Texas Instruments

TI-Innovator™ Technology Guidebook

This guidebook applies to TI-Innovator™ Hub software version 1.2. To obtain the latest version of the documentation, go to *education.ti.com/go/download*.

Important Information

Learning More with the TI-Innovator™ Technology eGuide

Parts of this document refer you to the TI-Innovator™ Technology eGuide for more details. The eGuide is a Web-based source of TI-Innovator™ information, including:

- Programming with the TI CE Family of Graphing Calculators and TI-Nspire™ Technology, including sample programs.
- Available I/O Modules and their commands.
- Available breadboard components and their commands.
- Available TI-Innovator™ Rover and its commands.
- Link to update the TI-Innovator™ Sketch software.
- Free classroom activities for TI-Innovator™ Hub.

To access the eGuide, visit the Web address shown below, or use your mobile device to scan the corresponding QR Code®.

https://education.ti.com/go/eguide/hub/EN

Contents

TI-Innovator™ Technology Getting Started Guide

The TI-Innovator™ Hub is the centerpiece of the TI-Innovator™ Technology, a project kit that extends the functionality of Texas Instruments (TI) graphing calculators to make coding and engineering design accessible to students in the classroom.

Topics to help you get started include:

TI-Innovator™ Technology Overview

The TI-Innovator™ Technology consists of TI-Innovator™ Hub with TI LaunchPad™ Board, and optional TI-Innovator™ components.

The TI-Innovator™ Hub lets you use your compatible TI graphing calculator or TI-Nspire™ CX computer software to control components, read sensors, and create powerful learning experiences.

- You communicate with the Hub through TI Basic programming commands.
- Hosts that are compatible with TI-Innovator™ Hub include:
  - TI CE Family of Graphing Calculators (TI-83 Premium CE, TI-84 Plus CE, and TI-84 Plus CE-T) with operating system version 5.3 or later installed. You also need to install or update the Hub App, which contains the Hub menu.
  - TI Nspire™ CX or TI Nspire™ CX CAS handheld with operating system version 4.5 or later installed
  - TI Nspire™ computer software version 4.5 or later
- **TI-Innovator™ Hub.** Communicates with the host, the Hub on-board components, and connected external components. It also distributes power to external components.
- **TI-Innovator™ Components**. These components, sold separately, include sensors, motors, and LEDs that connect to the Hub through its I/O ports and breadboard connector.

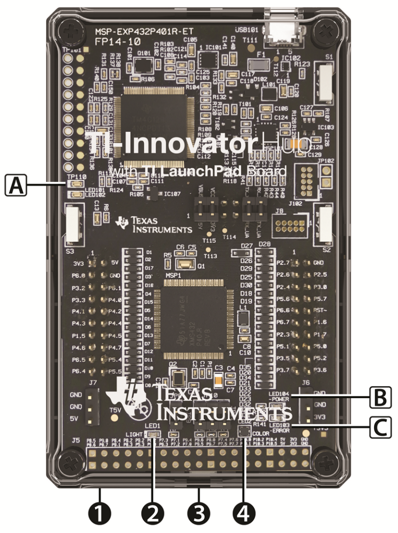
Learn More

For a list of precautions to take while using the Hub and its components, refer to *General Precautions* (page 29).

To find information on accessories, external modules, and breadboard components, visit education.ti.com/go/innovator.

What's in the Box

TI-Innovator™ Hub with On-Board Components



❶ A Light Brightness Sensor at the bottom of the Hub can be read as "BRIGHTNESS" in Hub command strings.

❷ Red LED is addressable as "LIGHT" in Hub command strings.

❸ Speaker (at back of Hub, not shown) is addressable as "SOUND" in Hub command strings.

❹ Red-Green-Blue LED is addressable as "COLOR" in Hub command strings.

Also visible on the face of the Hub are:

A Green auxiliary power LED

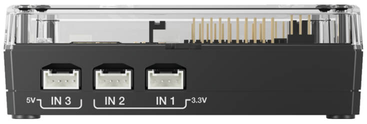
B Green power LED,

C Red error LED.

Built-in Ports

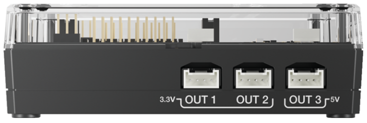
Left side - Three ports for collecting data or status from input modules:

- **IN 1** and **IN 2** provide 3.3V power.
- **IN 3** provides 5V power.



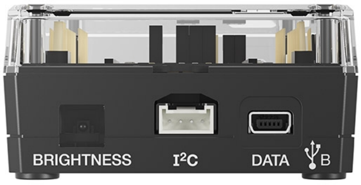
Right side - Three ports for controlling output modules:

- **OUT 1** and **OUT 2** provide 3.3V power.
- **OUT 3** provides 5V power.



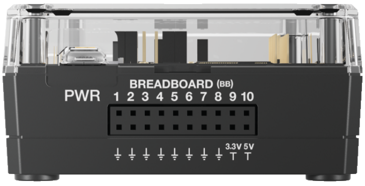
Bottom - Light Brightness Sensor (described earlier) and two ports:

- **I^{2}C** port connects to peripherals that use the I^{2}C communication protocol.
- **DATA** Mini-B port, used with the appropriate cable, connects to a compatible graphing calculator or computer for data and power.

