

### General Description

The V2044A improves on ladder filter topology allowing rich tonal features that display the best attributes of subtraction synthesis. This is one of the best-sounding analog synthesis filter integrated circuits ever produced.

The V2044A has many desirable characteristics, such as at least 10,000 to 1 sweep range, on-chip control of resonance, differential input, high control suppression, minimization of external components and retaining excellent acoustic characteristics. At the same time, V2044A has made many improvements, for example, running on a power supply as low as  $\pm 4$  V, reducing noise, improved control feedthrough, and more consistent unit-to-unit performance.

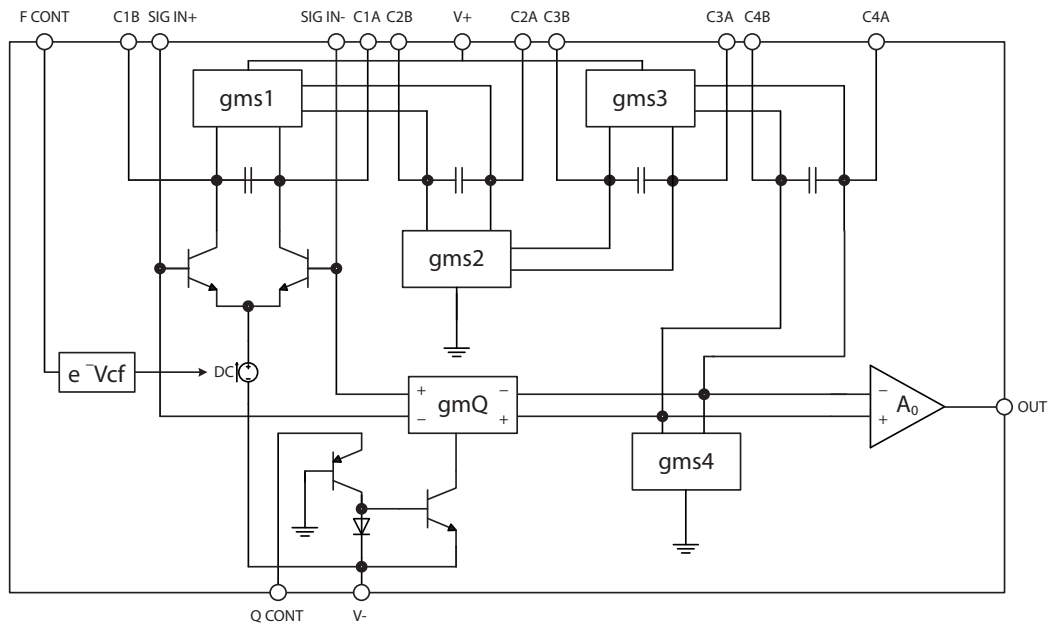
### Features

- Excellent acoustic characteristics
- On-chip resonance circuit improved for more consistent control and performance
- Operating Voltage +4 V to +16 V
- Same pinout as the original IC
- Differential Inputs
- Sweep range up to 1-20000
- Low Feedthrough on both control ports
- SOP 16-pin package with minimal external components

### Pin Description

No.	Name	Functions Description	No.	Name	Functions Description
1	SIG IN+	Positive signal input	9	V-	Negative supply voltage
2	Q CONT	Q Control Port	10	C2B	Cap2 port B
3	OUT	Signal output	11	C2A	Cap2 port A
4	C4A	Cap4 port A	12	C1B	Cap1 port B
5	C4B	Cap4 port B	13	F CONT	Frequency control port
6	C3A	Cap3 port A	14	C1A	Cap1 port A
7	C3B	Cap3 port B	15	SIG IN-	Negative signal input
8	GND	Ground	16	V+	Positive supply voltage

## Functional Block Diagram



Functional Block (Fig. 1)

## Absolute Maximum Ratings

Description	Value range
Supply Voltage	±18 V
Storage Temperature Range	-65 °C to +150 °C
Operating Temperature Range	-40 °C to +85 °C
Lead Temperature Range (Soldering, 10 sec)	260 °C

**Note:** Stresses greater than those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “Recommended Operating Conditions” is not implied. Exposure to “Absolute Maximum Ratings” for extended periods may affect device reliability.

