VEX Robotics – Hexbug Spider

-= Kit review =-

In this review I want to present you **VEX Robotics - Hexbug Spider Kit**, this kit lets you to build a six legs, large size robot, about 30cm tall.

This kit was kindly offered by LMR and RobotShop and my daughter and I, had a great time building it.

Packaging

The kit arrived well packed and wrapped in a secondary box. The kit box contains about 350 parts organized in separate bags so they were easy to identify and use.

Building

Assembling the kit was very easy and my daughter (she's seven), helped by me here and there, complete the build in about two hours. At some points she needs help because some parts were too stiff for hers little fingers, but I guess an eight years (or older) kid should be able to assemble the kit without help.

The mechanical parts are well designed and made from quality plastic, not too soft to bend but not too stiff to break when put to mechanical stress.

Assembly process is well thought, **manual** is very well made and the entire building path is shown only in pictures, no reading (eventually translation) is required. Building process is split in small accessible steps, building parts are shown at 1:1 scale for easy identification. The only part where help was really required was wiring the motors and sensor.

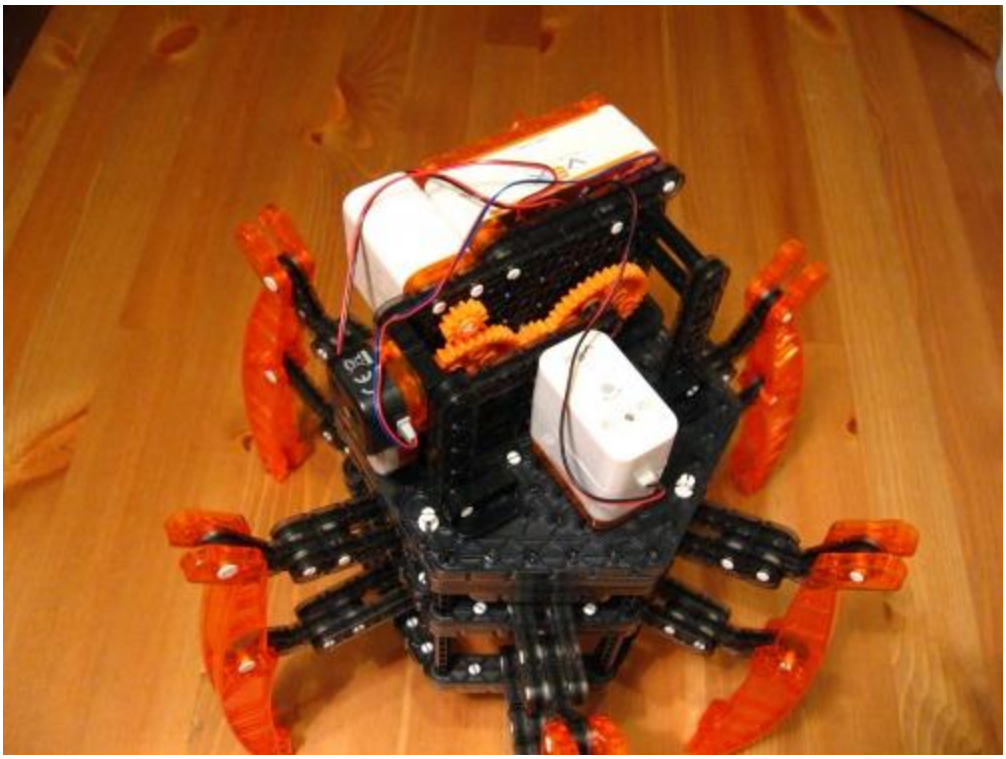
Parts are assembling together using small plastic pins made from a quite soft plastic (the white ones), easy for kids to assemble. Some pins (the black ones) which required a greater structural strength are a little stiff and sometimes were a little harder to assemble.

The robot design can be split in two major parts:

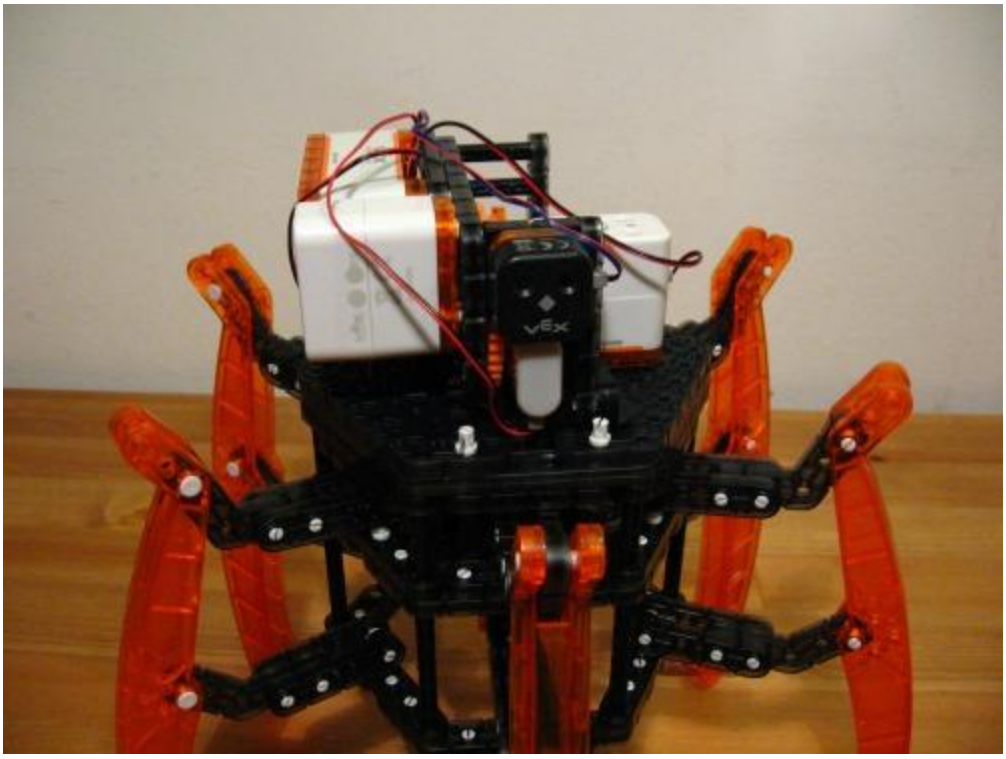
- the head - which contain two geared down DC motors, an infrared distance sensor, the brain of the robot which is also the power source for motors and sensor, a two-color red/green LED and the gears assembly used to move the legs. The LED can be mounted on either motor connector, if it's mounted on the motor used for head turning will light when the head turns left or right, if it's mounted on the motor used for walking will light when moves forward or rear.

