Solid State Micro Technology for Music

ADVANCE INFORMATION

SSM 2014

SSM 2014 OPERATIONAL VOLTAGE CONTROLLED ELEMENT*

DESCRIPTION:

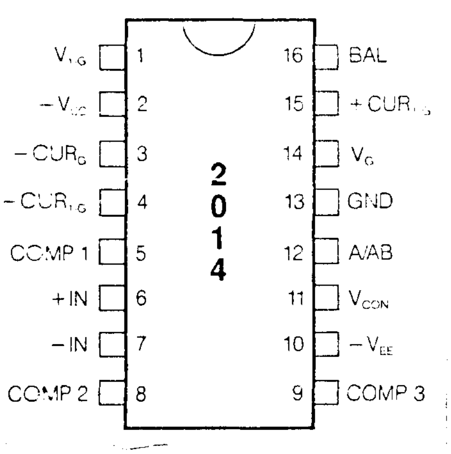
The SSM 2014 is a generalized VCA building block which will substitute for any VCA circuit presently available, in addition to possessing powerful features not available using any other device. It may be configured as a voltage-in or current-in VCA or VCP (voltage controlled potentiometer). In most applications it will replace a standard VCA and two or more op amps. The performance of the SSM 2014 is equal to or better than the best integrated VCA's available and closely approaches the performance of modular devices. Configured as a standard VCA circuit it provides true gain to over 50dB with excellent specifications at any signal level or gain. It provides the function of a voltage controlled preamp for both high impedance and balanced low impedance inputs simultaneously. Class A or class AB operation may be selected at the user's option.

FEATURES (Used as a standard VCA)

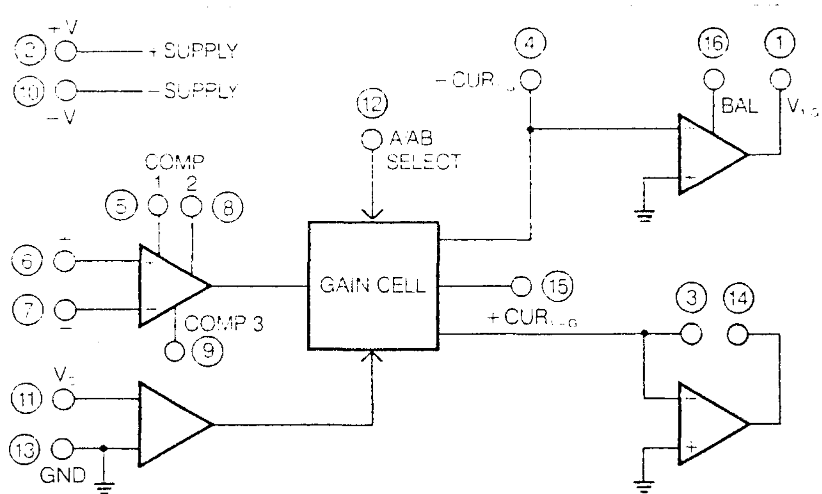
- 118dB Dynamic Range (Class AB)
- .01% Class A Distortion (Any Gain, Signal Levels Up To 10dB Below Clipping)
- 5MHz Gain Bandwidth Product
- 100dB Open Loop Gain
- Minimum External Component Count
- No Trimming Required In Many Applications
- Low Cost

UNIQUE FEATURES

- Replaces Any VCA In Any Application
- Combines All Features Of Op Amps and VCA's
- Acts As A Voltage Controlled Potentiometer
- Two Complementary Outputs For Use In Panning Or Reciprocal Equalizer circuits
- Acts As A Voltage Controlled Preamp
- Has High and Low (Balanced) Impedance Inputs
- Fully Buffered Control Port
- Voltage Selectable Class A or Class AB Operation
- Maximum Class AB Modulation Noise Is Equal To Class A Noise



PIN OUT (TOP VIEW)



BLOCK DIAGRAM

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* U.S. PATENT #4,471,320

Rev. Nov. '85

SPECIFICATIONS* **OPERATING TEMPERATURE** −10°C to +55°C **STORAGE TEMPERATURE** −55°C to +125°C

The following specifications apply for $V_{sup} = \pm 15V$, $T_A = 25°C$.

