



# Evaluation Board for 3V to 5V, 12-Bit 200kSPS, Single Channel, Sampling ADC

## EVAL - AD7853CB

### FEATURES

- Full-Featured Evaluation Board for the AD7853
- Compatible with 3.3V and 5V Systems
- On-Board Reference and Digital Buffers.
- Various Linking options
- EVAL-CONTROL BOARD Compatibility

### GENERAL DESCRIPTION

This Application Note describes the evaluation board for the AD7853 12-Bit A/D converter. The AD7853 is a high speed, low power ADC which operates from a single +3V or +5V supply. It features self-calibration and system calibration options and also includes a power down mode. It incorporates an on chip track/hold amplifier and a versatile serial I/O port. This flexible serial interface allows the AD7853 to connect directly to Digital Signal Processors (ADSP-2101, TMS320C25, etc.) and Microcontrollers (8XC51, 68HC11, etc.). Full data on the AD7853 is available in the AD7853 data sheet available from Analog Devices and should be consulted in conjunction with this Application Note when using the Evaluation Board.

On-board components include an AD780, which can be configured as a +2.5 V or +3.0 V ultra high precision bandgap reference, an AD845 and two OP-07 amplifiers, an SSM2141 line receiver, and a 74HC08 quad AND gate.

Interfacing to this board is through a 96-way connector. External sockets are provided for the clock input, conversion start input, analog input, and external supplies if required. The complete circuit diagram is given in Figure 10.

### OPERATING THE AD7853 EVALUATION BOARD.

#### Power Supplies

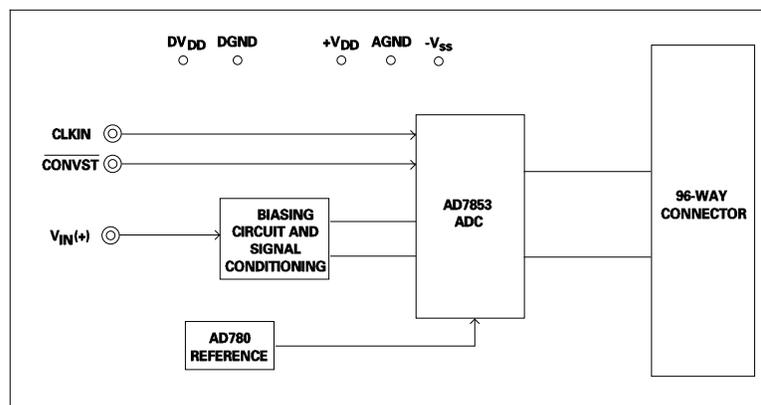
When using this evaluation board with the EVAL-CONTROL BOARD there will be no need to provide any external supplies. All supplies will be provided from the EVAL-CONTROL BOARD through the 96-way connector.

The evaluation board uses extensive ground planes to minimise high frequency noise interference from the on-board clocks or any other sources. The ground plane for the analog section is kept separate from that for the digital section and they are joined only at the AD7853 AGND and DGND pins. Therefore, it is recommended not to connect AGND and DGND elsewhere in the system to avoid ground loop problems.

When using this evaluation board as a stand alone unit external supplies must be provided. The AD7853 evaluation board has five power supply inputs:  $DV_{DD}$ ,  $+V_{DD}$ ,  $-V_{SS}$ , AGND and DGND. The  $DV_{DD}$  is used to supply both the  $AV_{DD}$  and the  $DV_{DD}$  of the AD7853 directly, and is also connected to the  $V_{CC}$  pin of the 74HC08. The  $+V_{DD}$  and  $-V_{SS}$  supply the different op amps, biasing circuit and external reference. The AGND input is connected to the analog ground plane and the DGND input is connected to the digital ground plane.

All analog supply pins are decoupled to AGND with 10 $\mu$ F tantalum capacitors in parallel with 0.1 $\mu$ F multilayer ceramic capacitors. These pins are the  $AV_{DD}$  pin of the AD7853, the  $+V_{DD}$  and  $-V_{SS}$  pins of the op amps, and SSM2141, and the  $+V_{IN}$  pin of the external reference. The digital supply for the AD7853 is decoupled to DGND with a 10 $\mu$ F tantalum capacitor in parallel with a 0.1 $\mu$ F disc ceramic capacitor at the power-supply terminals, and at the  $DV_{DD}$  pin of the AD7853. The logic chip, 74HC08, is decoupled with a DIL 0.02  $\mu$ F capacitor to DGND.

### FUNCTIONAL BLOCK DIAGRAM



REV. aa

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One Technology Way, P.O. Box 9106, Norwood, MA 02062-9106, U.S.A.  
Tel: 617/329-4700 Fax: 617/326-8703

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## SHORTING PLUG AND SWITCH OPTIONS:

There are a number of link options on the evaluation board which should be set for the required operating setup before using the board. The function of these link options are described in detail below:

| Link No. | Function   |
|----------|--|
| LK1      | <p>This link option is used to select between a 2.5 V or 3.0 V external reference.</p> <p>By default this link option is connected tying pin 8 of the AD780 to AGND giving a 3.0 V reference.</p> <p>With this link unconnected a 2.5 V external reference is selected.</p>  |
| LK2      | <p>This link option is used to select between the external reference and the internal reference.</p> <p>With this link connected the external reference is selected and this is the default setting.</p> <p>With this link unconnected the internal 2.5 V reference is used.</p>   |
| LK3      | <p><b>This link must be unconnected if an external supply is used.</b> Otherwise, if the supply from the EVAL-CONTROL BOARD is used this link should be connected.</p> <p>With this link connected the -12 V is supplied from the EVAL-CONTROL BOARD.</p> <p>With this link unconnected the -12 V must be supplied externally at the -12 V power supply terminal connector.</p>  |
| LK4      | <p>This link option is used to connect the signal from the AD845 buffer amplifier to the AIN(+) pin of the AD7853.</p> <p>With this link connected the output of the AD845 buffer amplifier is connected to the 50 <math>\Omega</math>, 10 nF filter to the AIN(+) pin of the AD7853.</p> <p>With this link unconnected, the output of the AD845 is disconnected from the RC filter and thus from the AIN(+) pin of the AD7853.</p> <p>Note that the analog input may also be connected to a component grid for extra signal conditioning.</p>   |
| LK5      | <p><b>This link must be unconnected if an external supply is used.</b> Otherwise, if the supply from the EVAL-CONTROL BOARD is used this link should be unconnected.</p> <p>With this link connected the +12 V is supplied from the EVAL-CONTROL BOARD.</p> <p>With this link unconnected the +12 V must be supplied externally at the +12 V power supply terminal connector.</p>  |
| LK6      | <p><b>This link must be unconnected if an external supply is used.</b> This link option is used to select between an external <math>V_{DD}</math> supply and the <math>V_{DD}</math> supply from the EVAL-CONTROL BOARD. The <math>V_{DD}</math> supplies the <math>AV_{DD}</math> and the <math>DV_{DD}</math> for the AD7853 and the <math>V_{CC}</math> for the 74HC08.</p> <p>With this link connected the <math>V_{DD}</math> is supplied from the EVAL-CONTROL BOARD.</p> <p>With this link unconnected the <math>V_{DD}</math> must be supplied externally at the <math>DV_{DD}</math> power supply terminal connector.</p> |
| LK7      | <p>This link option adds a 50 <math>\Omega</math> termination to DGND to the <math>\overline{\text{CONVST}}</math> line.</p> <p>This link option should be unconnected when using the <math>\overline{\text{CONVST}}</math> from the EVAL-CONTROL BOARD.</p> <p>If a 50 <math>\Omega</math> termination is required when using an external <math>\overline{\text{CONVST}}</math> signal this link should be connected.</p>   |
| LK8      | <p>This link option adds a 50 <math>\Omega</math> termination to DGND to the CLKIN line.</p> <p>This link option should be unconnected when using the CLKIN from the EVAL-CONTROL BOARD.</p> <p>If a 50 <math>\Omega</math> termination is required when using an external CLKIN signal this link should be connected.</p>   |
| LK9      | <p>This link option is in series with the SCLK1 input from the 96-way connector. When using the EVAL-CONTROL BOARD this input supplies the clock signal for the CLKIN input of the AD7853.</p> <p>This link should be connected when using the EVAL-CONTROL BOARD and no external CLKIN signal.</p> <p>This link should be unconnected when using an external CLKIN signal.</p>  |

