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GPS User Guide

GPS – The Dexter Industries GPS is a GPS unit for the Lego Mindstorms NXT. The sensor calculates positional and navigational data. The sensor delivers latitude, longitude, time, velocity, angle of travel, and navigational information such as distance to a specified destination and angle to a specified destination.

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http://www.dexterindustries.com

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GPS User Guide

Getting Started:

- Hardware and Setup
- Software setup: NXT-G
- Software setup: RobotC

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Getting Started

Hardware:

Connect the GPS unit to the NXT through any of the four sensor ports. Two types of data are sent back and forth between the NXT:

Positional Data: The GPS sensor sends data on Time (UTC), latitude, longitude, velocity (in cm/s), and heading (in degrees).

Navigational Data: A user can easily program the NXT to send the latitude and longitude of a desired destination or waypoint to the GPS sensor. The GPS sensor calculates the distance to the destination and angle of travel to the destination and can send that information back to the NXT. For more accurate direction of travel data, the GPS can calculate an angle since last call.

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Understanding the GPS Coordinate Systems: The Basics

Imagine the earth, divided by lines running north and south (latitude) and east and west (longitude). One can describe any place on earth with a pair of latitude and longitude coordinates. Furthermore, the earth is typically divided into North (the northern hemisphere north of the equator) and South (the southern hemisphere south of the equator) and East (the eastern hemisphere east of the Prime Meridian) and West (the western hemisphere west of the Prime Meridian).

These coordinates are traditionally divided into degrees, minutes, and seconds. A position will typically be described in the following format: 77°04' 85.54" W (seventy seven degrees, four minutes, eighty five point five four seconds West).

Positional data from the Dexter Industries GPS is in integer decimal-degree format. Most mapping systems, like Google Maps, run on a format called "decimal degrees" where the output data looks like this: dd.mmmmmm.

Because of NXT-G 1.0's integer math limitations, the Dexter Industries GPS sensor sends and receives data in the format ddmmmmmm. Therefore data must be input into the GPS sensor in integer format (no decimals).

- Latitude is represented by an 8-digit integer. If the position is in the northern hemisphere, the number is positive. If the position is in the southern hemisphere, the latitude is negative.
- Longitude is represented by a 9-digit integer. If the position is in the eastern hemisphere, the longitude is positive. If the position is in the western hemisphere, the longitude is negative.

Traditional Format	77°04'85.54" W
Decimal Degrees Format	-77.048554
GPS Sensor Format	-77058554

Getting Started

Understanding the GPS Coordinate Systems: An Example with Google Maps

The NXT-G software can be used to constantly tell the robot where it is, how far it is from its destination, and what angle to travel to. For our example, we'll select a destination we want our robot to navigate to: the Washington Monument in Washington, DC.

1. Using Google maps (maps.google.com), we'll find the Washington Monument. Type in "Washington Monument".
2. Right-click on the monument and the option "What's Here" shows up. Click on "What's here."
3. In the search-box on the top of the page, the longitude and latitude of the point you clicked on should appear in decimal-degree format.
4. You can see the decimal-degree latitude and longitude of the Washington Memorial in the image below and to the right. The latitude is 38.889463, and the longitude is -77.03526. That makes sense because the Washington monument is in the northern hemisphere (latitude is positive), and the western hemisphere (longitude is negative).
5. Before using this as our destination, we have to multiply both numbers by 1,000,000, making them integers. The numbers we will enter into the GPS sensor will be 38889463 and -7703536.

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Startup

Starting the hardware and acquiring the signal:

The GPS unit can be connected to the NXT through any of the sensor ports.

On startup, the GPS will begin searching for GPS satellites. Depending on location and the amount of horizon visible, the GPS may take up to a minute to find a satellite signal. Acquisition time varies widely and depends on the view of the horizon, the time of day, and the number of satellites in view of your particular location. For example, if starting in a position with no obstructions and a clear view of the entire horizon, the GPS can take as little as 30 seconds to acquire a signal. However, when part or all of the view is blocked, it may take the GPS longer to acquire a signal. Before a signal is acquired, the GPS will begin sending the default location and time (121000000 E, 24000000 W) until a valid signal is locked by the sensor.

