



External Expansion Board
User Guide
Revision 1.6

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Table of Contents

Table of Contents	2
1. Introduction	3
2. General Information	4
2.1. Pre-Requisites	4
2.2. External Expansion Board Features	4
2.3. Wire Connections.....	5
2.4. Test Pad Connections.....	6
2.5. Board Layout.....	7
3. Using the External Expansion Board (Typical Applications)	8
3.1. Connecting an Analog Output Sensor	8
3.2. Connecting a Digital Output Sensor using the SPI interface	8
Note for Shimmer3 users.....	8
3.3. Connecting to a Serial UART	9
3.4. Connecting a Parallel Bus interface	9
3.5. Connecting an External Power Battery Pack.....	9
4. Firmware Considerations	10
4.1. +/-5V DC Regulator	10
4.2. User button	10
4.3. Multifunction pins.....	10

1. Introduction

This document is an accompaniment to the *Shimmer External Expansion Board* (formerly known as the Shimmer AnEx Board). Its purpose is to be used in conjunction with the *Shimmer External Expansion Board Tutorial Video* to aid the user in getting started with the *External Expansion Board*.

The *External Expansion Board* Board enables an Analog Output Sensor, a Digital Output Sensor, a Serial UART or a Parallel Bus Interface to connect to Shimmer. The *External Expansion Board* is connected to a Shimmer device via the external connector and is positioned outside the Shimmer enclosure.

The *External Expansion Board* enables users to incorporate additional functionality to the Shimmer providing an outlet to develop their specific application to their own user requirements. It allows easy prototyping of 3rd part sensors or custom sensing solutions with Shimmer.

2. General Information

2.1. Pre-Requisites

- A *Shimmer 2*, *Shimmer 2r* or *Shimmer3*¹ device programmed with appropriate firmware. For example, *LogAndStream* (*BtStream* for Shimmer2/2r) firmware can be used to stream data over Bluetooth and/or log data to the SD card or *SDLog* firmware can be used to log data to the SD card; both are available for download from www.shimmersensing.com and the latest version should always be used.
- An *External Expansion Board*.

2.2. External Expansion Board Features

- Easy access to Shimmer microcontroller signals using wire hole or solder pads.
- +/-5VDC charge pump regulator with software-controlled enable pin².
- Software assignable User Control button.
- Connect an auxiliary power supply.

¹ Please refer to the later sections of this document for more details on using the Expansion Board with Shimmer3.

² The 5V regulator is not compatible with Shimmer3.

2.3. Wire Connections

PCB Label	Connector Pin#	hardware.h Pin Label	Shimmer2/2r Function
CLK	4	UCLK0	SPI0 CLK, or GPIO (wired to MicroSD)
SI	6	SIM00	SPI0 SIMO or GPIO (wired to MicroSD)
#RST	8	N/A	BSL programming, Power control and Board Reset. Same as Shimmer reset button.
RX	2	URXD0	UART0 RXD or GPIO A level shifter is required to interface with an RS-232 cable
CTS	16	SER0_CTS	SPI0 UART CTS or interruptible GPIO
+3	17	PV	3.0V regulated voltage. Do not exceed 50mA when using this connection.
+5	N/A	N/A	5.0V regulated voltage. Do not exceed 12mA when using this connection
-5	N/A	N/A	-5.0V regulated voltage. Do not exceed 12mA when using this connection
TX	3	UTXD0	UART0 TXD or GPIO. A level shifter is required to interface with an RS-232 cable
SO	5	SOMI0	SPI0 SOMI, or GPIO (wired to MicroSD)
A7	13	ADC_7	Analog ADC input 7, DAC output or GPIO. Also used for MicroSD Flash Dat1
G	GND		Ground Connection
A0	12	ADC_0	Analog ADC input 0 or GPIO. . Also used for MicroSD Flash Dat2

