

MUTING CIRCUIT

5 The present invention relates to a muting circuit for eliminating transients. Illustrative embodiments of the invention concern an audio signal processing system in a television receiver or the like arranged to suppress the audible effects of transients produced when the system is energized or de-energized.

10 In an audio-frequency amplifier, sound is sometimes generated from a loudspeaker of the system when the system is energized and de-energized. Upon turn-on or turn-off of the TV receiver, radio receiver, or the like, the audio circuit may produce a very noticeable "pop" or "click"
15 despite the absence of noise at its input because of rapid transitions of potentials within the amplifier or components coupled to the amplifier due to power supply transitions. If such a phenomenon occurs in a pre-amplifier, the aforesaid sound can be greatly amplified by
20 the power amplifier. To eliminate this source of undesirable sound or noise, it is desirable to silence or mute the signal during these transient conditions. Accordingly, the audible effects of transients associated with energization and de-energization of the system are
25 suppressed by apparatus arranged according to the present invention.

According to the present invention, there is provided a muting circuit for eliminating transient generated signals due to power supply turn-on comprising:
30 a first amplifier having a signal input terminal, a second amplifier having a signal output terminal coupled to the signal input terminal of the first amplifier by a path, a switchable power supply coupled to the second amplifier, a first power supply voltage means coupled to the path
35 a second power supply voltage means, and coupling means responsive to the first and second power supply voltage means, and comprising a series circuit of a diode or other non-linear device and a capacitor, the series circuit being coupled from the path to an reference potential, said

diode or other non-linear device being switchably biased during power supply "turn-on" from being forward biased to being reverse biased, said capacitor being charged during power supply "turn-on".

Reference may be had to the drawings wherein:

5 Figure 1 shows, partly in block diagram form and partly in schematic form, an embodiment of a portion of an audio signal processing network of a television receiver as disclosed and claimed in copending application GB-A-2251350 from which this application is derived.

10 Figure 2 shows, partly in block diagram form and partly in schematic form, an embodiment of a portion of an audio signal processing network of a television receiver comprising apparatus according to the present invention.

Referring now to the drawings wherein like members have been designated like numbers, there is shown in Figure 1 an integrated circuit (IC) source of audio
15 signals 10 including an amplifier. Preferably the audio signal source 10 is an integrated circuit M52038SP which also performs intermediate frequency (IF) video and sound processing in a color television receiver, provides a video signal for driving a cathode ray tube (not shown). One of
20 the functions of IC 10 is to detect the sound from a program source and provide such an audio signal at output terminal 12.

The low level audio signals at terminal 12 require further voltage and power amplification in order to drive
25 loudspeaker 14 or the like, and such amplification is provided by amplifier 16 which in the exemplary embodiment is a TDA2030 integrated circuit coupled to loudspeaker 14 through capacitor 18. The main power supply is controlled by microprocessor 20 which also controls other functions,
30 e.g. X-ray protection, and remote control commands. In many microprocessor controlled television receivers, there are a plurality of power supplies including a stand-by power supply so that the receiver can respond to a remote command to turn the set "on".

35 Circuit 10 is powered by a main power supply controlled by microprocessor 20, which in the exemplary embodiment is a TEA2260. However, amplifier 16 is constantly powered by a "stand-by" power supply because,

preferably, switching power supply current to amplifier 16 would require a switch of higher current capability than is provided within microprocessor 20.

5 Audio signals provided at terminal 12 are DC coupled via the parallel combination of resistor 22 and capacitor 24 to node or junction 26 wherein the signal is DC coupled to non-inverting input terminal 29 of amplifier 16 via resistor 28. Amplifier 16 is provided with feedback and
10 frequency compensation components (not shown) coupled to the inverting input terminal (not shown). Preferably DC bias for terminal 29 is amplifier 16 is provided by terminal 12 of IC 10. When the main power supply which powers circuit 10 is de-energized (turned "off") or
15 energized (turn "on") by microprocessor 20, transient DC voltages within circuit 10 are caused to be generated by the increasing or decreasing of power voltages. These transient generated signals propagate through the system and are amplified as a noise emitted by loudspeaker 14.

20 It is desirable to eliminate this transient generated noise in a manner which does not effect the DC quiescent status of the system otherwise the transient elimination circuit will introduce its own noise into the system. To this end, the transient noise elimination circuit 30 is
25 provided. The microprocessor 20 provides what is called a "standby" signal at terminal 32 which, when it goes high, indicates that the main power supply has been switched "off". This "standby" signal can be provided by other appropriate means, such as another circuit powered from the
30 standby power supply and providing a signal responsive to the status of the main power supply.