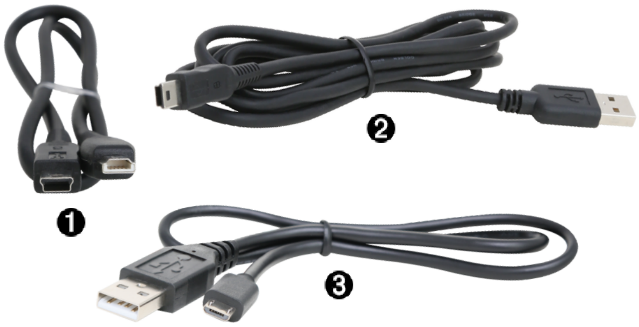


Top - Two connectors:

- USB-Micro connector (**PWR**) for auxiliary power required by some components. Also used for updating the Hub internal software.
- Breadboard Connector with 20 labeled pins for communication with connected components. A breadboard and jumper cables are included with the TI-Innovator™ Breadboard Pack, sold separately.



USB Cables



❶ USB Unit-to-Unit (Mini-A to Mini-B) - Connects the Hub to a TI CE Graphing Calculator or a TI-Nspire™ CX Handheld.

❷ USB Standard A to Mini-B - Connects the Hub to a computer running TI-Nspire™ CX Software.

❸ USB Standard A to Micro - Connects the **PWR** port of the Hub to a TI approved power source required by some peripherals.

Auxiliary Power

TI Wall Charger - Supplies power through the TI-Innovator™ Hub for components, such as motors, that require additional power.

The optional External Battery Pack can also provide auxiliary power.

Note: An auxiliary power LED on the Hub indicates when the Hub is receiving auxiliary power.

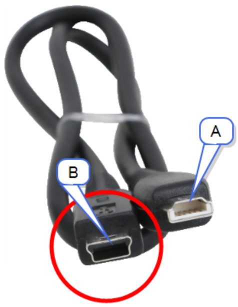
Connecting TI-Innovator™ Hub

The TI-Innovator™ Hub connects by a USB cable to a graphing calculator or computer. The connection lets the Hub receive power and exchange data with the host.

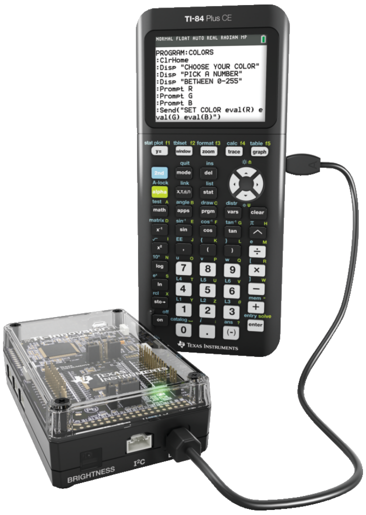
Note: Some peripherals, such as motors, may require auxiliary power. For more information, see Using an Auxiliary Power Source (page 25).

Connecting to a Graphing Calculator

1. Identify the "**B**" connector on the USB Unit-to-Unit (Mini-A to Mini-B) cable. Each end of this cable is embossed with a letter.
2. Insert the "**B**" connector into the **DATA** port at the bottom of the TI-Innovator™ Hub.

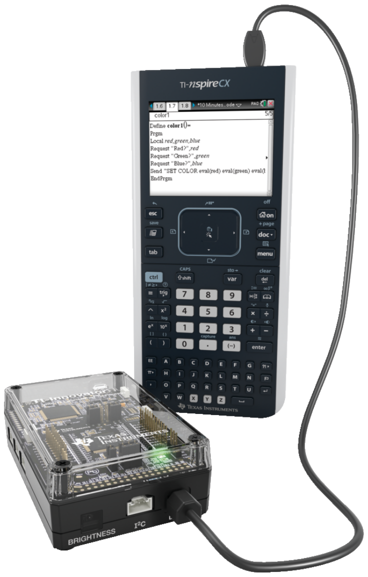


3. Insert the free end of the cable (the "**A**" connector) into the USB port on the calculator.



```
PROGRAM:COLORS
:ClrHome
:Disp "CHOOSE YOUR COLOR"
:Disp "PICK A NUMBER"
:Disp "BETWEEN 0-255"
:Prompt R
:Prompt G
:Prompt B
:Send("SET COLOR eval(R) e
val(G) eval(B)")
```

Hub connected to
TI CE Graphing Calculator



```
Define color1()=
Prgm
Local red,green,blue
Request "Red?",red
Request "Green?",green
Request "Blue?",blue
Send "SET COLOR eval(red) eval(green) eval(
EndPrgm
```

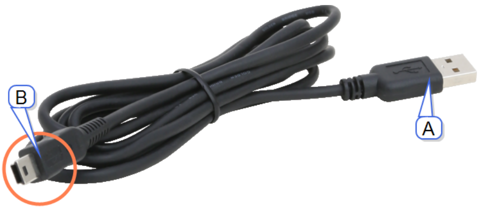
Hub connected to
TI-Nspire™ CX Handheld

4. Turn on the calculator if it is not already on.

   The power LED on the Hub glows green to show that it is receiving power.

Connecting to a Computer Running TI-Nspire™ CX Software

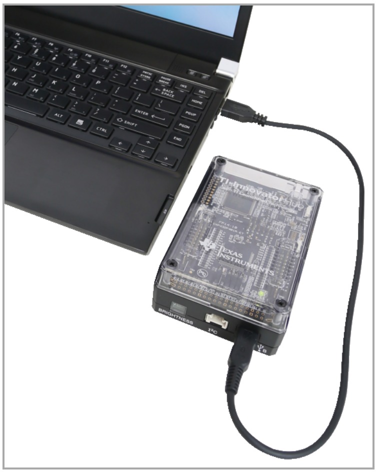
1. Identify the "**B**" connector on the USB Standard A to Mini-B cable for Windows®/Mac®. Each end of this cable is embossed with a letter.



