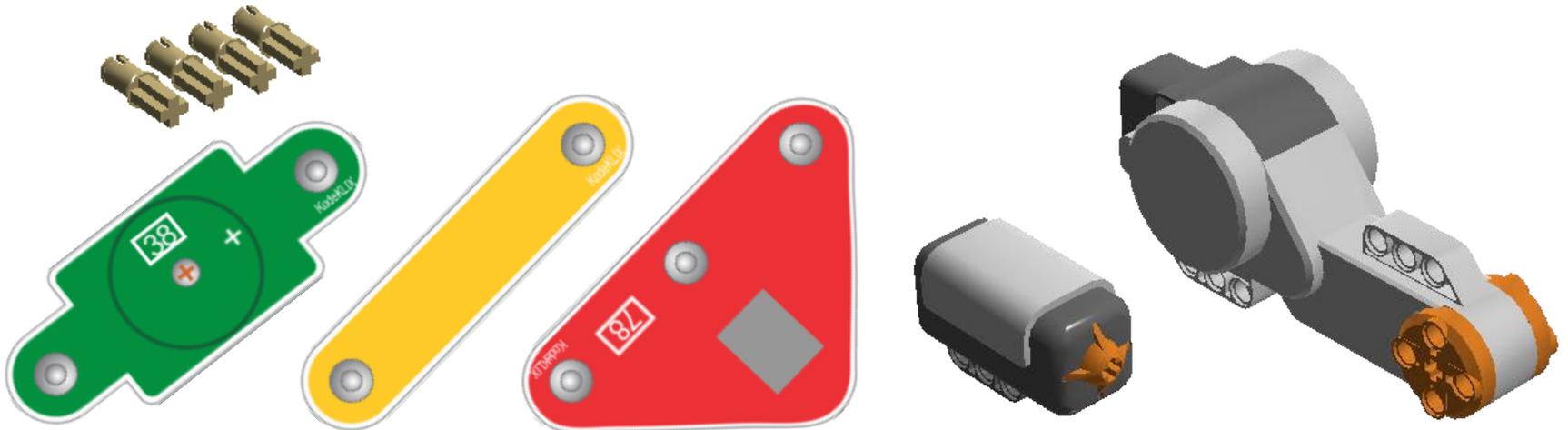


# KODEKLIX<sup>®</sup>



## Lego Connectivity

Example from the Project Guides





# Introduction

- This guide includes extracts from the KodeKLIX project and activity guides focused on Lego connectivity
- KodeKLIX includes some specialist components that allow you to connect snap circuit electronics to construction building blocks and robotics such as Lego and Lego Mindstorms
- There are also third-party items and custom built adaptors you can find



# Connecting LEGO® to Motors...

- All kits supplied with motor [38] include a genuine LEGO® cross-axle coupled to the motor shaft
  - This axle connects to models you build with building blocks that you can drive
  - Motor [38] is more powerful than motor [39], but less energy efficient
  - Motor [38] is controlled in exactly the same way that motor [39] is controlled by the SnapCPU™

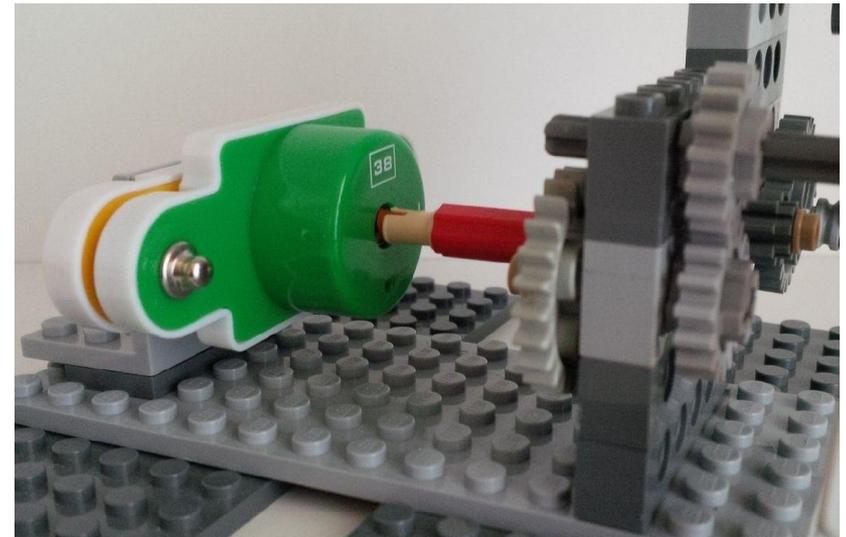


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# Building Motor Models...

