

FEATURES

Single or Dual Device Operation
Transresistance Output Amplifier
Jumper Programmable Input Attenuator
Optional Inverted Output
User Area
Offset Nulling

GENERAL DESCRIPTION

The AD640-EB is an evaluation board for the AD640, Analog Devices' high frequency DC coupled demodulating log amp. The features of the AD640-EB include the following:

- The option of evaluating a single AD640 or cascading two devices to extend the dynamic range
- The option to quickly enable the AD640s' on board attenuator to evaluate different signal levels
- An additional amplifier to realize a current to voltage converter
- A user area to facilitate the addition of any external components that may be required

These features, combined with the careful layout and decoupling of the board, greatly simplify the evaluation of the AD640.

INTRODUCTION

There are essentially four basic ways to configure the AD640-EB. These include using one AD640 or two, either with or without the input attenuator. Among these four there are several techniques for offset nulling. The AD640-EB comes from the factory configured as shown in fig. 1. This configuration is chosen to give maximum functionality from the onset. The configuration highlights two AD640s cascaded with an inductor at the interstage for offset nulling and no input attenuation used. The following sections outline the details of the remaining possibilities.

CASCADED AD640s

Many of the applications requiring logarithmic compression often demand more than 45 dB of dynamic range. To achieve an extended range two AD640s may be cascaded and their log outputs summed together. The AD640-EB is capable of realizing a circuit similar to that shown in figure 30 of the AD640 data sheet. The first step is to make sure that both Log Out pins of the AD640s (U1 and U2) are connected to the AD846 (U3). This is done by inserting jumpers J6 and J9 in the vertical direction and jumpers J7 and J8 in the horizontal direction (thus grounding

LOG COM). When using cascaded AD640s, significant errors can arise from the input offset voltage and large overall gain. Therefore, use either the feedback or inductor offset nulling techniques as outlined in the AD640 data sheet. The details of implementing these techniques are explained next.

The feedback technique is implemented by including 12.5k Ω resistors in locations R7, R8, R18, and R19. If the input attenuator is used, these resistors should be reduced to 7k Ω each to retain approximately the same level of DC feedback. Also .001 μ F capacitors should be installed in locations C15 and C16 for AC suppression in the feedback.

Another possible option for offset nulling is the use of an inductor between the two AD640s. This technique eliminates only the offset generated by the first stage. As noted in the AD640 data sheet, this coil will short out the DC component of the output while appearing as a high impedance above 30 MHz. Typically, an inductor of 5 μ H should be used and may be installed in the two plated through holes provided directly between U1 and U2.

SINGLE STAGE OPERATION

If a specific application requires 45 dB of dynamic range or less, a single stage of compression will be sufficient. Several steps are required to configure the AD640-EB for single device operation. The first step is to remove U2 from the board. Next the output of U1 should be connected to U3 by grounding the LOG COM pin (jumper J7 in horizontal direction) and connecting the LOG OUT pin to the AD846 (jumper J6 in vertical position). When using only one stage, there is usually little need for offset adjustment, but the user still has the option of including such a circuit (see MANUAL OFFSET ADJUST). Operations requiring the input attenuators are described in the following section. This section contains instructions for both single and dual operation modes.

CONFIGURING THE INPUT ATTENUATOR

The AD640 comes equipped with an on board attenuator which may be used to reduce the input signal by a nominal 20 dB thus allowing a full scale input of 2V instead of 200 mV. This section illustrates the steps required to include the input attenuator. These steps have also been summarized in Table 1, JUMPER POSITIONS.

To use the input attenuator take the following steps. First connect the input signal to ATN IN at pin 5 and remove it from +SIG IN at pin 20. Do this by inserting jumper J2 and removing jumper J1. Next, connect the input signal to the first amplifier stage by inserting jumpers J3 and J4 onto the board. Now, because the attenuator resistor provides the required intercept temperature compensation, the on board compensation circuit should be disabled. This means grounding pin 8 of U1 by including jumper J5 on the board. Note that the intercept temperature compensation circuit of the second device has been permanently disabled since it is never needed.