2. Insert the "**B**" connector into the **DATA** port at the bottom of the TI-Innovator™ Hub.

3. Insert the free end of the cable (the "**A**" connector) into a USB port on the computer.

   The power LED on the Hub glows green to show that it is receiving power.



Updating the Hub Software

The TI-Innovator™ Hub contains software, TI-Innovator™ Sketch, that interprets Hub commands and communicates with on-board devices and connected modules. A Web-based tool lets you update the Sketch. Updated versions contain bug fixes and ensure that your TI-Innovator™ Hub can communicate with the latest components.

To obtain the latest version of the TI-Innovator™ Sketch go to the following site:

https://education.ti.com/en/us/hubsw

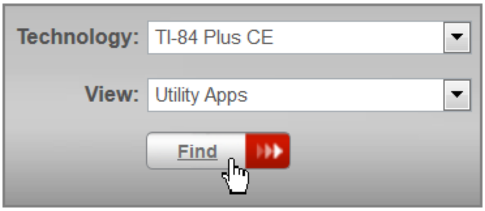
Installing the Hub App on TI CE Graphing Calculator

All TI CE Graphing Calculator running Operating System v5.2 can use TI-Innovator™ Hub commands. However, the Hub Menu for OS v5.2 resides in a separate Hub App.

To Download the App:

Note: This procedure applies only to TI CE Graphing Calculator Operating System v5.2 users who need to install or update the Hub App. To determine your calculator's OS version, press [2nd] [mem] and select **About**. To determine if the Hub App is already installed, press [2nd] [mem], select **Mem Management/Delete**, select **Apps**, and look for "**Hub**" in the list of installed Apps.

1. Make sure you have installed version 5.2 or later of the TI Connect™ CE Software on your computer. You can download and install it free of charge.
2. Use your Web browser to go to education.ti.com/go/download.
3. Select your preferred country and language.
4. On the download screen (for this example), select **TI-84 Plus CE**, select **Utility Apps**, and then click **Find**.



Technology: TI-84 Plus CE

View: Utility Apps

A list of Apps appears.

5. Click **TI-Innovator™ Hub App** to start the download process. Note the name of the download file and the folder where you save it.

To Install or Update the App:

1. Connect the calculator to the computer, using the USB Standard A to Mini-B cable.
2. Open the TI Connect™ CE software on the computer. It should recognize the calculator.
3. On the **Actions** menu, select **Add Files from Computer**. You are prompted to choose a file.
4. Navigate to the folder where you saved the App file, type ***.8ek** into the File name field, and press **enter** to show App files only.
5. Double-click the Hub App file that you downloaded.
6. On the Send to Calculator screen, Click **Send**.

Hub Programming on TI CE Graphing Calculator

Note: These instructions apply to TI CE graphing calculator. For similar instructions for TI-Nspire™ CX technology, refer to Hub Programming on TI-Nspire™ CX Technology (page 14).

The TI-Innovator™ Hub responds to TI Basic programming commands such as **Send** and **Get**.

- **Send** - Sends command strings to the Hub to control devices or request information.
- **Get** - Retrieves information requested from the Hub.
- **eval** - Supplies the result of an expression as a character string. Especially useful within the Hub command string in **Send** commands.
- **Wait** - Pauses program execution for a specified number of seconds.

Code Examples: TI CE Graphing Calculator

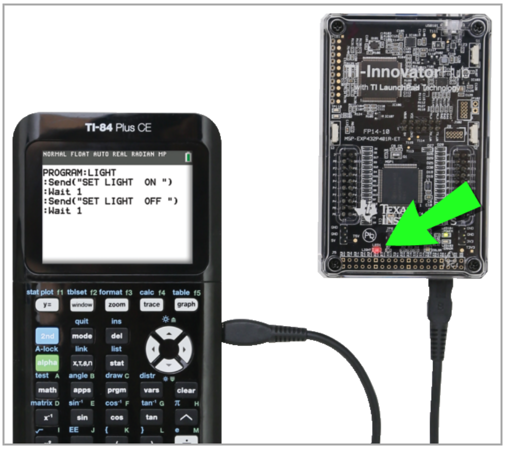
Desired Action	**Program Code**
Turn on the on-board Red LED ("LIGHT").	`Send("SET LIGHT ON")`
Play a 440Hz tone on the on-board speaker ("SOUND") for 2 seconds.	`Send("SET SOUND 440 TIME 2")`
Turn on blue element of on-board RGB LED ("COLOR") at 100% brightness.	`Send("SET COLOR.BLUE 255")`

Read and display the current value of the on-board light sensor ("BRIGHTNESS"). Range is 0% to 100%.	`Send("READ BRIGHTNESS")`
	`Get(A):Disp A`

Sample Program to Blink an On-Board LED

The following TI CE graphing calculator program uses the **Send** and **Wait** commands to blink the on-board red LED in the Hub. The commands are contained in a "For...End" loop that repeats the ON/OFF blink cycle for 10 iterations.

```
PRGM: BLINK
For(N,1,10)
Send("SET LIGHT ON")
Wait 1
Send("SET LIGHT OFF")
Wait 1
End
```



```
PROGRAM:LIGHT
:Send("SET LIGHT  ON ")
:Wait 1
:Send("SET LIGHT  OFF ")
:Wait 1
```

TI-84 Plus CE
NORMAL FLOAT AUTO REAL RADIAN MP
TI-Innovator Hub
with TI LaunchPad Technology

How to Create and Execute a Program

Note: These are abbreviated instructions. For detailed instructions on creating and executing programs, refer to *TI-Basic Programming for the TI CE Graphing Calculator*. The guide is available through the TI-Innovator™ Technology eGuide (page ii).

