Teacher's guide

Turn off The light Project

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I- Part 1 : The Embedded systems

1) General concepts

What is an Embedded system ?

An embedded system is a combination of computer hardware and software designed for a specific function. Embedded systems can also work within a larger system. These systems can be programmable or have a fixed functionality. Embedded systems are used today to control numerous devices. For example, they're used in industrial machines, consumer electronics, agricultural and processing industry devices, automobiles, medical devices, cameras, digital watches, household appliances, airplanes, vending machines, toys and mobile devices.

Embedded systems typically contain a microprocessor -- or a microcontroller-based system, memory and input/output (I/O) devices, all of which share a dedicated function within a larger system. While embedded systems are computing systems, they can range from having no user interface (UI) -- for example, on devices designed to perform a single task -- to complex graphical user interfaces (GUIs), such as in mobile devices. UIs can include buttons, light-emitting diodes (LEDs) and touchscreen sensing. Some systems use remote user interfaces as well.

What is Microcontroller?

A microcontroller unit (MCU) is essentially a small computer on a single chip. It is designed to manage specific tasks within an embedded system without requiring a complex operating system.

These compact integrated circuits (ICs) contain a processor core (or cores), random-access memory (RAM) and electrically erasable programmable read-only memory (EEPROM) for storing the custom programs that run on the microcontroller, even when the unit is disconnected from a power supply.

The ESP8266 family

The ESP8266 is a system-on-chip (SoC) that combines:

A 32-bit microcontroller

Built-in Wi-Fi (802.11 b/g/n)

TCP/IP networking stack

GPIO, ADC, PWM, SPI, I²C, UART interfaces

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This means it can connect directly to the internet without an external Wi-Fi module.

2. Key Features (Common Across the Family)

CPU: 32-bit Tensilica L106 (up to 80 or 160 MHz)

Wi-Fi: 2.4 GHz, Station / Access Point / Both

Operating Voltage: 3.3 V

Flash Memory: External (typically 1 MB – 16 MB depending on board)

GPIO Pins: Limited but flexible

ADC: 1 analog input (0–1 V on bare chip)

Low power modes: Deep sleep supported

Cost: Very low (ideal for large IoT deployments)

The Light sensor BH1750

The BH1750 is a digital ambient light sensor. It is widely used in electronics projects because it is affordable, easy to use, and provides readings directly in Lux (the standard unit of light measurement). Unlike simple photoresistors (LDRs) that give you a raw resistance value you have to interpret, the BH1750 is a smart sensor. It measures the intensity of light falling on it and converts it internally into a precise digital number representing Lux. The measurement Range is from 1 to 65,535 Lux.

Human Eye Response: It is calibrated to "see" light similar to how the human eye does (filtering out infrared light that we can't see but other sensors might pick up).

2. Key Specifications

Communication: Uses the I2C protocol (uses only 2 wires for data).

Operating Voltage: Typically 3.3V.

Resolution: High resolution (1 Lux) or Low resolution (4 Lux).

Power Consumption: Very low (great for battery projects).

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The LUX unit

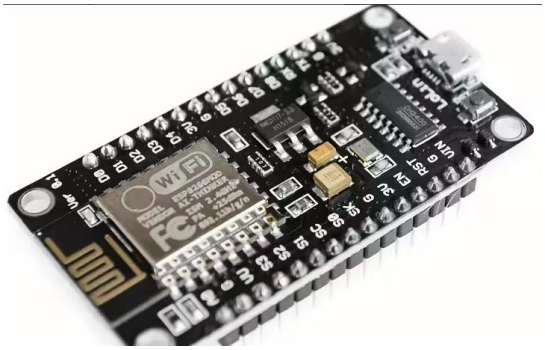
To understand the readings you might get from your BH1750 sensor, here is a scale of common environments:

Environment	Typical Lux
Moonlight	0.1 – 1 Lux
Dark Room / Candlelight	5 – 10 Lux
Living Room (Evening)	50 – 100 Lux
Office / Classroom	300 – 500 Lux
Supermarket / Studio	1,000 Lux
Overcast Day	1,000 – 5,000 Lux
Direct Sunlight	30,000 – 100,000+ Lux

2) Setting the environment

a. Hardware

In this project, we will use the board NODEMCU based on the chip ESP8266.



We will also use a Basics USB 2.0 A-Male to Micro B cable to connect the board to the computing to program it.

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b. Software

For the software part, we need to install the Arduino IDE or use the offline version.

To install the Arduino IDE, you can check the video (Software Install).

For this project, we recommend using the offline version of the Arduino IDE. You will find it in the Resource folder. This version is for Windows 10/11 OS. You just need to download the file, uncompress it and run the Arduino.exe file.

You also need to install the CH340 driver. You can use the file on the resource folder or choose the version from this site.

3) Blinking the internal LED

Blinking the internal LED is an important test for both the hardware and software.

Follow the video “R2 Blinking internal LED” for the visual instruction.

This block with turn on the internal LED. In reality, it will send power to the pin D4. The internal LED is connected to that PIN. If you have an LED connected to D4, it will be turned on.