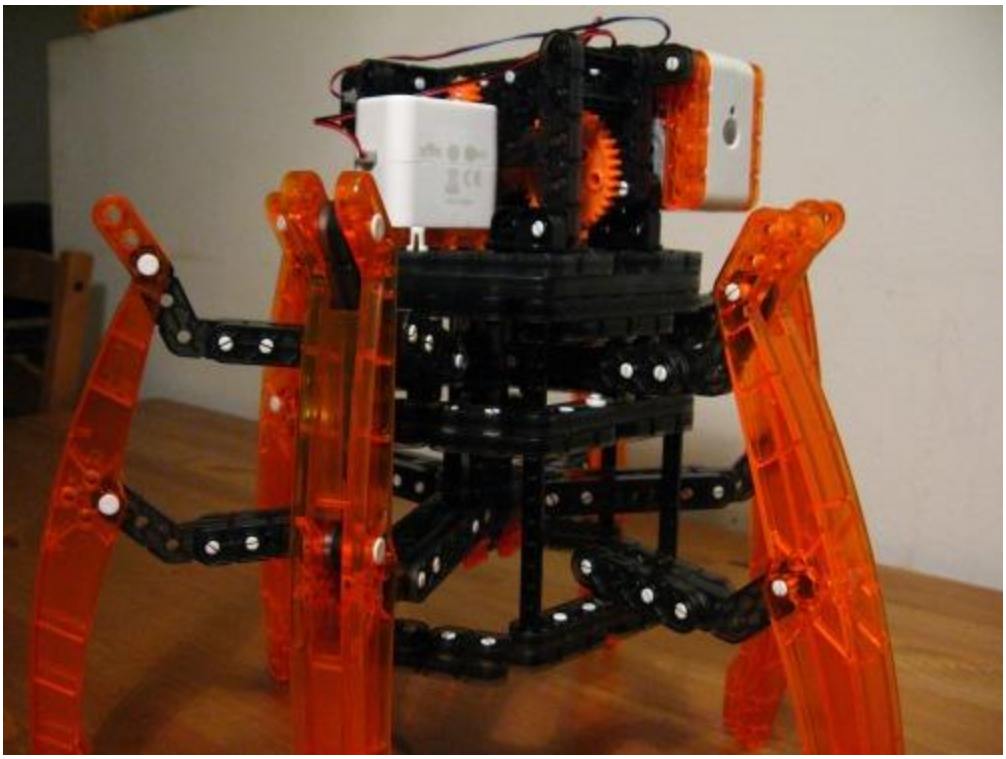
- the Brain box have a DIP switch which can be used to change robot's behavior:

- the lower frame - which holds the legs and linkages for them.



The robot have a clever design and use only two motors and four gears to operate all six legs. The legs have multiple connecting points and I suppose some tweaking can be made to adjust the walking gait, although we used the default/recommended configuration.





To power the robot are used 3 x AA batteries placed in the brain box, and one 9V battery for Remote Control unit.

Playing

The robot is quite tall, 27 centimeters from my measurements, and have a great look.

Turn on the power on Remote Controller and on the robot and they are pairing automatically, no other actions are required.

Robot can be operated in two ways, manual or autonomous, these modes are selected from Remote Control unit.

The manual mode was the favorite so far :), kids enjoy it very much.

In autonomous mode, robot navigate by itself using the infrared sensor and when it found an obstacle, change it's walking direction according with programming settings.

For autonomous navigation, robot use an infrared sensor placed in front of the head with a detection range of about 40 - 50cm, from my tests. When an object is detected by the sensor, the robot change it's behavior: change walking direction, reverse motors, turn head fast or slow, etc.

To enter autonomous mode, on Remote Controller move de mode selector switch to position "A". To start the robot, move up the Controller Right button, towards the [>] (play) sign. To pause the robot in autonomous mode, move the Controller Right button down, towards the [| |] (pause) sign.