ELECTRICAL CHARACTERISTICS

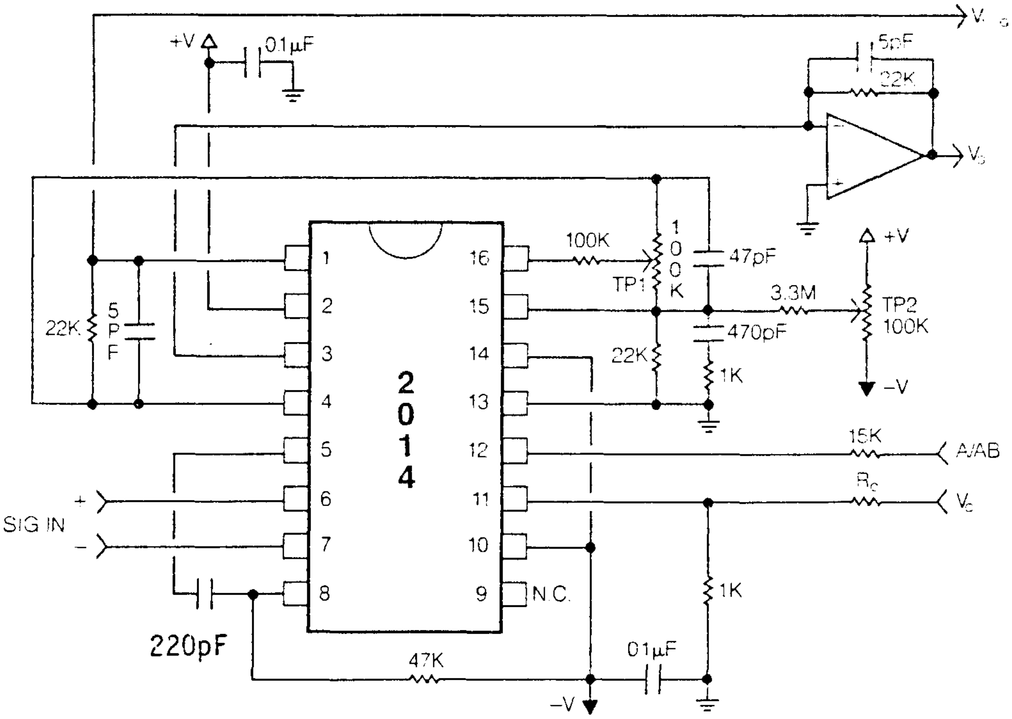
PARAMETER	MIN	TYPICAL	MAX	UNITS	CONDITIONS
Front End					
Bias Current		150	300	nA	
Input Offset Current		15	30	nA	
Input Offset Voltage		1	5	mV	
Input Impedance	.5	1		MΩ	
Equivalent Input Noise		12		nV/√Hz	@ 1kHz
Common Mode Range		+13, −12		V	
Open Loop Gain	75	100		V/mV	
Unity Gain Bandwidth		5		MHz	VCA Configuration
		.5		MHz	VCP Configuration
Slew Rate		6V/μs			
Supply Current		7.5	9	mA	
		10	12	mA	
Output Amplifiers					
Offset Voltage		10	20	mV	
Minimum Load		8	10	kΩ	For Full Output Swing
Output Voltage Swing		±13.5		V	
Noise Residual		7	8	μV	20kHz BW
Control Port Amplifier					
Bias Current		2	4	μA	
Input Impedance	80	100		kΩ	
Gain Constant		−30		mV/dB	Ratio at Outputs
Gain Linearity		1		%	
Control Feedthrough					100Hz Sine Wave Applied to Control Port
Class A		10		mV	Causing −50dB to +30dB of Gain for
Class AB		1		mV	VCA (Trimmed)

VCA CHARACTERISTICS (TYPICAL)

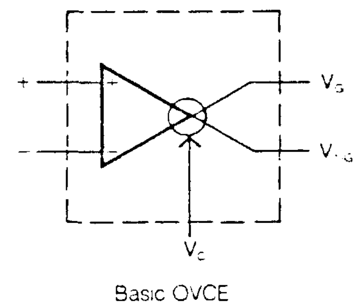
	CLASS A	CLASS AB
Noise (20kHz BW)		
No Input Signal, Unity Gain	−83dBV*	−96dBV
Peak Signal at Input, Unity Gain	−80dBV	−80dBV
Infinite Attenuation	−103dBV	−103dBV
Distortion (THD, 1kHz Sine Wave) @ ≤10dB Below Clipping at Input or Output		
Unity Gain	.01%	.03%
±20dB Gain	.02%	.06%

* 0dBV = 1V RMS

*Final specifications may be subject to change.



