PMI

Audio Silicon Specialists™

SSM-2120/2122

DYNAMIC RANGE PROCESSOR/DUAL VCA

SSM Audio Products

DESCRIPTION

The SSM 2120 is a state of the art dynamic range processor integrated circuit designed specifically for use in professional audio systems. The chip, offered in a 22 pin 'skinnydip' package, has two fully independent class A VCA's that exhibit extremely low distortion and offer a 100dB dynamic range. Each VCA has two complementary antilog (dB/volt) control ports to simplify system design. Also included on chip are two independent control side chain circuits, each of which consist of a full wave rectifier, a logging circuit, and a high impedance amplifier. The log/antilog nature of the control paths make possible precisely defined compression/expansion ratios over a 100dB dynamic range.

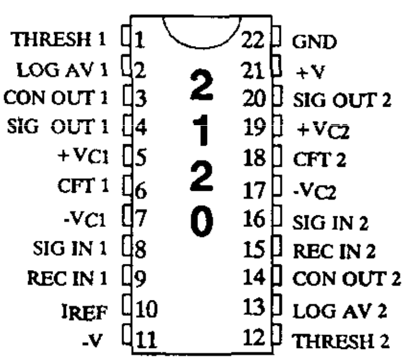
The SSM 2122 is the same die offered in a 16 pin package as a dual VCA without the level detection circuitry accessible.

FEATURES

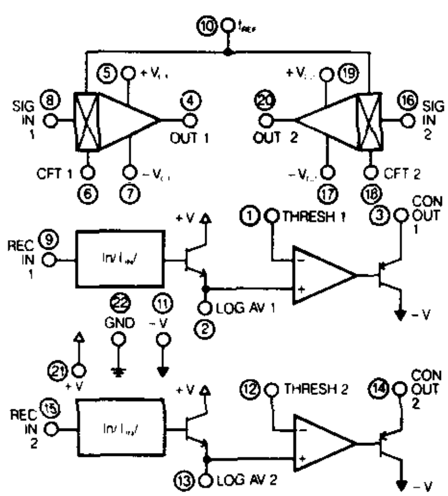
0.01% THD @ +10dBV In/Out
100dB VCA Dynamic Range
Low VCA Control Feedthrough
100dB Level Detection Range
Log/Antilog Control Paths
Low External Component Count

APPLICATIONS

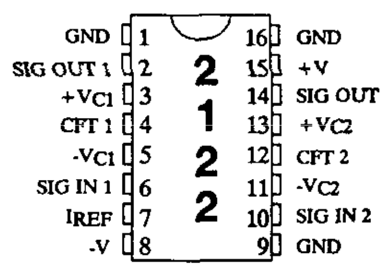
Compressors
Expanders
Limiters
Dual VCA
AGC Circuits
Voltage Controlled Filters
Noise Reduction Systems
Stereo Noise Gate



2120 PIN OUT (TOP VIEW)



BLOCK DIAGRAM (2120)



2122 PIN OUT (TOP VIEW)

Revised August 1988
Protected under U. S. Patents #4,471,320 and #4,560,947. Other Patent Pending.
The SSM 2120/2122 has been granted mask work protection under the Semiconductor Chip Protection Act of 1983.

PRELIMINARY SPECIFICATIONS*

Operating Temperature: -10°C to +55°C; Storage Temperature: -55°C to +125°C

The following specifications apply for @VS = ±15V, T_a = 25° C, I_{ref} = 200μA

PARAMETER	MIN	TYP	MAX	UNITS	CONDITIONS
General					
Positive Supply Range	+5		+18	V	
Negative Supply Range	-18		-5	V	
I_{CC}		8	10	mA	
I_{EE}		6	8	mA	
VCA's					
Max I_{signal} (in/out)	±387	±400	±413	μA	
Output Offset		±1	±2	μA	
Control Feedthrough (trimmed)		750μV			
Gain Control Range	-100		+40	dB	Unity Gain
Control Sensitivity		6		mV/dB	
Gain Scale Factor Drift		-3300		ppm/°C	
Frequency Response		250		kHz	Unity Gain or less
Off Isolation		100		dB	@ 1KHz
Current Gain	-0.25	0	+0.25	dB	V_c+ = V_{c-} = 0V
THD (Unity Gain)		0.005	0.02	%	+10dBV In/Out
Noise (20KHz Bandwidth)		-80		dB	RE: 0dBV
Level Detectors (2120 only)					
Dynamic Range	100	110		dB	
Input Current Range	0.03		3000	μApp	
Rectifier Input Bias Current		4	16	nA	
Output Sensitivity		3		mV/dB	
Output Offset Voltage		±0.5	±2	mV	
Frequency Response:					
I_{IN} = 1mApp		1000		KHz	
I_{IN} = 10μApp		50		KHz	
I_{IN} = 1μApp		7.5		KHz	
***Control Amplifiers* (2120 only)**					
Input Bias Current		85	175	nA	
Output Drive (Max Sink Current)	5.0	7.5		mA	
Input Offset Voltage		±0.5	±2	mV	

*Specifications are subject to change without notice.

