coolaudio

Voltage Controlled Operational Amplifier

V662A

The V662A is a dual low-noise, low-offset programmable operational amplifier. Offering a superb linearity over a broad range, this IC is designed so that the forward direction conductivity (g_m) can be changed; making it ideal for applications such as voltage control amplifiers (VCA), voltage control filters (VCF) and voltage control oscillators (VCO).

The open loop gain is determined by the control current and an attached gain determining resistance R_L, enabling a wide range of settings.

In addition, a built-in low-impedance output buffer circuit reduces the number of attachments.

- **Applications**

  Electronic Volume Controls
  Voltage-Controlled Impedances (VCI)
  Voltage-Controlled Amplifiers (VCA)
  Voltage-Controlled Filters (VCF)
  Voltage-Controlled Oscillators (VCO)
  Multipliers
  Sample Holds
  Schmitt Triggers

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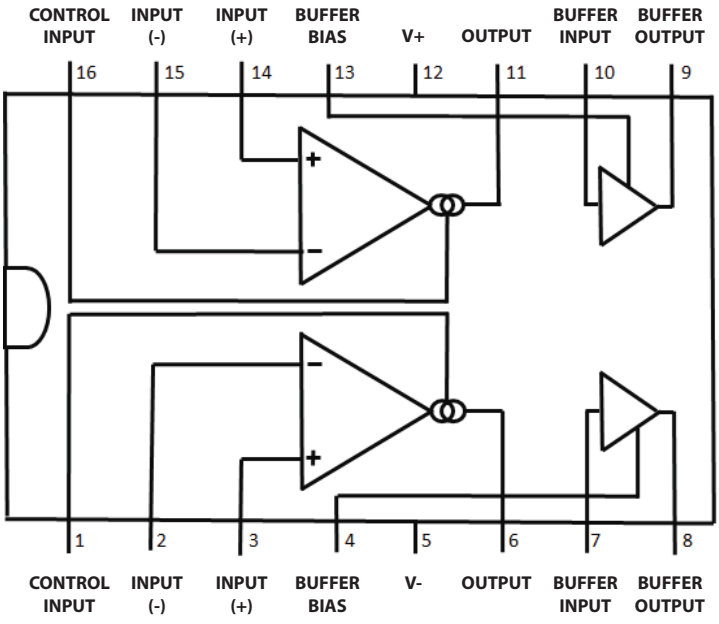
- **Features**

1) Low distortion at nominal signal levels, excellent overload characteristics at higher levels
2) Low noise
3) Low input offset voltage (3 mV max)
4) Built-in output buffer
5) Variable g_m with superb linearity across three decade fields

Block Diagram and Pin Description

SMALL OUTLINE PACKAGE



Absolute Maximum Ratings (Ta = 25°C)

Parameter		Symbol	Limits	Unit
Power supply voltage		V_{cc}	34	V
Power dissipation	V662A	P_d	*300	mW
Operation temparature		T_{opr}	-20~70	°C
Storage temperature		T_{stg}	-55~125	°C
Maximum control current		$I_{c\,Max}$	650	μ A

* Reduced by 3 mW for each increase in Ta of 1°C for each 25°C

Electrical Characteristics (Unless Otherwise Noted, Ta= 25°C, V_{CC} = 15 V, V_{EE} = -15 V)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions	Measurement Circuit
Quiescent current	I_o	0.9	3.0	6.0	mA	$I_{CONTROL}$ = 0 μ A	Fig.1
Pin 1 bias current	I_{1PIN}	—	0.8	5	μA	—	Fig.1
Distortion	THD	—	0.2	1	%	$I_{CONTROL}$ = 200 μ A, V_I = 5 mVrms	Fig.1
Forward transmission conductance	g_m	4800	8000	12000	μ S	$I_{CONTROL}$ = 500 μ A	Fig.1
Pin 6 maximum output voltage	V_{OM6}	12	14	—	V	$I_{CONTROL}$ = 500 μ A	Fig.1
Pin 8 maximum output voltage	V_{OM8}	9	11	—	V	RL = 47 kΩ	Fig.1
Pin 6 maximum output current	I_{OM6}	300	500	650	μ A	$I_{CONTROL}$ = 500 μ A	Fig.1
Residual noise 1	VN_1	—	-94	-90	dBm	$I_{CONTROL}$ = 0 μ A, BPF (30~320 kHz, 3 dB, 6 dB / Oct)	Fig.1
Residual noise 2	VN_2	—	-74	-66	dBm	$I_{CONTROL}$ = 200 μ A, BPF (30~20 kHz, 3 dB, 6 dB / Oct)	Fig.1
Discontinuous noise	VNP_2	—	10.5	11.5	dB	$I_{CONTROL}$ = 200 μ A, BPF (30~20 kHz, 3 dB, 6 dB / Oct)	Fig.1
Leakage level	L (Leak)	—	-94	-75	dBm	$I_{CONTROL}$ = 0 μ A, V_{IN} = -30 dBm f_{IN} = 20 kHz	Fig.1

Measurement Circuit

*Pin numbers shown in the diagram are for the V662A.

