# SSI2164

## FATKEYS™ QUAD VOLTAGE CONTROLLED AMPLIFIER

The SSI2164 provides four independent, high-performance VCA's in a single package. A versatile Mode control allows selection of Class A, Class AB, or in-between using a single resistor to optimize noise versus distortion performance. Current input and output of audio signals provides design flexibility, with ground-referenced -33mV/dB control ports.

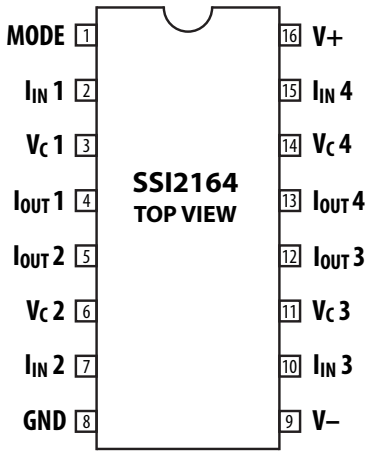
Further flexibility is provided by the SSI2164's four-fold increase of input current handling over the SSM/V2164 which allows reduction of $R_{IN}/R_{OUT}$ values for lower noise at little to no cost in THD.

The SSI2164 will operate on supplies as low as ±4V for battery-powered devices, or up to ±17V in systems where maximum headroom is desired.

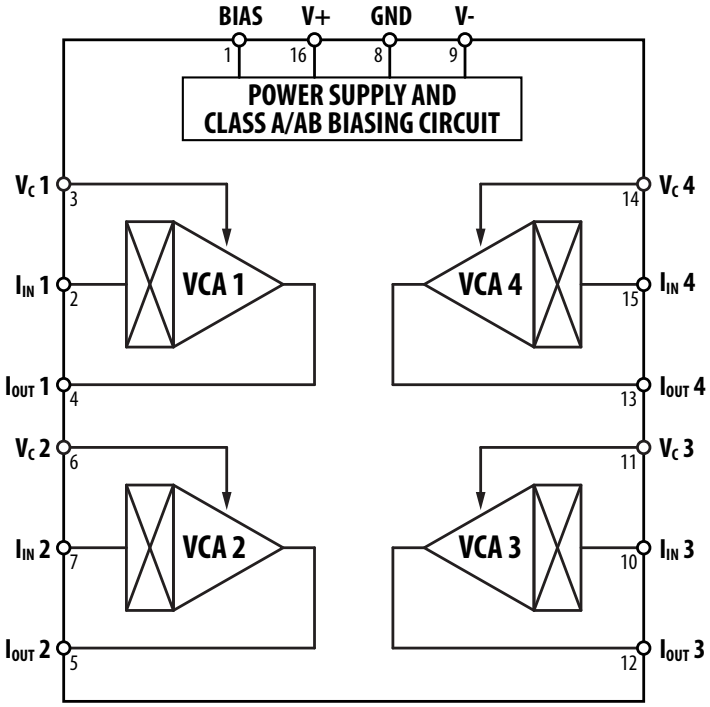
Distortion performance is improved across the board compared to the SSM2164/V2164. Depending on bias mode selection, extremely low noise (-96dBu typical, Class AB) or distortion (0.025%, Class A) can be achieved. The SSI2164 offers low control feedthrough, channel-to-channel gain matching better than 0.25dB, and a wide gain range of 120dB.

### FEATURES

- **Improved Direct Replacement for SSM2164/V2164**
- **Input Current Handling Increased 4x to 2mA**
- **Pin-Selectable Class A or AB Operation**
- **118dB Dynamic Range (Class AB)**
- **Low Distortion – Typical 0.025% (Class A)**
- **Large Gain Range: -100dB to +20dB**
- **±4V to ±18V Operation**
- **No External Trimming**
- **Low Control Feedthrough – Typical -60dB**




