1. Overview

The V2164M/D contains four independent voltage controlled amplifiers(VCAs) in a single package. High performance(100 dB dynamic range, 0.02% THD) is provided at a very low-cost-per-VCA, resulting in excellent value for cost sensitive gain control applications. Each VCA offers current input and output for maximum design flexibility, and a ground referenced –33 mV/dB control port..

The V2164M/D will operate over a wide supply voltage range of ±4 V to ±18 V. Available in 16-pin SOIC packages, the device is guaranteed for operation over the extended industrial temperature range of –40°C to +85°C.

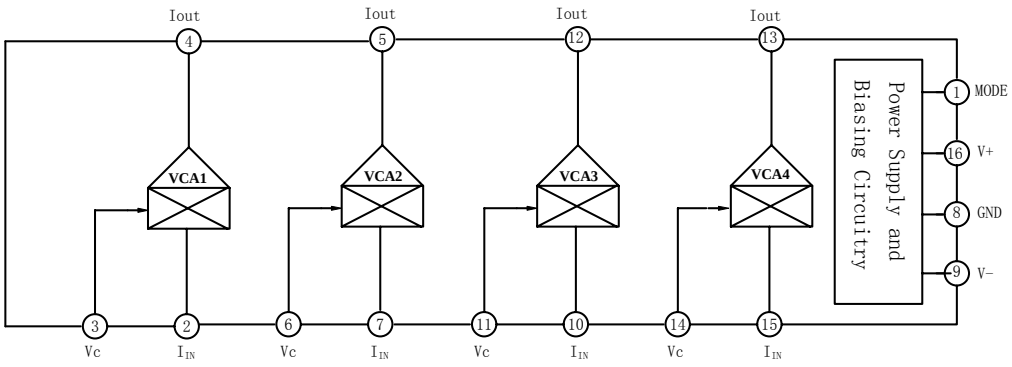
The V2164M/D is available for many applications as Remote, Automatic, or Computer Volume Controls , Automotive Volume / Balance/Faders, Audio Mixers, Compressor / Limiters / Compandors, Noise Reduction Systems, Automatic Gain Controls, Voltage Controlled Filters, Spatial Sound Processors, Effects Processors.

Its features are:

- Four High Performance VCAs in a Single Package
- 0.02% THD
- No External Trimming
- 120 dB Gain Range
- 0.07 dB Gain Matching (Unity Gain)
- Class A or AB Operation

2. Block Diagram and Pin Description

2.1 Block Diagram



2. 2 Pin Description

Pin No.	Symbol	Function	Pin No.	Symbol	Function
1	MODE	Mode select	9	V-	negative power supply
2	I_{IN1}	current input1	10	I_{IN3}	current input 3
3	V_{C1}	voltage controller 1	11	V_{C3}	voltage controller 3

4	I_{OUT1}	current output 1	12	I_{OUT3}	current output 3
5	I_{OUT2}	current output 2	13	I_{OUT4}	current output 4
6	V_{C2}	voltage controller 2	14	V_{C4}	voltage controller 4
7	I_{IN2}	current input 2	15	I_{IN4}	current input 4
8	GND	GND	16	V+	positive power supply

3. Electrical Characteristics

3.1 Absolute Maximum Ratings

Unless otherwise specified, T_{amb}= 25℃

Parameter	Symbol	Value	Unit
Supply voltage	Vcc	±18	V
input, output, control voltages	Vin、Vout、VCA	V- ~ V+	V
Output Short Circuit Duration to GND		Indefinite	S
Storage Temperature Range	Tstg	-65~+150	℃
Operating Temperature Range	Topr	-40~+85	℃
Junction Temperature Range	Tj	-65~+150	℃
Lead Temperature Range (Soldering 60 sec)		+300	℃

3. 2 Electrical Characteristics

Unless otherwise specified, T_{amb} = 25℃， V_{CC}=±15V， A_V=0dB， V_{IN}=0dBμ， R_{IN}=R_{OUT}=30kΩ， f=1kHz， using Typical Application Circuit (Class AB)

