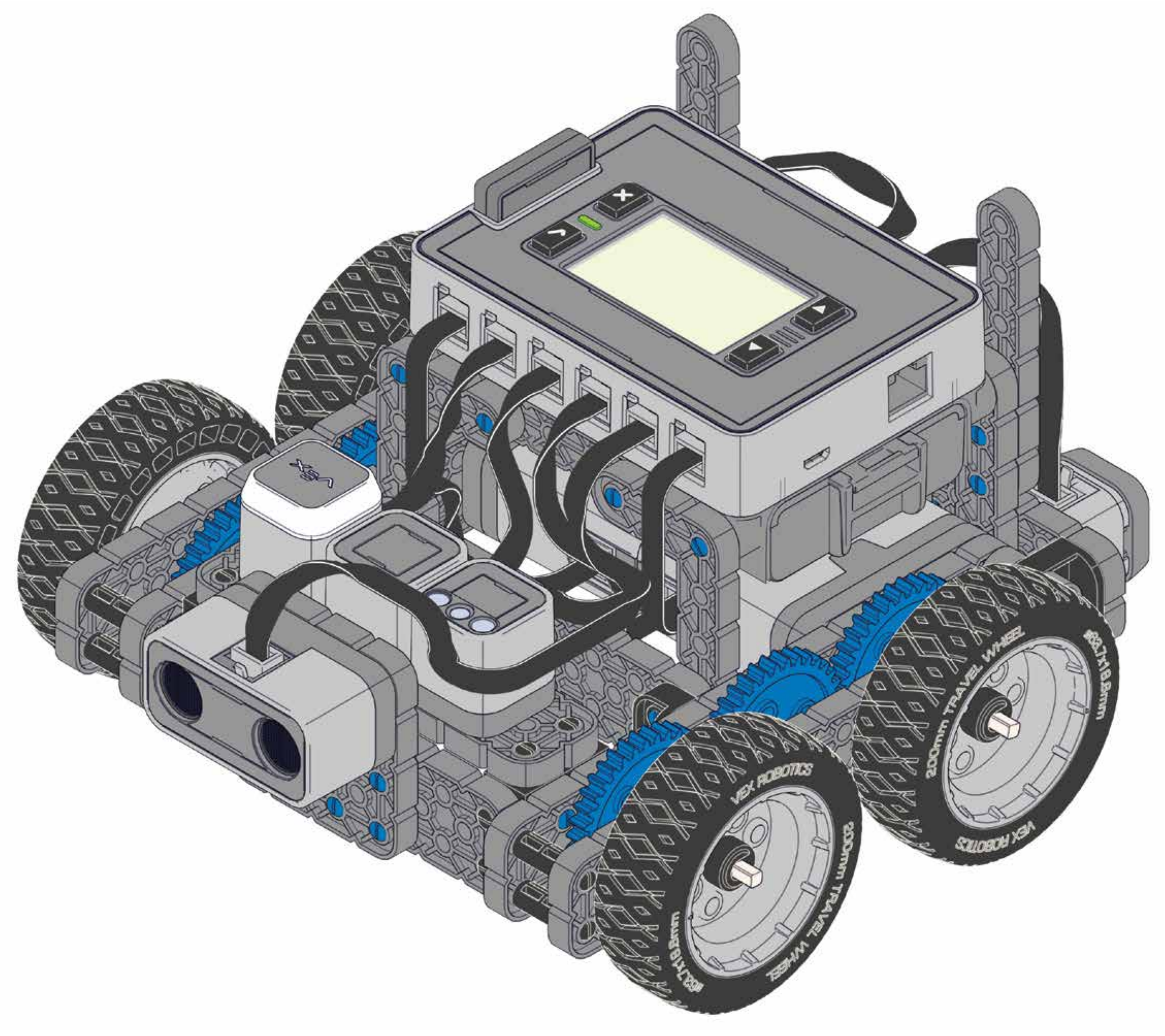