- Even though motor [38] is powerful, sometimes gears are needed to multiply the torque available or slow down the speed of the mechanism
- The yellow Snap-to-Brick adaptor allows fastening of Snap based motors and sensors to brick mechanisms





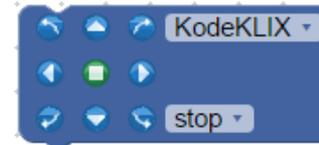
# Built-in Motor Code Blocks

- For this SnapCPU, **motor D** is the correct setting to use
- Simple motor command is used to control direction
- The complex motor block can also control speed
  - Speed has a value between 0 and 255
  - Plug-in uses % pwr



set motor D to forwards

set motor D to forwards for 1000 ms



set KodeKLIX motor D to forwards at 100 %

\* For speed control blocks



# Exempl Project 1.1

## Basic motor direction control

- Assemble the snap components as shown in Circuit 9.1; Construct the BLOCKLY code below and download to the SnapCPU™
- Observe the direction the motor according to whether buttons C.3a or C.3b is pressed.
- Review the code to understand how it works.

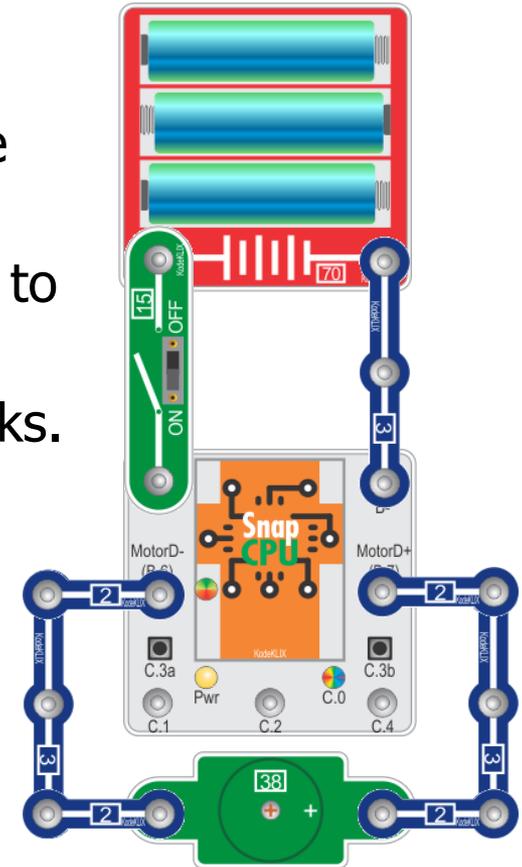
```

start
forever
do
  read analogue C.3 to varA
  if varA > 200
  then
    set motor D to backwards
  else
    if varA > 165
    then
      set motor D to forwards
    else
      set motor D to stop
  
```

Read the status of the built-in buttons

Rather than manipulate pins, use the motor blocks

Rather than manipulate pins, use the motor blocks



Circuit 1.1

The motor block greatly improves the ease with motors can be controlled and their direction changed. This control however is only available with the SnapCPU™ on the two pins shown.



# Example Project 1.2

Completed

## Basic motor speed control

- Assemble the snap components as shown in Circuit 9.2; Construct the BLOCKLY code below and download to the SnapCPU™
- Observe the direction of the motor in response to buttons C.3a or C.3b being pressed
- Review the code\*\* to understand how it works

```

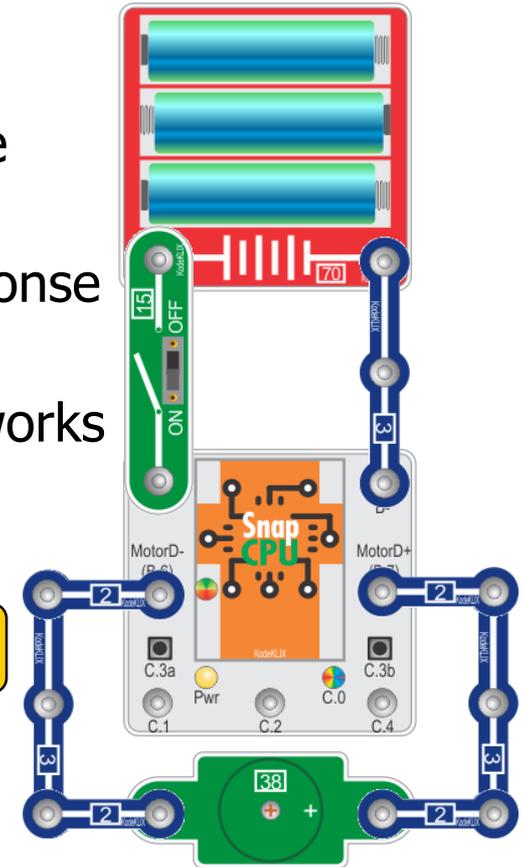
start
forever
do
  if input C.3 is on
  then
    set varA to 255
  else
    set varA to 25
  KodeKLIX+speed
  forward
  left speed varA
  right speed

