ANALOG DEVICES

TECHNICAL NOTE

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Obtaining Optimum Performance From the AD7731 Sigma Delta ADC.

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Introduction

The AD7731 is a complete analog front-end for process control applications. The device has a proprietary programmable gain front end which allows it to accept a range of input signal ranges including low-level signals directly from a transducer. The sigma delta architecture of the part consists of an analog modulator and a low-pass programmable digital filter, allowing adjustment of filter cutoff, output rate and settling-time.

The part features three buffered differential programmable gain analog inputs (which can be configured as five pseudo-differential inputs) as well as a differential reference input. The part operates from a single +5 V supply and accepts seven unipolar analog input ranges: 0 to +20 mV, +40 mV, +80 mV, +160mV, +320 mV, +640 mV and +1.28 V and seven bipolar ranges ±20 mV, ±40 mV, ±80 mV, ±160 mV, ±320 mV, ±640 mV and ±1.28 V. The peak-to-peak resolution achievable directly from the part is 16 bits at an 800 Hz output rate. The part can switch between channels with 1ms settling time and maintain a performance level of 13 bits of peak-to-peak resolution.

The serial interface on the part can be configured for three-wire operation and is compatible with microcontrollers and digital signal processors. The AD7731 contains self-calibration and system calibration options and features an offset drift of less than 5nV/°C and a gain drift of less than 2ppm/°C.

As with all high resolution converters care has to be taken with printed circuit board layout to achieve optimum performance. The issues that give the greatest concern include power supply decoupling, grounding techniques and the general location of the digital and analog signals on the printed circuit board. This technical note outlines general guidlines on printed circuit board design and layout in order to obtain the optimum performance from the AD7731.

Grounding and Layout

Since the analog inputs and reference input are differential, most of the voltages in the analog modulator are common-mode voltages. The excellent Common-Mode Rejection of the AD7731 will remove common-mode noise on these inputs. The analog and digital supplies to the AD7731 are independent and separately pinned out to minimize coupling between the analog and digital sections of the device. The digital filter will provide rejection of broad-band noise on the power supplies, except at integer multiples of the modulator sampling frequency. The digital filter also removes noise from the analog and reference inputs provided those noise sources do not saturate the analog modulator. As a result, the AD7731 is more immune to noise interference that a conventional high resolution converter. However, because the resolution of the AD7731 is so high and the noise levels from the AD7731 so low, care must be taken with regard to grounding and layout.

The printed circuit board which houses the AD7731 should be designed such that the analog and digital sections are separated and confined to certain areas of the board. This facilitates the use of ground planes which can be separated easily. A minimum etch technique is generally best for ground planes as it gives the best shielding. Digital and analog ground planes should only be joined in one place. If the AD7731 is the only device requiring an AGND to DGND connection, then the ground planes should be connected at the AGND and DGND pins of the AD7731. If the AD7731 is in a system where multiple devices require AGND to DGND connections, the connection should still be made at one point only, a star ground point which should be established as close as possible to the AD7731.

Avoid running digital lines under the device as these will couple noise onto the die. The analog ground plane should be allowed to run under the AD7731 to avoid noise coupling. The power supply lines to the AD7731 should use as large a trace as possible to provide low impedance paths and reduce the effects of glitches on the power supply line. Fast switching signals like clocks should be shielded with digital ground to avoid radiating noise to other sections of the board and clock signals should never be run near the analog inputs. Avoid crossover of digital and analog signals. Traces on opposite sides of the board should run at right angles to each other. This will reduce the effects of feedthrough through the board. A microstrip technique is by far the best but is not always possible with a double-sided board. In this technique, the component side of the board is dedicated to ground planes while signals are placed on the solder side.

Good decoupling is important when using high resolution ADCs. All analog supplies should be decoupled with 10µF tantalum in parallel with 0.1µF capacitors to AGND. To achieve the best from these decoupling components, they have to be placed as close as possible to the device, ideally right up against the device. All logic chips should be decoupled with 0.1µF disc ceramic capacitors to DGND. In systems where a common supply voltage is used to drive both the AV_{DD} and DV_{DD} of the AD7731, it is recommended that the system's AV_{DD} supply is used. This supply should have the recommended analog supply decoupling capacitors between the AV_{DD} pin of the AD7731 and AGND and the recommended digital supply decoupling capacitor between the DV_{DD} pin of the AD7731 and DGND.