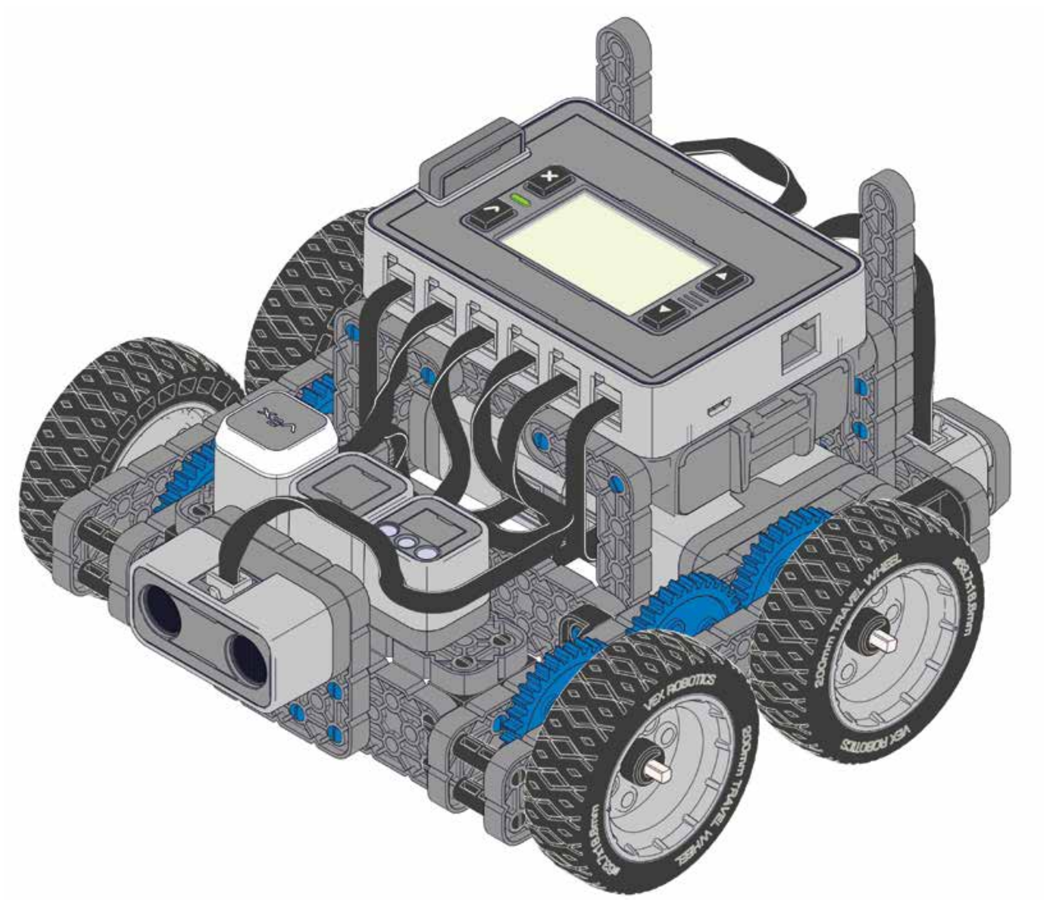
I