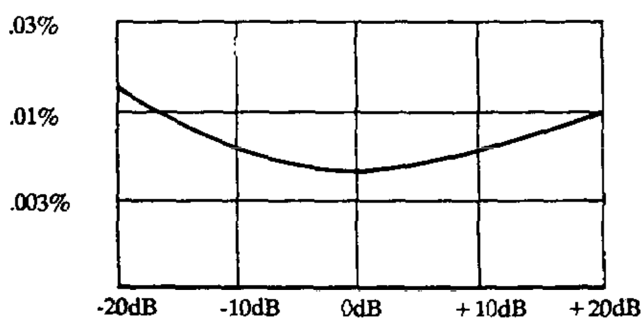


FIGURE 1A: VCA THD PERFORMANCE VS. GAIN (+10dBV IN/OUT @ 1kHz).

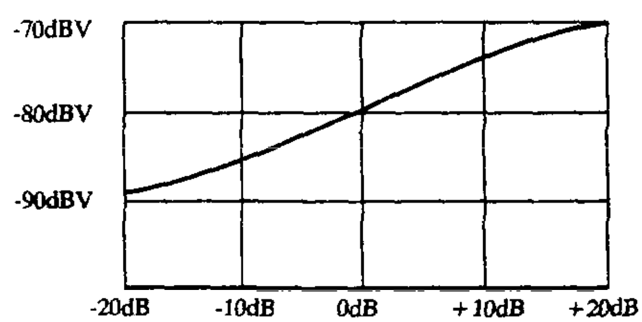


FIGURE 1B: VCA NOISE VS. GAIN (20kHz BANDWIDTH).

VCA's (2120 and 2122)

The two VCA's are full class A current in/current out devices with complementary dB/volt gain ports. For best performance, these pins should be connected to ground with resistors valued at 200 ohms or less. Control sensitivities at the pins are plus (or minus) 6mV/dB. The resistor to ground forms part of an attenuator that determines the sensitivity of the VCA to a control voltage source.

The signal inputs are virtual grounds and the outputs are designed to be connected to the virtual grounds of operational amplifiers configured as current to voltage converters. The input/output current compliance range is determined by the current into the reference current pin (pin 10 for the 2120, and pin 7 for the 2122). The voltage at the pin is about two volts above the negative supply. A resistor can be connected from the pin to the positive supply with a value that determines the current into the pin. The current consumption of the device will be directly proportional to this current which should be nominally 200μA. Smaller values can be chosen for battery operation at the expense of lower dynamic range from the VCA's. With a 200μA reference current, the input/output current clip point at unity gain will be ±400μA. In the general case:

$$I_{clip} = \pm 2 I_{ref}$$

This, together with the power supplies used, determines the value of input and output resistors for optimum dynamic range. For example, with ±15 volt supplies:

$$400\mu A \times 36K = 14.4V$$

This coincides with the output clip points of the op amps.

The CFT pins are optional control feedthrough null points which are required in some applications, most notably noise gating and downward expansion. The trim procedure is to apply a sinusoidal signal at 100Hz to the control point attenuator whereby it's peaks correspond to the VCA's maximum intended gain and at least 30dB of attenuation. The trim pot is then adjusted for minimum feedthrough. With 36K input and output resistors, the trimmed control feedthrough is typically well under 1mV RMS. This adjustment may not be required in compressor/limiter applications because the VCA operates at unity gain unless the signal is large enough to initiate gain reduction, in which case the control feedthrough is masked by the signal. The trim is ineffective for voltage controlled filter circuits. Refer to figures 1A and 1B for typical VCA THD and noise performance. Leave the CFT pins open if unused.