**PIN CONNECTIONS**
**16-PIN SOP**
**(JEDEC MS-012-AC)**




**FUNCTIONAL BLOCK DIAGRAM**

**The SSI2164 is distributed exclusively by CruzTOOLS, Inc. and its authorized resellers**
**PO Box 250, Standard, CA 95373 USA Phone 209-536-0493, www.soundsemiconductor.com**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## SPECIFICATIONS ($V_S$ = ±15V, $V_{IN}$ = 0.775$V_{RMS}$, f = 1kHz, $A_V$ = 0dB, Class AB, $T_A$ = 25°C; using Figure 1 circuit without options)

| Parameter | Symbol | Conditions | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| POWER SUPPLY | | | | | | |
| Supply Voltage Range | $V_S$ | | ±4 | | ±17 | V |
| Supply Current | $I_{CC}$ | Class AB | | 6 | 8 | mA |
| Supply Current | $I_{EE}$ | Class A | | 8 | | mA |
| Power Supply Rejection Ratio | PSRR | 60Hz | | 90 | | dB |
| CONTROL PORTS | | | | | | |
| Input Impedance | | | | 10 | | kΩ |
| Gain Constant | | After 60 seconds of operation | | –33 | | mV/dB |
| Gain Constant Temp. Coefficient | | | | –3300 | | ppm/°C |
| Control Feedthrough | | $A_V$ = 0dB to –40dB | | –60 | | dB |
| Gain Accuracy | | $A_V$ = 0dB | | ±0.30 | | dB |
| | | $A_V$ = +20dB | | ±0.55 | | dB |
| | | $A_V$ = –20dB | | ±0.55 | | dB |
| Channel-to-Channel Gain Matching | | $A_V$ = 0dB | | 0.07 | | dB |
| | | $A_V$ = –40dB | | 0.24 | | dB |
| Maximum Attenuation | | | | –100 | | dB |
| Maximum Gain | | | | +20 | | dB |
| SIGNAL INPUTS | | | | | | |
| Input Bias Current | $I_B$ | | | ±10 | | nA |
| Input Current Handling | | | | 2 | | mA |
| SIGNAL OUTPUTS | | | | | | |
| Output Offset Current | | $V_{IN}$ = 0 | | ±60 | | nA |
| Output Compliance | | | | ±100 | | mV |
| PERFORMANCE | | | | | | |
| Output Noise | | Class AB | | | | |
| | | $R_{IN/OUT}$ = 30kΩ | | -93 | | dBu |
| | | $R_{IN/OUT}$ = 20kΩ | | -96 | | dBu |
| | | $R_{IN/OUT}$ = 10kΩ* | | -100 | | dBu |
| | | $R_{IN/OUT}$ = 7.5kΩ* | | -101 | | dBu |
| | | Class A | | | | |
| | | $R_{IN/OUT}$ = 30kΩ | | -80.5 | | dBu |
| | | $R_{IN/OUT}$ = 20kΩ | | -84 | | dBu |
| | | $R_{IN/OUT}$ = 10kΩ* | | -90 | | dBu |
| | | $R_{IN/OUT}$ = 7.5kΩ* | | -92 | | dBu |
| Headroom | HR | | | +22 | | dBu |
| Total Harmonic Distortion | THD | Class AB (*80kHz BW, f=1kHz)* | | | | |
| | | $A_V$ = 0dB | | 0.058 | | % |
| | | $A_V$ = 0dB, $V_{IN}$ = –15dBu | | 0.037 | | % |
| | | $A_V$ = +20dB, $V_{IN}$ = –15dBu | | 0.17 | | % |
| | | $A_V$ = –20dB, $V_{IN}$ = +10dBu | | 0.15 | | % |
| | | Class A (*80kHz BW, f=1kHz)* | | | | |
| | | $A_V$ = 0dB | | 0.03 | | % |
| | | $A_V$ = 0dB, $V_{IN}$ = –7dBu | | 0.025 | | % |
| | | $A_V$ = +20dB, $V_{IN}$ = –15dBu | | 0.045 | | % |
| Channel Separation | | $A_V$ = –20dB, $V_{IN}$ = +10dBu | | 0.118 | | % |
| Unity Gain Bandwidth | | | | -110 | | dB |
| Slew Rate | SR | $C_F$ = 10pF | | 500 | | kHz |
| | | $C_F$ = 10pF | | 700 | | µA/µs |

*Requires changes to input RC compensation network which will be advised in a future data sheet update.



## ABSOLUTE MAXIMUM RATINGS

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

## ORDERING INFORMATION

| Part Number | Package Type | Quantity |
|---|---|---|
| SSI2164S-TU | 16-Lead SOP* - Tube | 50 |
| SSI2164S-RT | 16-Lead SOP* - Tape and Reel | 4000 |

*Compliant to JEDEC MS-012-AC. Please order in full container multiples.

NOTES:
*15kΩ for Class A; Open for Class AB
[1]Optional - for improved control feedthrough
[2]Optional - as needed for asymmetrical power-up protection in modular systems. 1N4001-style.