Smart Machines





I.1

Smart Machines

Unit Overview:

This unit introduces students to Sensors and Programming with VEX IQ. VEX IQ Sensors allow for autonomous and hybrid control of VEX IQ robots and other creations. VEX IQ Sensors connect to a robot or mechanism quickly and are easily programmed to help measure time, position distance, rotation, sense touch, provide feedback, allow for human-to-robot interaction, and much more.

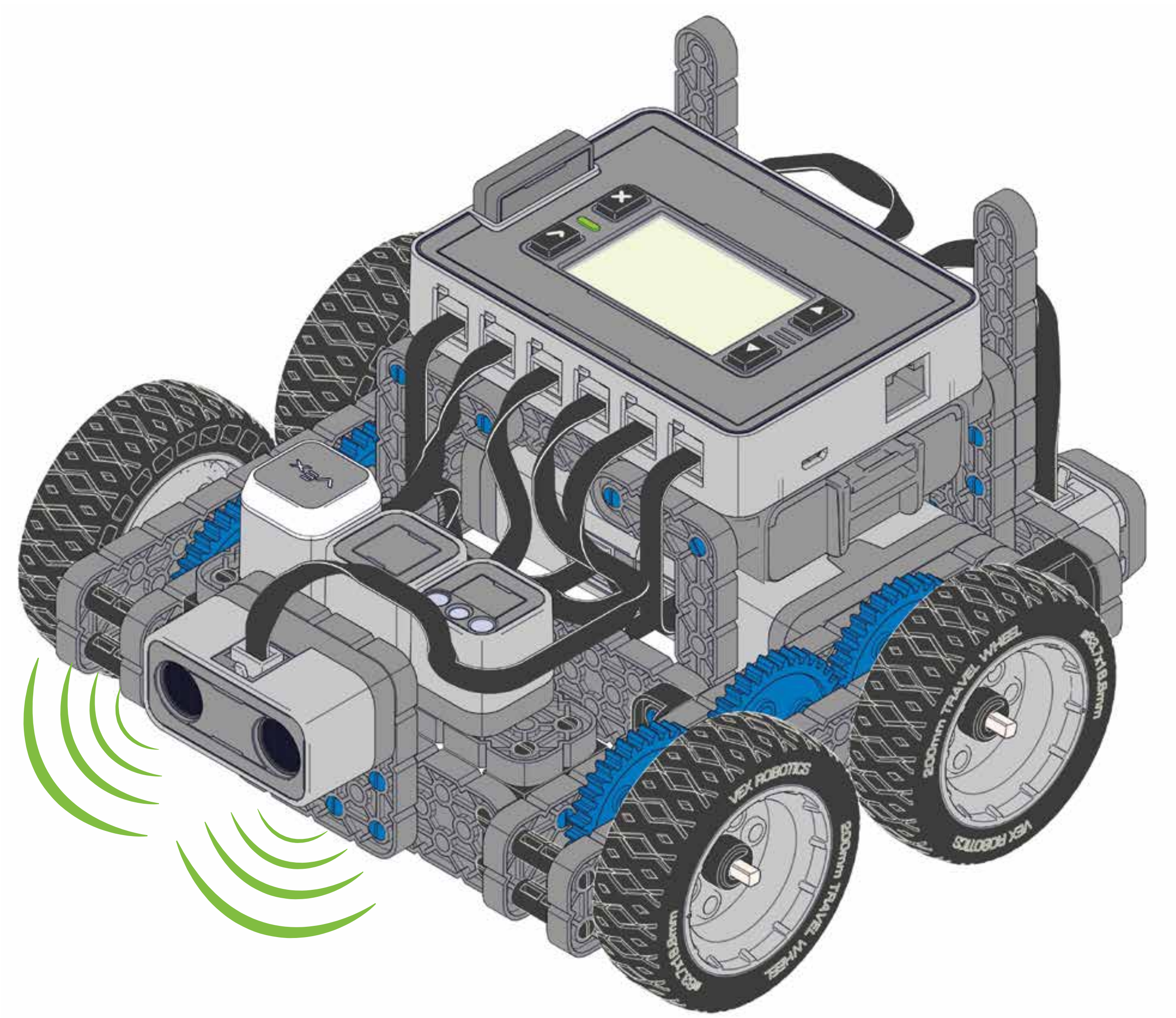
Unit Content:

- Key Terms: Sensor, Programming, Ultrasonic Sound Waves, Distance Sensor, Gyroscope, Degrees of Turn, Encoder
- VEX IQ Sensor Overview

Unit Activities:

- Matching Exercise
- Autopilot Robot Build with assembly instructions (included with kit)
- Run Autopilot Modes (instructions included with kit documentation)
- Default Sensor Functionality Exercises
- Simple Programming Exercises using only the Robot Brain
- Simple Programming Exercises using Programming Software
- Completion of Idea Book Pages with robot programming and testing

Note: Separate copies and/or printouts of activities may be used for student work. Please see your teacher BEFORE writing in this guide. Visit www.vexiq.com/curriculum to download and print PDFs of all exercises!



I.2

Key Terms

A Sensor is a device that detects and responds to some type of input from the physical environment. VEX IQ sensors can detect light, color, objects, motion, and more!

Programming is the process of providing a computer or other machine, such as a robot and its components, with coded instructions for the automatic performance of a particular task.

