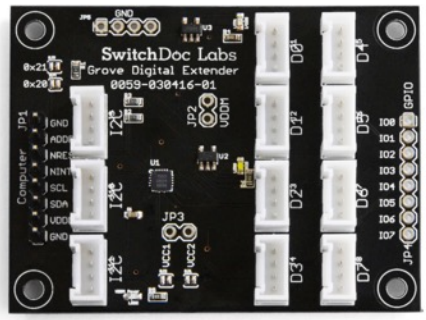
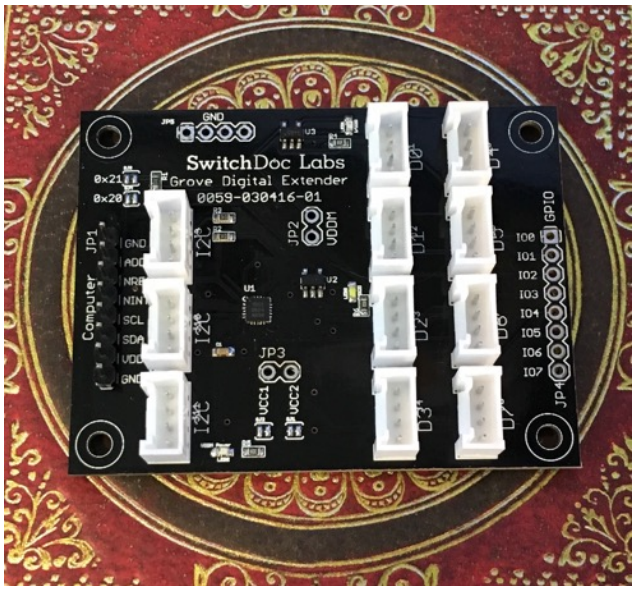


The **Grove Digital Extender board** is an easy to use I2C controlled board that provides 8 Grove Digital I/O ports.

Features and Benefits:

- 8 Grove Digital Connectors
- I2C controlled
- 3 total Grove I2C Connectors (2 spare)
- 8 GPIO pins
- 3.3V and 5V compatible
- Buffered LEDS located on D0 and D2
- All pins can interrupt the computer
- Digital Grove pins are by default 3.3V or 5.0V depending on VDD
- Optional Two bank power supply allows two banks of 4 GPIO pins to have 5V or 3.3V
- Can program GPIO pins to make up to 3 pin logic gates (PLD)
- Software drivers for Arduino and Raspberry Pi Included
- Low Cost
- Quantity Discounts Available
- Immediate Availability

Introduction



This board is an inexpensive Grove I2C controlled 8 pin GPIO Extender Board for the Raspberry Pi, Arduino and the ESP8266. It has 8 Grove Digital Connectors and 3 Grove I2C connectors (which form an I2C Hub).

We are always running out of GPIOs on the Raspberry Pi. We wanted a clean way of adding more GPIO ports (Digital Grove ports) and we decided this was the way to do it. 8 Digital Grove ports (and a bonus 2 extra Grove I2C) is the way to do it in style.
This board connects to the I2C bus on the Raspberry Pi and adds 8 additional 3.3V GPIOs to the Pi. You can also make them 5V GPIO pins if you wish.

