Using the ADS7846 Touch Screen Controller with the Intel SA-1110 StrongArm Processor

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ABSTRACT

The Intel SA-1110 StrongArm processor is a popular platform for development of personal digital assistants (PDAs) and other hand-held computing devices. The human interface for these devices is generally a touch screen. This application report provides information on connecting the TI ADS7846 touch screen controller to an SA-1110, and provides documentation for a Windows CE driver that has been developed for the ADS7846. The circuits and code used herein have been tested using the SA-1110 Development Kit.

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Introduction

The Intel SA-1110 StrongArm processor is a popular platform for development of PDAs and other hand-held computing devices. The human interface for these devices is generally a touch screen.

Intel provides a development kit for the StrongArm processor, which includes a graphic LCD display and integrated touch screen, as well as other peripherals. The touch screen controller device used on this board is a UCB1300.

The ADS7846 touch screen controller from Texas Instruments provides a lower cost solution. It can easily be used with StrongArm-based processors. Texas Instruments is currently developing drivers for the StrongArm platform under several operating systems, including Windows CE and Linux. A Windows CE driver is presented in this application report.

The methods described herein are only some of the possible implementations and are only intended to serve as a guideline for hardware and software developers in developing their own solutions. The sample setup and driver provided only demonstrate the basic functionality of using the ADS7846 with the SA-1110, they have not been extensively tested, and are not intended for use "as is" in production systems.

Connecting the ADS7846

The ADS7846 can be connected to the SA-1110 as shown in Figure 1, and detailed in Table 1.
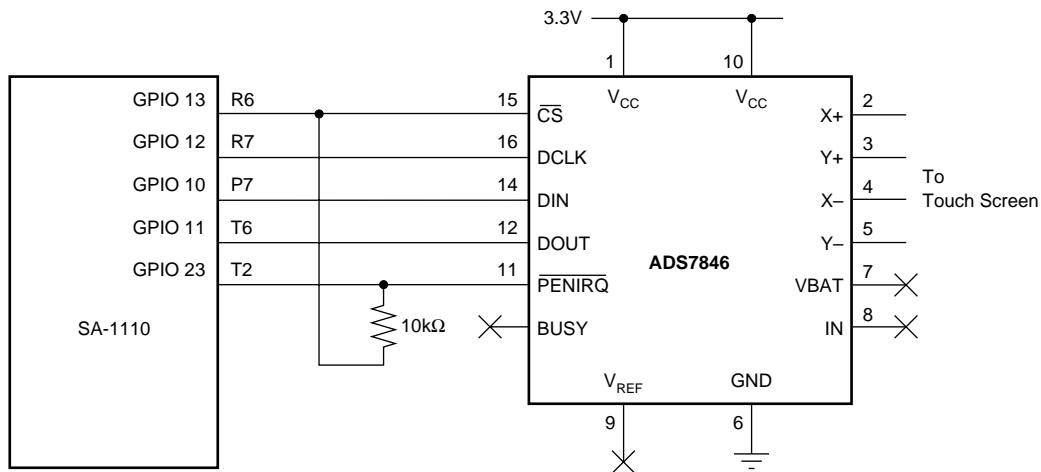
Figure 1. ADS7846 Connected to SA-1110.

In this implementation, the serial data pins on the ADS7846 are connected to serial port 4 on the SA-1110 using GPIO pins 10-13 in their alternate function state, and the $\overline{PENIRQ}$ pin on the ADS7846 is connected to GPIO pin 23. For the purpose of simplicity, direct connections are shown.

Table 1. SA-1110-to-ADS7846 Connections.

Intel® SA-1110	TI ADS7846
GPIO10-pin P7 (STEREO_TXD)	Pin 14 (DIN)
GPIO11-pin T6 (STEREO_RXD)	Pin 12 (DOUT)
GPIO12-pin R7 (STEREO_CLK)	Pin 16 (DCLK)
GPIO13-pin R6 (STEREO_SFRM)	Pin 15 ($\overline{CS}$)
GPIO23-pin T2 (UCB_IRQ)	Pin 11 ($\overline{PENIRQ}$)

NOTE: $\overline{PENIRQ}$ on the ADS7846 connected to its $\overline{CS}$ pin through a 10kΩ pull-up resistor (see Figure 1).

