

IO Expander Shield

User Guide

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Introduction

Numato Lab's IO Expander Shield extends Arduino's digital and analog I/O pins and makes Arduino suitable for high pin count applications. This shield suitable for applications that needs to control more number of input and output devices (sensors, LEDs etc..). This shield will add **44 additional I/O pins** to your Arduino. 28 of these pins are digital I/Os controlled via I2C bus by using two I2C pins on Arduino (A4 and A5) and rest 16 pins can be used as analog inputs, which uses only one analog pin(A0) of Arduino. Overall plugging this shield on to Arduino will give 61 pins to work with (including existing Arduino's I/Os).

Some of the possible uses of this shield include

- Robotics
- Lighting Control
- Sensor and switches interfacing
- Keyboard interfacing
- General-purpose I/O functionality
- DIY and Hobby

Features

- Adds 28 digital I/O and 16 Analog Input pins by using just 3 Arduino pins.
- Two Microchip MCP23017 ICs for digital I/O expansion
- One NXP 74HC4067 Analog Multiplexer/Demultiplexer IC for Analog expansion
- Jumpers provided for I2C Address selection for MCP23017 ICs
- Arduino Uno, Arduino Mega compatible
- Small size, Low cost and Light weight

IO Expander shield consists of two 16 bit MCP23017 GPIO Expander ICs(U2 & U4) and one NXP 74HC4067 Analog Multiplexer. The digital I/O pins from MCP23017(U3) are available on 10×2 header and digital I/O pins from MCP23017(U4) are available on 8×2 header. These headers include 5V, GND and Interrupt pins for convenience. More details on Digital I/O pins is available else where in this document. 74HC4067 is a 16 channel Analog Multiplexer/Demultiplexer with four selection inputs(S0, S1, S2, S3) connected to the MCP23017(U4) IC PORTA pins(PA0, PA1, PA2, PA3), 16 independent inputs/outputs(Y0 to Y15) are available on a 10×2 header along with two 5V and two GND pins. This shield is powered from Arduino Vin pin, an on board voltage regulator is provided on the shield to derive 5V operating power supply. A power on LED indicates when the shield is powered up.