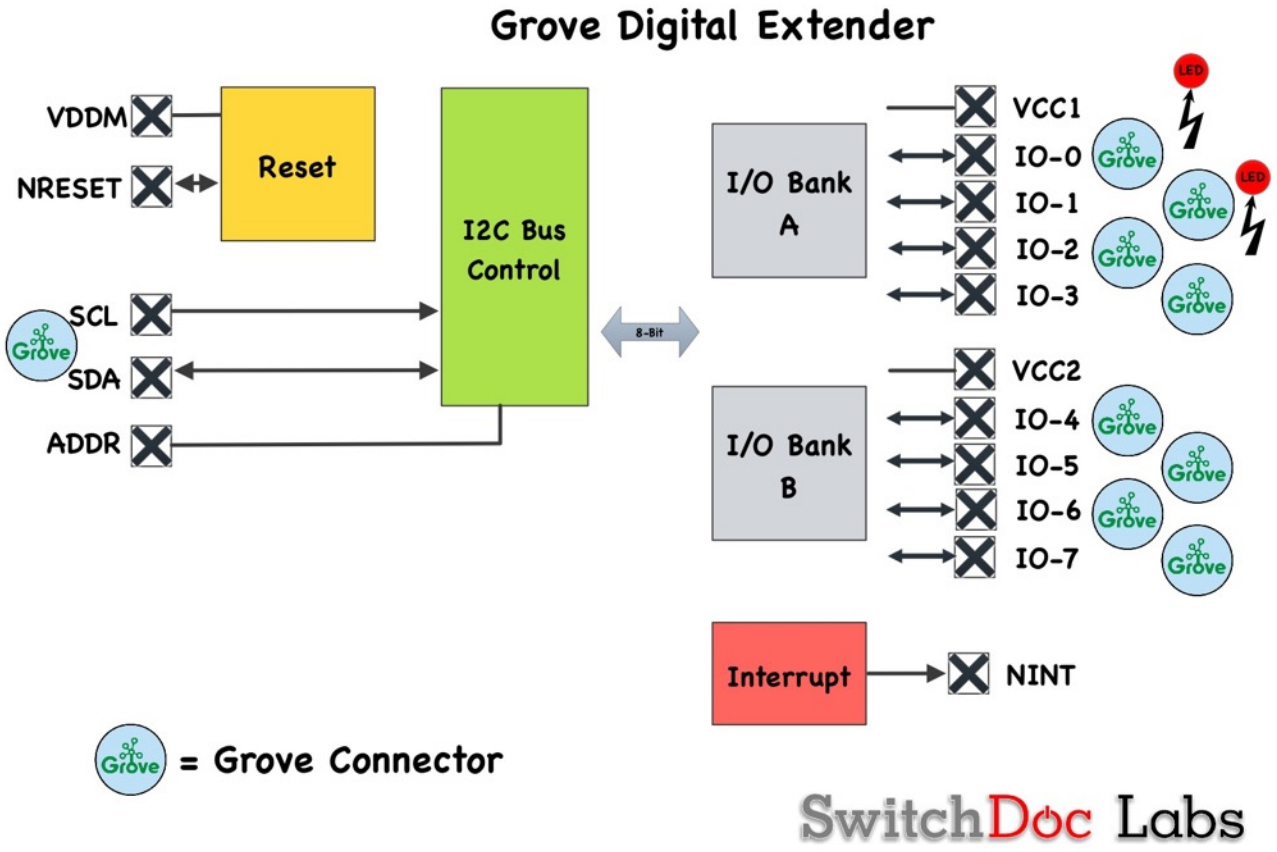
Board Compatibliity			
Board	**Raspberry Pi**	**Arduino**	**ESP8266**
Digital Grove Extender	**X**	**X**	**X**

How To Use

The Grove Digital Extender is a eight-channel, flexible 8 Grove Digital / Connector GPIO extender controlled by an I2C bus. The Grove Digital Extender board uses a 3.3V / 5V SX1502 8 channel GPIO extender.

The default I2C Address is 0x21.

To use the 8GPIO board, you connect up the I2C bus to an Arduino, ESP8266 or Raspberry Pi. The 8 GPIO pins are split into two banks, A and B. Each bank can be set to be 3.3V or 5.0V compatible.

