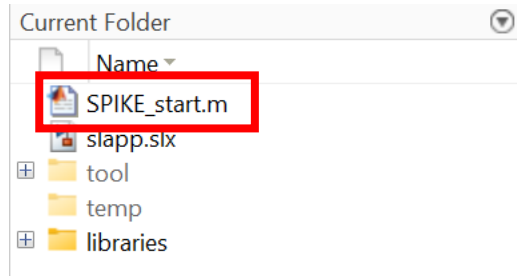# How to use SPIKE library

1. **How to start**

    a. Run SPIKE_start.m to pass through the file.

    b. Start slapp.slx. This will launch the model for SPIKE.
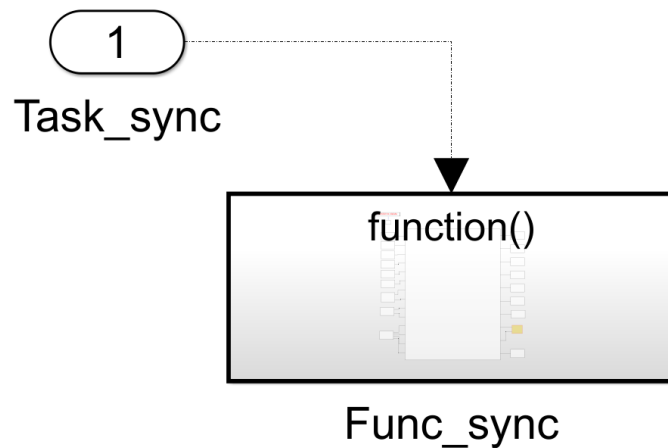
    [Note]

    You can change the file name of the Simulink model to anything you like.

2. Creating a model

The model consists of three layers: the task layer, the interface layer, and the application layer.

- **Task layer**

Please do not change this top task layer

1

Task_sync

function()

Func_sync

This layer is located at the top. Please do not change this top task layer. The task is created by the Function-Call subsystem and the logic inside runs at a constant cycle of 4 ms.

- **Interface layer**

SPIKE_HUB
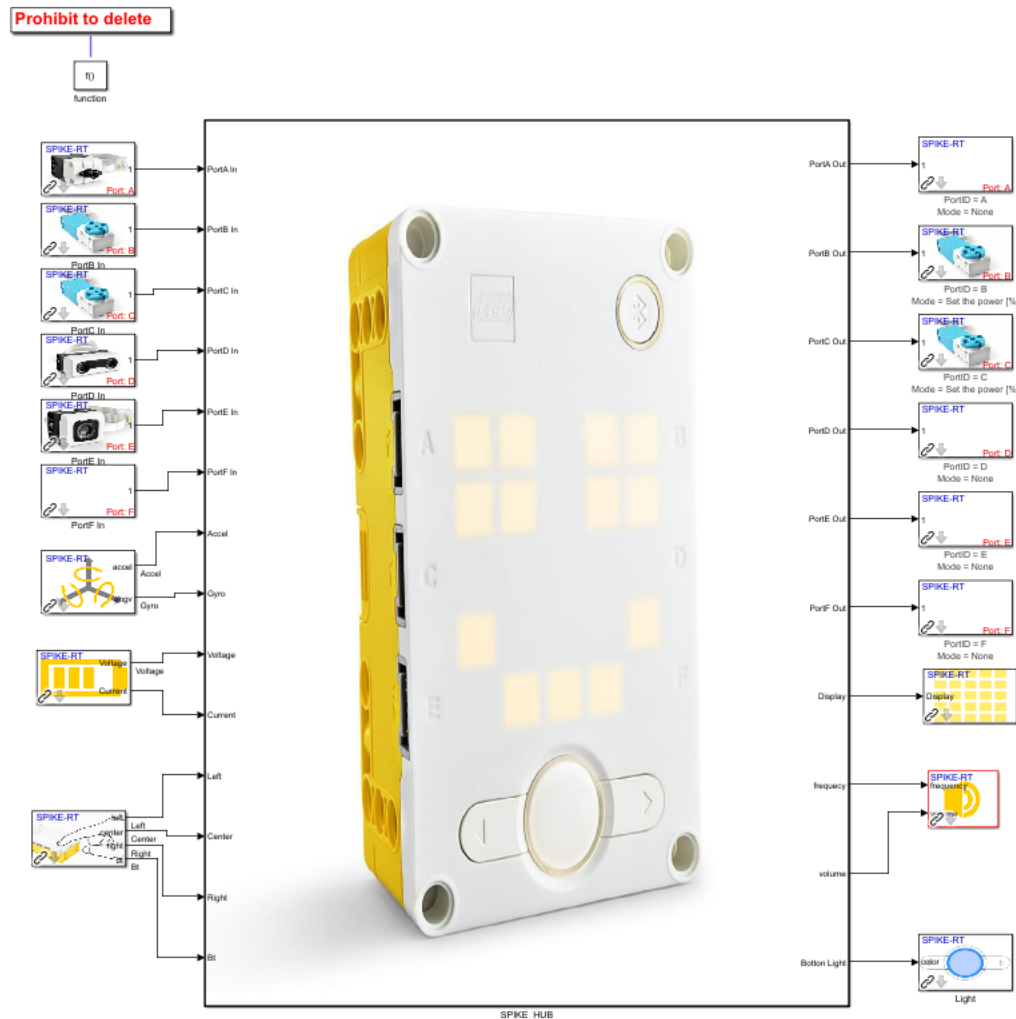
 Located in the task layer Func_sync, it shows the interface with the sensors and actuators of the large hub.