- LK10 This link option is in series with the BUSY output to the 96-way connector.  
This link has the function of connecting the BUSY output to the 96-way connector.
- LK11 This link option is in series with the FL0 input from the 96-way connector. When using the EVAL-CONTROL BOARD this input supplies the conversion start signal for the  $\overline{\text{CONVST}}$  input of the AD7853.  
This link should be connected when using the EVAL-CONTROL BOARD and no external  $\overline{\text{CONVST}}$  signal.  
This link should be unconnected when using an external  $\overline{\text{CONVST}}$  signal.
- LK12 This link option is used to tie the DIN pin to DGND or to connect it to the 96-way connector.  
In position A, the DIN pin is tied to DGND and there will be no writing to the part.  
In position B, the DIN pin is connected to the 96-way connector and writing to the part will take place.  
When using the EVAL-CONTROL BOARD this link should be in position B.
- LK13 This link option is used to select between the two analog input ranges of the AD7853: the unipolar input range and bipolar input range.  
With this link in position A, the AMODE pin is tied to a logic high and the bipolar input range is selected; in this case LK18 should be in position B tying AIN(-) to Vref/2.  
With this link in position B, the AMODE pin is tied to a logic low and the unipolar input range is selected; in this case LK18 should be in position A tying AIN(-) to AGND.  
When using the EVAL-CONTROL BOARD this link should be in position B.
- LK14 This link controls the polarity of the serial clock, SCLK.  
With this link in position A, the POLARITY pin is tied to a logic high. With this input high, the first transition of the serial clock in a data operation is from a high to a low.  
With this link in position B, the POLARITY pin is tied to a logic low. With this input low, the first transition of a serial clock in a data operation will be from low to high.
- LK15,LK16 These links control the serial interface mode of the part.  
With both these links in position A, the SM1 and SM2 pins will be connected to a logic high and with both these links in position B, the SM1 and SM2 pins will be connected to a logic low.  
There are three external clocking modes (the user must provide the serial clock and frame sync) and two internal clocking modes (the part provides the serial clock, and frame sync). Table I details the link positions for selecting the different interface modes. Please see the AD7853 data sheet for further information on the different serial interface modes.  
When using the EVAL-CONTROL BOARD with this evaluation board both LK15 and LK16 should remain in position B for correct operation.

**TABLE I. INTERFACE MODES**

| LK15 | LK16 | INTERFACE MODE          |
|------|------|-------------------------|
| B    | B    | 1,2 (External Clocking) |
| B    | A    | 3 (External Clocking)   |
| A    | B    | 4 (Internal Clocking)   |
| A    | A    | 5 (Internal Clocking)   |

- LK17 This link is used to short the analog inputs, AIN(+) and AIN(-), together.  
With this link connected the AIN(+) and AIN(-) pins are shorted together.  
With this link unconnected the AIN(+) and AIN(-) are not shorted together.

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- LK18 This link is used to tie the AIN(-) pin to AGND or to  $V_{REF}/2$ .  
With this link in position A, the AIN(-) pin is tied to  $V_{REF}/2$  (in this case the bipolar analog input range should be selected by having LK13 in position A).  
With this link in position B, the AIN(-) pin is tied to AGND (in this case the unipolar analog input range should be selected by having LK13 in position B).
- When performing a histogram of codes LK17 should be connected and LK13 and LK18 should both be in position A. **(In this case care should be taken to ensure that LK4 is unconnected to avoid shorting the output of the AD845 buffer to AGND through the 50  $\Omega$  resistor).**
- LK19 This link option is used to select between normal mode operation and sleep mode.  
With this link in position A, the  $\overline{\text{SLEEP}}$  pin is tied to a logic high and normal operation results.  
With this link in position B, the  $\overline{\text{SLEEP}}$  pin is tied to a logic low and the part is put into sleep mode.  
When using the EVAL-CONTROL BOARD with this evaluation board LK19 should be in position B to allow both normal mode operation and sleep mode to be programmed by the software.
- LK20, LK21 These link option is used to select between two different voltage ranges at the  $V_{IN}$  socket (0 to  $V_{REF}$  volts or  $\pm V_{REF}/2$  volts). The voltage range is changed by connecting the biasing circuit on the evaluation board in or bypassing it.  
LK21 should only be connected when LK20 is in position B.  
With LK20 in position A, LK21 should be left unconnected, the biasing circuit is bypassed and the signal at the  $V_{IN}$  socket should be in the range 0 to  $V_{REF}$  volts.  
With LK20 in position B, LK21 should be connected, the biasing circuit is connected in and the signal at the  $V_{IN}$  socket should be in the range  $\pm V_{REF}/2$  volts.
- LK22 This link option adds a 50  $\Omega$  termination to AGND at the  $V_{IN}$  socket. In most applications this link will be left unconnected.  
If a 50  $\Omega$  termination is required this link should be connected. Care must be taken when connecting this link in case the signal source driving the  $V_{IN}$  socket cannot drive a 50  $\Omega$  load.  
When the signal source driving the  $V_{IN}$  socket has a 50  $\Omega$  output impedance it may be advantageous to connect this link to give the correct termination to AGND.
- SW1 This is a push button switch which is used to manually calibrate the AD7853. **Note that when using the internal reference of the AD7853 as the reference for the system, and the biasing circuitry to bias up the input voltage (LK20 in position B and LK21 connected) the voltage applied to SK3 should not be less than 0 V.**

## SET-UP CONDITIONS

Care should be taken before applying power and signals to the evaluation board to ensure that all link positions are as per the required operating mode. Table II shows the position in which all the links are set when the evaluation board is sent out. These links settings are consistent when operating with the EVAL-CONTROL BOARD.

**TABLE II. INTIAL LINK POSITIONS**

| Link No. | Position    | Function   |
|----------|-------------|--|
| LK1      | Connected   | 3.0 V External Reference selected  |
| LK2      | Connected   | External Reference selected  |
| LK3      | Connected   | -12 V supplied via the 96-way connector. Sets up the board for -12 V generated from EVAL-CONTROL BOARD.  |
| LK4      | Connected   | This connects the signal at the $V_{IN}$ socket via the biasing circuit to the AIN(+) pin of the AD7853. When performing a histogram of codes with the EVAL-CONTROL BOARD this link should be unconnected. |
| LK5      | Connected   | +12 V supplied via the 96-way connector. Sets up the board for +12 V generated from EVAL-CONTROL BOARD.  |
| LK6      | Connected   | $V_{DD}$ is supplied via the 96-way connector. Sets up the board for $V_{DD}$ generated from the EVAL-CONTROL BOARD.   |
| LK7      | Unconnected | This ensures there is no 50 $\Omega$ termination on the $\overline{CONVST}$ line.  |
| LK8      | Unconnected | This ensures there is no 50 $\Omega$ termination on the CLKIN line.  |
| LK9      | Connected   | CLKIN pin is connected to the SCLK1 pin of the 96-way connector. Sets up the board for the CLKIN being generated from the EVAL-CONTROL BOARD.  |
| LK10     | Unconnected | BUSY pin is not connected to the $\overline{IRQ2}$ pin of the 96-way connector.  |
| LK11     | Connected   | $\overline{CONVST}$ pin is connected to the FL0 pin of the 96-way connector. Sets up the board for the $\overline{CONVST}$ being generated from the EVAL-CONTROL BOARD.                                    |
| LK12     | B           | DIN pin is connected to the DT0 pin of the 96-way connector. Sets up the board for the DIN generated from the EVAL-CONTROL BOARD.  |
| LK13     | B           | This selects the unipolar analog input range. Sets up the board for the correct input range when interfacing to the EVAL-CONTROL BOARD.  |
| LK14     | A           | Sets POLARITY pin high such that the first transition of the serial clock in a data transfer is from a high to a low.  |
| LK15     | A           | This connects SM1 and SM2 pins to a logic high selecting interface mode 5 (Internal clocking). Sets up the board for interfacing to the EVAL-CONTROL BOARD.  |
| LK16     | A           |  |
| LK17     | Unconnected | This ensures that the AIN(+) and AIN(-) pins are not shorted together. When performing a histogram of codes test with the EVAL-CONTROL BOARD this link should be connected.                                |
| LK18     | B           | AIN(-) tied to AGND.   |
| LK19     | B           | This connects the $\overline{SLEEP}$ pin to DGND and allows the EVAL-CONTROL BOARD to program the different power down modes.  |
| LK20     | B           | This connects in the biasing circuit on the evaluation board and sets the analog input range at the $V_{IN}$ socket to $\pm V_{REF}/2$ .   |
| LK21     | Connected   |  |
| LK22     | Unconnected | This ensures that there is no 50 $\Omega$ termination from the $V_{IN}$ socket to AGND.  |

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## EVALUATION BOARD INTERFACING

Interfacing to the evaluation board is via a 96-way connector, J1. The 96-way connector is used for connecting the evaluation board to the EVAL-CONTROL BOARD or other system. The pinout for the 96-way connector is shown in Figure 1 and its pin designations are given in Table 2.