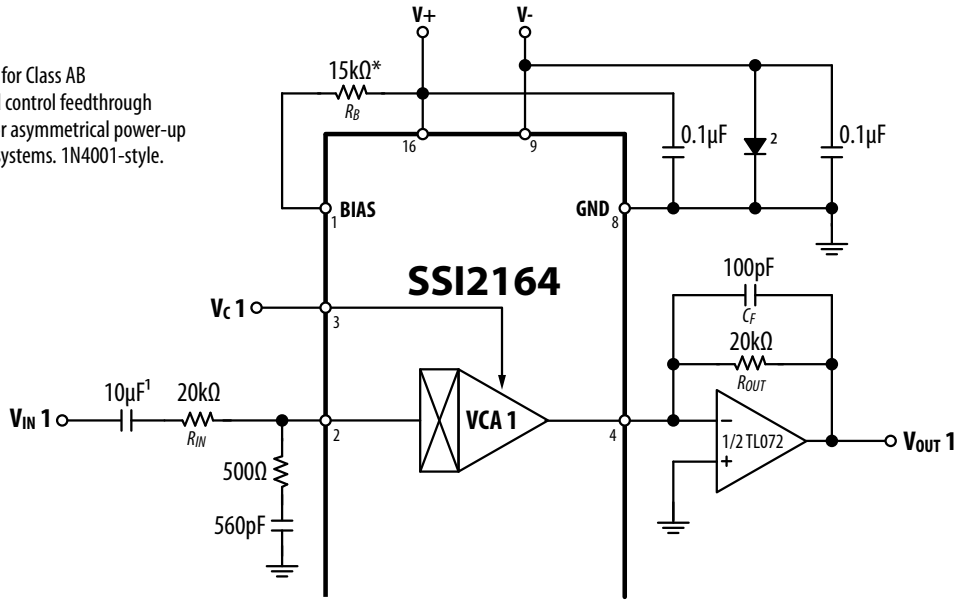



**Figure 1: Typical Application Circuit**

## GENERAL DESCRIPTION

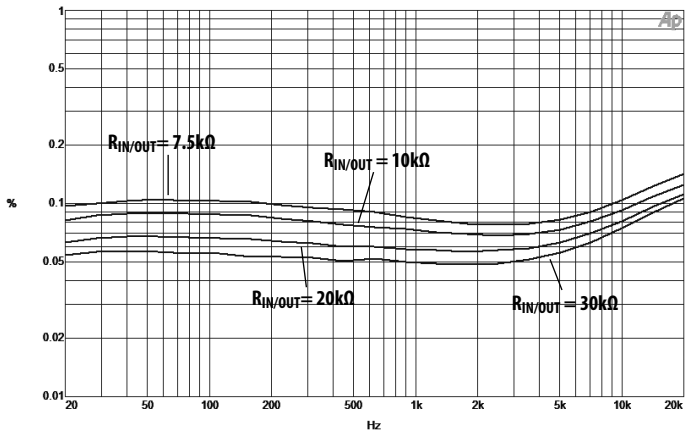
The SSI2164 is a versatile VCA building block for high performance audio applications. Four independent channels provide voltage control of current-mode inputs and outputs for a gain range of +20dB to -100dB. Among improvements over the SSM/V2164 is a four-fold increase in input current handling. As a result, one can trade a minor increase in distortion for substantial improvement in output noise by reducing the input and output resistor values. For example, changing Rin/out from 30kΩ to 20kΩ increases THD+N marginally from 0.05% to 0.058% while lowering output noise from -93dB to -96dB. Further flexibility is provided by the Mode Control (Pin 1) that biases gain cores as class A (lowest THD but higher noise) or AB (lowest noise but higher THD). Finally, improvements in the VCA core have the result of lower distortion across the board compared to the SSM/V2164.

Each channel has a dedicated control port with a -33mV/dB gain constant. For the full gain range -660mV results in 20dB of gain, and 3.3V provides 100dB of attenuation. If only attenuation is desired, the control port can be driven directly from a 5V DAC.

