INTRODUCTION
LEGO MINDSTORMS NXT
AND LABVIEW 8.6

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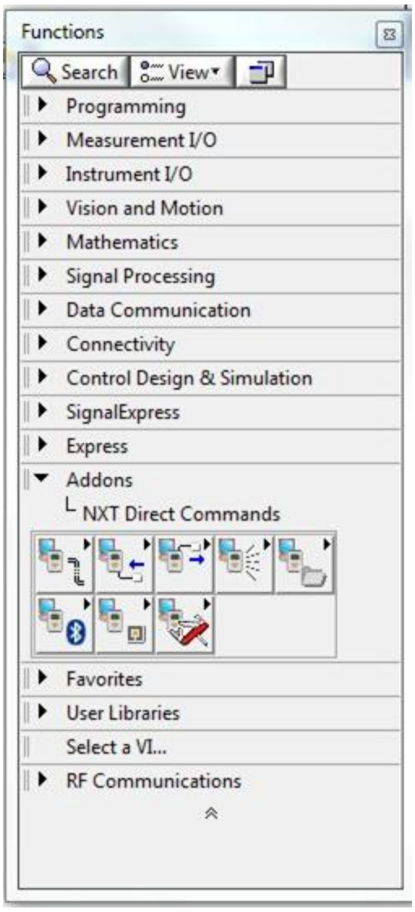
1 NXT DIRECT COMMANDS

There are two different kinds of programming Lego Mindstorms NXT with LabVIEW: Either the NXT direct commands or the NXT Toolkit is used. The *Direct Commands* allow to use all standard LabVIEW functions because the program is running on the PC. The *NXTToolkit* is running on the NXT itself but has only a very limited number of functions to be used. The advantage of the NXTToolkit is that it allows disconnecting the USB cable between the PC and the NXT after programming. This is not possible using the direct commands but instead of a USB cable a Bluetooth connection can be used.

The intention of our course is to make you familiar with the graphical programming language of LabVIEW. For this reason the scope of this document are the Direct commands.

The direct commands are found by right-clicking on the white block diagram to open the functions palette and by choosing Addons > NXT Direct Commands.



1.1 CONNECTION

Before any functions of the *Direct Commands* can be used a connection between the LabVIEW program and the NXT must be established. Open a blank vi and right click on the block diagram so that the functions palette appears. Select the following function blocks and place them on the block diagram (> Addons > NXT Direct Commands > Connection):

- Find NXT
- Create NXTObject
- Destroy NXTObject

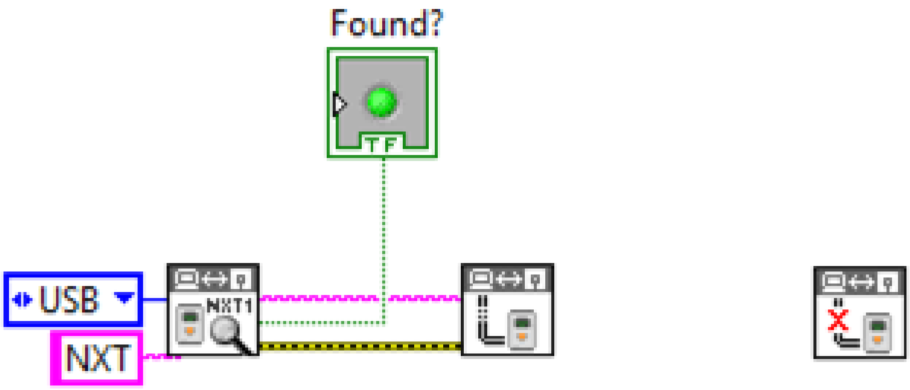
The inputs "Connection type" and "NXT Name" of the function block „Find NXT" must be wired. Therefore, right-click on the corresponding inputs and choose *Create > Constant* to define a new constant. Select as connection type "USB" and as Name "NXT".

In addition an indicator can be placed by right-clicking on the output "Found?" and selecting *Create > Indicator* to place an LED on the Front Panel that reports the successful connection with the NXT.

The „Create NXTObject" function must be connected with the "Find NXT" block by wiring the „Visa resource string" input with the „Visa resource string" output and „Error out" of the "Find NXT" block with the „Error in" input of the Create-block. The block „Create NXTObject" establishes a connection with the NXT that allows other functions blocks to communicate with the NXT.

At this point the application specific function blocks are connected with the "Create NXTObject" block.

Before the program exits the NXTObject must be destroyes to deallocate the memory. Therefore, the last block must be the „Destroy NXTObject". The wires "NXTObject" and "Error in" must be connected with the previous blocks.