It is important to note that **the evaluation board is only setup for the AD7853 interface modes 4 and 5** (LK15 always in position B and LK16 in position A or B). This means that the SCLK, and SYNC are always outputs and DIN is always an input. Both the SCLK and SYNC are buffered from the AD7853 to the 96-way connector. The 74HC08 only buffers the SCLK and SYNC in one direction and assumes that the signals are outputs from the AD7853. If the AD7853 is required to operate in interface mode 1, 2, or 3, the 74HC08 should first be removed from the circuit. Failure to remove the 74HC08 from the board before configuring the AD7853 in interface mode 1, 2 or 3 may result in the AD7853 and the other IC's on the board being permanently damaged.

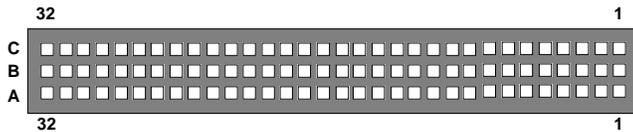


Figure 1. Pin Configuration for the 96-Way Connector (looking in to the AD7853 evaluation board)

|            |   |
|------------|---|
| SCLK1      | Serial Clock 1. This is a logic input and is connected to CLKIN pin on the device via LK9. This is the master clock signal for the device. It sets the conversion and calibration times.  |
| DGND       | Digital Ground. These lines are connected to the digital ground plane on the evaluation board. It allows the user to provide the digital supply via the connector along with the other digital signals.   |
| DT0        | Data Transmit 0. This line is connected to the DIN pin of the AD7853 via LK12. The data to be loaded to the control register of the device is applied to this pin in serial form. (This pin can act as an input pin or an I/O pin depending on the mode that the part is in. When using the EVAL-CONTROL BOARD this pin should always be configured as an input). |
| DR0        | Data Receive 0. The buffered output data from the AD7853 is received at this pin as a 16-bit serial word.   |
| TFS0, RFS0 | Transmit Frame Synchronisation 0, Receive Frame Synchronisation 0. These pins are tied together on the connector and buffered from the SYNC pin on the AD7853. The SYNC pin on the device can be a level triggered active low input (similar to a chip select in one case and to a frame sync in another case) or an output (similar to a frame sync)             |

SCLK0

depending on the interface mode that the part is in (See Table 1). With the 74HC08 buffer in place the SYNC should only be configured as an output from the AD7853.

Serial Clock 0. This is a logic input/output and is buffered from the SCLK pin on the device. This is the serial port clock and it can be configured as an input or I/O, depending on interface mode that the part is in. The SCLK clock edge on which the data is latched is determined by the POLARITY

TABLE III. 96-WAY CONNECTOR PIN FUNCTIONS

| ROW | PIN NO. | MNEMONIC         |
|-----|---------|------------------|
| A   | 3       | SCLK1            |
| A   | 4       | DGND             |
| B   | 4       | DGND             |
| C   | 4       | DGND             |
| A   | 5       | DT0              |
| C   | 5       | DR0              |
| A   | 6       | TFS0             |
| C   | 6       | RFS0             |
| C   | 7       | SCLK0            |
| A   | 12      | DGND             |
| B   | 12      | DGND             |
| C   | 12      | DGND             |
| A   | 17      | FL0              |
| C   | 17      | IRQ2             |
| A   | 20      | DGND             |
| B   | 20      | DGND             |
| C   | 20      | DGND             |
| A   | 21      | AGND             |
| A   | 22      | AGND             |
| A   | 23      | AGND             |
| A   | 24      | AGND             |
| A   | 25      | AGND             |
| A   | 26      | AGND             |
| A   | 29      | AGND             |
| B   | 29      | AGND             |
| C   | 29      | AGND             |
| A   | 32      | AV <sub>DD</sub> |
| B   | 32      | AV <sub>DD</sub> |
| C   | 32      | AV <sub>DD</sub> |

Note : The remainder of the pins on the 96-way connector are no connects.

|                          |  |
|--------------------------|--|
|                          | input logic level. With the buffer in place the SCLK should only be configured as an output from the AD7853.   |
| FL0                      | Flag zero. This is a logic input and is connected to the CONVST logic input on the device via LK11. A high to low transition on this input resets the AD7853 data register. A low to high transition on this input puts the track/hold amplifier into its hold mode and starts a conversion.                                       |
| $\overline{\text{IRQ2}}$ | Interrupt Request 2. This is a logic output and is connected via LK10 to the BUSY logic output on the device. The output goes high when a conversion begins and stays high until the conversion is complete, at which time it goes low. This output also indicates when the AD7853 has completed its on-chip calibration sequence. |
| AGND                     | Analog Ground. These lines are connected to the analog ground plane on the evaluation board.   |
| AV <sub>DD</sub>         | Analog +3V to +5V Supply. This line is connected to both the AV <sub>DD</sub> and DV <sub>DD</sub> (via LK6) supply lines on the board.  |

## SOCKETS

There are three input sockets on the AD7853 evaluation board. The function of these sockets is outlined in Table 4.

**Table IV. Socket Functions**

| Socket | Function  |
|--------|---|
| SKT1   | Sub-Minature BNC Socket for CLKIN input.                      |
| SKT2   | Sub-Minature BNC Socket for $\overline{\text{CONVST}}$ input. |
| SKT3   | Sub-Minature BNC Socket for V <sub>IN</sub> input.            |

## CONNECTORS

There is one connector on the AD7853 evaluation board as outlined in Table V.

**Table V. Connector Functions**

| Connector | Function   |
|-----------|--|
| SKT4      | 96-Way Connector for Serial Interface connections. |

## OPERATING WITH THE EVAL-CONTROL BOARD

The evaluation board can be operated in a stand-alone mode or operated in conjunction with the EVAL-CONTROL BOARD. This EVAL-CONTROL BOARD is available from Analog Devices under the order entry "EVAL-CONTROL BOARD". When operated with this control board, all supplies and control signals for operating the AD7853 are provided by the EVAL-CONTROL BOARD. Software for the EVAL-CONTROL BOARD is provided with the AD7853 evaluation board package. This EVAL-CONTROL BOARD will also operate with all Analog Devices evaluation boards which end with the letters CB in their title.

The 96-way connector on the EVAL-AD7853CB plugs directly into the 96-way connector on the EVAL-CONTROL BOARD. The EVAL-CONTROL BOARD is powered from a 12V ac transformer. This is a standard 12V ac 1A transformer. These can also be ordered from Analog Devices under the order entry "EVAL-110AC" for a 110V compatible transformer and "EVAL-220AC" for a 220V compatible transformer. These transformers are also available for other suppliers including Digikey (110V models) and Campbell Collins (220V models). The EVAL-CONTROL BOARD generates all the required supplies for itself and for the EVAL-AD7853CB.

Connection between the EVAL-CONTROL BOARD and the serial port of a PC is via a standard RS-232 cable which is provided as part the EVAL-CONTROL BOARD package. Please refer to the manual which accompanies the EVAL-CONTROL BOARD for more details on the EVAL-CONTROL BOARD package.

## SOFTWARE DESCRIPTION

Included in the EVAL-AD7853CB evaluation board package is a PC-compatible disk which contains software for controlling and evaluating the performance of the AD7853 when it is operated with the EVAL-CONTROL BOARD. The EVAL-AD7853CB Demonstration/Evaluation Software runs under DOS 4.0 or later and requires a minimum of a 386-based machine, with 500kB of RAM and 500kB of free hard disk space. It may be necessary to disable some TSR's or load the TSR's into high memory, like a network TSR for example, to ensure that adequate base memory is available. Operation under Windows is not recommended since the Windows COM interrupt can interfere with communication between the PC and the EVAL-CONTROL BOARD. The user interface on the PC is via a dedicated program written especially for the AD7853.

The disk which accompanies the EVAL-AD7853CB contains several files. The user should create a new directory on the main PC drive and label this "AD7853". Then, all files on the EVAL-AD7853CB disk should be copied into this directory. The Mouse Driver on the PC should be enabled before running the software. If this has not been loaded, the program will not run.

To run the software, simply make the AD7853 directory the current directory and type "go". When the software is running, the user sees the screen shown on Figure 3 (without any FFT or scope waveforms). This is the main screen and it is divided into three parts. The top part provides the main control interface for the AD7853 evaluation software. The middle part of the main screen functions as a digital storage oscilloscope and the bottom part of the main screen operates as either a Digital Spectrum Analyzer or a Histogram analyzer.