SA-1110 register setup

Serial port 4 on the SA-1110 is set to SSP mode using the National Microwire™ serial data format in this implementation. GPIO pins 10-13 are set to their alternate functions, becoming the serial data pins for serial port 4, allowing simultaneous SSP and MCP operation. The register setup used in this implementation for the SA-1110 is shown in Table 2.

Table 2. SSP Register Setup.

ACTION	REGISTER	BITS	VALUE
Disable SSP	SSCR0	SSE	0
Set Data Size to 12 Bytes	SSCR0	DSS	11
††Set National Microwire™ Frame Format	SSCR0	FRF	2
Set Serial Clock Rate to 100MHz	SSCR0	SCR	17
Disable Receive Interrupt	SSCR1	RIE	0
Disable Transmit Interrupt	SSCR1	TIE	0
Disable Loop-back Mode	SSCR1	LBM	0
Serial Clock Polarity (NA)	SSCR1	SPO	0
Serial Clock Phase (NA)	SSCR1	SP	0
External Clock Select	SSCR1	ECS	0
Enable SSP Pin Re-assignment	PPC	SPR	1
Set GPIO10 Alt. Function (SSP_TXD)	GAFR	AF10	1
Set GPIO11 Alt. Function (SSP_RXD)	GAFR	AF11	1
Set GPIO12 Alt. Function (SSP_SCLK)	GAFR	AF12	1
Set GPIO13 Alt. Function (SSP_SFRM)	GAFR	AF13	1
Set GPIO10 Pin Direction (output)	GPDR	PD10	1
Set GPIO11 Pin Direction (input)	GPDR	PD11	0
Set GPIO12 Pin Direction (output)	GPDR	PD12	1
Set GPIO13 Pin Direction (output)	GPDR	PD13	1
†Enable MCP	MCCR0	MCE	1
Enable SSP	SSCR0	SSE	1

†MCP takes precedence over SSP, but no issues have been noticed if this step is omitted. †† Microwire is a registered trademark of National Semiconducter.

Because $\overline{\text{PENIRQ}}$ on the ADS7846 goes LOW when pressure is applied to the touch screen (corresponding to the PEN DOWN state), the edge detection register for the interrupt pin (GPIO23) on the SA-1110 is initially set to detect a falling edge. When a falling edge is detected, a touch screen sample is taken, the edge detection register for the interrupt pin on the SA-1110 is reset to detect a rising edge (the PEN UP state), and a timer interrupt is initialized to continue sampling the touch sceen while the pen is down. The interrupt register settings for the SA-1110 are detailed in Table 3.

Table 3. Interrupt Register Settings.

ACTION	REGISTER	BITS	VALUE
Set Rising Edge Detect	GRER	RE23	1
Clear Rising Edge Detect	GRER	RE23	0
Set Falling Edge Detect	GRER	FE23	1
Clear Falling Edge Detect	GRER	FE23	1
Read Edge Detect Status Register	GEDR	ED23	NA
Clear Edge Detect Status Register	GEDR	ED23	1

Windows CE Driver

The basic Windows CE driver presented here operates as shown in Figure 2. This psuedocode shows the three states that the driver's receive interrupt can take, and how the driver responds. The driver source code can be found in the file Tchpdd.cpp.

```
On Receive interrupt (PEN UP/PEN DOWN/PEN TIMER)

        If PEN DOWN

                Sample touch screen

                Set edge detection to rising edge

                Return coordinates/tip state = PEN DOWN

        If PEN TIMER

                Sample touch screen

                Return coordinates/tip state = PEN DOWN

        If PEN UP

                Set edge detection to falling edge

                Return tip state = PEN UP
```

Figure 2. Basic Driver Operation.

The files provided in the software archive are listed in Table 4.

Table 4. Source File Descriptions.