How to Use the Shield

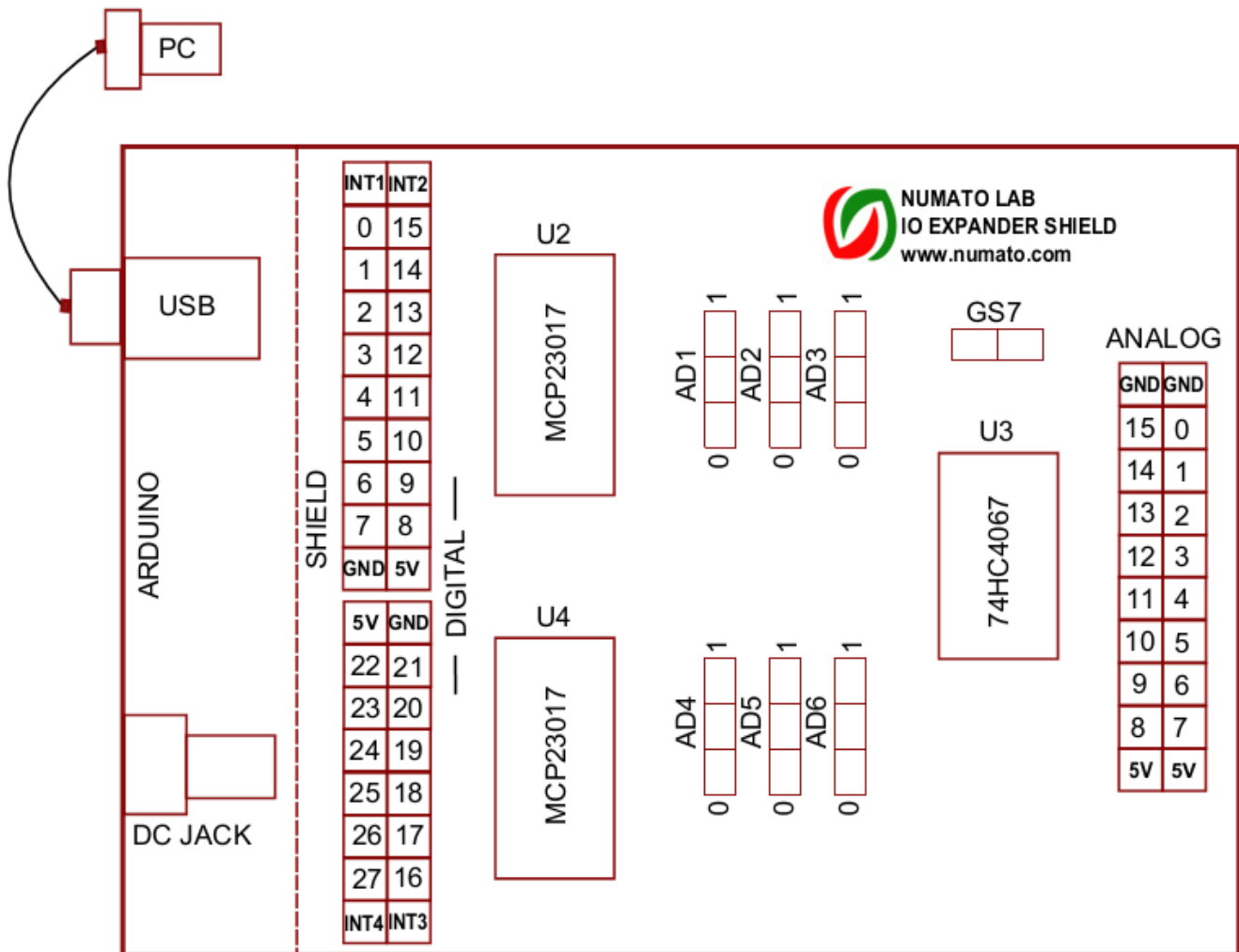
The following section describes how to use this shield.

Components / Tools Required

Along with this shield, you may need the following items for easy and fast installation.

1. Arduino Uno / Arduino Mega or a Compatible board
2. 7-12V External DC power supply to power Arduino
3. USB A to B cable to connect Arduino to host PC.

Connection Diagram



Address Pins

MCP23017 I2C slave interface can have up to 8 unique bus addresses, that means 8 chips can communicate over a single I2C bus at a time. IO Expander shield uses two MCP23017 ICs (U2 and U4) each supports 7 bit addressing with four fixed upper bits(0100) and three user-defined hardware address bits(A0, A1, A2). Jumpers are used to set the user definable part of the device address. There are six selection jumpers available on the board for these hardware address bits. AD1, AD2 and AD3 for MCP23017(U2), and AD4, AD5 and AD6 for MCP23017(U4) thus allowing user to set the address of each IC by connecting the address pin to GND (0) or VDD (1). **The shield is shipped with address 0x20 for U2 and 0x21 for U4.** One can use 4 shields over single I2C bus ie4 shields can be controlled with single Arduino board by properly selecting address for each chip. Stacking the multiple shields this way can yield up to 176 I/O pins.

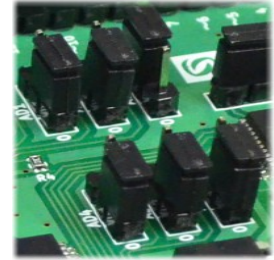
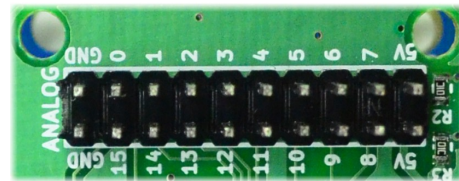
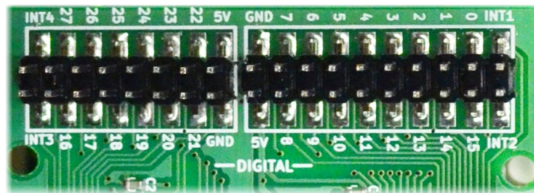


Table below summarizes the Address pins connection in detail.