Table 1 Wire Connections for Shimmer2/2r

PCB Label	Connector Pin#	MSP430 Pin / Label	Shimmer3 Function
RX	2	P3.5 / SA_SOMI_RXD	USART A0 SOMI or RXD or GPIO A level shifter is required to interface with an RS-232 cable
TX	3	P3.4 / SA_SIMO_TXD	USART A0 TXD or SIMO or GPIO. A level shifter is required to interface with an RS-232 cable
CLK	4	FLASH_SCLK_EXT	USART B1 SPI CLK, or GPIO (wired to MicroSD)
SO	5	P5.4 / FLASH_SOMI	USART B1 SPI SOMI, or GPIO (wired to MicroSD)
SI	6	P3.7 / FLASH_SIMO	USART B1 SPI SIMO or GPIO (wired to MicroSD)
#RST	8	RST / MSP_RESET_N	Microcontroller Reset line - typically used to reset the board
A0	12	P6.6 / ADC6_FLASHDAT2	Analog ADC input 6 or GPIO

			(wired to MicroSD)
A7	13	P6.7 / ADC7_FLASHDAT1	Analog ADC input 7 or GPIO (wired to MicroSD)
CTS	16	P7.7 / ADC_15_RADIO_DC	ADC Input 15 or GPIO Alternate function is reserved for coprocessor Spy-Bi-Wire
+3	17	PV	3.0V regulated voltage. Do not exceed 100mA when using this connection.
+5	N/A	N/A	5.0V regulated voltage. Do not exceed 12mA when using this connection. NOT compatible with Shimmer3.
-5	N/A	N/A	-5.0V regulated voltage. Do not exceed 12mA when using this connection. NOT compatible with Shimmer3.
G	GND		Ground Connection

Table 2 Wire Connections for Shimmer3

2.4. Test Pad Connections

PCB PAD Location	Connector Pin# (name)	hardware.h Pin Label	Function
Center above Shimmer Connector	14 (BSL_TX)	PROG_OUT	Programming pin or interruptible GPIO
Right of Center below Shimmer Connector	11 (BSL_RX)	PROG_IN	Programming pin. Do not use this pin for GPIO.
Left of Center below Shimmer Connector	9 (PV_REG)	N/A	Board pre-regulator voltage after isolation diode. When used as an output, this will be the battery voltage. Typically 2.8-3.7V. Do not exceed 200mA when using this connection. A DC power source (bench or battery) can be connected to this connection. To prevent damage to the power source a series diode is recommended when the Shimmer battery is also in use and the power supply is <4.0VDC. Do not exceed 5.5V or 200mA.

