coolaudio V3320 Voltage Controlled Filter User Guide

Voltage Controlled Filter
V3320

Contents

Overview

The V3320 is a high-performance voltage-controlled four-pole filter with voltage controllable resonance. A wide variety of filter responses, such as low pass, high pass, bandpass, and all pass can be achieved by connecting the four independent sections. A single input exponentially controls the frequency over greater than a ten-octave range with little control voltage feed-through. Another input controls the resonance from zero to low distortion oscillation in a manner of modified linearity.
Every filter section includes a novel variable gain cell and a buffer. The variable gain cell features a better signal-to-noise ratio and low distortion.

Features

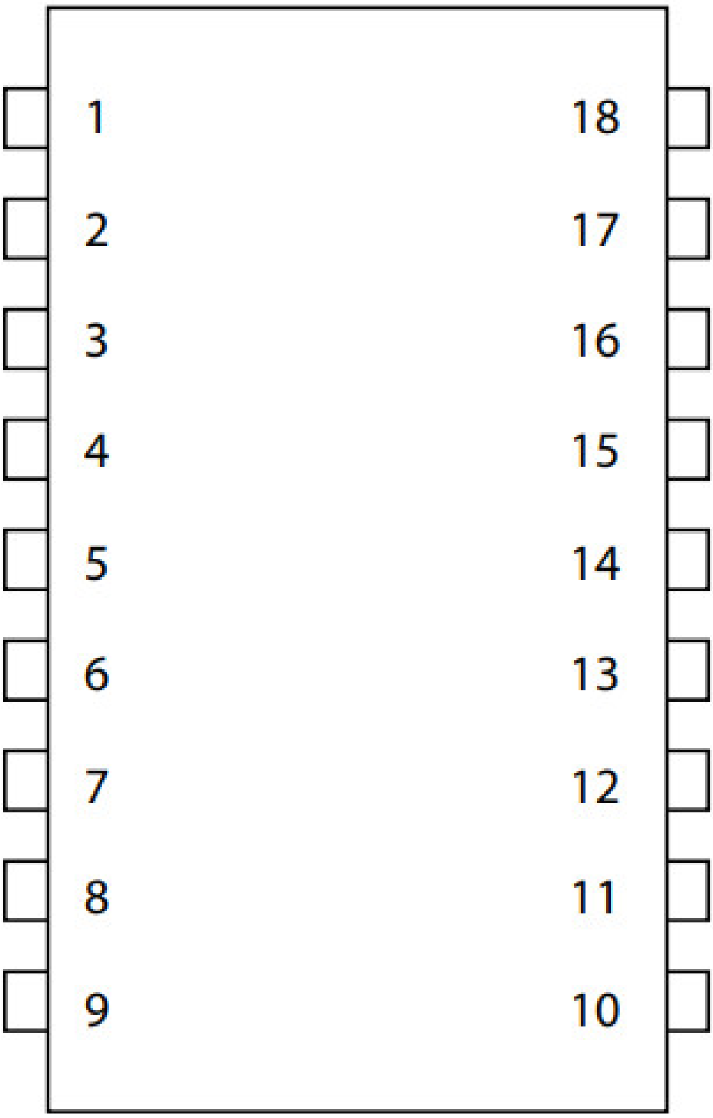
- ±15V Volt Supplies
- Low Cost
- Voltage Controllable Frequency: 12-octave range minimum

- Accurate Exponential Frequency Scale
- Accurate Linear Resonance Scale
- Low Control Voltage Feedthrough: -45 dB typical
- Filter Configurable into the low pass, high pass, all pass, etc
- Large Output: .12 V.P.P. typical
- Low Noise: -86dB typical
- Low Distortion in Passband: 0.1% typical
- Low Warm-Up Drift
- Configurable into Low Distortion Voltage Controlled Sine Wave Oscillator