The entire building process and "Spidey" first steps are caught in the following video - **www.youtube.com/watch?v=3l0mgInQGqc**.

In the end it was a pleasing building experience for kids and adults alike and I recommend this kit for those who want to start build robots. The good part is that you are not restricted to Spider design, the parts are easy to disassembly and can be combined in different ways.

After the construction was done and initial test proved to be successful, it was time to explore in detail this robot.

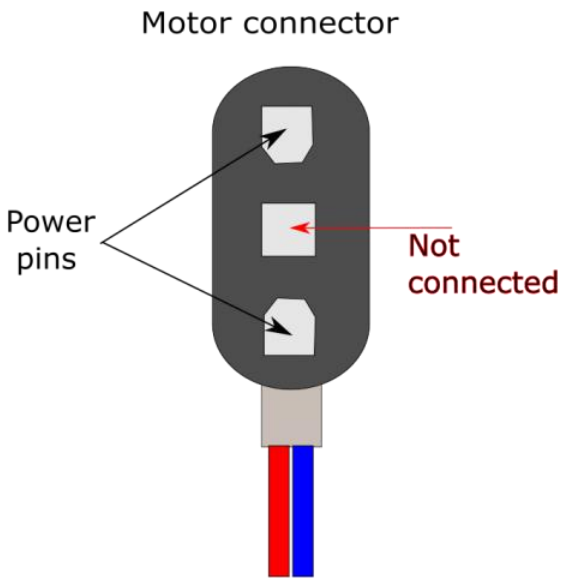
Next I want to talk about Hexbug Spider programming, electric/electronic components and various findings related to this robot.

1. Motors

- geared down DC motors.

- form factor - the motor enclosure and shaft are mechanically compatible with **VEX IQ construction system**.

- connector to Brain - motors are connected to the Brain with a custom three pins connector. Orientation of this connector is not critical, it can be inserted both ways with the only effect of reversed motors operation.



- operating voltage - from my measurements was 4.3Volts, which is basically the voltage supplied by the 3 X AA batteries from the Brain box.

- operation mode - motors are powered from Brain box and can be turned in both directions at two speeds each. Possible states are:

    - STOP

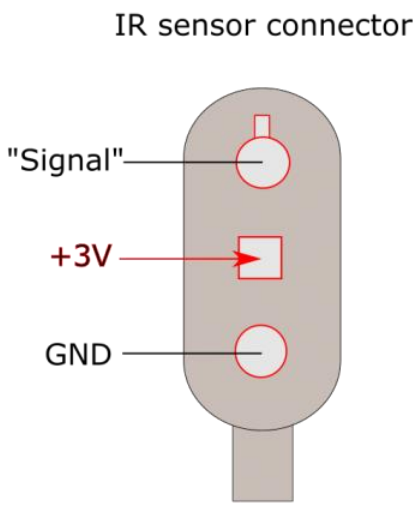
    - Speed 1 - lower

    - Speed 2 - higher (I don't have RPM numbers yet)

2. Sensor

- form factor - the sensor enclosure is mechanically compatible with **VEX IQ construction system**.

- connector to Brain - IR sensor is connected to the Brain box with a custom three pins connector. Orientation of this connector is important, it can NOT be inserted both ways. This connector have different shapes for each pin in order to prevent (or at least to make it harder) a wrong connection.



- operating voltage: 3V

- detection range: 40-50 cm

- operation mode - when robot runs in autonomous mode, the IR sensor become operational. I did not pick any readings on "Signal" pin when robot is in manual mode.

If no obstacle is detected the voltage between "+3V" pin and the "Signal" pin is zero.

When a detection occurred, the voltage between "+3V" pin and the "Signal" pin become +3V. So that means this sensor's output is HIGH when an obstacle is detected and LOW when it don't sense anything, the output is not a continuous analog voltage.

3. Brain

- form factor - the Brain enclosure is mechanically compatible with **VEX IQ construction system**. Unfortunately the compatibility is only mechanical because VEX IQ connectors are different from Hexbug ones and I assume communication between components is different too.

