Digitally Controlled Transconductance Block

GT560 DATA SHEET

FEATURES

- **1.0 to 5 V DC supply voltage**
- **70 μA of analog current drain (typical)**
- **6 μA of memory current drain (typical)**
- **single or dual switch control**
- **touch plate compatible, (30 MΩ typ. impedance)**
- **typical 42 dB range**
- **adjustable clock frequency increases or decreases time required to change diode impedance**

STANDARD PACKAGING

- 10 pin PLID®
- Chip (79 x 60 mils)

CIRCUIT DESCRIPTION

The GT560 is a low voltage transconductance block which can be used as an electronic volume control. The transconductance element consists of two diodes back-to-back, whose impedance is varied by changing the amount of current through the diodes.

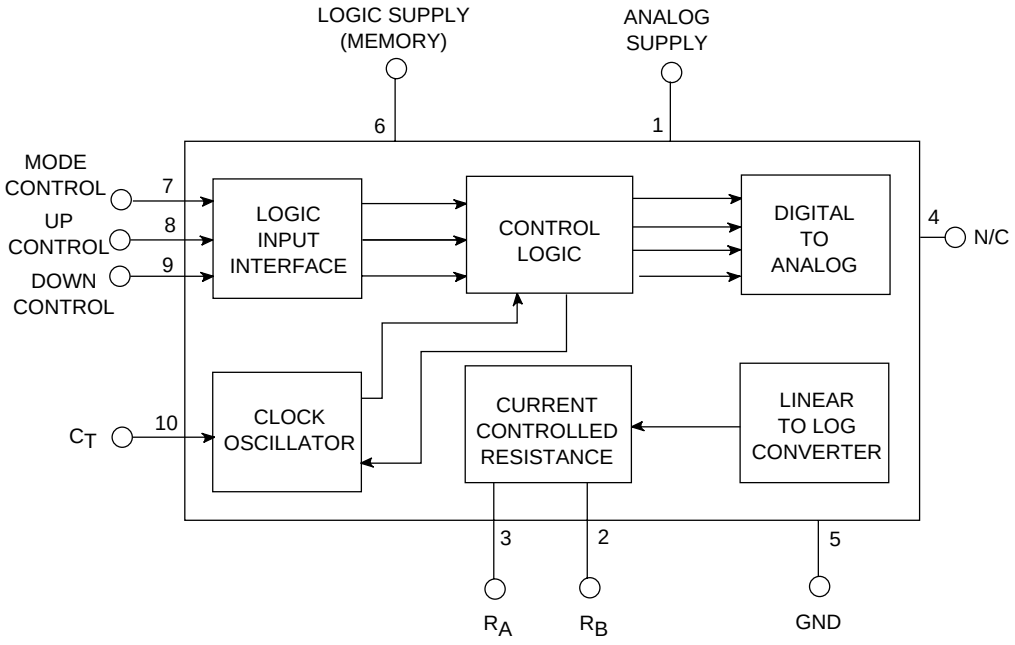
The impedance of the diodes is controlled by digital circuitry which consists of:

- an oscillator with an external capacitor, C_T, to set the ramp frequency f_c,

$$f_c \approx \frac{5 \times 10^{-7}}{C_T}$$

- logic interface, which senses the volume up-down controls
- a digital / analog converter
- the control logic/debounce logic
- synchronous up-down counter

To increase or decrease the GT560 impedance, the switching mechanism can be touch sensitive contacts or a mechanical switch. In either configuration, the switches are connected from pin 8 to V_{CC} and pin 9 to V_{CC}. Any resistance (30 MΩ typ.), from pin 8 or 9 to V_{CC} will activate the GT560 control circuitry and the device will change impedance levels.