Pin configuration

	SOP18L	
IN1		IN4
IN2		IN3
GND		OUT3
OUT2		BOUT3
OUT1		VCC
BOUT2		VSS
BOUT1		FCIN
GM-IN		OUT4

RCIN		BOU T4



Typical Ap

- Voltage

PIN Description

No.	Name	Functions Description	No.	Name	Functions Description
1	IN1	First Gain Cell Input	10	BOUT4	Fourth Buffer Output
2	IN2	Second Gain Cell Input	11	OUT4	Fourth Gain Cell Output
3	GND	GND	12	FCIN	Frequency Cntl Input
4	OUT2	Second Gain Cell Output	13	VSS	Negative Voltage
5	OUT1	First Gain Cell Output	14	VCC	Positive Voltage
6	BOUT2	Second Buffer Output	15	BOUT3	Third Buffer Output
7	BOUT1	First Buffer Output	16	OUT3	Third Gain Cell Output
8	GM-IN	GM Input	17	IN3	Third Gain Cell Input
9	RCIN	Resonance Cntl Input	18	IN4	Fourth Gain Cell Input

Functional Block Diagram

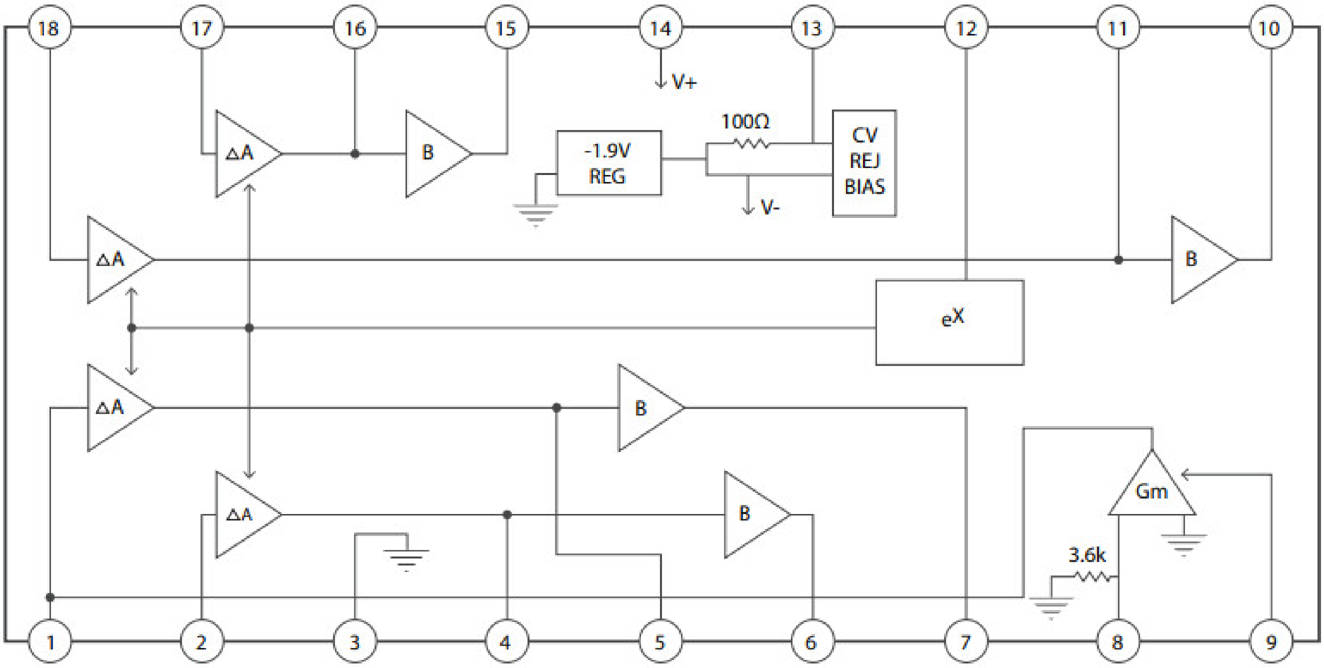


Figure 1. Functional Block

Absolute Maximum Ratings

Description	Symbol	Value range	Unit
Voltage Between VCC and VEE	VVCC-VEE	–0.5~+22	V
Voltage Between VCC and Ground	VVCC-GND	-0.5-+18	V
Voltage Between VEE and Ground	VVEE GND	-4-+0.5	V
Voltage Between Frequency Control and Gro und	Wreq Cntl- GND	-6-+6	V
Voltage Between Resonance Control and Gr ound	VRes Cntl-GND	—18-4-2	V
Current Through Any Pin	I	-40-+40	mA
Storage Temperature Range	TSTG	-55-+150	°C
Operating Free-air Temperature Range	TA	-25-+75	°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.