Ultrasonic Sound Waves are sounds that are too high of a frequency to be heard by humans. The VEX IQ Distance Sensor sends ultrasonic sound waves out that will bounce back if something is in its path, measuring distance by the amount of time it takes the sound to return.

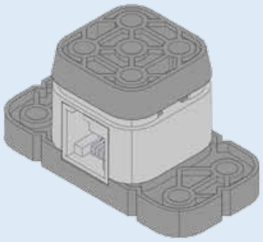
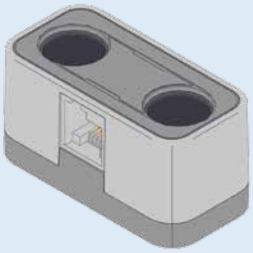
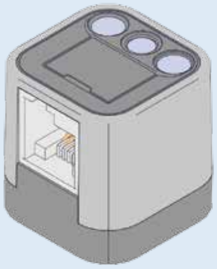
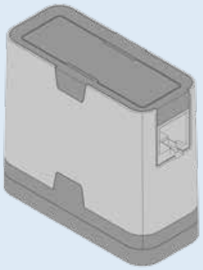
A Gyroscope (or Gyro) is a sensor that can detect and measure rotation or turning of an object.

Degrees of Turn describes how far an object, like a robot, has turned. An object that spins completely around to its original starting position has turned 360 degrees. An object that has turned to face the opposite direction has turned 180 degrees. VEX IQ Sensors can measure Degrees of Turn, allowing for precise control.

An Encoder senses mechanical motion and translates the information (velocity, position, acceleration) into useful data. VEX IQ Smart Motors have built in Encoders.

I.3

VEX IQ Sensor Overview

Sensor Name	Sensor Image	Sensor Specs & Use	Default Functionality
Bumper Switch		Allows for the sense of touch in the VEX IQ platform. Detect a wall, obstacle, or limit mechanism movement.	With a Bumper Switch in port 2, it disables/ enables a Smart Motor in port 4.
Touch LED		Smart Sensor with red, green, blue LEDs. Constant on, off, or blink at any desired rate. Touch sensor with finger for interaction.	Enables and disables Autopilot or similar robot running Driver Control Program when dome of sensor is tapped. Glows green when enabled, red when disabled.
Distance Sensor		Uses ultrasonic sound waves to measure distance. Measures distance from 1 inch to 10 feet. Commonly used to avoid obstacles.	Slows down and eventually stops as Autopilot or similar robot running Driver Control Program as the robot approaches an obstacle.
Color Sensor		Detects the color of objects. Measures independent red, green, and blue in 256 levels each.	Enables and disables Autopilot or similar robot running Driver Control Program when the sensor is "shown" a green card (enabled) or red card (disabled).
Gyro Sensor		Measures turn rate and calculates direction. Frequently used in autonomous robot navigation and turning.	With Autopilot or similar robot running Driver Control Program, it returns a robot to its original direction when driving stops.
Smart Motor		Commands and measures speed, direction, time, revolutions and/or degrees of turn using its Encoder.	No extra default functionality, but Encoders allow for superior motor control with simple programming.

I.4

Smart Machines Matching Exercise

Student Name(s): ____

Teacher/Class: ______________________ Date: ______________ Page#: __________

Part I Instructions:

Match terms from the word bank to the correct definition or statement by writing terms on the correct line. Each term is only used once.

Part I Word Bank:

Degrees of Turn

Encoder

Gyroscope

Programming

Sensor

Ultrasonic Sound Waves

A(n) ______________________ is a device that detects and responds to some type of input from the physical environment.

______________________ is the process of providing a computer or other machine, such as a robot and its components, with coded instructions for the automatic performance of a particular task.

______________________ are sounds that are too high of a frequency to be heard by humans.

A(n) ______________________ is a sensor that can detect and measure rotation or turning of an object.

______________________ describes how far an object, like a robot, has turned.

A(n) ______________________ senses mechanical motion and translates the information into useful data.