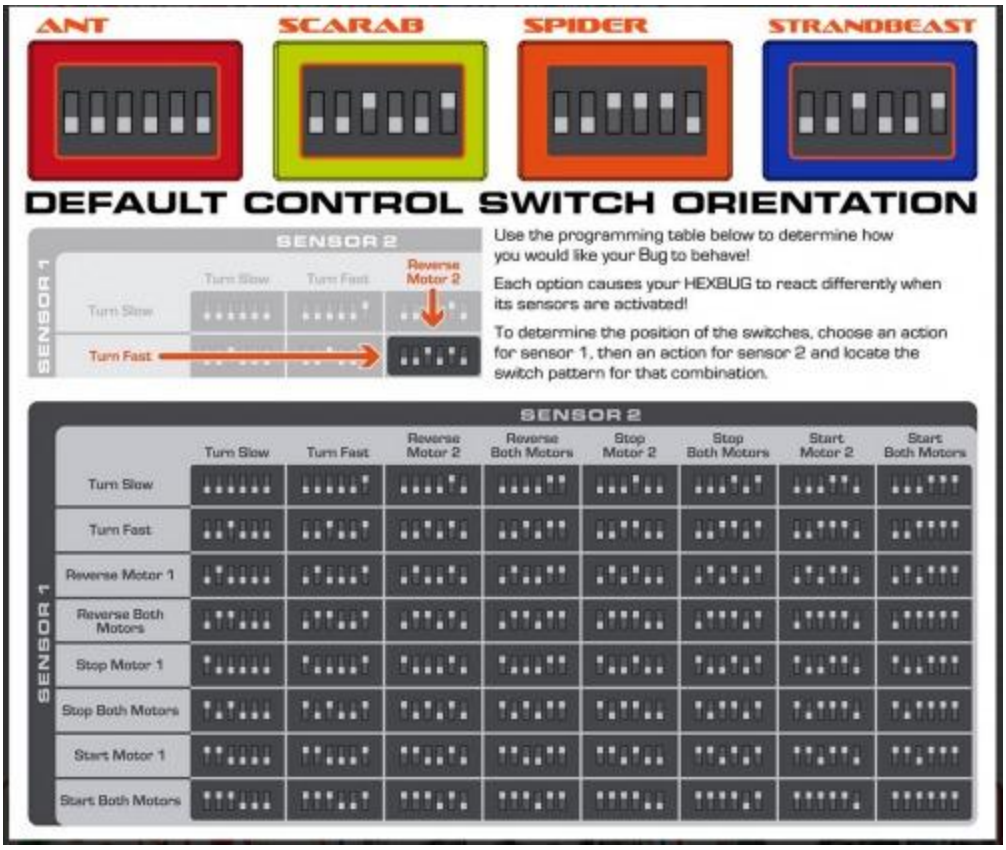
- connectors - Brain have four connectors, two for motors and two for sensors, although only one sensor is used in this case. Also the Brain box have a bidirectional 2.4GHz wireless link with the Remote Controller.

- operating voltage - 3xAA batteries, so around 4.5V.

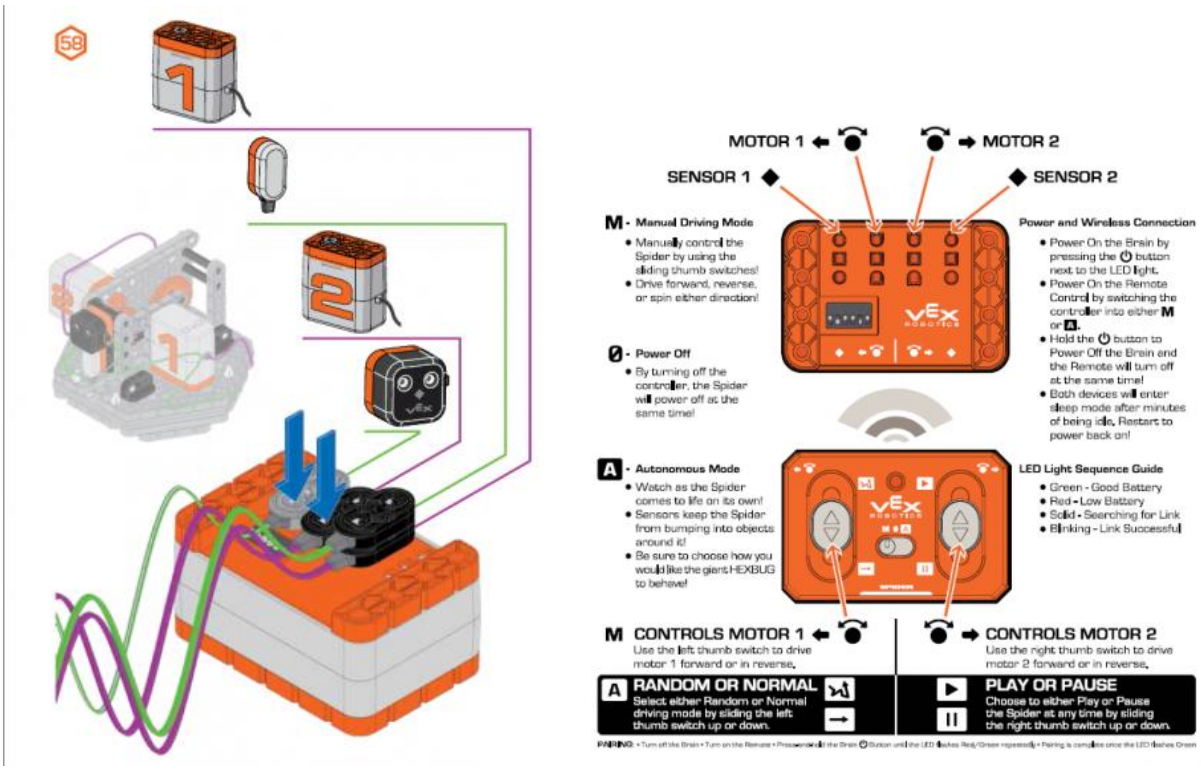
- operation mode - Brain box have a push button for Start/Stop and a green LED for status. After power up, Brain looks for the Remote Controller and after the link is established the status LEDs of both Brain and controller blink synchronously.

- programming – for programming the Brain box include a DIP switch, which is a group of six on/off micro switches used to modify the robot behavior when running in autonomous mode.

Instructions manual did not include the programming guide but it can be found on **Hexbug website**, I put it bellow.



