Interfacing Telos (rev B) to 51-pin Sensor Boards

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1 Introduction

In this document we describe the theory of operation using Telos, a new IEEE 802.15.4-compliant mote with a Texas Instruments MSP430 microcontroller, to connect to legacy 51-pin sensor boards. We use the Extreme Scaling Mote (XSM) for illustration of how the lines on the 51-pin connector may be used by Telos through the 10 and 4 pin IDC connectors. XSM has been designed as part of the DARPA NEST program. Since over 10,000 of these nodes will be manufactured, we are interested in leveraging the sensors to connect to new platforms.

In this document we describe how to interface the XSM mote to Telos (revision B), Telos may interface with the Atmel ATmega128 on XSM as a co-processor or it may bypass the ATmega128 and directly drive the sensors.

2 Design and Mappings

Telos is a new generation of mote design featuring a new connector specification and on-board sensors. The essential functions are exposed through 10-pin and 4-pin IDC headers. By using an I^2C switch and I^2C I/O expander, we can achieve the same functionality as having a larger connector through the use of a digital bus. The schematic of the Telos-XSM adapter is at the end of this document. Table 1 shows the pin mappings between Telos and XSM and their functions.

The Telos Legacy Adapter takes advantage of Phillips PCA9555 digital I/O expanders. These 16-bit I/O parts include an active-low interrupt pin to notify microcontrollers of changes on the 16-bit I/O bus. The I/O pins on the 51-pin socket are connected to the I/O pins of two PCA9555 I/O expanders. The PCA9555 may configure the pins as input or output and may drive low and high signals via the I/O pins. If a pin is configured as input and its value changes, the PCA9555 generates an interrupt on the INT pin. The interrupt is cleared by reading the PCA9555 input register.

In addition to the I/O expander, the Telos Legacy Adapter uses an ADG715 analog 8-bit switch with low impedance to multiplex ADC signals. The switch is implemented with two multiplexers. The first connects to ADC0, ADC1, ADC4, and PWM1B on the 51-pin socket, and ADC6 on the Telos header. ADC6 may be configured as an input to the MSP430's 12-bit analog to digital converter or as a 12-bit digital to analog channel (DAC). The second multiplexer connects to ADC0, ADC1, ADC7, and PWM1A on the 51-pin socket, and ADC7 on the Telos header. ADC7 may be an ADC input, DAC output, or used as input to the on-chip supply voltage supervisor (SVS).

3 XSM as a Co-processor

In the simplest setup, XSM may be loaded with an application that accepts commands via the UART or I^2C bus. Telos and XSM may communicate via the digital bus to collect and report data. This mode allows the Telos-XSM adapter to act as a bridge between CC1000 networks and the 2.4GHz IEEE 802.15.4 networks.

4 XSM as a sensor board

If low power operation is critical, the ATmega128 may be removed or placed into its lowest power state and Telos' TI MSP430 ultra low power microcontroller may drive the XSM's sensors. This permits direct interfacing with the sensors while leveraging the advancements in data rate and low power operation provided by the Telos platform.

4.1 Magnetometer

The magnetometer power is enabled via the PW5 pin by setting port I/O05 on the PCA9555 to output and then setting or clearing the pin. When powered, the magnetometer may be reset using the MAG_SR signal by again setting the corresponding I/O port as output. Analog output from the magnetometer may be sampled through Telos' ADC2 and ADC3 ports.

4.2 PIR

The PIR sensor consists of a general threshold interrupt as well as interrupts for each individual direction. The AC+, AC-, PWM0, and PWM1A pins cause the PCA9555 to generate an interrupt on each edge transition. The PIR analog signal may be monitored through Telos' ADC7 port by selecting ADC7 through the ADG715 switch.