```

\*\* using varA for speed reduces code size; 255=100%

\*\* experiment with this value to see how slow you can go before the motor refuses to spin up

Only the left motor driver is available in this model SnapCPU™



Circuit 1.2

The motor accepts either fixed values or variables for the speed parameter. This parameter is used to adjust the PWM frequency of the control signal gated to the H-bridge driver chip.



# Connecting LEGO® Robotics...

- Snap [78] includes a NXT/EV3 compatible connector allowing connection to selected LEGO® Mindstorms® motors and touch sensors (sensors and cable not included):
  - NXT and EV3 motors can be driven forward and backwards; and their speed detected
  - NXT and EV3 touch sensors can be detected as input switches
  - Other sensors cannot be presently connected (check for updates)



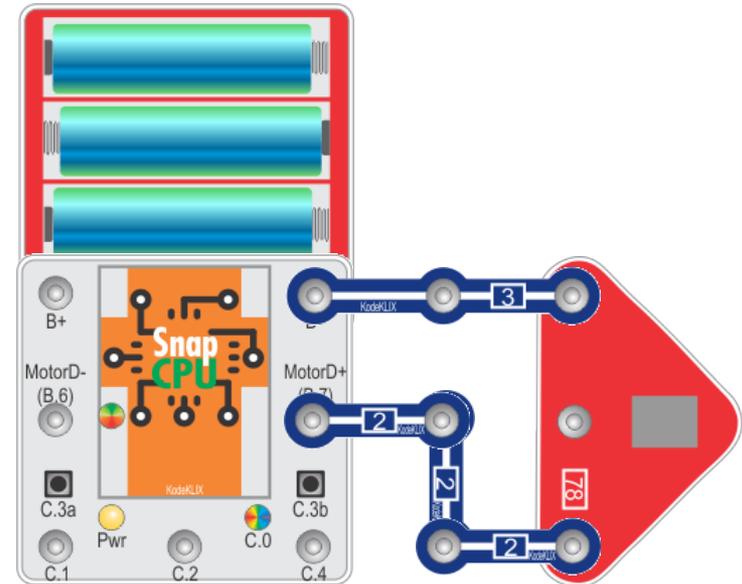
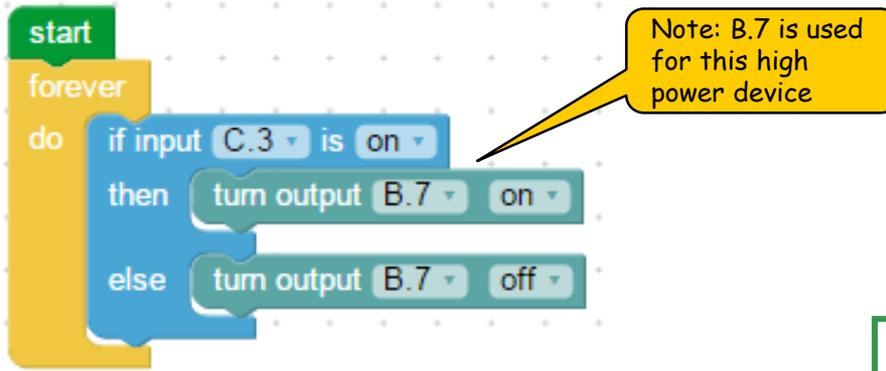
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# Example Project 2.1

## Basic MindStorms® Motor Control Interfacing

- Assemble the snap components as shown in Circuit 9.5; Construct the BLOCKLY code below and download to the SnapCPU™
- Construct the BLOCKLY code below and download to the SnapCPU™
- Pressing the built-in button C.3 will power-up the motor it works



Circuit 2.1

Servo motors use a little rotary motor to wind their way to new positions. Consequently they are a little slow in moving from one position to another; so allow for this in your code with delays.