TYPICAL CONNECTION WITH FULL TRIMMING



SCHEMATIC DIAGRAM FOR CONNECTION SHOWN

General:

The SSM 2014 OVCE is extremely simple to use. Once the basic external components are added, it can be configured the same way as an op amp. The basic connection is shown above (typical connection with full trimming). As shown it is compensated for unity gain feedback: that is, 100% feedback from the $V_{I\text{-}G}$ output to the − input. The 180pf capacitor is used for this compensation. When using the OVCE as a potentiometer (any time feedback is applied from both outputs, V_G and $V_{I\text{-}G}$, back to the − input), use a .002uf capacitor from pin 5 to ground and leave pin 8 open, leaving out the 180pf capacitor shown. The 22K resistors and 5pf capacitors should always be used.

Trim pot TP1 and the 100k resistor tied to its tap should be used to trim for minimum distortion. TP2 and the 3.3MΩ resistor are used to trim the input offset voltage (for minimum control voltage feedthrough). Either or both trim networks may be left out depending on the application. In any application trimming may be accomplished as follows: Set $V_C = 0$, drive the OVCE to a peak signal anticipated, and at the V_G output measure distortion. Adjust TP 1 for minimum distortion. It should be about .01% Now apply no signal input. Drive the control port with a 100Hz sine wave, 2 volt peak to peak (1 volt with respect to ground). Adjust TP2 until minimum output is seen at the V_G output. It should be less than ± 10mV. The 15K resistor between pins 12 and 2 will select class A operation. Leaving this resistor out selects class AB operation. Trim Tp1 should always be used for class AB operation. In typical applications, a blocking capacitor should be placed between the output of preceding stages and the OVCE network. This prevents offsets due to other sources from degrading the control rejection of the voltage controlled network. Consult SSMT for additional applications and special problems.

A circuit symbol for the OVCE is shown next to the typical connection. In each of the circuits shown in figs. 1–6, it is assumed that the typical connection as shown has been made. Only the additional feedback components are shown. Of course the trim networks are optional and in figs. 3 and 6 a .002uf compensation capacitor connected as described in the above paragraph should replace the 180p capacitor between pins 5 and 8.

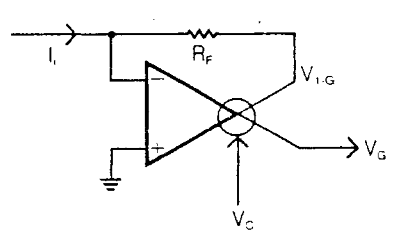


FIGURE 1

Applications:

In fig. 1 an equivalent to a current-in VCA for summing applications is shown. No op amp is needed to convert an output current to a voltage. The output, V_G is equal to $-I_i R_F$ times the decliner gain function. At $V_C = 0$, $V = -I_i R_F$. As V_C is increased the gain decreases at a rate of -1dB/30mV. Decreasing V_C causes a similar gain. Excellent performance over the full audio spectrum is guaranteed to over 40d of gain beyond the nominal, or "unity", gain of $-I_i R_F$. R_F should be selected so that R_F times the peak anticipated input current, I_i, is less than the clip point of the output amplifiers, which is within 1.5 volts of the supply rails. For example, if the peak value of I_i is 500μA, then $R_F = 24K$ is a good choice. The voltage at the $V_{I\text{-}G}$ output is $-I_i R_F$, independent of V_C. This can be a very useful output, which is not available with other VCA's.