Selection Jumper	Pin connection with MCP23017	Default jumper position on shield
AD1	A2 of MCP23017(U2)	GND(0)
AD2	A1 of MCP23017(U2)	GND(0)
AD3	A0 of MCP23017(U2)	GND(0)
AD4	A2 of MCP23017(U4)	GND(0)
AD5	A1 of MCP23017(U4)	GND(0)
AD6	A0 of MCP23017(U4)	VDD(1)

I/O Ports



There are total 28 digital I/O and 16 analog pins available on three separate headers on the shield. The digital pins are numbered from 0 to 27 in which 0 to 15 are controlled by MCP23017(U2) and 16 to 27 are controlled by MCP23017(U4) through I2C bus. Each pin can individually be controlled by accessing the specific port register. Please refer to MCP23017 data-sheet for register addresses and more details. The Analog pins are numbered from 0 to 15. These pins are connected to analog multiplexer IC 74HC4067. The selection inputs(S0, S1, S2, S3) of this IC are connected to the PORTA pins(PA0, PA1, PA2, PA3) of MCP23017(U4), hence the pin selection for 74HC4067 IC can be done by writing the address input(0–15) to PORTA register of MCP23017(U4). The Z terminal (common terminal) of 74HC4067 is wired to Arduino's Analog pin(A0). Reading Arduino's A0 pin will read the analog voltage on 74HC4067's analog pin that is selected by the selection inputs(S0, S1, S2, S3). Each header has 5V and GND connections available for convenience.

Table below summarizes the description of each pin on the header.

Digital I/Os

Pin out connections of MCP23017 (U2)		Pin out connections of MCP23017 (U4)	
Pin name on the Digital Header	Description	Pin name on the Digital Header	Description
INT1	Interrupt output for PORTB	INT3	Interrupt output for PORTB
INT2	Interrupt output for PORTA	INT4	Interrupt output for PORTA
0 – 7	I/O pins of PORTB(GPB0-7)	16 – 23	I/O pins of PORTB(GPB0-7)
8 – 15	I/O pins of PORTA(GPA0-7)	24 – 27	I/O pins of PORTA(GPA4-7)
GND	Ground Connection	GND	Ground Connection
5V	VDD Connection	5V	VDD Connection

Analog Inputs

Pin name on the Analog Header	Pin connection with 74HC4067	Description
0	Y0	Analog In
1	Y1	Analog In
2	Y2	Analog In
3	Y3	Analog In
4	Y4	Analog In
5	Y5	Analog In
6	Y6	Analog In
7	Y7	Analog In
8	Y8	Analog In
9	Y9	Analog In
10	Y10	Analog In
11	Y11	Analog In
12	Y12	Analog In
13	Y13	Analog In
14	Y14	Analog In
15	Y15	Analog In

Power Supply

The power supply for this shield is derived from Vin/DC Jack of the Arduino board, connect a 7-12V of DC supply to the external power supply pin (DC Jack) of Arduino. This power supply voltage is regulated using an onboard 7805 voltage regulator. The power on LED indicates the power supply status.

Additional Information

Selection Jumper(GS7)

This on board jumper pin is used to connect the Enable input pin of 74HC4067 IC to GND. When this Enable input pin is LOW one of the sixteen Analog pins of 74HC4067 IC is selected(ON-state). All unselected pins will be in OFF-state. When this pin is HIGH, it makes all pins to OFF-state. (This shield is shipped with Enable Input connected to GND).