Table 3 Test Pad Connections for Shimmer2/2r

2.5. Board Layout

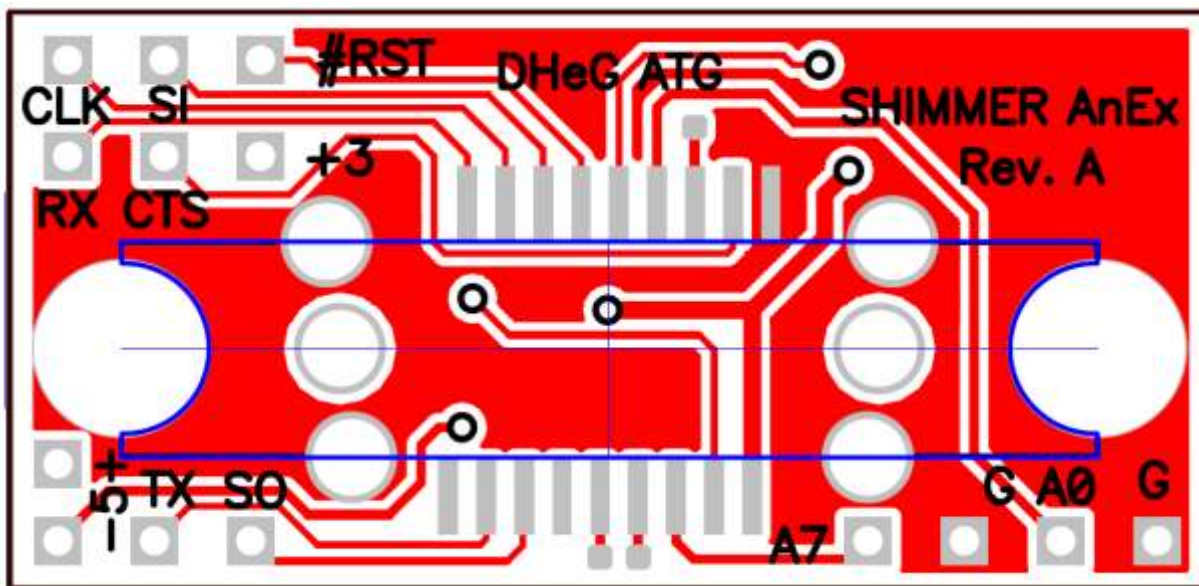


Figure 1: External Expansion Board Top View

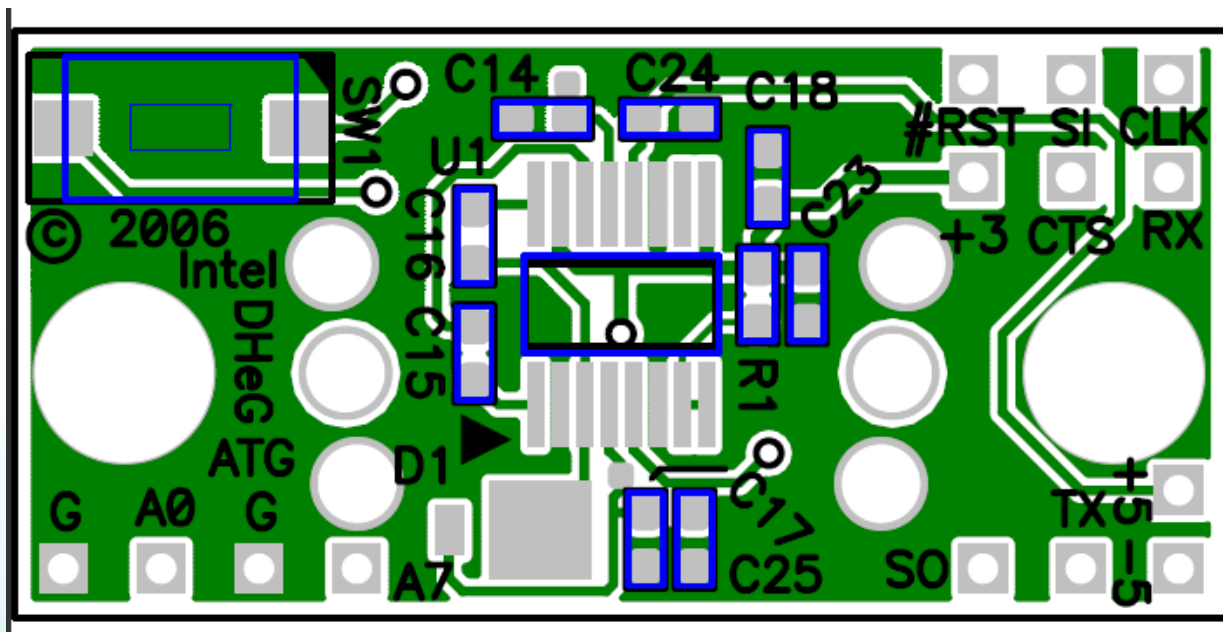


Figure 2: External Expansion Board Bottom View

3. Using the External Expansion Board (Typical Applications)

3.1. Connecting an Analog Output Sensor

Using the sensor specification, chose either +3, +5, or +/-5V³ as the power supply connections to the sensor (in order of preference). The output of the sensor should be tied to either the A0 or A7 ADC inputs⁴. If the output is outside of the range of the Shimmer ADC (3V max) an attenuator must be added.

Note: For *Shimmer2/2r* there is an issue with crosstalk on the accelerometer signals when the ADC is provided with an un-buffered moderate to high impedance signal. To avoid such issues signals should be buffered with an appropriate voltage buffer.

If the sensor uses the bipolar power supply, the output must be AC-coupled via a series capacitor to an appropriate DC bias resistor network connected to the ADC input pin.

