PSLab

Technical Specifications

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Introduction

. *PSLab provides an array of test equipment that includes an oscilloscope, waveform generators, frequency counters, Programmable voltage sources and many more for the curious ones among us. The measurement/control functions are accessible from the Python programming language and GUI applications are also available for a variety of science and engineering experiments.* .

Pin Definitions and Functions

Analog Inputs - Measure Voltages with 12-bit resolution

CH1 **Range:**± **16**, Gain:up to 32x., .

CH2 **Range:**± **16**, Gain:up to 32x., .

CH3 **Range:**± **3.3V**.
*manual gain control by grounding Rg via resistor R . $gain = 1 + \frac{10K}{R_g}$

MIC **Range:** $\pm 15mV$, Gain:200x..

SEN **Range:** $0 - 3.3V$, Internally Pulled up to 3.3V via 5.1KOhm resistor.

Analog Outputs

Waveform Generators

WG1 **5Hz to 5KHz Arbitrary Waveform Generator**, *Range:* $\pm 3V$ *.Attenuable.*

WG2 **5Hz to 5KHz Waveform Generator**, *Range:* $\pm 3V$.

Programmable Voltage and Current Sources (12-bit)

PVS1 **Range:** $\pm 5V$, Up to 10mA.

PVS2 **Range:** $\pm 3.3V$, Up to 10mA.

PVS3 **Range:** $0 - 3.3V$, Up to 10mA.

PCS **Range:** $0 - 3.3mA$.
Subject to Load resistance. Up to 3.3V voltage drop

Digital Inputs - Measure Logic Levels with 15nS resolution

Logic Analyzer, Frequency Counter, Timing Functions

ID1 **Range:** $0-5V$, 0-32MHz.

ID2 **Range:** $0-5V$, 0-32MHz.

ID3 **Range:** $0-5V$, 0-32MHz.

ID4 **Range:** $0-5V$, 0-32MHz.

Fin **Range: Up to** $\pm 5V$, 0-16MHz.

Digital Outputs

4x PWM output with 15nS frequency, phase, and DCycle control

SQR1 **Range:** $0-5V$.

SQR2 **Range:** $0-5V$.

SQR3 **Range:** $0-5V$.

SQR4 **Range:** $0-5V$.

Data Buses - I2C , SPI, UART

I2C (Inter-Integrated Circuit) Master: Up to 4MHz Clock speed

Vdd **3.3V Power output**.

GND **Return path**.

SCL **I2C Clock Output**.

SDA **I2C Data Line**.

SPI(Serial-Peripheral Interface) Master: Available on the 20-pin Expansion Slot. Supports all four modes of operation.

SCK **SPI Clock Output**, Tested Up To 16MHz.

SDO **SPI Data Output (MOSI)**.

SDI **SPI Data Input (MISO)**.

CS1 **Chip Select 1**.

CS2 **Chip Select 2**.

A Few Definitions For The Expansion slot

CLK **16MHz , 0-3.3V TTL output**, This is also the reference clock for the 0-2MHz sine/triangle wave generator, and can be used to create phase correlated wavegen add-ons.

AN8 **Analog Input**, Range: $0-3.3V$.

Additional Nomenclature

GND **Short for GROUND.**, This is the reference voltage, and is taken as 0 volts. It is also connected to the ground level of the power source (power adapter)

V+/V- **Power Outputs**, $\pm 9V$. Current limit 20mA per channel.

Sensors and Add ons

Plug and Play Sensors

- MPU6050 : 3-Axis Accelerometer , 3-Axis GyroScope, temperature sensor
- HMC5883L : 3-Axis Magnetometer with adjustable ranges
- MLX90614 : Passive IR temperature sensor
- BMP180 : Pressure , Temperature and Altitude module.
- TSL2561 : Luminosity measurements up to 40K Lux
- BH1750 : Luminosity measurements up to 40K Lux
- SHT21 , Si7021 : Ambient Temperature and Humidity Module
- SSD1306 : 128x64 OLED Display
- HCSR501 : Passive IR module for motion sensing
- AD9833 : 28-bit DDS function generator
- PT100 temperature sensor, MQ Series Gas sensors
- DSM501 : PM2.5 Dust Sensor
- YL-69 : Hygrometer for soil humidity measurements
- WS2812B RGB LED with 16 million shades
- HX711 24-bit differential ADC with 128x PGA
- MFRC522 : RFID Reader
- HB100 : 10.25GHz Doppler Radar

Wireless Subunits : 3-Byte addresses [Purchase separately]

PSLab has an On-board Transceiver (2-way radio link) Capable of communicating with multiple wireless nodes to control and receive sensor data payloads.
These wireless nodes are drop-in replacements for sensors, and have a typical line of sight range of 50 meters.

