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Application Report
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Interfacing the ADS8361 to TMS470 Processors

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ABSTRACT

This application report presents methods of interfacing the ADS8361 16-bit SAR analog-to-digital converter to the serial peripheral interface (SPI) port of TMS470 processors. The flexible clocking scheme of the TMS470 SPI port, along with its internal 16-bit shift register provides an easy hardware/software interface to this high-speed, simultaneous sampling SAR converter for a variety of motor control applications.

The software associated with this application report uses the SPI port of the TMS470R1B1M to operate the ADS8361 in the user's choice of operating modes and can be downloaded free of charge from the Texas Instruments Web site. Project collateral discussed in this application report can be downloaded from the following URL: www.ti.com/lit/zip/SLAA314.

2 Introduction

The ADS8361 is a dual, 16-bit, 500 KSPS, analog-to-digital (A/D) converter with four fully differential input channels grouped into two pairs for high-speed, simultaneous signal acquisition. Inputs to the sample-and-hold amplifiers are fully differential and are maintained differentially to the input of the A/D converter.

The ADS8361 offers a high-speed, dual serial interface and control inputs to minimize software overhead. The output data for each channel is available as a 16-bit word. TMS470 devices, such as the TMS470R1B1M with two SPI ports, can be used in a simple and straight-forward interface that requires no *glue logic* and little software overhead.

3 Hardware

The hardware used to produce the code associated with this application report includes the TMS470R1B1M Kickstart Development Kit, the HPA-MCU Interface Board, and the ADS8361EVM.

3.1 ADS8361EVM

The ADS8361EVM is a member of the modular EVM series of serial A/D converters available from Texas Instruments. The EVM provides a platform to demonstrate the functionality of the ADS8361 with various Texas Instruments DSPs and microcontrollers, while allowing easy access to all analog and digital signals for customized end-user applications. For more information on the ADS8361EVM, see the Texas Instruments user's guide SLAU094.

3.2 HPA-MCU Interface Board

The HPA-MCU Interface Board is a carrier board which allows the user to mount several different varieties of microcontrollers and C2000™ Series DSPs together with modular EVMs from the Data Acquisition Products group at Texas Instruments. For more information on the HPA-MCU Interface Board, see the Texas Instruments user's guide SLAU106.

3.3 TMS470R1B1M Kickstart Development Kit

The TMDS-FET470R1B1M is a complete development kit including all the hardware and software necessary to evaluate the TMS470R1B1M microcontroller. The hardware is provided in a convenient modular form factor. The TMDS-FET470R1B1M uses the IAR Embedded Workbench™ Integrated Development Environment (IDE) to provide full emulation with the option of designing with a stand-alone system or detaching the removable target board for integration with external analog components via the HPA-MCU Interface Board.

3.4 Hardware Interface

A three-wire interface is the minimum requirement to connect the TMDS-FET470R1B1M and the ADS8361EVM. The hardware connections for Modes II and IV are shown in Figure 1. Chip Select ($\overline{CS}$) to the ADS8361 is controlled in this case by a GPIO line, but could be tied to ground. The serial clock (SCLK), Read and Convert Start (RD+CONVST) and Serial Data Output (SDO) pins from the ADC are connected to SPI Clock (SPI1CLK), SPI Slave Chip Select (SPI1SCS), and SPI Slave Out Master In (SPI1SOMI) pins, respectively, of the serial port.

3.5 Modes II and IV

For this application report, the first SPI port (SPI1) was used as an SPI Master for Modes II and IV operation. The SPI1SCS pin is used as a general purpose input/output (GPIO) pin in this implementation in order to drive the RD+CONVST pin of the ADS8361. These pins are tied together on the ADS8361EVM by jumper W2 when the shunt is placed on pins 1-2. All connections between the TMS470 and ADS8361 are realized through the HPA-MCU Interface board in Modes II and IV.