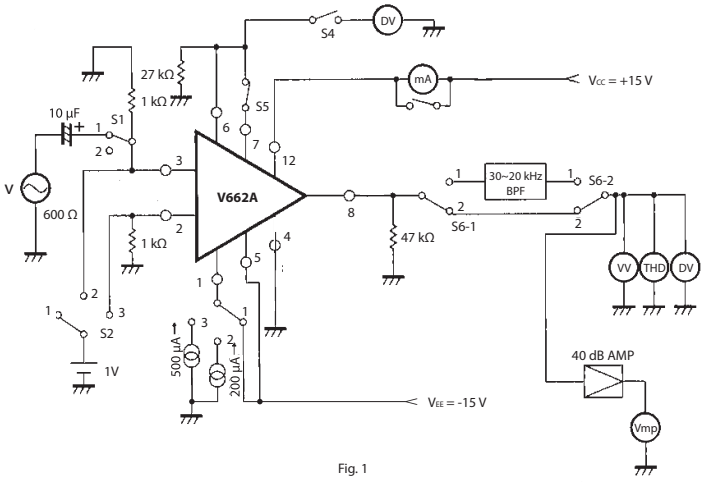


Fig. 1

Circuit Configuration

(reference numbers in the internal circuit configuration diagram are for the V662A)

The V662A is composed of two identical operational amplifiers which can control the forward propagation conductance (g_m) using the control current, a bias setter and an output buffer.

In the operational amplifier, Pin 3 is the positive input and Pin 2 is the negative input. Pin 1 is the control pin which determines the differential current. Pin 6 is the output pin which determines the open loop gain using the external resistor and the control current.

The output current is on Pin 6. An output voltage can be generated using an external resistance. For the open loop gain of this operational amplifier, if the Pin 1 control current is $I_{CONTROL}$ and the Pin 6 external resistance is R_O, then:

$$A\,(v) = g_m \cdot R_O = \frac{I_{CONTROL} \times R_O}{2\frac{KT}{q}}$$

In the buffer circuit, Pin 7 is the buffer input and Pin 8 is the buffer output.

Attachments (Pin Numbers are for the V662A)

1) Positive input (Pin 3)
   This is the differential positive input pin. To minimize the distortion, an input resistor is connected in series with the signal source. By increasing the input resistance, distortion is minimized. However, the degree of improvement for resistances greater than 10 kΩ is about the same. An input resistance of 1 kΩ to 20 kΩ is recommended.

2) Negative input (Pin 2)
   This is the differential negative input pin. It is grounded with roughly the same resistance value as that of the positive input pin. The offset adjustment is also connected to this pin. Make sure a sufficiently high resistance is used, so as not to disturb the balance of the input resistance (see Fig. 3).

Application Examples (Pin Numbers refer to the V662A)

1) Fig. 2 shows a voltage-controlled amplifier (AM modulation) as an example of an application of the V662A.
   By changing the $I_{CONTROL}$ current on Pin 1, the differential gain can be changed. The gain (AV), if the resistance of Pin 6 is R_O, is determined by the following equation:

$$A\,(v) = g_m \cdot R_O = \frac{I_{CONTROL}\,(mA)}{52\,(mV)} \times R_O$$

Good linearity can be achieved when controlling over three decades.

Fig. 3 shows a graph of the control current in relation to the open loop gain.

Fig. 4 shows a graph of the control current in relation to the SN ratio.

Fig. 5 shows a graph of the power supply voltage characteristics.

2) Fig. 6 shows a low pass filter as an example of an application of the V662A.
   The cutoff frequency fo can be altered by changing the Pin 1 control current.
   The cutoff frequency fo is expressed as:

$$fo = \frac{R_A \cdot g_m}{(R + R_A)\,2\,\pi\,C}$$

This is attenuated by -6 dB/OCT.

Fig. 7 shows a graph of the $I_{CONTROL}$ in relation to the output characteristics.

3) Control (Pin 1)
   This pin controls the differential current. By changing the current which flows into this pin, the gain of the differential amplifier can be changed.

4) Output (Pin 6)
The differential amplifier gain (AV) is determined by the resistor R_O connected between the output terminal and the Pin 1 control terminal, as follows:

$$A_v = g_m X R_O = \frac{I_{CONTROL}\ (mA)}{52\ (mV)}\ X\ R_O$$

Make sure the resistor is selected based on the desired maximum output and gain.

5) Buffer Input (Pin 7)
The buffer input consists of the PNP and NPN emitter follower. The bias current is normally about 0.8 µ A. Consequently, when used within a small region of control current, we recommend using the high input impedance FET buffer.

6) Buffer Output Resistance (Pin 8)
An 11 kΩ resistor is connected between V_{CC} and the output within the IC. When adding an external resistance between the GND and the output, make sure the resistor R_L = >33 kΩ.

7) Buffer Bias (Pin 4) For Bi-polar power supplies this pin can be connected directly to ground or via a 100 kΩ resistor for reduced output offset. For single rail power supplies it can be connected to a voltage reference that is around 50% of the supply voltage.