Electrical Characteristics

(VCC = 15 V, RF = 100 K. A current limiting resistor is connected between -15 V and VSS, TA = +20 °C. Actual circuit connection sees typical application circuit, unless otherwise noted)

Parameter	Symbol	Test Condition	Min.	Typ.	Max.	Unit
Pole Frequency Control Range	pfc	—	3500:01:00	10000:01:00	—	Hz
Positive Supply Voltage Range	VCC	—	9	—	18	V
Negative Supply Voltage Range	VSS	Current limiting resistor always required	-4	—	-18	V
Positive Supply Current	I've	—	4.	5	7.	mA
Sensitivity of Pole Frequency Contro l Range Scale, Mid range	S-Fp	—	58.	60	63.	mv/decad e
Tempco of Pole Frequency Contro l Range Scale	TEMP-Fp	—	3000	3300	3500	ppm
Exponential Error of Pole Frequency Control Range Sc ale	ER,	-25mV<Vc<155 mV	—	4	12	%
Gain of Variable Gain Cell	Gain	Vc=OV	0.7	0.9	1.	—
Max Gain of Varia ble Gain Cell	Gain-MAX	—	2.	3	4.	—
Tempco of Variabl e Gain Cell	TEMP-Ganca	Vc=OV		500	1500	ppm
Output Impendence of Gain Cell	RO-GainCell	Vc=OV	0.5	1	2	MO
Pole Frequency Control Feed-thro ugh	WEED-FP	—	—	60	200	mV
Pole Frequency Warm-up Drift	Drift-„	-25°C<TA<75°C	—	0.5	2.	96
Gm of Resonance control Element	Gm-Ris	Iok=100uA	0.8	1	1.	mmhos

Amount of Resonance Obtainable Before Oscillation	Amount-Fes	—	20	30	—	dB
Resonance Contr ol Feed-through	VFEED-RES	0<lat<100UA	—	0.2	2.	V
Output Swing At Clipping	Output Swing	—	10	12	14	V.P.P
Output Noise re Max Output	/ V P P VN..	Low Pass and 2 0 Khz cut-off frequency	-76	-86	—	dB
Rejection in Band-reject	REJ-BANDR oca	—	73	83	—	dB
Distortion in Pass-band	THD- mssemo	Output Signal is 3 dB below clippi ng point and Dis tortion is predom inantly second h armonic	—	0.1	0.3	96
Distortion in Band-reject	THD-SAMDR EIET	Output Signal is 6 dB below clippi ng point and Dis tortion is predom inantly second h armonic	—	0.3	1	%
Distortion of Sine Wave Oscillation	THD-98,	Sinewave is not clipped by first st age	—	0.5	2.	96
Internal Reference Current	IKF	—	45	63	85	uA
Input Bias Current of Frequency Control Input	181M-FON	FCIN=OV	0.2	0.5	2.	uA
Input Impedance to Resonance Signal Input	Rin-,”	IAciti=150uA	3.	4.	5.	KO
Buffer Slew Rate	SlhuFFER	—	2.	3	–	V/us
Buffer Input Bias Current	WS-BUM*	IEE=8mA	±8	±30	±100	nA

Buffer Sink Capab ility	I-seoc	—	0.4	0.5	0.63	mA
Buffer Output Impedance	Ro-ellirut	Vc=0V	75	100	200	0

Functional Description

1. Supplies

   A shunt regulator is built-in to regulate the negative supply at -1.9 volts. The shunt regulator can reduce the warm-up drift of the pole frequencies, at the same time, any negative supply greater than -4 volts can be used with the current limiting resistor. The value of the current limiting resistor is given by the following expression:

$$R_{EE} = \frac{V_{SS} - 2.7\ V}{0.008}$$

   Any positive supply between 9 volts and 18 volts can be applied to pin 14, but this will affect the output swing. The maximum possible peak to peak output swing is given by:

$$V_{OUT}\ (V.P.P.) = V_{CC} - 3\ V$$

2. **Operation of Each Filter stage**

   Each filter section contains a variable gain cell and a high impedance buffer. The variable gain cell is a current-in, the current-out device, the output current IOUT is calculated as follows:

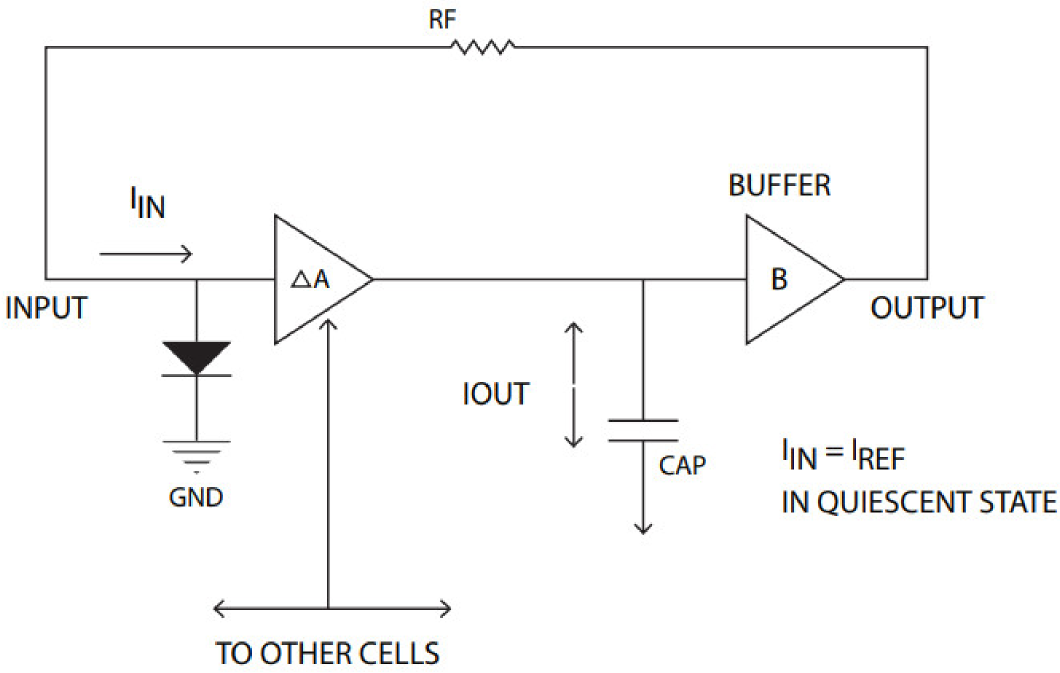
$$I_{OUT} = (I_{REF} - I_{IN})\ A_{10}e^{-V_C/V_T}$$

   Where VT = KT/q, VC is the voltage applied to pin 12, and AIO is the current gain of the cell at VC = 0, the IREF is given

$$I_{REF} = \frac{0.46V_{CC} - 0.65\ V}{100K}$$

   For normal operation of any filter type, each stage is set up with a feedback resistor and a pole capacitor.

   The feedback resistor, RF, is connected between variable gain cell input and buffer output, and the pole capacitor, CP, is connected to the output of the variable gain cell. Figure2 shows this setup, the output of the buffer will always adjust itself so that a current equal to IREF flows into the input.



The quiescent output voltage of each buffer, VODC, should be set to 0.46VCC for the lowest control voltage feed-through and maximum peak-to-peak output signal, so the RF in Figure2 can be calculated as follows:

$$R_F = \frac{V_{ODC} - 0.65\ V}{I_{REF}} = 100\ K\ \text{nominal}$$

The output impedance of the variable gain cell has reflected in the input as an A.C. resistance (nominally 1M) in parral with the feedback resistor regardless of the control voltage value. The total equivalent feedback resistance, REQ, determines the pole frequency of each filter section.

$$R_{EQ} = \frac{R_F * 1\ M\Omega}{F_R + 1\ M\Omega}$$

And

$$f_p = \frac{A_{IO}}{2\pi R_{EQ} C_p}\ e^{-V_c/V_T}$$

3. **Pole Frequency Control**

The voltage applied to pin 12 controls the current gain of each filter section because the exponential scale needs to meet the standard 18 mV/octave(60 mV/decade), an input attenuator network may be required in most case.