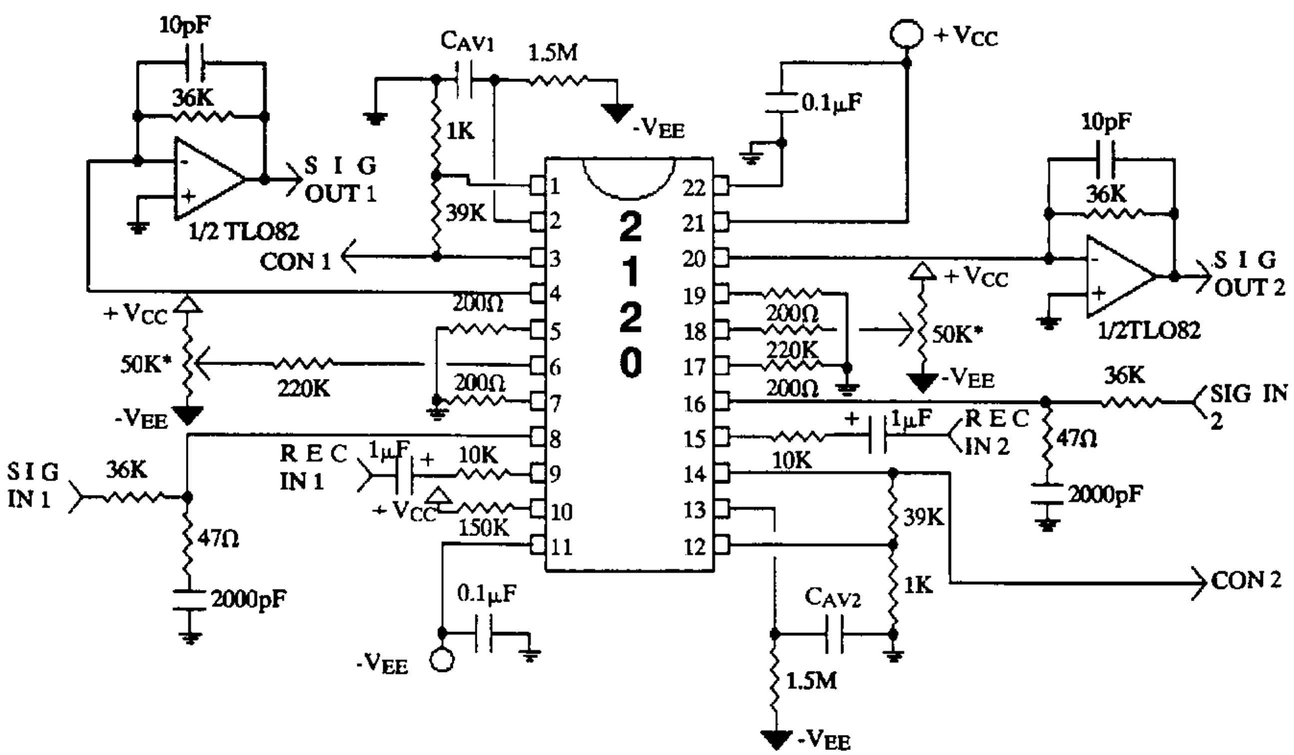


FIGURE 2: 2120 BASIC CONNECTION AT $V_S = \pm 15V$ (CONTROL CIRCUITS UNCOMMITTED). *OPTIONAL CONTROL FEEDTHROUGH NULL ADJUSTMENTS.

Control Sections (2120 only)

The 2120 has two separate control sidechain circuits, each of which consist of a wide dynamic range full wave rectifier and logging circuit followed by an amplifier with unipolar drive. The rectifier input has a D.C. voltage about 2.1 volts above ground so a low leakage blocking capacitor in series with the input resistor is required for proper operation. This resistor should be chosen to give a ± 1.5mA peak input signal. When operating from ± 15 volt supplies, this corresponds to a value of 10K ohms. The detector will provide accurate level information over a dynamic range from 3mA to 30nA peak to peak, or about 100dB. The logarithm of this level information appears at the LOG AV pin(s) where it can be averaged with a capacitor connected to ground. The voltage at the pin is no more than a few hundred millivolts above or below ground. The output transistor is run at a constant current. This is accomplished by connecting a resistor from the pin to the negative supply. With ± 15 volt supplies, a 1.5M resistor will establish a 10μA reference current in the transistor which is the middle of the detector's dynamic current range in dB. This is also about the optimum value for dynamic range and accuracy. The LOG AV outputs are buffered and amplified by unipolar drive op amps. A 39K, 1K resistor network connected between the output, threshold pin (inverting op amp input) and ground provides a gain of 40. An attenuator from the output to the appropriate VCA control port establishes the control sensitivity.

Applications of the 2120

The threshold control pin and the negative-going unipolar output are useful in dynamic filter, downward expander, and noise gating applications (Figure 3). Adding a resistor from the op amp output to the positive supply will make the drive bipolar for compandor circuits (Figure 4). The resistor's value can be chosen to determine the maximum output from the control amplifier. By modifying this circuit with a couple of diodes, one can obtain a unipolar drive in the positive direction. This is useful in compressor/limiter applications (Figure 5).

The threshold control circuits shown in Figures 3 to 5 can be used to control the signal level versus control voltage characteristic and/or the onset of control action in the case of Figures 3 and 5. The 1K and series resistor values from the threshold pin to the threshold control pot determines the sensitivity of the control.