BLOCK DIAGRAM

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OPERATION

The impedance can be controlled using one of two methods. The first method utilizes a Single Pole Single Throw (SPST), momentary contact switch which combines the up/down function in one action (see Fig. 2). The second method (see Fig. 3) uses one Single Pole Double Throw (SPDT), or two SPST switches which provide a separate action for the up-down function. These switches can be mechanical or touch sensitive.

To operate the GT560 using a single switch, the Mode Control (MC) is connected to the positive supply, the switch will then act in an alternating manner first increasing impedance when activated, then decreasing impedance when activated a second time, both at a rate determined by the external timing capacitor.

If separate UP or DOWN switches are used, the Mode Control pin connects to ground. Making contact to the DOWN switch, the diode impedance will decrease until the switch is released or the diodes reach minimum impedance (4 kΩ). Similarly, contact to the UP switch will increase the diodes impedance until the switch is released or the maximum value of diode impedance has been reached (500 kΩ).

Once the minimum (4 kΩ) or maximum (500 kΩ) impedance is reached and the switch is still closed, the impedance will stop changing until the switch is released and the direction is reversed. Should both switches be closed simultaneously, the output impedance will remain unchanged.

In order for the GT560 to be activated and change impedance the switch must be pressed for at least one time constant, t_C,

where $t_C = \frac{1}{fc}$

Normally the timing capacitor C_T, is connected to ground, as shown in Figure 1. When the circuit is turned on, C_T is required to charge from 0 VDC to approximately 0.56 VDC. During this charge up condition, the clock is disabled and ramping of the impedance by the touch contacts or switches will be inactive until C_T is charged.

Small values of C_T eg. 0.1 µF, will cause a time delay of less than 2 seconds, however as the value of C_T is increased, eg. 1.0 µF the charge time can be as high as 20 seconds.

If the length of the charge time is undesirable, the capacitor can be referenced to a microphone decoupling point as shown in Figure 3. In this configuration the capacitor charge time will be less than 2 seconds with a 1.0 µF capacitor.

It is required that C_T be connected to a positive reference voltage which has a high supply line rejection ratio, such as a voltage regulator, or a microphone decoupling point. If C_T was referenced directly to the supply, any battery line signals greater than 10 mVRMS will affect the clock rate on the GT560 This would cause the ramp speed to become erratic as the impedance is being changed.

When the hearing aid is initially turned on, e.g. insertion of the battery , the diode impedance will be at mid gain setting (which is typically 7 steps from the minimum impedance setting). Once the desired impedance is determined this value will be held constant by the memory circuitry on the GT560. Connecting the memory supply (VM), to the battery positive bypassing the on-off switch, will allow the volume control to retain the selected impedance even with the hearing aid switched off. The memory current drain is extremely low at 6 µA. If however the battery is removed, memory will be lost.

The GT560 may be used as the feedback impedance across an inverting gain block, such as a LC508 preamplifier. The gain of the amplifier would then be determined by the ratio of the diode impedance to the source impedance of the LC508 preamplifier. For example, if a microphone with a typical impedance of 4 kΩ were to be used as the source to the LC508 preamplifier, and the GT560 connected across the input and output pins with a minimum impedance of 4 kΩ, the minimum gain would be a ratio of 4:4 (or 0 dB).

With the maximum impedance at 500 kΩ, the maximum gain would be a ratio of 500:4 approximately (or 42 dB). The volume control range is 42 dB.

It is important that either R_A or R_B on the GT560 be DC coupled to the LC/LP508 preamplifier stage to set up a reference voltage on the diodes, otherwise the volume control will not be biased properly. The GT560 pins R_A and R_B, will operate from 200 mV below supply to 500 mV above ground.

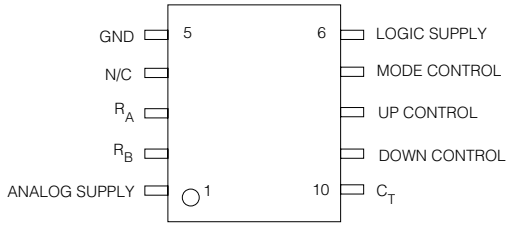
Note: A resistor of 1.2 MΩ is required between Pin 2 and Pin 3 to limit the step size to 3.0 dB. If this resistor is not used at high gain settings the steps will be greater than 3.0 dB, resulting in high distortion on the LC/LP508.

