SSI2144

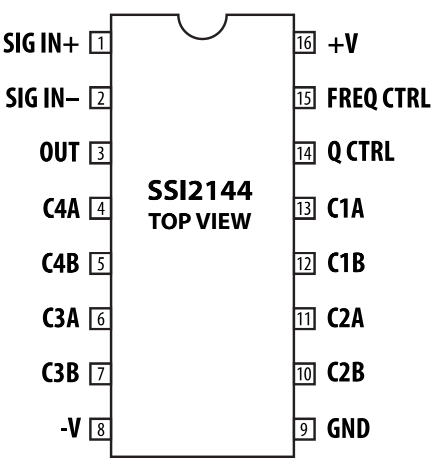
FATKEYS™ FOUR-POLE VOLTAGE CONTROLLED FILTER

The SSI2144 reprises the SSM2044 of legacy chipmaker Solid State Microtechnology, which many believe to be the best-sounding analog synthesis filter IC ever produced. Based on Dave Rossum's patented classic improved ladder topology, the SSI2144 allows rich tonal characteristics that showcase the very best attributes of subtractive synthesis.

The SSI2144 uses the same internal circuit as the SSM2044 but incorporates improvements by the original designer and takes advantage of modern process technology. Features include a minimum 10,000 to 1 sweep range, on-chip control of resonance, differential inputs, high control rejection, and minimized external components. The SSI2144 will operate on supplies as low as ±4V, and improvements include lower noise, significantly better control feedthrough, and more consistent unit-to-unit performance of the resonance control. Pin connections were revised for PCB layout ease. Most importantly, the SSI2144 preserves the coveted sonic character of the SSM2044.

FEATURES

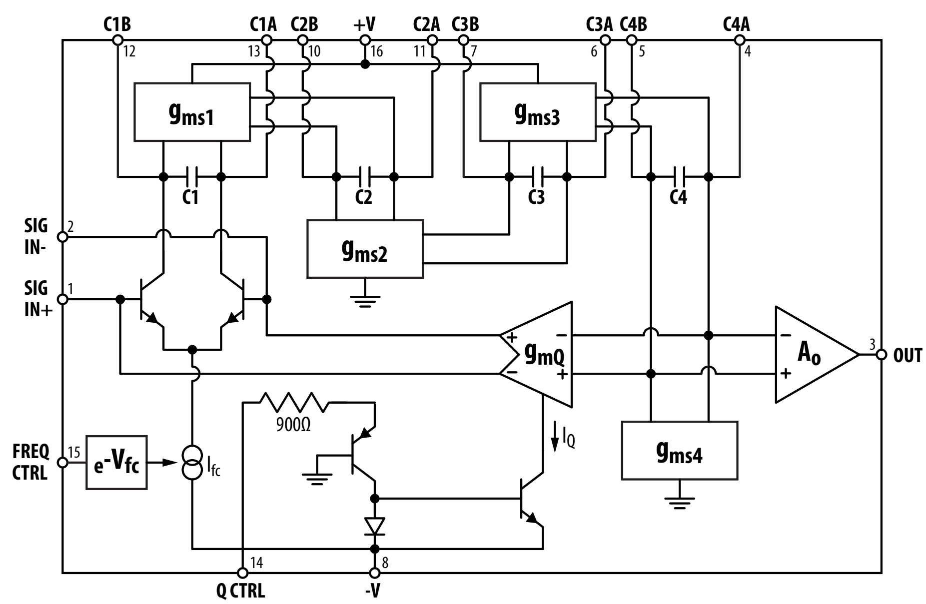
- **Classic Analog Synthesis Timbre**
- **On-Chip Resonance Circuit Improved for More Consistent Control and Performance**
- **±4V to ±16V Operation**
- **Pin Connections Optimized for PCB Layout**
- **Differential Inputs**
- **Large Sweep Range - Typical 20,000 to 1**
- **Low Feedthrough on Both Control Ports**
- **16-Pin SSOP Package with Minimal External Components**



PIN CONNECTIONS

16-LEAD SSOP

16-LEAD EPOXY DIP (future)



FUNCTIONAL BLOCK DIAGRAM

The SSI2144 is distributed exclusively by CruzTOOLS, Inc., PO Box 250, Standard, CA 95373 USA
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SPECIFICATIONS (V_S = ±12V, T_a = 25°C unless otherwise noted)

