SHM-DAQ Board

Data Acquisition Board

Datasheet and User's Guide

ISHMP UIUC OSL & SSTL

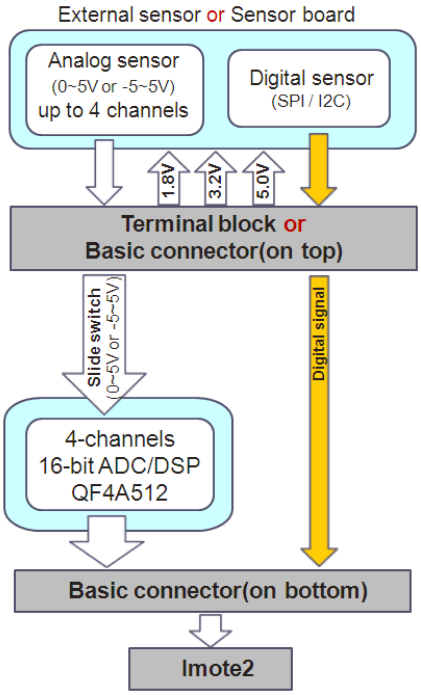
Overview

Developed as part of the Illinois Structural Health Monitoring Project, the SHM-DAQ board is designed to use with the Imote2 smart sensor platform. This data acquisition board includes a signal conditioning circuit, QF4A512 ADC, terminal blocks and basic connectors. The all 4 channels of the QF4A512 are open to external analog inputs. The available range of the input is 0 ~ +5VDC or -5 ~ +5VDC, one of which is selected by the slide switches on the bottom side. This data acquisition board can accommodate four analog sensors, a SPI digital sensor and I2C digital sensors through terminal blocks as well as basic connectors on the top side. The basic connectors are placed for stacked use with additional sensor board (e.g. SHM-S board).

Features

- Four-channel external analog input to 16-bit ADC
- User selectable input voltage range (0 ~ +5VDC or -5 ~ +5VDC)
- One SPI and I2C digital interface
- Diverse power supply (1.8V, 3.0V and 5.0V)
- Terminal blocks to direct interface with external sensors
- Basic connector for stacked use with additional sensor board
- User-selectable sampling rates and cut-off frequencies
- Customizable digital filters

  Open-source software available for operation with the Imote2



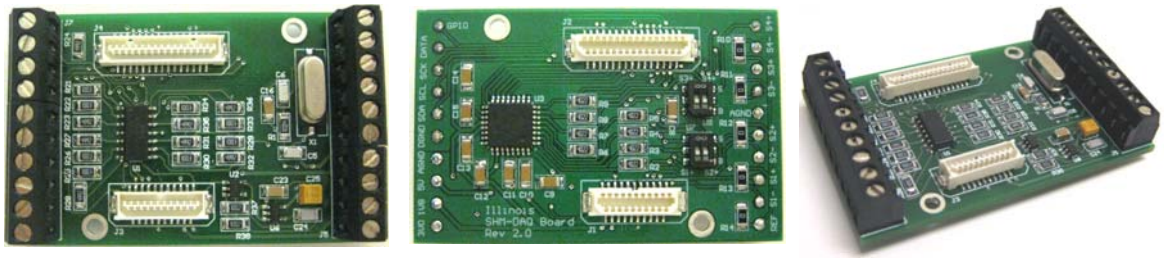


Figure 1. SHM-DAQ board: top (left), bottom (middle), and perspective (right).

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1 Block diagram and pin descriptions

