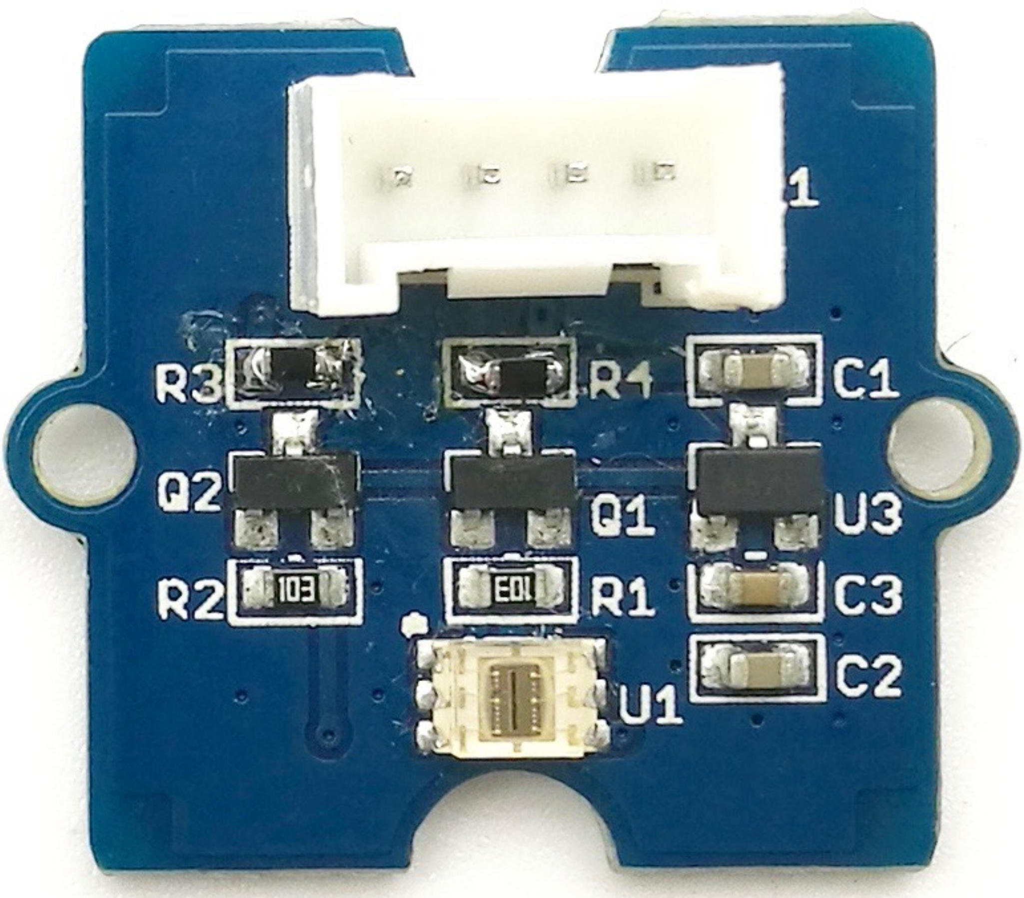
Grove - Digital Light Sensor



This module is based on the I2C light-to-digital converter TSL2561 to transform light intensity to a digital signal. Different from traditional analog light sensor, as Grove - Light Sensor [https://www.seeedstudio.com/depot/grove-light-sensorp-p-1253.html?cPath=144_148], this digital module features a selectable light spectrum range due to its dual light sensitive diodes: infrared and full spectrum.

We can switch among three detection modes to take your readings. They are infrared mode, full spectrum and human visible mode. When running under the human visible mode, this sensor will give you readings just close to your eye feelings.

Seeed IoTea Lora Solution

Get One Now [https://www.seeedstudio.com/Grove-Digital-Light-Sensor-p-1281.html]

Version

Product Version	Changes	Released Date
Grove - Digital Light Sensor V1.1	Initial	Oct 2015

Features

- Selectable detection modes
- High resolution 16-Bit digital output at 400 kHz I2C Fast-Mode
- Wide dynamic range: 0.1 - 40,000 LUX
- Wide operating temperature range: -40°C to 85°C
- Programmable interrupt function with User-Defined Upper and lower threshold settings
- I2C Address 0x29

Note
If you want to use multiplue I2C devices, please refer to Software I2C [https://wiki.seeedstudio.com/Arduino_Software_I2C_user_guide/].

Tip
More details about Grove modules please refer to Grove System [https://wiki.seeedstudio.com/Grove_System/]

Specifications

Items	Min	Typical	Max	Unit
Supply voltage, VDD	3.3	5	5.1	V
Operating temperature	-30	\	70	℃
SCL,SDA input low voltage	-0.5	\	0.8	V
SCL,SDA input high voltage	2.3	\	5.1	V

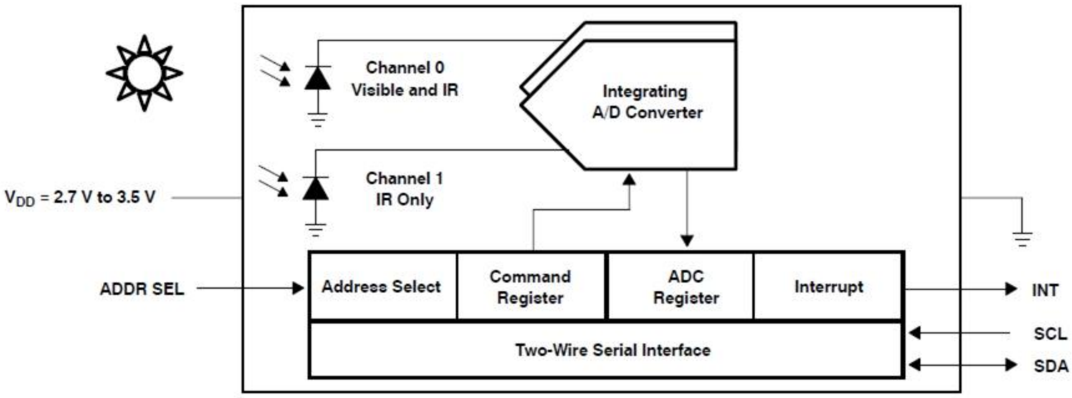
Platforms Supported

Arduino	Raspberry Pi	

Caution
The platforms mentioned above as supported is/are an indication of the module's software or theoritical compatibility. We only provide software library or code examples for Arduino platform in most cases. It is not possible to provide software library / demo code for all possible MCU platforms. Hence, users have to write their own software library.