The left-hand side shows the sensor inputs, while the actuators and display functions are grouped together on the right-hand side. The block parameters of each block are opened to summarise how to use them.

If you have different sensors or actuators connected to each port, be sure to change the settings of the corresponding block. If nothing is connected, set to 'None'.

【Sensor block specification】

1) Force sensor

   Get the load value.
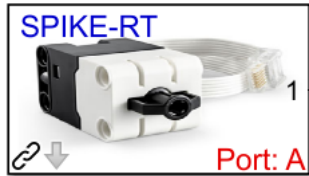
   Output signal type: double

   Output signal unit: N

   Output signal range:0 - about 10

   LEGO specification document:

   https://assets.education.lego.com/v3/assets/blt293eea581807678a/blt23df304b05e587b2/5f8801ba721f8178f2e5e626/techspecs_technicforcesensor.pdf?locale=en-us

2) Color sensor

Get the value of the reflection, ambient light, or color (HSV).

- Reflection mode

  Get the percentage of how much a surface reflects the light emitted by the sensor.

  Output signal type: double

  Output signal unit: %

  Output signal range:0-100 (100= white, 50= gray, 01=black, 00=No surface)

- Ambient mode

  Get the ambient light intensity.

  Output signal type: double

  Output signal unit: %

  Output signal range:0-100 (0=dark, 100=bright)

- Color mode

  Get the color of surface.

  Output signal type: integer

  Output signal unit: Non-dimensional

  Output signal range: 0-7 (0=Others, 1=Red, 2=Orange, 3=Yellow, 4=Green,

  5=Blue, 6=Indigo, 7=Violet)

LEGO specification document:

https://assets.education.lego.com/v3/assets/blt293eea581807678a/blt62a78c227e
def070/5f8801b9a302dc0d859a732b/techspecs_techniccolorsensor.pdf?locale=en-
us

3) Ultrasonic sensor

Get the distance [mm] in front of the ultrasonic sensor.

Output signal type: double

Output signal unit: mm

Output signal range: 0-2000

LEGO specification document:

https://assets.education.lego.com/v3/assets/blt293eea581807678a/blt64c2b95
34cf10f68/5f8801b8bc43790f5c4389ea/techspecs_technicdistancesensor.pdf?loc
ale=en-us

4) Rotation sensor

Get the angle and angle velocity of the motor. The angle counts 360° per revolution. Angular velocity is calculated internally from the angle.