ABSOLUTE MAXIMUM RATINGS

Parameter	Value & Units
Supply Voltage	5 VDC
Power dissipation at $T_A \leq 70°C$	25 mW
Operating Temperature	-10°C to + 40°C
Storage Temperature	-20°C to + 70°C

CAUTION
CLASS 1 ESD SENSITIVITY

PIN CONNECTION



ELECTRICAL CHARACTERISTICS

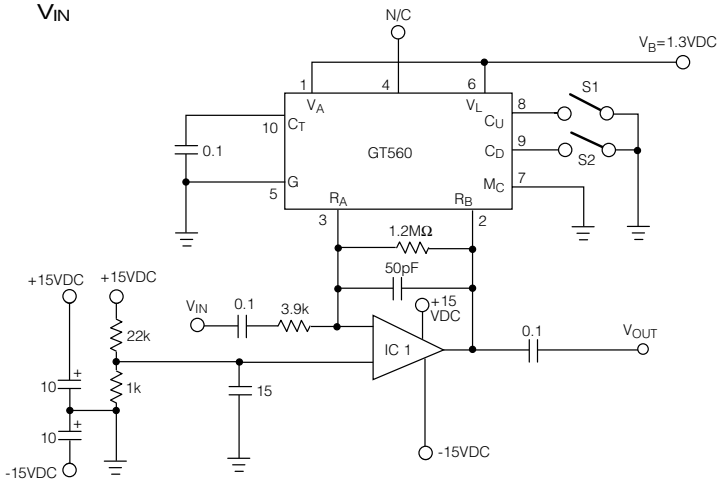
Conditions: Temperature = 25 °C, Frequency = 1 kHz, Supply Voltage = 1.3 VDC

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Total Current	I_{TOT}	Minimum Impedance	10	70	130	µA
Logic Current	I_{LOGIC}		-	6	10	µA
Distortion	THD	V_{OUT} = 10 mVRMS	-	1	2.9	%
Step Size			1.0	2.5	4.0	dB
Impedance :						
Low	Z_{LOW}	Minimum Impedance, V_{OUT} = 15 mVRMS, See Note 1	2.5	4	6	kΩ
High	Z_{HIGH}	Maximum Impedance, V_{OUT} = 15 mVRMS, See Note 1	250	500	700	kΩ
Volume Control Range			36	42	48	dB

All parameters and switches remain as shown in Test Circuit unless otherwise stated in Conditions column

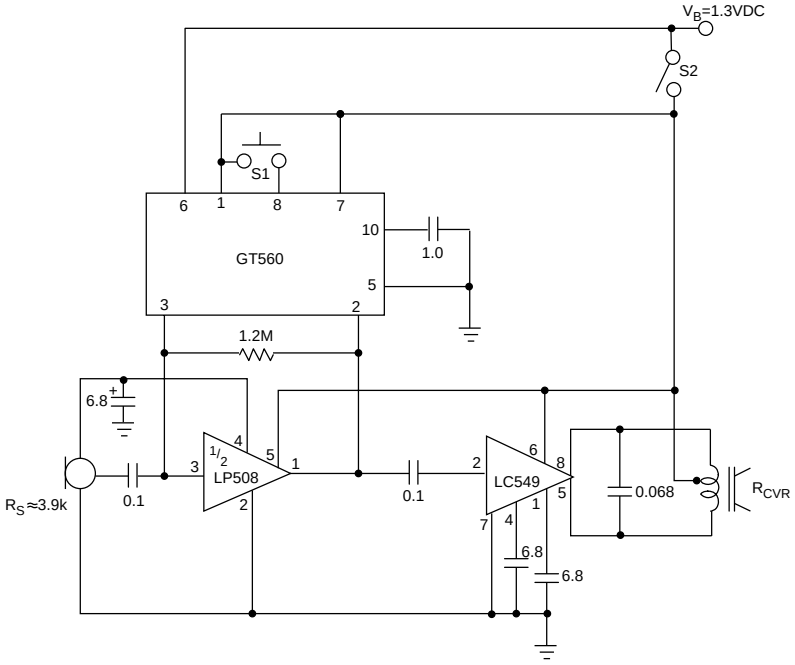
NOTES: 1 Measure V_{IN} for V_{OUT} = 15 mVRMS