Hardware Overview

U1: TSL2561 IC, Light-To-Digital Converter. Here is the Functional Block Diagram.

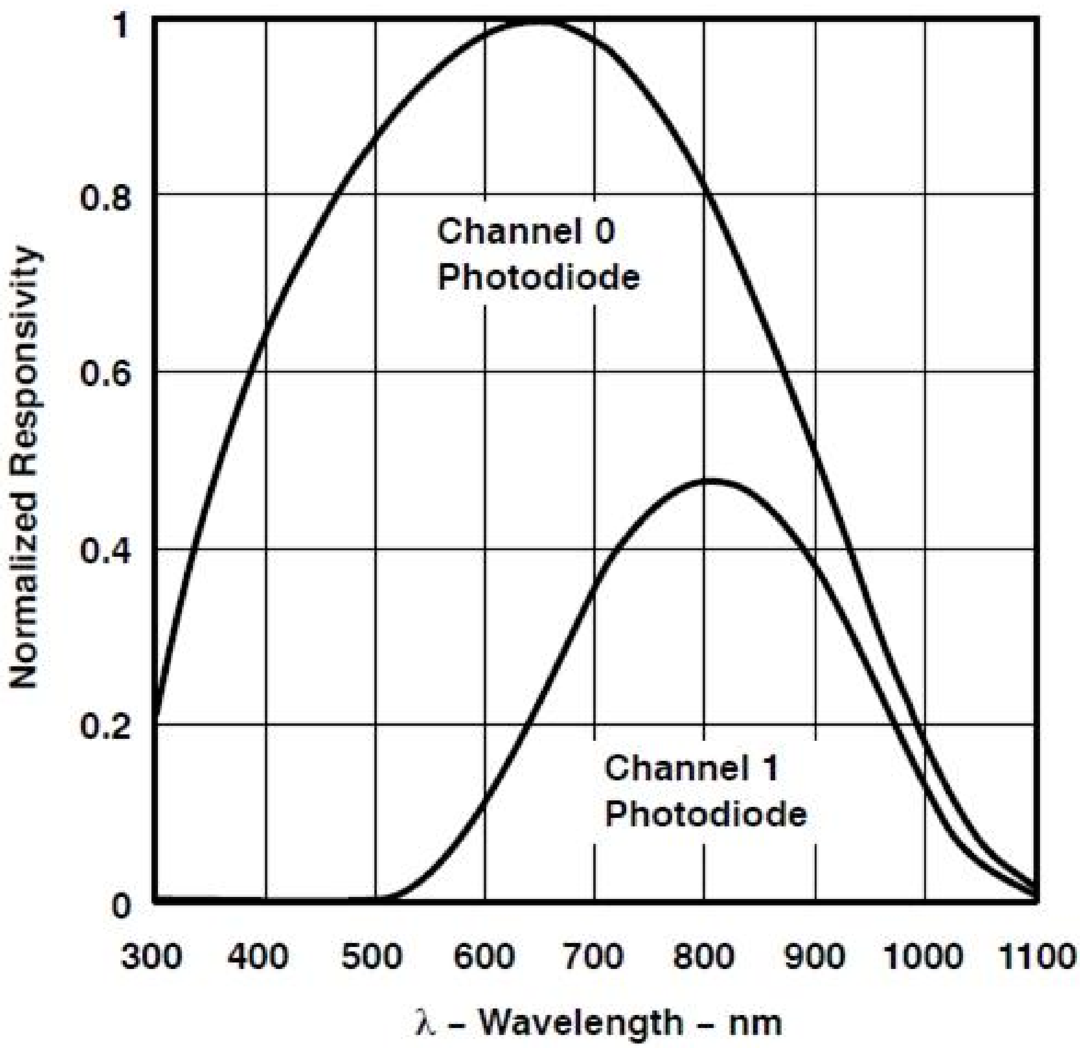


- **Register Map**

The TSL2561 is controlled and monitored by sixteen registers (three are reserved) and a command register accessed through the serial interface. These registers provide for a variety of control functions and can be read to determine results of the ADC conversions. The register set is summarised as shown below.

ADDRESS	RESISTER NAME	REGISTER FUNCTION
--	COMMAND	Specifies register address
0h	CONTROL	Control of basic functions
1h	TIMING	Integration time/gain control
2h	THRESHLOWLOW	Low byte of low interrupt threshold
3h	THRESHLOWHIGH	High byte of low interrupt threshold
4h	THRESHHIGHLOW	Low byte of high interrupt threshold
5h	THRESHHIGHHIGH	High byte of high interrupt threshold
6h	INTERRUPT	Interrupt control
7h	--	Reserved
8h	CRC	Factory test — not a user register
9h	--	Reserved
Ah	ID	Part number/ Rev ID
Bh	--	Reserved
Ch	DATA0LOW	Low byte of ADC channel 0
Dh	DATA0HIGH	High byte of ADC channel 0
Eh	DATA1LOW	Low byte of ADC channel 1
Fh	DATA1HIGH	High byte of ADC channel 1

- **Spectrum Response Curve**



Two channels of the digital light sensor have different response characteristic. That's why you can choose its working mode by having both of them on or one of them off.