**Specifications** ( $V_S = \pm 12V$ ,  $T_A = 25^\circ C$ ; using Figure 5 circuit unless otherwise noted)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
<b>Power Supply</b>						
Supply Voltage Range	$V_S$		$\pm 4$		$\pm 16$	V
Supply Current-Positive	$I_{CC}$	$V_{FC}$ and Q CNTRL at ground	4.0	5.0	6.2	mA
Supply Current-Negative	$I_{EE}$	$V_{FC}$ and Q CNTRL at ground	4.2	5.2	6.4	mA
<b>Filter Section</b>						
Frequency Sweep Range			10:000:1	20:000:1		
Frequency Control Sensitivity			-20	-19	-18	mV/oct
Frequency Control Input Bias Current				4	10	$\mu A$
Frequency Control Input Range	$V_{FC}$		-120		+150	mV
Frequency Control Feedthrough		$\pm V_{IN} = GND$ ; $-90\text{ mV} \leq V_{FC} \leq +90\text{ mV}$	-36	-50		dB
Frequency Control Offset Voltage		Untrimmed	-10	0	+10	mV
Maximum Available Control Current		$V_{FC} = -120\text{ mV}$	500	720	1000	$\mu A$
<b>Resonance (Q) Section</b>						
Q Current Input Range	$I_Q$		0		1000	$\mu A$
Q Current at Oscillation		$-90\text{ mV} \leq V_{FC} \leq +90\text{ mV}$	350	400	450	$\mu A$
Q Control Feedthrough		$0 < I_Q < 400\ \mu A$		-40	-20	dB
<b>Signal Inputs</b>						
Input Bias Current	$I_B$	Either Input, $V_{FC} = 0$ , $I_Q = 0$		40	150	nA
Input Signal Range	$V_{IN}$	Clipping		$\pm 50$		mV
<b>Signal Output</b>						
Max. Output Signal Current	$I_{OMAX}$		$\pm 300$	$\pm 400$	$\pm 520$	$\mu A$
Dynamic Range	DR	Noise floor to 1% THD, A Wtd		92		dB
Output Offset	$I_{OS}$	$V_{IN+} = V_{IN-} = V_{FC} = 0$ , $I_Q = 0$		10	55	$\mu A$

## Functional Description

### 1. Signal Inputs

Figure 5 shows typical connection of the V2044A as a four-pole low-pass filter in electronic music systems. Differential inputs allow the convenience of directly connecting two oscillators. To prevent cancellation of in-phase signals, a 3 dB attenuation of the SIG IN- input is accomplished using the resistor values shown. If only one input is needed, the unused input pin should be connected to ground via a 200 resistor.

The V2044A differential input signal level is nominally  $\pm 20$  mV and clips at  $\pm 50$  mV. The resistor values in Figure 5 result in  $\pm 7$  V being the nominal input signal level.

### 2. 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 13) 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 typical application circuit,  $\pm 90$  mV at the Frequency Control pin corresponds to a 1000:1 sweep range using  $\pm 12$  V supplies.

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

### 3. Resonance (Q) Control

The Q Control (pin 2) is a current input summing node. Minimum resonance occurs at zero current. Oscillation will occur when current into the Q Control reaches approximately 400  $\mu$ A, equating to 10.8 V using the resistor value of 27 k $\Omega$  in the typical application circuit.

Due to response of the Q circuit (see Figure 4), the ideal potentiometer feel is achieved with a "reverse audio taper" (90% at 50% rotation)

If accurate musical intervals during oscillation are desired, the V/OCT trim and a temperature compensating resistor are necessary. If such intervals aren't important, substitute 1% 187 k $\Omega$  in the Control Summer feedback network and 1% 1 k $\Omega$  in place of the temperature compensating resistor. The temperature compensating resistor should be physically as close to the V2044A as possible to maintain good thermal coupling.