Parameter	Symbol	Conditions	Value			Unit
			Min	Typ	Max	
Audio signal path						
Noise	V_{NO}	V_{IN}=GND,BW=20kHz		-94		dBμ
Headroom	Hr	Clip point=1%THD+N		22		dBμ
Total Harmonic Distortion (2nd and 3rd Harmonics Only)	THD	A_V=0dB，Class A		0.02	0.1	%
		A_V=±20dB，Class A[1]		0.15		%
		A_V=0dB，Class AB		0.16		%
		A_V=±20dB，Class AB[1]		0.3		%
Channel Separation	Sep			-110		dB
Unity Gain Bandwidth	GB	C_F=10pF		500		kHz
Slew Rate	S_R	C_F=10pF		0.7		mA/μs
Input Bias Current	I_{IB}			±10		nA
Output Offset Current	I_{IO}	V_{IN}=0		±50		nA
Output Compliance	V_{OD}			±0.1		V
Control port						
Input Impedance	Rin			5		kΩ

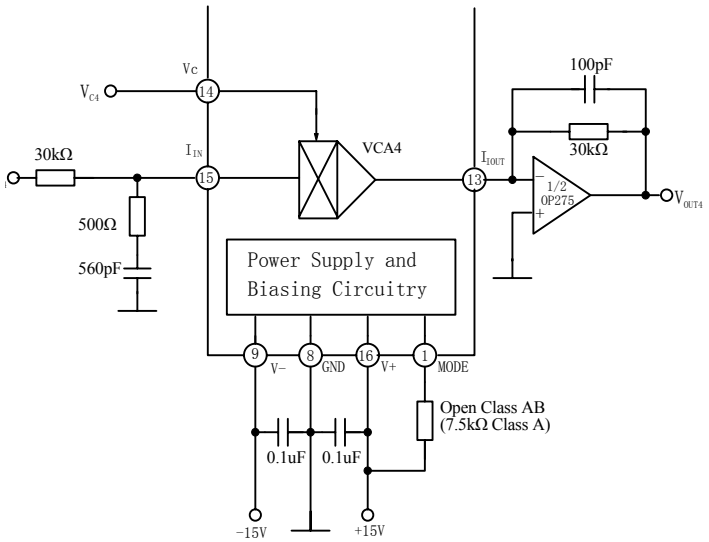
Gain Constant	G_C	（note 2）		-33		mV/dB
Gain Constant Temperature Coefficient	G_{CT}			-3300		ppm/℃
Control Feedthrough	V_{CF}	0dB to -40dB Gain Range[3]		1.5	8.5	mV
Gain Matching, Channel-to-Channel	G_M	A_V=0dB		0.07		dB
		A_V=-40dB		0.24		dB
Maximum Attenuation	G_A			-100		dB
Maximum Gain	G_{MAX}			+20		dB
Power supplies						
Supply Voltage Range	V_{CC}		±4		±18	V
Supply Current	I_{CCQ}	Class AB		6	8	mA
Power Supply Rejection Ratio	PSRR	60Hz		90		dB