At this point things became a little more complicated, starting with instructions manual itself. There are two contradictory images about motors connection:



The connectors for motors are switched from one picture to the other. I choose the second picture to connect motors.

Unfortunately none of the switches combinations from programming sheet match robot behavior.

To enter autonomous mode, on Remote Controller move de mode selector switch to position "A" and power the Brain box. To start the robot, move up Right controller button, towards the [>] (play) sign. To pause the robot in autonomous mode, move Right controller button down, towards the [| |] (pause) sign.

Next I'll show you some useful combinations I found during programming test:

Brain ports configuration:

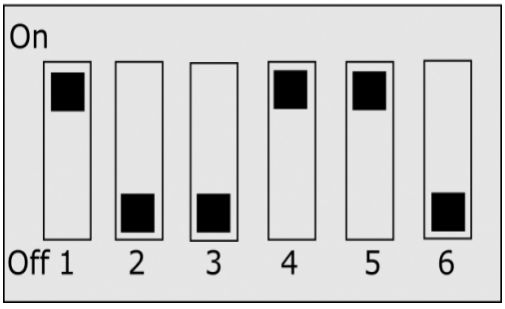
- IR sensor -> Sensor port 1

- walking motor -> Motor port 1

- turning motor -> Motor port 2

- Setting no. 1

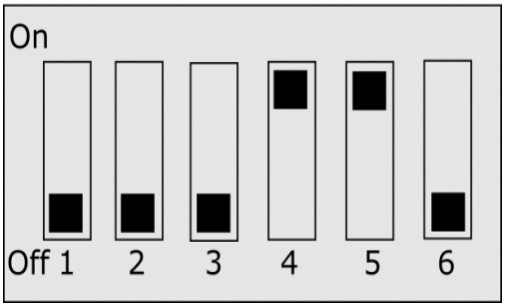
Programming switch



What it does:	What should it do acc. to programming sheet:
- Motor 1 (walk) - Stop	Motor 1 (walk) - Stop
- Motor 2 (turn) - Stop	Motor 2 (turn) - Start

- **Setting no. 2**

Programming switch

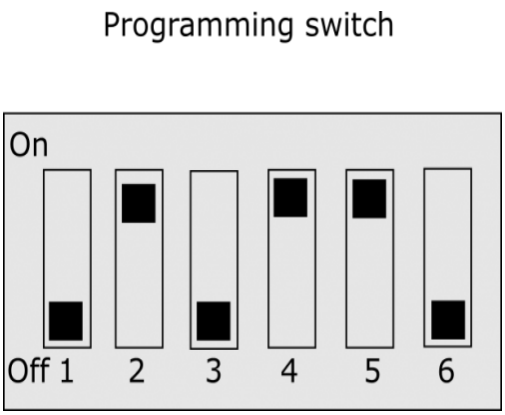


What it does: What should it do acc. to programming sheet:

- Motor 1 (walk) - Stop Motor 1 (walk) - turn slow

- Motor 2 (turn) - turn slow Motor 2 (turn) - Start

- **Setting no. 3**



What it does: What should it do acc. to programming sheet:

- Motor 1 (walk) - Reverse Motor 1 (walk) - reverse

- Motor 2 (turn) - Stop Motor 2 (turn) - Start

I'll continue testing with motors connectors swaped to see if I can get more useful combinations or match somehow the programming sheet.

UPDATE 1

Swap motors connectors did not help. Somehow I expect that because even stop commands did not match.

After a couple of hours of testing I managed to compile a list of DIP switch combinations, see it bellow.

- good for Spider
- not good for Spider

Motor 1 - = Walking
Motor 2 - = Turn head
Sensor conn. to port 1

Fast turn = head is turned about 180 degrees
Slow turn = head is turned about 45 degrees