1.1 Block diagram

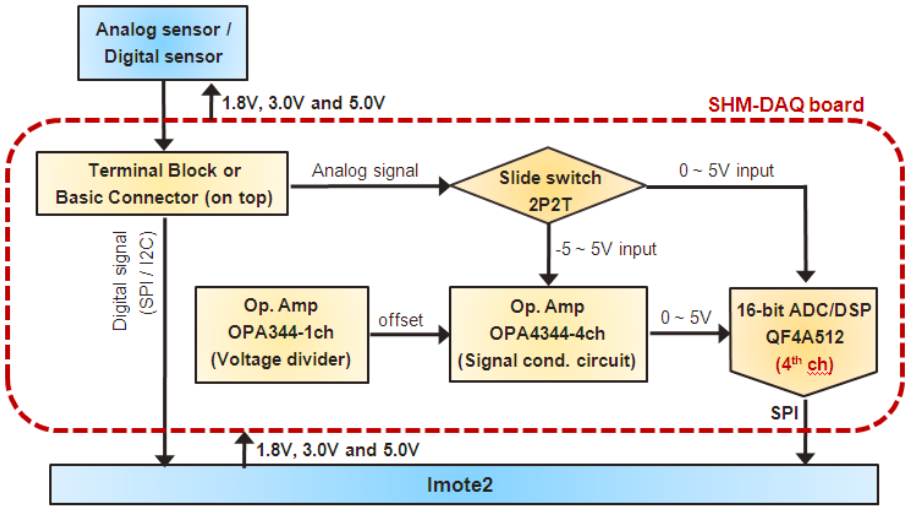

Figure 2. SHM-DAQ block diagram

1.2 Pin descriptions

The SHM-DAQ board connects to the Imote2 via two connectors located on the bottom of the board. In addition, the SHM-DAQ board provides two connectors on the top to allow the stacking of additional sensorboard as well as two terminal blocks for direct connection of external analog & digital inputs to interface with both the SHM-DAQ and the Imote2. Figure 3 gives the dimensions of the SHM-DAQ sensor board, indicates the location of the connector on the bottom, Figure 4 shows the example of stacked use with additional sensorboard, and the terminal block on the top of the board. The pin descriptions are given in Tables 1 ~ 3.

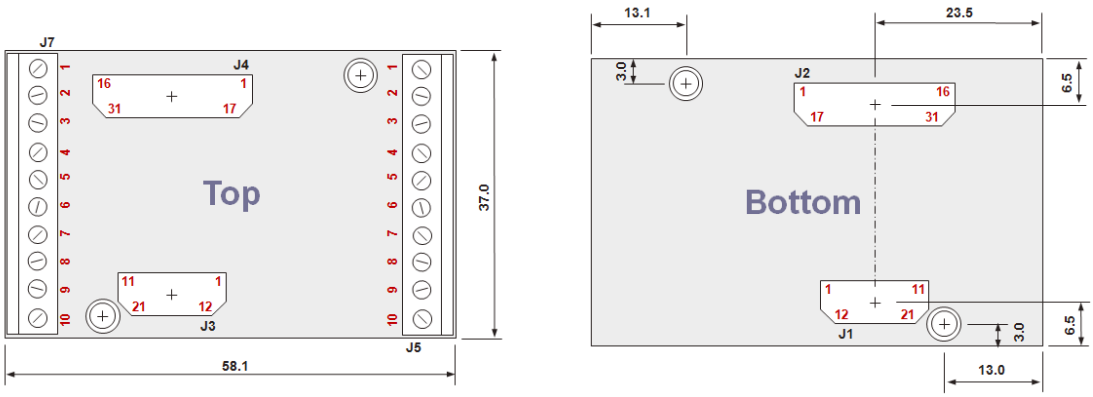

Figure 3. SHM-S dimensions (all dimensions in mm)

Table 1. Imote2/SHM-DAQ 31-pin connector (J2 and J4) descriptions[1]