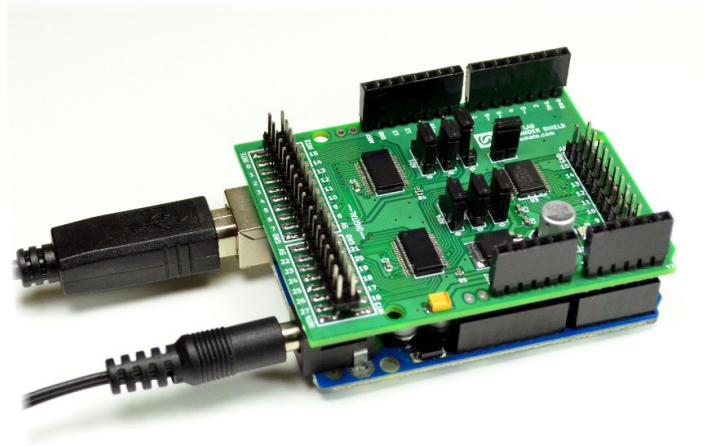
Common Input/Output

Common Input/Output (Z)pin of 74HC4067 IC, is connected to Arduino's Analog pin A0. This common I/O is internally routed to one of the 16 I/Os (Y0 – Y15) on the chip based on the configuration of selection inputs.

Interrupt Pins

The Interrupt pins of MCP23017 are brought out as standard header pins in which INT2, INT4 are associated with PORTA and INT1, INT3 are associated with PORTB of corresponding chips. The chip generates an interrupt if a mismatch condition exists between the current port value and the previous port value. This could be very useful for detecting changes quickly without having to poll all the I/O over I2C frequently. Please see MCP23017 data-sheet for more details on using interrupts.

Connecting the shield to Arduino Uno



1. Mount IO Expander Shield on Arduino Uno (or compatible) board.
2. Connect 7-12V DC power supply to the Arduino's external DC jack/Vin.
3. Download Arduino IO Expander Demo code from www.numato.com.
4. Open the code in Arduino IDE, compile and upload to the board. The following three sample sketches are available.
 1. DigitalOut.ino – Generates square wave on all Digital pins
 2. DigitalIn.ino – Prints the logic state on digital input pins if at least one input is high
 3. AnalogIn.ino – Displays reading equivalent to the analog voltage on analog input pin 7
5. Test the port outputs using LEDs or a multimeter.
6. Test the port inputs using potentiometers (for analog input) or other input devices.
7. Open serial monitor to check the input readings.

Technical Specifications

Parameter *	Value	Unit
Basic Specifications		
Number of Expanded Digital I/Os	28	
Number of Expanded Analog I/Os	16	
Digital circuit power supply voltage	7-12	V
Maximum current drawn by shield	400	mA
MCP23017 Specifications		
Supply Voltage(VDD)	1.8-5.5	V
GPIO Input Low Voltage(V _{IL})	V _{SS} -0.2V _{DD}	V
GPIO Input High Voltage(V _{IH})	0.8V _{DD} -V _{DD}	V
GPIO Output Low Voltage(V _{OL})	0.6	V
GPIO Output High Voltage(V _{OH})	V _{DD} -0.7	V
Maximum Output Current sunk/source by any output pin	25	mA
74HC4067 Specifications		
Supply Voltage(V _{CC})	2-10	V
Supply Current(I _{CC})	50	mA
Input Voltage	0-V _{CC}	V
Output Voltage	V _{CC}	V

* All parameters considered nominal. Numato Systems Pvt Ltd reserve the right to modify products without notice.