Description	File name
Driver Source	Tchpdd.cpp
Interrupt Service Routine Source	int11x0.c
Interrupt Kernel Interface Source	Cfwsarm.c
Related Marcros, Defines, etc.	Sa11x0BD.h
Related Structures, Defines, etc.	Sa11x0.h
Sets Platform Components	SA11x0BD.bat
Includes App. to Start Calibration	Platform.bib
Default Calibration Data Removed	Platform.reg
Modified to Auto Run Calibration	WCESHELL.reg
Added Entry for ADS7846 Calib	Dirs

This implementation relies on the macros and structures included with the SA-1110 Windows CE 3.0 Driver Kit (see included files referenced above).

Components have been removed from the SA111x0 platform to reduce its debug size to less that 16MB so that the download process will not hang.

This implementation uses 100kHz clock to drive the ADS7846 and waits 250µs between writing a control byte and reading the sample (~24 clocks • 10µs). This delay is provided to allow for touch panel settling.

A total of 5 samples are taken for each axis in this setup. The first two are discarded, again to account for touch panel settling. The remaining three are evaluated to determine if the sample was accurate. The max error allowed in a sample is set to 10.

Using the Supplied Files

The following is an implementation example using the SA-1110 Development Board and the ADS7846 Touchscreen Controller Demo Kit (DEM-ADS7846E).

1. Setup the SA-1110 Development Board in stand-alone configuration (not using SA-1111). Some or all of the following items may be required to build and test the SA11x0BD CE platform:

Intel® SA11x0 Software:

• Eboot software

• JTAG software

• Windows CE Binary Kit

• Windows CE Driver Kit (SA11x0BD Platform)

See Intel® StrongARM SA-1110 Development Board documentation for details regarding

this setup. The updated files provided are intended to be used with default install directories and suggested platform configurations as described in the SA-1110 documents.

2. Update Platform Files.

If not using the provided binary release image (SA11x0_ADS7846_WCE300.bin), update SA11x0BD platform files by unzipping sa11x0bd_ADS7846_WCE300.zip to C:\ where C:\WINCE300 is the directory in which you have Platform Builder installed. Rebuild the SA11x0BD platform.