### 4. Signal Output

The output of V2044A is directly connected to the inverted input of a TL072. The signal passes through the TL072, and the output waveform is obtained from the TL072 output.

## V2044A Filter Characteristics

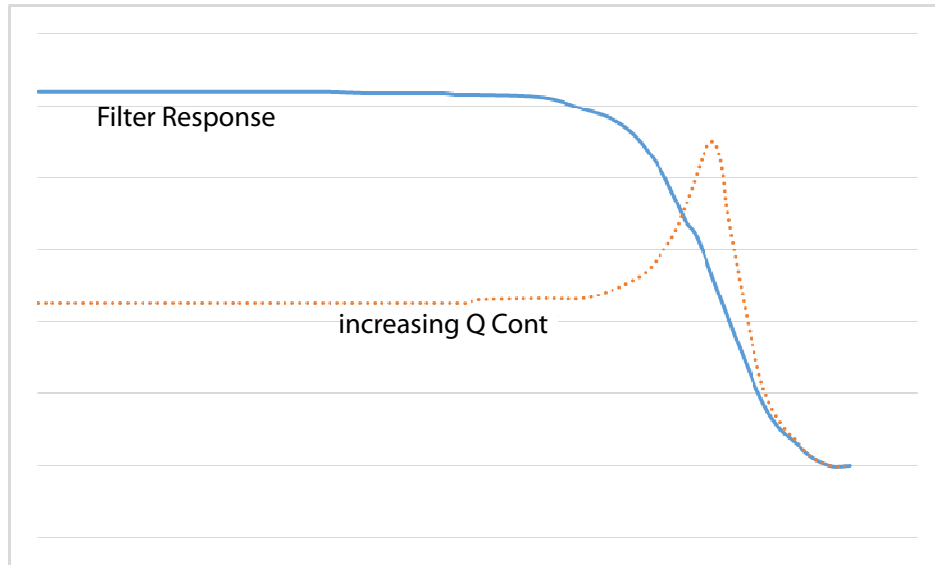
Figures 2 and 3 show the behavior of the V2044A filter. Figure 2 shows the Q-control set at minimum resonance (solid line), the filter consists of four individual poles, each of which produces 3 dB attenuation at the cutoff frequency. As voltage is applied to the Fc input, cutoff frequency will vary exponentially in response to the control voltage.

The Q circuit provides negative feedback around the filter. As the 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 2. At higher frequencies, an approximate 24 dB/octave roll off will be maintained.

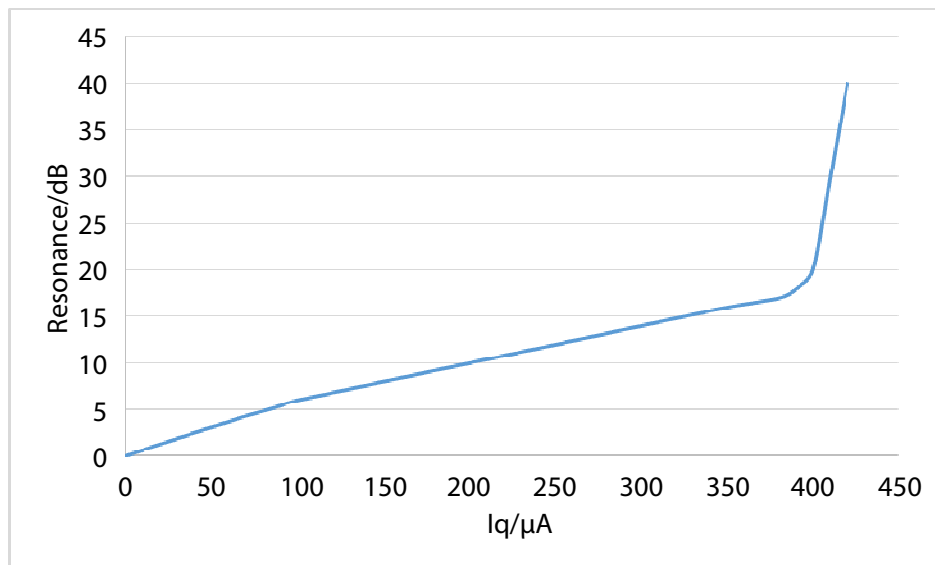
When feedback exceeds 12 dB, loop gain at cutoff exceeds unity and the filter oscillates with a pure sinewave at the cutoff frequency. This waveform can therefore become a very useful tone source in electronic music systems.