SIGNAL INPUT

The input to the first AD640 (U1) is accessed via the SMA connector labeled IN and is AC coupled through a 0.1 μ F capacitor. While this capacitor is not necessary for all applications, it is included to provide convenient DC blocking of any residual offset present in the signal source. Following the input capacitor is a 50 Ω termina-

tion resistor (location R1 or R2) to ground. The combination of these two elements forms a first order high pass network with its half power frequency at 31.8 kHz. When the on board input attenuator is used the impedance looking into the AD640-EB is much less than 50Ω (typically $50\Omega\parallel 300\Omega$). To preserve impedance matching the termination resistor will have to be increased to approximately 60Ω . For this case it is possible to use two 120Ω resistors in parallel installed in locations R1 and R2. Because it is always good practice to equalize the offset error due to bias currents, as a rule, keep R3 equal to R1 and a resistor in location C3 equal to R2. The exception to this rule is when the attenuator is being used in which case there should be nothing in locations R3 and C3.

Note that for DC or pulse response the input coupling capacitor C1 will have to be removed and replaced with a jumper wire.

MANUAL OFFSET ADJUSTMENT

In certain applications it may be necessary to trim the input offset voltage of a single AD640. If this situation arises, include the following components on the AD640-EB. In the location labeled R4 near the lower left of the board install a $20k\Omega$ potentiometer such as the Bourns 339/844c. In locations R5 and R6 use a $50k\Omega$, 1/4 watt resistor. For capacitors C2 and C8 use a value of $0.1\mu f$ and $100pf$ respectively. As noted in the AD640 data sheet, the offset may be nulled by applying a zero volt input and adjusting R4 until the logarithmic output reaches a local maximum or minimum. When using the input attenuator R3 and C3 should be omitted and R5 and R6 should be $250k\Omega$ each. The manual offset adjustment is generally not recommended when cascading two AD640s since the high gain (100 dB) and open loop condition will lead to significant output drift. However, the technique may be useful for evaluating performance under controlled conditions. Under any other conditions use either the feedback or inductor offset techniques.

POWER SUPPLIES

The AD640-EB requires two dual power supplies, one of which should be operated at ± 5 volts and the other at ± 15 volts. The power supply lines may be clipped onto the posts provided on the right side of the board or may be soldered directly onto the printed circuit lands. Each power supply input is diode protected to avoid damage to the active components in case of accidentally reversed wires. Each of the devices on the board is supplied with its own decoupling capacitors and isolation resistors as needed so there is no need for outside decoupling components. The $\pm 15V$ supply is used to power the AD846 transimpedance amp and should be capable of delivering a minimum of 20 mA. The $\pm 5V$ supply is used to power both AD640s and should be able to deliver at least 100 mA to the board. Tables 3 and 4 show the recommended and maximum operating conditions for these supplies. An alternative to using two dual supplies is to use one dual supply operated at ± 6 volts. In this configuration connect the power supply as shown in figure 4.

OUTPUT SECTION

The output of the AD640-EB is accessed via the SMA connector labeled OUT near the top center of the board. The output is derived by performing a current to voltage conversion using the AD846 transimpedance op-amp (U3) and a single feedback resistor. This resistor ($R16=1k\Omega$) is currently set up to give a slope of 1 volt/decade, but may need to be increased slightly to compensate for slope at higher frequencies (see figure 12 AD640 data

sheet). To calculate the feedback resistance for a given slope and frequency the following expression may be used:

$$R_s = \text{LOGSLOPE}/L_y$$

where:

R_s is the resistance in $k\Omega$'s

LOGSLOPE is the desired system response in volts/decade

L_y is the slope current, in mA, from figure 12 of the AD640 data sheet.

Note the values of feedback resistance should not be less than 500Ω for a transimpedance op-amp such as the AD846 since it may lead to instability. An external capacitor (C9) has been included at the TZ node of U3 to provide high frequency carrier suppression. In effect the capacitor transforms U3 into a first order low pass filter with its break frequency at $1/2\pi R_{16}C_9$. The capacitor may be omitted if averaging at the output is not required. In this case maximum frequency response may be desired and an AD844 should be used in location U3. The AD846 is capable of driving ± 10 volts into a 500Ω load and is current limit protected to 65 mA at 25°C . Note that jumpers J6 through J9 have been provided to allow easy conversion to a complementary output voltage. This output is realized by grounding LOGOUT and taking the output signal from LOGCOM. This means that J6 should be horizontal and J7 should be vertical. When using two stages, the same jumper positions apply for J9 and J8 respectively.