Before You Begin

- Refer to System Requirements (page 2), and update your calculator's OS (Operating System) and Hub App, as needed. You can update from TI Connect™ CE software or from another updated calculator.

To Create a New Program on TI CE Graphing Calculator:

1. On the Home Screen, press [prgm], select **New**, and press [enter].
2. Type a name for your program, such as "SOUNDTST," and then press [enter].

   The Program Editor opens, displaying a template for your program code.
3. Enter the lines of code that make up your program.
   - You must use the Hub Menu to enter TI-Basic commands, such as **Send** and **Get**. (Press [prgm] and select **Hub**.)
   - You can enter Hub command strinSetgs and parameters such as **"SET LIGHT ON"** by using the menu or by typing. If you type the strings, make sure to use the correct case.
   - At the end of each line, press [enter]. Each new line is automatically preceded by a colon (:).
   - Use the arrow keys to move through a program. Press [del] to delete, or press [2nd] [ins] to insert.

To Close the Program Editor

- Press [2nd] [quit] to return to the Home Screen.

The program remains available through the prgm key.

To Run the Program:

1. Ensure that the TI-Innovator™ Hub is connected to your calculator.
2. Ensure that any needed I/O Modules or Breadboard components are connected to the Hub.
3. From the Home Screen, press prgm, select your program name from the displayed list, and press enter.

   The program name is pasted to the Home Screen.
4. Press enter again to run the program.

To Edit an Existing Program:

1. On the Home Screen, press prgm, select **Edit**.
2. Select the program name from the displayed list, and press enter.

   The program opens in the Program Editor.

Using the Hub Menu to Build Commands

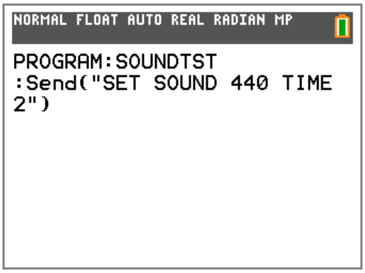
The Hub menu is available on the TI CE graphing calculator anytime you are creating or editing a program. It can save you time building commands and help you with correct command spelling and syntax.

Note: To build a command from the Hub menu, you need to know:

- The unique name of the component that you are addressing, such as "SOUND" for the on-board speaker.
- The command parameters that apply to the component, such as sound frequency and duration. Some parameters are optional, and you might need to know the value range of a parameter.

Example of Using the Hub Menu:

This TI CE graphing calculator example builds the command **Send ("SET SOUND 440 TIME 2")** to sound a 440Hz tone for 2 seconds on the on-board speaker.



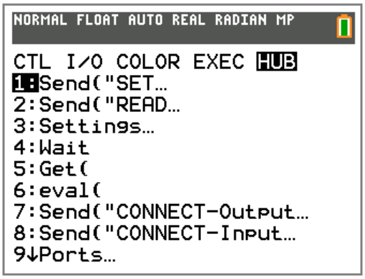
```
PROGRAM:SOUNDTST
:Send("SET SOUND 440 TIME
2")
```

1. Open (or create) the program that you will use to communicate with the Hub.

2. Position the cursor where you want to place the command.

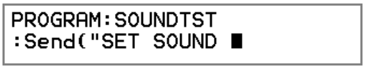
3. Press prgm and select **Hub**.

   The Hub menu appears.



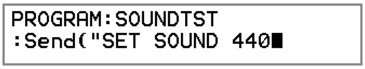
```
NORMAL FLOAT AUTO REAL RADIAN MP
CTL I/O COLOR EXEC HUB
1:Send("SET…
2:Send("READ…
3:Settings…
4:Wait
5:Get(
6:eval(
7:Send("CONNECT-Output…
8:Send("CONNECT-Input…
9↓Ports…
```

4. Select **Send "SET** and press enter, and then select **SOUND** and press enter.



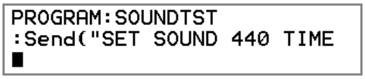
```
PROGRAM:SOUNDTST
:Send("SET SOUND ■
```

5. Type **440** as the sound frequency.



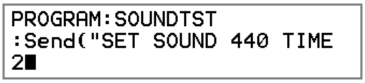
```
PROGRAM:SOUNDTST
:Send("SET SOUND 440■
```

6. On the Hub menu, select **Settings > TIME**.



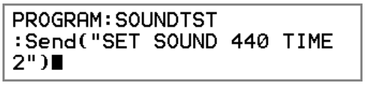
```
PROGRAM:SOUNDTST
:Send("SET SOUND 440 TIME
■
```

7. Type **2** as the TIME value.



```
PROGRAM:SOUNDTST
:Send("SET SOUND 440 TIME
2■
```

8. To complete the command, type closing quotes (press alpha +), and then press).



```
PROGRAM:SOUNDTST
:Send("SET SOUND 440 TIME
2")■
```

9. To return to the Home Screen and test the command, press 2nd [quit] and then follow the previous instructions for running a program.