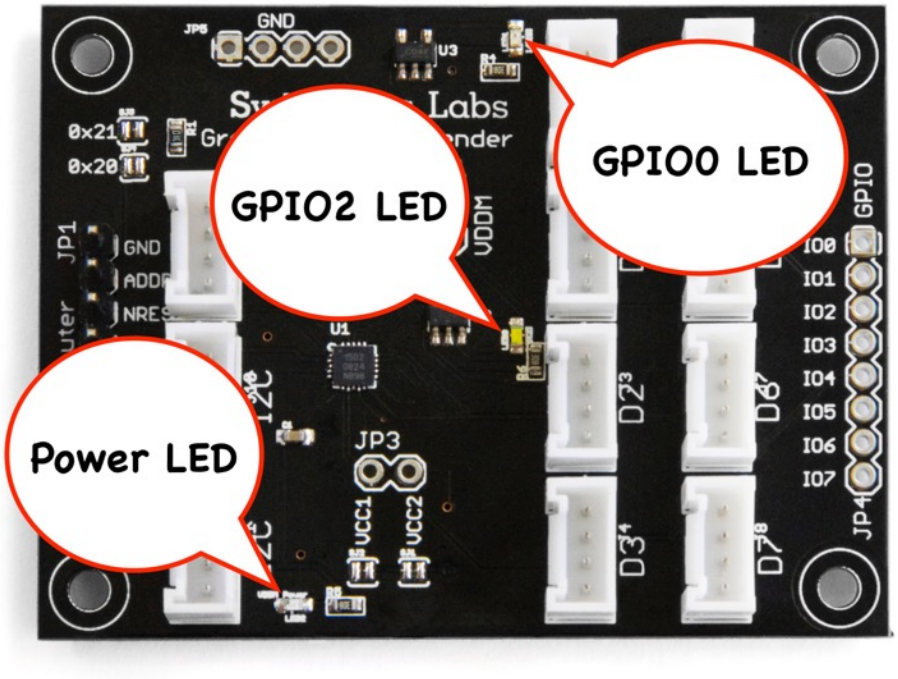


LEDs on the Grove Digital Extender

D0 - Buffered Green LED

D1 - Buffered White LED

VDDM Power LED



What are Grove Connectors?

A Grove connector is a four pin standardized size connector used to plug into the Pi2Grover base unit and Grove devices and modules. These standardized connectors (common to all types of Grove Connectors) are the key to making this system work. They are keyed to prevent plugging them in backwards, and the four types of connectors (see below) are all designed so that if you plug the wrong type of device into the wrong type of base unit, there is no problem. They just won't work. This is a good thing. Less smoke, more prototyping!

The Four Types of Grove Connectors

Below are some of the specifics of each of the four types of connectors. First of all, physically all of them are the same. Exactly. The differences are in the signal types that are provided. Now, note. You will never short out power and ground by mis-plugging one type of Grove connector in the other. **However, it is possible to plug a 3.3V Grove Module into a 5.0V Grove connector and damage the device**. The same could happen with an output coming back from a Grove button or switch for example into another output. While you do need to be careful and think about what you are doing, it is a lot less risky than soldering or using just jumpers to wire up devices to your Pi or Arduino.

Generically, all of the Grove connectors are wired the same: Signal 1, Signal 2, Power, Ground.

Grove Digital

A digital Grove connector consists of the standard four lines coming into the Grove plug. The two signal lines are generically called D0 and D1. Most modules only use D0, but some do (like the LED Bar Grove display) use both. Often base units will have the first connector called D0 and the second called D1 and they will be wired D0/D1 and then D1/D2, etc.

Grove Digital		
Pin 1	D0	Primary Digital Input/Output
Pin 2	D1	Secondary Digital Input/Output
Pin 3	VCC	Power for Grove Module (5V or 3.3V)
Pin 4	GND	Ground

Examples of Grove Digital modules are: Switch Modules, the Fan Module, and the LED Module.

Grove Analog (Note: The Grove Digital Extender has no Analog Connectors. Grove Analog is supplied by the Grove 4Channel 16 bit ADC Module)

An Grove Analog connector consists of the standard four lines coming into the Grove plug. The two signal lines are generically called A0 and D0. Most modules only use A0. Often base units will have the first connector called A0 and the second called A1 and they will be wired A0/A1 and then A1/A2, etc.

Grove Analog		
Pin 1	A0	Primary Analog Input
Pin 2	A1	Secondary Analog Input
Pin 3	VCC	Power for Grove Module (5V or 3.3V)
Pin 4	GND	Ground

Examples of Grove Analog modules are: Potentiometer, Voltage Divider and the Grove Air Quality Sensor.

Grove UART (No Grove UART on the Grove Digital Extender)

The Grove UART module is a specialized version of a Grove Digital Module. It uses both Pin 1 and Pin 2 for the serial input and transmit. The Grove UART plug is labeled from the base unit point of view. In other words, Pin 1 is the RX line (which the base unit uses to receive data, so it is an input) where Pin 2 is the TX line (which the base unit uses to transmit data to the Grove module).