Parameter	Symbol	Conditions	Min	Typ	Max	Units
POWER SUPPLY						
Supply Voltage Range	V_S		±4		±16	V
Supply Current - Positive	I_{CC}	V_{fc} = GND	3.6	5.0	6.2	mA
Supply Current - Negative	I_{ee}	V_{fc} = GND	3.8	5.2	6.4	mA
FILTER SECTION						
Frequency Sweep Range			10:000:1	20:000:1		
Frequency Control Sensitivity			20	19	18	mV/oct
Frequency Control Input Bias Current				4	10	µA
Frequency Control Input Range	V_{fc}		-120		+150	mV
Frequency Control Feedthrough		±V_{in}=GND; -90mV≤V_{fc}≤+90mV	-36	-50		dB
Frequency Control Offset Voltage		Untrimmed	-10	0	+10	mV
Maximum Available Control Current		V_{fc} = -120mV	500	720	1000	µA
RESONANCE (Q) SECTION						
Q Current Input Range	I_q		0		1000	µA
Q Current at Oscillation		-90mV ≤ V_{fc} ≤ +90mV	350	400	450	µA
Q Control Feedthrough		0 < I_q < 400µA		-60	-20	dB
SIGNAL INPUTS						
Input Bias Current		Either Input, V_{fc} = 0, I_q = 0		40	150	nA
Differential Input Signal Range	V_{in}	Clipping		±50		mV
SIGNAL OUTPUT						
Maximum Output Signal Current	IoMax		±300	±400	±520	µA
Dynamic Range	DR	Noise floor to 1% THD		92		dB
Total Harmonic Distortion	THD			TBA		%
Output Offset	Io/IoMax	V_{in+} = V_{in-} = V_{fc} = 0, I_q = 0		0.01	0.2	mA

ABSOLUTE MAXIMUM RATINGS

Supply Voltage	±18V
Input, Output, Control Voltages	TBA
Pins subject to damage by shorting to ground	TBA
Storage Temperature Range	TBA
Operating Temperature Range	TBA
Lead Temperature Range (Soldering, 60 sec)	TBA

ORDERING INFORMATION

Part Number	Package Type	Tube Qty.
SSI2144SS-TU	16-Lead SSOP (JEDEC MO-137)	100
SSI2144P*	16-Lead Epoxy DIP	25

*Future availability. NOT pin-compatible with SSM2044
Please order in full tube quantity multiples.

USING THE SSI2144

Signal Inputs

Figure 1 shows typical connection of the SSI2144 as a four-pole lowpass filter in electronic music systems. Differential inputs allow the convenience of directly connecting two oscillators. To prevent cancellation of in-phase signals, a 3dB attenuation of the SIG IN- input is recommended using the resistor values shown. If only one input is needed, the unused input should be connected to ground via a 200Ω resistor.

The SSI2144 differential input signal level is nominally ±20mV and clips at ±50mV. The resistor values in Figure 1 result in ±7V being the nominal input signal level.

Frequency Control

The Control Summer adds voltages from various sources such as the panel frequency control, ADSR, LFO, etc. Any number of signals can be mixed through resistors to the summing node of the op amp. For best control rejection, the Control Summer and input attenuator should be designed such that maximum swing to the Frequency Control (pin 15) matches extremes of the intended sweep range when the Control Summer is driven to the op amp's full output voltage swing. With values shown in Figure 1, ±90mV at the Frequency Control pin corresponds to a 1000:1 sweep range using ±12V supplies.

A frequency offset adjustment is necessary in polyphonic systems for consistent cutoff fequency across voices, or programmable systems where repeatable performance from a given control voltage is desired.

Resonance (Q) Control

The Q Control (pin 14) is a current input summing node at ground. Minimum resonance occurs at zero current. Oscillation will occur when current into the Q Control reaches approximately 400µA, equating to 10.7V using the resistor value of 26.7kΩ in Figure 1.