The LED on the GPS unit indicates a valid GPS signal. When a signal is acquired, the LED on the GPS sensor will turn on. If satellite signals are lost, the LED will turn off. When a signal is lost, the GPS sensor will continue to transmit the location of the last valid signal. The GPS clock will continue to operate and provide an accurate time.

After locking the initial signal, the GPS sensor can retain a valid signal with limited view of the horizon. For example, in many cases, the GPS will continue to work inside a building or in a position with less view of the horizon. Also after locking the initial signal, reacquiring a signal after it is lost can take less than 1 second.

When the sensor is disconnected or the power to the NXT is lost, the signal must be reacquired with maximum view of the horizon.

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NXT-G: GPS Read

The GPS Read block can be used to read position, time, velocity, and heading.

Positional information is read by the GPS and returned in integer format.

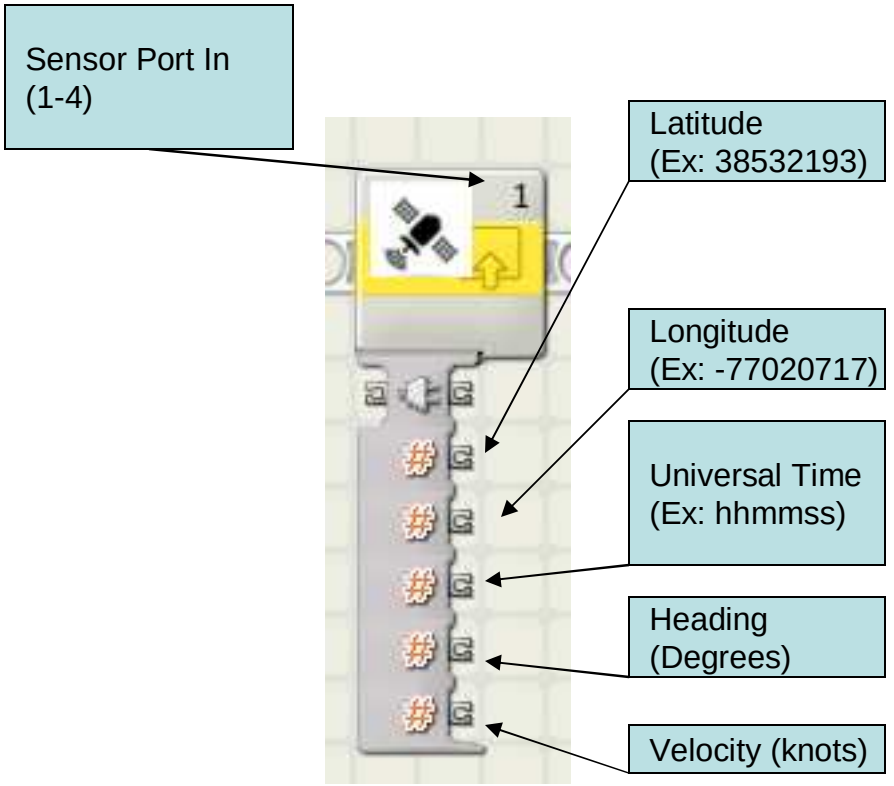
Latitude – output is integer/decimal degree format. Positive is norther hemisphere, and negative is southern hemisphere.

Longitude – Output is in integer/decimal degree format. Positive is eastern hemisphere and negative indicates western hemisphere.

Universal Time – Output is an integer and reads hhmmss. (Hour hour minute minute second second).

Heading – Integer format, is a 0 to 360 degree heading of direction. “0” is directly north, “90” is directly east, “180” is directly south, and “270” is directly west.

Velocity – Integer format in cm/s.