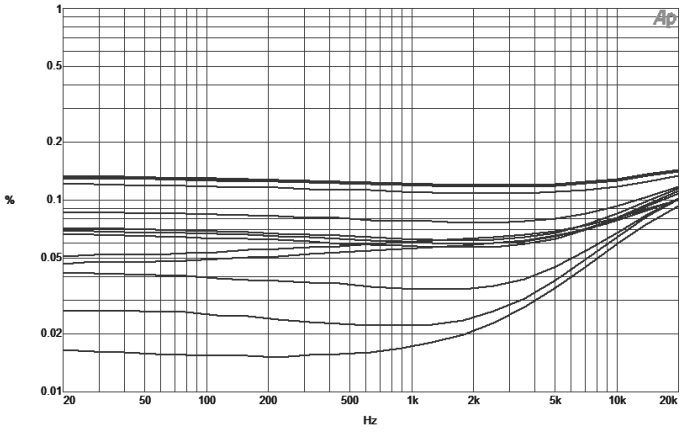
The SSI2164 retrofits SSM2164 and V2164 application circuits, using the standard 30kΩ input and output resistors and 500 ohm/560pF input compensation network. For best overall performance 20kΩ is recommend, with no changes necessary to compensation network. However, the same network results in oscillation at high signal levels with Rin/out values below 20kΩ and therefore requires changes in RC values. Watch for future data sheet updates with further information on RC network values when using Rin/out resistors below 20kΩ. *(continued next page)*

## TYPICAL PERFORMANCE GRAPHS

Figure 1 Application Circuit at $V_S$ = ±15V, $A_V$ = 0dB, f = 1kHz; w/o options unless otherwise noted




**THD+N vs. Frequency vs. $R_{IN/OUT}$**
*Class AB, $V_{IN}$ = 0dBu, 22Hz - 80kHz Filter*

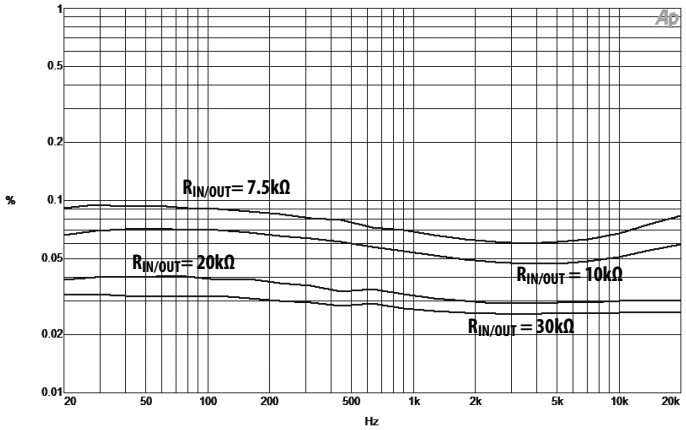



**THD+N vs. Frequency Distribution - 12 Channels**
*Class AB, $V_{IN}$ = 0dBu, 22Hz - 80kHz Filter*

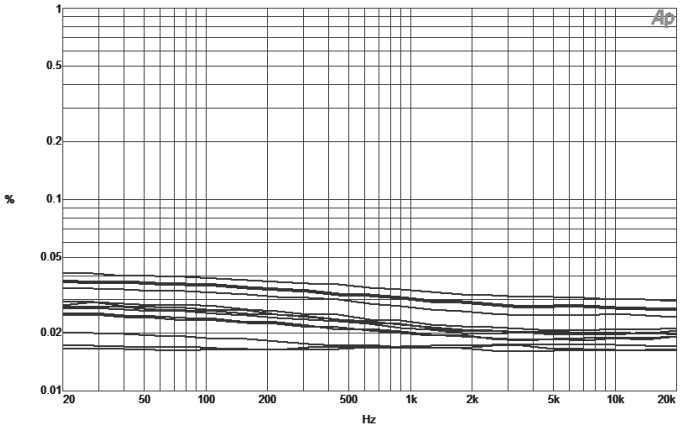
Internal protection has been added to prevent catastrophic failure during asymmetrical power-up, which may occur in modular synthesizers. For most applications, no external components for protection are necessary but modular system designers may want to include the standard diode shown in Figure 1 as an extra measure of protection.

If any channels of the SSI2164 are unused, outputs should grounded. Inputs can be left open, but the input compensation RC network should remain in place. Control pins can be left open or grounded.