Note：1，-10 dBμ input @ 20 dB gain，+10 dBμ input @ -20 dB gain

2，After 60 seconds operation

3，+25℃ to +85℃

4. Test Circuit



5. Characteristics Curve

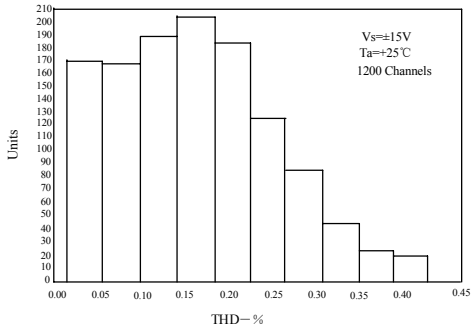


Figure 1 THD Distribution,Class AB

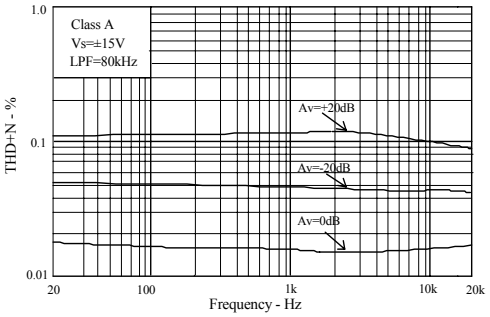


Figure 2 THD+N vs. Frequency，Class A

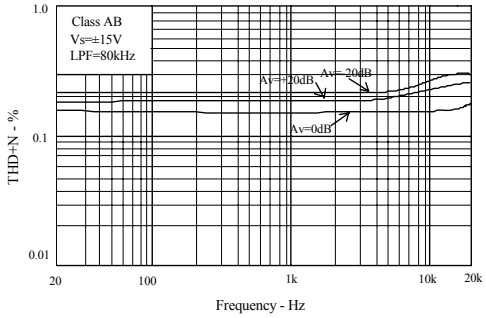


Figure 3 THD+N vs. Frequency，Class AB

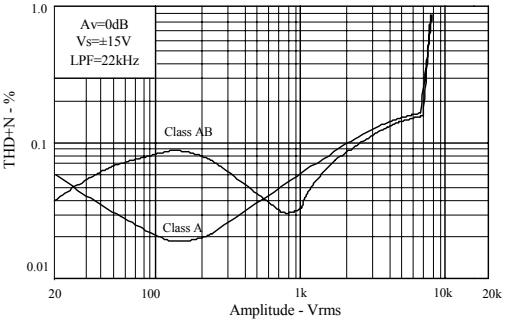


Figure 4 THD+N vs. Amplitude

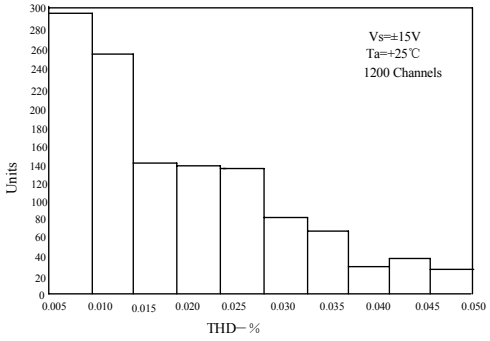


Figure 5 THD Distribution，Class A

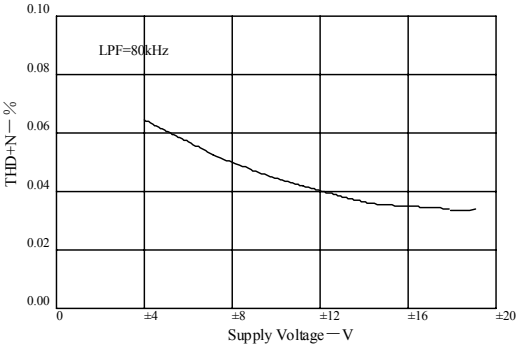


Figure 6 THD+N vs. Supply Voltage，Class A

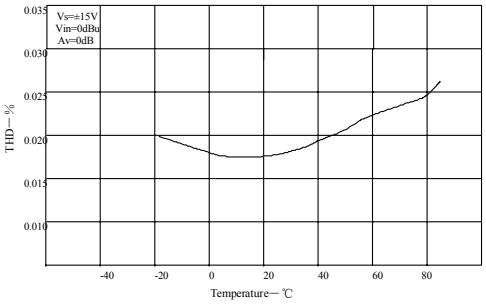


Figure 7 THD vs. Temperature, Class A

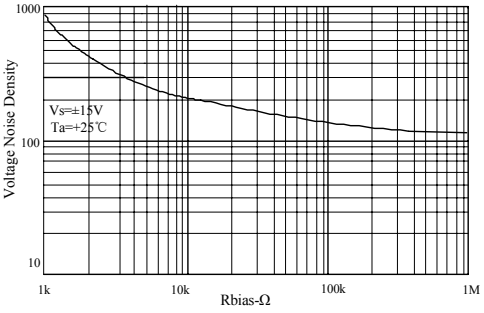