	DIP setting	After 'Play' command	What robot do	After sensor detect obstacle	What robot do	After obstacle is removed	What robot do
1		Motor 1 - Stop Motor 2 - Stop	Not moving	Motor 1 - Start forward Motor 2 - Turn fast	Moves erratically	Motor 1 - start forward Motor 2 - turn fast	Does not react anymore to sensor activity
2		Motor 1 - Start forward Motor 2 - Stop	Move forward	Motor 1 - Start in reverse Motor 2 - Stop	Moves backward	Motor 1 - move in reverse Motor 2 - Stop	If sensor activity is detected Motor 1 change direction again
3		Motor 1 - Start forward Motor 2 - Stop	Move forward	Motor 1 - Stop Motor 2 - Turn fast	Robot is stopped and head is turning fast until no obstacle is detected	Motor 1 - Start forward Motor 2 - Stop	Move forward
4		Motor 1 - Start forward Motor 2 - Stop	Move forward	Motor 1 - Stop Motor 2 - Turn slow	Robot is stopped and head is turning slow until no obstacle is detected	Motor 1 - Start forward Motor 2 - Stop	Move forward
5		Motor 1 - Start forward Motor 2 - Stop	Move forward	Motor 1 - Stop Motor 2 - Stop	Robot is stopped and wait until no obstacle is detected	Motor 1 - Start forward Motor 2 - Stop	Move forward
6		Motor 1 - Stop Motor 2 - Stop	Not moving	Motor 1 - Start forward Motor 2 - Stop	Moves forward Not reacting anymore to sensor activity	Motor 1 - Forward Motor 2 - Stop	Move forward
7		Motor 1 - Start forward Motor 2 - Stop	Move forward	Motor 1 - Stop Motor 2 - Turn fast	Robot is stopped and head is turning fast until no obstacle is detected	Motor 1 - start forward Motor 2 - turn fast	Moves erratically but react to sensor activity
8		Motor 1 - Start in reverse Motor 2 - Stop	Move forward	Motor 1 - Start in reverse Motor 2 - Stop	Moves backward	Motor 1 - move in reverse Motor 2 - Stop	If sensor activity is detected Motor 1 change direction again
9		Motor 1 - Stop Motor 2 - Stop	Not moving	Motor 1 - Start forward Motor 2 - Turn fast	Moves erratically	Motor 1 - start forward Motor 2 - turn fast	Does not react anymore to sensor activity
10		Motor 1 - Start forward Motor 2 - Turn fast	Moves erratically	Motor 1 - Stop Motor 2 - Turn slow	Robot is stopped and head is turning slow until no obstacle is detected	Motor 1 - start forward Motor 2 - turn fast	Moves erratically
11		Motor 1 - Start forward Motor 2 - Turn fast	Moves erratically	Motor 1 - Stop Motor 2 - Turn slow	Robot is stopped and head is turning slow until no obstacle is detected	Motor 1 - start forward Motor 2 - turn fast	Moves erratically
12		Motor 1 - Start forward Motor 2 - Turn fast	Moves erratically	Motor 1 - Stop Motor 2 - Turn slow	Robot is stopped and head is turning slow until no obstacle is detected	Motor 1 - start forward Motor 2 - turn fast	Moves erratically
13		Motor 1 - Start forward Motor 2 - Stop	Move forward	Motor 1 - Stop Motor 2 - Turn slow	Robot is stopped and head is turning slow until no obstacle is detected	Motor 1 - Start forward Motor 2 - Stop	Move forward
14		Motor 1 - Start forward Motor 2 - Stop	Move forward	Motor 1 - Stop Motor 2 - Turn slow	Robot is stopped and head is turning slow until no obstacle is detected	Motor 1 - Start forward Motor 2 - Stop	Move forward
15		Motor 1 - Stop Motor 2 - Stop	Not moving	Motor 1 - Start forward Motor 2 - Turn fast	Moves erratically	Motor 1 - start forward Motor 2 - turn fast	Does not react anymore to sensor activity
16		Motor 1 - Start forward Motor 2 - Turn fast	Moves erratically	Motor 1 - Forward Motor 2 - Turn fast	Don't react to sensor activity	Motor 1 - Forward Motor 2 - turn fast	Moves erratically
17		Motor 1 - Start forward Motor 2 - Turn fast	Moves erratically	Motor 1 - Forward Motor 2 - Turn fast	Don't react to sensor activity	Motor 1 - Forward Motor 2 - turn fast	Moves erratically
18		Motor 1 - Stop Motor 2 - Stop	Not moving	Motor 1 - Start forward Motor 2 - Stop	Moves forward Not reacting anymore to sensor activity	Motor 1 - Forward Motor 2 - Stop	Move forward
19		Motor 1 - Stop Motor 2 - Stop	Not moving	Motor 1 - Start forward Motor 2 - Stop	Moves forward Not reacting anymore to sensor activity	Motor 1 - Forward Motor 2 - Stop	Move forward
20		Motor 1 - Start forward Motor 2 - Turn fast	Moves erratically	Motor 1 - Stop Motor 2 - Turn slow in reverse	Robot is stopped and head is turning slow until no obstacle is detected	Motor 1 - Forward Motor 2 - Turn fast	Moves erratically
21		Motor 1 - Start forward Motor 2 - Turn fast	Moves erratically	Motor 1 - Forward Motor 2 - Turn fast	Don't react to sensor activity	Motor 1 - Forward Motor 2 - Turn fast	Moves erratically
22		Motor 1 - Start forward Motor 2 - Turn fast	Moves erratically	Motor 1 - Forward Motor 2 - Turn fast	Don't react to sensor activity	Motor 1 - Forward Motor 2 - Turn fast	Moves erratically
23		Motor 1 - Stop Motor 2 - Stop	Not moving	Motor 1 - Start forward Motor 2 - Stop	Moves forward Not reacting anymore to sensor activity	Motor 1 - Forward Motor 2 - Stop	Move forward