U3: XC6206MR332 IC, Positive Voltage Regulators.

Q1,Q2: BSN20 IC, N-channel Enhancement Mode Vertical D-MOS Transistor.

SCL,SDA: I2C Signal Interface

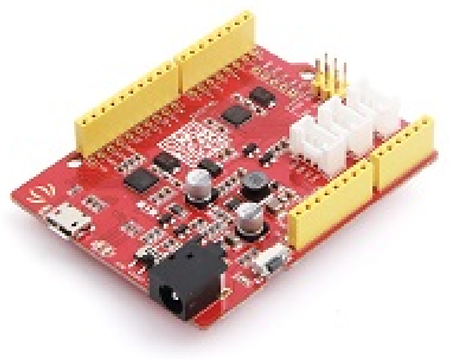
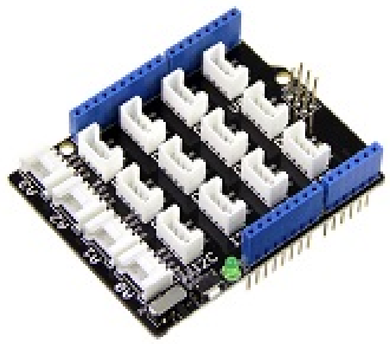
Getting Started

> **Note**
> If this is the first time you work with Arduino, we firmly recommend you to see Getting Started with Arduino [https://wiki.seeedstudio.com/Getting_Started_with_Arduino/] before the start.

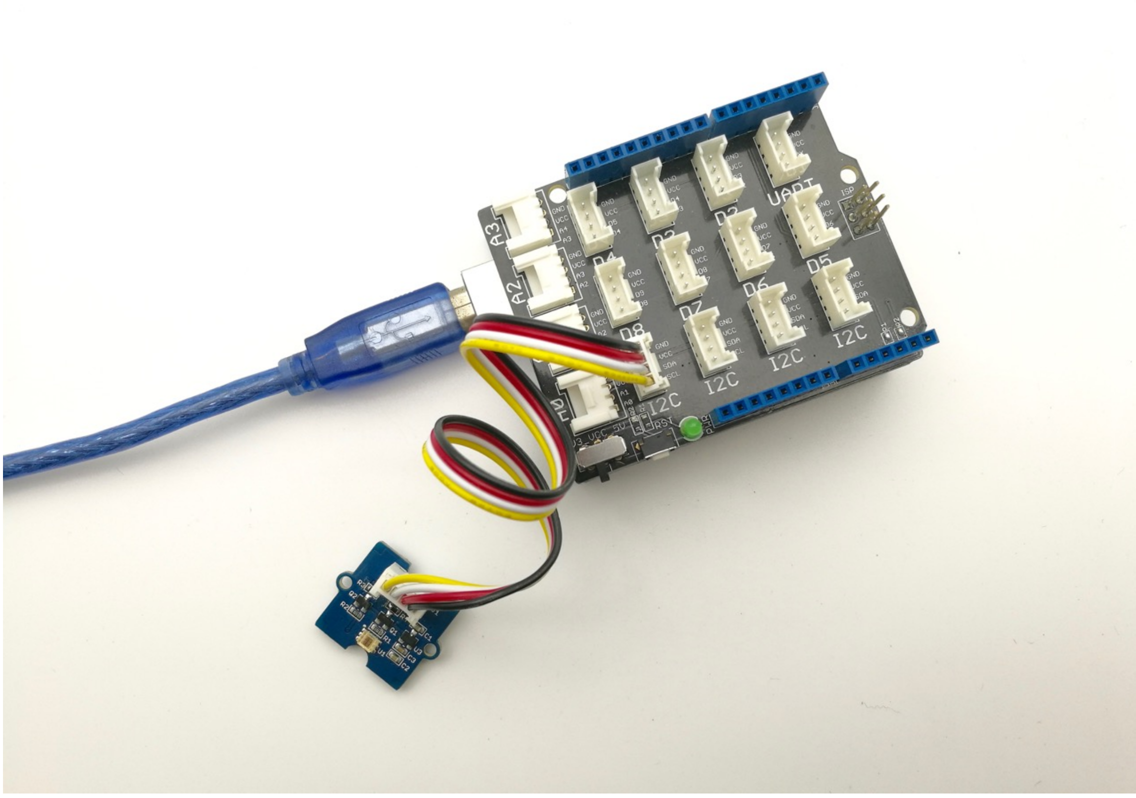
Play With Arduino

Hardware

- **Step 1.** Prepare the below stuffs:

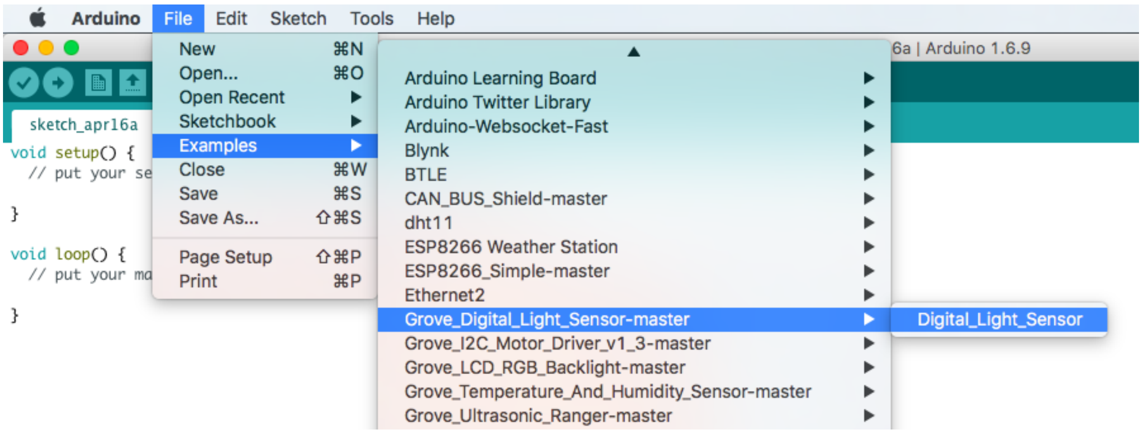
Seeeduino V4	Base Shield
	
Get ONE Now [https://www.seeedstudio.com/Seeeduino-V4.2-p-2517.html]	Get ONE Now [https://www.seeedstudio.com/Base Shield-V2-p-1378.html]