POWER SUPPLIES

There is no specific power sequence required for the AD7731, either the AV_{DD} or the DV_{DD} supply can come up first. While the latch-up performance of the AD7731 is very good, it is important that power is applied to the AD7731 before signals at REF IN, AIN or the logic input pins in order to avoid latch-up caused by excessive current. If this is not possible, then the current which flows in any of these pins should be limited to less than 30mA per pin and less than 100mA cumulative. If separate supplies are used for the AD7731 and the system digital circuitry, then the AD7731 should be powered up first. If it is not possible to guarantee this, then current limiting resistors should be placed in series with the logic inputs to again limit the current to less than 30mA per pin and less than 100mA total.

Evaluating the AD7731 Performance

Figures 1 and 2 show a recommended layout for achieving optimum performance from the AD7731. Figure 3 shows a silkscreen for this layout. Details on this board are outlined in the evaluation board application note for the AD7731.
Noise levels in the signals applied to the AD7731 may also affect performance of the part. The AD7731 allows a technique for evaluating the true performance of the part, independent of the analog input signal. This scheme should be used after a calibration has been performed on the part. The performance obtained from the layout shown in figures 1 and 2 is outlined in Tables 1 to IV on the AD7731 data sheet.
A full evaluation board package including a fully assembled and tested evaluation board, documentation, software for controlling the board over the printer port of a PC and software for analyzing the AD7731's performance on the PC is available from Analog Devices. The evaluation board order number is EVAL-AD7731EB.