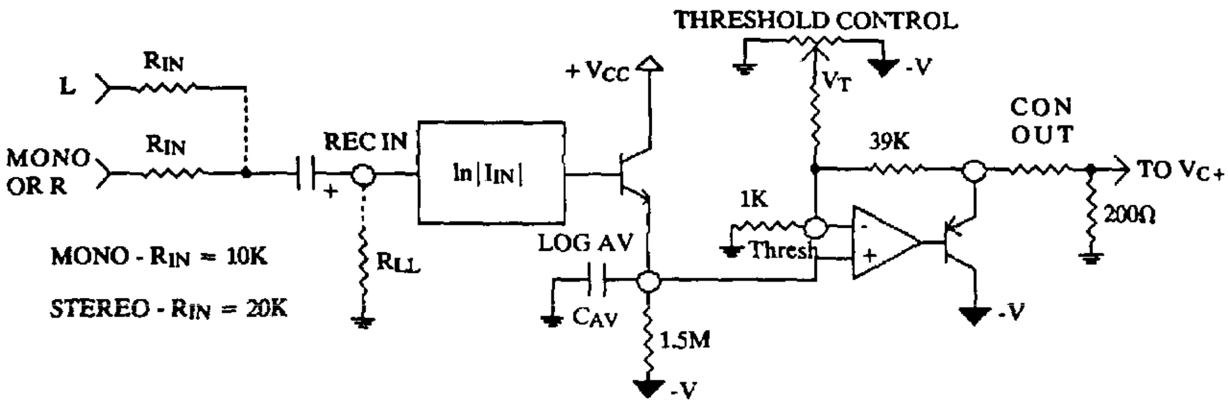


FIGURE 3: NOISE GATE/DOWNWARD EXPANDER CONTROL CIRCUIT.

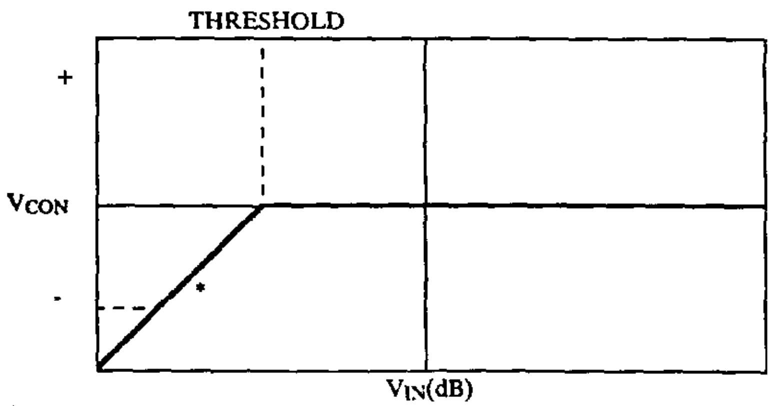


FIGURE 3A: TYPICAL DOWNWARD EXPANDER CONTROL CURVE. *LOWER LIMIT CAN BE FIXED BY CONNECTING A RESISTOR R_{LL} FROM REC IN TO GROUND.

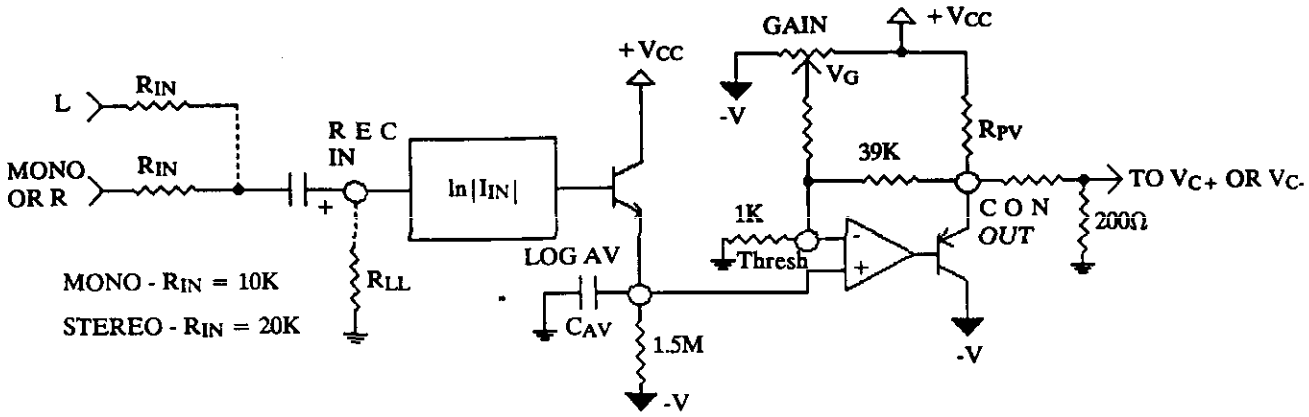


FIGURE 4: COMPANDOR CONTROL CIRCUIT.