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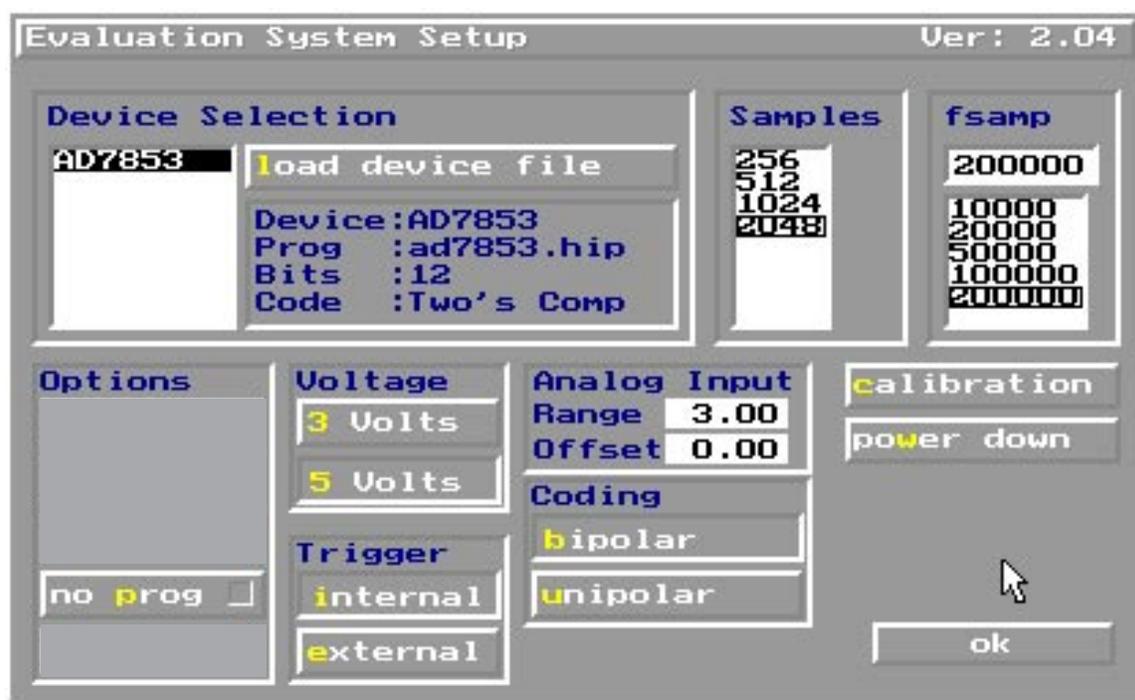


Figure 2. Setup Menu

Each part of the screen has several buttons that can be pressed by using the mouse or the keyboard. To press a button using the mouse, simply use it to move the on-screen pointer to the button to be activated and click. To use the keyboard, simply press the appropriate key as highlighted on the button. Lower case letters must be used. When a button is pressed, it is highlighted on the screen. The next button can be highlighted by using the Tab key or the previous button by holding down the shift key and the Tab key together. The highlighted button can also be pressed by pressing the space bar. Pressing the ESC key halts any operation currently in progress. In this document, if a button can be activated from the keyboard then the key used is shown in bold in the button name. For example, "no **prog**" had the p highlighted in bold indicating that the button can be activated by pressing the "p" key.

Some buttons have a red indicator. A red indicator on the button means that the function associated with that button is on. Absence of the red indicator means that the function associated with the button is off. The on/off status of these buttons is changed simply by selecting the button.

### Setting up the EVAL-CONTROL BOARD

When the software is run, the F2 Setup button in the top left of the screen should be selected to pop up the setup menu. This menu sets up the EVAL-CONTROL BOARD for use with the EVAL-AD7853CB. The Setup Menu is shown in Figure 2.

Firstly, a configuration file must be chosen. The configuration file contains the default configuration information for the EVAL-CONTROL BOARD, the Digital Spectrum Analyzer and the Digital Storage Oscilloscope. It also tells the AD7853.EXE software which .HIP file to download to the ADSP-2111. The .HIP file contains the dsp code which is executed by the ADSP-2111. Normally, the "no **prog**" button is

off so when the configuration file is loaded, the .HIP file is automatically downloaded to the ADSP-2111. However, if the "no prog" button is on then the .HIP file is not downloaded to the ADSP-2111. See Appendix A for further information about the .CFG file.

When the file is downloaded to the EVAL-CONTROL BOARD, the sample rate, number of samples, internal or external  $\overline{\text{CONVST}}$  and CLKIN, and bipolar or unipolar input range should be chosen. If the internal  $\overline{\text{CONVST}}$  option is in use, the available  $\overline{\text{CONVST}}$  frequencies are limited to frequencies of the form  $16 \text{ MHz}/4N$ , where N is an integer in the range 1 to 16384. If a frequency other than one of these frequencies is chosen, the EVAL-CONTROL BOARD generates the next lowest available frequency.

The first option that the user should choose in the Setup Menu is whether to run the AD7853 at 5V or 3.3V. To select 5 V operation the "5 Volts" button should be pressed, and the EVAL-CONTROL BOARD provides a 5 V supply to the AD7853. To select 3.3 V operation the "3 Volts" button should be pressed, and the EVAL-CONTROL BOARD provides a 3.3V supply to the AD7853.

The next option is whether to use internal or external CLKIN and  $\overline{\text{CONVST}}$  signals. To select the internal CLKIN and  $\overline{\text{CONVST}}$  signals (signals generated from the EVAL-CONTROL BOARD) the "internal trigger" button should be pressed. To select external CLKIN and  $\overline{\text{CONVST}}$  signals (signals are externally supplied by the user) the "external trigger" button should be pressed (note that LK9 and LK11 should also be disconnected before the external signals are applied).

The input voltage range and the input offset voltage are shown in "Range" and "Offset" boxes under the Analog Input section respectively. The offset voltage should be set to the input

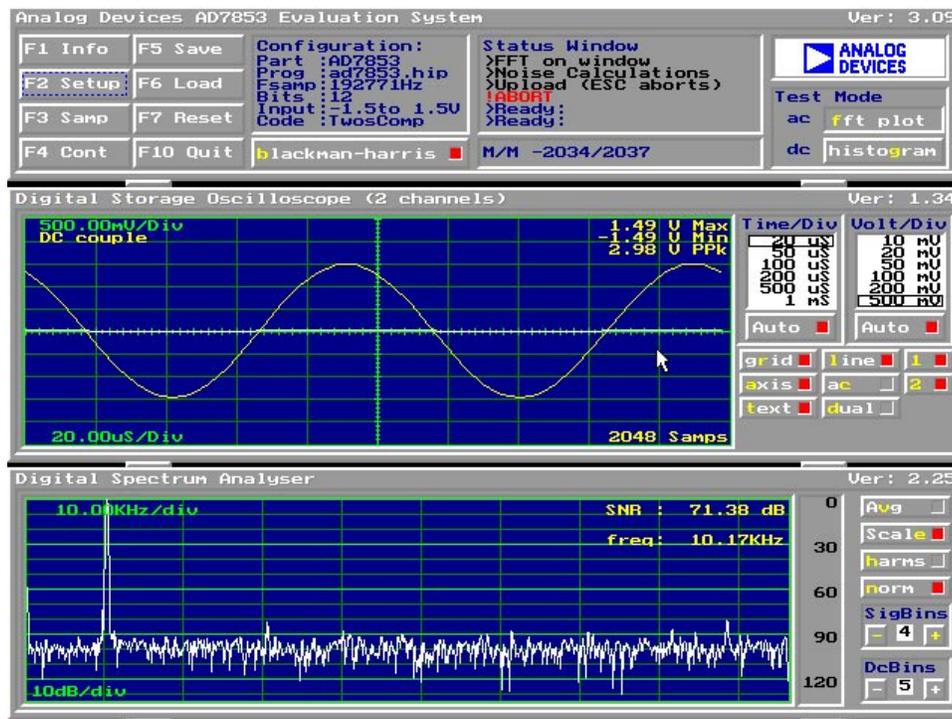


Figure 3. FFT Screen

voltage which causes the ADC to return a code of zero. These figures can be altered if required. These figures are used for calculating the Max, Min, and PPK (peak to peak) voltage numbers which are displayed in the top right hand corner of the digital oscilloscope window and for the histogram analyser calculations.

To choose the Unipolar analog input mode the "unipolar" button should be pressed and for the Bipolar analog input mode the "bipolar" button should be pressed.

Once these options are selected, the sample rate and number of samples to be taken are selected. The function of the "calibration" and "power down" buttons are covered separately later on in this document. Hit the return key or click the OK Button when the desired operating conditions have been chosen. The default settings are for 5 V operation, bipolar mode, internal CLKIN and CONVST signals (provided by the EVAL-CONTROL BOARD), and 2048 samples with a sample rate of 200 kHz.

Press the enter key or click on the OK button when the setup is complete.