An increasing positive control voltage will cause a drop of the pole frequency. If you want to get a thousand-to-one control range, the voltage applied to pin 12 should be maintained between -25 mV and 155 mV.

4. **Resonance Control**

The traditional transconductance type of amplifier can control the amount of resonance. Pin 8 is a separate signal voltage input and pin 9 is a separate control current input with a modified linear scale. The current output of the amplifier is internally connected to the input of stage one. The input impedance of the amplifier is 3.6 K ±900 Ω, and the input refers to ground, so a coupling capacitor is needed to be connected to the filter output.

Control of the transconductance is accomplished with current input. Since the control input is a low impedance summing node, which is a potential near ground, the control current may be derived by an input resistor, RRC, from the resonance control voltage, at the same time, this resistor should meet the requirement that the maximum available resonance control voltage produces the maximum desired control current.

5. **Stage Buffers**

   For any sections, each buffer can source up to 10 mA and sink a nominal 500 uA, when any D.C. load greater than ±200 us to ±300 uA, the performance of the filter will drop, especially the loads on each buffer differ by more than this amount, so the maximum recommended D.C. loads are 1 mA source, 250 uA sink, and a 150 uA load difference between buffers. The maximum recommended A.C. loads are ±250 uA.

   The D.C. level of the filter output has been set to 0.46VCC (6.9 volts for VCC = 15 V), the coupling capacitor will be needed at the filter output or the following input of the device.

6. **Filter Responses**

   In the typical application circuit, Figures 3, 4, 5, and 6 show four filter responses: low pass, high pass, bandpass, and all pass. All filter responses have the function of voltage-controlled resonance, Since the configuration of the resonance feedback, the resonance frequency of the high pass will be about 2.4 times higher than low pass, however, the resonance frequency of the bandpass and all pass will be 0.42 times lower than the low pass.