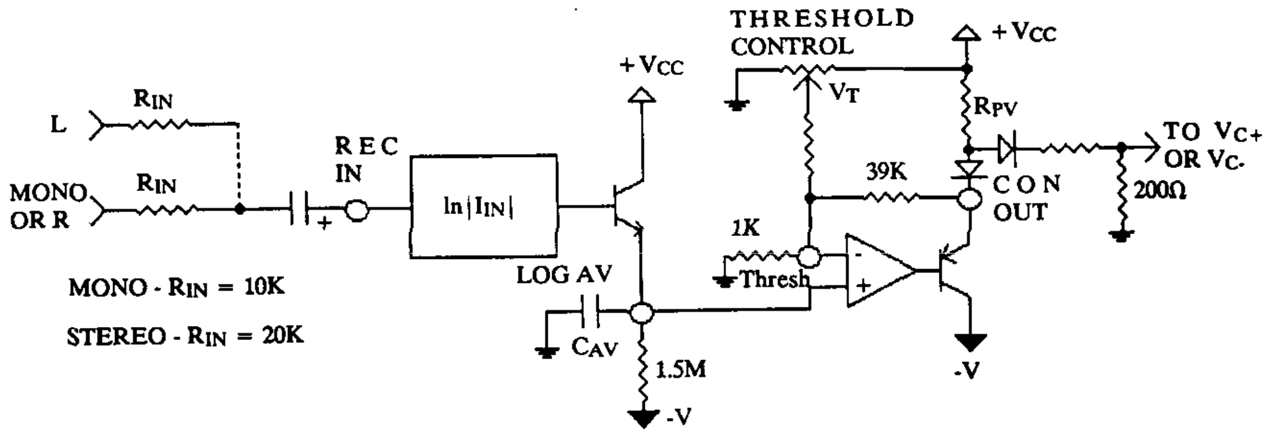


FIGURE 5: COMPRESSOR/LIMITER CONTROL CIRCUIT.

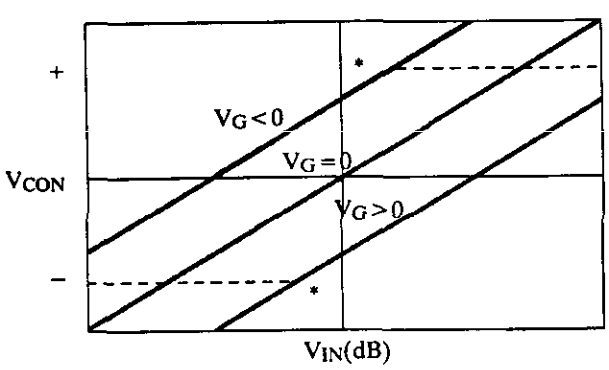


FIGURE 4A: TYPICAL COMPANDOR CONTROL CURVES. *UPPER AND LOWER LIMITS CAN BE ESTABLISHED BY VALUES OF R_{PV} AND R_{LL}, RESPECTIVELY.

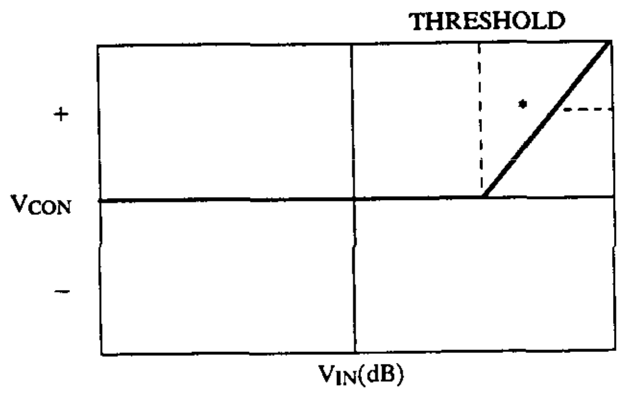


FIGURE 5A: TYPICAL COMPRESSOR/LIMITER CONTROL CIRCUIT. *UPPER LIMIT CAN BE FIXED BY VALUE OF PULL UP RESISTOR (R_{PV}) CONNECTED TO POSITIVE SUPPLY.

The two control circuits can also be used in conjunction to produce composite control voltages. Figure 6 shows such a circuit for a stereo compressor/limiter that also acts as a downward expander for noise gating. In the absence of signal, the output noise will be determined by the op amp used in the output current to voltage convertors if the expansion ratio is high enough. Figure 7 shows a control circuit for a dynamic filter which can be used in single ended (non-encode/decode) noise reduction. Such circuits usually suffer from a loss of high frequency content at low signal levels since the control circuit detects the absolute amount of highs present in the signal. Figure 7 measures the relative amount of highs in the signal by effectively producing a composite control voltage which is the difference between absolute amount of highs and the full audio band signal level. The values of the RB resistors establish a default signal level (for instance -30 to -50dBV) below which the filter(s) will start to close down to their minimum bandwidth, which should be about 1kHz. This minimum cutoff frequency is determined by the value of the filter capacitor and the ratio of the RB resistors.