#### Main Screen

The top left part of the main screen contains eight buttons which are selected using the mouse or by using the function keys from the keyboard. These buttons and the actions they perform are:

- F1:** Info. Activating this button provides information on the software.
- F2:** Setup . Pressing this button pops up the Setup Menu. This menu is described above.
- F3:** Samp. When this key is pressed, the software causes the AD7891-1 to perform a number of conversions as determined by the setup menu (see above). The data from these conversions is then analyzed by the AD7853 evaluation software. Another set of samples may be taken by pressing the F3 key again.
- F4:** Cont. Pressing this button causes the software to repeatedly perform conversions and analyze them. Once the conversions and analysis has been done for one set of samples, the software automatically repeats the process. It continues to do this until the ESC key is pressed.
- F5:** Save. This saves a set of samples to a file for use either at a later date or with other software. The samples can be saved either as "volts", "ints" or "binary". The format of all these files is ASCII text. Note that the AD7853 software can only reload files saved in the "ints" format. Files saved in the "volts" and "ints" formats can be used with packages such as Mathcad. Files saved in the "binary" format are for viewing purposes only.
- F6:** Load. This allows the user to load data from a file. Only data which was saved as "ints" can be loaded. The configuration file must be loaded via the "F2 setup" menu in the AD7853.EXE software before the data file can be analyzed. If there is no EVAL-CONTROL BOARD connected to the PC, then the "no prog" button in the "F2 Setup" menu must be on. Once a

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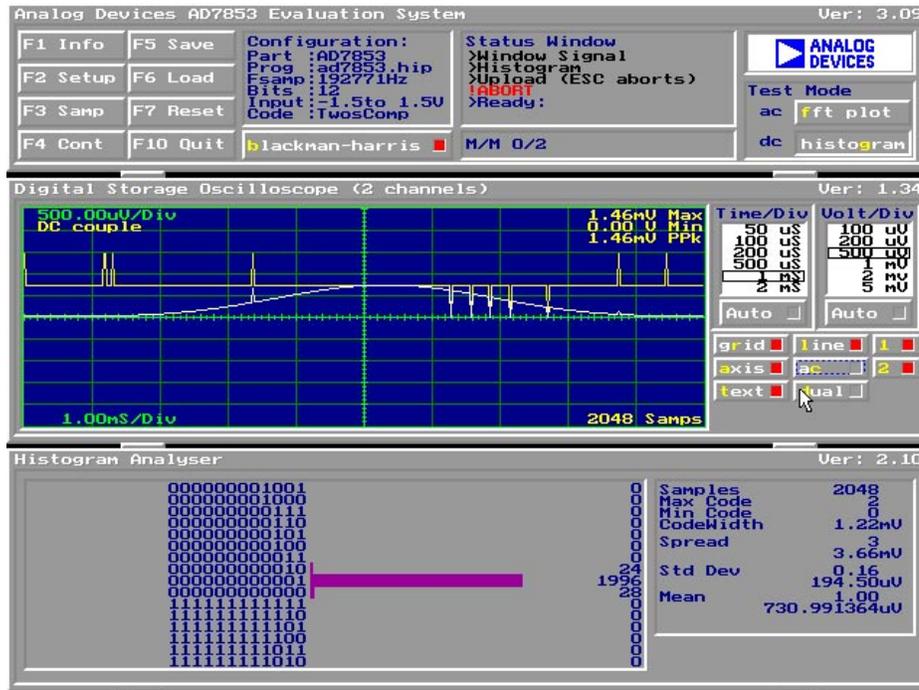


Figure 4 Histogram Screen

configuration file has been loaded, the data loaded from the .DAT file is analyzed according to the settings in the "F2 Setup" menu.

- F7:** Reset. Choosing this option resets the EVAL-CONTROL BOARD.
- F10:** Quit. This quits the AD7853 evaluation software and returns control to the operating system.

### Information Windows

There are three information windows at the top of the main screen. The leftmost window is the configuration window and gives details about part being evaluated. It shows the name of the program that has been downloaded to the EVAL-CONTROL BOARD, the sampling frequency, the number of bits, the analog input range of the part and the output code format of the part. The rightmost large window is the Status window. This window provides feedback to the user as to what operations are currently being performed by the software and also displays error messages. Directly underneath the status window is a small window that shows the maximum and minimum values of the most recently captured samples.

### Test Mode

At the top left of the main screen are the Test Mode buttons. These buttons determine what sort of testing is done on the samples captured by the software. Both an ac analysis and dc analysis can be performed. The function of these buttons are:

- fft plot** Choosing this button causes the Digital Spectrum Analyzer to appear at the bottom of the screen.  
Link Settings as per Table II for unipolar input. For bipolar input change LK13 to position A and LK18 to position A.

- histogram:** Choosing this button causes the Histogram Analyzer to be displayed at the bottom of the screen.

For a quick histogram test the link settings as per Table II, for unipolar range, except for LK4 unconnected, and LK17 connected. No signal is required at the Vin socket. For bipolar range the link settings are as per Table II except for LK4 unconnected, LK13 and LK18 in position A, and LK17 connected.

There is one other button near the top of the screen, beside the **F10 Quit** button. This is:

- blackman-harris:** When performing a fourier transform of the sampled data, this button determines whether or not the data is windowed by a blackman-harris window before the transform. When this button is on, the data is windowed. When this button is off, the data isn't windowed. See the Digital spectrum analyzer section for more details.

**Remember to check the link options LK13 and LK18 for the correct bipolar or unipolar settings before performing any ac or dc testing.**

### Digital Storage Oscilloscope.

When samples of data are captured, they are displayed on the Digital Storage Oscilloscope. If the **blackman-harris** button is turned on then the windowed data is also displayed on the oscilloscope. The 'scope has been designed to act in a similar way as a conventional oscilloscope. To the right of the oscilloscope are several buttons that control the manner in which data is displayed on the oscilloscope. The timebase for the oscilloscope is automatically chosen by the software if the Time/Div Auto button is on. The user can also select the timebase by clicking in the Time/Div window and scrolling up and down

through the possible timebases. Similarly, the vertical scale of the oscilloscope is chosen automatically if the Volt/Div Auto button is on. The user also has the option of selecting the desired vertical scale in a similar manner to selecting the timebase.

The other buttons associated with the oscilloscope are:

- grid** This button toggles the grid display of the oscilloscope on and off.
- axis** This button toggles the axis display of the oscilloscope on and off
- text** This button toggles the text displayed on the oscilloscope screen on and off.
- line** When the line button is on, the displayed samples are joined together by lines. When this button is off, the samples are displayed as points.
- ac** When this button is on, the dc component of the sampled signal is removed and the signal is displayed. This has the effect of centering the signal vertically on the oscilloscope screen. When this button is on, the dc component is not removed and the signal is displayed with its horizontal axis corresponding to a code of 0. The ac display option is useful for zooming in on a low-level signal that has a large dc offset.
- dual** When the dual button is on, the oscilloscope screen is divided into two parts with the sampled data display centered on one horizontal axis and the windowed data display centered on another. When the dual button is off, both traces are centered on the same horizontal axis.
- 1** This button toggles the sampled data trace on and off
- 2** This button toggles the windowed data trace on and off.

### Digital Spectrum Analyzer

The Digital Spectrum Analyzer performs a fast fourier transform of the sampled data and displays the magnitude of the results on its screen in decibels (dB). It also calculates the signal to noise ratio of the sampled data, assuming the samples are those of a sine wave. If the blackman-harris button near the top of the main screen is on then the data is windowed by a blackman-harris window before the fast fourier transform is performed. Normally, the blackman-harris button needs to be on in order to obtain meaningful results from the spectrum analyzer. If the evaluation board is used in a coherent sampling system, ie. one where the conversion start signal applied to the AD7853 is synchronized to an input sine wave, in such a way that an integral number of periods of the sine wave are contained in the sampled data, then the blackman-harris window can be turned off.

The buttons to the right of the spectrum analyzer display control the operation of the analyzer. These buttons are:

- Avg** When this button is on, the fourier transforms on each new set of sampled data are averaged so that the noise floor decreases relative to the signal contained in the data.

- Scale** When this button is on, the complete fourier transform from 0 Hz up to fs/2 is displayed in the spectrum analyzer window. When this button is off, the first 510 bins (less for transforms of less than 512 points) of the fourier transform are displayed.

- harms** When this button is on, the harmonics of the input signal are included in the SNR calculation. When this button is off, the harmonics are replaced by average noise in the SNR calculation.

- norm** When the norm button is on, the fourier transformed data is normalized so that the zero dB level is set to the level of the frequency bin with the largest magnitude. The data is displayed on-screen with the largest magnitude bin at the zero dB level. When the norm button is off, the data is not normalized. Instead the zero dB level is assigned to the level that the largest magnitude input signal would have and the data is displayed accordingly.

When a fourier transform of a windowed sine wave is performed, the power contained in the fundamental frequency is spread out over several frequency bins. To calculate the signal to noise ratio of the signal, the power contained in those frequency bins is summed to give the power of the fundamental. Also, the dc component of the signal is spread over the first few frequency bins. In the SNR calculation, the dc signal must be replaced by the average noise.

