signal and its non-inverting input receives a PWM signal which is the reverse of the PWM signal, and connected at the output to the input of the buffer circuit.

4. Circuit according to claim 3, characterized by the fact

that the comparator has a high voltage supply constituted by the high voltage supply V_i and a low voltage supply constituted by the output line.

5. Circuit according to any one of claims 1 to 4, characterized by the fact

that the control means comprise at the output a polarization network connected at the output to a DC voltage generator and to the grids of the transistors.

6. Circuit according to claim 5, characterized by the fact

that the connection between the grids of the transistors, at the output of the polarization network, is by means of a level adaptation network.

7. Circuit according to any one of claims 1 to 6, characterized by the fact

that it comprises a filter for filtering the output signal.

8. Power amplifier with cutting out of the voltage control, characterized by the fact

that it includes the circuit according to any one of claims 1 to 7.

DESCRIPTIVE ABSTRACT

ELECTRONIC CIRCUIT FOR CONVERTING A SIGNAL AND AMPLIFIER
INCORPORATING SAME

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The present invention relates to an electronic circuit
10 for the conversion of an input electric signal (In). This
circuit comprises:

- at least two transistors (4, 5) of complementary
polarities and mounted with a common drain,
- control means (2) for the transistors (4, 5) adapted
15 to generate a single control signal (13) for the grids of
said transistors (4, 5), an output line (14) connected to
the sources of said transistors.

The invention also relates to a power amplifier with
cutting out of the voltage control, including this circuit.

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FIGURE 1