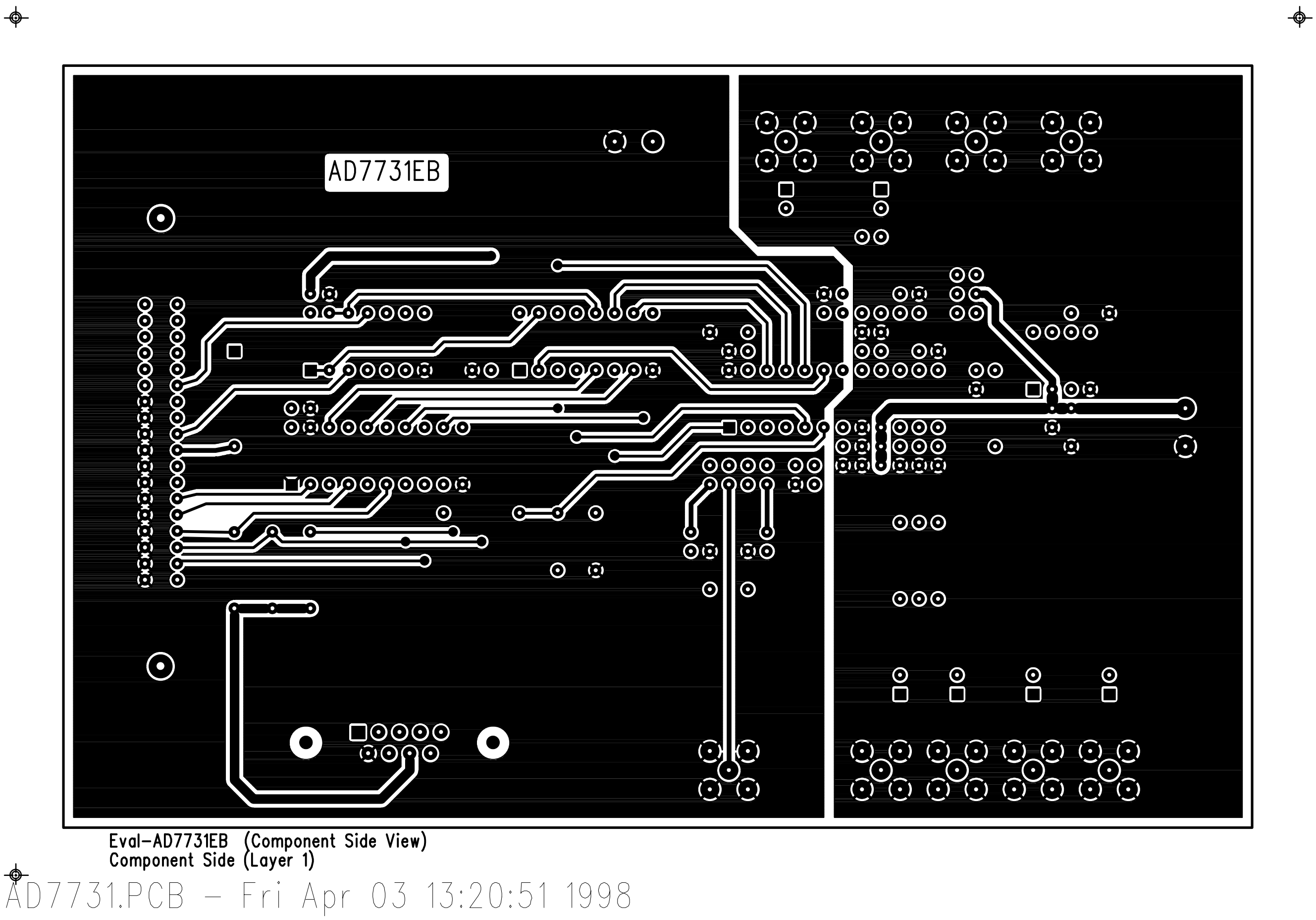

Figure 1. Eval-AD7731EB Component Side Artwork.

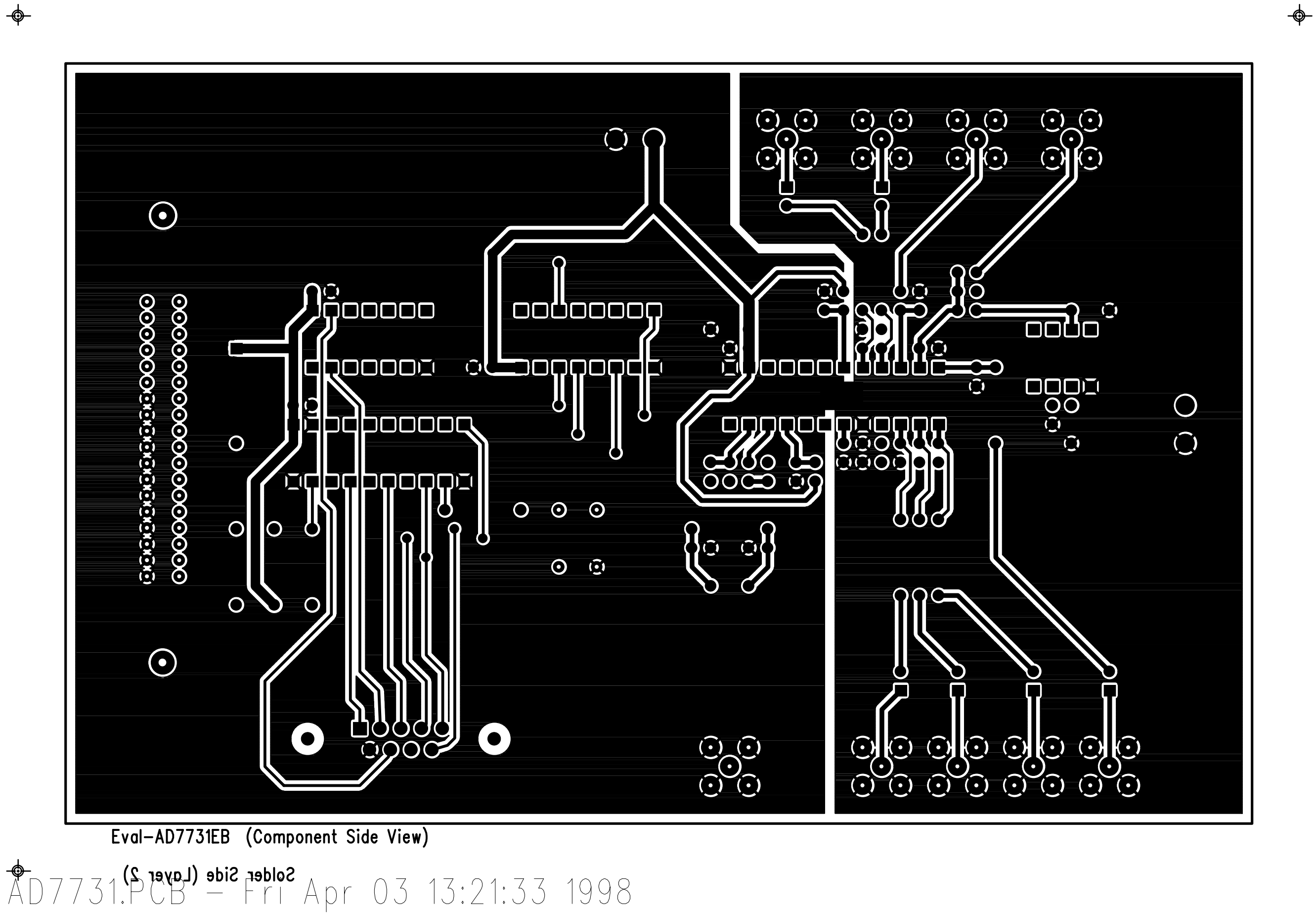

Figure 2. Eval-AD7731EB Solder Side Artwork.