- **Step 2.** Connect Grove - Digital light Sensor to **I2C** port of base shield.
- **Step 3.** Plug the base Shield into Arduino.
- **Step 4.** Connect Arduino to PC by using a USB cable.



Software

- **Step 1.** Download the library from here Digital Light Sensor Library [https://github.com/Seeed-Studio/Grove_Digital_Light_Sensor/archive/master.zip];
- **Step 2.** Please follow how to install an arduino library [https://wiki.seeedstudio.com/How_to_install_Arduino_Library/] procedures to install library.
- **Step 3.** Open the code directly by the path: **File -> Example ->Digital_Light_Sensor->Digital_Light_Sensor**.



- Or copy below code to IDE and upload to Arduino.

```
/*
    Digital_Light_Sensor.ino
    A library for TSL2561

    Copyright (c) 2012 seeed technology inc.
    Author      : zhangkun
    Create Time:
    Change Log :

    The MIT License (MIT)

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    LIABILITY, WHETHER IN AN ACTION OF CONTRACT, TORT OR
    OUT OF OR IN CONNECTION WITH THE SOFTWARE OR THE USE
```
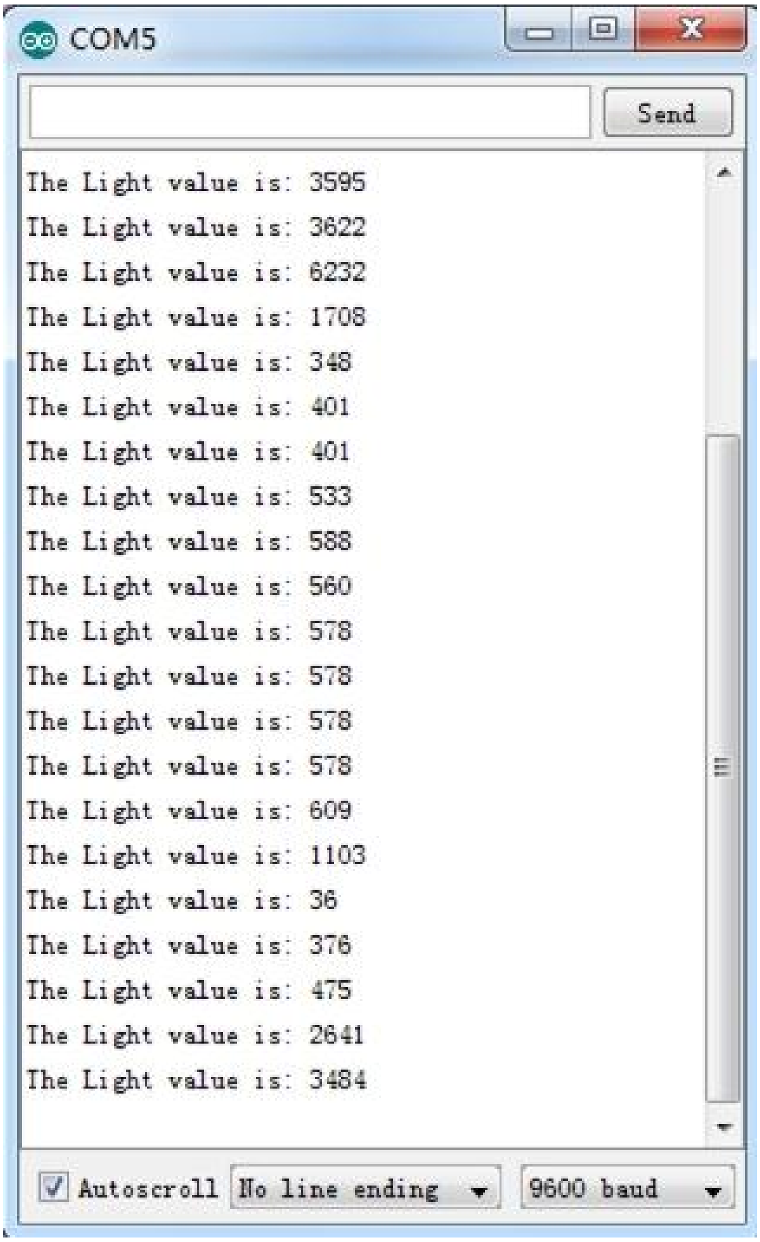

```
    THE SOFTWARE.
*/

#include <Wire.h>
#include <Digital_Light_TSL2561.h>
void setup()
{
  Wire.begin();
  Serial.begin(9600);
  TSL2561.init();
}

void loop()
{
  Serial.print("The Light value is: ");
  Serial.println(TSL2561.readVisibleLux());
  delay(1000);
}
```

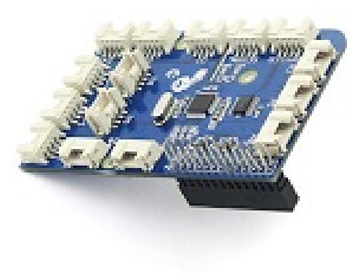
- **Step 4.** Open the serial monitor to monitor the result.