Tips for Coding with TI CE Graphing Calculator

- Make sure your code is free of unnecessary spaces that can cause syntax errors. This includes repeated spaces within the line and one or more spaces at the end of a line.
- Code from an external source might show "curly" quotation marks (“...”) in places that require straight quotes ("..."). To type straight quotes, press alpha and then +.
- To clear the current line of code, press clear.
- To type relational operators such as =, <, and ≤, press 2nd [test].
- To type a space, press alpha and then 0.
- If your program becomes unresponsive while running, press the on key.
- **Note**: If a command syntax does not include an opening left parenthesis, such as **"Wait "**, using a pair of parentheses in an argument may be interpreted as the full argument and give an unexpected syntax error. When entering long expressions with parentheses, enclose the entire expression with paired parentheses to avoid syntax errors of this nature.

```
Valid: Wait ((X+4)*5)
Valid: Wait X+4*5
Syntax Error: Wait (X+4)*5
```

Learn More

To find sample programs and details about programming the TI-Innovator™ Hub, see the TI-Innovator™ Technology eGuide (page ii).

Hub Programming on TI-Nspire™ CX Technology

Note: These instructions apply to TI-Nspire™ CX technology. For similar instructions for TI CE graphing calculator, refer to Hub Programming on TI CE Graphing Calculator (page 9).

The TI-Innovator™ Hub responds to TI Basic programming commands such as **Send** and **Get**.

- **Send** - Sends command strings to the Hub to control devices or request information.
- **Get** and **GetStr** - Retrieve information requested from the Hub.
- **eval()** - Supplies the result of an expression as a character string. Valid only within **Send**, **Get**, and **GetStr** commands.
- **Wait** - Pauses program execution for a specified number of seconds.

Code Examples: TI-Nspire™ CX Technology

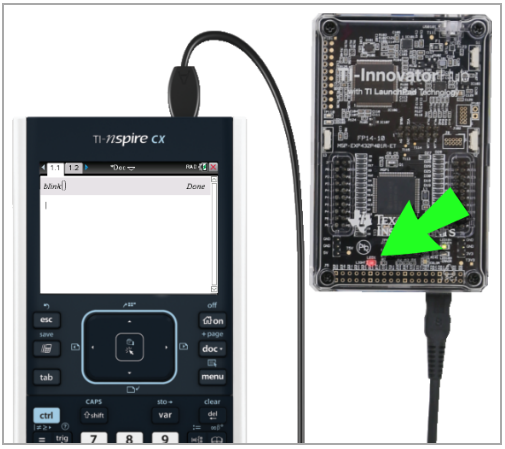
Desired Action	Program Code
Turn on the on-board Red LED ("LIGHT").	`Send "SET LIGHT ON"`
Play a 440Hz tone on the on-board speaker ("SOUND") for 2 seconds.	`Send "SET SOUND 440 TIME 2"`
Turn on blue element of on-board RGB LED ("COLOR") at 100% brightness.	`Send "SET COLOR.BLUE 255"`

Read and display the current value of the on-board light sensor ("BRIGHTNESS"). Range is 0% to 100%.	`Send "READ BRIGHTNESS"`
	`Get a: Disp a`

Sample Program to Blink an On-Board LED

The following TI-Nspire™ CX program uses the **Send** and **Wait** commands to blink the on-board red LED in the Hub. The commands are contained in a "For...EndFor" loop that repeats the ON/OFF blink cycle for 10 iterations.

```
Define blink()=
Prgm
For n,1,10
  Send "SET LIGHT ON"
  Wait 1
  Send "SET LIGHT OFF"
  Wait 1
EndFor
EndPrgm
```



How to Create and Execute a Program

Note: These are abbreviated instructions. For detailed instructions, refer to the *TI-Nspire™ CX Program Editor*, accessible through the TI-Innovator™ Technology eGuide (page ii).

Before You Begin:

- Refer to System Requirements (page 2), and update your software as needed.
  - On TI-Nspire™ CX handhelds, use TI-Nspire™ computer software to update the Operating System.
  - On computers running TI-Nspire™ CX software, use the Help menu to update the software.

To Create a New Program in a TI-Nspire CX Document:

1. On the handheld, press doc▾ and select **Insert > Program Editor > New**.
   From the computer software, click **Insert > Program Editor > New**.
2. Type a name for your program, such as "soundtst," select **Program** as the Type, and then click **OK**.

   The Program Editor opens, displaying a template for your program code.
3. Between the **Prgm** and **EndPrgm** lines, type the lines of code that make up your program.
   - You can either type command names or insert them from the Program Editor menu.
   - After typing each line, press **Enter** to type additional code.
   - Use the arrow keys to scroll through the program.

To Store the Program:

You must store your program before you can run it.

▶ On the handheld, press menu and select **Check Syntax & Store > Check Syntax & Store**.
On the Program Editor menu, click **Check Syntax & Store > Check Syntax & Store**.

To Close the Program Editor

▶ On the handheld, press menu and select **Actions > Close**.
On the Program Editor menu, click **Actions > Close**.

If you have made changes since storing the program, you are prompted to Check Syntax & Store.

To Run the Program:

1. Ensure that the TI-Innovator™ Hub is connected to your handheld or computer.
2. Ensure that any needed I/O Modules or Breadboard components are connected to the Hub.
3. Open the document that contains the program.
4. On a Calculator page, type the program name and parentheses. If the program requires arguments, enclose them in the parentheses, separated by commas.

   The program runs.

To Edit an Existing Program:

1. If necessary, open the document that contains the program.
2. Go to a Calculator page.
3. On the handheld, press menu and select **Functions & Programs > Program Editor > Open**.
   On the Calculator menu, click **Functions & Programs > Program Editor > Open**.
4. Select the program name name from the displayed list.

