



Interfacing AD7865 Parallel ADCs to ADSP-21161 SHARC® Processors

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Rev 1 – December 17, 2004

Introduction

This application note explains how to interface parallel ADCs to ADSP-21161 SHARC® processors. The parallel ADC considered in this application note is AD7865. This application note also provides example code to demonstrate how the SHARC processor's external port can be programmed to receive data from the AD7865 in core and DMA modes.

About AD7865 ADCs

The AD7865 is a fast, low-power, four-channel simultaneous sampling 14-bit A/D converter that operates from a single 5 V supply. The device contains a 2.4 μ s successive approximation ADC, four track/hold amplifiers, 2.5 V reference, on-chip clock oscillator, signal conditioning circuitry, and a high-speed parallel interface. The input signals on four channels are sampled simultaneously, thus preserving the relative phase information of the signals on the four analog inputs.

The AD7865 allows any subset of the four channels be converted, maximizing the throughput rate on the selected sequence. The channels to be converted can be selected via hardware (channel select input pins) or via software (programming the channel select register).

The high-speed parallel interface also allows interfacing to 3 V processors.

AD7865 Product Highlights

- The AD7865 features four track/hold amplifiers and a fast (2.4 μ s) ADC, allowing simultaneous sampling and then conversion of any subset of the four channels.
- The AD7865 operates from a single 5 V supply and consumes only 115 mW (typical), making it ideal for low-power and portable applications.
- The AD7865 offers a high-speed parallel interface for easy connection to microprocessors, microcontrollers, and digital signal processors.
- The AD7865 is offered in three versions, each with different analog input ranges. The AD7865-1 offers the standard industrial ranges of ± 10 V and ± 5 V; the AD7865-2 offers a unipolar range of 0 V to 2.5 V (or 0 V to 5 V); and the AD7865-3 offers the common signal processing input range of ± 2.5 V.
- The AD7865 features very tight aperture delay matching between the four input sample-and-hold amplifiers.

AD7865 ADC Applications

AD7865 applications include:

- AC motor control
- Uninterruptible power supplies
- Industrial power meters/monitors

- Data acquisition systems
- Communications

About ADSP-21161 Processors

The ADSP-21161 is the second member of the SHARC processor family of 32-bit floating-point programmable processors to be based on a SIMD core architecture optimized for digital signal processing performance. This processor is capable of 600 million math operations per second (MFLOPs). Like all SHARC processors, the ADSP-21161 is code-compatible with the other members of the SHARC family and supports both fixed- and floating-point data types. The ADSP-21161 lowers the price for SIMD SHARC processing performance and is an outstanding solution for many price-sensitive applications.

ADSP-21161 Processor Features

ADSP-21161 processor features include:

- 100 MHz (10 ns) SIMD SHARC DSP core
- 600 MFLOPS (32-bit floating-point data), 600 MOPS (32-bit fixed-point data)
- Code-compatible with all SHARC processors
- Supports IEEE-compatible 32-bit floating-point, 40-bit floating-point, and 32-bit fixed-point math
- Single-cycle instruction execution, including SIMD operations in both computational units
- One Mbit on-chip dual-ported SRAM
- 2.4 Gbyte/second on-chip data bandwidth
- 14 zero-overhead DMA channels
- Four synchronous serial ports with I2S support
- Serial ports support 128 channels TDM frames with selection of companding on a per-channel basis

- Integrated support for SDRAM and SBSRAM external memories
- Support for single-cycle, 100 MHz instruction execution from 48-bit-wide external memories

ADSP-21161 Applications

ADSP-21161 applications include:

- Speech recognition
- Professional and high-end consumer audio
- Automotive entertainment
- Fingerprint recognition
- Digital audio broadcast
- Wireless communications
- Motor control
- Global positioning systems
- Medical equipment
- Telephony
- Test equipment

AD7865-to-ADSP-21161 Interface

This application note employs a high-speed parallel 14-bit ADC for the interface. A single conversion start signal ($/CONVST$) places all of the track/holds into hold mode simultaneously and initiates conversion sequence for the selected channels. The $/EOC$ signal indicates the end of each individual conversion in the selected conversion sequence. The $BUSY$ signal indicates the end of the conversion sequence. Data is read from the part via a 14-bit parallel data bus using the standard $/CS$ and $/RD$ signals.