The V2044A 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.

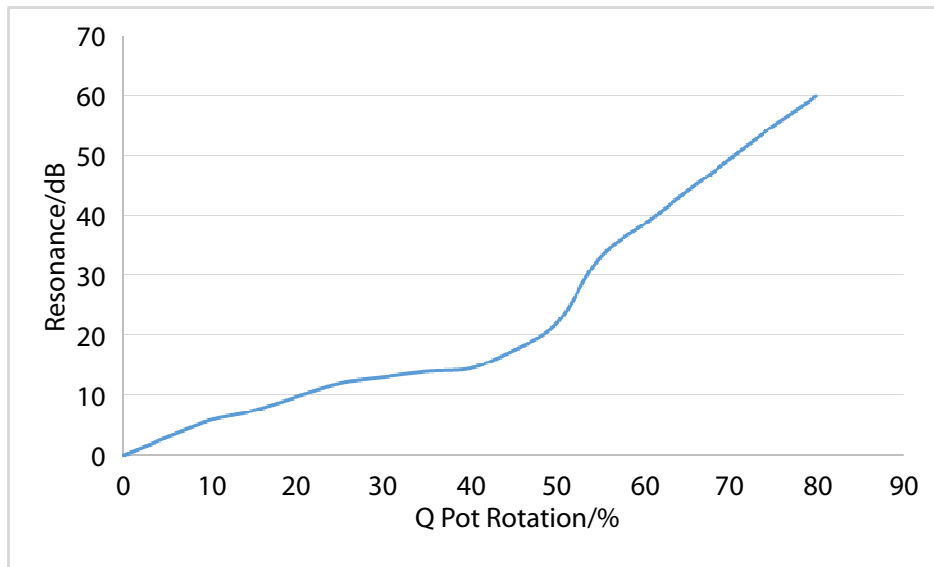
Figure 3 shows resonance, measured as the height of the resonant peak above the low frequency gain, as a function of Q Control current. Note that the slope is more flat at lower current, then increases rapidly as oscillation is approached. Figure 4 shows the corrected response; the rightmost portion of the rotation represents the region of oscillation.



Filter and Q Response (Fig. 2)



Resonance Peak Height vs. Q Current (Fig. 3)



Q Response Using "Reverse Audio" Pot (Fig. 4)