The number of frequency bins that are summed to give the power in the fundamental is controlled by the SigBins counter. The range of valid values is 0 to 9. The number contained in the SigBins counter is the number of frequency bins each side of the central peak that are used to calculate the power in the fundamental frequency. The counter is increased by clicking on the SigBins '+' button and decreased by pressing on the SigBins '-' button. As the counter is changed, the SNR is re-calculated and displayed. For a blackman-harris window, the power in the central peak plus the power in four bins each side of the central peak is normally used for SNR calculations. In a coherent sampled data system, all the power from the sine wave is contained in one frequency bin. In such a case the SigBins counter should be set to zero.

The number of low frequency bins that are replaced by average noise in the SNR calculation, is controlled by the DcBins counter. The range of valid values is 0 to 9. The counter is increased by clicking on the DcBins '+' button and decreased by pressing on the DcBins '-' button. As the counter is changed, the SNR is re-calculated and displayed. For a blackman-harris window, the first three to five bins are normally replaced by average noise in the SNR calculation. In a coherent sampled data system, all the dc power is contained in the first frequency bin. In such a case the SigBins counter should be set to one.

After an FFT has been performed and the frequency spectrum is displayed in the Digital Spectrum Analyser window, the mouse may be used to determine the frequency and dB level of any point in the frequency spectrum. Note that this will only

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work when one set of samples were taken, it will not work when in the continuous sampling mode. Once the mouse is positioned in the Digital Spectrum Analyser window the coordinates of the mouse in terms of frequency and dBs will be displayed on the right hand side of the window.

## Histogram Analyzer

The histogram analyzer counts the number of occurrences of each code in the captured samples and displays a histogram of these counts. The most frequently occurring code is displayed in the center of the histogram. The analyzer is normally used with a dc input signal and calculates the mean and the standard deviation of the sampled data. The mean and standard deviation are displayed in both volts and in units of the lsb size of the converter. The histogram gives a good indication of the dc noise performance of the ADC. The standard deviation shows directly the noise introduced in the conversion process.

The procedure from power-on to performing AC or DC tests is detailed by the flowchart in Figure 5. This flowchart is only accurate when using the ECAL-CONTROL BOARD in conjunction with the AD7853 evaluation board.

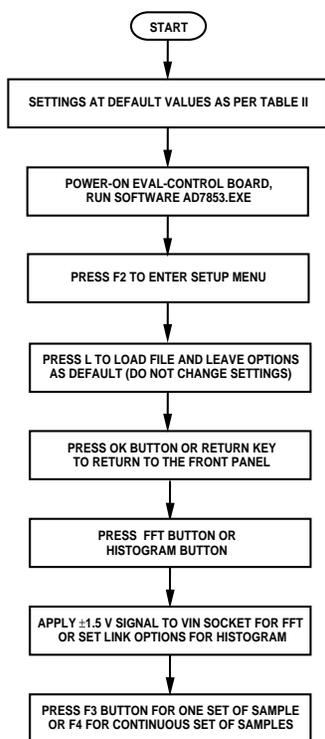


Figure 5. Flowchart for performing AC and DC tests after power-on.

## Calibration Options Menu

Included in the Setup menu (obtained by pressing F2 key when in the front panel) is the Calibration options button and the Power-Down options button. Pressing the Calibration Options button brings the user into the Calibration Options Menu. Several calibration options are presented in the Calibration Options Menu as shown in Figure 6. These options include Full self calibration, Self gain calibration, Self offset calibration, System gain calibration, System offset calibration, and Calibration registers. On selecting any one of the three Self calibration buttons the part is calibrated appropriately. On selecting one of the System calibration buttons the user will be prompted by an extra pop-up window to apply the required system voltage across the AIN(+) and AIN(-) pins of the AD7853. Upon hitting the OK button in this prompt window the part is calibrated and the software returns to the Calibration Options Menu. At this point the user can select OK to return to the Setup menu or select another calibration option. Please see the AD7853 data sheet for more information on system calibration.



Figure 6. Calibration Options Menu

**Note that when using the internal reference of the AD7853 as the reference for the system, and the biasing circuitry to bias up the input voltage (LK20 in position B and LK21 connected) the voltage applied to SK3 should not be less than 0 V.**

## Calibration Registers Menu

On selecting the Calibration registers button, the offset, gain and DAC calibration registers contents will be displayed as shown in Figure 7. The calibration register values shown in Figure 7 are typical values and will vary from device to device. The contents of the gain calibration register is listed first, second is the offset calibration register followed by the 8 DAC calibration registers. For the DAC calibration registers, the DAC 1st MSB calibration register contents is listed first, the DAC 2nd MSB calibration register contents second, and so on down to the DAC 8th MSB calibration register contents. The contents of any of the calibration registers can be altered if so required. In most applications there will be no need to alter the register contents. Once the contents of the register are altered the new values will not be loaded to the AD7853 until the ok

button is pressed (Function key "o"). If the cancel button is pressed (Function key "c") then no data will be loaded to the AD7853. Once the ok or cancel buttons are pressed the software will return to the Calibration Options Menu. At this point the user can select ok to return to the Setup Menu or select another calibration option.

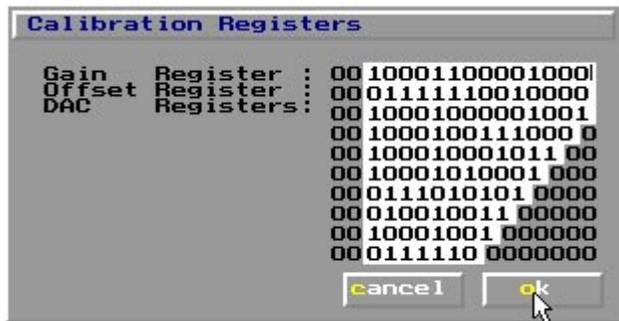


Figure 7. Calibration Registers

To demonstrate the workings of the calibration registers the user can change the offset calibration register contents and then perform a self offset calibration which will cause the offset calibration register to return to its initial value. A similar approach can be used on the Gain and DAC calibration registers to see how the registers change when a self gain calibration and full self calibration are performed respectively.

### Power Down Menu

Also included in the Setup menu is the Power-Down Options button. **Link LK19 should be in position B to allow correct operation of the Power-Down functions.** When this button is pressed several Power-Down Options will be presented in the Power-Down Options Menu as shown in Figure 8. The options include Normal operation (default mode), Full power-down, and Partial power-down. The option of turning off the master clock, CLKIN, (when the CLKIN and CONVST signals are provided by the EVAL-CONTROL BOARD) is also available. Each of these options is selected by clicking the appropriate tick box and pressing the ok button. By monitoring the supply current while programming the different power down modes demonstrates how the supply current can be reduced significantly (e.g. 1-2  $\mu\text{A}$  in Full power-down mode with the clock disabled). Please see the AD7853 data sheet for more information on the Power-Down modes of the AD7853.



Figure 8. Power Down menu

To monitor the supply current, when using this evaluation board with the EVAL-CONTROL BOARD, LK4 should be unconnected and an ammeter should be connected across the link, LK4. This has the effect of connecting the ammeter in series with the  $V_{DD}$  supply from the EVAL-CONTROL BOARD. If the  $V_{DD}$  is supplied via socket 3 and not from the EVAL-CONTROL BOARD the ammeter should be connected externally and LK4 unconnected. This  $V_{DD}$  supplies only the AD7853 and the 74HC08. Since the 74HC08 takes significantly less current than the AD7853 the current measured by the ammeter represents the AD7853 supply current. A typical procedure for evaluating how the current reduces, when using the EVAL-CONTROL BOARD to supply the  $V_{DD}$ , is shown by the flowchart in Figure 9 on the next page.

To return to normal operation, return to the power down menu, select normal operation, ensure that the clock is enabled and press the ok button.

Note that the AD7853 should be set to Normal Operation mode before AC or DC tests are performed.

For the full power down the current should be in the 1-2  $\mu\text{A}$  range typically (clock disabled).

For the partial power down the current should be in the 200-250  $\mu\text{A}$  range typically (clock disabled).

In normal mode operation the supply current should be at the 4.5 mA level typically (clock disabled).

Enabling the clock in both the partial and normal modes of operation will cause the current to increase by the order of 1.5 mA. This is because the driver for the SCLK will be enabled and consumes 1.5 mA typically. In the Full power down mode then with the clock enabled the current should be in the range 10-20  $\mu\text{A}$ . The reason for only the small increase here is that the SCLK driver will always be disabled internally by the device when in Full power down mode.