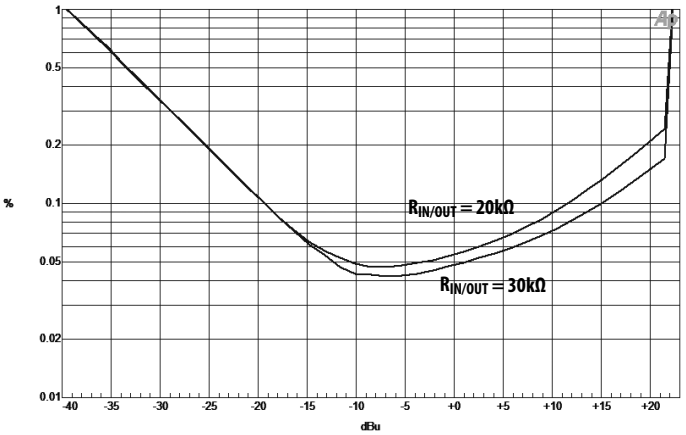
Figure 1 shows the typical application circuit with recommended 20kΩ $R_{IN/OUT}$ values. An optional input coupling capacitor provides improved control feedthrough.



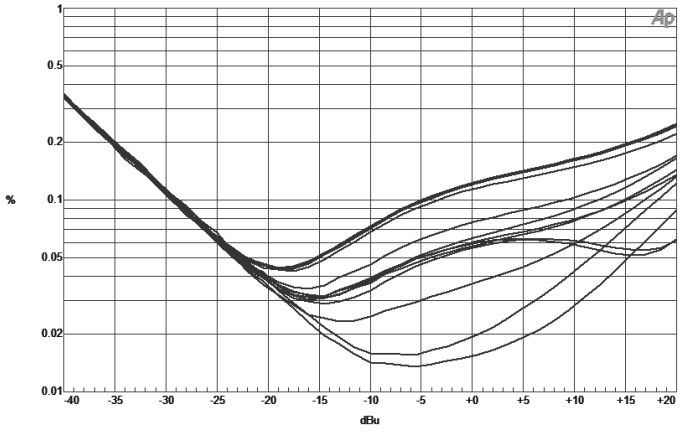

**THD+N vs. Frequency vs. $R_{IN/OUT}$**
*Class A, $V_{IN}$ = 0dBu, 22Hz - 80kHz Filter*



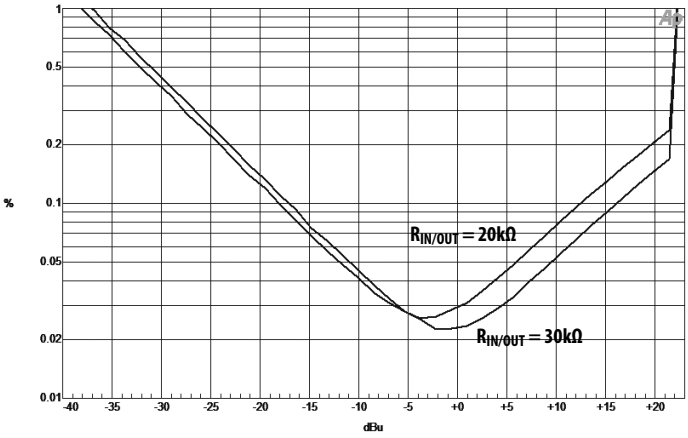

**THD+N vs. Frequency Distribution - 12 Channels**
*Class A, $V_{IN}$ = 0dBu, 22Hz - 80kHz Filter*



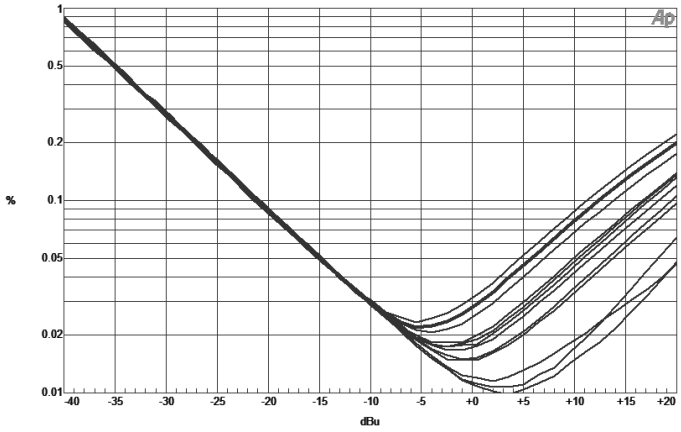

**THD+N vs. Amplitude vs. $R_{IN/OUT}$**
*Class AB, <10Hz - 22kHz Filter*




**THD+N vs. Amplitude Distribution - 12 Channels**
*Class AB, <10Hz - 22kHz Filter*




**THD+N vs. Amplitude vs. $R_{IN/OUT}$**
*Class A, <10Hz - 22kHz Filter*




**THD+N vs. Amplitude Distribution - 12 Channels**
*Class A, <10Hz - 22kHz Filter*