# Example Project 2.3

Completed

## MindStorms® Motor Control with Feedback

- Assemble the snap components as shown in Circuit 9.7; Construct the BLOCKLY code below and download to the SnapCPU™
- Observe the direction of the motor in response to buttons C.3a or C.3b being pressed
- Review the code to understand how it works

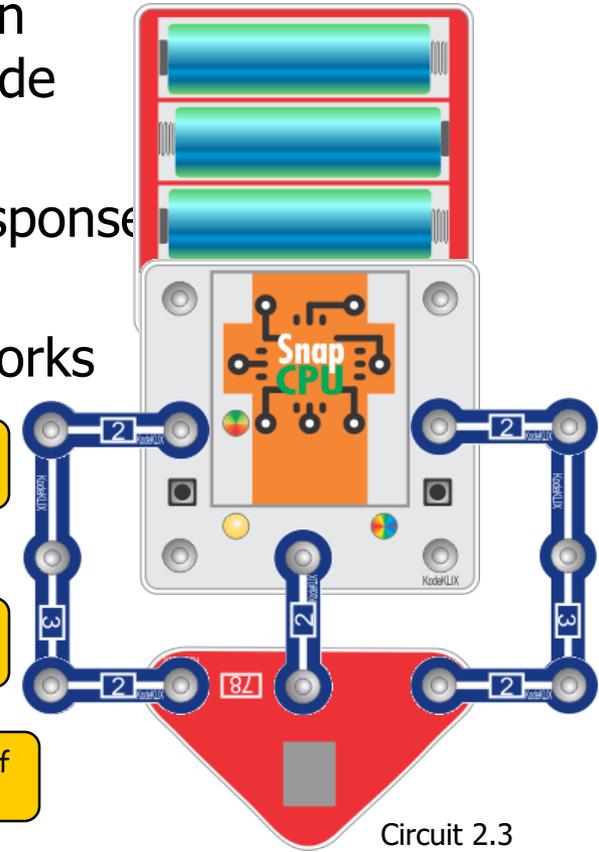
```

start
forever
do
  if input C.3 is on
  then
    set KodeKLIX motor D to forwards at 100 %
  else
    set KodeKLIX motor D to stop at 100 %
  call Is motor actually turning?
  to Is motor actually turning?
    count C.2 for 100 ms to varA
    if varA > 10
    then
      set SnapCPU20 RGB LED to GREEN
    else
      set SnapCPU20 RGB LED to RED
  
```

Enable motor by either pressing the C3 button

If motor connected and turning, encoder sends pulses

Lights GREEN if actually turning



Circuit 2.3

LEGO motors include an encoder wheel which sends pulses at approximately 1 pulse per degree of revolution. The pulses can be detected by the COUNT block to determine that the motor turns.



