



## CC80

### **Precision Full Balanced LEF - Single Ended Class A Universal Amplifier**



#### Features

- Full Differential Operation (4-pole)
- LEF Class-A Output Stage
- Wide Range of Application
- Integrated Offset Servo Control
- Integrated Voltage Regulator
- Selectable Gain 0...800
- Unity Zero Gain Stable
- Configurable Internal Filter
- Configurable Frequency Compensation
- Configurable Feedback Ratio
- Configurable LEF Current
- Configurable Current Injection
- Very Low Dynamic Distortion
- Low Noise
- Target Offset Adjustment
- Easy To Use

#### Description

The CC80 universal Amplifier defines a new quality standard for analog signal amplifiers and provides a wide range of applications. The unique LEF-Technology neutralizes the Vce and the Ic distortions naturally, so that a signal correction by negative feedback is normally not required any more. Especially audio equipment takes a lot of sonic benefit of CC80's unique circuitry. However, an operation with negative feedback is possible as well. The fully balanced design allows a cross loop feedback with 2 balanced loops. The open loop gain and frequency response is user adjustable in a wide range. Thus the feedback ratio is free to choose by the user. The free adjustable characteristic of CC80 in feedback loop operation and the balance between precision and speed, allows a wide field of engineers the use of CC80 in their own way. The voltage amplifier is a multiple cascaded folded single ended amplifier. This means: just one voltage amplifier stage receives a signal on any DC level and outputs at GND (or user adjustable offset level). There is no active complementary transistor pair sharing a signal. Due to the single ended amplifier topology CC80 operates always in "Class A".

CC80 has balanced inputs and outputs and is therefore a 4-pole amplifier. The open loop gain is adjustable by just one external resistor at the "Gain" pins. Without any resistor CC80 provides a gain of 0 - practically about

#### Applications

- Very High Performance Audio Circuitry
- DAC Output Amplifier
- ADC Input Amplifier
- Active Filters
- Single Ended To Differential Converter
- Transformerless Microphone Amplifier
- Differential Receivers
- Precision Instrumentation
- *Current Injection*<sup>®</sup> Amplifiers
- *Differential Current Injection*<sup>®</sup>
- *Differential Integrators*
- *Moving Coil Current Injection*<sup>®</sup> Phono Amplifier
- *Ribbon Microphone Current Injection*<sup>®</sup> Amplifier
- Headphone Amplifier

more than -90dB. Therefore it is easy to use the gain pins for a filter pole.

The C-pins are for filter purposes and for setting the gain/maximum voltage/noise relation or volume control. Adding a capacitor to GND causes a low pass filter inside of CC80. This filter can be used for frequency compensation in closed loop operation. A resistor connected to these pins reduces the gain, the noise and the maximum output voltage. The C-pins allow lossless volume control as well.

The "Offset" pins allow to trim the offset to zero or even any other required output voltage - e.g. 2.5 V for ADC converter inputs. The offset can be externally adjusted for both differential outputs separately. CC80 has an internal offset servo circuit and provides a stable offset even without negative feedback.

CC80 as well includes an internal voltage regulator, which makes external designs easier. The internal regulator is designed for best dynamic performance rather than the smallest tolerance. The active regulating frequency range is wider than the available signal range of CC80 and therefore dynamically stable.

The basic pins are easy to use and allow even unexperienced users to build excellent amplifiers for various applications.

## Pin Description

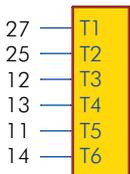
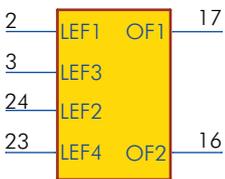
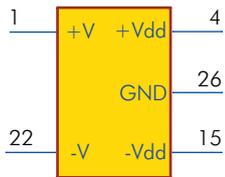
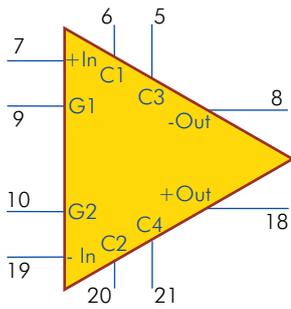


Fig. 1

1. Positive supply voltage. Range from 18 V...25 V unregulated.
2. LEF current range configuration 1
3. LEF current range configuration 3
4. Positive Internal Voltage +Vdd
5. Virtual ground -Out voltage amp
6. Voltage amp configuration pin
7. Non inverted input
8. Inverted output
9. Gain configuration 1; inverted CI-input
10. Gain configuration 2; non inverted CI-input
11. Expert use. Contact application centre.
12. Expert use. Contact application centre.
13. Expert use. Contact application centre.
14. Expert use. Contact application centre.
15. Negative Internal Voltage -Vdd
16. Offset adjustment +Out
17. Offset adjustment -Out
18. Non inverted output
19. Inverted input
20. Virtual ground +Out voltage amp
21. Voltage amp configuration pin
22. Negative power supply. Range from -18 V...-25 V unregulated.
23. LEF current range configuration 4
24. LEF current range configuration 2
25. Expert use. Contact application centre.
26. GND
27. Expert use. Contact application centre.