$$Z = \frac{V_{OUT} \times 3.9K}{V_{IN}}$$



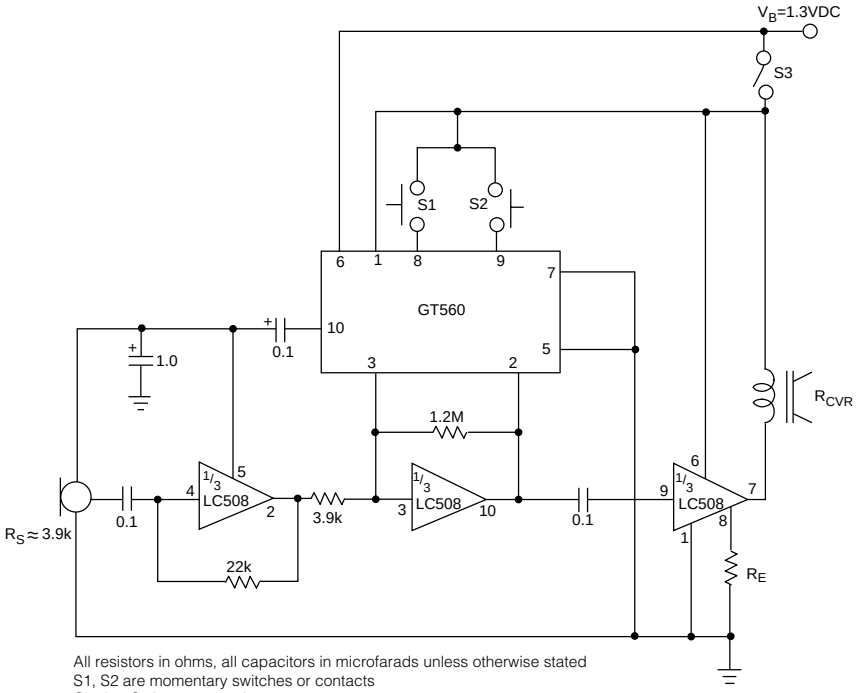
All resistors in ohms, all capacitors in microfarads unless otherwise stated
IC1 = CA 3140 Operational Amplifier

Fig.1 GT560 Test Circuit



All resistors in ohms, all capacitors in microfarads unless otherwise stated
S1 can be a momentary SPST switch or a pair of contacts.
On initial power-up (insertion of the battery) the gain will be at a random setting

Fig. 2 Typical Hearing Aid Circuit



All resistors in ohms, all capacitors in microfarads unless otherwise stated
S1, S2 are momentary switches or contacts
Closing S1 increases gain
Closing S2 decreases gain