# Example Project 2.4

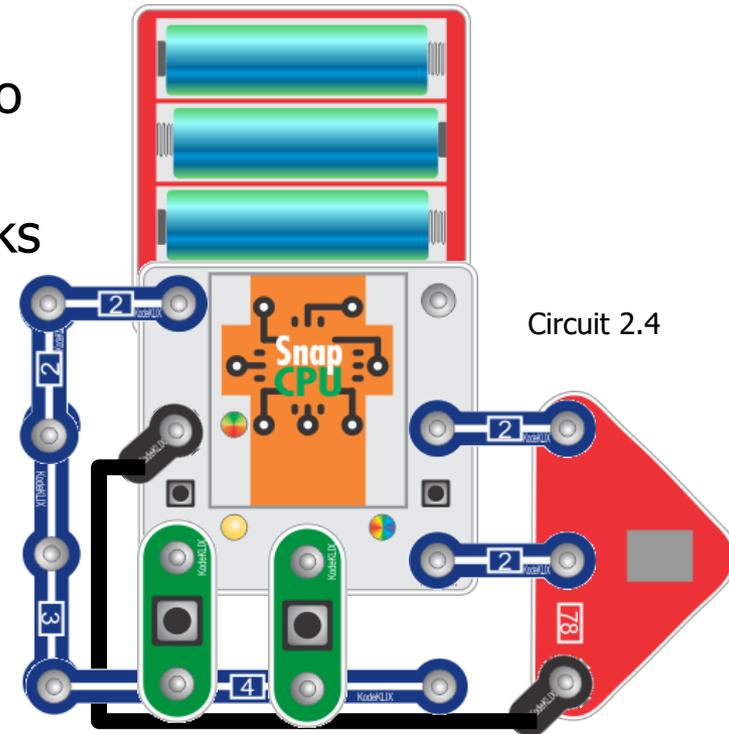
 Completed 

## MindStorms<sup>®</sup> Motor Control Project

- Assemble the snap components as shown in Circuit 9.8; Construct the BLOCKLY code below and download to the SnapCPU<sup>™</sup>
- Observe the LED colour response to the motor's motion and direction
- Review the code to see how it works

```

start
forever
do
  if input C.1 is on
  then
    set KodeKLIX motor D to forwards at 100 %
  if input C.2 is on
  then
    set KodeKLIX motor D to backwards at 100 %
  call Is motor actually turning?
  to Is motor actually turning?
  count C.4 for 100 ms to varA
  if varA > 10
  then
    set SnapCPU20 RGB LED to green
  else
    set SnapCPU20 RGB LED to red
  
```



Circuit 2.4

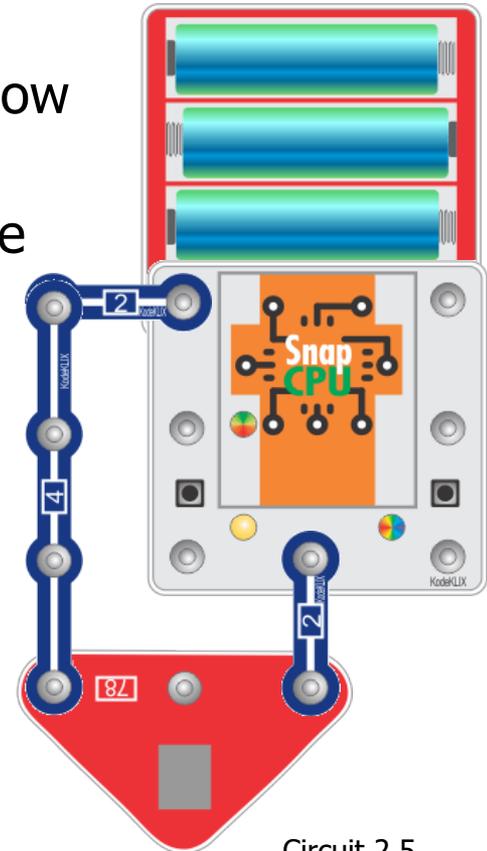
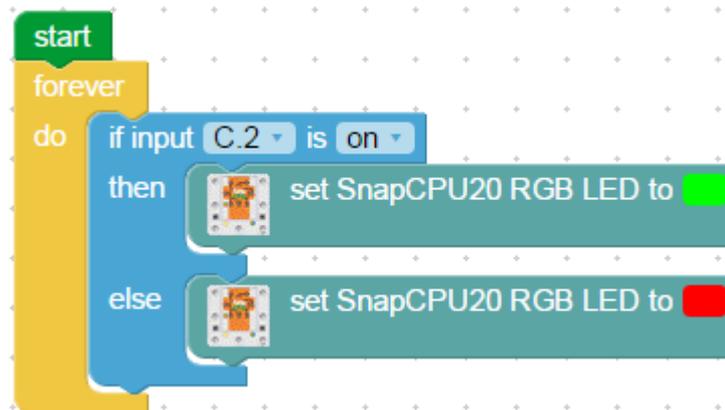
The encoder signal from the LEGO motors provided by adapter [78] provides speed information only, not direction.



# Example Project 2.5

## MindStorms® Touch Sensor (NXT) Input

- Assemble the snap components as shown in Circuit 9.9; Construct the BLOCKLY code below and download to the SnapCPU™
- Observe the colour of the RGB LED when the touch sensor is pressed
- Review the circuit and code to understand how to use these LEGO® touch sensors