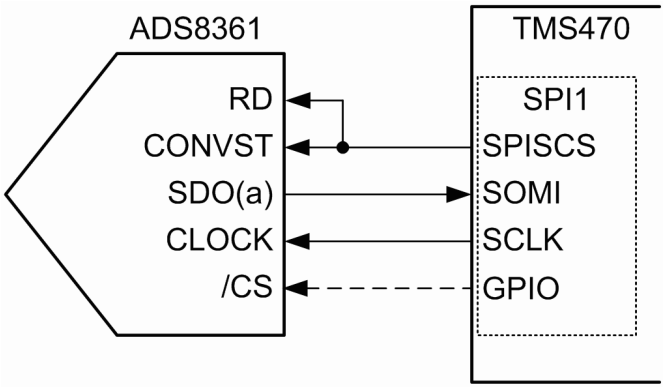

Figure 1. Hardware Interface – Modes II and IV

Modes II and IV sample two and four channels, respectively, and provide all conversion results through a single serial output pin (SDOA). In applications where only one serial port is available, this is the most efficient way to get data from the ADS8361. The maximum throughput rate using Mode II is 250 KSPS per channel and in Mode IV is 125 KSPS per channel.

3.6 Modes I and III

For Modes I and III, two serial receiver inputs are required. For these two operating modes, SPI1 was configured as a master, and SPI2 was configured as a slave device. In this case, external wire jumpers were added to the hardware to couple the serial clock from Port 1 to Port 2. A second wire jumper was added to bring the serial output *B* data from the ADS8361EVM to the Slave In Master Out (SIMO) pin of Port 2 on the TMS470. To control SPI2SCS, an optional third wire jumper can be routed from the GPIO line controlling the ADC $\overline{CS}$ signal back to SPI2SCS.

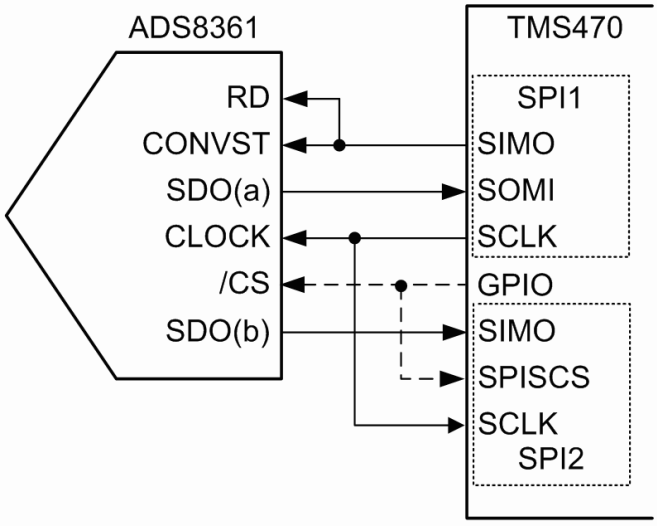

Figure 2. Hardware Interface – Modes I and III

4 Software Interface

All the software was written and compiled using the Kickstart version of Embedded Workbench™ from IAR. This software is the free version of the IDE and is available for download from the TI Web site.

4.1 SPI1 Settings

SPI Control registers 1 and 2 (SPIxCTRL1 and SPIxCTRL2) set up the basic operation of the serial interface. Character length and clock speed are set in SPIxCTL1 by writing 0xAA to the respective register. This sets up the port for 10-bit transfers with a serial clock of 9.8 MHz. SPI1 is configured in SPI master mode with CPOL=0 and CPHA=0 by writing 0x28 to the SPI1CTRL2 register.

The SPISIMO, SPISOMI, and SPICLK functions are enabled in the SPI Pin Control register 6 (SPI1PC6) by writing 0x0E to the SPI1PC6 register. The SPI1SCS pin is configured as a GP output pin and used to control the start of conversion as well as the read function of the ADS8361. SPISIMO also is enabled in this step and could be used to drive the input to an SPI-based DAC, if desired.