Figure 8 Voltage Noise Density vs. R_{BIAS}

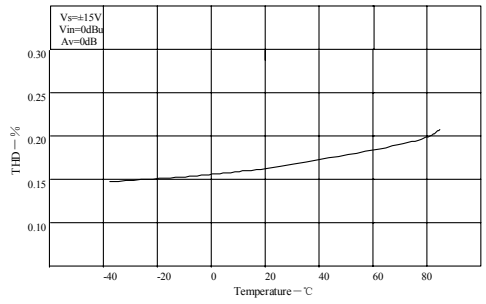


Figure 9 THD vs. temperature, Class AB

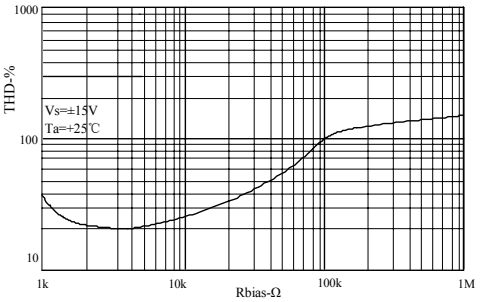


Figure 10 THD vs. R_{BIAS}

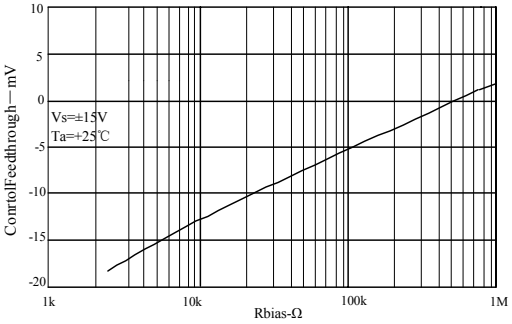


Figure 11 Control Feedthrough vs. R_{BIAS}

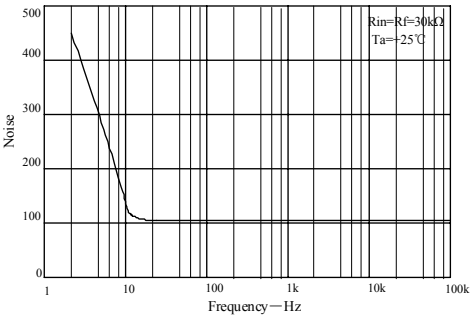
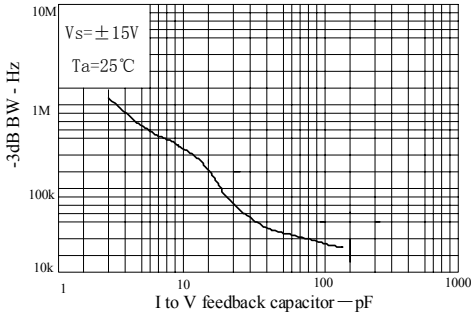


Figure 12 Voltage Noise Density vs. Frequency，Class AB



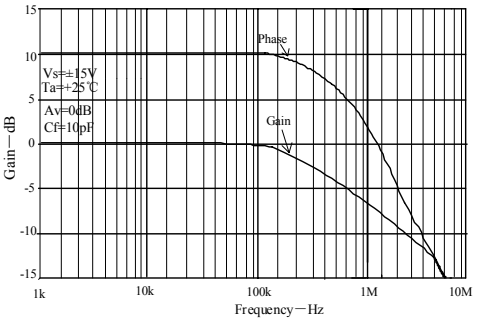
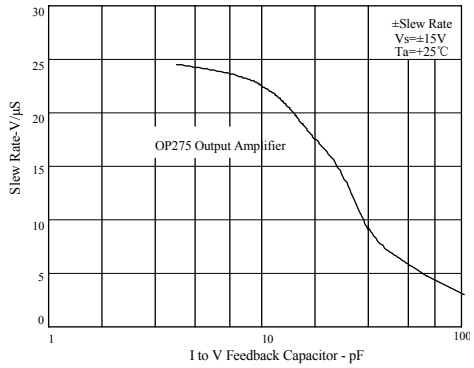


Figure 13 –3 dB Bandwidth vs. I-to-V Feedback Capacitor Figure 14 Gain/Phase vs. Frequency



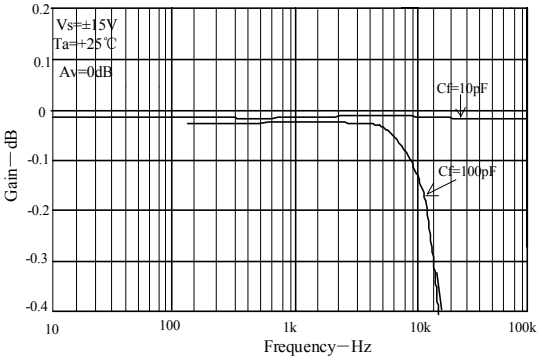


Figure 15 Slew Rate vs. I-to-V Feedback Capacitor Figure 16 Gain Flatness vs. Frequency