Circuit 2.5

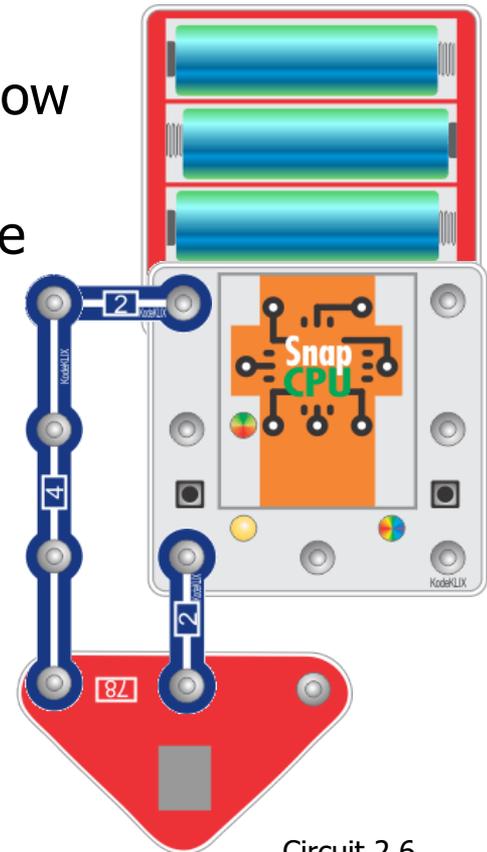
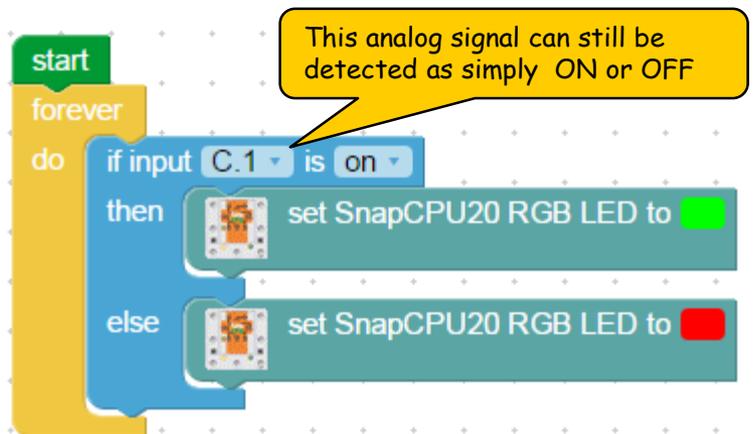
Older LEGO NXT touch sensors are simple switch devices. Just like a KodeKLIX switch, connect the outer most snaps; remembering that "inputs loop to positive"!



# Example Project 2.6

## MindStorms® Touch Sensor (EV3) Input

- Assemble the snap components as shown in Circuit 9.9; Construct the BLOCKLY code below and download to the SnapCPU™
- Observe the colour of the RGB LED when the touch sensor is pressed
- Review the circuit and code to understand how to use these LEGO® touch sensors



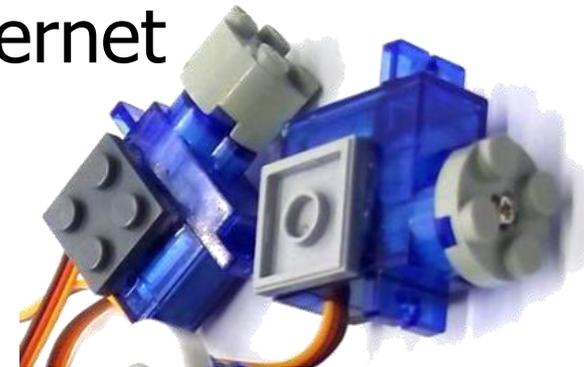
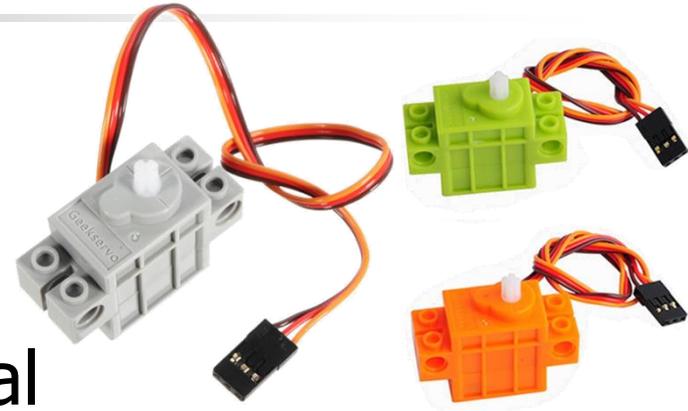
Circuit 2.6

Newer LEGO EV3 touch sensors are switch devices but output an analog signal. This analog signal is output on the middle snap of adaptor [78]; remembering that "inputs loop to positive"!