Grove UART		
Pin 1	RX	Serial Receive (from base point of view)
Pin 2	TX	Serial Transmit (from base point of view)
Pin 3	VCC	Power for Grove Module (5V or 3.3V)
Pin 4	GND	Ground

Examples of Grove UART modules are: XBee Wireless Sockets, 125KHz RFID Reader

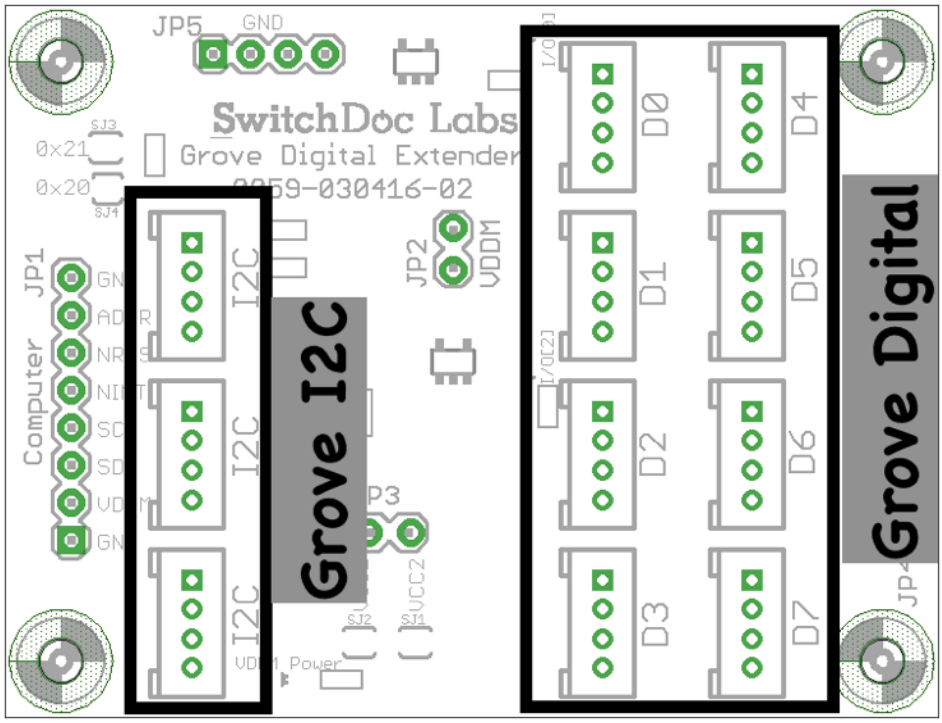
Grove I2C

There are many types of I2C Grove sensors available. Most are 5V/3.3V devices, but there are a few that are only 3.3V or 5.0V. You need to check the specifications.

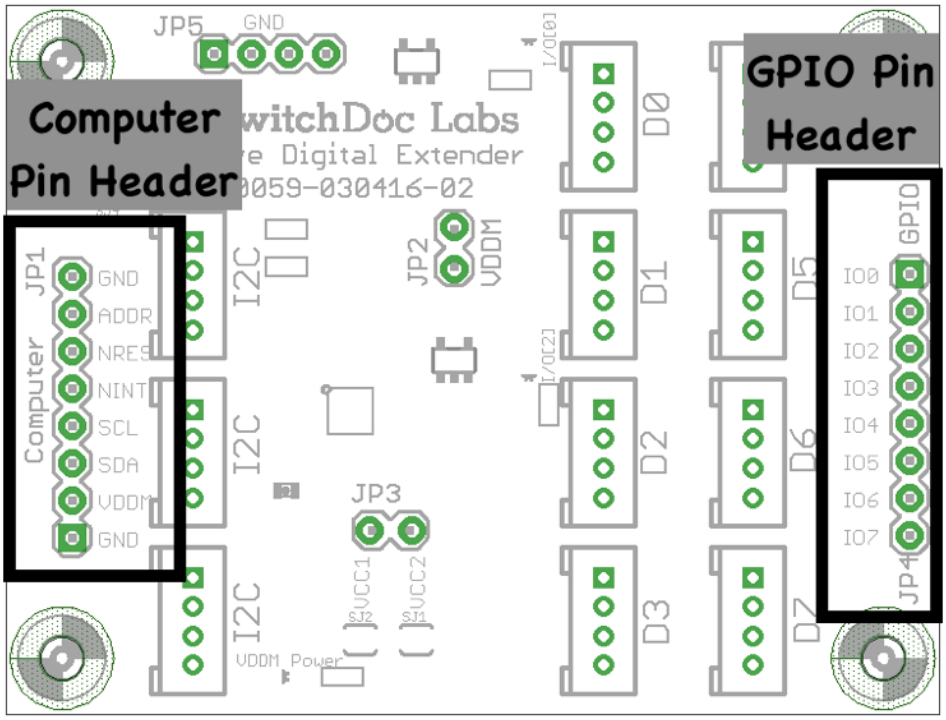
The Grove I2C connector has the standard layout. Pin 1 is the SCL signal and Pin 2 is the SDA signal. Power and Ground are the same as the other connectors. This is another special version of the Grove Digital Connector. In fact, often the I2C bus on a controller (like the ESP8266, Raspberry Pi and the Arduino) just uses Digital I/O pins to implement the I2C bus. The pins on the Raspberry Pi and Arduino are special with hardware support for the I2C bus. The ESP8266 is purely software.