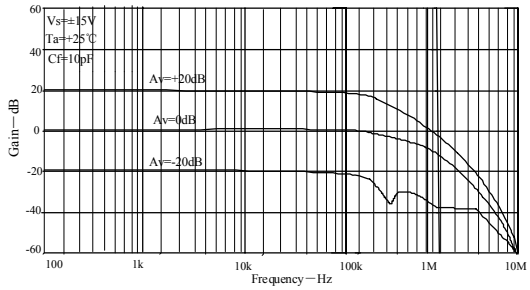


Figure 17 Bandwidth vs. Gain

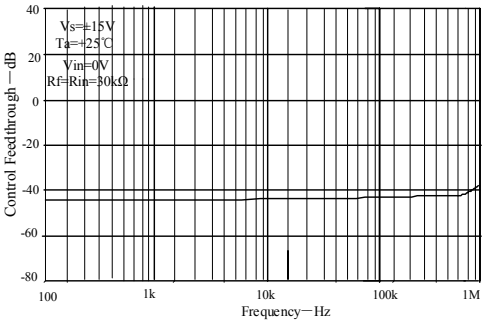


Figure 18 Control Feedthrough vs. Frequency

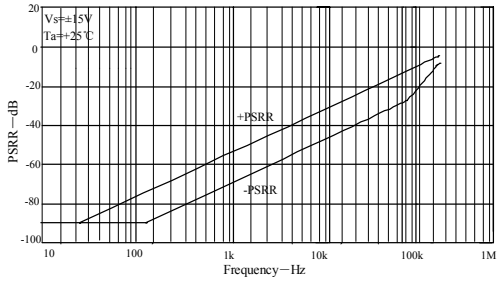


Figure 19 PSRR vs. Frequency

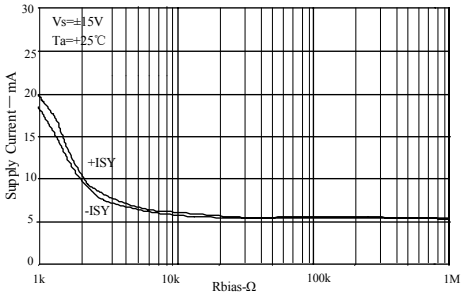


Figure 20 Supply Current vs. R_{BIAS}

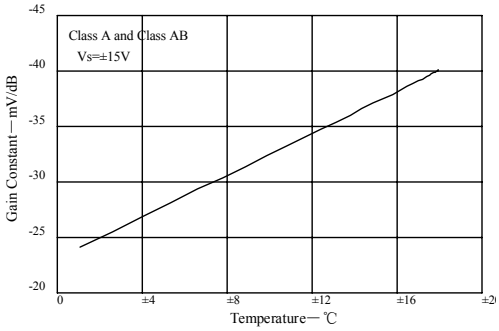
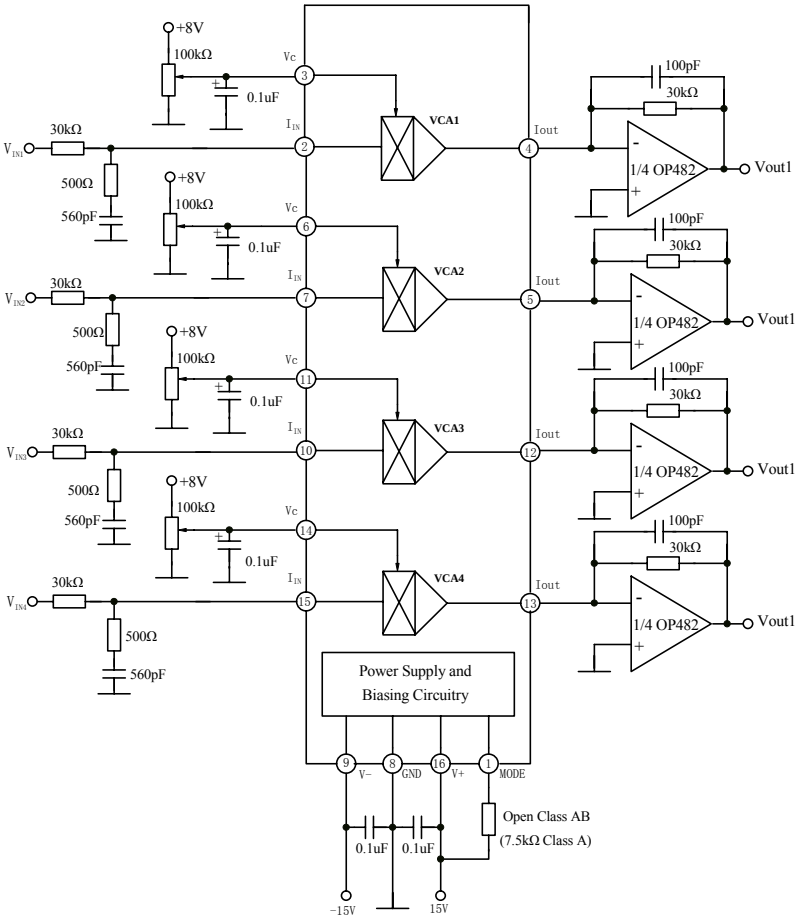