24		Motor 1 - Start forward Motor 2 - Turn fast	Moves erratically	Motor 1 - Reverse Motor 2 - Turn slow in reverse	Robot move backwards and head is turning slow until no obstacle is detected	Motor 1 - Start forward Motor 2 - Turn fast	Moves erratically
25		Motor 1 - Start forward Motor 2 - Turn fast	Moves erratically	Motor 1 - Reverse Motor 2 - Turn slow in reverse	Robot move backwards and head is turning slow until no obstacle is detected	Motor 1 - Start forward Motor 2 - Turn fast	Moves erratically
26		Motor 1 - Start forward Motor 2 - Turn fast	Moves erratically	Motor 1 - Forward Motor 2 - Turn fast	Don't react to sensor activity	Motor 1 - Forward Motor 2 - Turn fast	Moves erratically
27		Motor 1 - Start forward Motor 2 - Turn fast	Moves erratically	Motor 1 - Stop Motor 2 - Stop	Robot is stopped and wait until obstacle is removed	Motor 1 - Start forward Motor 2 - Turn fast	Moves erratically
28		Motor 1 - Start forward Motor 2 - Turn slow	Moves erratically	Motor 1 - Stop Motor 2 - Turn slow in reverse	Robot is stopped and head is turning slow until no obstacle is detected	Motor 1 - Forward Motor 2 - Turn fast	Moves erratically
29		Motor 1 - Start forward Motor 2 - Turn fast	Moves erratically	Motor 1 - Forward Motor 2 - Turn fast	Don't react to sensor activity	Motor 1 - Forward Motor 2 - Turn fast	Moves erratically
30		Motor 1 - Start forward Motor 2 - Turn fast	Moves erratically	Motor 1 - Forward Motor 2 - Turn fast	Don't react to sensor activity	Motor 1 - Forward Motor 2 - Turn fast	Moves erratically
31		Motor 1 - Stop Motor 2 - Stop	Not moving	Motor 1 - Start forward Motor 2 - Stop	Moves forward Not reacting anymore to sensor activity	Motor 1 - Forward Motor 2 - Stop	Move forward
32		Motor 1 - Start forward Motor 2 - Turn slow	Moves erratically	Motor 1 - Reverse Motor 2 - Turn slow in reverse	Robot move backwards and head is turning slow until no obstacle is detected	Motor 1 - Start forward Motor 2 - Turn fast	Moves erratically
33		Motor 1 - Start forward Motor 2 - Turn slow	Moves erratically	Motor 1 - Reverse Motor 2 - Turn slow in reverse	Robot move backwards and head is turning slow until no obstacle is detected	Motor 1 - Start forward Motor 2 - Turn fast	Moves erratically
34		Motor 1 - Start forward Motor 2 - Turn slow	Moves erratically	Motor 1 - Stop Motor 2 - Stop	Robot is stopped and wait until obstacle is removed	Motor 1 - Start forward Motor 2 - Turn fast	Moves erratically
35		Motor 1 - Start forward Motor 2 - Turn slow	Moves erratically	Motor 1 - Forward Motor 2 - Turn fast	Don't react to sensor activity	Motor 1 - Forward Motor 2 - Turn fast	Moves erratically
36		Motor 1 - Start forward Motor 2 - Turn fast	Moves erratically	Motor 1 - Reverse Motor 2 - Turn fast in reverse	Robot move backwards and head is turning fast in reverse until no obstacle is detected	Motor 1 - Start forward Motor 2 - Turn fast	Moves erratically
37		Motor 1 - Start forward Motor 2 - Turn fast	Moves erratically	Motor 1 - Stop Motor 2 - Turn fast in reverse	Robot is stopped and head is turning fast in reverse until no obstacle is detected	Motor 1 - Start forward Motor 2 - Turn fast	Moves erratically
38		Motor 1 - Start forward Motor 2 - Turn slow	Moves erratically	Motor 1 - Stop Motor 2 - Stop	Robot is stopped and wait until obstacle is removed	Motor 1 - Start forward Motor 2 - Turn fast	Moves erratically
39		Motor 1 - Start forward Motor 2 - Turn slow	Moves erratically	Motor 1 - Forward Motor 2 - Turn fast	Don't react to sensor activity	Motor 1 - Forward Motor 2 - Turn fast	Moves erratically
40		Motor 1 - Start forward Motor 2 - Turn fast	Moves erratically	Motor 1 - Forward Motor 2 - Turn fast	Don't react to sensor activity	Motor 1 - Forward Motor 2 - Turn fast	Moves erratically
41		Motor 1 - Start forward Motor 2 - Turn fast	Moves erratically	Motor 1 - Forward Motor 2 - Turn fast	Don't react to sensor activity	Motor 1 - Forward Motor 2 - Turn fast	Moves erratically
42		Motor 1 - Stop Motor 2 - Stop	Not moving	Motor 1 - Start forward Motor 2 - Stop	Moves forward Not reacting anymore to sensor activity	Motor 1 - Forward Motor 2 - Stop	Move forward
43		Motor 1 - Start forward Motor 2 - Turn fast	Moves erratically	Motor 1 - Reverse Motor 2 - Turn slow in reverse	Robot move backwards and head is turning slow until no obstacle is detected	Motor 1 - Start forward Motor 2 - Turn fast	Moves erratically
44		Motor 1 - Start forward Motor 2 - Turn fast	Moves erratically	Motor 1 - Reverse Motor 2 - Turn slow in reverse	Robot move backwards and head is turning slow until no obstacle is detected	Motor 1 - Start forward Motor 2 - Turn fast	Moves erratically
45		Motor 1 - Start forward Motor 2 - Turn fast	Moves erratically	Motor 1 - Forward Motor 2 - Turn fast	Don't react to sensor activity	Motor 1 - Forward Motor 2 - Turn fast	Moves erratically