Note:

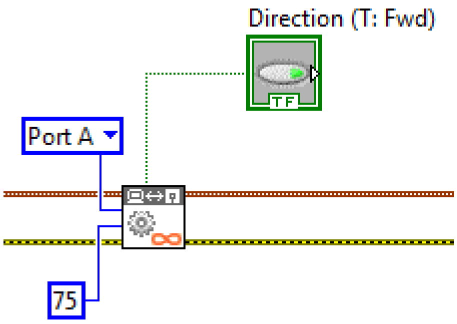
This is the basic framework for all programs. In the following examples this framework is not shown.

1.2 MOTOR ON AND OFF

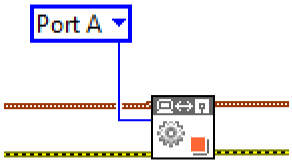
A motor is started by using a „Motor Unlimited“ block to be found here: Functions Palette
> *Addons > NXT Direct Commands > Output*.

The input “Power” and “Output Port” should be wired with a control or a constant. The direction of the motor can be changed by a Boolean constant or control wired to the Direction input on the top of the “Motor Unlimited” block.

Unlimited means that the motor is started and does not stop, even if the program exits.

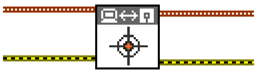


To stop the motor a second block „Motor Stop“ is required. This block is found in the same location: *Function Palette > Addons > NXT Direct Commands > Output*. It must be specified which motor has to be stopped.



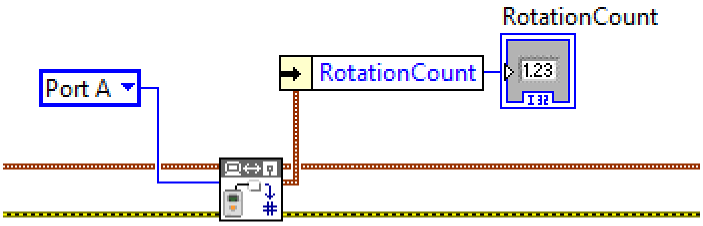
1.3 INKREMENTAL ENCODER OF THE MOTOR

All motors have a built in sensor to determine the rotation angle. These incremental encoders provide the angle in degrees. Before reading the value the incremental encoder should be reset to zero by the function block „Reset Motor Position“ (see: *Function Palette > Addons > NXT Direct Commands > Output)*.



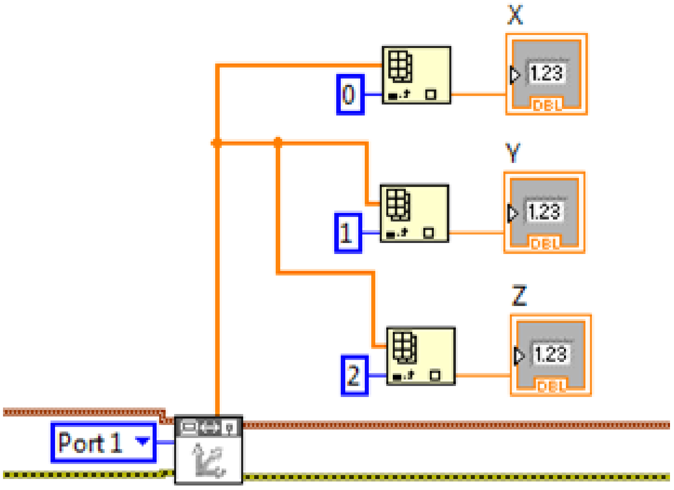
To read the angle information the function block „Get Output Values“ is required (see *Addons > NXT Direct Commands > Output)*. The motor sensor to be read is selected by wiring the input „Output Port“ with a constant or control element.

The function block “GetOutputValues” provides a set of different data. To select the angle information the output “Output Port Info” must be connected to an „Unbundle By Name“ block (see *Function Palette > Programming > Cluster, Class, &Variant).* Click on this block and set it to „RotationCount“. This is the value of the incremental encoder in degrees.



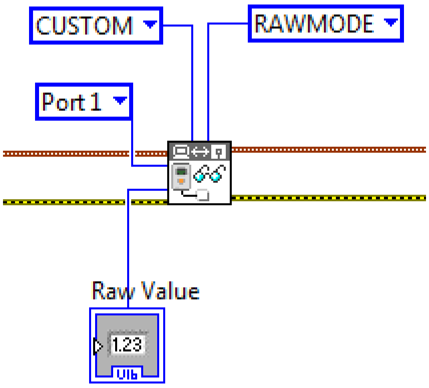
1.4 ACCELERATION SENSOR

The acceleration sensor is read by placing the function block „Read Acceleration Sensor“ (Functions Palette > *Addons* > *NXT Direct Commands* > *Input*). This block returns an array of the three acceleration values in x, y and z direction. To read each value separately, the array can be converted into a number by the function block „Index Array“ (see *Programming → Array)*. The „array“ input of this block must be wired to the „Acceleration“ output of the „Read Acceleration Sensor“ Object. The x, y and z direction is selected by connecting a constant to the „index“ input of the “Index Array” block with the corresponding value of 0, 1 or 2. The acceleration value of the corresponding axis is available by the output „element“ of “Index Array”.