- Angle

Output signal type: double

Output signal unit: deg

Output signal range: Nothing

- Angular velocity

Output signal type: double

Output signal unit: deg/s

Output signal range: Nothing

LEGO specification document:

- Medium motor

https://assets.education.lego.com/v3/assets/blt293eea581807678a/blt69243 6dd1e8fa71c/5f8801d5c8a27c1d9614c27e/techspecs_technicmediumangular motor.pdf?locale=en-us
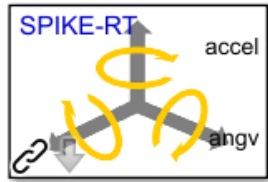
- Large motor

https://assets.education.lego.com/v3/assets/blt293eea581807678a/bltb9abb 42596a7f1b3/5f8801b5f4c5ce0e93db1587/le_spike-prime_tech-fact-sheet_45602_1hy19.pdf?locale=en-us

5) IMU

Get the acceleration and angular velocity.

- Acceleration

This is a vector signal which contains x, y, z axes of the acceleration.

Output signal type: double

Output signal unit: mm/s^2

Output signal range: Nothing

- Angular velocity

This is a vector signal which contains roll, pitch and yaw of the angular velocity.

Output signal type: double
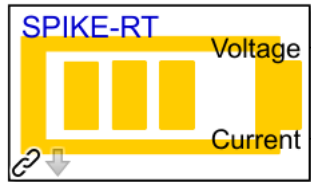
Output signal unit: deg/s

Output signal range: Nothing

LEGO specification document:

https://assets.education.lego.com/v3/assets/blt293eea581807678a/bltf512a371e82f6420/5f8801baf4f4cf0fa39d2feb/techspecs_techniclargehub.pdf?locale=en-us

6) Battery

Retrieve the battery voltage and the battery current.

- Voltage

  Output signal type: double

  Output signal unit: mV

  Output signal range: Nothing

- Current

  Output signal type: double

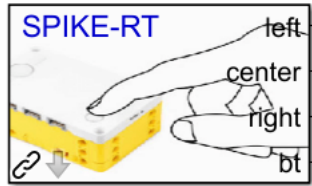 Output signal unit: mA

  Output signal range: Nothing

  LEGO specification document:

  https://assets.education.lego.com/v3/assets/blt293eea581807678a/blt706bc b108ec66a2b/6630d4aeba17b0181acb6d3d/SPIKE_Prime_Battery_Tech_Spec _Sheet.pdf?locale=en-us

7) Buttons

Checks which buttons (left, center, right, bluetooth) are currently pressed.

Output signal type: double

Output signal unit: Non-dimensional

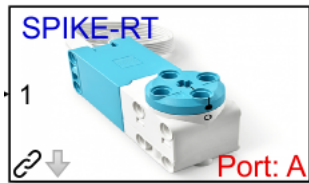Output signal range: 0(Not pressed) or 1(Pressed)

LEGO specification document:

https://assets.education.lego.com/v3/assets/blt293eea581807678a/bltf512a371e82f6420/5f8801baf4f4cf0fa39d2feb/techspecs_techniclargehub.pdf?locale=en-us

【Actuator block specification】

1) Motor

Control the motor according to the settings and the input.

- Motor mode

    a) Set the speed of rotation

    Control the motor speed at the specified value. Control method and

    parameters cannot be changed.

    Input signal type: double

    Input signal unit: deg/s

    Input signal range: Nothing

    b) Set the power of the motor

    Set the motor voltage.

    Input signal type: double

    Input signal unit: %

    Input signal range: -100~100[%]

c) Stop

Stop the motor. But the encoder is active.

Input signal type: any signal is ok

d) None

Stop the motor. And the encoder is also inactive.