USER AREA

A user area has been provided at the top of the board just to the right of the SMA OUT connector. This area consists of an 8 X 9 matrix of 0.1" on center plated through holes which may be soldered to with external components. Power supply and ground pins are located near the user area for easy access.

| | Cascaded Operation | | | | Single Stage Operation | |
|-----------|------------------------|----------------|------------------------|----------------|------------------------|----------------|
| | Inductor offset adjust | | feedback offset adjust | | with atten. | without atten. |
| | with atten. | without atten. | with atten. | without atten. | | |
| C3 | — | — | — | — | — | — |
| C15 | — | — | .001 μ F | .001 μ F | — | — |
| C16 | — | — | .001 μ F | .001 μ F | — | — |
| R3 | — | 50 Ω | — | 50 Ω | — | 50 Ω |
| R1 | 120 Ω | 50 Ω | 120 Ω | 50 Ω | 120 Ω | 50 Ω |
| R2 | 120 Ω | — | 120 Ω | — | 120 Ω | — |
| R7 | — | — | 5K Ω | 12.5K Ω | — | — |
| R8 | — | — | 5K Ω | 12.5K Ω | — | — |
| R18 | — | — | 5K Ω | 12.5K Ω | — | — |
| R19 | — | — | 5K Ω | 12.5K Ω | — | — |
| J1 | — | ✓ | — | ✓ | — | ✓ |
| J2 | ✓ | — | ✓ | — | ✓ | — |
| J3 | ✓ | — | ✓ | — | ✓ | — |
| J4 | ✓ | — | ✓ | — | ✓ | — |
| J5 | ✓ | — | ✓ | — | ✓ | — |
| J6 | V | V | V | V | V | V |
| J7 | H | H | H | H | H | H |
| J9 | V | V | V | V | — | — |
| J8 | H | H | H | H | — | — |
| L1* | ✓ | ✓ | — | — | — | — |
| CONDITION | 1 | 2 | 3 | 4 | 5 | 6 |

Legend: H = in place horizontally
V = in place vertically
✓ = in place
— = not in place

Table 1 Jumper and Resistor Settings

* L1 may also be replaced by a capacitor for high frequency roll-off but will provide no offset nulling compensation.

* In some instances the dynamic range may be increased by installing a 0.1 μ F capacitor in location C3 to decouple the inverting input from stray feedback paths.

Table 2 Functional Description of Jumpers

| Jumper Number | Description |
|---------------|--|
| J1 | connect SMA input to +SIG IN pin (pin 1) |
| J2 | connect SMA input to attenuator input (pin 5) |
| J3 | connect attenuated signal to first amplifier stage |
| J4 | connect inverting input to attenuator |
| J5 | disable intercept temperature compensation |
| J6 | connect Log Out of U1 to output or ground |
| J7 | connect Log Com of U1 to output or ground |
| J8 | connect Log Com of U2 to output or ground |
| J9 | connect Log Out of U2 to output or ground |

Table 3 Recommended Operating Conditions

| Parameter | min | typ | max | units |
|--------------------|-------|-----|--------|-------|
| Vin with atten. | — | — | ±2V | peak |
| Vin without atten. | — | — | ±200mV | peak |
| R _L | 50 | — | — | Ω |
| C _L | — | — | 100 | pF |
| +15 | 4.5 | 15 | +18 | volts |
| -15 | -4.5 | -15 | -18 | volts |
| +5 | 4.782 | 5 | +7.5 | volts |
| -5 | -4.65 | -5 | -7.5 | volts |

Table 4 Absolute Maximum Ratings*

| Parameter | max | min |
|----------------|--------|-----|
| +15 | +18 V | — |
| -15 | -18 V | — |
| +5 | 7.5 V | — |
| -5 | -7.5 V | — |
| Vin | 300mV | -3V |
| R _L | — | 0 Ω |

* Absolute maximum ratings are derived from the data sheets of the individual components. For more information consult the respective data sheet.

| | |
|----------------------|--------|
| R1 | 50Ω |
| R2 | 50Ω |
| R3 | 50Ω |
| C3 | 50Ω |
| R5 | 50kΩ |
| R6 | 50kΩ |
| R7 | 12.5kΩ |
| R8 | 12.5kΩ |
| R9 | 10Ω |
| R10 | 10Ω |
| R11 | 4.7Ω |
| R12 | 4.7Ω |
| R13 | 4.7Ω |
| R14 | 10Ω |
| R15 | 10Ω |
| R16 | 1kΩ |
| R17 | 4.7Ω |
| R18 | 12.5kΩ |
| R19 | 12.5kΩ |
| C9 | 1000pf |
| C16 | 1000pf |
| C15 | 1000pf |
| L1 | 5μH |
| All other capacitors | 0.1μf |