Example: A sensor requires +/-5V supply, and has a output of +/- 1.25V. A 10 μ F capacitor is used to couple a signal such that 1.5V = zero-signal by connecting a 100k resistor from A0 (ADC0) to +3 (3.0V) and a 100k resistor from A0 (ADC0) to G (GND).

Any remaining GPIO pins can be used to configure control pins on the sensor. Verify the configuration of any of these pins in the Shimmer application code.

3.2. Connecting a Digital Output Sensor using the SPI interface

Paying attention to the required master-slave relationship in your application (Shimmer is usually master), connect up the SI,SO, and CLK pins. Use another GPIO pin as a Chip Select to complete the digital interface. The UART0 module will need to be configured for SPI mode-- there are examples for *Shimmer2/2r* in the TinyOS reference code library. For power supply connections chose either +3, +5, or +/-5V as the power supply connections to the sensor (in order of preference).

Remember that the Shimmer's microSD storage is also connected to the SPI bus. An internal expansion board may also use this signal. The application must ensure that the bus is correctly multiplexed using the SPI0 chip-select signals.

Any remaining GPIO pins can be used to configure control pins on the sensor. Verify the configuration of any of these pins in the Shimmer application code.

Note for Shimmer3 users

When using the *External Expansion Board* with *Shimmer3*, the SPI bus is shared with the microSD, making the interface much more complicated than that for the *PROTO3 Deluxe Expansion Board*, which uses the dedicated internal bus. For that reason, Shimmer recommends use of *PROTO3 Deluxe Expansion Board* wherever possible. Furthermore, Shimmer recommends that the *External*

³ Do not choose +/- 5V for Shimmer3.

⁴ Note that for Shimmer3, the pin marked A0 on the Expansion Board is tied to the A6 ADC channel.

Expansion Board should only be used in cases where MicroSD will not be used, and noting that this use case will receive limited support from Shimmer.

3.3. Connecting to a Serial UART

Similar to the SPI directions above, the UART0 module must be configured for UART operation. The output signals will be digital at a 3.0V reference. A level shifter IC or RS-232 level shifter may be used to interface with instrumentation or other computers.

3.4. Connecting a Parallel Bus interface

To use a parallel bus interface, most pins will need to be configured as GPIO instead of the default functionality. Up to a 9-pin bus can be configured.

3.5. Connecting an External Power Battery Pack

The PV_REG pad can be used to solder on a battery pack or power supply. This power supply will not charge the Shimmer battery and must be isolated by a Schottky diode when the Shimmer battery is also in use. This Schottky diode should be included in the users circuitry.

Note: Do not exceed 5.5VDC.

Note: Do not exceed 200mA.

When operating without a Shimmer battery, the recommended input voltage range is 3.1-5.0V

When operating with a Shimmer battery, the recommended input voltage range after an isolation diode is 4-5.0V

For example, a battery pack consisting of 3 "D" alkaline cells in series is used instead of the stock Shimmer battery. The resulting voltage will be 4.5V at start. The resulting battery pack will have over 18000mAh capacity. A Shimmer application burning 25mA will run for over 2years.

4. Firmware Considerations

4.1. +/-5V DC Regulator

The signal, SERO_RTS from the processor is used as an enable signal on the 5.0V regulator on *Shimmer2/2r*⁵. When driven low (clear) the regulator will be shut down. The power consumption of the regulator in shut down state is 10 μ A.

4.2. User button

For *Shimmer2/2r*, the user button is pulled down on the Shimmer board. Pressing the button will result in a high signal that can be used as a polled or interruptible signal on Shimmer applications.

For *Shimmer3*, the user button on the *External Expansion board* is tied to P1.5 of the MSP430 (GPIO External).

4.3. Multifunction pins

The MSP430 processor uses multifunction pins. The functionality of the pin depends on firmware configuration. For example the pin A7 (ADC input 7) can be configured an ADC input or GPIO pin. For more information please refer to the MSP430 programmers guide and TinyOS reference code. Also, developers can post a question on the shimmer-users mailing list or support@shimmersensing.com.

⁵ Note this is not available on Shimmer3.

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