Input signal type: any signal is ok

- Encoder mode
    a) No reset

    Initial encoder value is set to an absolute angle.

    b) Reset

    Initial encoder value is set to 0.

- Direction

Defines whether clockwise or anti-clockwise rotation is treated as positive.

    a) Clockwise
    b) Couter-clockwise

LEGO specification document:

- Medium motor

  https://assets.education.lego.com/v3/assets/blt293eea581807678a/blt692436d d1e8fa71c/5f8801d5c8a27c1d9614c27e/techspecs_technicmediumangularmotor. pdf?locale=en-us

- Large motor

  https://assets.education.lego.com/v3/assets/blt293eea581807678a/bltb9abb42 596a7f1b3/5f8801b5f4c5ce0e93db1587/le_spike-prime_tech-fact- sheet_45602_1hy19.pdf?locale=en-us

2) Display

Light up a 5x5 matrix display. There are three ways to specify how to make it glow, and the display direction can be specified as up, down, left or right.

- Mode

e) Numeric

Displays a number. A minus sign (-) is shown as a faint dot in the center of the display.

Input signal type: double

Input signal unit: Non-dimensional

Input signal range: -99 to 99

f) Character

Display one character at a time.

Input signal type: string

Input signal unit: Non-dimensional

Input signal range: letter (a–z), capital letter (A–Z) or

symbols: !"#$%&'()*+,-./:;<=>?@[]^_`{|}

g) Matrix

Light up any pattern you like. Each element of the vector corresponds to a respective LED and specifies the luminance as a number from 0-100.

Input signal type: integer array (size 25×1)

Each element of the vector corresponds to each LED

Input signal unit: Non-dimensional

Input signal range: 0-100

Specifies the luminance as a number from 0-100.

(0=dark, 100=bright)

LEGO specification document:

https://assets.education.lego.com/v3/assets/blt293eea581807678a/bltf512a371e82_f6420/5f8801baf4f4cf0fa39d2feb/techspecs_techniclargehub.pdf?locale=en-us

3) Speaker

Tone sound with the speaker.

- frequency

  Input signal type: double

  Input signal unit: Hz

  Input signal range: 0-24000

  0: silent, other: sound the corresponding tone

- volume

  Input signal type: double

  Input signal unit: %

  Input signal range: 0-100

LEGO specification document:

https://assets.education.lego.com/v3/assets/blt293eea581807678a/bltf512a371e82_f6420/5f8801baf4f4cf0fa39d2feb/techspecs_techniclargehub.pdf?locale=en-us

4) Light

Turn the light on with specified color.

Input signal type: double

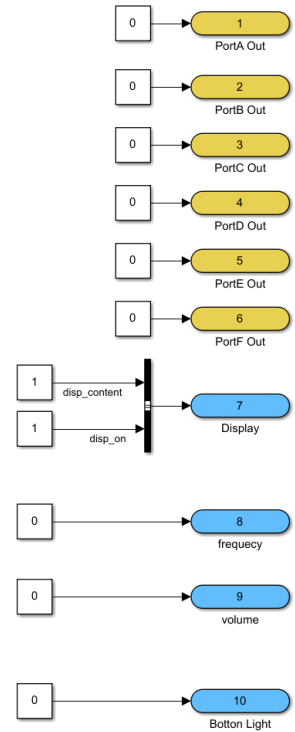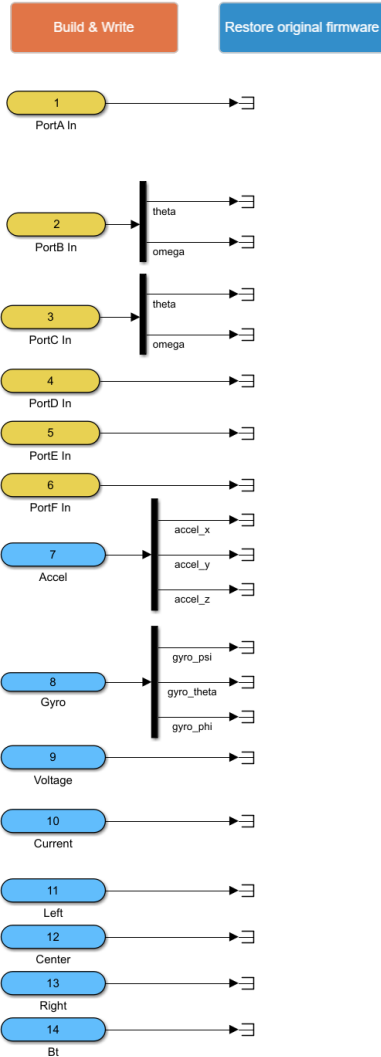Input signal unit: Non-dimensional