3. Connect DEM-ADS7846E to SA-1110 development board. This was done by fitting a 50-pin header on the SA-1110, connected as shown in Figure 3. The signal pins were isolated from the SA-1110 by lifting pins 40, 46, 47, and 35 on E3 (CPLD PZ3128) and pin 43 on E18 (UCB1300). Wires were then run from the pads on the PCB to the header. A 50-pin straight-through ribbon cable is then run from the header on the SA-1110 to the DEM-ADS7846E.
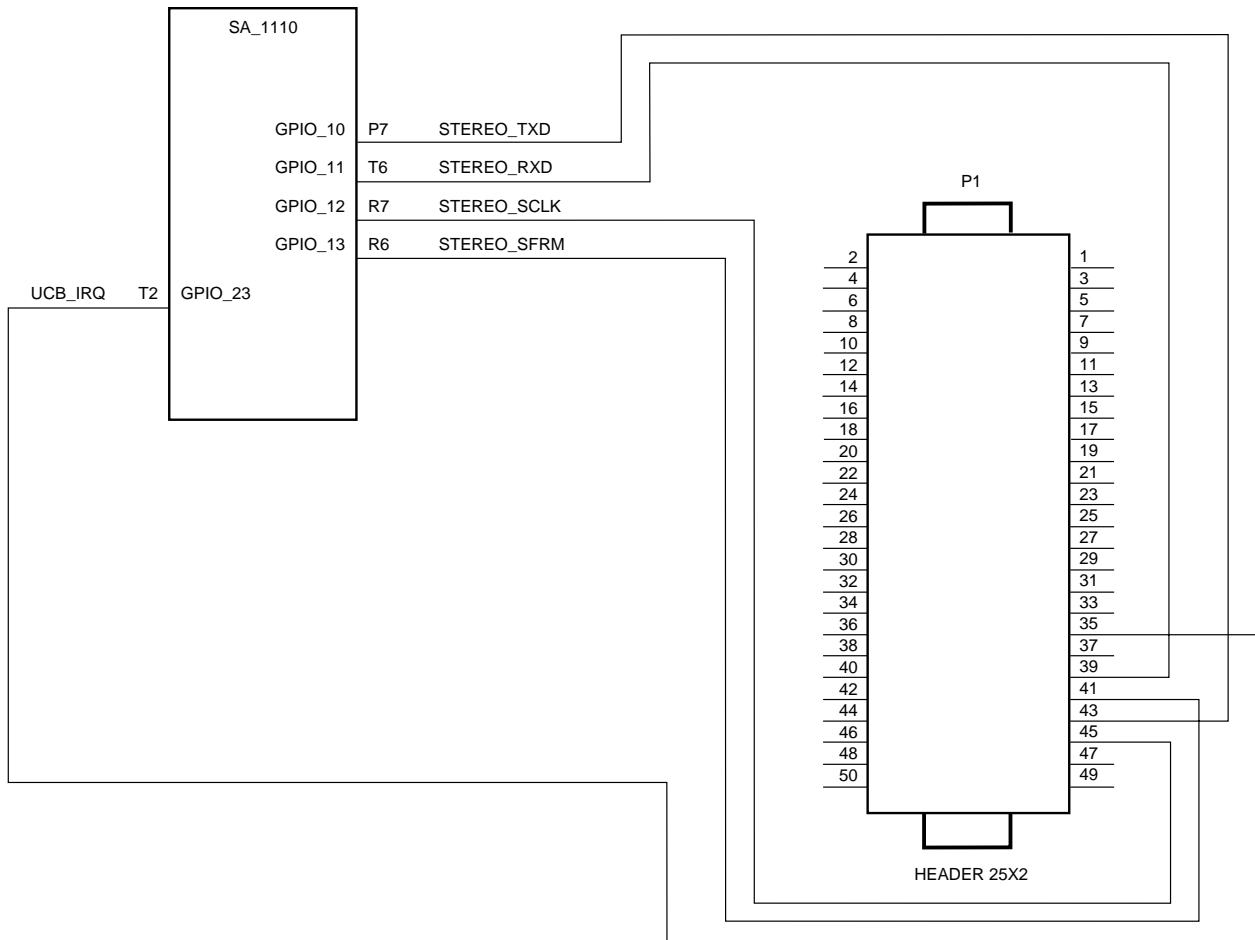

Figure 3. SA-1110 Header Installation.

4. Place and secure the touch screen included with the ADS7846 over the existing touch screen on the SA-1110.

5. Download image to target.

6. Calibrate the touch screen (will run automatically at boot).

If you are using a hub connected to the a shared network with a DHCP server, network traffic may cause the kernel debugger to hang during a debug download. To prevent this, disconnect all other devices from the hub connecting your development workstation and target device after download has begun.

Hold down S1 on the SA-1110 Development Board briefly after the image is loaded to turn on the backlight on the SA-1110 Development Board.

Using SSP_SFRM tied to the ADS7846 $\overline{CS}$ can cause spikes in $\overline{PENIRQ}$ if the last two bits of the control byte are not 0 (power down). These spikes can cause the interrupt handler to receive false PEN UP/PEN DOWN messages. Since FRM goes HIGH at the end of each frame, the ADS7846 powers down anyway, so there is no reason to set these bits differently in this configuration.

References

ADS7846 Datasheet, Texas Instruments (SBAS125A)

DEM-ADS7846E User's Guide, Texas Instruments (SBAU067)

StrongARM SA-1110 Microprocessor - Advanced Developer's Manual, Intel

StrongARM SA-1110 Microprocessor Development Board - Schematics, Intel

StrongARM SA-1110 Microprocessor Development Board - User's Guide, Intel

StrongARM SA-1110 Microprocessor Development Platform - Microsoft Windows^{TM} CE Software User's Guide, Intel

StrongARM SA-1110 Microprocessor Development Board Quick Start Guide, Intel

SA-1110 Advanced Developers Guide, specifically:

> *Section 11.12.7 - SSP Operation*
>
> *Section 11.12.8 - SSP Register Definitions*
>
> *Section 11.12.2 - MCP Register Definitions*
>
> *Section 11.13.2 - PPC Register Definitions*
>
> *Section 9.1.1 - GPIO Register Definitions*

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