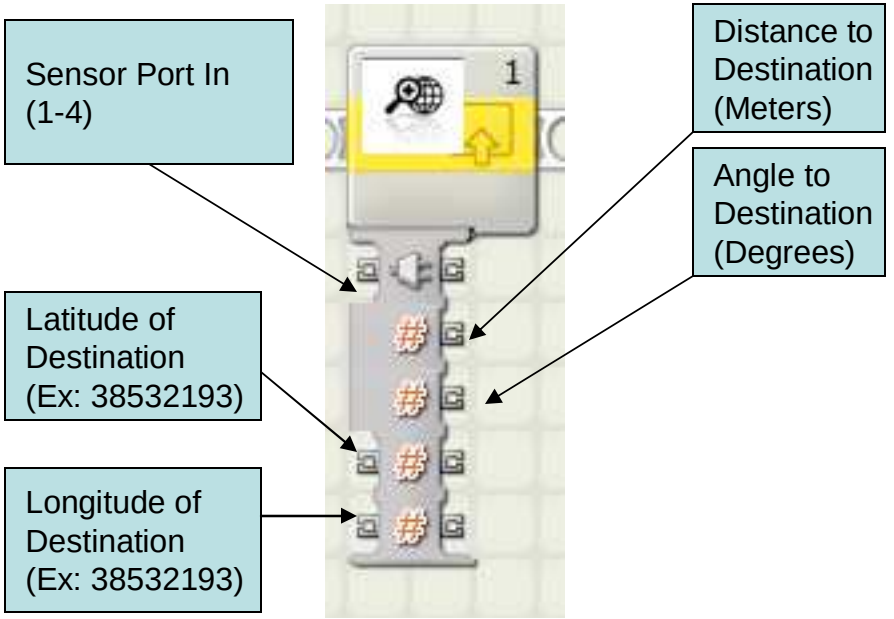


NXT-G: GPS Navigation

The GPS Navigation block can be used to navigate to a user-defined destination. The destination is defined by latitude and longitude in integer format. To get a decimal degree, one can use a program such as Google Maps (see Google Maps section).

Coordinates are entered in as integers.

The GPS sensor calculates the distance to the destination (in meters) and the angle to the destination (in degrees). The distance to destination and angle to destination is returned in integer format.



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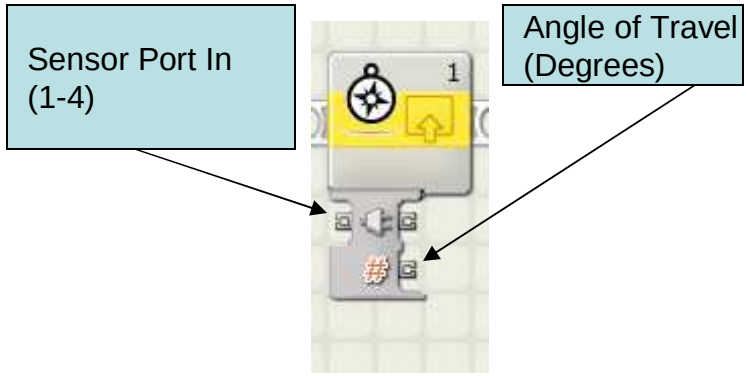
NXT-G: GPS Angle of Travel

The “Angle of Travel” is a function that reads the GPS position, and calculates the angle traveled since the function was last called. This function can serve as a more precise compass than the GPS output when used over distance. Calling the function intermittently over travel distances great than 10 feet will give a more accurate compass reading.