Part II Instructions:

Match terms from the word bank and label correctly below each image (images are NOT to scale)

Part II Word Bank:

Bumper Switch

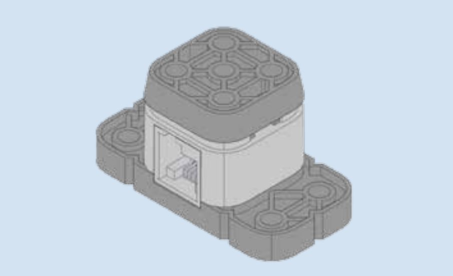
Color Sensor

Distance Sensor

Gyro Sensor

Smart Motor

Touch LED



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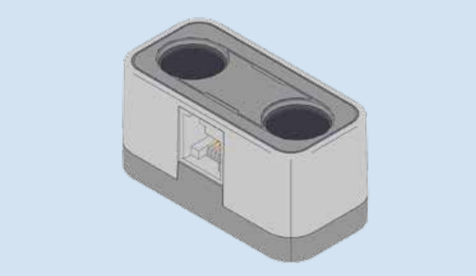

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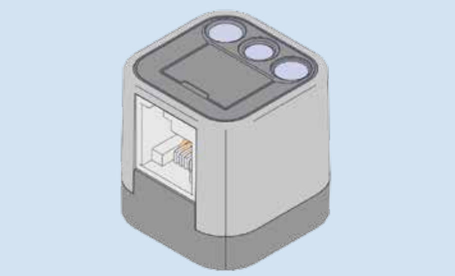

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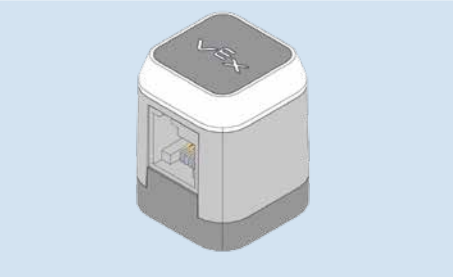

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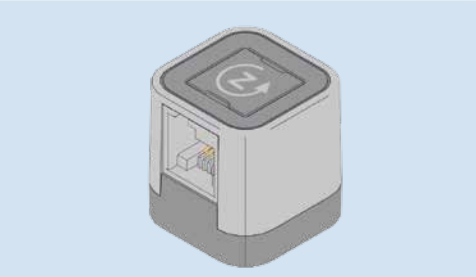

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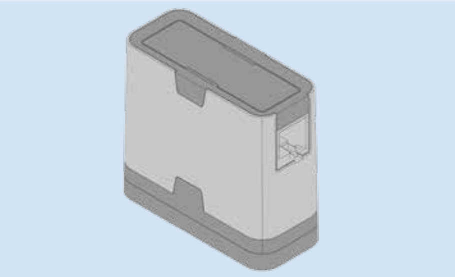

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I.5

Autopilot Robot Build

See the Autopilot Robot Assembly Instructions in your kit documentation. 1+4

I.6

Running Autopilot Modes

Your teacher will decide what of the lessons below you will complete as part of the unit. Below are the lessons along with necessary information.

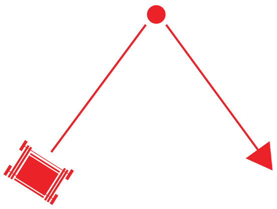
I. Read and review Key Terms and Sensor Overview with your classmates and teacher.

II. Complete the unit Matching Exercise. See separate handout.

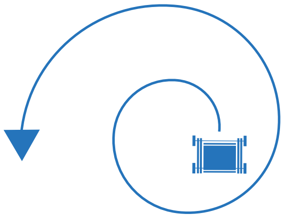
III. Build Autopilot Robot. See the Autopilot Robot Assembly Instructions in your User Guide.