Figure 21 Gain Constant vs. Temperature

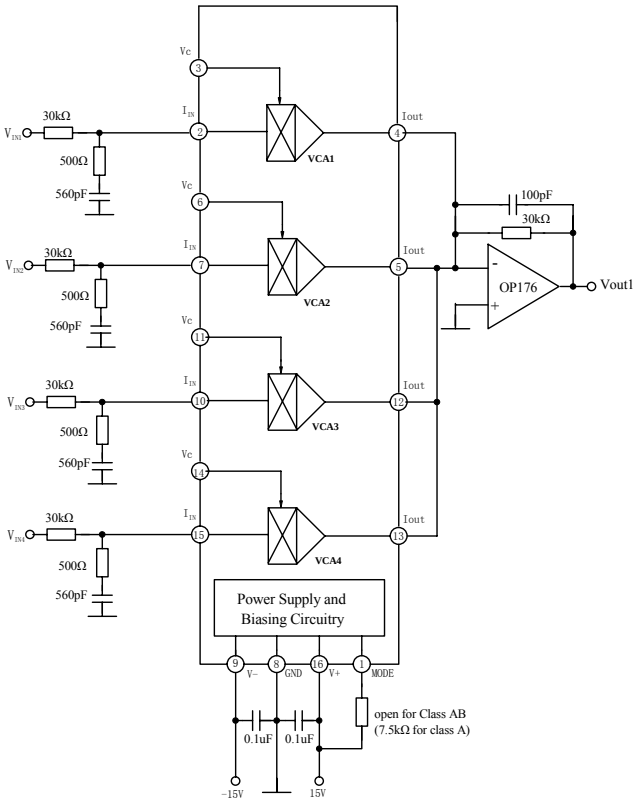
6. Application Circuit and Information

6. 1 Basic VCA Configurationm



This is the basic application circuit of V2164M/D.， Each of the four channels is configured identically. A 30 k Ω resistor converts the input voltage to an input current for the VCA. Additionally, a 500 Ω resistor in series with a 560 pF capacitor must be added from each input to ground to ensure stable operation. The output current pin should be maintained at a virtual ground using an external amplifier.