## Pin Orientation

### Top View

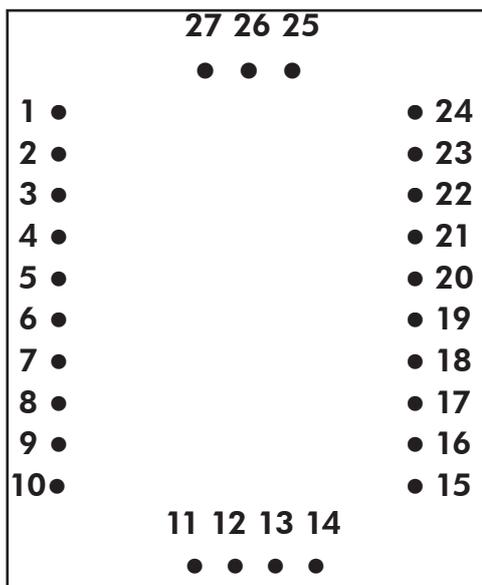


Fig. 2

## Mechanical Dimension

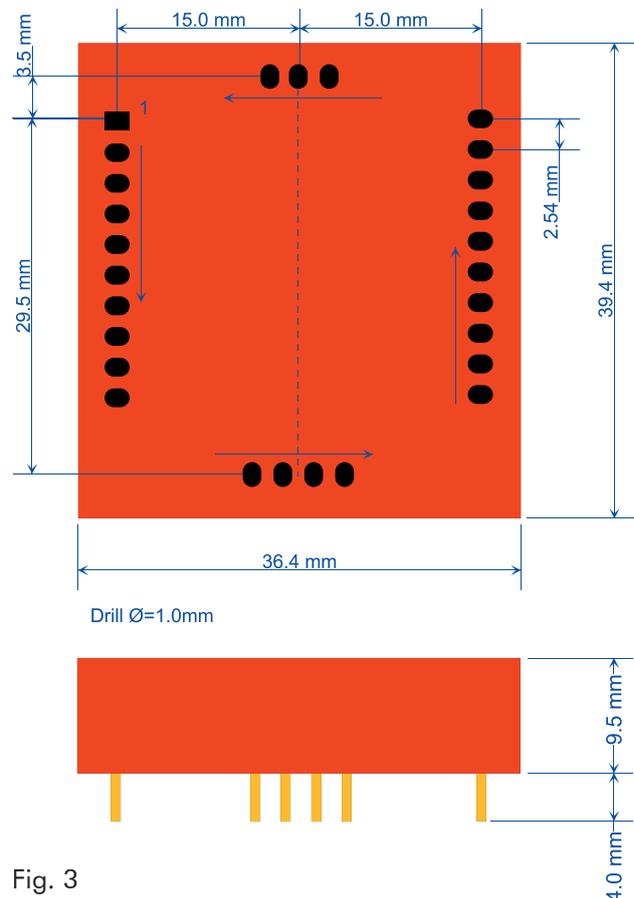


Fig. 3

## Basic Applications - Non Feedback Use

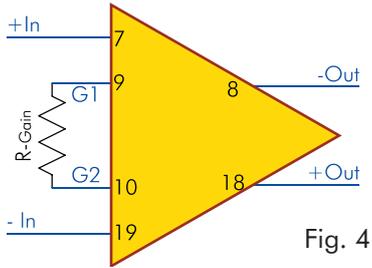


Fig. 4

### Fig. 4 • Balanced Sources

This is the basic use of CC80 as a differential Amplifier. This circuit requires a balanced input signal and provides a balanced output signal. To set a gain higher than 0, a resistor must be applied between the gain pins. The resulting gain is  $G = 94000/R_{gain}$  - means: a 10kΩ gain resistor would result in a gain of 9.4=19.4dB. The maximum gain of about 800 is set by shorting G1 and G2. Unity gain requires a resistor of 94kΩ.