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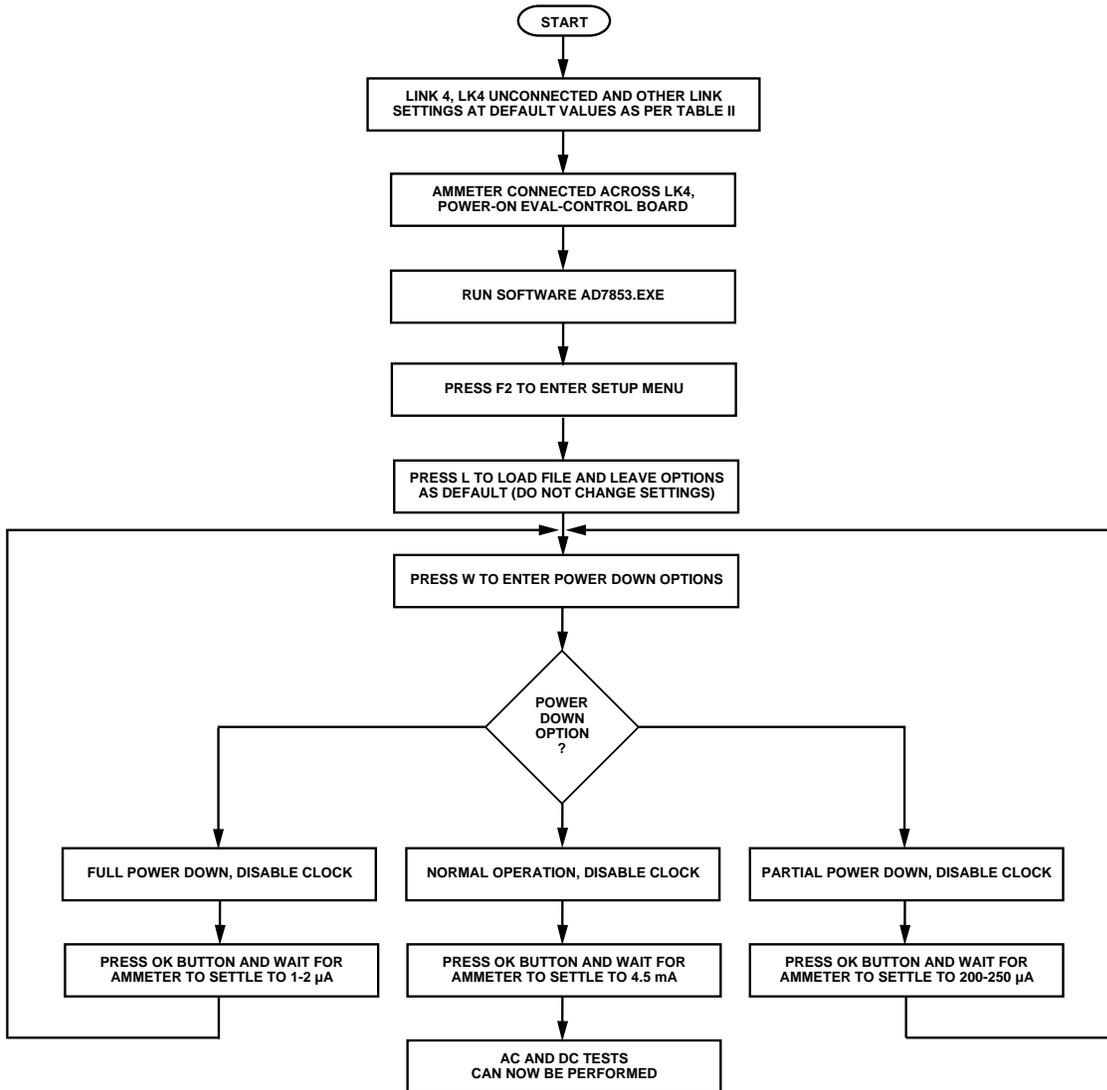


Figure 9. Flowchart for monitoring the current in power down modes.

**Appendix A: AD7853.CFG FILE DESCRIPTION**

The AD7853.CFG file is on the distribution diskette that comes with the AD7853 evaluation board. It provides initial configuration information to the AD7853.EXE program. Normally no changes need to be made to the .CFG file. However sometimes it may be desired to change the initial configuration. This is done by editing the file to make the changes and then saving the changes before running the AD7853.EXE program. Here is a listing of the contents of the AD7853.CFG file.

```
[DemoController]
```

```
Use69=FALSE
```

```
AFlags=TRUE
```

```
Sports=FALSE
```

```
Voltage=5
```

```
[EvalBoard]
```

```
Part=AD7853
```

```
Program=ad7853.hip
```

```
NumBits=12
```

```
MaxFrequency=200000
```

```
DefaultFrequency=200000
```

```
DefaultNsamp=2048
```

```
BinaryCoding=TwosComplement
```

```
;BinaryCoding=Binary
```

```
;BinaryCoding=OffsetBinary
```

```
[AnalogInput]
```

```
InputPeak=3
```

```
InputRange=3
```

```
;InputOffset=0
```

There are three main sections to the configuration file. The name of each section is given in square brackets in the file listing. These sections are [DemoController], [EvalBoard] and [AnalogInput]. Comments are included in the listing by preceding the comment with a semi-colon.

[DemoController] section

This section controls some of the settings of the EVAL-CONTROL BOARD card. **These settings should not be changed.**

[EvalBoard] section

This section tells the AD7853.EXE program the name of the part being evaluated, the .HIP program that needs to be downloaded to the ADSP-2111, the number of bits of the ADC, the maximum sampling frequency, the default sampling frequency, the default number of samples to be taken and the form of coding used by the ADC.

The sampling frequencies are in Hertz. There are three valid types of binary coding. These are TwosComplement, Binary and OffsetBinary. Binary and OffsetBinary are interpreted in the same manner in the AD7853.EXE program and may be used interchangeably.

[AnalogInput] section

InputRange gives the default voltage range of the input channel. The InputRange for the AD7853 should be the same as the reference voltage. InputOffset should be set to the input voltage that returns a code of zero when converted by the AD7853.

**APPENDIX A2: AD7853.DSP FILE DESCRIPTION**

There is a software listing in the file AD7853.dsp on the disk which comes with the AD7853 evaluation board. This software listing details the code to allow the AD7853 interface to the DSP-2111. It describes the ADSP-2111 configuration and the interface setup. This is not the full section of code that is used, but the relevant sections for interfacing the AD7853 to the ADSP-2111 are listed. This code is provided as a means of easing the development of dsp code for interfacing the AD7853 to the ADSP-2111 and other DSP processors.

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## Appendix B: AD7853 EVALUATION BOARD CIRCUIT DIAGRAM, COMPONENT LAYOUT, AND COMPONENT LISTING