Pins	Imote2 Description	SHM-DAQ Functionality (bottom connector, J2)	SHM-DAQ Functionality (top connector, J4)
1	UART1: Serial port communication or General purpose I/O	none	none
2		none	none
3		Serial Data	Serial Data
4		Serial Clock	Serial Clock
5-8	UART2	none	none
9	GND	GND	GND
10	SSPCLK2– SPI Clock	SCLK – SPI Clock	SCLK – SPI Clock
11	SSPFRM2 – Chip Select	SFRM – Chip Select	SFRM – Chip Select
12	SSPTxD2 – Serial Data Input	SPTxD – SPI Transmit Data	SPTxD – SPI Transmit Data
13	SSPRxD2 – Serial Data Output	SPRxD – SPI Receive Data	SPRxD – SPI Receive Data
14	General purpose I/O	GPIO	GPIO
15,16	Reserved	none	none
17	SCL – I2C Clock	SCL – I2C Clock	SCL – I2C Clock
18	SDA – I2C Data	SDA – I2C Data	SDA – I2C Data
19	SSPCLK1– SPI Clock	QF4A512 (ADC) SPI Clock	none
20	SSPFRM1 – Chip Select	QF4A512 (ADC) Chip Select	none
21	SSPTxD1 – Serial Data Input	QF4A512 (ADC) Serial Data Output	none
22	SSPRxD1 – Serial Data Output	QF4A512 (ADC) Serial Data Input	none
23	General Purpose I/O	QF4A512 (ADC) Data Ready Interrupt	GPIO
24	Ground	GND	GND
25	MMCLK	none	none
26	MMCMD	none	none
27	MMD0	none	Analog Input ch3 (negative)
28	MMD1	none	Analog Input ch3 (positive)
29	MMD2	none	Analog Input ch4 (negative)
30	MMD3	none	Analog Input ch4 (positive)
31	General Purpose I/O	QF4A512 (ADC) Chip Reset	GPIO

[1] The top and bottom connectors of SHM-DAQ board have different functionalities.

Table 2. Imote2/SHM-DAQ 21-pin connector (J1 and J3) descriptions[1]

Pins	Imote2 Description	SHM-DAQ Functionality (bottom connector, J1)	SHM-DAQ Functionality (top connector, J3)
1	Drives power to processor (3.2 – 4.7V input)	none	5V (regulated, 20mA limit)
2			none
3	GND	GND	GND
4	PMIC battery temperature input	none	none
5	5.0V (USBH)	5V supply (USBH)	5V supply (USBH)
6-7	Reserved	none	none
8			Analog Input ch2 (negative)
9			Analog Input ch2 (positive)
10	Reserved. But, available for expansion		Analog Input ch1 (negative)
11			Analog Input ch1 (positive)
12	Power supply (Programmable 1.8 – 3.3V)	1.8V supply	1.8V supply
13		3.2V supply	3.2V supply
14	Reserved	none	none
15	Alarm input to PMIC	Connected to VRTC (18)[2]	none
16	Reset – manual reset	None	none
17	Ground	GND	GND
18	Imote2 processor powered indicator - high if on or asleep	Connected to Alarm (15)[2]	none
19	Battery select (primary or rechargable)	None	none
20	STD_RxD – Debugging with BLUSH	none	none
21	STD_TxD – Debugging with BLUSH	none	none

[1] The top and bottom connectors of SHM-DAQ board have different functionalities.

[2] VRTC is connected to the PMIC Alarm if R10 is populated. This connection causes the Imote2 to power on if a USB plug power source is inserted or the Imote2 is connected to a powered battery board without the need to press the reset button.

Table 3. Terminal blocks (J5 and J7) pin descriptions

Pins	J5 – digital interface	J7 – Analog interface
1	GPIO	Analog Input channel 4 (positive)
2	DATA – Serial port data	Analog Input channel 4 (negative)[1]
3	SCK – Serial port clock	Analog Input channel 3 (positive)
4	SCL – I2C Clock	Analog Input channel 3 (negative)[1]
5	SDA – I2C Data	AGND
6	DGND – digital ground	Analog Input channel 2 (positive)
7	AGND – analog ground	Analog Input channel 2 (negative)[1]
8	5V supply (regulated , 20mA limit)	Analog Input channel 1 (positive)
9	1.8V supply	Analog Input channel 1 (negative)[1]
10	3.2V supply	Reference[1]

[1]SHM-DAQ board is released for single-ended input signal by default. All the negative signal pins (2, 4, 7 and 9 of J7) are connected to the reference pin 10 with dummy resistors (R10 ~ R13), and the reference pin 10 is grounded using another dummy resistor R14. If differential (double-ended) inputs are used with the terminal blocks, all the dummy resistors (R10 ~ R14) on the bottom should be removed.