Grove I2C		
Pin 1	SCL	I2C Clock
Pin 2	SDA	I2C Data
Pin 3	VCC	Power for Grove Module (5V or 3.3V)
Pin 4	GND	Ground

Grove Digital Extender Interface Pinout



Pin Headers



Wiring Lists for Non Grove Pin Headers

Raspberry Pi (A/B/A+/B+/Pi 2/Pi 3)

Signal Name	Raspberry Pi A/B/A+/B+/Pi 2	Grove Digital Extender
GND	GND (GPIO/6)	GND (JP1/1)
Power	3.3V (GPIO/1)	VDDM (JP1/2)
SDA	I2C1_SDA (GPIO/3)	SDA (JP1/3)
SCL	I2C1_SCL (GPIO/5)	SCL (JP1/4)

Arduino Uno

Signal Name	Arduino Uno	Grove Digital Extender
GND	GND (POWER/GND)	GND (JP1/1)
Power	5.0V (POWER/5V)	VDDM(JP1/2)
SDA	ADC4/SDA (ANALOG IN/A4)	SDA (JP1/3)
SCL	ADC5/SCL (ANALOG IN/A5)	SCL (JP1/4)

Ardunio Mega 2560

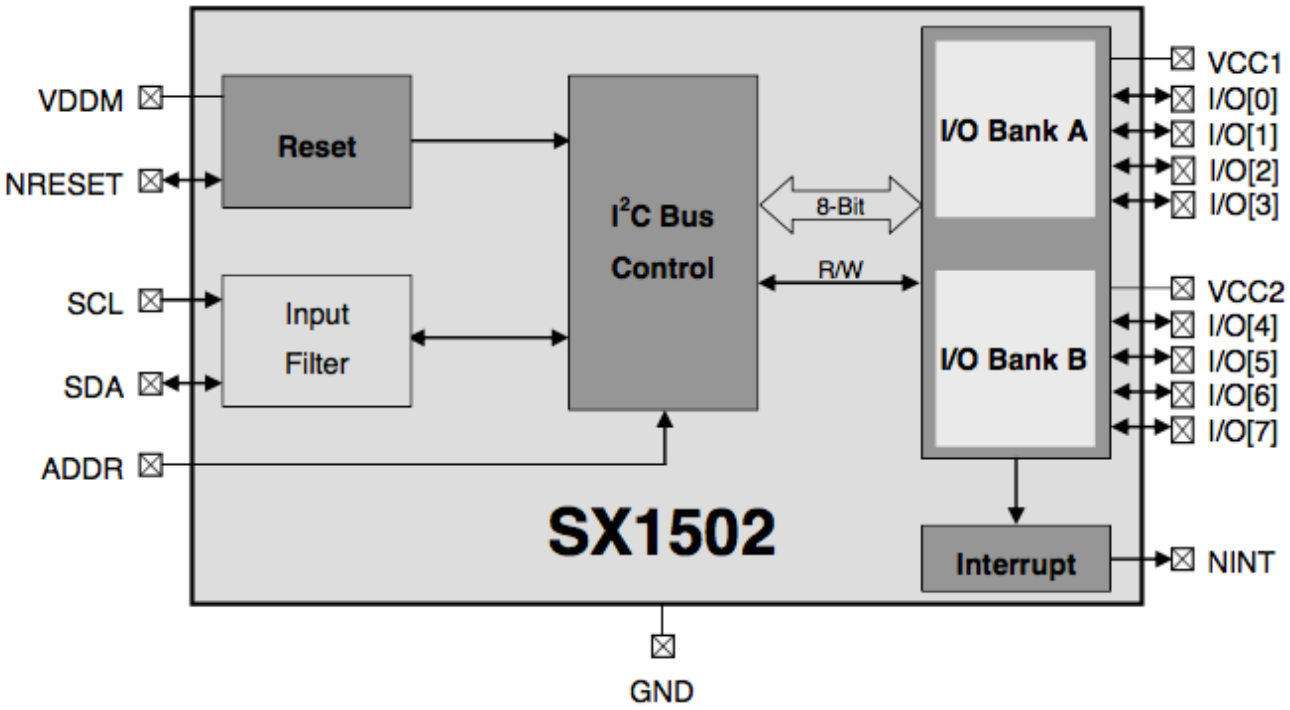
Signal Name	Arduino Mega 2560	Grove Digital Extender
GND	GND (POWER/GND)	GND (JP1/1)
Power	5.0V (POWER/5V)	VDDM (JP1/2)
SDA	SDA (COMMUNICATIONS 20)	SDA (JP1/3)
SCL	SCL (COMMUNICATIONS 21)	SCL (JP1/4)