Core Mode Interface

Refer to the functional block diagram in [Figure 1](#) for details on the ADSP-21161-to-AD7865 ADC interface. This interface scheme is used to receive data from the ADC in processor core mode. Note that all of the four ADC channels are

selected in hardware. When the H#/S SEL pin is at logic 0, the AD7865 conversion sequence selection is controlled via the SL1-SL4 input pins and uses an internal clock. The AD7865's data bus (DB0-DB13) is interfaced with DATA16-DATA29 of the ADSP-21161 processor.

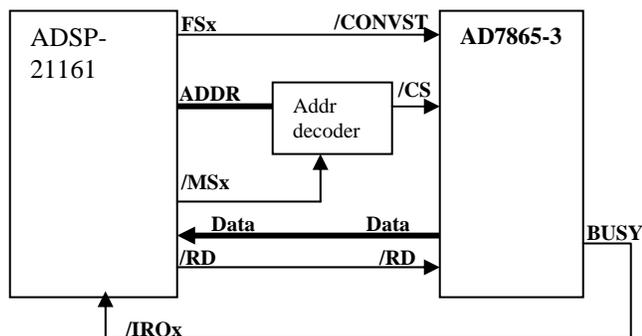


Figure 1. Interface Block Diagram in Core Mode

A low-to-high transition on the /CONVST input places all of the track/holds into hold mode and starts the conversion on the selected channels.

Frame sync of SPORT0 is used to generate the /CONVST signal for the ADC. The serial port is configured to transmit with frame sync as data independent frame sync. The SPORT frame sync frequency is determined by the value loaded in the DIV0 register. An initial dummy write to the SPORT TX0A register is required to start continuous frame sync on the FS0 signal. A BUSY signal from the AD7865 indicates the end of conversion on all the selected ADC channels. The falling edge of BUSY triggers an interrupt. The interrupt is configured to be edge sensitive. The ADC FIFO is read with four consecutive core read operations in the interrupt service routine. The AD7865, in this case, is a memory-mapped device for the ADSP-21161 processor. Refer to the timing diagram in Figure 2 for reading after the conversion sequences.

The screen captures in Figure 3 and Figure 4 were taken with a logic analyzer while receiving data from the AD7865 in core mode.