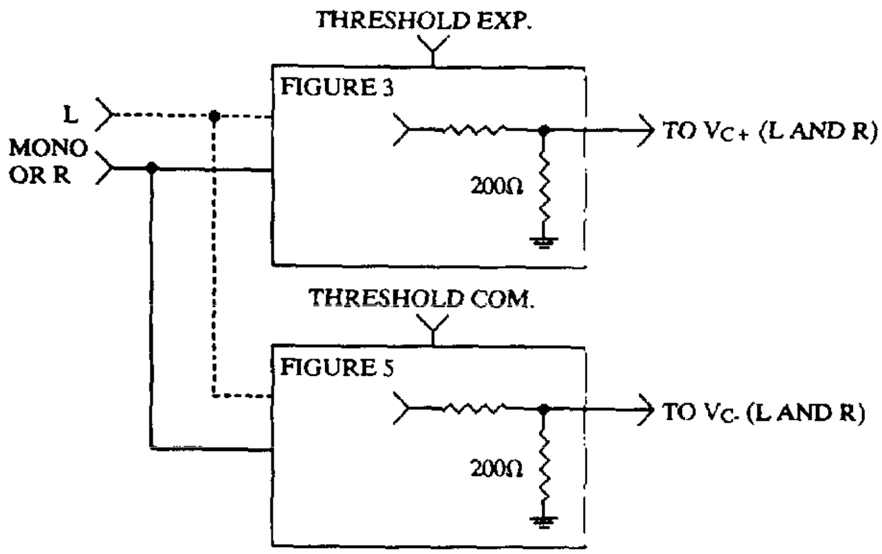


FIGURE 6: CONTROL CIRCUIT FOR STEREO COMPRESSOR/LIMITER WITH NOISE GATING.

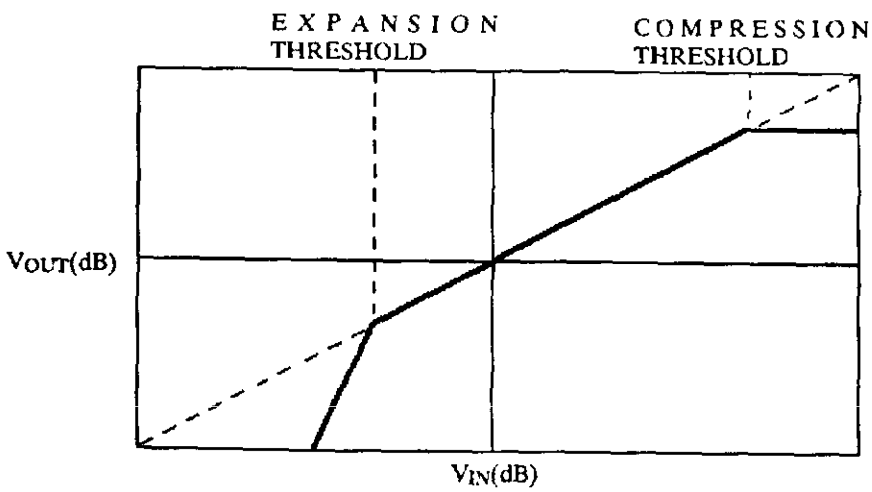


FIGURE 6A: INPUT/OUTPUT CURVE FOR CIRCUIT OF FIGURE 6.