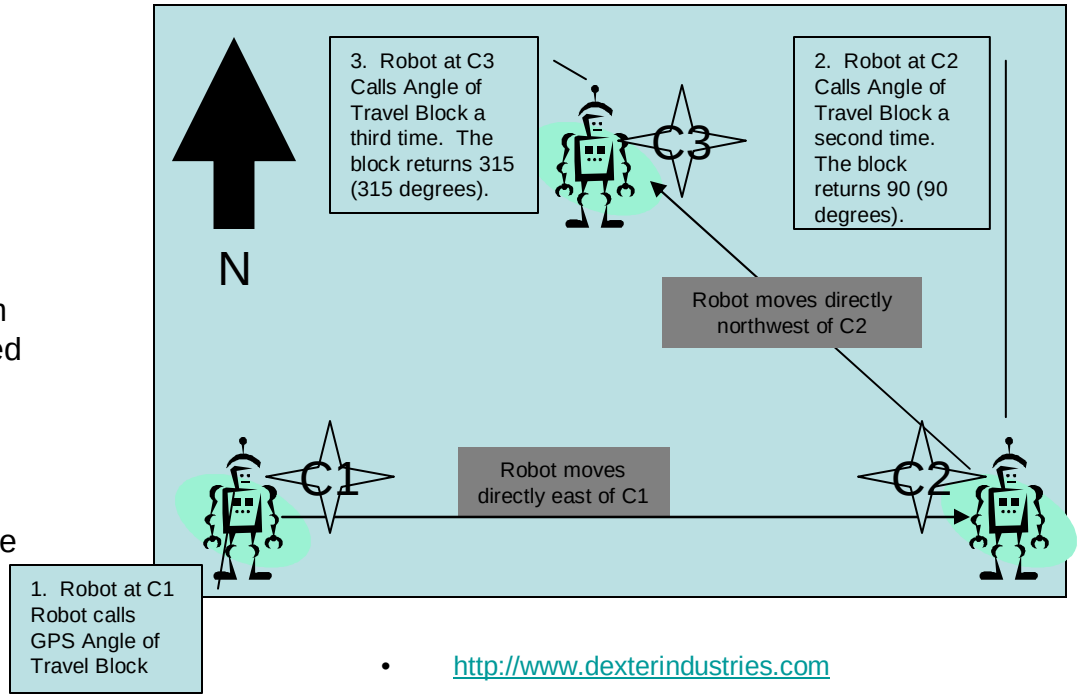


The function works as follows:

1. When the function is first called, the GPS coordinates are stored in the GPS chip. We will call the coordinates C1.

2. When the function is called a second time, the coordinates at that point are stored (we’ll call them C2) and the angle between C1 and C2 are returned through the “Angle of Travel” port.

3. When the function is called a third time, the coordinates at that point are stored (C3), and the angle between C2 and C3 are returned through the “Angle of Travel” port.



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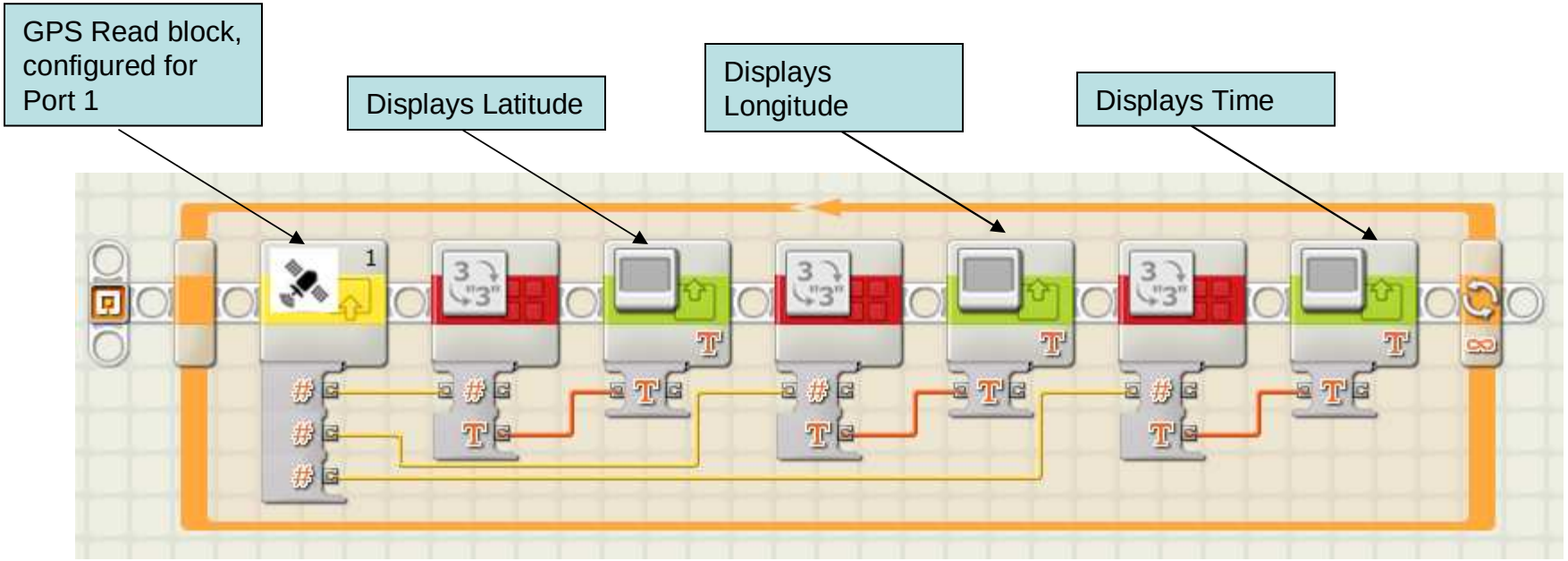
“Hello World”: a Quick Start