# Servo Motors and Options

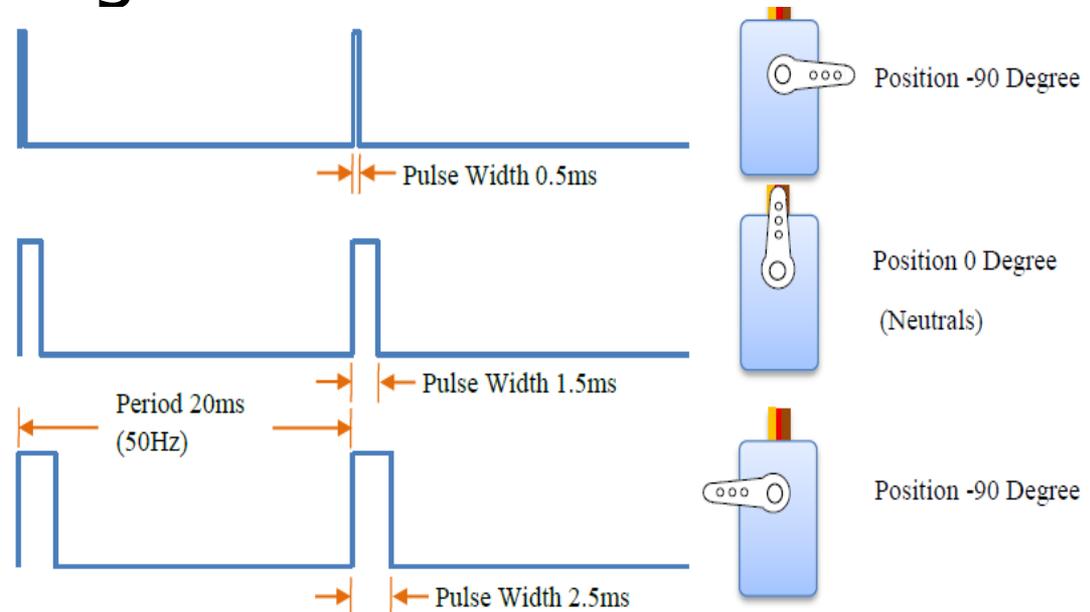
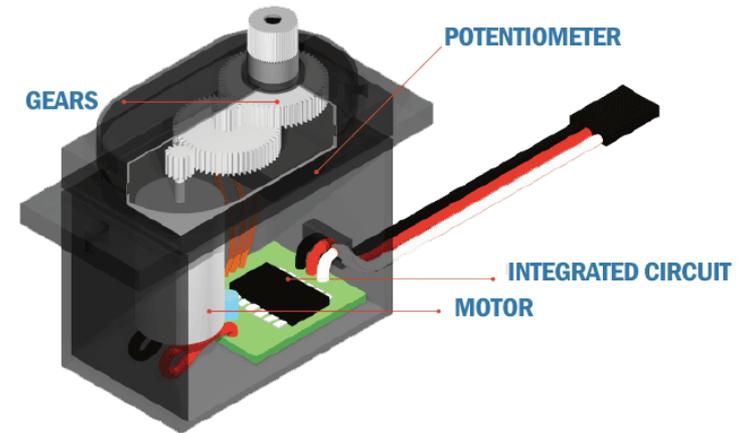
- Geekservo make a nice 'Lego compatible' servo
  - grey is 270° positional; others are 360° rotational
- Customised 'Lego compatible' SG90 can be made with real Lego parts and glue
  - There are various home-brew designs available on the internet
  - At KodeKLIX we developed these based on the SG90 and which work very well





# More about Servo Controls...

- Inside the servo unit is a small computer that translates SERVO commands pulses into motor control signals
- Giving the servo the wrong pulse signal could make it lose control!





# KodeKLIX Brick Connectivity



Core and Core PLUS kits include a sampling of Lego connectivity parts. The KodeKLIX Brick Connectivity pack includes adaptors for power function motors and a range of additional items. Custom servos are available by special order.



# KODEKLIX

[www.kodeklix.com](http://www.kodeklix.com)  
Coding for Young Engineers

Creator: Nick Coplin  
Projects: [www.kodeklix.com/snapcpu4stem/](http://www.kodeklix.com/snapcpu4stem/)  
Microchips: PICAXE  
PICAXE: [www.picaxe.com](http://www.picaxe.com)