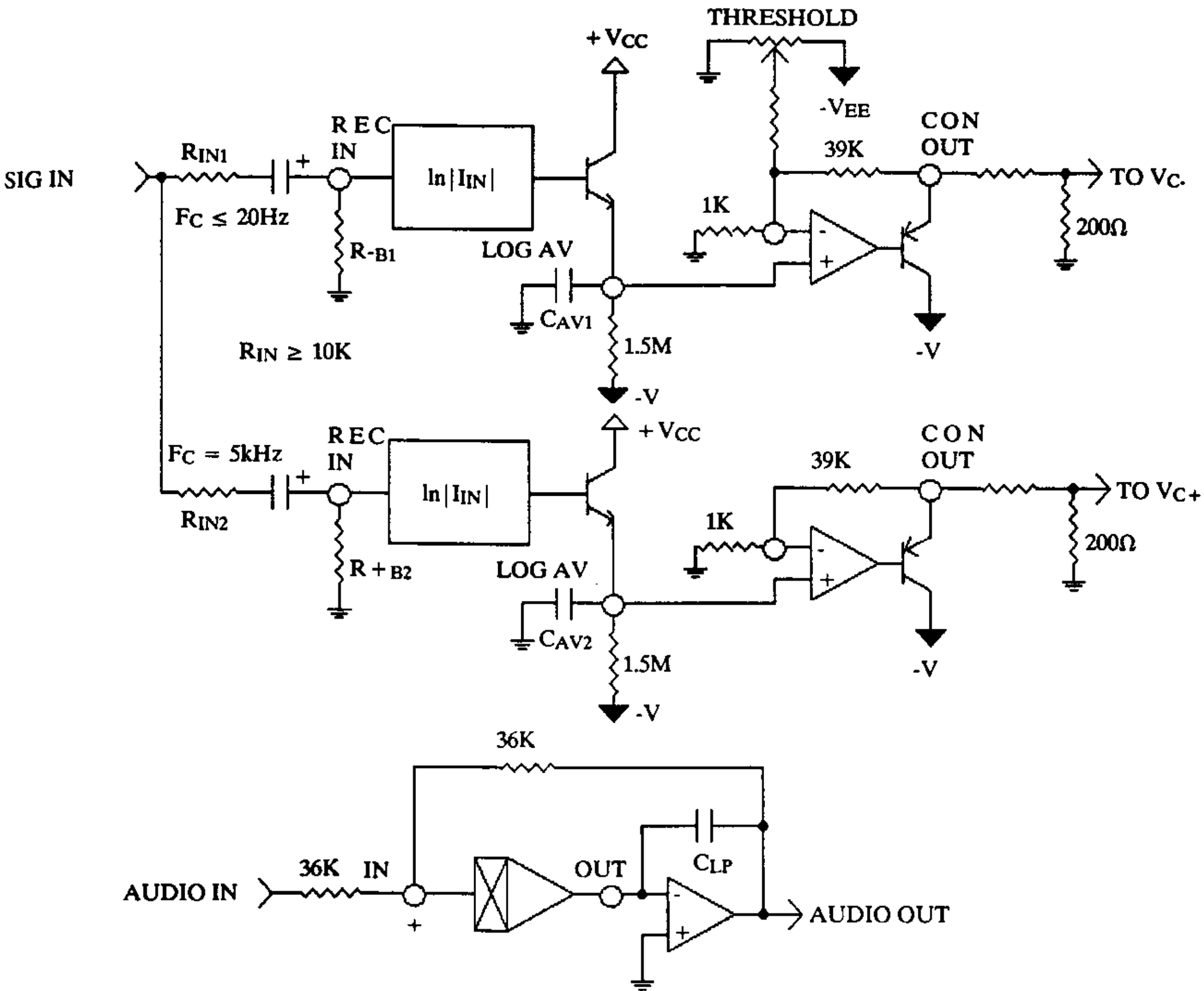


FIGURE 7: DYNAMIC NOISE FILTER CIRCUIT.

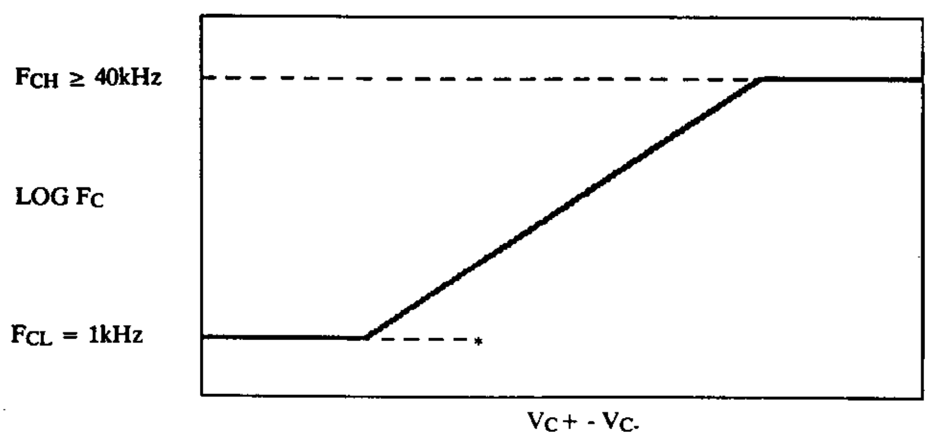


FIGURE 7A: DYNAMIC NOISE FILTER CONTROL CURVE. *FILTER WILL CLOSE DOWN TO MINIMUM FREQUENCY WHEN INPUT SIGNAL AMPLITUDE IS BELOW THRESHOLD.