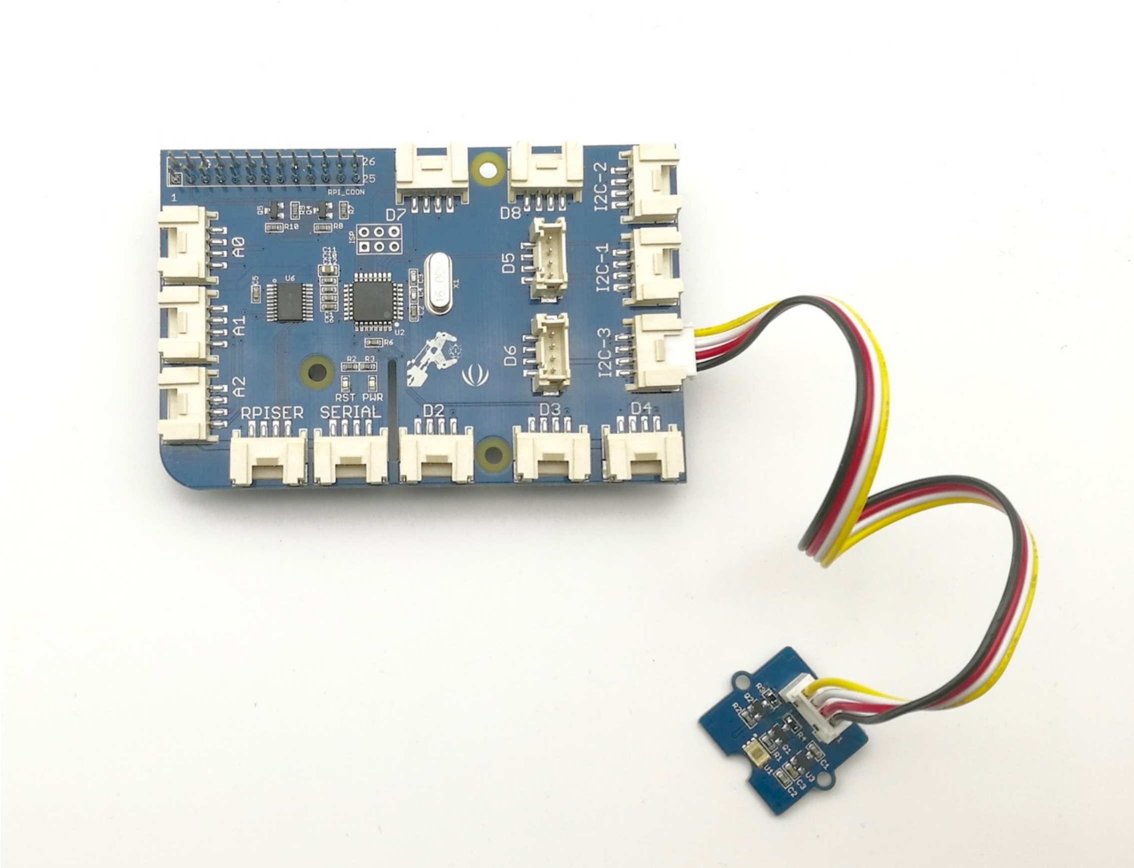
Play With Raspberry Pi

Hardware

- **Step 1.** Prepare the below stuffs:

Raspberry pi	GrovePi_Plus
	
Get ONE Now [https://www.seeedstudio.com/Raspberry-Pi-3-Model-B-p-2625.html]	Get ONE Now [https://www.seeedstudio.com/Grov p-2241.html]

- Follow instruction [https://wiki.seeedstudio.com/GrovePi_Plus/] to configure the development environment.
- Plug the sensor to grovepi+ socket **I2C** by using a grove cable.



Software

> **Attention**
> If you are using **Raspberry Pi with Raspberrypi OS >= Bullseye**, you have to use this command line **only with Python3**.

- **Step 1.** Follow Setting Software [https://www.dexterindustries.com/GrovePi/get-started-with-the-grovepi/setting-software/] to configure the development environment.
- **Step 1.** Navigate to the demos' directory:

```
cd yourpath/GrovePi/Software/Python/grove_i2c_digital_light_
```