The standby signal at terminal 32 is low-pass frequency filtered by series resistor 35 and shunt capacitor 33 and is coupled to a base electrode of NPN
35 transistor 34. Transistor 34 has an emitter electrode coupled ground and a collector electrode coupled to a junction 39 of a resistor 36 and a capacitor 38 with the other end of resistor 36 coupled to ground and the other

end of capacitor 38 coupled to node 26. In this manner, there is a signal divider between resistor 22 and resistor 36. Capacitor 38 isolates the DC voltage at junction 26 from resistor 36 and transistor 34.

With a forward bias provided at the base-emitter junction of transistor 34 by the "standby" signal, the collector-emitter impedance to ground decreases so as to present a shunt impedance of a value much lower than resistor 36, which has a value of 10K ohms. This impedance change of transistor 34 is shown by commonly published emitter-collector characteristics for bipolar transistors for a family of base currents, that shows a sloped resistor-like characteristic for low collector voltages and currents. Thus, when the "standby" signal is present, the collector-emitter circuit shunts resistor 36 changing the signal divider ratio with resistor 22 and substantially attenuating any AC signal at junction 26 for the duration of the presence of the "standby" signal. Capacitor 38 prevents any change of the DC voltage present at junction 26 due to the shunting effect of transistor 34.

In this manner, the AC signal at node 26 will be substantially attenuated without effecting the DC voltage level present at node 26.

When the main power supply is energized, the standby signal is quickly provided from the standby power supply before the main power supply capacitors have developed appreciate charge. When the main power supply is de-energized in response to a control signal initiated by microprocessor 20, the shunting effect of transistor 34 is maintained to eliminate the turn "off" transient by the charge maintained on capacitor 33 for a short time after the main power supply is powered down.

However, there are instances where the DC coupling between two integrated circuits may be undesirable. In such an instance, the embodiment of the present invention shown in Figure 2 can be used wherein like members common to Figure 1 are given the same numeral designations. IC

10 and amplifier 16 are AC signal coupled by capacitor 40 having a negligible impedance at the frequencies of interest, and accordingly the bias voltage for terminal 29 is provided through resistors 28 and 43 by voltage source ps1 which derives its voltage from the switched main power supply. In this way, when the main power supply is switched "off", the bias supply will be cut off from terminal 29 thus muting any transient signals.

The operation of the pop-elimination upon turn "on" will now be discussed. A diode or other non-linear device 42 is coupled to junction 29 and poled for conduction through capacitor 46 to ground. The cathode of diode 42 is also coupled through resistor 44 to voltage source ps2 which also derives its voltage from the switched main power supply. Voltage sources ps1 and ps2, both derived from the switched main power supply, will be zero volts after turn "off" if all power supply capacitors have had sufficient time to fully discharge. Upon turn "on", the switched main power supply is energized as are ps1 and ps2. However, capacitor 46 has little or no charge and any bias appearing at terminal 29 causes diode 42 to be forward biased thus providing an AC shunt to ground through capacitor 46. This AC shunting of terminal 29 will continue until sufficient DC voltage is developed across capacitor 46 to switch "off" diode 42 by reverse biasing the diode. This is accomplished by having ps2 provide a higher steady state voltage than the steady state voltage provided by ps1, e.g. ps1 and ps2 being derived from a voltage divider off of the main power supply with ps2 being tapped off at a higher voltage. When the voltage across capacitor 46 is approximately equal to the voltage provided at terminal 29 by ps1, the charging capacitor 46 continues to the higher voltage of ps2 thus switching diode 42 "off" and removing the AC shunt to ground of capacitor 46 from terminal 29. Thus, terminal 29 is AC shunted to ground for a period of time after energization of the main power supply eliminating transient noises during "turn-on", and

said AC shunt is removed after a period of time permitting normal audio operation.

Reference is invited to copending application 9121414.8; (GB-A-2251350) from which this application is
5 derived and which also discloses and claims a Muting Circuit.

**CLAIMS:**

1. A muting circuit for eliminating transient generated signals due to power supply turn-on comprising:
5 a first amplifier having a signal input terminal,
a second amplifier having a signal output terminal coupled to the signal input terminal of the first amplifier by a path,

10 a switchable power supply coupled to the second amplifier,

a first power supply voltage means coupled to the path

15 a second power supply voltage means, and coupling means responsive to the first and second power supply voltage means, and comprising a series circuit of a diode or other non-linear device and a capacitor, the series circuit being coupled from the path to an reference potential, said diode or other non-linear device being
20 switchably biased during power supply "turn-on" from being forward biased to being reverse biased, said capacitor being charged during power supply "turn-on".

2. The circuit of claim 1 wherein the second power supply voltage means charges the capacitor to a voltage higher than the first power supply voltage means.

25 3. A circuit substantially as hereinbefore described with reference to Figure 2 of the accompanying drawings.