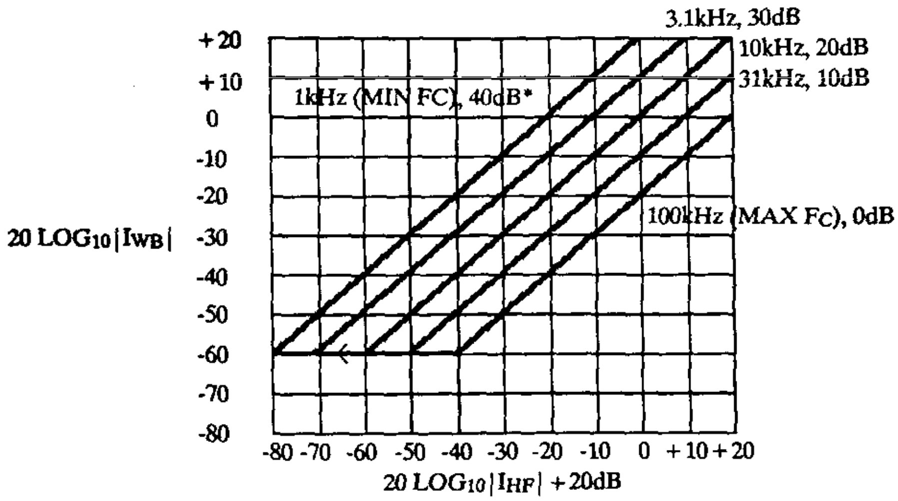


FIGURE 7B: EXAMPLE DYNAMIC FILTER CURVES. *NUMBERS IN dB ARE 20 $LOG_{10}|I_{WB}|$ - 20 $LOG_{10}|I_{HF}|$. LINES INDICATE FILTER CUTOFF FREQUENCY.

The 2120 can also be used in VCA fader automation systems to serve two channels. The inverting control port is connected through an attenuator to the VCA control voltage source* and the non-inverting control port is connected to a figure 3 control circuit which senses the input signal level to the VCA. Above the threshold voltage which can be set quite low (such as -50 or -60dBV), the VCA operates at its programmed gain. Below this threshold the VCA will downward expand at a rate determined by the $V_{C}+$ control port attenuator. By keeping the release time constant in the 10 to 25 millisecond range, the noise floor modulation, which is -82dBV maximum, can be kept inaudible.

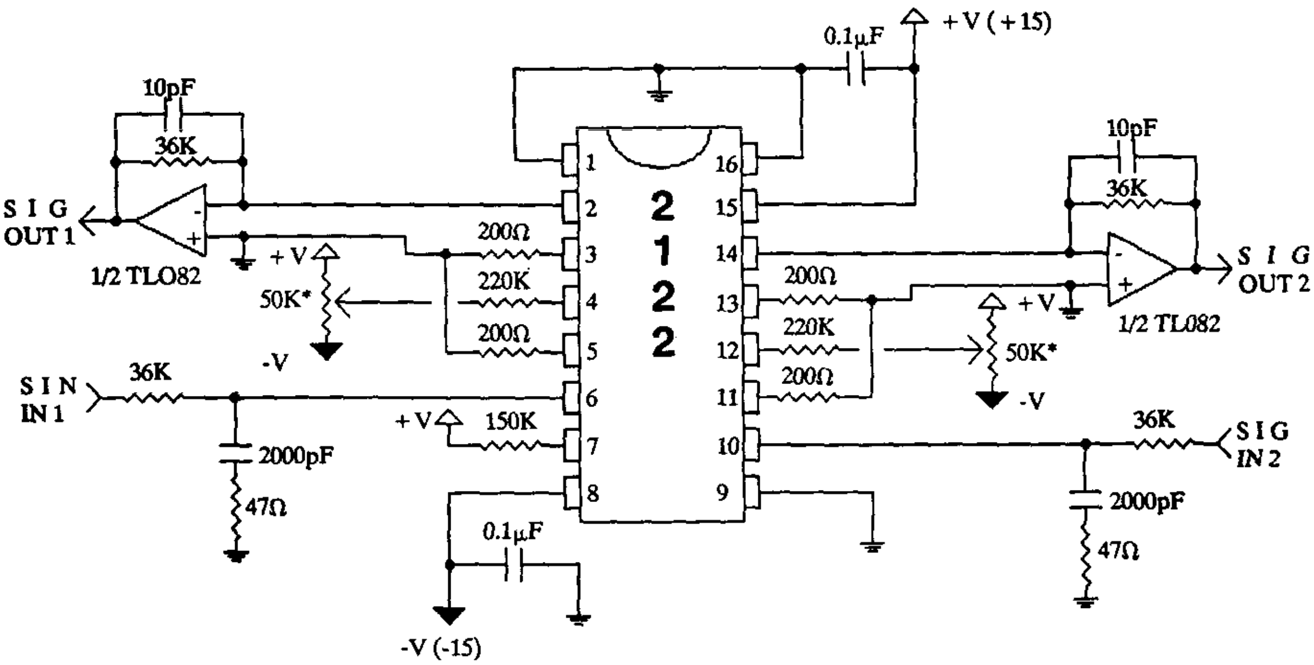


FIGURE 8: 2122 BASIC CONNECTION (CONTROL PORTS AT 0V). *OPTIONAL CONTROL FEEDTHROUGH NULL POT.

*The SSM 2300 8 Channel Multiplexed Sample and Hold I. C. makes an excellent controller for VCA's in automation systems.