46		Motor 1 - Start forward Motor 2 - Turn fast	Moves erratically	Motor 1 - Stop Motor 2 - Stop	Robot is stopped and wait until obstacle is removed	Motor 1 - Start forward Motor 2 - Turn fast	Moves erratically
47		Motor 1 - Start forward Motor 2 - Turn fast	Moves erratically	Motor 1 - Forward Motor 2 - Turn fast	Don't react to sensor activity	Motor 1 - Forward Motor 2 - Turn fast	Moves erratically
48		Motor 1 - Start forward Motor 2 - Turn fast	Moves erratically	Motor 1 - Forward Motor 2 - Turn fast	Don't react to sensor activity	Motor 1 - Forward Motor 2 - Turn fast	Moves erratically
49		Motor 1 - Stop Motor 2 - Stop	Not moving	Motor 1 - Start forward Motor 2 - Stop	Moves forward Not reacting anymore to sensor activity	Motor 1 - Forward Motor 2 - Stop	Move forward
50		Motor 1 - Start forward Motor 2 - Turn fast	Moves erratically	Motor 1 - Reverse Motor 2 - Turn slow in reverse	Robot move backwards and head is turning slow until no obstacle is detected	Motor 1 - Start forward Motor 2 - Turn fast	Moves erratically
51		Motor 1 - Start forward Motor 2 - Turn fast	Moves erratically	Motor 1 - Reverse Motor 2 - Turn slow in reverse	Robot move backwards and head is turning slow until no obstacle is detected	Motor 1 - Start forward Motor 2 - Turn fast	Moves erratically
52		Motor 1 - Start forward Motor 2 - Turn fast	Moves erratically	Motor 1 - Forward Motor 2 - Turn fast	Don't react to sensor activity	Motor 1 - Forward Motor 2 - Turn fast	Moves erratically
53		Motor 1 - Start forward Motor 2 - Turn fast	Moves erratically	Motor 1 - Stop Motor 2 - Stop	Robot is stopped and wait until obstacle is removed	Motor 1 - Start forward Motor 2 - Turn fast	Moves erratically
54		Motor 1 - Start forward Motor 2 - Turn fast	Moves erratically	Motor 1 - Reverse Motor 2 - Turn slow in reverse	Robot move backwards and head is turning slow until no obstacle is detected	Motor 1 - Start forward Motor 2 - Turn fast	Moves erratically
55		Motor 1 - Start forward Motor 2 - Turn fast	Moves erratically	Motor 1 - Reverse Motor 2 - Turn slow in reverse	Robot move backwards and head is turning slow until no obstacle is detected	Motor 1 - Start forward Motor 2 - Turn fast	Moves erratically
56		Motor 1 - Start forward Motor 2 - Turn fast	Moves erratically	Motor 1 - Stop Motor 2 - Turn slow in reverse	Robot is stopped and head is turning slow until no obstacle is detected	Motor 1 - Forward Motor 2 - Turn fast	Moves erratically
57		Motor 1 - Start forward Motor 2 - Turn fast	Moves erratically	Motor 1 - Forward Motor 2 - Turn fast	Don't react to sensor activity	Motor 1 - Forward Motor 2 - Turn fast	Moves erratically
58		Motor 1 - Start forward Motor 2 - Turn fast	Moves erratically	Motor 1 - Forward Motor 2 - Turn fast	Don't react to sensor activity	Motor 1 - Forward Motor 2 - Turn fast	Moves erratically
59		Motor 1 - Start forward Motor 2 - Turn fast	Moves erratically	Motor 1 - Forward Motor 2 - Turn fast	Don't react to sensor activity	Motor 1 - Forward Motor 2 - Turn fast	Moves erratically
60		Motor 1 - Start forward Motor 2 - Turn fast	Moves erratically	Motor 1 - Stop Motor 2 - Stop	Robot is stopped and wait until obstacle is removed	Motor 1 - Start forward Motor 2 - Turn fast	Moves erratically
61		Motor 1 - Stop Motor 2 - Stop	Not moving	Motor 1 - Start forward Motor 2 - Stop	Moves forward Not reacting anymore to sensor activity	Motor 1 - Forward Motor 2 - Stop	Move forward
62		Motor 1 - Start forward Motor 2 - Stop	Move forward	Motor 1 - Stop Motor 2 - Stop	Robot is stopped and wait until no obstacle is detected	Motor 1 - Start forward Motor 2 - Stop	Move forward
63		Motor 1 - Start forward Motor 2 - Stop	Move forward	Motor 1 - Start in reverse Motor 2 - Stop	Moves backward	Motor 1 - move in reverse Motor 2 - Stop	If sensor activity is detected Motor 1 change direction again
64		Motor 1 - Start forward Motor 2 - Stop	Move forward	Motor 1 - Stop Motor 2 - Stop	Robot is stopped and wait until no obstacle is detected	Motor 1 - Start forward Motor 2 - Turn fast	Move forward

The most useful combinations are :

- No.4, No.13 and No.14 - this is the best obstacle avoidance mode so far because direction is changed in small steps.

- No.3 - this is a fair obstacle avoidance mode, direction is changed in big steps.

- No.2, No.8 and No.63 - when sensor activity is detected robot start to move backwards but head is not turned. If sensor activity is detected again, walking direction is changed again, that means robot start moving forward again.

- No.5, No.62 and No.64 - when sensor activity is detected robot stops and wait until obstacle is removed then continue moving forward.

The other combinations I found so far did not generate useful behaviors for Spider mode. However, applications of this kit are not restricted only to Spider build. If someone is going to build something else from this kit, the combinations which are not good for Spider may be useful for these builds.