This block will cut the power to the pin D4. And the Internal LED (or any other LED connected to D4) will be turned off.

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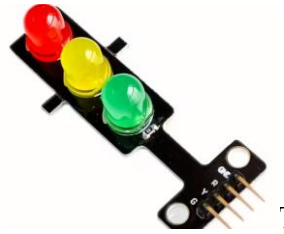
This block will create a pause in the program. The unit here is in millisecond. 1 second is equal to 1000 milliseconds.

4) The traffic light module:


This module is composed of 3 LED of 3 colors: RYG (Red, Yellow and Green). It has 4 pins.

GND: GROUND

R: RED

Y: Yellow

G: Green

Before starting the wiring, ask the students about the different pins and the meaning.

The GND pin should be connected to the G pin of the NODEMCU. You can choose any G pin. They are all connected together.

For the RYG pins, you can connect them to any of the digital pins. In a classroom situation, we recommend that all the students connect the module to the same pins shown in the file: R5 Trafic Light wiring. It will be easier for debugging.

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✅ Wiring layout (Common Cathode Traffic Light)

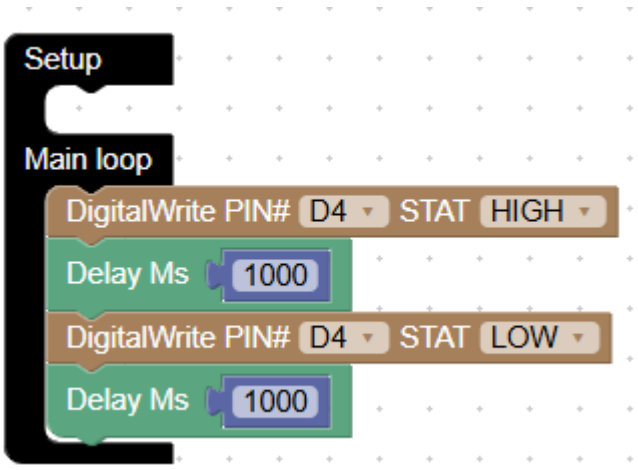
LED Color	NodeMCU Pin
🟢 Green	D4 (GPIO2)
🟡 Yellow	D5 (GPIO14)
🔴 Red	D6 (GPIO12)
Common (–)	GND

The video “R6 Test Traffic Light Module” shows how to turn on all the LEDs in the same time. This example is very important to test the module and be sure that the LED are lighting on correctly. It is possible that some LED get damaged after several use. The student might also have a problem with the correct wiring (connecting G for green to GND).

Extra activity 1:

Make a program to blink the green LED.

Extra activity 1 answer:



We should place our blocks inside the main loop because we want this sequence to be executed for ever. If you place the blocks inside the Setup part, the LED we be turned ON and OFF only once.

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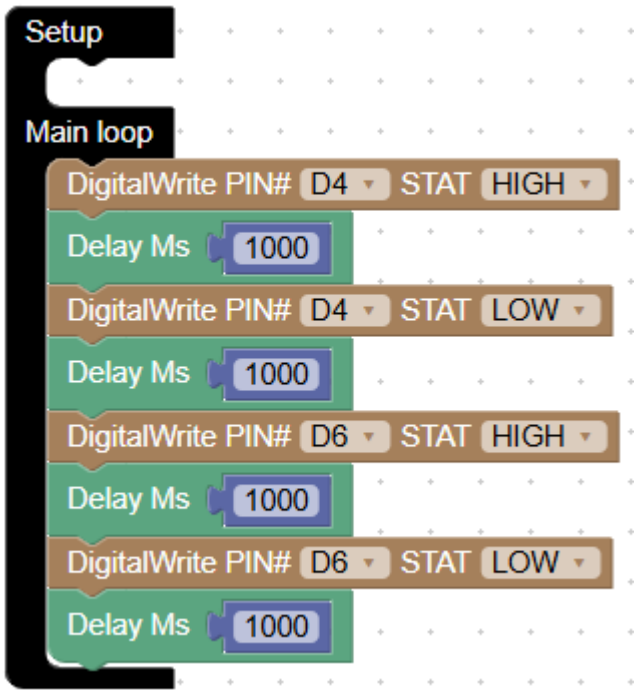
Extra activity 2:

Make a program that turns on and off the Green and the Red LED one by one.

Extra activity 2 answer:



Extra activity 3:

Make a traffic light program. The RED should be ON for 5 seconds, followed by the Yellow for 2 seconds and in the end the RED for 5 seconds.