Fig. 3 Typical Hearing Aid Application

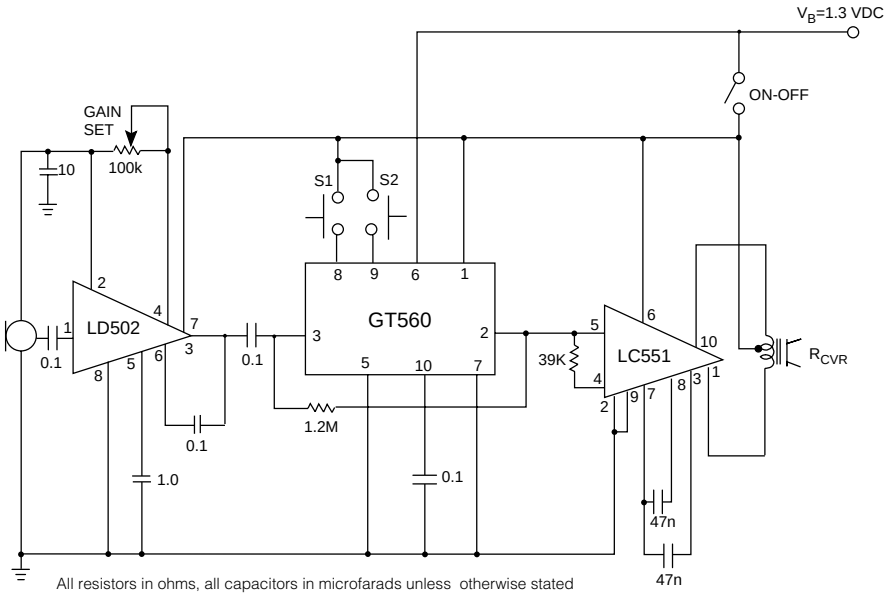


Fig. 4 LD502 / GT560 / LC551 Typical Application

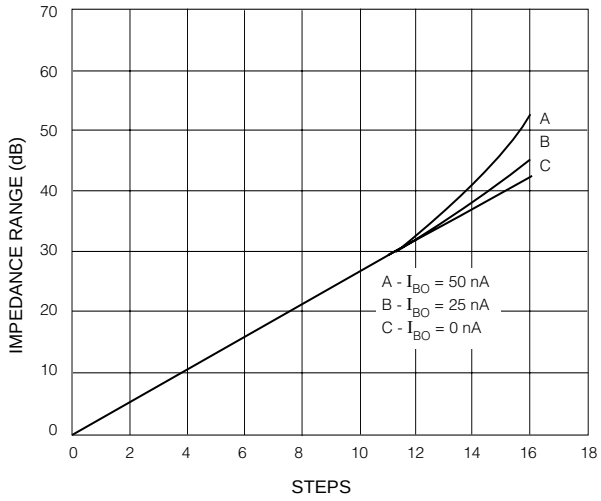
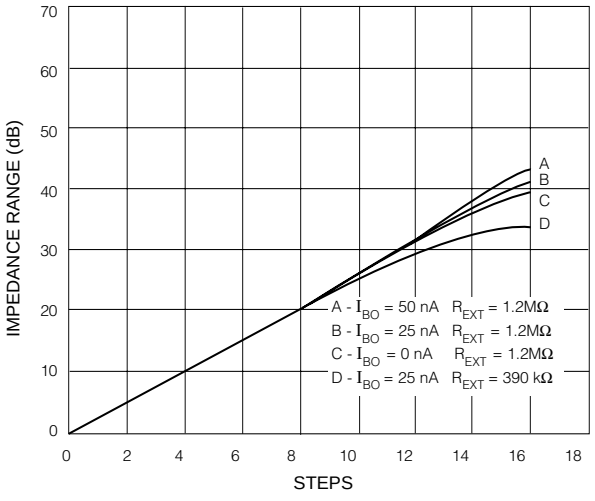


Fig. 5 Output Impedance Characteristics without External Shunt Resistor



Note: I_{BO} is the Input Bias Current of the LP/LC508 Preamplifiers

Fig. 6 Output Impedance Characteristics with R_{EXT} = 1.2 MΩ

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DOCUMENT IDENTIFICATION: DATA SHEET
The product is in production. Gennum reserves the right to make changes at any time to improve reliability, function or design, in order to provide the best product possible.

REVISION NOTES:
Changes to standard packaging information.