IV. Use Autopilot Robot to run the three Autopilot Modes.

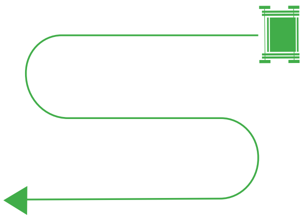
These are demonstrations of different ways Sensors can work together in a Smart Machine. See your kit documentation for details. 6.2



Random Mode



Spiral Mode



Lawnmower Mode

V. Default Sensor Functionality Exercises

See your kit documentation for details in addition to information below. 6.1

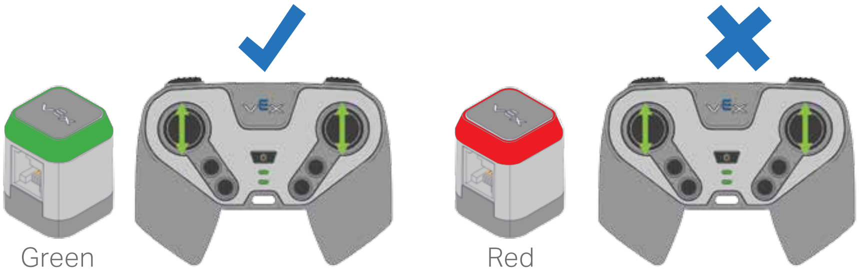
I.7

Default Sensor Functionality Exercises

Touch LED Default Functionality Exercise: “Stop and Go”

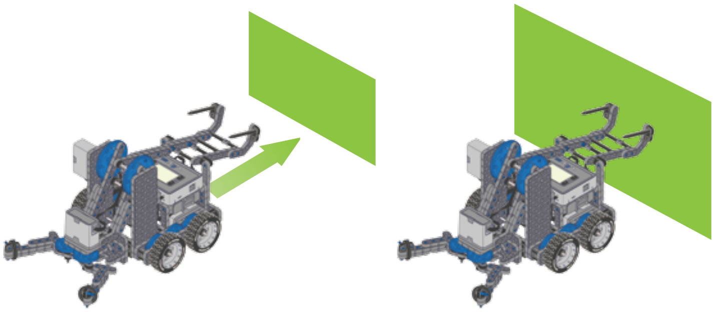
The default Touch LED functionality in the Driver Control program is to act like a traffic light for the robot. Using the Autopilot or similar robot with ONLY Smart Motors and Touch LED connected to any unused port in the Robot Brain:

- Turn ON the Robot Brain and Controller.
- Select and run the Driver Control program.
- The robot starts in enabled mode with the Touch LED glowing green. Tap the top dome of the Touch LED to change between enabled (glowing green) and disabled (glowing red).
- Try to drive when green
- Try to drive when red



Distance Sensor Default Functionality Exercise: “Collision Avoidance”

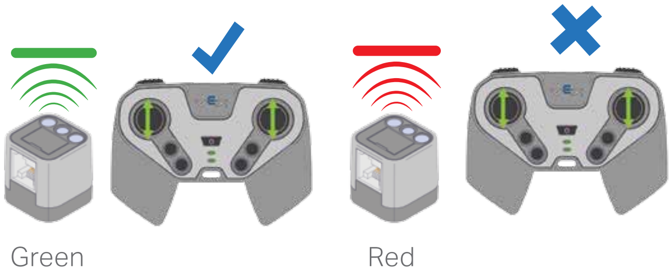
The default Distance Sensor functionality in the Driver Control program is to prevent a robot from running into an object or wall. When the Distance Sensor sees an object, it will slow down the Autopilot Robot as it approaches the object, eventually stopping to avoid collision. Using the Autopilot or similar robot with ONLY Smart Motors and a Distance Sensor connected to any unused port in the Robot Brain:



- Turn ON the Robot Brain and Controller.
- Select and run the Driver Control program.
- Use the Controller to drive the robot toward a wall. When the Distance Sensor sees an object that is too close to the robot, it will stop the robot from hitting that object.

Color Sensor Default Functionality Exercise: “Red Light, Green Light”

The default Color Sensor functionality in the Driver Control program is to act like a traffic light for the robot, much like the Touch LED. When the Color Sensor “sees” a green card (or other object) you can drive the robot. When it “sees” a red card (or other object) you cannot drive the robot. Using the Autopilot or similar robot with ONLY Smart Motors and a Color Sensor connected to any unused port in the Robot Brain:

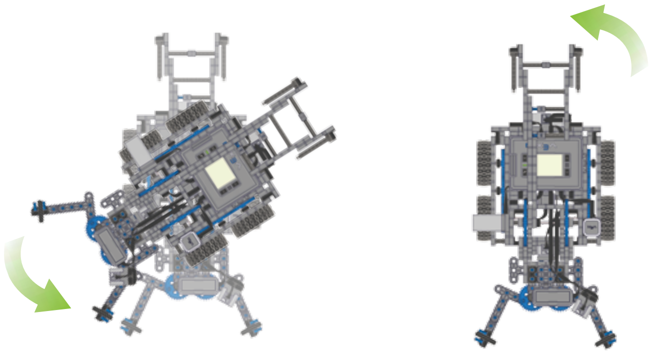


- Turn ON the Robot Brain and Controller.
- Select and run the Driver Control program.
- The robot will start in enabled mode. When a red card or object is shown in front of the color sensor, the robot will be disabled. When a green card is shown in front of the color sensor, the robot will be enabled.

Gyro Sensor Default Functionality Exercise: “Home Direction”

The default Gyro Sensor functionality in the Driver Control program is to keep the robot pointed in the same direction when not being driven by the Controller. If a robot is pushed or spun by anything other than being driven by the Controller, the robot will use the Gyro Sensor to measure how much it spun. The robot will then automatically spin back to the original direction it was pointing. Using the Autopilot or similar robot with ONLY Smart Motors and a Gyro Sensor connected to any unused port in the Robot Brain:

- Turn ON the Robot Brain and Controller.
- Select and run the Driver Control program.
- Use the Controller to turn the Robot to a new direction. When you stop driving, the robot will automatically turn back to the original direction.



I.8

Simple Programming Exercises Using Only the Robot Brain

You can make some changes to the way a robot is programmed by making simple configuration changes using only the LED screen and buttons on the VEX IQ Robot Brain. Please see your kit documentation and follow instructions to make configuration changes, testing out each change.

I.9

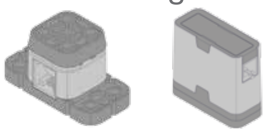
Simple Programming Exercises Using Programming Software

Before you complete any of the exercises below, you will need to:

1. RETURN THE DRIVER CONTROL PROGRAM TO ITS DEFAULT SETTINGS.
2. Become familiar with your programming software. Specifically, you should be able to open and use your programming software, save custom programs, connect your programming computer to your VEX IQ robot, successfully transfer custom programs to your Robot Brain, and run custom programs after they are transferred. Your teacher will decide the best way to get you comfortable with your programming software.

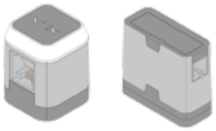
Notes: All of the possible exercises below utilize an Autopilot or similar robot with ONLY Smart Motors and the featured sensor connected to any unused port in the Robot Brain. Be sure to use the unit Idea Book Page to plan and troubleshoot your custom programs as part of these exercises. A sample Idea Book Page is provided for reference as needed.

Possible Programming Exercises with Bumper Switch & Smart Motors:



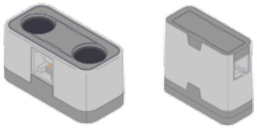
1. Robot backs up autonomously to a wall until one or both of the bumper switches on the Autopilot Robot is/ are activated by the wall, stopping the robot.
2. Teacher-created exercise.

Possible Programming Exercises with Touch LED Sensor & Smart Motors:



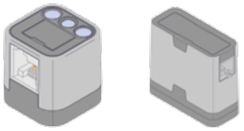
1. Robot drives autonomously forward 5 motor revolutions with Touch LED glowing green.
2. LED starts out red. Tap Touch LED, it glows green and robot drives forward autonomously. Tap LED again to change it back to red and robot stops.
3. Teacher-created exercise.

Possible Programming Exercises with Distance Sensor & Smart Motors:



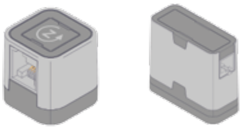
1. Robot drives autonomously toward a wall. Robot stops driving 6 inches from wall.
2. Robot drives autonomously toward a wall. Robot stops driving 6 inches from wall, then backs up 5 motor revolutions in return direction.
3. Teacher-created exercise.