- **Step 2.** To see the code

```
nano grove_i2c_digital_light_sensor.py  # "Ctrl+x" to exit #
```

```
#!/usr/bin/python
# TSL2561 I2C Light-To-Digital converter library for th
# Datasheet: https://www.adafruit.com/datasheets/TSL256
#
# This library is based on the work by Cedric Maion htt
#
# Read http://www.dexterindustries.com/topic/greehouse-

from time import sleep
import smbus
from Adafruit_I2C import Adafruit_I2C
import RPi.GPIO as GPIO
from smbus import SMBus

TSL2561_Control = 0x80
TSL2561_Timing = 0x81
TSL2561_Interrupt = 0x86
TSL2561_Channel0L = 0x8C
TSL2561_Channel0H = 0x8D
TSL2561_Channel1L = 0x8E
TSL2561_Channel1H = 0x8F

TSL2561_Address = 0x29 #device address

LUX_SCALE = 14 # scale by 2^14
RATIO_SCALE = 9 # scale ratio by 2^9
CH_SCALE = 10 # scale channel values by 2^10
CHSCALE_TINT0 = 0x7517 # 322/11 * 2^CH_SCALE
CHSCALE_TINT1 = 0x0fe7 # 322/81 * 2^CH_SCALE

K1T = 0x0040 # 0.125 * 2^RATIO_SCALE
B1T = 0x01f2 # 0.0304 * 2^LUX_SCALE
M1T = 0x01be # 0.0272 * 2^LUX_SCALE
K2T = 0x0080 # 0.250 * 2^RATIO_SCA
```

```
B2T = 0x0214 # 0.0325 * 2^LUX_SCALE
M2T = 0x02d1 # 0.0440 * 2^LUX_SCALE
K3T = 0x00c0 # 0.375 * 2^RATIO_SCALE
B3T = 0x023f # 0.0351 * 2^LUX_SCALE
M3T = 0x037b # 0.0544 * 2^LUX_SCALE
K4T = 0x0100 # 0.50 * 2^RATIO_SCALE
B4T = 0x0270 # 0.0381 * 2^LUX_SCALE
M4T = 0x03fe # 0.0624 * 2^LUX_SCALE
K5T = 0x0138 # 0.61 * 2^RATIO_SCALE
B5T = 0x016f # 0.0224 * 2^LUX_SCALE
M5T = 0x01fc # 0.0310 * 2^LUX_SCALE
K6T = 0x019a # 0.80 * 2^RATIO_SCALE
B6T = 0x00d2 # 0.0128 * 2^LUX_SCALE
M6T = 0x00fb # 0.0153 * 2^LUX_SCALE
K7T = 0x029a # 1.3 * 2^RATIO_SCALE
B7T = 0x0018 # 0.00146 * 2^LUX_SCALE
M7T = 0x0012 # 0.00112 * 2^LUX_SCALE
K8T = 0x029a # 1.3 * 2^RATIO_SCALE
B8T = 0x0000 # 0.000 * 2^LUX_SCALE
M8T = 0x0000 # 0.000 * 2^LUX_SCALE



K1C = 0x0043 # 0.130 * 2^RATIO_SCALE
B1C = 0x0204 # 0.0315 * 2^LUX_SCALE
M1C = 0x01ad # 0.0262 * 2^LUX_SCALE
K2C = 0x0085 # 0.260 * 2^RATIO_SCALE
B2C = 0x0228 # 0.0337 * 2^LUX_SCALE
M2C = 0x02c1 # 0.0430 * 2^LUX_SCALE
K3C = 0x00c8 # 0.390 * 2^RATIO_SCALE
B3C = 0x0253 # 0.0363 * 2^LUX_SCALE
M3C = 0x0363 # 0.0529 * 2^LUX_SCALE
K4C = 0x010a # 0.520 * 2^RATIO_SCALE
B4C = 0x0282 # 0.0392 * 2^LUX_SCALE
M4C = 0x03df # 0.0605 * 2^LUX_SCALE
K5C = 0x014d # 0.65 * 2^RATIO_SCALE
B5C = 0x0177 # 0.0229 * 2^LUX_SCALE
M5C = 0x01dd # 0.0291 * 2^LUX_SCALE
K6C = 0x019a # 0.80 * 2^RATIO_SCALE
B6C = 0x0101 # 0.0157 * 2^LUX_SCALE
M6C = 0x0127 # 0.0180 * 2^LUX_SCALE
```

```
K7C = 0x029a # 1.3 * 2^RATIO_SCALE
B7C = 0x0037 # 0.00338 * 2^LUX_SCALE
M7C = 0x002b # 0.00260 * 2^LUX_SCALE
K8C = 0x029a # 1.3 * 2^RATIO_SCALE
B8C = 0x0000 # 0.000 * 2^LUX_SCALE
M8C = 0x0000 # 0.000 * 2^LUX_SCALE

# bus parameters
rev = GPIO.RPI_REVISION
if rev == 2 or rev == 3:
    bus = smbus.SMBus(1)
else:
    bus = smbus.SMBus(0)
i2c = Adafruit_I2C(TSL2561_Address)

debug = False
cooldown_time = 0.005 # measured in seconds
packageType = 0 # 0=T package, 1=CS package
gain = 0        # current gain: 0=1x, 1=16x [dynamicall
gain_m = 1      # current gain, as multiplier
timing = 2      # current integration time: 0=13.7ms, 1
timing_ms = 0   # current integration time, in ms
channel0 = 0    # raw current value of visible+ir senso
channel1 = 0    # raw current value of ir sensor
schannel0 = 0   # normalized current value of visible+i
schannel1 = 0   # normalized current value of ir sensor


def readRegister(address):
    try:
        byteval = i2c.readU8(address)

        sleep(cooldown_time)
        if (debug):
            print("TSL2561.readRegister: returned 0x%02
        return byteval
    except IOError:
        print("TSL2561.readRegister: error reading byte
        return -1