FAQ

Q. Where do I find Demo code for this product?

A. Visit <http://numato.com> and navigate to the product page to download Demo code.

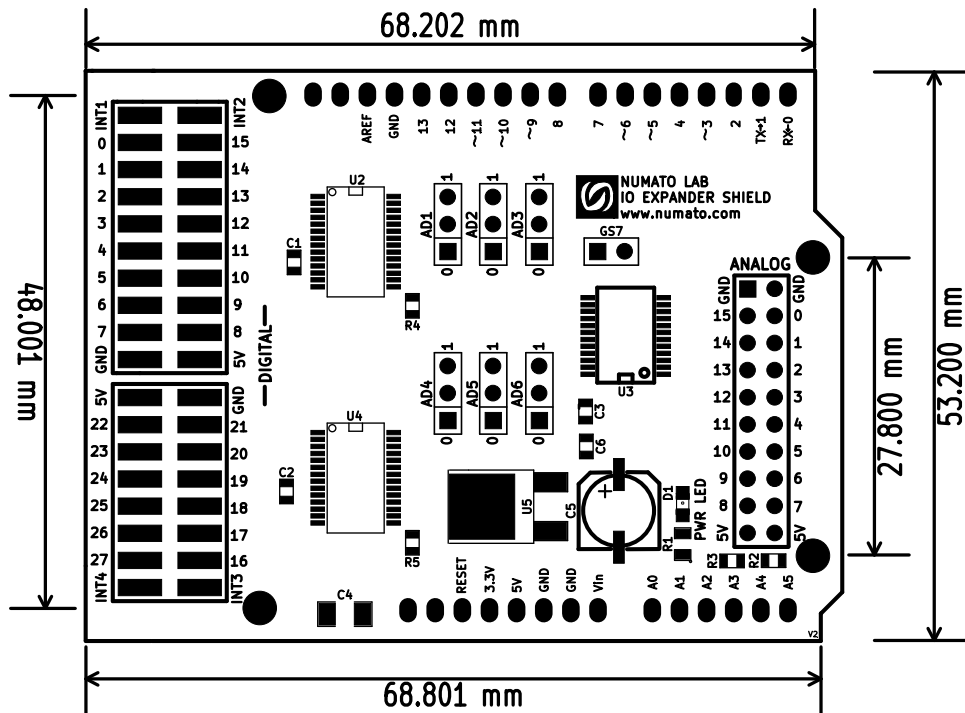
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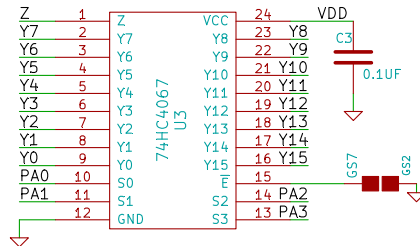
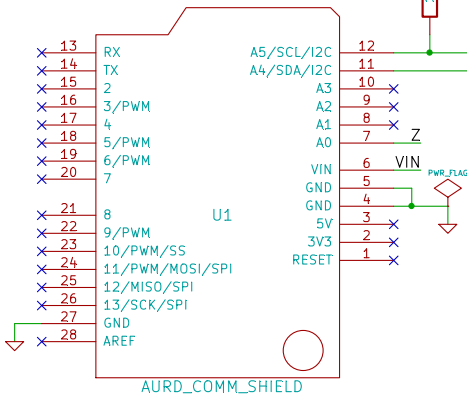
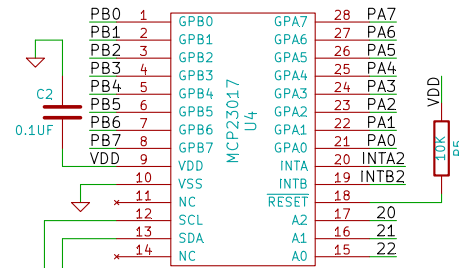
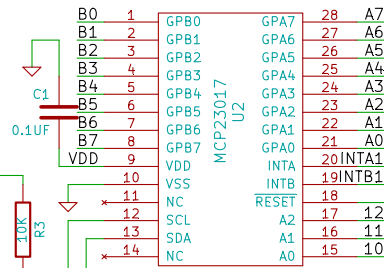
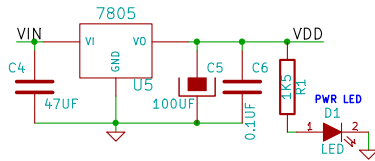
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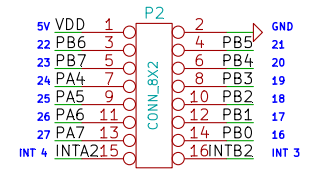
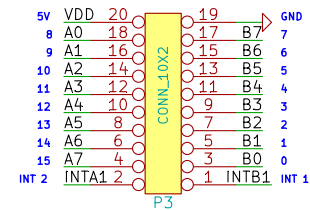
Physical Dimensions



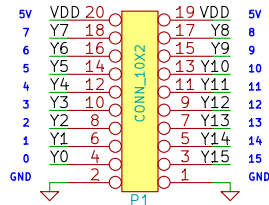
IO Expander Schematics



DIGITAL



ANALOG



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Size: A4	Date: 16 jul 2013
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Rev:	Id: 1/1