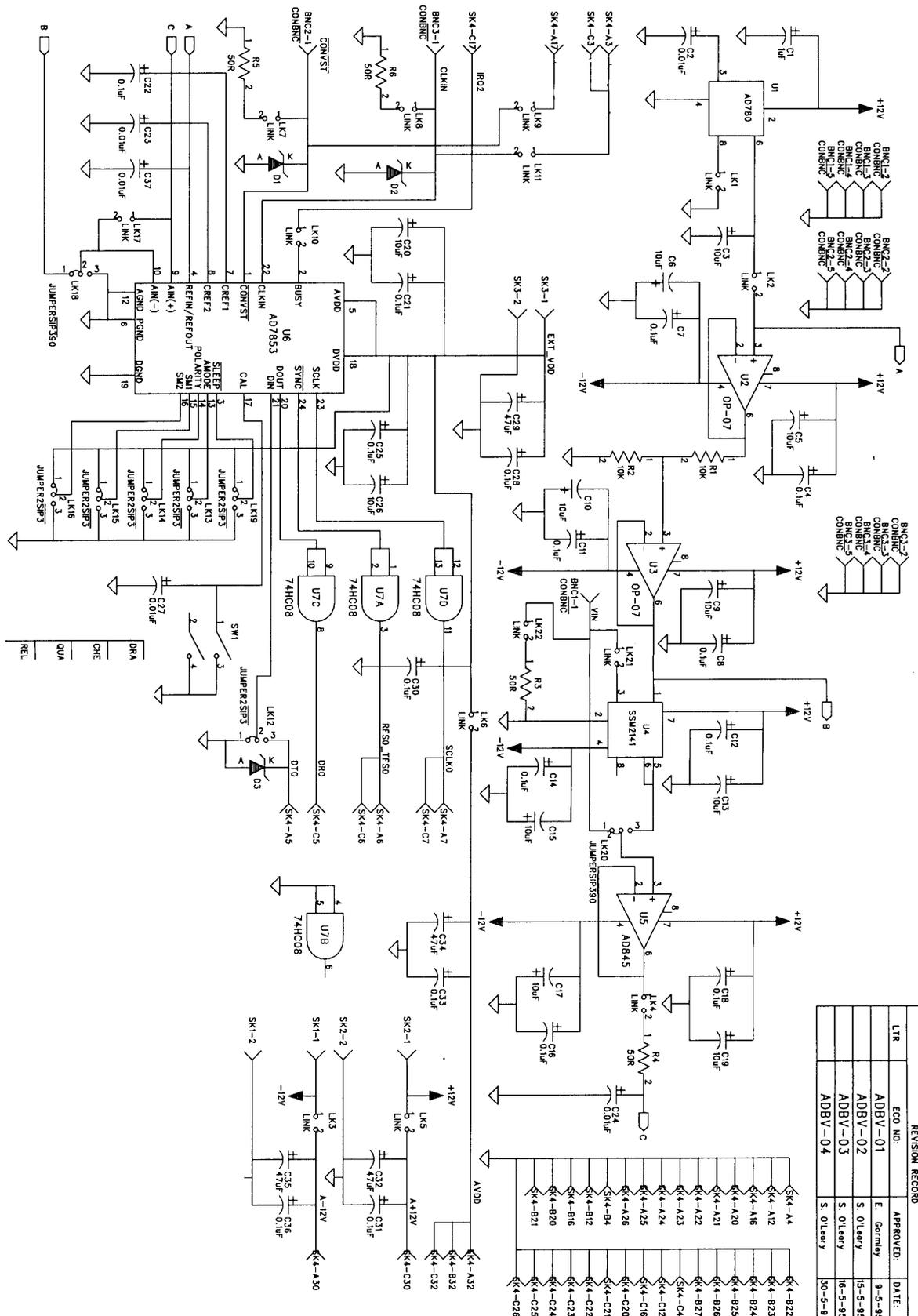


Figure 10. Evaluation Board Circuit Diagram

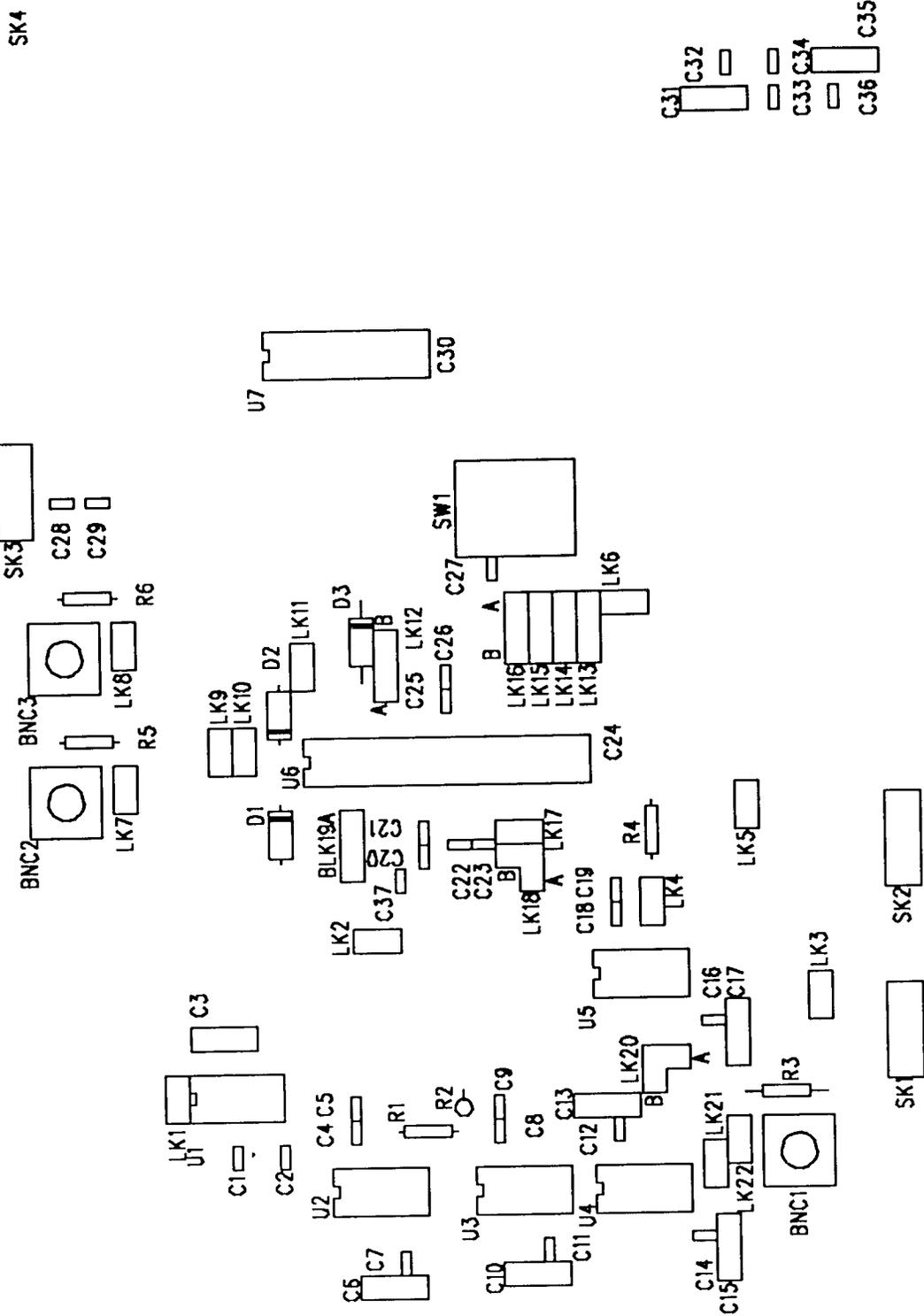


Figure 11. Evaluation Board component layout

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## COMPONENT LIST

| Item | Qty. | label   | IC                | Manufacturer   | Description   |
|------|------|---|-------------------|----------------|---|
| 1    | 1    | U1  | AD780             | Analog Devices | 2.5/3 V Reference   |
| 2    | 2    | U2-3  | ADOP-07           | Analog Devices | OP-AMP  |
| 3    | 1    | U4  | SSM2141           | Analog Devices | Line receiver   |
| 4    | 1    | U5  | AD845             | Analog Devices | OP-AMP  |
| 5    | 1    | U6  | AD7853            | Analog Devices | ADC   |
| 6    | 1    | U7  | 74HC08            | Motorola       | Quad 2-Input POS-AND gate   |
| 7    | 1    | C1  | CAP, 1 $\mu$ F    | AVX-Kyocera    | Tantalum Bead   |
| 8    | 4    | C2 C23  | CAP, 0.01 $\mu$ F | Philips        | Multilayer Ceramic Cap  |
| 9    | 11   | C3 C5 C6<br>C9 C10<br>C13 C15<br>C17 C19<br>C20 C26             | CAP, 10 $\mu$ F   | AVX-Kyocera    | Tantalum Bead   |
| 10   | 15   | C4 C7 C8<br>C14 C16<br>C18 C21<br>C22 C25<br>C28 C31<br>C33 C36 | CAP, 0.1 $\mu$ F  | Philips        | Multilayer Ceramic Cap  |
| 11   | 1    | C24   | CAP, 0.01 $\mu$ F |                | Multilayer Ceramic COG (NPO) Cap 0.01 $\mu$ F<br>10%, 2.54mm (0.1") Pin |
| 12   | 4    | C29 C32<br>C34 C35  | CAP, 47 $\mu$ F   | AVX-Kyocera    | Tantalum Bead   |
| 13   | 1    | C30   | CAP, 0.02 $\mu$ F |                | DIL14 Ceramic Decoupling Cap.   |
| 14   | 3    | SK1-3   |                   |                | Interlocking PCB terminal block   |
| 15   | 1    | SK4   |                   |                | Harting 90 degree 96 way PCB plug (male).                               |
| 16   | 3    | D1-3  | SD103C            | HP             | Small signal Schottky Diode   |
| 17   | 14   | LK1-11<br>LK17<br>LK21-22                                       | Jumper            |                | 2-way Jumper block  |
| 18   | 6    | LK12-L16<br>LK19  | Jumper            |                | 3-way Jumper block  |
| 19   | 2    | LK18 LK20   | Jumper            |                | 3-way Jumper block  |
| 20   | 3    | SMB 1-3   | SMB 50 $\Omega$   |                | SMB straight 50 $\Omega$ PCB jack                                       |
| 21   | 2    | R1-2  | 10k $\Omega$      |                | 0.1%, 1/4W resistor   |
| 22   | 4    | R3-6  | 51 $\Omega$       |                | 1%, 0.6W resistor   |
| 23   | 1    | SW1   | B3W1000           |                | SPNO 6mm x 6mm sealed switch  |