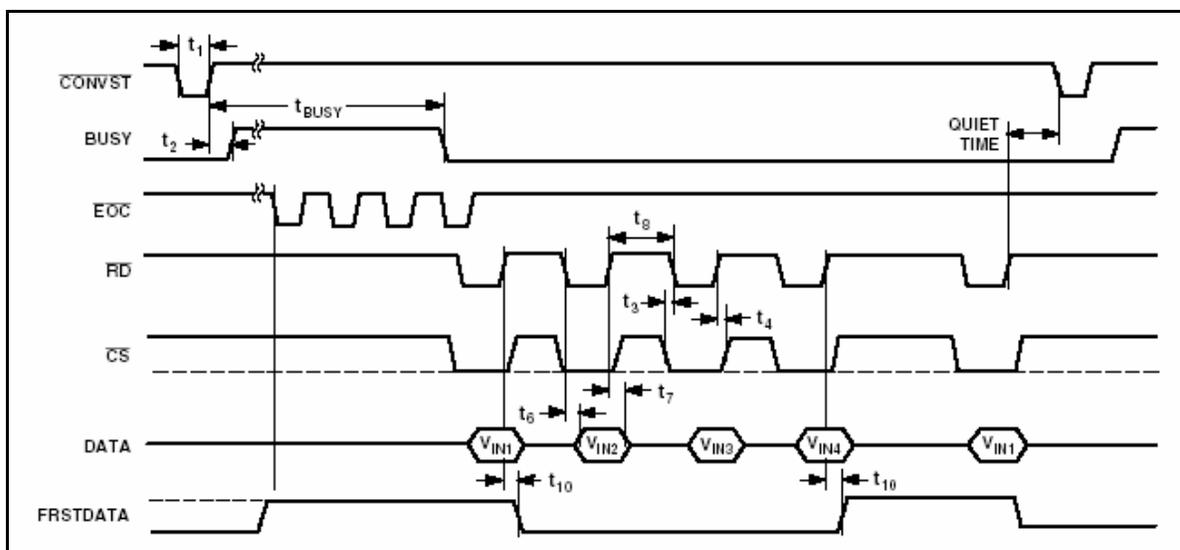


Figure 2. Timing Diagram, Reading After the Conversion Sequences

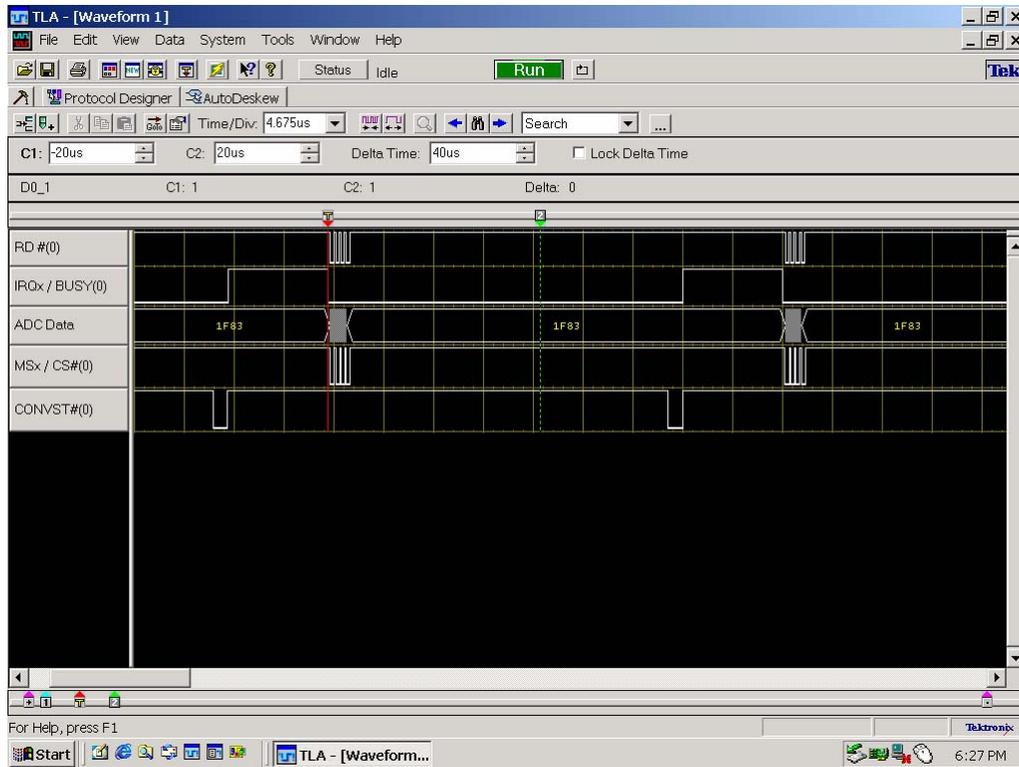


Figure 3. Timing Diagram 1, Reading After the Conversion Sequences

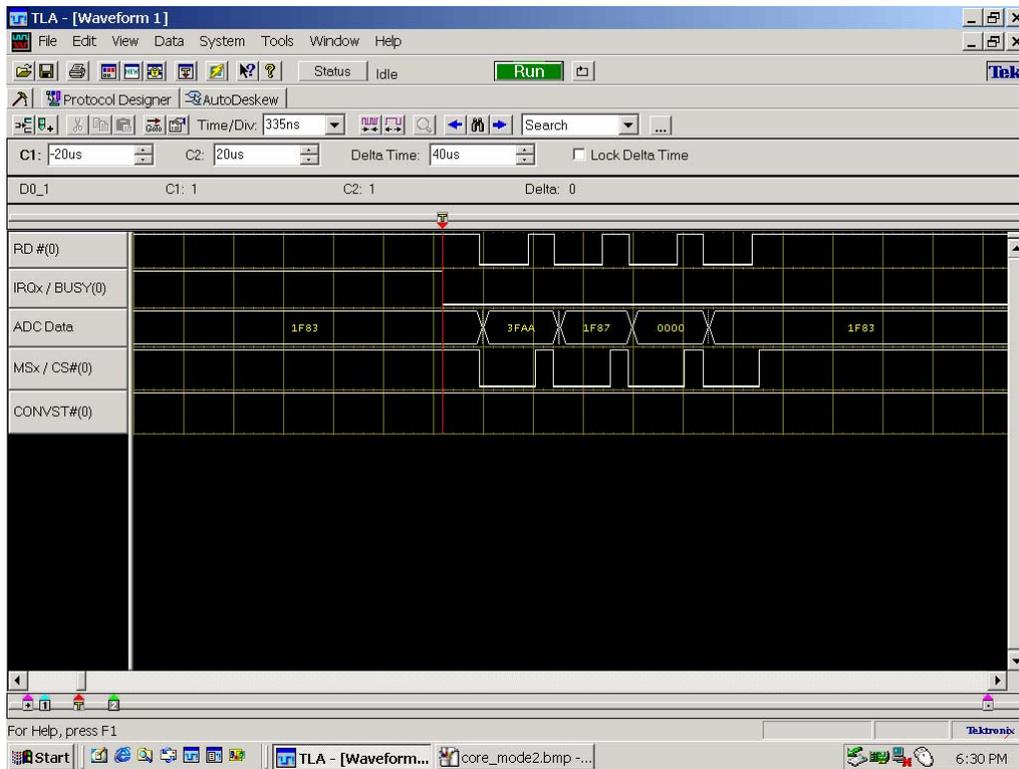


Figure 4. Timing Diagram 2, Reading After the Conversion Sequences

DMA Mode Interface

Refer to the functional block diagram in [Figure 5](#) for details on the ADSP-21161-to-AD7865 ADC interface scheme to receive data from the ADC in DMA mode. The ADC channel selection is performed in hardware.

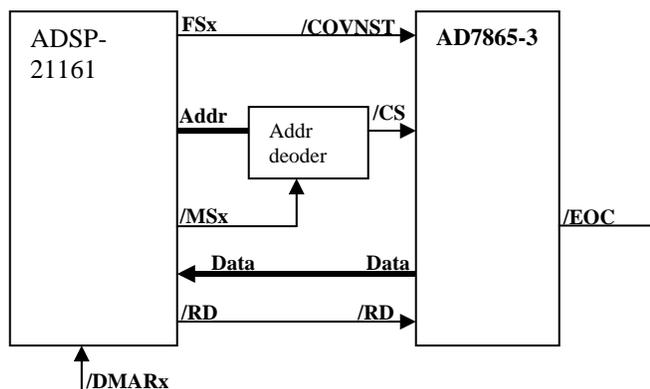


Figure 5. Interface Block Diagram in Paced Master DMA Mode

The /EOC (end of conversion) signal is activated after the conversion of each channel. /EOC is

connected to DMAR1 of the processor. The end-of-conversion pulses act as DMA requests for the SHARC. In this scenario, paced master mode for DMA seems appropriate. In this mode, the processor attempts the internal memory DMA transfers indicated by the DMA counter (CEP_x), making transfers based on external DMA request inputs. The processor generates a DMA request whenever the external device asserts the $DMAR_x$ pin. To read data from the ADC, the processor controls the data transfer using the /RD signal and by applying the selected number of wait states. The /COVNST start signal is generated using the SPORT0 frame sync.

Refer to the timing diagram in [Figure 6](#) for reading between conversion sequences. The screen captures in [Figure 7](#) and [Figure 8](#) were taken with a logic analyzer while receiving data in paced master DMA mode.