Possible Programming Exercises with Color Sensor & Smart Motors:



1. Robot drives autonomously forward when Color Sensor is shown a green card. Robot stops when Color Sensor is shown a red card.
2. Robot drives autonomously forward when Color Sensor is shown a green card. Robot drives autonomously backwards when Color Sensor is shown a blue card. Robot stops when Color Sensor is shown a red card.
3. Teacher-created exercise.

Possible Programming Exercises with Gyro Sensor & Smart Motors:



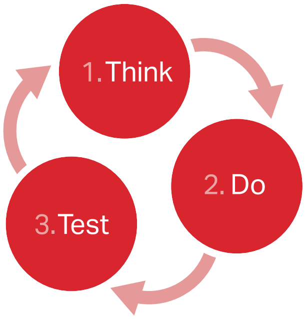
1. Robot drives autonomously forward 5 motor revolutions, then spins 180 degrees and stops.
2. Robot spins 90 degrees, then pauses for 5 seconds, then spins another 90 degrees, then pauses another 5 seconds, and keeps repeating the pattern until program is stopped.
3. Teacher-created exercise.

I.10

Smart Machines Idea Book Page: Simple Programming Exercises Using Programming Software

Student Name(s): ____

Teacher/Class: ____________________ Date: _________ Page #: _____



1. Think

2. Do

3. Test

Instructions:

Before completing these exercises, be sure you are familiar with your programming software and how it works. Follow the steps on this page to document, test, troubleshoot, and refine your program. If your program includes more steps than fit on one page, use multiple copies as necessary.

Describe what you want your program to be able to do here:

Describe the device/robot you will be programming:

List the sensors that will be used in your program:

“THINK” Write step-by-step program instructions here.	“DO” Write your program using programming software and make notes here as you work.	“TEST” Does this step of your program function as expected? What needs improvement (NI)?
		Yes No NI:
		Yes No NI:
		Yes No NI:
		Yes No NI:
		Yes No NI:
		Yes No NI:
		Yes No NI:
		Yes No NI:

If ALL program steps do NOT function as expected, address your “NI” items using as many copies of this page as necessary until all parts of your program function as expected.

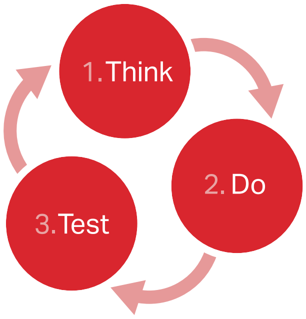
Remember: Problems ARE NOT failures, they are an expected part of the design process!

1.10 cont.

Smart Machines Idea Book Page: Simple Programming Exercises Using Programming Software

Student Name(s): John and Jane Doe

Teacher/Class: Mr. Smith Date: 9/1/2013 Page #: 1



Instructions:

Before completing these exercises, be sure you are familiar with your programming software and how it works. Follow the steps on this page to document, test, troubleshoot, and refine your program. If your program includes more steps than fit on one page, use multiple copies as necessary.

Describe what you want your program to be able to do here:
Drive autonomously straight forward for five motor revolutions Touch LED glowing green.

Describe the device/robot you will be programming:
Autopilot Robot with only Touch LED and Smart Motors plugged into Robot Brain.

List the sensors that will be used in your program:
Touch LED, Smart Motor Encoders

"THINK" Write step-by-step program instructions here.	"DO" Write your program using programming software and make notes here as you work.	"TEST" Does this step of your program function as expected? What needs improvement (NI)?
Power up Robot Brain, select and run custom autonomous program	Be sure to select custom program to run	[✓ Yes] No NI: Nothing
Robot drives autonomously straight forward for five motor revolutions	Use Smart Motor Encoders for this task	[✓ Yes] No NI: Nothing
Touch LED turns on green and glows while robot is driving forward	Use Touch LED for this task	Yes [✓ No] NI: LED did not turn on
Robot stops driving after five motor revolutions and Touch LED turns off	Power is cut to the Smart Motors and Touch LED at the end of the program	Yes [✓ No] NI: Program repeats and doesn't stop
		Yes No NI:
		Yes No NI:
		Yes No NI:
		Yes No NI:

If ALL program steps do NOT function as expected, address your "NI" items using as many copies of this page as necessary until all parts of your program function as expected.
Remember: Problems ARE NOT failures, they are an expected part of the design process!