Extra activity 3 answer:

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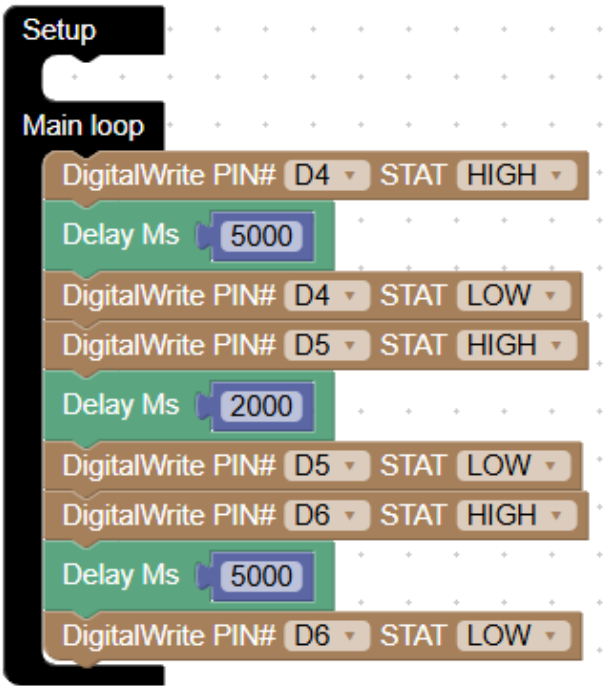
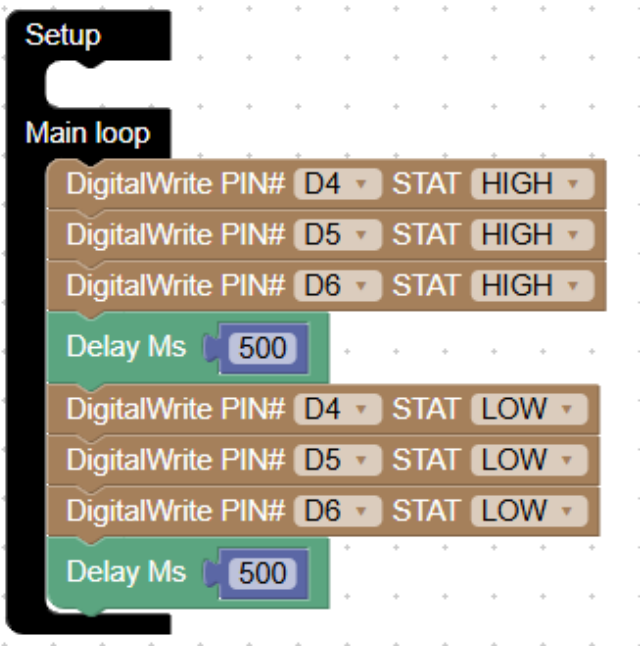


Extra activity 4:

Make a program to blink ALL the 3 LEDs in the same time.

Extra activity 4 answer:



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5) The light sensor BH1750

First, connect the light sensor to the NODEMCU. Use the resource 8 “The light Module sensor”

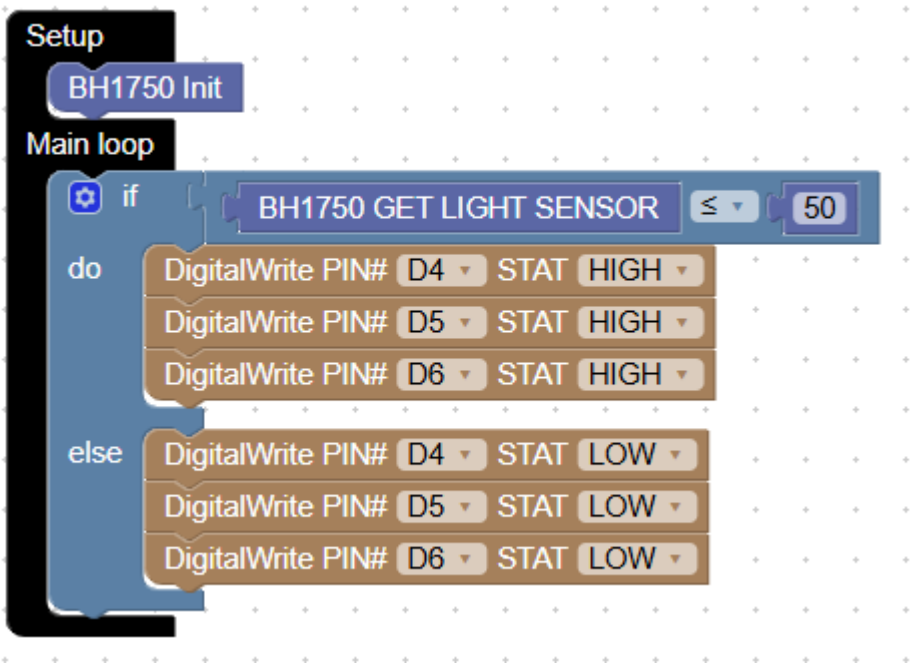
Wiring (with colors)

BH1750 Pin	Wire Color (Adafruit)	NodeMCU Pin	Notes
VIN	Red	3V3	Power (3.3V recommended)
GND	Black	GND	Ground
SDA	Blue	D2 (GPIO4)	I²C Data
SCL	Yellow	D1 (GPIO5)	I²C Clock

Extra activity 5:

Make a program that turns on ALL the LEDs when it is dark.

Extra activity 5 answer:



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