Input signal range: Nothing

0=White, 1=Red, 2=Orange, 3=Yellow, 4=Green, 5=Blue,

6=Indigo, 7=Purple, Others=Off

LEGO specification document:

https://assets.education.lego.com/v3/assets/blt293eea581807678a/bltf512a371e8 2_f6420/5f8801baf4f4cf0fa39d2feb/techspecs_techniclargehub.pdf?locale=en-us

- **Application layer**

You model the control logic in this layer. When creating the model, only discrete systems are used and the sample time should be '-1'. If you want to change the execution period of the control from 4 ms, do not change the sample time of the blocks in the simulink model, but change the slapp.cfg file in the 'libraries¥libspikert' folder.

[Note]

- The blocks corresponding to the respective sensors and actuators do not respond when the simulation is run. If you wish to run the simulation, It is recommended to use a test harness.
- Some blocks, such as the 1D Lookup table, require external C libraries and may not be usable.
- Model reference cannot be used.
- Create a model using slapp.slx as template. Creating from an blank model is not supported. Note that copying or renaming slapp.slx is not a problem.

3. Building & writing a model

Once you have finished creating your model at the application layer, you can implement your code into LEGO SPIKE to run. The implementation approach is as follows.

   A. Connecting SPIKE Prime to a computer
- 1) Switch off the SPIKE Prime large hub.
- 2) With the Bluetooth button pressed, connect to the PC with the USB cable.
- 3) When connected to the PC, the Bluetooth button lights up purple.
- 4) Hold the Bluetooth button down for a while and the Bluetooth button will light up repeatedly in the following order: red → green → blue → off → red → ... and then release the Bluetooth button. Then release the Bluetooth button.

   B. Build & Write

Press the Build & Write button in the top left-hand corner of the Application layer. This will generate, build and write the code. The program starts as soon as the writing is completed. After start-up, check that the central LED light swirls and the central button flashes blue. Afterwards, unplug the USB cable.

Note that the results of code generation, building and writing are also displayed in the MATLAB command window. If the program is not written, please check the error message displayed on the command window and take action.
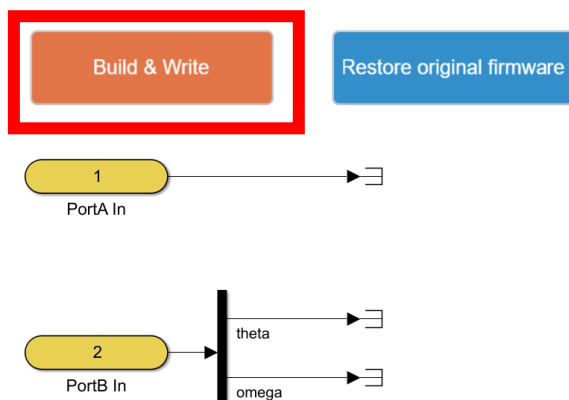
4. How to restore original firmware

After the code has been written to the LEGO SPIKE, the original firmware of LEGO SPIKE Prime changes and the regular LEGO SPIKE App can no longer be used. To restore the original firmware, press the 'Restore original firmware' button in the application layer. When restoring the firmware, follow the same procedure as in 3.A to connect the SPIKE to the computer.