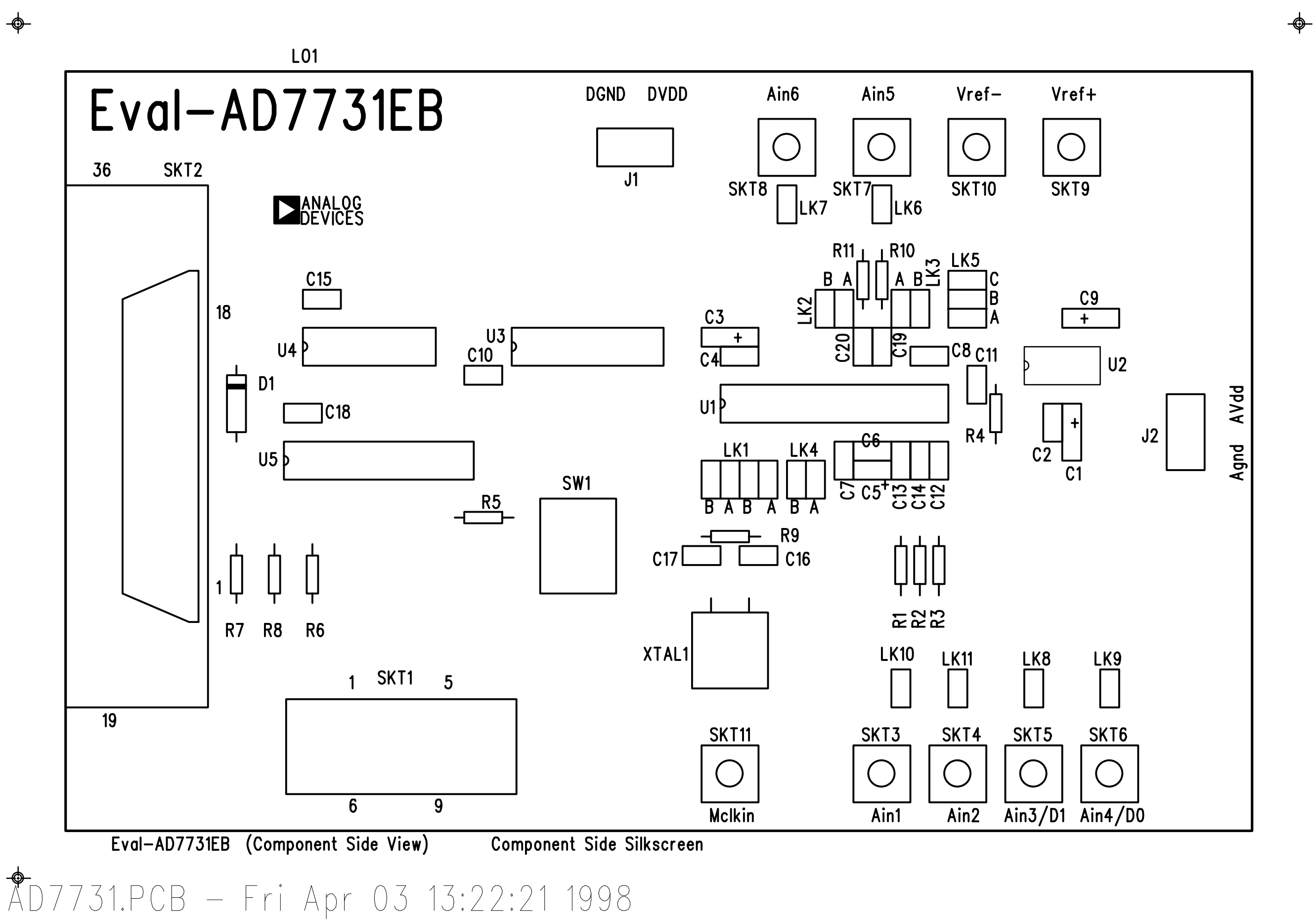

Figure 3. Eval-AD7731EB Silkscreen Artwork.