   The program appears in a Program Editor page.

Using the Hub Menu to Build Commands

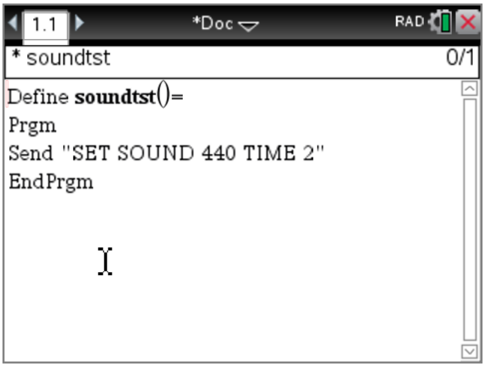
The Hub menu is available on the TI-Nspire™ CX technology anytime you are creating or editing a program. It can save you time building commands and help you with correct command spelling and syntax.

Note: To build a command from the Hub menu, you need to know:

- The unique name of the component that you are addressing, such as "SOUND" for the on-board speaker.
- The command parameters that apply to the component, such as sound frequency and duration. Some parameters are optional, and you might need to know the value range of a parameter.

Example of Using the Hub Menu:

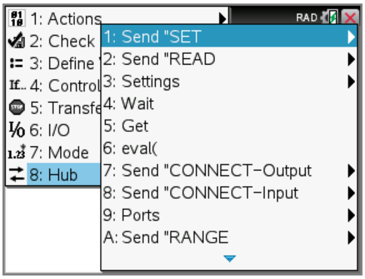
This TI-Nspire™ CX example builds the command **Send "SET SOUND 440 TIME 2"** to sound a 440Hz tone for 2 seconds on the on-board speaker.



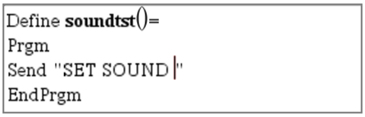
```
Define soundtst()=
Prgm
Send "SET SOUND 440 TIME 2"
EndPrgm
```

1. Open (or create) the program that you will use to communicate with the Hub.
2. Position the cursor where you want to place the command.
3. On the handheld, press menu and select **Hub**.
   In the Program Editor menu, select **Hub**.

   The Hub menu appears.

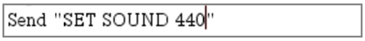


4. Select **Send "SET**, and then select **SOUND** to insert the first part of the command.



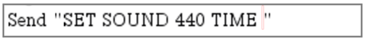
```
Define soundtst()=
Prgm
Send "SET SOUND "
EndPrgm
```

5. Type **440** as the frequency value.



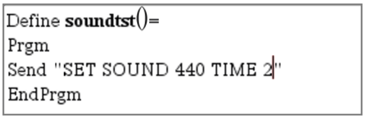
```
Send "SET SOUND 440"
```

6. On the Hub menu, select **Settings > TIME**.



```
Send "SET SOUND 440 TIME "
```

7. To complete the command, Type **2** as the TIME value.



```
Define soundtst()=
Prgm
Send "SET SOUND 440 TIME 2"
EndPrgm
```

8. To test the command, follow the previous instructions for running a program.

Tips for Coding with TI-Nspire™ CX Technology

- Code from an external source might contain "curly" quotation marks (“...”) in places that require straight quotes ("..."). To type straight quotes, press ctrl ×.
- To clear the current line of code, press ctrl clear.
- To type relational operators such as =, <, and ≤, press ctrl =.
- To type a space, press ␣.
- If your program becomes unresponsive while running:

  TI-Nspire™ CX Handheld: Hold down the on key and press enter repeatedly.
  Windows®: Hold down the **F12** key and press **Enter** repeatedly.
  Mac®: Hold down the **F5** key and press **Enter** repeatedly.

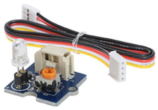
Learn More

To find sample programs and details about programming the TI-Innovator™ Hub, see the TI-Innovator™ Technology eGuide (page ii).

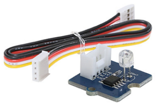
TI-Innovator™ I/O Modules

These Input/Output modules (purchased separately) include cables for connecting the modules to the TI-Innovator™ Hub.

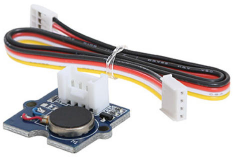
Module	Ports	Image	Sample code for TI CE Graphing Calculator

White LED *	OUT 1 OUT 2 OUT 3		Turn on the White LED module connected to **OUT 1**:
			`Send("CONNECT LED 1 TO OUT 1")`
			`Send("SET LED 1 ON")`

Servo Motor **	OUT 3		Rotate the shaft of the Servo Motor connected to **OUT 3** counter clockwise by 90°:
			`Send("CONNECT SERVO 1 TO OUT 3")`
			`Send("SET SERVO 1 TO -90")`
			Equivalent code using a variable with **eval()**:
			`angdeg:=-90`
			`Send("CONNECT SERVO 1 TO OUT 3")`
			`Send("SET SERVO 1 TO eval(angdeg)")`

Analog Light Sensor	IN 1 IN 2 IN 3		Read and display ambient light level from the sensor connected to **IN 2**:
			`Send("CONNECT LIGHTLEVEL 1 TO IN2")`
			`Send("READ LIGHTLEVEL 1")`
			`Get(L):Disp(L)`

Ultrasonic Ranger	IN 1 IN 2		Read and display measured distance from the ranger connected to **IN 2**:
			`Send("CONNECT RANGER 1 TO IN2")`
			`Send("READ RANGER 1")`
			`Get(R):Disp(R)`

Vibration Motor	OUT 1 OUT 2 OUT 3		Turn on the Vibration Motor connected to **OUT 1**:
			`Send("CONNECT VIB.MOTOR 1 TO OUT 1")`
			`Send("SET VIB.MOTOR 1 TO ON")`

*The White Led module requires some assembly.