Table 5 Component Values

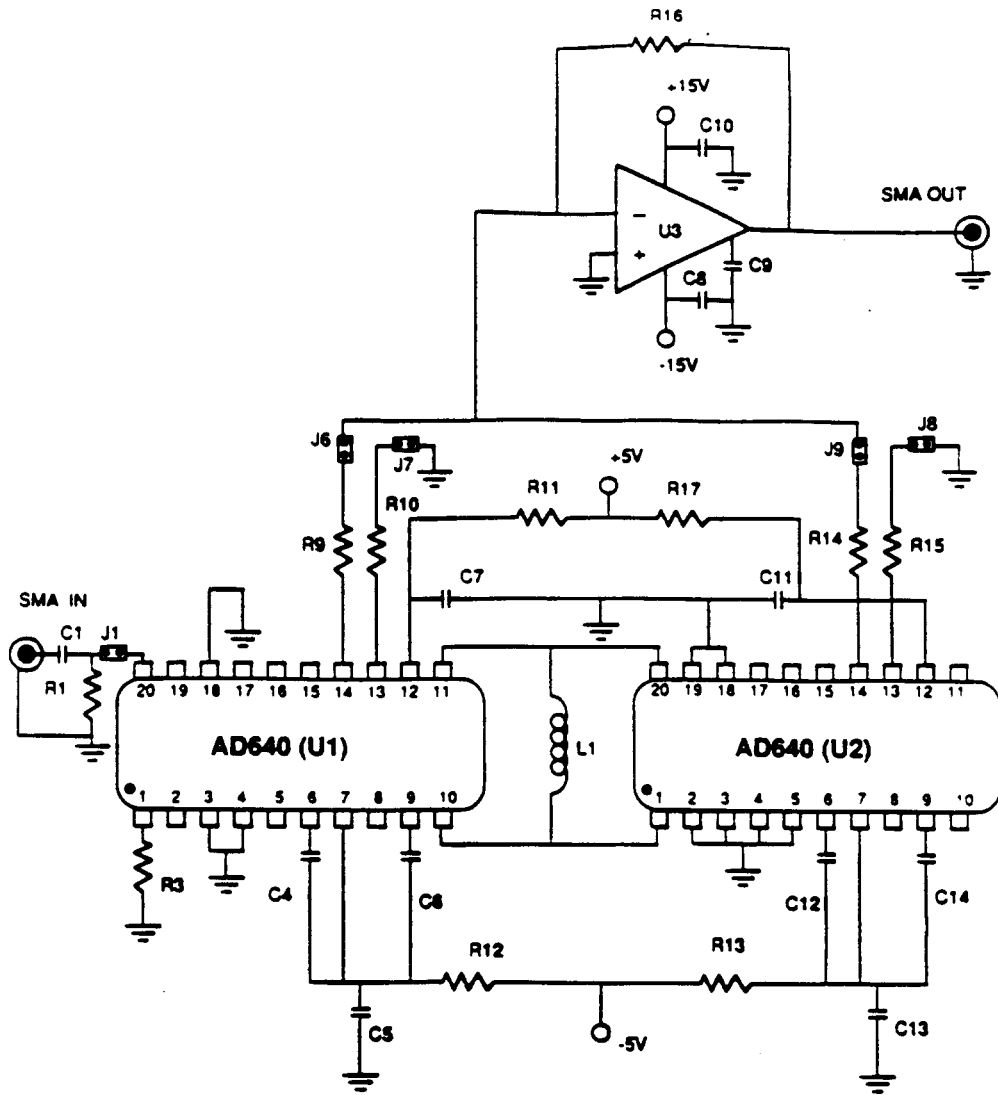


Figure 1 Default Configuration

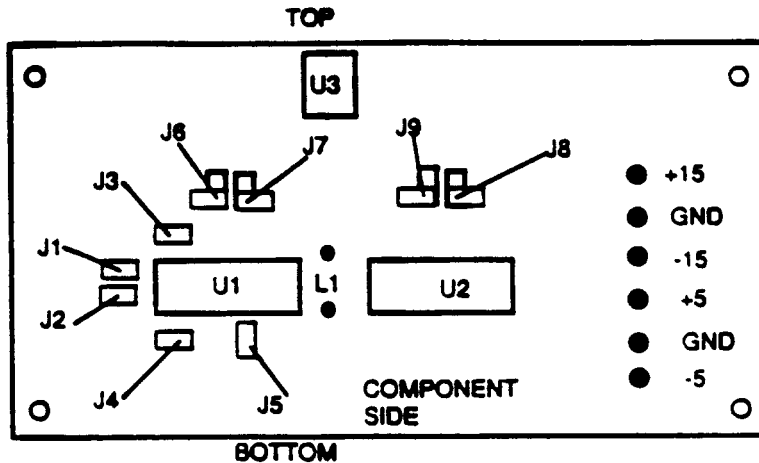


FIGURE 2 Jumper and Power Supply Identification