The values are multiples of the acceleration of gravity and the range is -2 … 2 g.

1.5 GYRO SENSOR FOR ANGULAR RATE



The Gyro allows measuring the angular rate of a mobile robot. The value of the Gyro is read by the function „Read.DC Sensor Value“ (see *Addons* > *NXT Direct Commands* > *Input)*. The port must be specified and the following inputs of this block must wired with constants and configured as follows:
SensorType : „CUSTOM“
Sensor Mode: „RAWMODE“
The sensor value can be read at the output „Raw Value“.

If the sensor is not turning, this value is about 605 … 620. By subtracting this offset the sensor provides the turning rate in degrees per second and the maximum range is ±360°/sec.

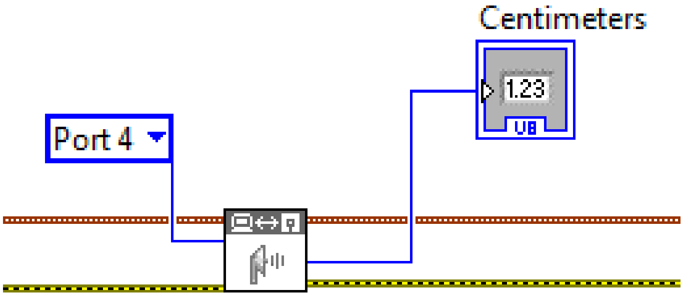
The type of the value is *Unsigned Long Int.* Before subtracting the offset the value must be converted into a *Signed Long Int* (see *Programming* > *Numeric* > *Conversion* > „To Word Integer“).

The gyro provides the angular rate but not the angular acceleration. One measurement cycle requires about 3,3ms.

1.6 OTHER SENSORS

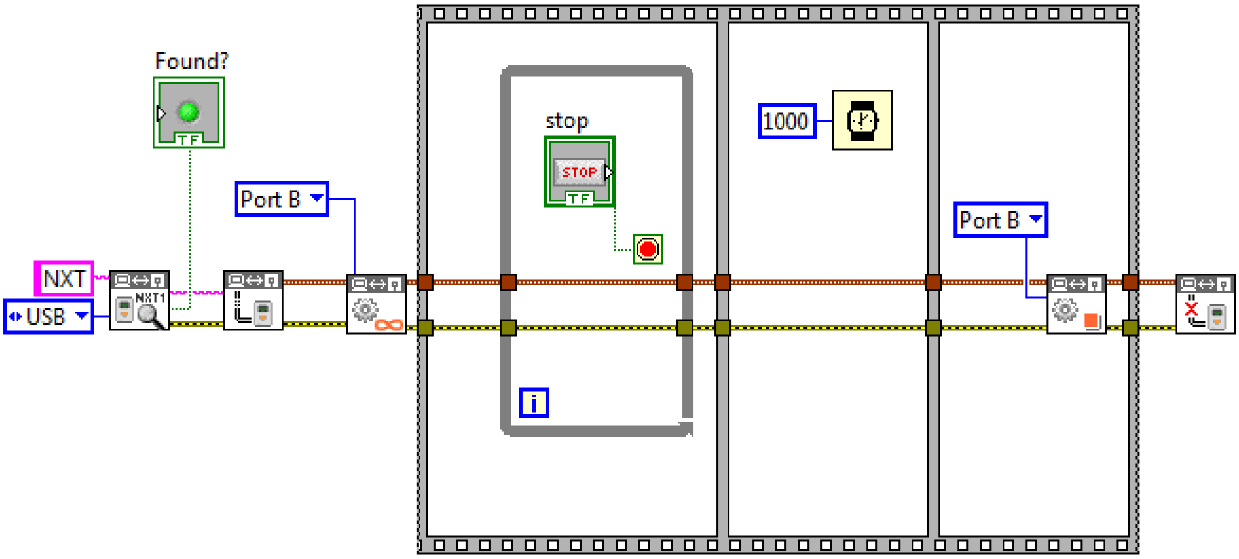
Select the appropriate sensor block to be found in the Functions Palette > *Addons* > *NXT Direct Commands* > *Input.* Create a constant to define the port number and connect the output to read the measurement result.

This example shows how to read the ultrasonic sensor. The output of this sensor is called „Centimeters“.



2 SAMPLE PROGRAM

The following sample program starts the motor, waits until a stop button is pressed and waits another 1000 ms before it stops the motor and exits.


Found?
TF
NXT
USB
NXT1
Port B
stop
STOP
TF
i
1000
Port B