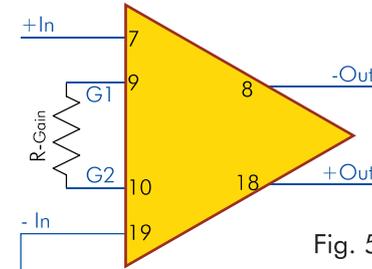


Fig. 5

### Fig. 5 • Unbalanced Sources

This is the basic use of CC80 as a differential Amplifier for unbalanced input signals. However, this circuit provides a balanced output signal. The gain calculation is related to the balanced output. This means that e.g. a gain of 2 for an input voltage of 1V would result in 1V output voltage on +out and inverted on -out. The differential summary is 2V.

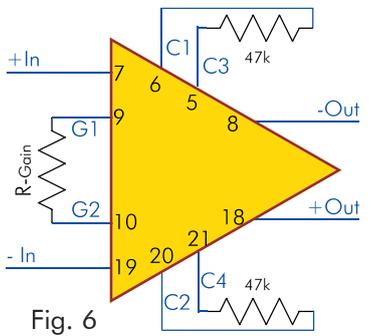


Fig. 6

### Fig. 6 • Gain / Noise Reduction

For output noise sensitive applications it is suggested to add two 47kΩ resistors to the C-pins. The gain is then calculated:  $G = 47k\Omega/R_{gain}$ . The maximum gain is reduced, however for all applications requiring a gain of less than 100 this circuit is recommended.

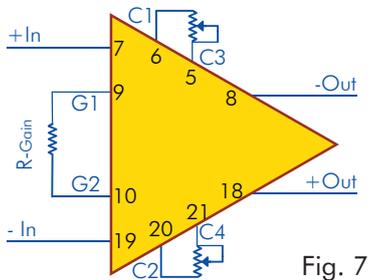


Fig. 7

### Fig. 7 • Volume Control

For volume control it is suggested to add a stereo potentiometer to the C-pins. The maximum gain for a 47kΩ potentiometer is then calculated:  $G = 47k\Omega/R_{gain}$ . By reducing the potentiometer's resistance the input signal and also noise and THD are reduced accordingly. This means: When turning down volume to 0, only the noise of the LEF output stage can be recognized.

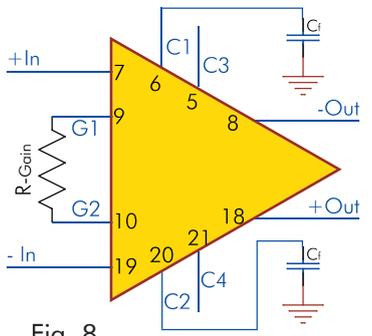


Fig. 8

### Fig. 8 • Low Pass Filter

This circuit shows how to make a simple buffered low pass filter inside the CC80. The output impedance at the C-pins is about 47kΩ and therefore the filter is easy to calculate:  $f_0 = 1/(2\pi \times 47k\Omega \times C_f)$ . If the output impedance of the C-pins should be changed by an additional resistor, the calculation impedance changes accordingly.

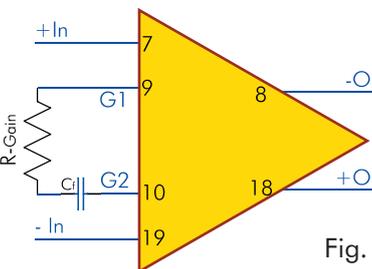


Fig. 9

### Fig. 9 • High Pass Filter

This circuit shows a simple high pass filter inside the CC80. For low frequencies the gain decreases according to the resistor/capacitor relation. This filter calculation is as followed:  $f_0 = 1/(2\pi \times R_{gain} \times C_f)$ . High pass and low pass filter can be combined and are decoupled.

# Basic Applications - Non Feedback Use - Current Injection®

## Description

Current Injection is another method of using CC80 as signal amplifier. The use of current injection looks a little like the use of an inverted OP-amp, but is basically different. Current injection requires no feedback. Due to the sophisticated CC80 internal voltage amplifier, the source current can be used to directly result in an output voltage. In current injection operation CC80's internal voltage amplifier currents are all static and the source current itself causes internal unbalanced currents which causes an output voltage. Dynamically this voltage amplifier is naturally excellent. The noise and the THD of CC80's input stage is avoided. Just the LEF output stage buffers the signal.

A disadvantage of current injection is a limited flexibility in use due to possible input impedance limitations. According to the required gain, the input impedance might be too low for some applications. Another limitation is the need for a balanced or earth free input source.