Typical Application Circuit

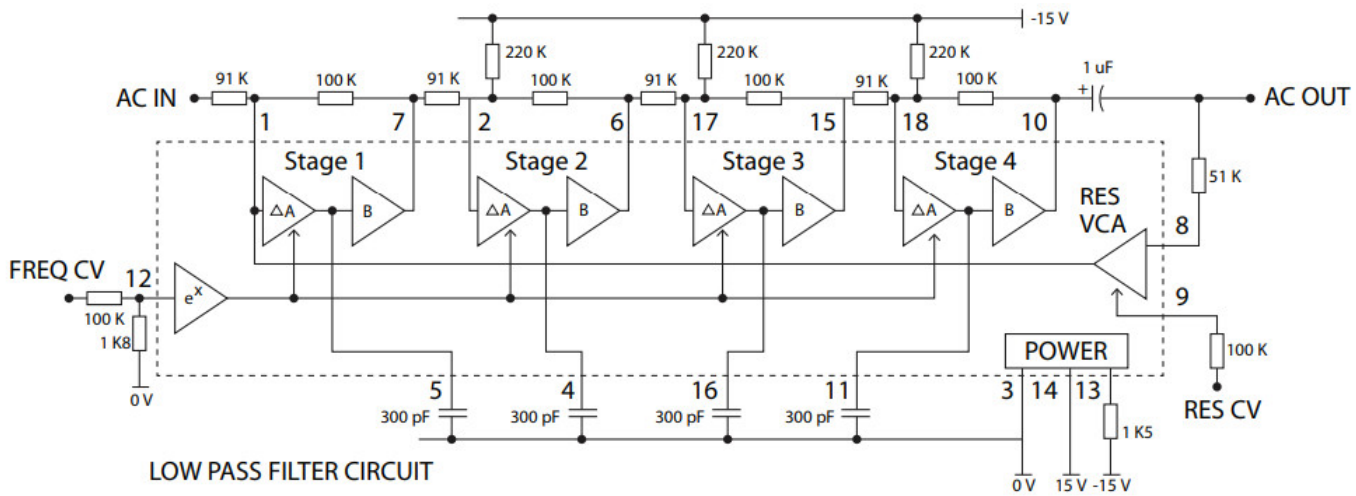


Figure 3. Low Pass Filter Circuit

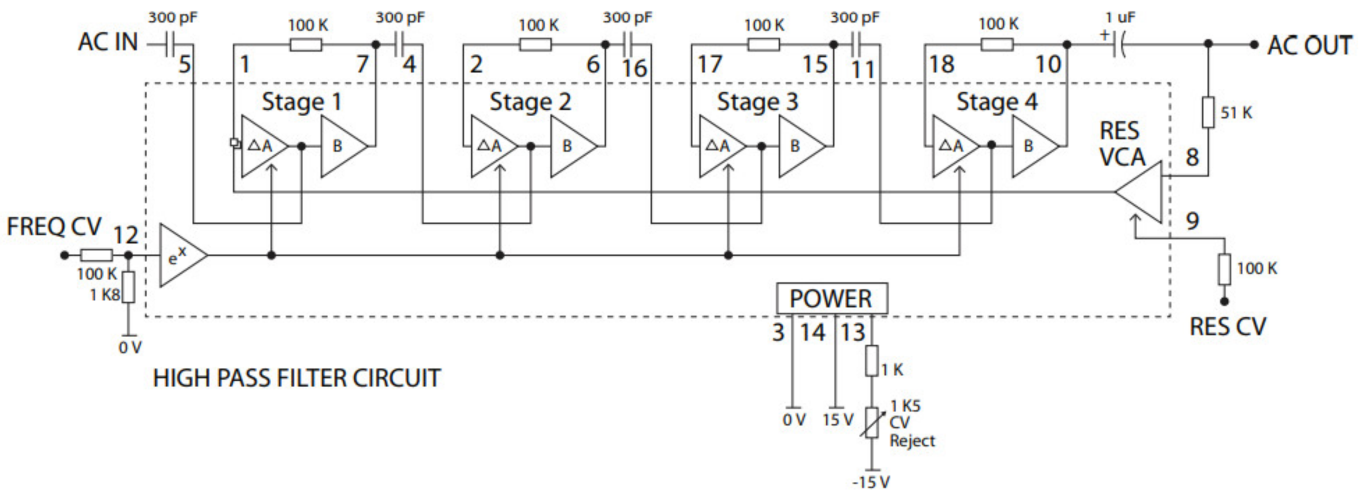


Figure 4. High Pass Filter Circuit

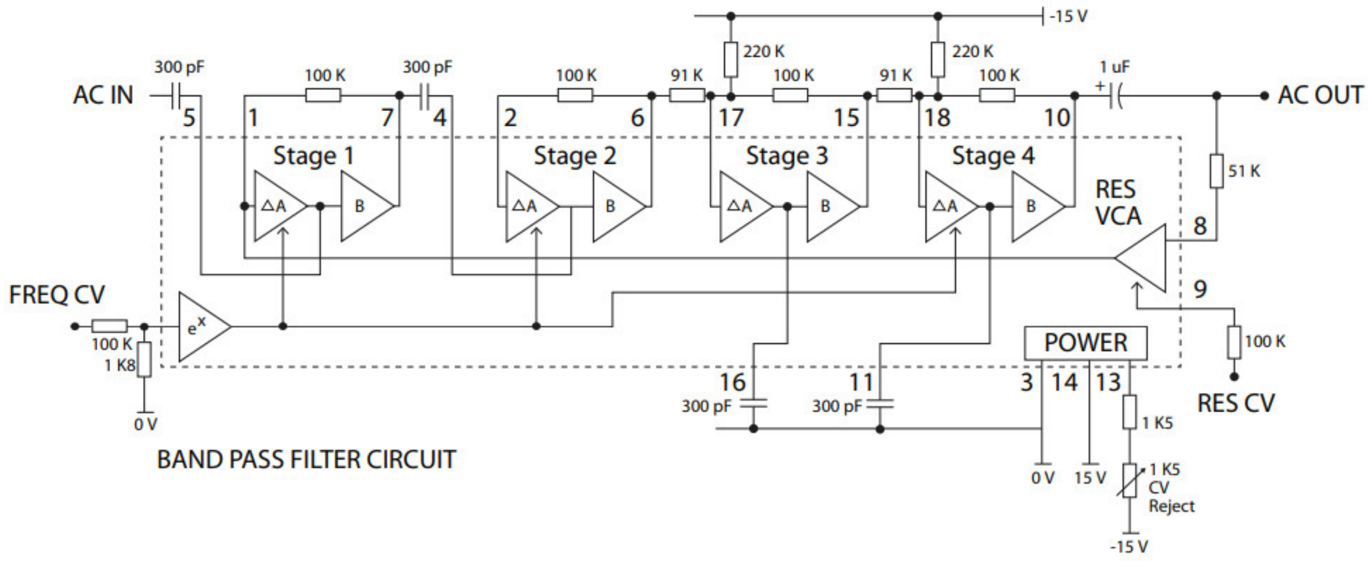