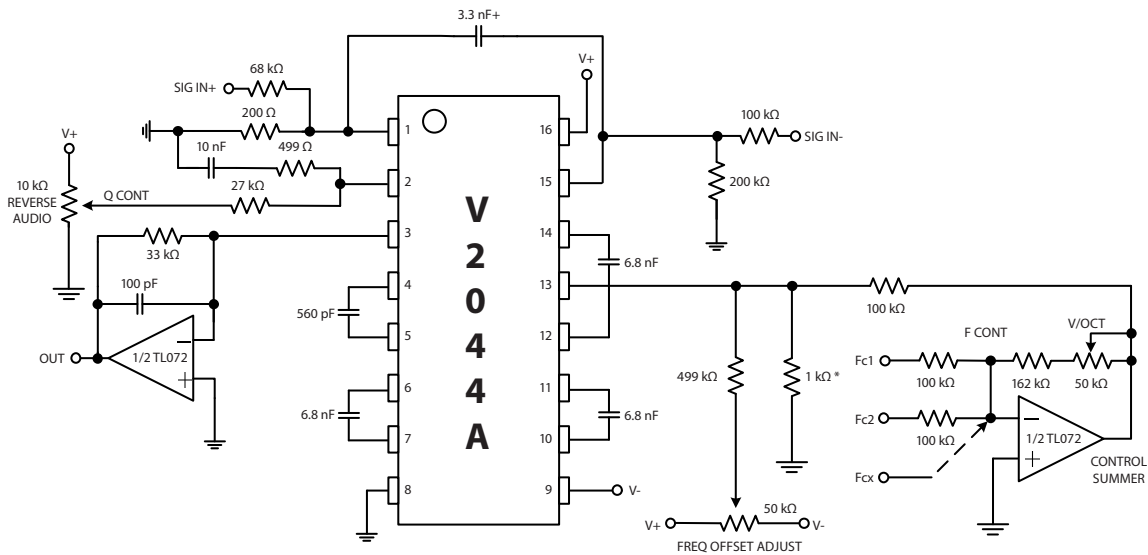
## Typical Application Circuit

**NOTES:**

All resistors are 1% and capacitors 5% C0G

\*Optional 3300 ppm/°C temperature-compensating resistor - see text

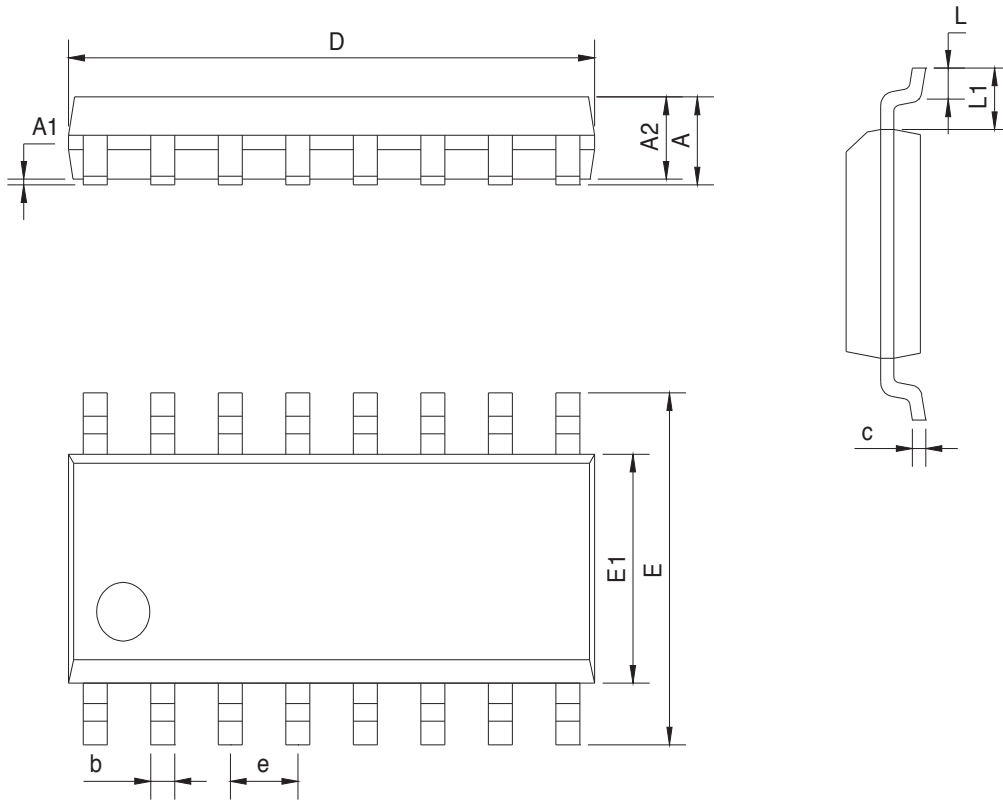
+Optional - improves Q stability and amplitude over frequency sweep



Typical Application Circuit (Fig. 5)

## Package Information

### SOP 16



SYMBOL	mm	
	min	max
A		1.75
A1	0.05	0.23
A2	1.30	1.50
b	0.35	0.45
c	0.18	0.25
D	9.70	10.10
E	5.80	6.20
E1	3.70	4.10
e	1.27BSC	
L	0.40	0.80
L1	1.05BSC	