By setting the CHARLEN bits in the SPI1CTRL to 0x0A, 10 serial clocks are transmitted from the TMS470 to the ADS8361 on each conversion cycle. The ADS8361 requires 20 clock cycles to complete a conversion; two 10-bit transfers are carried out with each conversion cycle. Received data (including channel ID bits) is contained in the 9 LSBs of the first transfer, and 9 MSBs of the second.

4.2 Starting a Conversion

By connecting the GP output configured SPISCS of the SPI port to the RD+CONVST input on the ADS8361 EVM, a conversion cycle is started by setting the GPIO high and writing a dummy command to the SPI Data register (SPIDAT) to start the SCLK. The SPISCS is driven low by the TMS470 at the end of the first data transfer.

Channel information is contained in the serial output from the ADS8361 when operating the device in multichannel modes. The channel ID bits are presented with the second and third SCLK cycles. The conversion results, starting with the MSB, are shifted out of the ADS8361 on the fourth SCLK cycle.

The $\overline{CS}$ pin to the ADC is controlled by GPIO. In cases where a single SPI port is driving multiple devices, using GPIO to control individual Chip Select lines allows the user to share common SPICLK, SPISOMI, and SPISIMO lines. The $\overline{CS}$ pin on the ADS8361 could be tied low to conserve GPIO resources, if necessary. The following diagram is a generalized depiction of one conversion cycle.

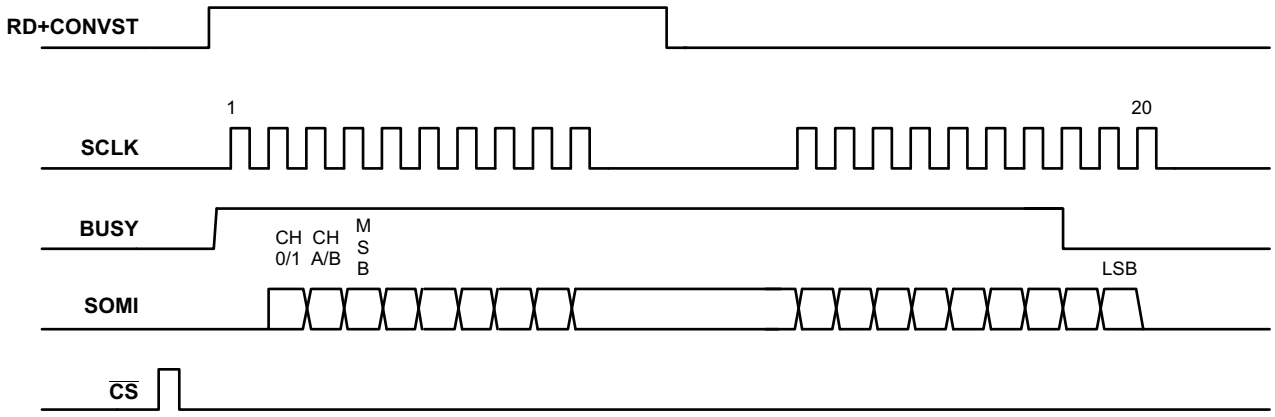

Figure 3. Timing of a Single Conversion

5 Conclusion

Using the high-performance ADS8361 combined with the SPI port of TMS470 processors is a relatively simple and straight-forward task. In motor control applications where simultaneous sampling is required, the ADS8361 can provide 16 bits of resolution to position, current, and speed loops. The flexibility of the HET timer can provide PWM control based on the feedback of the ADS8361, providing a simple flexible control solution.

6 References

1. *ADS8361, Dual, 500kSPS, 16-Bit, 2+2 Channel, Simultaneous Sampling Analog-to-Digital Converter* data sheet (SBAS230)
2. *ADS7861/8361 EVM User's Guide* (SLAU094)
3. *TMS470R1x Serial Peripheral Interface (SPI) Reference Guide* (SPNU195)
4. *HPA-MCU Interface Board User's Guide* (SLAU106)

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