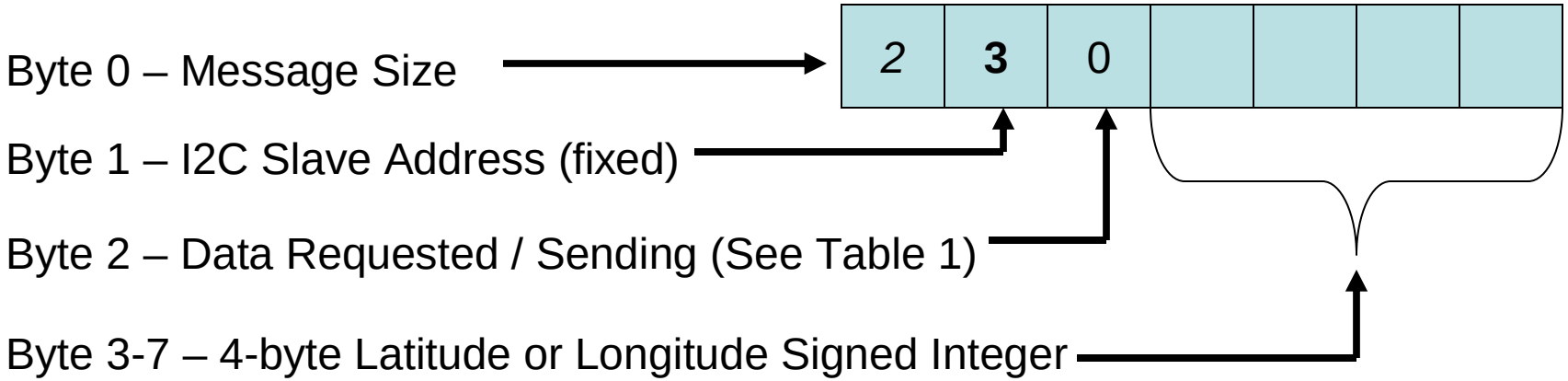
The program below shows a very basic NXT-G program using the Dexter Industries GPS Sensor. The Read GPS block is used to get the time, the latitude, and the longitude and display these values on the screen.



I2C Communications

The NXT communicates with the Dexter Industries GPS sensor via I2C. The NXT will send 7 bytes of data to the GPS. The first three bytes will signal to the GPS what type of data to send back to the NXT. The last 4 bytes are reserved for Lattitude and Longitude of a destination.

I2C communications are diagramed in the figure below. A complete list of I2C calls are tabulated on the next page.



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Data Requested / Sending	Sending Size (bytes)	Receiving Size (bytes)	NXT Sends Data	NXT Receives Data
0	3	4		Time in UTC (hhmmss)
1	3	1		Status of the GPS (0 – invalid signal, 1 – valid signal)
2	3	4		Integer latitude. (ddddddddd) (Positive = North, Negative = South)
4	3	4		Integer longitude. (ddddddddd) (Positive = East, Negative = West)
6	3	3		Velocity in cm/s
7	3	2		Heading in degrees.
8	3	4		Distance to the destination in meters.
9	3	2		Angle to destination in degrees.
10	3	2		Angle travelled since last request, resets the request coordinates on the GPS sensor, sends the angle of travel since the last time NXT called “10” back to the NXT.
11	7	0	Latitude	NXT sends 4-byte signed integer destination latitude to GPS sensor.
12	7	0	Longitude	NXT sends 4-byte signed integer destination longitude to GPS sensor.

Default:: If the GPS sensor receives any number other than those listed above under “Data Requested / Sending”, it will return time in UTC.

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FAQ

Got a question? Yell at us: info@dexterindustries.com