Fig. 2 shows a non inverting VCA circuit which accepts an input voltage. The gain from the input to the $V_{I\text{-}G}$ output is $(R_1 + R_2)/R_1$, independent of V_C. At the V_G output the gain is the same at $V_C = 0$, and changes at the rate of -1dB/30mV as V_C is varied. The input impedance of this circuit is quite high (>1M) and it makes a good preamp. $(R_1 + R_2)/R_1$ should be chosen so that $V_{I\text{-}G}$ will not clip for the largest possible input voltage. If the peak input voltage is 1 volt, than $R_1 = 1K$ and $R_2 = 10K$ will work fine, providing over 20dB of nominal, or "unity" ($V_C = 0$), gain, and much more at the V_G output for $V_C < 0$. For this choice of R_1 and R_2, the 180pF compensation capacitor may be reduced to 22 pF, allowing for 60dB of gain at the V_G output with full audio bandwidth and excellent performance.

Fig. 3 shows a panpot circuit using the OVCE. The outputs, V_G and $V_{I\text{-}G}$, are complementary in that their sum is always 2 times V_i. A larger gain can be had by adding a resistor from the $-$ input to ground. V_C controls the ratio of V_G to $V_{I\text{-}G}$. At $V_C = 0$, the ratio is 1—that is, $V_{I\text{-}G} = V_G = V_i$. As V_C is varied the ratio changes at a rate of 1dB/30mV.

Fig. 4 shows how powerful the OVCE structure can be. It shows a voltage controlled RIAA phono preamp. For the values shown the nominal gain ($V_C = 0$) to the V output is 20dB at 1KHz, and can be varied using V_C with the control constant, -1dB/30mV. For all gains, to plus 40dB or down to infinite attenuation (>100 dB), the equalization curve is constant.

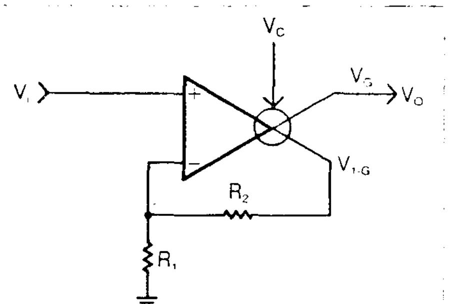


FIGURE 2

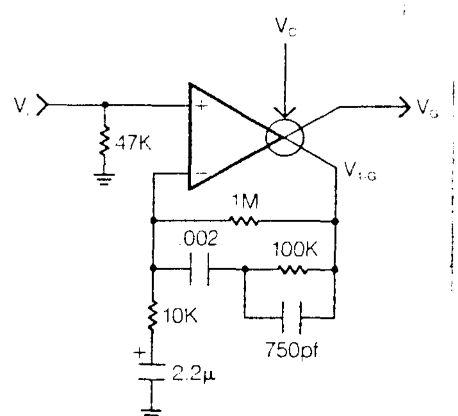


FIGURE 4

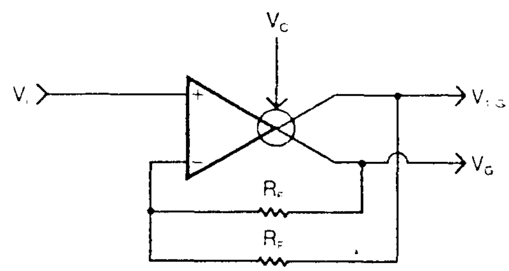


FIGURE 3

Fig. 5 shows a powerful voltage controlled preamp which accepts both high and balanced low impedance inputs simultaneously. 470 ohm resistors are connected to pins 3 and 15 on the I.C. to create the balanced input. For the values shown, the nominal signal (at $V_C = 0$) at the V_G output is the sum of the high impedance input with about 20dB of gain and the low impedance input (assuming 600Ω source) with about 50dB of gain. Full audio bandwidth is achieved with gains 30dB above this. Class A operation should be selected for high gain applications. If peak inputs will cause clipping at the nominal gain stated above, the gain setting resistors should be changed. For example, the nominal gain from both inputs may be reduced by 10dB using a 10K resistor in place of the 2K. A 20dB reduction may be achieved taking out the 2K, 20K resistors and the 22uf capacitor and simply tying the $V_{I\text{-}G}$ output to the $-$ input.