```

```
def writeRegister(address, val):
    try:
        i2c.write8(address, val)

        sleep(cooldown_time)
        if (debug):
            print("TSL2561.writeRegister: wrote 0x%02X 
    except IOError:

        sleep(cooldown_time)
        print("TSL2561.writeRegister: error writing byt
        return -1

def powerUp():
    writeRegister(TSL2561_Control, 0x03)

def powerDown():
    writeRegister(TSL2561_Control, 0x00)

def setTintAndGain():
    global gain_m, timing_ms

    if gain == 0:
        gain_m = 1
    else:
        gain_m = 16

    if timing == 0:
        timing_ms = 13.7
    elif timing == 1:
        timing_ms = 101
    else:
        timing_ms = 402
    writeRegister(TSL2561_Timing, timing | gain << 4)

def readLux():
    sleep(float(timing_ms + 1) / 1000)

    ch0_low  = readRegister(TSL2561_Channel0L)
    ch0_high = readRegister(TSL2561_Channel0H)
    ch1_low  = readRegister(TSL2561_Channel1L)
```

```
    ch1_high = readRegister(TSL2561_Channel1H)

    global channel0, channel1
    channel0 = (ch0_high<<8) | ch0_low
    channel1 = (ch1_high<<8) | ch1_low

    sleep(cooldown_time)
    if debug:
        print("TSL2561.readVisibleLux: channel 0 = %i,

def readVisibleLux():
    global timing, gain

    powerUp()
    readLux()

    if channel0 < 500 and timing == 0:
        timing = 1
        sleep(cooldown_time)
        if debug:
            print("TSL2561.readVisibleLux: too dark. In
        setTintAndGain()
        readLux()

    if channel0 < 500 and timing == 1:
        timing = 2
        sleep(cooldown_time)
        if debug:
            print("TSL2561.readVisibleLux: too dark. In
        setTintAndGain()
        readLux()

    if channel0 < 500 and timing == 2 and gain == 0:
        gain = 1
        sleep(cooldown_time)
        if debug:
            print("TSL2561.readVisibleLux: too dark. Se
        setTintAndGain()
        readLux()

    if (channel0 > 20000 or channel1 > 20000) and timin
```

```
            gain = 0
            sleep(cooldown_time)
            if debug:
                print("TSL2561.readVisibleLux: enough light
            setTintAndGain()
            readLux()

        if (channel0 > 20000 or channel1 > 20000) and timin
            timing = 1
            sleep(cooldown_time)
            if debug:
                print("TSL2561.readVisibleLux: enough light
            setTintAndGain()
            readLux()

        if (channel0 > 10000 or channel1 > 10000) and timin
            timing = 0
            sleep(cooldown_time)
            if debug:
                print("TSL2561.readVisibleLux: enough light
            setTintAndGain()
            readLux()

        powerDown()

        if (timing == 0 and (channel0 > 5000 or channel1 >
            # overflow
            return -1

        return calculateLux(channel0, channel1)

    def calculateLux(ch0, ch1):
        chScale = 0
        if timing == 0:   # 13.7 msec
            chScale = CHSCALE_TINT0
        elif timing == 1: # 101 msec
            chScale = CHSCALE_TINT1;
        else:           # assume no scaling
            chScale = (1 << CH_SCALE)

        if gain == 0:
```

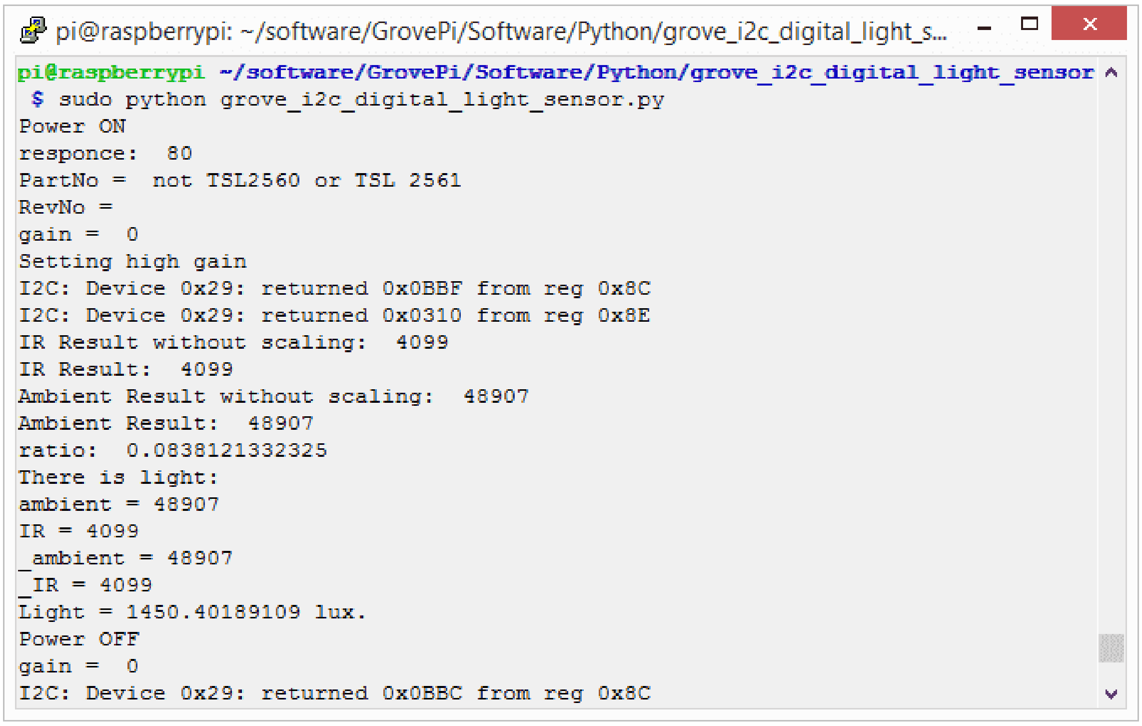
```
        chScale = chScale << 4 # scale 1X to 16X

    # scale the channel values
    global schannel0, schannel1
    schannel0 = (ch0 * chScale) >> CH_SCALE
    schannel1 = (ch1 * chScale) >> CH_SCALE

    ratio = 0
    if schannel0 != 0:
        ratio = (schannel1 << (RATIO_SCALE+1)) / schann
    ratio = (ratio + 1) >> 1

    if packageType == 0: # T package
        if ((ratio >= 0) and (ratio <= K1T)):
            b=B1T; m=M1T;
        elif (ratio <= K2T):
            b=B2T; m=M2T;
        elif (ratio <= K3T):
            b=B3T; m=M3T;
        elif (ratio <= K4T):
            b=B4T; m=M4T;
        elif (ratio <= K5T):
            b=B5T; m=M5T;
        elif (ratio <= K6T):
            b=B6T; m=M6T;
        elif (ratio <= K7T):
            b=B7T; m=M7T;
        elif (ratio > K8T):
            b=B8T; m=M8T;
    elif packageType == 1: # CS package
        if ((ratio >= 0) and (ratio <= K1C)):
            b=B1C; m=M1C;
        elif (ratio <= K2C):
            b=B2C; m=M2C;
        elif (ratio <= K3C):
            b=B3C; m=M3C;
        elif (ratio <= K4C):
            b=B4C; m=M4C;
        elif (ratio <= K5C):
            b=B5C; m=M5C;
        elif (ratio <= K6C):
```

```
            b=B6C; m=M6C;
        elif (ratio <= K7C):
            b=B7C; m=M7C;

    temp = ((schannel0*b)-(schannel1*m))
    if temp < 0:
        temp = 0;
    temp += (1<<(LUX_SCALE-1))
    # strip off fractional portion
    lux = temp>>LUX_SCALE
    sleep(cooldown_time)
    if debug:
        print("TSL2561.calculateLux: %i" % lux)

    return lux

def init():
    powerUp()
    setTintAndGain()
    writeRegister(TSL2561_Interrupt, 0x00)
    powerDown()

def main():
    init()
    while (True):
        print("Lux: %i [Vis+IR=%i, IR=%i @ Gain=%ix, Ti
        sleep(1)

if __name__ == "__main__":
        main()
```