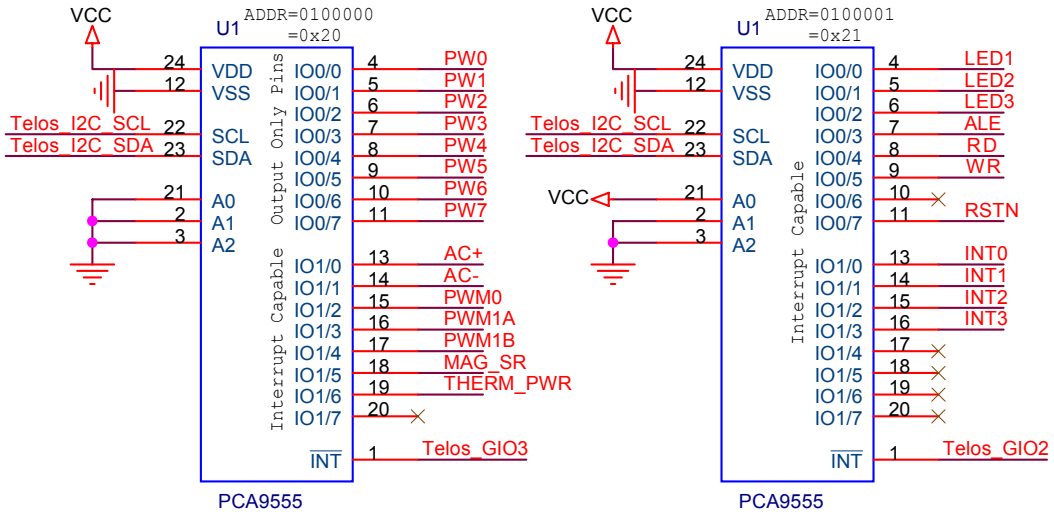
4.3 Sounder

The sounder requires a square wave to drive the diaphragm using a comparator. In order to achieve this, the DAC0 port may be connected to the PWM1B pin through the ADG715 switch. The DAC0 port is driven by the MSP430 DMA controller with a new DAC value realized on clock compare events from the 32.768kHz oscillator. This method may be used to not only drive fixed frequency oscillators, but also generic speakers for use in voice or sound applications.

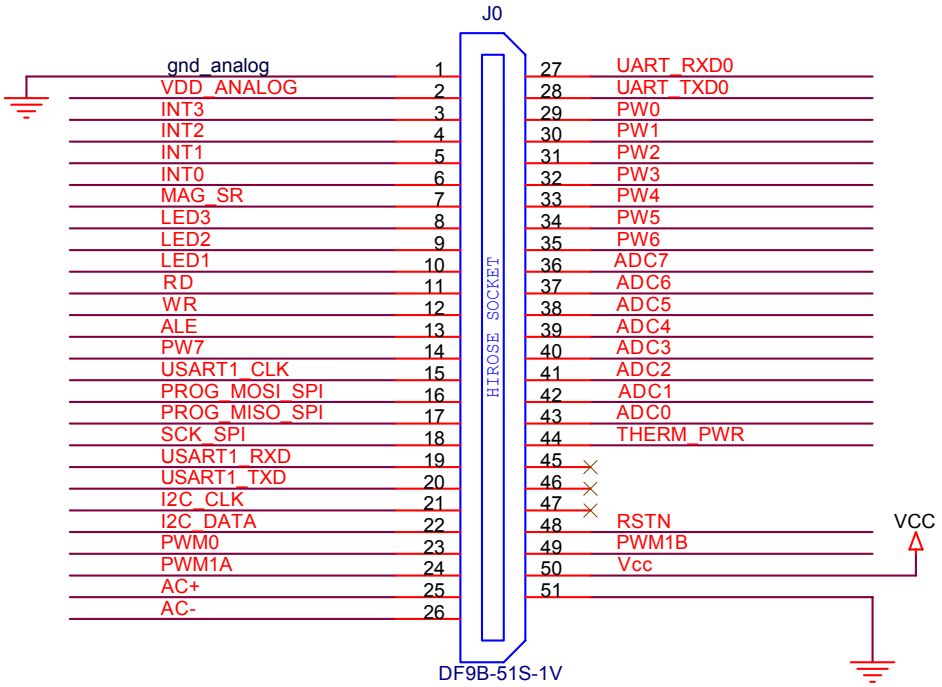
Sensor	Telos	XSM	Function
Accelerometer	I^2C	PW4	Power
	ADC2	ADC3	x-axis analog output
	ADC6	ADC4	y-axis analog output
Magnetometer	I^2C	PW5	Power
	I^2C	I^2C	Gain Control (1 on I^2C 1)
	I^2C	MAG_SR	Set-Reset
	ADC2	ADC5	x-axis analog output
	ADC3	ADC6	y-axis analog output
Microphone	I^2C	PW3	Audio receive power
	I^2C interrupt (GIO2)	INT1	Microphone interrupt
	ADC1	ADC2	Microphone analog output
Sounder	I^2C	PW2	Sounder power
	I^2C & DAC0	PWM1B	Sounder op-amp input
PIR	I^2C	PW6	PIR power
	I^2C interrupt (GIO2)	INT2	PIR interrupt
	ADC7	ADC7	PIR analog output
	I^2C interrupt (GIO3)	PWM10	PIR direction binary output 1
	I^2C interrupt (GIO3)	PWM1A	PIR direction binary output 1
	I^2C interrupt (GIO3)	AC+	PIR direction binary output 1
	I^2C interrupt (GIO3)	AC-	PIR direction binary output 1
Photo	I^2C	PW0	Photo power
	ADC6 | ADC7	ADC1	Photo analog output
Thermistor	I^2C	THERM_PWR	Thermistor power
	ADC6 | ADC7	ADC1	Thermistor analog output
I^2C bus	I^2C	ALE	Switch I^2C bus destination
ATmega128	I^2C	I^2C	I^2C bus
	UARTTX0	UARTRXD0	UART receive
	UARTRX0	UARTTXD0	UART transmit
Leds	I^2C	LED1-3	Turn LEDs on/off
User Interrupt	I^2C interrupt	INT0	User interrupt
Reset	I^2C	RSTN	Reset