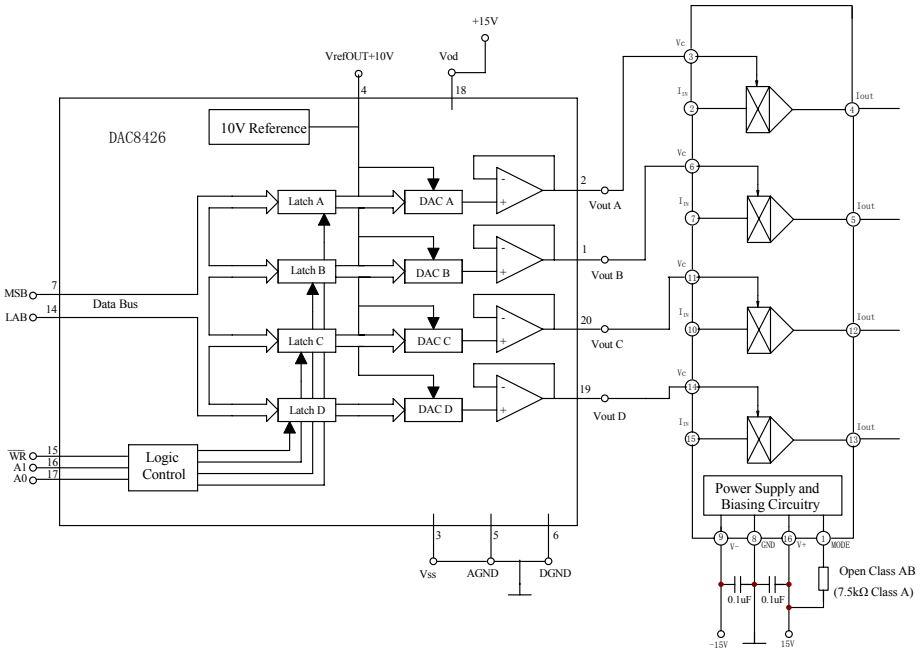
6. 2 Low Cost , Four-Channel Mixer



The four VCAs in a single package can be configured to create a simple four-channel mixer. The inputs and control ports are configured the same as for the basic VCA, but the outputs are summed into a single output amplifier.

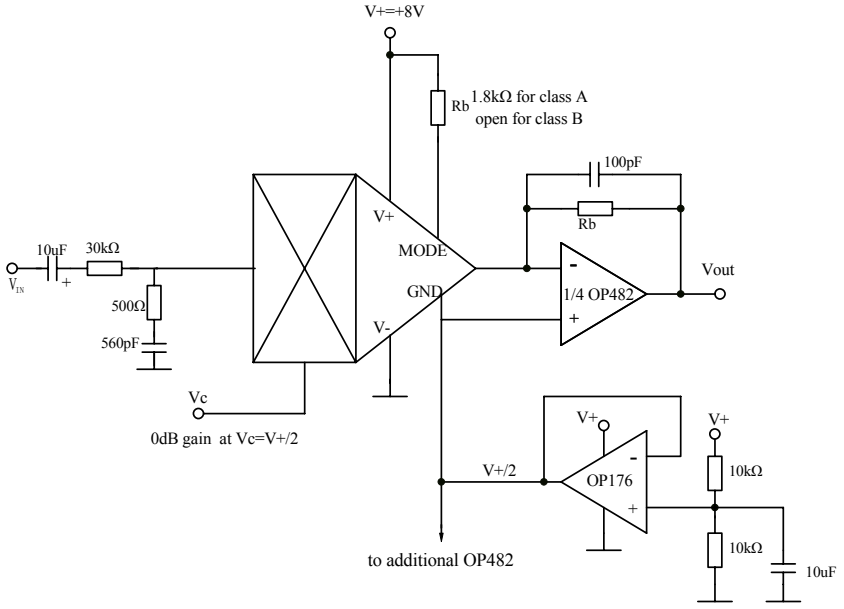
Additional V2164M/D could be added to increase the number of mixer channels by simply summing their outputs into the same output amplifier. Another possible configuration is to use a dual amplifier such as the OP275 to create a stereo, two channel mixer with a single V2164M/D .If additional V2164M/Ds are added, the 100 pF capacitor may need to be increased to ensure stability of the output amplifier. Most op amps are sensitive to capacitance on their inverting inputs. The capacitance forms a pole with the feedback resistor, which reduces the high frequency phase margin. As more V2164M/D's are added to the mixer circuit, their output capacitance and the parasitic trace capacitance add, increasing the overall input capacitance. Increasing the feedback capacitor will maintain the stability of the output amplifier.

6.3 Digital Control of the V2164M/D



Using a voltage output digital-to-analog converter such as DAC8426 also can control the gain and attenuation of the V2164M/D. In Digitally Controlled system, its simple 8-bit parallel interface can easily be connected to a microcontroller or microprocessor, The coltage output of D/A provedes a low impenence drive to the V2164M/D, so the attenuation can be controlled accurately. The input and output configuration for the V2164M/D is the same as for the basic VCA circuit shown . The 4-to-1 mixer configuration could also be used.

6.4 V2164M/D Single Supply Operation



The V2164M/D can easily be operated from a single power supply as low as +8V or as high as +36V. The key to using a single supply is to reference all groung connection to a voltage midway between the supplly

and ground.,as shown above. The OP176 is used to create a pseude-ground reference for the V2164M/D .Both the OP482 and OP176 are single supply amplifiers, and can operate over the same voltage range as the V2164M/D, with little or no change in performance.

7. Package Dimensions