Theory of Operation

SX1502 IC

For more complete information, see the full SX1502 Specification at: http://www.semtech.com/images/datasheet/sx150x.pdf.

The Grove Digital Extender board uses a Semtech SX1502 8 GPIO I2C IC to supply the 8 Grove Digital on the board.



The SX1502 is a complete ultra low voltage General Purpose parallel Input/Output (GPIO) expanders ideal for low power handheld battery powered equipment. It allows easy serial expansion of I/O through a standard I2C interface. GPIO devices can provide additional control and monitoring when the microcontroller or chipset has insufficient I/O ports, or in systems where serial communication and control from a remote location is advantageous.

These devices can also act as a level shifter to connect a microcontroller running at one voltage level to a component running at a different voltage level. The core is operating as low as 1.2V while the I/O banks can operate between 1.2V and 5.5V independent of the core voltage and each other.

Each GPIO is programmable via 8-bit configuration registers. Data registers, direction registers, pull- up/pull-down registers, interrupt mask registers and interrupt registers allow the system master to allow the system master to program and configure 8 GPIOs using a 2 wire standard 400kHz I C interface.

PLD (Programmable Logic Device)

The SX1502 offers a unique fully programmable logic functions like a PLD to give more flexibility and reduce external logic gates used for standard applications. Pins IO4-IO7 are available for PLD use on the 8GPIO board.

Since the whole truth table is fully programmable, the SX1502 can implement combinatory functions ranging from the basic AND/OR gates to the most complicated ones with up to four 3-to1 PLDs or two 3-to-2 PLDs which can also be externally cascaded if needed.

In all cases, any IO not configured for PLD functionality retains its GPIO functionality while I/Os used by the PLD have their direction automatically set accordingly.

Please note that while RegDir corresponding bits are ignored for PLD operation they may still be set to input to access unused PLD inputs as normal GPI (PLD truth table can define some inputs to have no effect on PLD output) and/or generate interrupt based on any of the PLD inputs or outputs bits.

For more information, check out the SX1502 specification from Semtech.

Operating Values

			Min	Normal	Max	Unit
VDDM	Supply Voltage		1.2		5.5	V
VCC1/VCC2	IO Supply Voltage		1.2		5.5	V
IOH	GPIO Output High Source Current				8 at VCC1/ VCC2 > 2V 0.3 at VCC1/ VCC2 < 2V	mA
IOL	GPIO Output High Source Current				12 at VCC1/ VCC2 > 2V 6 at VCC1/ VCC2 < 2V	mA

Pin Locations

Physical dimensions of board: 63 mm x 48 mm x 10mm(max).

I/O Key:

I - Digital Input

O - Digital Output
A - Analog

Pin Functions

JP1 - Computer Side Pins

Input / Output Control Lines for Grove Digital Extender

NAME	PIN	I/O	DESCRIPTION
GND	JP1 / 1	A	GND
VDDM	JP1 / 2	A	Power for the Grove Digital Extender. Use 3.3V with Raspberry Pi and 5.0V with Arduino
SDA	JP1 / 3	I/O	Serial bus data line; open-drain input/output.
SCL	JP1 / 4	I	Serial bus clock line; open-drain input.
NINT	JP1 / 5	O	Outgoing Interrupt Line; 0 = Interrupt; open-drain output
NRES	JP1 / 6	I	Reset SX1502; open-drain input
ADDR	JP1 / 7	I	8GPIOB I2C Address Select - 0x21 if tied to VDDM, 0x20 if tied to GND. Default 0x21
GND	JP1 / 8	A	GND