- **Step 3.** Run the demo.

```
sudo python3 grove_i2c_digital_light_sensor.py
```

- **Step 4.** Here is the Result.



```
pi@raspberrypi: ~/software/GrovePi/Software/Python/grove_i2c_digital_light_s...
pi@raspberrypi ~/software/GrovePi/Software/Python/grove_i2c_digital_light_sensor
 $ sudo python grove_i2c_digital_light_sensor.py
Power ON
responce:  80
PartNo =  not TSL2560 or TSL 2561
RevNo =
gain =  0
Setting high gain
I2C: Device 0x29: returned 0x0BBF from reg 0x8C
I2C: Device 0x29: returned 0x0310 from reg 0x8E
IR Result without scaling:  4099
IR Result:  4099
Ambient Result without scaling:  48907
Ambient Result:  48907
ratio:  0.0838121332325
There is light:
ambient = 48907
IR = 4099
_ambient = 48907
_IR = 4099
Light = 1450.40189109 lux.
Power OFF
gain =  0
I2C: Device 0x29: returned 0x0BBC from reg 0x8C
```

Schematic Online Viewer

Resources

- **[Eagle]** Grove - Digital Light Sensor Schematic [https://files.seeedstudio.com/wiki/Grove-Digital_Light_Sensor/res/Grove-Digital%20%20light%20%20sensor%20v1.0%20eagle%20file.zip]
- **[PDF]** Grove - Digital Light Sensor Sch PDF File [https://files.seeedstudio.com/wiki/Grove-

Digital_Light_Sensor/res/Digital%20light%20sensor%20v1.0%20Sch.pdf]

- **[PDF]** Grove - Digital Light Sensor PCB PDF File [https://files.seeedstudio.com/wiki/Grove-Digital_Light_Sensor/res/Digital%20light%20sensor%20v1.0%20PCB.pdf]
- **[Library]** Library Github Grove-Digital Light [https://github.com/Seeed-Studio/Grove_Digital_Light_Sensor/archive/master.zip]
- **[Datasheet]** TSL2561 Datasheet [https://files.seeedstudio.com/wiki/Grove-Digital_Light_Sensor/res/TSL2561T.pdf]

Projects

Seeed LoRa IoTea Solution: An automatic information collection system applied to tea plantation. It is part of intelligent agricultural information collection.

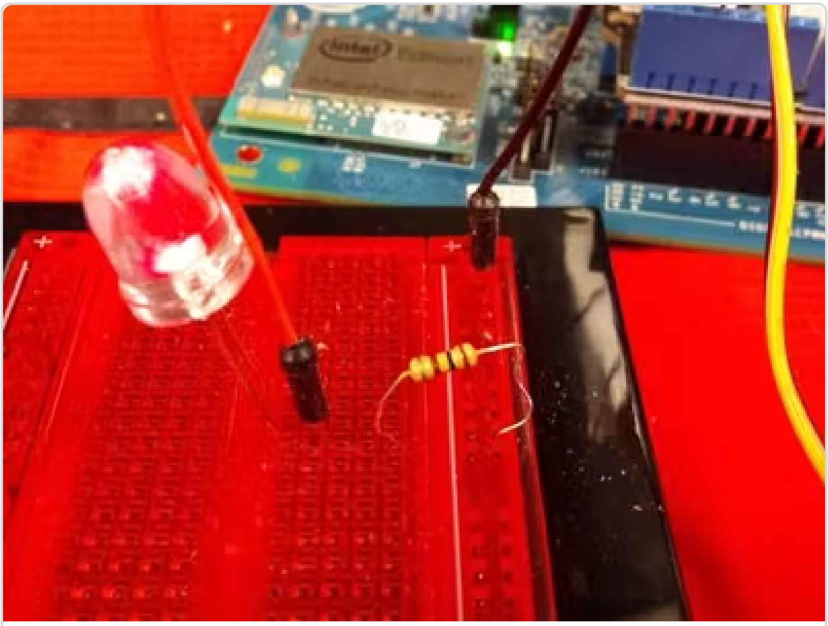
(https://www.hackster.io/SeeedStudio/se
lora-iotea-solution-b5ee95)

Seeed LoRa IoTea Solution
(https://www.hackster.io/SeeedStudio/seeed

Intel Edison IoT Hydroponic Controller: An IoT enabled Hydroponics Controller using the Intel Edison during the Boston IoT Hackathon.

(https://www.hackster.io/bltrobotics/intel-
edison-iot-hydroponic-controller-d7132d)

COI - Light Transmission Meter: The finished product uses the light sensor provided in the Grove Starter Kit Plus to measure change in light intensity.



(https://www.hackster.io/DigitalFabber/coi-light-transmission-meter-8044fd)

Tech Support

Please submit any technical issue into our forum [https://forum.seeedstudio.com/].