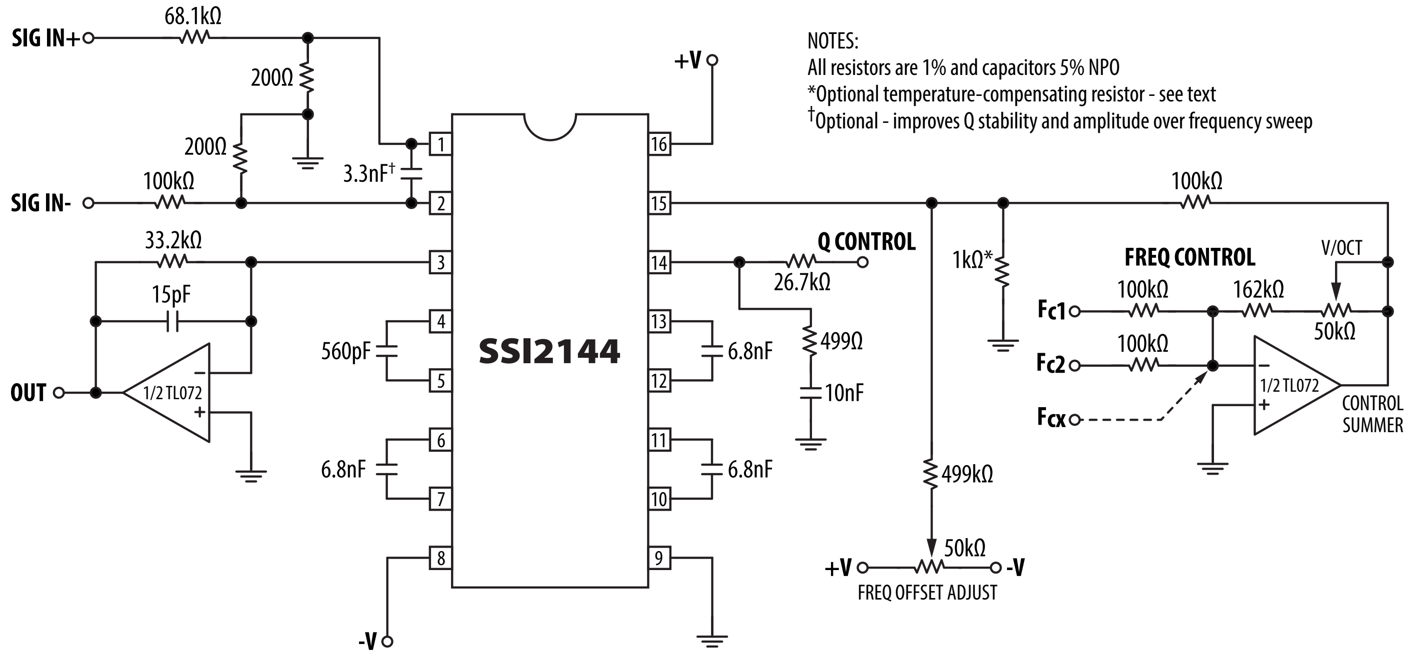

Figure 1: Typical Application Circuit

Due to response of the Q circuit (see "SSI2144 Filter Characteristics" below), ideal potentiometer feel is achieved with a "reverse audio taper" (90% at 50%; i.e. Bourns PDB181 series) configuration as shown in Figure 2.

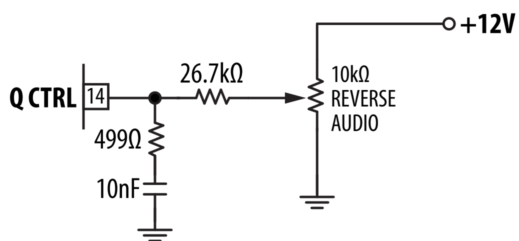

Figure 2: Recommended Q Control Potentiometer Circuit

If accurate musical intervals during oscillation are desired, the V/OCT trim and a temperature compensating resistor (such as the Panasonic ERA-V33J102V) are necessary. If such intervals aren't important, substitute 1% 187kΩ in the Control Summer feedback network and 1% 1kΩ in lieu of the temperature compensating resistor.

Signal Output

Figure 3 shows direct connection to a current input VCA from the SSI2144's output (pin 3). In this case, the intervening op amp isn't required. A 10µF cap blocks any DC offset present at Pin 3, so no further offset adjustment is neccesary to maintain the SSI2144's specified control rejection.

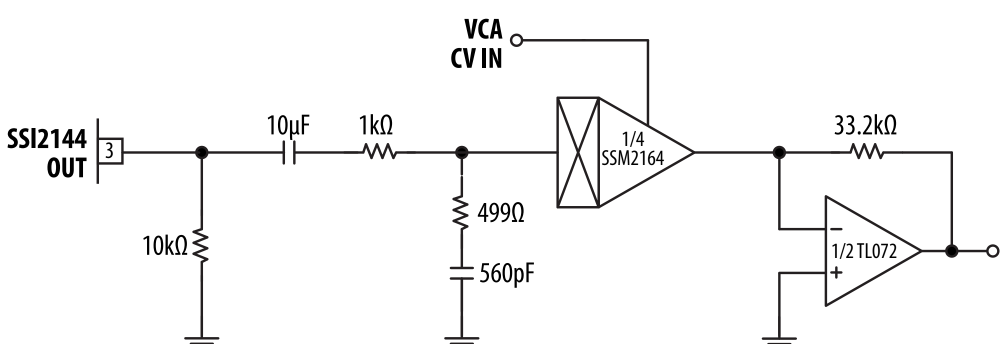

Figure 3: Direct Connection of SSI2144 to a VCA

SSI2144 FILTER CHARACTERISTICS

Figures 4 and 5 show behavior of the SSI2144 filter and Q circuits. In Figure 4, the solid line shows response of the filter with the Q control at ground. In this case, the filter comprises four real poles, each producing 3dB of attenuation at the cutoff frequency. As voltage is applied to the F_C input, cutoff frequency will vary exponentially in response to the control voltage.