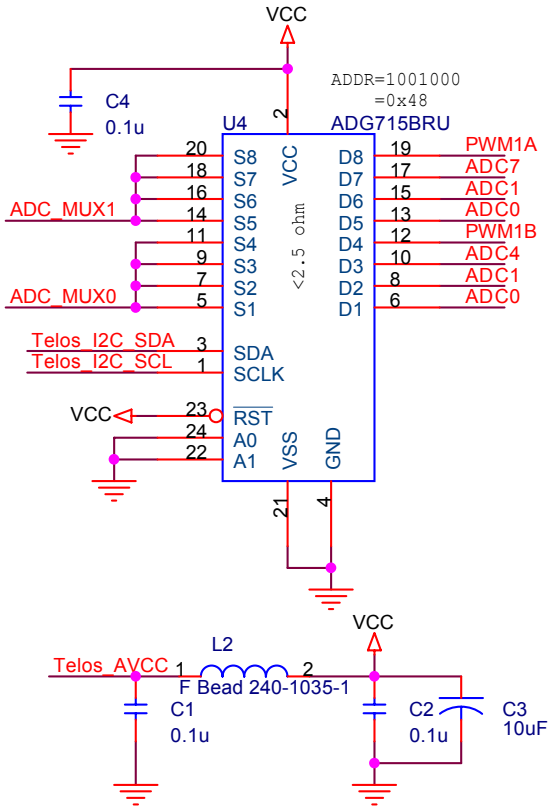
Table 1: Pin mappings between the Telos IDC header and the XSM 51-pin connector.

Power & I/O Switches

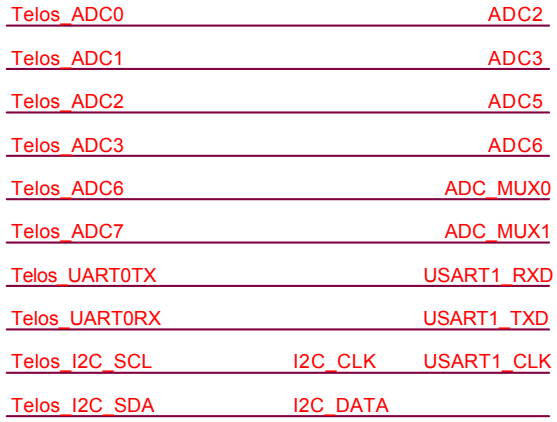


Legacy Connector

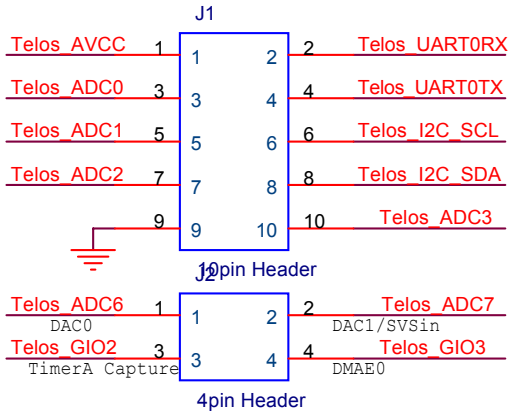




Pin Mappings



Connector to Telos



Title

Telos Legacy Adapter Board

Size	Document Number	Rev
A	*(c) Copyright 2004: UC Berkeley*	B

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