I2C	**Data bus for Interfacing with commonly available sensors.**, *Measure physical parameters with minimal mechanical interference.*
SPI	**Two Chip select pins**.
RGB out	**Control WS2812B arrays** , Daisy chained RGB LEDs with 16 million shades each.

Control And Measurement Equipment Specifications

Calibrated Against Professional equipment for high accuracy

Feature	Description	Socket Labels	Range
Analog Inputs	Up to 6 analog inputs with various voltage ranges. Programmable gain control. 12-bit voltage measurement. Up-to 2MSPS sampling. $3.3V$ Voltage Reference .	 CH1, CH2 CH3 MIC SEN	 $\pm 16Volts$ $\pm 3.3Volts$ $\pm 15mVV$ $0 - 3.3V$
Analog Outputs	Programmable Voltage Sources (12-bit) Programmable Constant Current Source .	PVS1 PVS2 PVS3 PCS .	$\pm 5V$ $\pm 3.3V$ $0 - 3.3V$ $0 - 3.3mA$.
Digital Inputs	4 x TTL compatible digital Inputs. Logic Analyzer Frequency Counter (0-16MHz), time measurement routines $\{\pm 30ppm, 12MHz$ Reference oscillator$\}$	 ID1 - ID4 Fin	 $0 - 5$ V $0 - \pm 5V$
Waveform Generators	Wavegen 1 (Sine/Triangle/Arbitrary) -Frequency -Amplitude. Manually attenuable Wavegen 2 (Sine/Triangle/Arbitrary) –Frequency -Amplitude. Fixed 4 x Phase Correlated Square Waves -Frequency -Phase difference maximum resolution -Duty Cycle maximum resolution -Also functions as simple state selectable output. -servo/stepper motor control supported	 W1 W2 SQ1 - SQ4 .	 $5 - 5K$Hz $\pm 3V$ $5 - 5K$Hz $\pm 3V$ $0 - 5Volts$ 10Hz - 16MHz 15nS 15nS .
Data Buses	I2C : Master Commonly Used by numerous sensor ICs SPI : Master -Chip Select pins UART .	SCL,SDA SCK,SDI,SDO CS1 , CS2 .	
Expansion Slot	20 - pin Socket designed to accommodate add-on modules. -Selection includes SPI,I2C,Analog input,Digital IO, 16MHz TTL output, and a bipolar power supply.		
Wireless Nodes	Battery Powered add-on units. Power Source -Acts as a wireless bridge for various sensors 3 Byte unique address -10 bit ADC , Digital I/O .	. Cell/Adapter .	. 3.7-4.2 V .

Data Acquisition and control software

Launch the PSLab Application , launch the oscilloscope utility listed in the *Test and Measurement* section

Control widgets

Voltage and current sources

PVS1 **Range :** $\pm 5V$, *Set the output voltage on PVS1 socket.*, Max Current 5mA.

PVS2 **Range :** $\pm 3.3V$, *Set the output voltage on PVS2 socket.*, Max Current 5mA.

PVS3 **Range :** $0 - 3V$, *Set the output voltage on PVS3 socket.*, Max Current 5mA.

PCS **Range :** $0 - 3.3mA$, *Set the output current on PCS socket. Current subject to load resistance*, PCS and PVS3 are linked, and only one can be used at a time.

Arbitrary Waveform Generators (W1,W2)

W1 **Range :** $5Hz - 5KHz$, *Set the output frequency of the waveform generator.*, Amplitude control($\pm 1mV - \pm 3V$) via physical knob located on the device.