Fig. 6 shows another unique OVCE application. It shows a circuit for a voltage controlled reciprocal shelving equalizer. The peak boost or cut is about 15dB at low frequencies. At $V_C = 0$, the response is flat, with the input equal to the output. As V_C is increased, there is bass boost and vice versa. Any other type of equalizer may be created, that is, bandpass or other—by substituting the appropriate filter in place of the low pass filter shown, composed of the two 10K ohm resistors, the two 0.1uf capacitors and the associated op amps. The filter should have unity gain in its pass band.

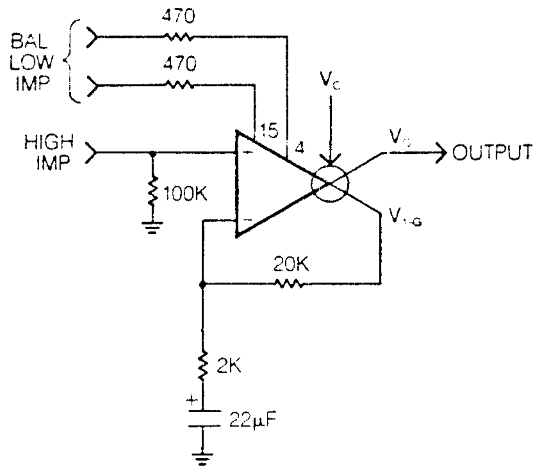


FIGURE 5

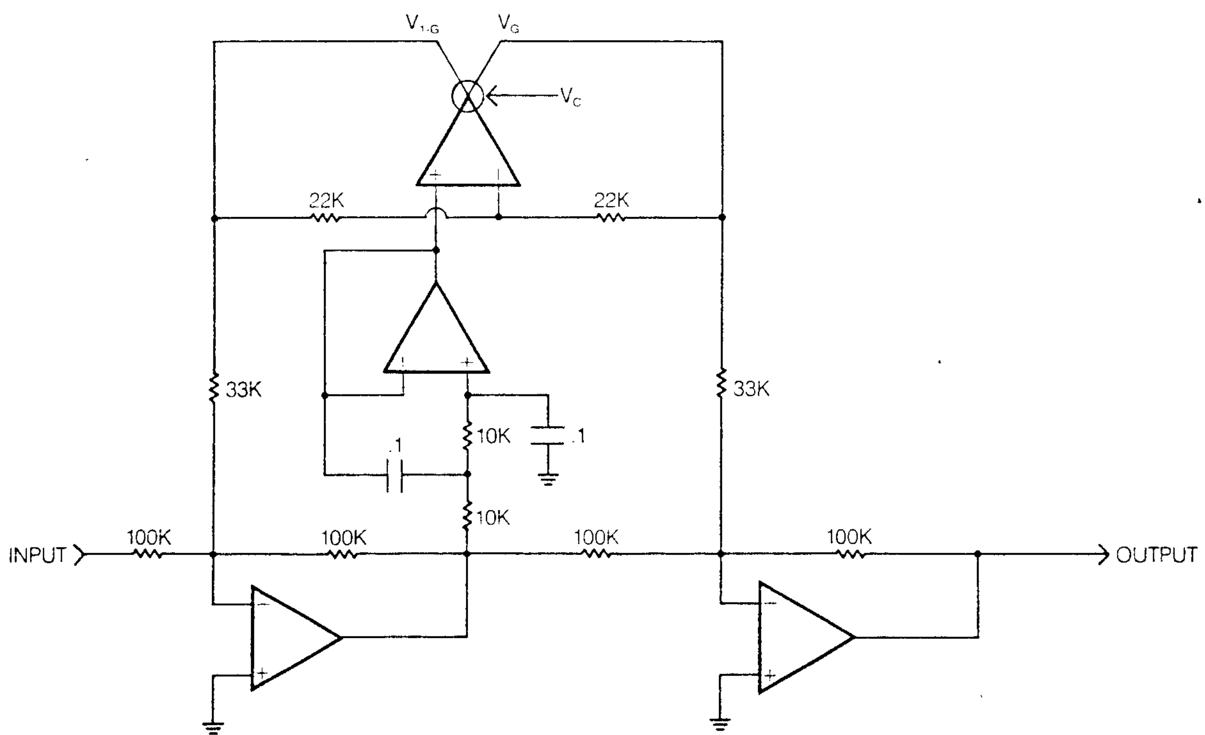


FIGURE 6