JP2 - Auxiliary VDDM Pins

Auxiliary VDDM pins

NAME	PIN	I/O	DESCRIPTION
VDDM	JP3 / 1	A	Tied to VDDM input on JP2 (JP1 / 2)

VDDM	JP3 / 2	A	Tied to VDDM input on JP2 (JP1 / 2)

JP3 - Bank A/B Power Supplies

VCC1/VCC2 Power Supplies

NAME	PIN	I/O	DESCRIPTION
VCC1	JP3 / 1	A	Supply for SX1502 IO pins 0-3. Default tied to VDDM, but can be tied to 3.3V or 5.0V to provide level translation. **To change you MUST cut SJ2**
VCC2	JP3 / 2	A	Supply for SX1502 IO pins 4-7. Default tied to VDDM, but can be tied to 3.3V or 5.0V to provide level translation. **To change you MUST cut SJ2**

JP4 - GPIO Pins

GPIO Pins

NAME	PIN	I/O	DESCRIPTION
IO0	JP4 / 1	D	GPIO Pin 0
IO1	JP4 / 2	D	GPIO Pin 1
IO2	JP4 / 3	D	GPIO Pin 2
IO3	JP4 / 4	D	GPIO Pin 3
IO4	JP4 / 5	D	GPIO Pin 4
IO5	JP4 / 6	D	GPIO Pin 5
IO6	JP4 / 7	D	GPIO Pin 6
IO7	JP4 / 8	D	GPIO Pin 7

JP5 - Auxiliary GND Pins

Auxiliary GND pins

NAME	PIN	I/O	DESCRIPTION
GND	JP4 / 1	A	GND
GND	JP4 / 2	A	GND

GND	JP4 / 3	A	GND
GND	JP4 / 4	A	GND

Jumpers

SJ1

Default closed - Cut SJ1 to supply a different voltage to VCC2 (Bank D4-D7). Supply VCC2 voltage at JP3 pin 2

SJ2

Default closed - Cut SJ2 to supply a different voltage to VCC1 (Bank D0-D3). Supply VCC1 voltage at JP3 pin 1

SJ3

Default closed - Cut SJ3 and solder SJ4 to change I2C Address to 0x23 from the default 0x21

SJ4

Default open - Cut SJ3 and solder SJ4 to change I2C Address to 0x23 from the default 0x21

Software for Arduino and Raspberry Pi

SwitchDoc Labs developed this pure Python Raspberry Pi library for this Grove Digital Extender as well as developing the Arduino C++ driver.

The Python Raspberry Pi software is located on the SwitchDoc Labs github under https://github.com/switchdoclabs/SDL_Pi_GroveDigitalExtender

Arduino drivers are located on github under https://github.com/switchdoclabs/SDL_Arduino_GroveDigitalExtender

The first test on the Raspberry Pi should always be “i2cdetect -y 1” which should show you the Grove Digital Extender at the default address of 0x21.

A similar test can be run on the Arduino (I2CTest - http://playground.arduino.cc/Main/I2cScanner).

Running the test results from the Grove Digital Extender are below on the Raspberry Pi:

```
pi@RPi3:~/SDL_Pi_GroveDigitalExtender $ sudo python SDL_Pi_GroveDigitalExtender_Test.py

Test SDL_Pi_GroveDigitalExtender Version 1.0 - SwitchDoc Labs

Sample uses 0x21 I2C Address
Program Started at:2016-05-15 00:20:02

----------------
setDirect channel = 0x1
oldDirectionReg= 0xff
newDirectionReg= 0xfe
setDirect channel = 0x4
oldDirectionReg= 0xfe
newDirectionReg= 0xfa
('GPIO Value =', 1)
----------------
++++++++++++++
('GPIO Value =', 0)
----------------


++++++++++++++
('GPIO Value =', 0)
----------------
```

Next, here are the results of the Grove Digital Extender test on the Arduino. This test blinks the D0 and D2 LEDs:

```
--------------------------
SDL_Arduino_GroveDigitalExtender_Test
Version 1.1
----------------
++++++++++++++
GPIO Value =1
----------------
----------------
```