W2 **Range :** $5Hz - 5KHz$, *Set the output frequency of the waveform generator.*, Fixed amplitude 3V.

Phase Correlated Square Waves (SQ1,SQ2,SQ3,SQ4)

Frequency **Range :** $0 - 8MHz$, *Set the output frequency of all four square waves.*, Resolution:$15nS$.

Output **Select the Output socket to configure**.

Phase **Set the phase difference ($0 - 100\%$)** , between the selected waveform and SQ1.

Duty Cycle **Set the Duty Cycle($0 - 100\%$)** , of the selected waveform.

Oscilloscope

From the PSLab Application , launch the oscilloscope utility listed in the *Test and Measurement* section

Chan 1 : Channel 1 of the oscilloscope

Remappable **Not restricted to 'CH1' input socket.**, *This is a very flexible acquisition channel, and can be mapped to any of the analog inputs via a drop down menu located at the top corner.*

Chan 2 : Channel 2 of the oscilloscope

Fixed **This channel can only record the signals input to the socket labelled CH2**.

TRIGGER : Allows selecting the channel to trigger the oscilloscope

Level **The rotary dial sets the trigger level, and this is also reflected in a marker located on the plot**.

Channel **The drop down menu allows selecting the trigger channel**, If CH1 is selected, the trigger signal will be obtained from the channel it has been mapped to.

TimeBase : Specify the time scale for the data acquisition

Dial **Set the delay(in uS) between each successive data point**.

Sine Fit :Uses Scipy to fit the data against a sine function

Menu 1 **Select input data channel for fitting**, Uses Scipy.optimize and obtains frequency, amplitude, phase and offset values.

Menu 2 **Select a second input data channel for fitting**.

checkbox **Overlay the fitted results**.

Results **The fitted values: Amplitude, Freq, Phase(and phase difference), Offset are displayed in the message window at the bottom of the screen**.

Lissajous : XY Plots

Menu 1 **Select input data channel for X-axis**.

Menu 2 **Select input data channel for Y-axis**.

Wireless Submodules

From the PSLab Application , launch the wireless-sensors utility listed in the *Test and Measurement* section

Interfacing a new wireless submodule carrying a sensor

1. **Plug in a supported sensor on to a wireless node by matching the pins labelled Vdd, GND, SCL, SDA . These pins appear in the same order on most sensor modules, and no extra wires should be needed**.
2. , Make sure that the option *Listen for nodes* on the Application is selected.
3. , Plug In the Battery onto the wireless node/ Turn on the node..
4. , Observe that the software has auto detected your wireless node as well as found out the address of the sensor you connected..
5. , Unselect *Register New Nodes*.
   If you wish, you may move the cursor over a sensor's address and the software will guess its model number/type
6. **Click on** , *Refresh Node List*, This loads a few controls for each wireless node, and also a drop down selection of the connected sensors.

Logging Data from a sensor

1. **After Following the steps in the previous section**, Select the appropriate sensor and click on *Go*, The software will continuously plot values fetched from the sensor.

Changing sensor parameters

1. **Open the auto-generated menu at the bottom left corner**, and change parameters., A few examples include gain, sampling rates, and datatype selection.

Data logger Application

This application plots the return values from any of the functions defined in the Python Module as long as they return integers or decimals.

From the PSLab Application , launch the *data streaming* utility listed in the *Test and Measurement* section

Choosing a command and starting the logger

1. **Refer to the programmer's manual for a list of valid commands**, and pick the function you would like to monitor.
2. **Paste the command name with correct arguments into the application.**, And now click on *Monitor*, This app also includes a few common commands and appropriate arguments packed into a drop down menu linked to the command entry box.

Additional Functionality Accessible through menus

Voltmeter	**Load Widgets that perform a single voltage measurement per click**.
Amplifiers	**Load a widget to set the gain on the voltage input channels**.
Wavegen	**Load a slider that allows setting the frequency of the sine wave output**.
IV sources	**Load widgets that**, enable setting programmable voltage and current.
Timing	**Load time measurement widgets**, These include duty cycle and frequency.
Console	**Insert an iPython Console with init commands preloaded**.
help	**Help menu that allows access to the programmer's manual as well as experiment specific HTML files**.