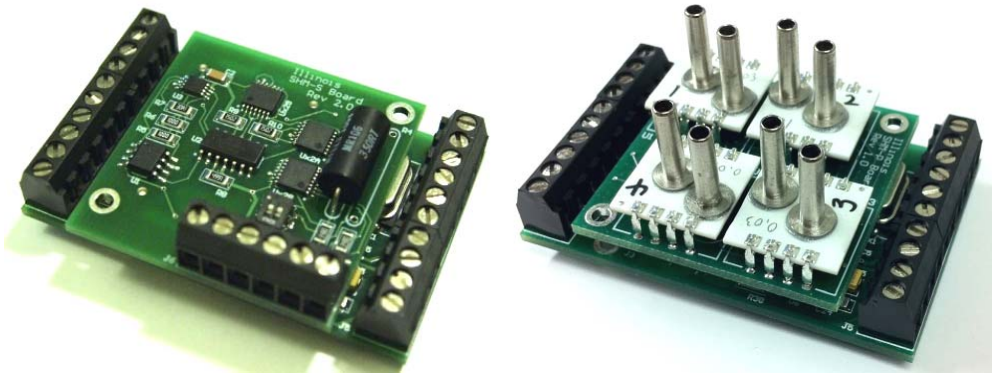

Figure 4. Examples of stacked use with additional sensorboard: with a strain sensorboard (SHM-S, left), with a pressure sensorboard (SHM-P, right)

2 Electrical specifications

Table 4. Electrical characteristics

Parameter	Min	Typ.	Max.	Units
Supply Voltage	1.75	1.8	1.85	V
	3.1	3.2	3.3	V
	4.9	5.0	5.1	V
Allowable analog input range[1]	0 ~ 5			V
	-5 ~ 5			V
Allowable digital input[2]		0 ~ 3.2		V
Sensitivity (for 0 ~ 5V analog input)	5600	5300	5000	LSB/V

[1]Analog input range is selected by slide switch (see Section 3 for detail)
[2]Imote2 allows up to 3.2V digital input.

3 Slide switch for analog input range selection

SHM-DAQ board is designed to allow 0 ~ 5V or -5 ~ 5V analog inputs. 0 ~ 5V inputs are connected directly to QF4A512 ADC, but -5 ~ 5V inputs are linked to Op Amp circuit for signal conditioning. Through the Op Amp signal conditioning circuit, the -5 ~ 5V signal is converted to 0 ~ 5V signal that QF4A512 can accept. This signal flows are controlled by the slide switch on the bottom of the board as shown in Figure 4. Note that only single ended inputs can be used when -5 ~ 5V input option is selected.

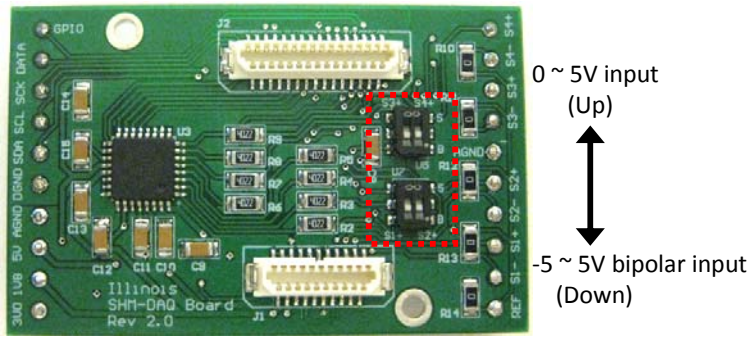

Figure 5. Slide switch on top side

4 Software

The software required to operate the SHM-DAQ board interfaced with the Imote2 is open-source and can be found at http://shm.cs.uiuc.edu/software.html. This software includes drivers for the QF4A512 as well as a wide range of application software for acquiring data locally and remotely.

4.1 Driver and application software

The driver for the SHM-DAQ sensor board is basically same as SHM-A board driver, which is QF4A512 ADC based, except temperature correction functionality. SHM-DAQ board driver doesn't include temperature compensation. Make sure that SHM-DAQ board should be specified in *MakeFile* such like

```
SENSORBOARD = SHM_DAQ
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For inquiries, please contact:

Professor B.F. Spencer, Jr.
bfs@illinois.edu
University of Illinois at Urbana-Champaign
Department of Civil and Environmental Engineering
2213 Newmark Civil Engineering Laboratory, MC-250
205 North Mathews Ave
Urbana, IL 61801
USA

Or visit:

http://shm.cs.uiuc.edu