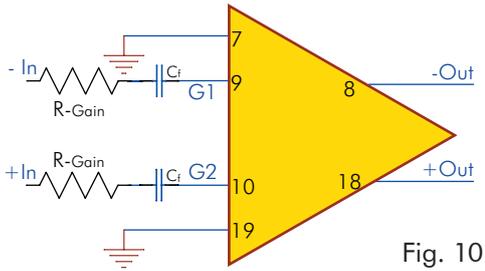


Fig. 10

### Fig. 10 • Current Injection For Balanced Sources

This is the basic circuit of CC80 in current injection use. The source signal current is directly injected to CC80's internal amplifier stages through a resistor. The G1/G2 input impedance is very low, so that the input impedance just depends on R-Gain. The gain calculation is very easy:  $G = 47000/R\text{-Gain}$ . If e.g. a preamplifier requires a gain of about 4, R-gain would be 12kΩ, which is also the input impedance. The source impedance at the CC80 inputs is 0 for this example and therefore the input noise is very low. To avoid DC offset currents a coupling capacitor is added. This capacitor could be avoided by trimming the G1/G2 voltage to the source potential.

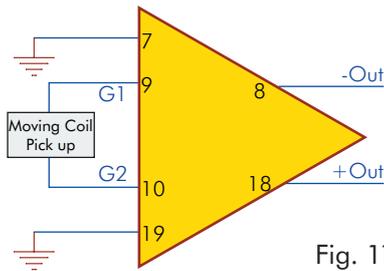


Fig. 11

### Fig. 11 • Current Injection For Earth Free Sources

For earth free sources, e.g. a phono MC pick up, current injection is the ideal way of achieving low noise, low THD and excellent dynamic performance. In this circuit the low source impedance of the MC pick up would cause a high gain inside CC80. For other earth free sources with higher voltage the gain can be set by a series resistor. The current injection operation is also best for professional audio application using transformer coupled lines.

## LEF Current Selection

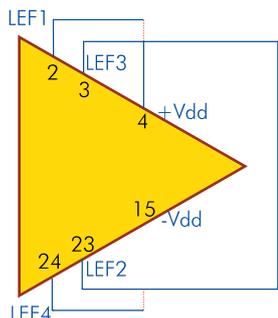


Fig. 12

### Fig. 12 • LEF Current Selection

CC80's normal maximum LEF current is 4.5 mA. Higher LEF current can be selected by connecting LEF pins to Pin 4 (+Vdd). Connecting Pin 2 (or 3) and Pin 23 (or 24) to Pin 4 (+Vdd), maximum LEF current will be 9 mA. Connecting all LEF pins (Pin 2+3+23+24) to Pin 4, maximum LEF current will be 13 mA. If output current is higher than maximum LEF current, CC80 works in Single Ended Class A mode, producing some more distortion than in LEF mode.

## Offset Voltage Setting

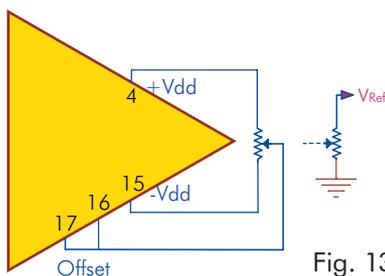


Fig. 13

### Fig. 13 • Offset Pins

CC80's Pin 16 and 17 normally remain unused. Internally the offset reference voltage is set to GND. However, in some applications it might be necessary to choose a different target offset voltage. This can be done by a simple voltage source. Stable voltage can be obtained from the internal stabilized Voltages at Pin 4 (+Vdd) and Pin 15 (-Vdd), or from a stable external Voltage (Vref). Any voltage at the offset pins will be the output DC-offset voltage. The impedance of the offset pins is about 100kΩ to GND.

## Absolute Maximum Ratings

	<b>Min</b>	<b>Norm</b>	<b>Max.</b>
<b>Power supply voltage</b>	18V	19V	25V
<b>Supply Current</b>		13mA	110mA
<b>Output current in LEF operation</b>			5/9/13mA
<b>Continuous output current</b>			100mA
<b>Gain resistor range</b>	0		$\infty$
<b>C-pin resistor range</b>	0		$\infty$
<b>Current injection</b>			400 $\mu$ A
<b>Target offset range</b>	-3V	0V	+3V

The basic pins are easy to use and allow even unexperienced users to build excellent amplifiers for various applications.

CC80 is a highest quality version of CC75 with some extra selections for LEF current and CI current. Without any changes CC80 can be an upgrade to replace CC75. Due to a double input stage, better transistors and resistors, CC80 has even less noise than CC75, sounds better and can easier drive low impedance loads at the output, especially because of CC80's feature to increase maximum LEF current. For experts there is also CC80's Current Injection adjustment, allowing perfect match to some D/A converters.

This data- and applicationsheet is subject to modification and preliminary in the actual status. Changes due to further improvement and errors expected.