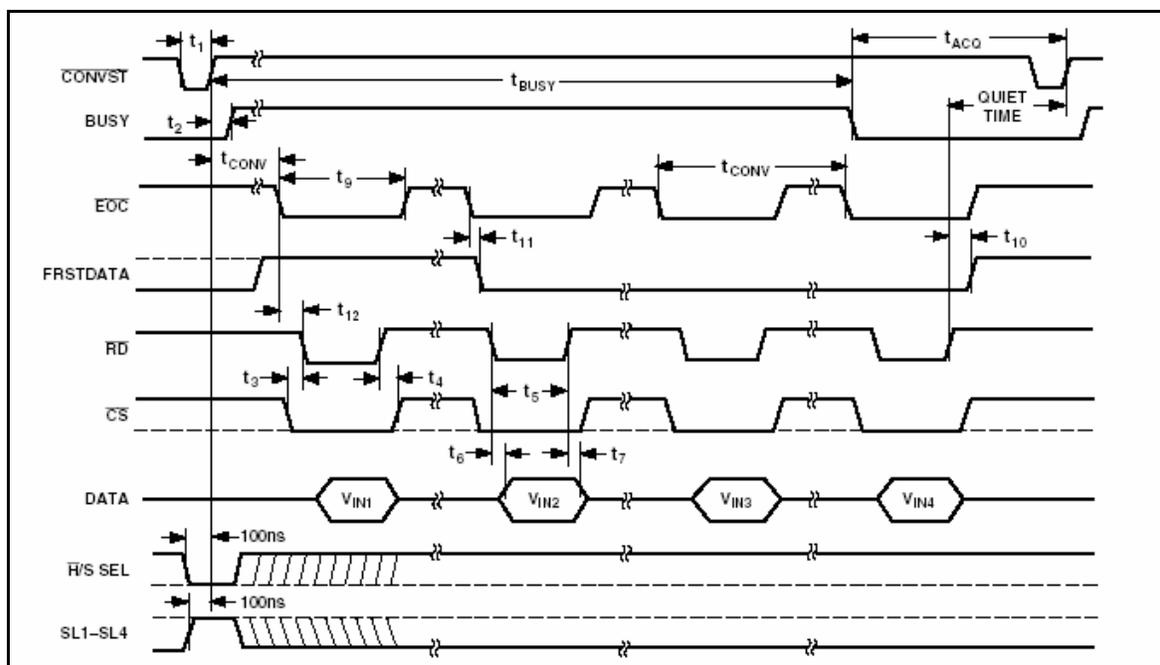


Figure 6. Timing Diagram for Reading During Conversion Sequences

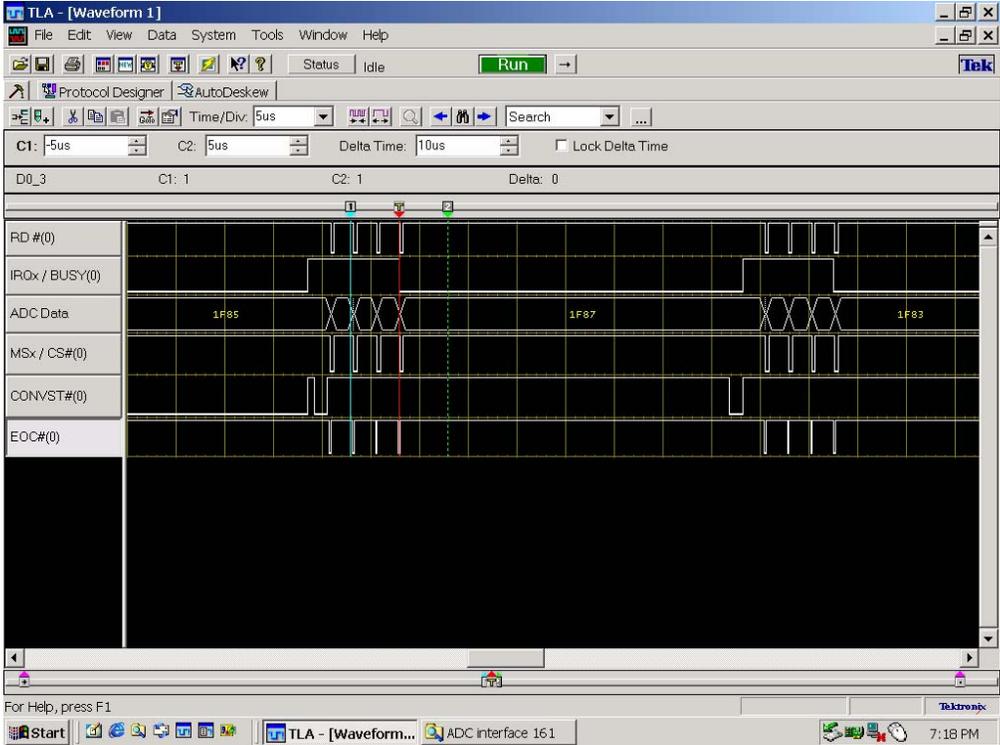


Figure 7. Timing Diagram 1 for Reading During Conversion Sequences

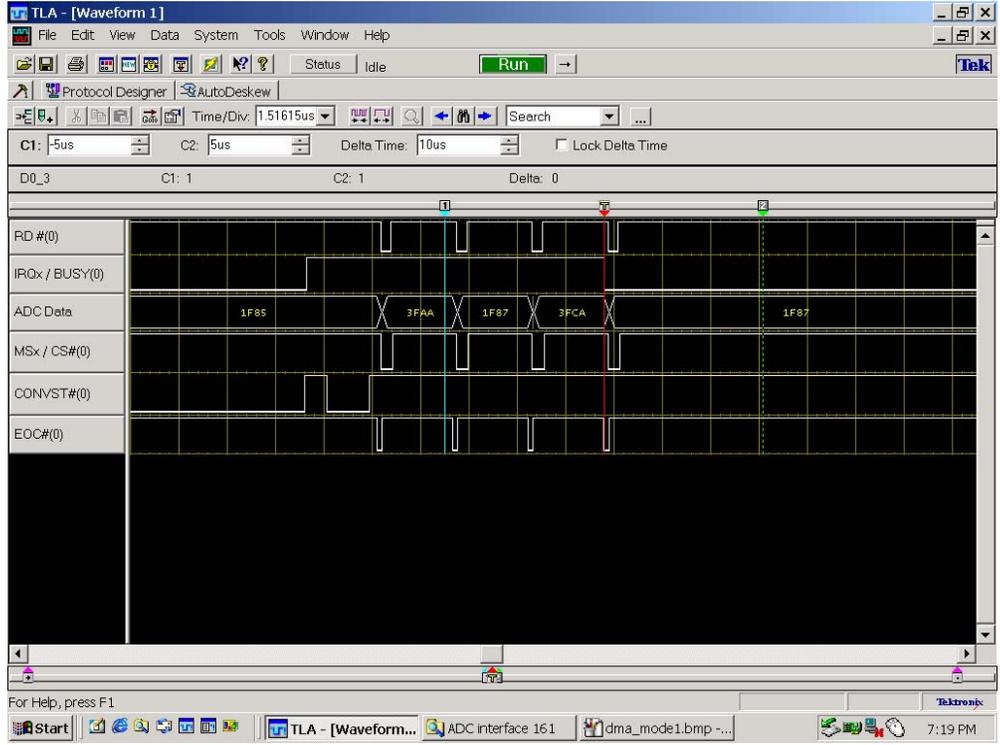


Figure 8. Timing Diagram 2 for Reading During Conversion Sequences

Conclusion

This application note shows that parallel ADCs like the AD7865 can be interfaced gluelessly with an ADSP-21161 processor. Also, the data from such ADCs can be read in core mode or DMA mode.

Appendix

Project files are included in a ZIP file attached to this application note.

References

- [1] *ADSP-21161 SHARC DSP Hardware Reference*. Third Edition, May 2002. Analog Devices, Inc.
- [2] *ADSP-21161 Evaluation System Board Schematics*, Analog Devices, Inc.
- [3] *AD7865 Technical Data Sheet*, Rev B. Analog Devices, Inc.

Document History

| Revision | Description |
|---|-----------------|
| <i>Rev 1 – December 17, 2004 by Aseem Vasudev Prabhugaonkar</i> | Initial Release |