The Q circuit provides negative feedback around the filter. As Q control current is increased, gain at DC and frequencies below cutoff are proportionately decreased, and gain at the cutoff frequency is increased as shown in the dotted line of Figure 4. At higher frequencies, an approximate 24dB/octave rolloff will be maintained.

When feedback exceeds 12dB, loop gain at cutoff exceeds unity and the filter oscillates with a pure sinewave at the cutoff frequency. This waveform can therefore become a very useful tone source in electronic music systems.

The SSI2144's Q control circuit has been improved over the SSM2044. It accurately applies the current supplied to the Q input summing node (which is maintained at a ground potential) to the feedback amplifier, eliminating process dependent variations in the gain of the Q control circuit.

Figure 5 shows resonance, measured as the height of the resonant peak above the low frequency gain, as a function of Q Control current. Note that the slope is more flat at lower current, then increases rapidly as oscillation is approached. To compensate for this variation in slope, the "reverse audio" taper potentiometer circuit in Figure 2 above is recommended. Figure 6 shows the corrected response; the rightmost portion of the rotation represents the region of oscillation.

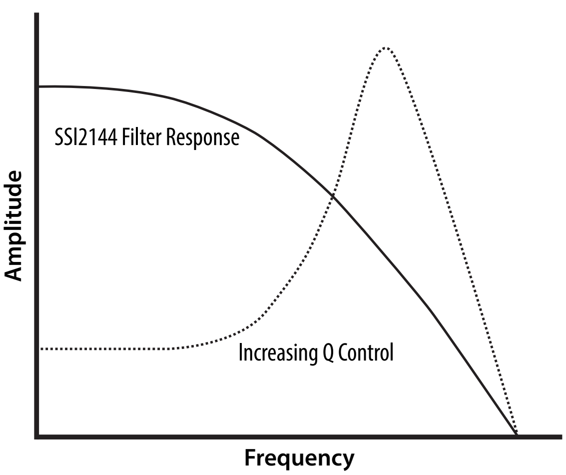

Figure 4: Filter and Q Response

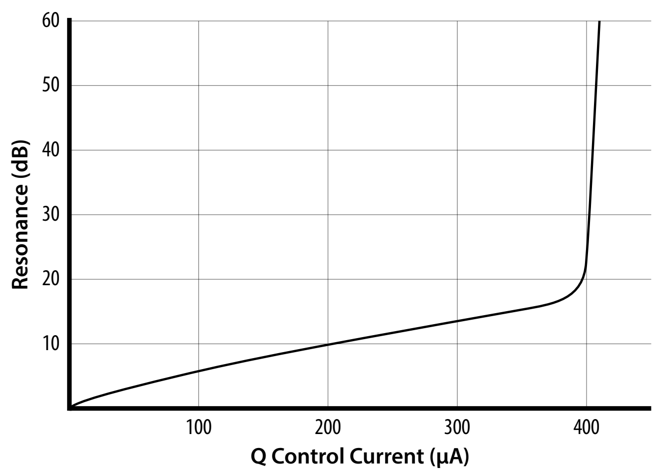

Figure 5: Resonance Peak Height vs. Q Current

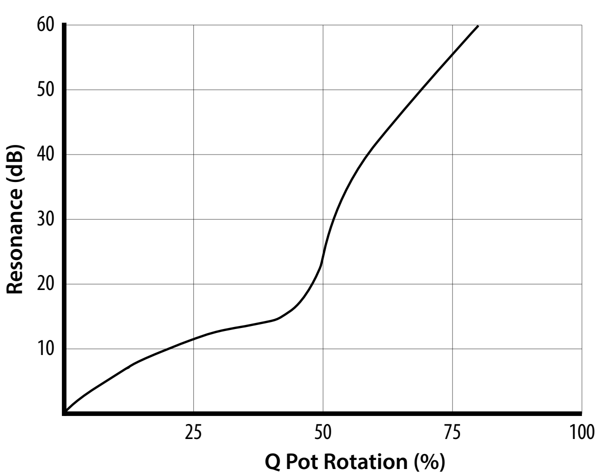

Figure 6: Q Response Using "Reverse Audio" Pot

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