**The Servo Motor requires auxiliary power and some assembly. For details, refer to the TI-Innovator™ Technology eGuide (page ii).

Connecting an I/O Module

You use the I/O cable included with the module to connect it to a Hub Input or Output port.

1. Check the above table to ensure that you know which I/O ports support the module that you are connecting.
2. Connect either end of the I/O cable to the white connector on the module.
3. Connect the free end of the I/O cable to the Hub port you have decided to use.
4. If the module requires auxiliary power, connect the power source (page 25),

Sample Program to Blink an LED Module

The following TI CE graphing calculator program uses **Send** and **Wait** commands to blink an LED module connected to an I/O port.

Note: This program operates correctly only if the calculator is connected to the Hub and an LED module is physically connected to port **OUT 1**.

```
PRGM: BLINKIO
Send("CONNECT LED 1 TO
OUT1")
For(N,1,10)
Send("SET LED 1 ON")
Wait 1
Send("SET LED 1 OFF")
Wait 1
End
Send("DISCONNECT LED 1")
```

Note: If you are using TI-Nspire™ CX technology, omit the parentheses, and change **`End`** to **`EndFor`**.

The Hub command string "CONNECT LED 1 TO OUT1" tells the Hub that an LED module is connected to port **OUT 1** on the Hub. After sending this command, the code can address the LED as "LED 1." The CONNECT command is required only for I/O Modules and Breadboard components. It is not necessary with the on-board components such as the built-in speaker.

Learn More

For a list of precautions to take while using the I/O Modules, refer to *General Precautions* (page 29).

To find sample programs, a list of additional I/O Modules, and details about programming I/O Modules, see the TI-Innovator™ Technology eGuide (page ii).

TI-Innovator™ Breadboard Pack

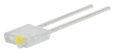
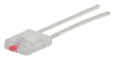
The breadboard and its components (purchased separately) let you build breadboard projects and connect them to the TI-Innovator™ Hub through its Breadboard Connector pins.

The breadboard components include:

- A breadboard and jumper cables for creating electrical connections.
- Addressable components, such as LEDs and sensors, that respond to Hub commands. These are listed in the table below.
- Passive components, such as resistors, capacitors, and manual switches that are not directly addressable by the Hub but are required in many breadboard projects.
- A Battery Holder that holds four AA batteries. Batteries are not included.

Addressable Components

Component	Image	Used with pins	Description
Red LEDs		BB 1-10	Light-emitting diode that emits light when current passes through it.
Green LEDs		BB 1-10	Light-emitting diode that emits light when current passes through it.
RGB (Red-Green-Blue) LEDs		BB 8-10	Light-emitting diode with independently adjustable red, green and blue elements. Can produce a wide variety of colors.
Thermistor		BB 5,6,7 (analog input required)	Resistor whose resistance changes based on temperature. Used for measurement and control.
7-segment Display		BB 1-10	Array of LEDs arranged to display numbers and some alphabetic characters. Also has an LED for a decimal point.
Small DC Motor		BB 1-10 (uses digital to generate software PWM)	Motor that converts direct current electrical power into mechanical power.

TTL Power MOSFET		BB 1-10	Transistor used for amplifying or switching electronic signals.
TI Analog Temperature Sensor		BB 5,6,7 (analog input required)	Sensor that reports a voltage proportional to the ambient temperature within a range of −55°C to 130°C.
Visible Light Sensor		BB 5,6,7 (analog input required)	Sensor that reports the level of ambient light.
Infrared Transmitter LTE-302, yellow dot		BB 1-10 (digital output)	Side emitting Infrared LED, designed to be paired with the LTR-301 Photo-Transistor.
Infrared Receiver LTR-301, red dot		BB 1-10 (digital input)	Side sensing Infrared photo transistor, designed to be paired with the LTE-302 Infrared Emitter.

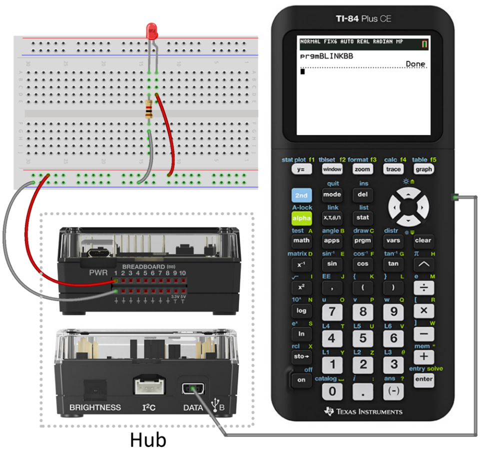
Sample Code to Blink a Breadboard LED

The following TI CE graphing calculator(s) program uses **Send** and **Wait** commands to blink a specific LED on the breadboard.

Note: This program operates correctly only if the calculator is connected to the Hub and the LED is physically connected to **BB1** (breadboard pin 1) on the Hub.

```
PRGM: BLINKBB
Send("CONNECT LED 1 TO BB1")
For(N,1,10)
Send("SET LED 1 ON")
Wait 1
Send("SET LED 1 OFF")
Wait 1
End
Send("DISCONNECT LED 1")
```

Note: If you are using TI-Nspire™ CX technology, omit the parentheses, and change **`End`** to **`EndFor`**.