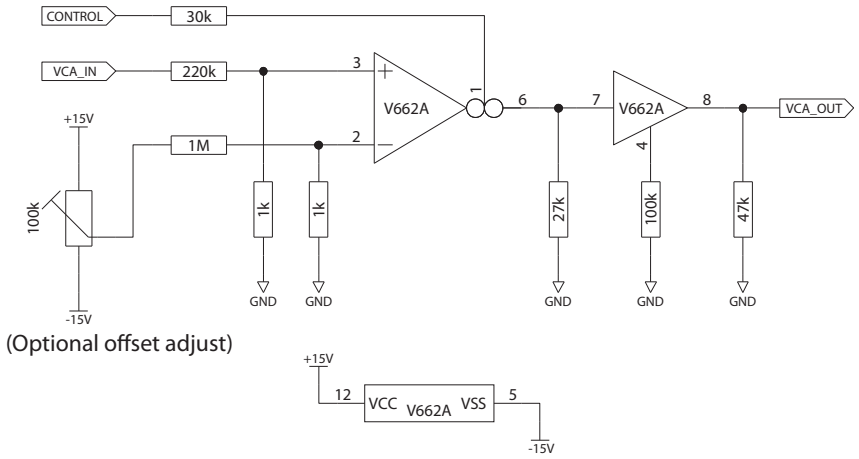


Fig.2 Voltage-controlled amplifier (electronic volume control)

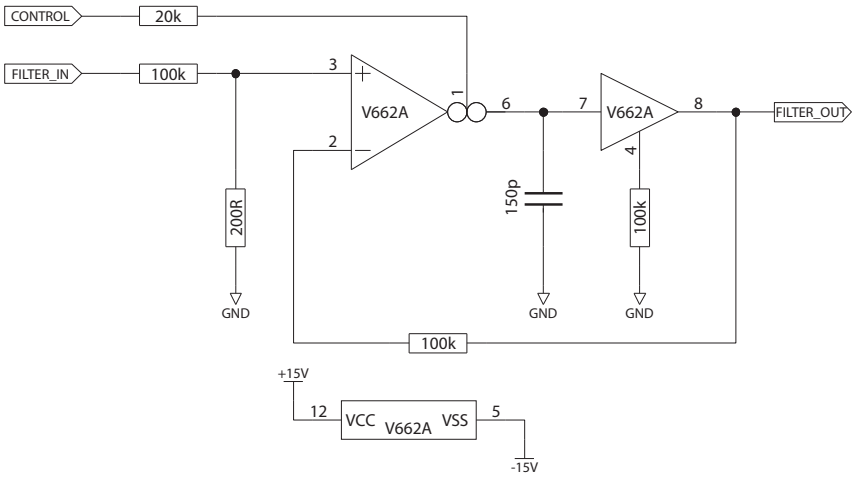


Fig.6 Voltage control low pass filter

Electrical Characteristic Curves

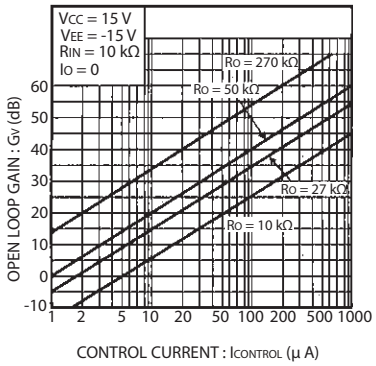


Fig.3 Open loop gain control current characteristic

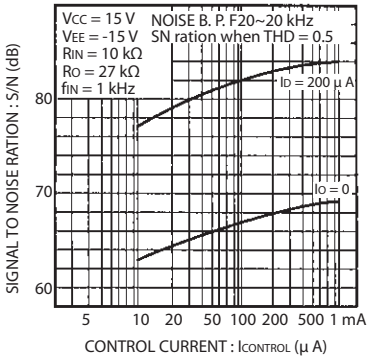


Fig.4 SN ratio - control current characteristic

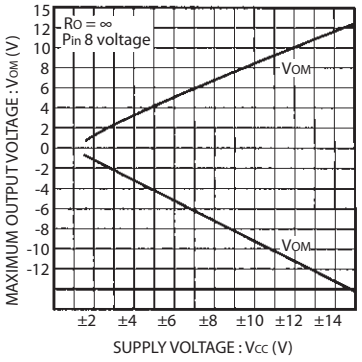


Fig.5 Maximum output voltage - power supply voltage characteristic

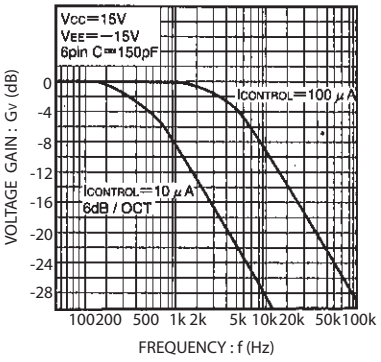


Fig.7 Low pass filter characteristic

Package Dimensions

SOP16