Figure 5. Band Pass Filter Circuit

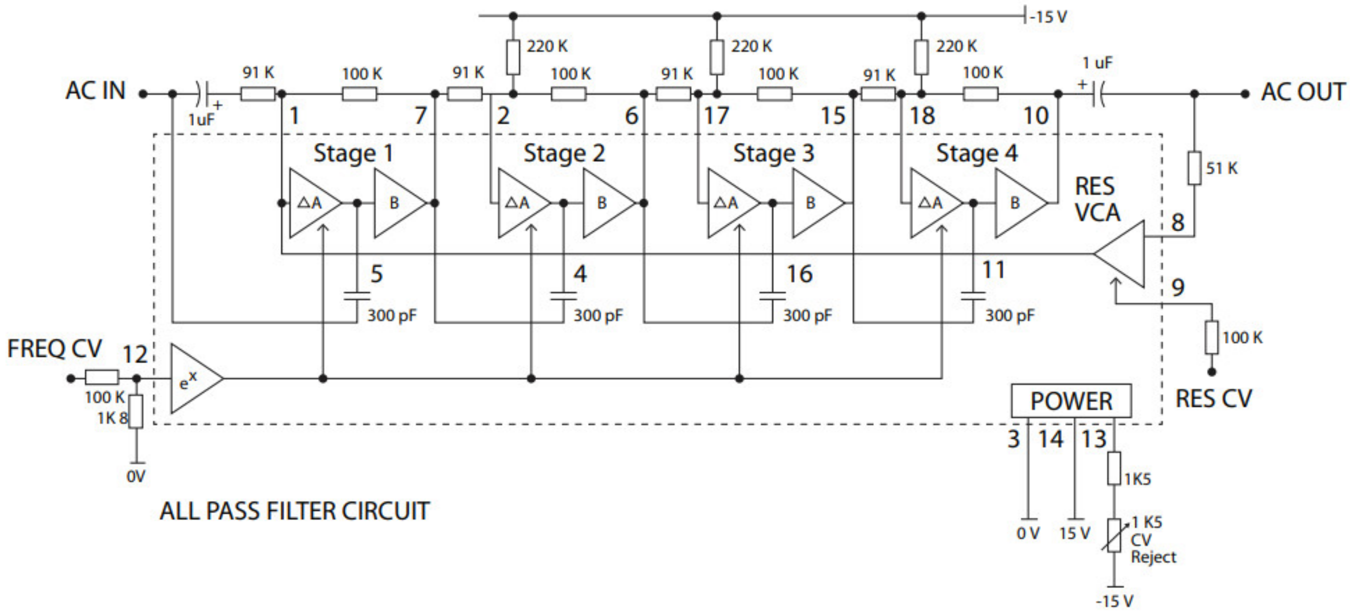
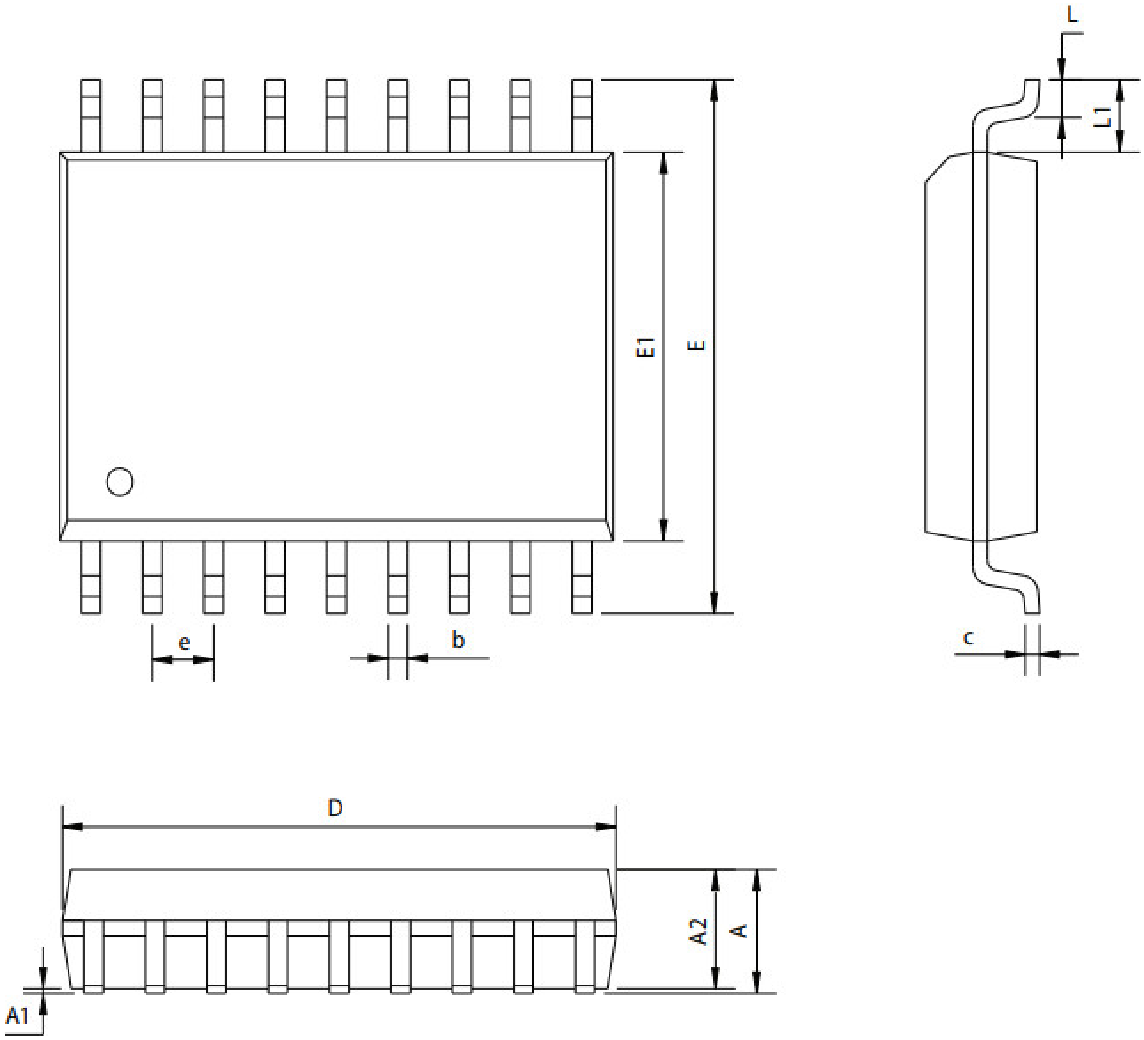


Figure 6. All Pass Filter Circuit

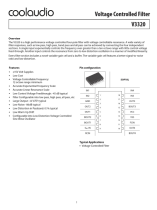
Package Information

SOP18L



SYMBOL	mm	
	min	max
A	—	2.65
AI	0.10	0.30
A2	2.20	2.40
b	0.35	0.45
c	0.20	0.30
D	11.25	12.
E	10.10	10.50
EI	7.30	7.70
e	1.27BSC	
L	0.50	1.00
LI	1.40BSC	

Documents / Resources

	**coolaudio V3320 Voltage Controlled Filter** [pdf] User Guide V3320, Voltage Controlled Filter