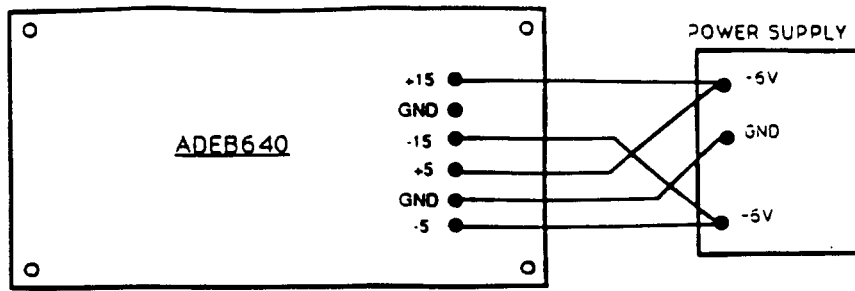


Figure 5 Single Power Supply Connection

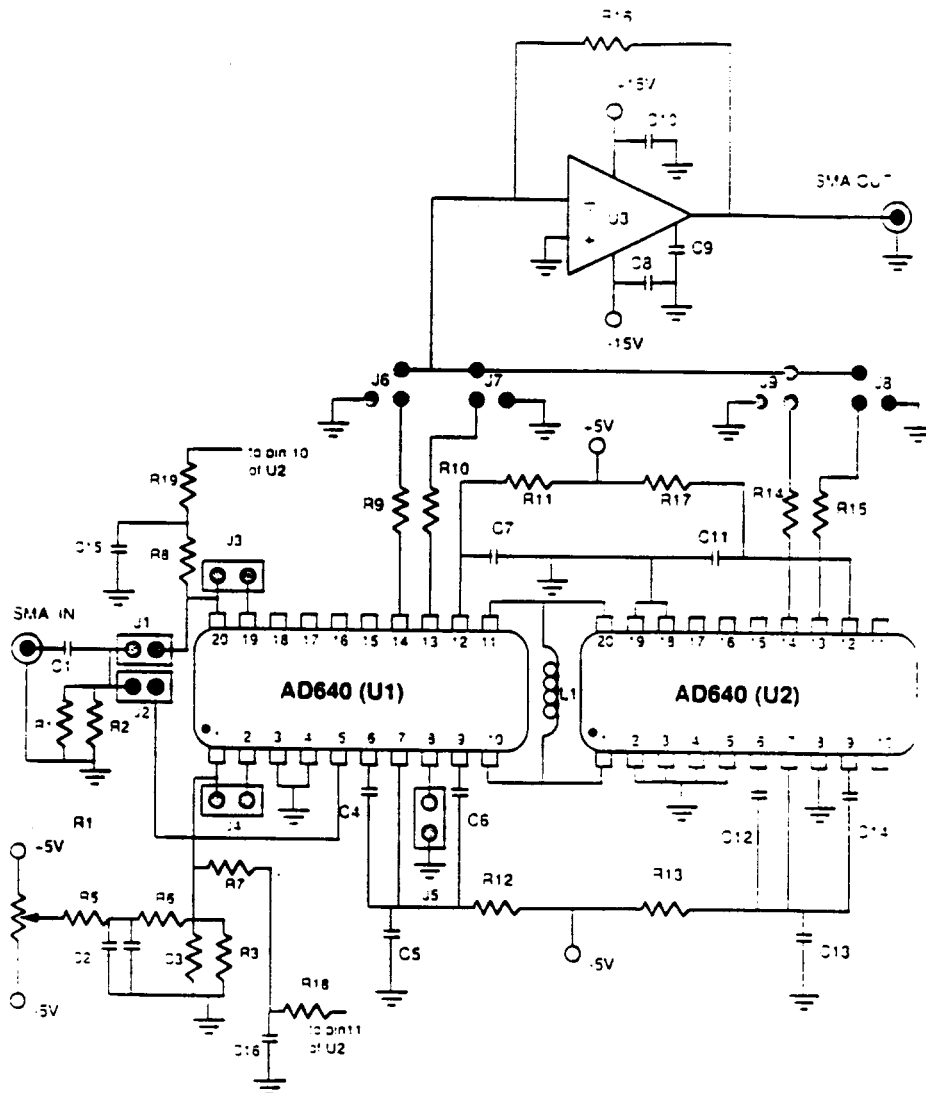


Figure 6 Complete Schematic