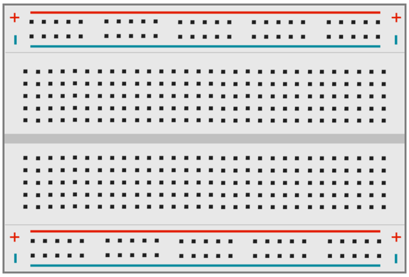
The Hub command string "CONNECT LED 1 TO BB1" tells the Hub that an LED on the breadboard is connected to pin **1** on the Hub. After sending this command, your code can address the LED as "LED 1." The CONNECT command is required only for I/O Modules and breadboard components. It does not apply to on-board components such as the built-in speaker.

Breadboard Basics

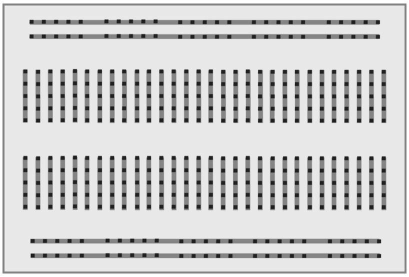
The breadboard makes it easy to connect the electronic components of a project by inserting component leads and jumper cables into pins on the breadboard.

The pins are arranged in groups of 5. The 5 pins in each group are electrically connected to each other at the back of the board. You connect leads and cables together by inserting them into pins within the same group.

- Power rails at the top and bottom are marked with red (+) and blue (–) stripes. The groups in each rail are electrically connected along the entire length of the stripe.
- The remaining 5-pin groups on the board are labeled with numbers and letters. Each group is electrically isolated from the others.



Front of board showing power rails and connection pins



Interconnections at back of board (normally hidden). The 5-pin groups in each power rail are interconnected. All other 5-pin groups are isolated.

The gap at the center of the breadboard allows easy connection of electronic components provided as dual-inline packages.

You use jumper cables between the Hub and the breadboard to power breadboard components and to control or monitor them through program code. The Hub has 20 labeled pins, including 10 signal pins, 8 ground pins, one 3.3V power pin, and one 5.0V power pin.

Learn More

For a list of precautions to take while using the breadboard and its components, refer to *General Precautions* (page 29).

To find sample programs and details about programming breadboard components on the TI-Innovator™ Hub, see the TI-Innovator™ Technology eGuide (page ii).

Using an Auxiliary Power Source

Normally, the TI-Innovator™ Hub and its connected components draw power from the host calculator or computer, through the **DATA** connector. Certain components, such as the optional Servo Motor, require more power than a calculator can provide reliably.

The **PWR** connector on the Hub lets you connect an auxiliary power source. You can use the TI Wall Charger or the External Battery Pack.

TI Wall Charger (included with the Hub)

- Plugs into a wall outlet.
- Does not use batteries.

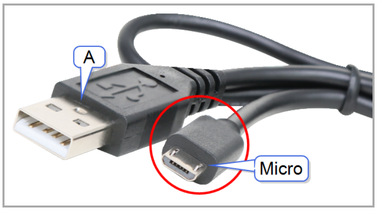
External Battery Pack (sold separately)

- Rechargeable.
- Has On/Off button with a row of LEDs that momentarily indicate the battery charge when you turn the battery on.
- Turns itself off after being disconnected from the Hub for about 3 minutes.

Note: To recharge the External Battery Pack, disconnect it from the Hub and then connect it to the TI Wall Charger using the USB Standard A to Micro cable. Do not use the External Battery Pack as an auxiliary power source while it is being charged.

Connecting the Power Source

1. Identify the Micro connector on the USB Standard A to Micro auxiliary power cable.
2. Insert the Micro connector into the **PWR** connector at the top of the Hub.



3. Insert the free end of the cable (the "**A**" connector) into the USB port on the power source.
4. Turn on the power source:
   - If using the TI Wall Charger, plug it into a wall socket.
   - If using the External Battery Pack, press the power button.

   An auxiliary power LED on the Hub glows to show that the Hub is receiving auxiliary power.
5. Connect the TI-Innovator™ Hub to the host calculator, using the USB Standard A to Mini-B cable.
6. Connect the I/O Module or breadboard component to the Hub.

Troubleshooting

I don't see the green LED when I connect TI-Innovator™ Hub.

- Make sure that the calculator is turned on.
- If you are using a USB Unit-to-Unit (Mini-A to Mini-B) cable to connect to a calculator, make sure to connect the "B" end of the cable to the **DATA** connector at the bottom of the Hub. Reversing this cable prevents the Hub from receiving power.
- Make sure your calculator or computer meets the System Requirements (page 2).
- Make sure the end of the USB cable connected to the calculator is inserted completely.

How do I turn the Hub off?

1. Turn off the host calculator or computer.
   – OR –
   Disconnect the USB cable.
2. Disconnect any auxiliary power source connected to the **PWR** port on the Hub.

Why does my program give me a syntax error?

- If you have pasted code from an external source or text editor, it might contain "curly" quotation marks (“...”) in places that require straight quotes ("..."). You may need to replace some or all of the curly quotes.
- The syntax rules are slightly different between the TI CE graphing calculator and TI-Nspire™ CX technology. Code originally created for one platform may need to be modified to work on the other.
- On the TI CE graphing calculator, make sure you don't have a space character at the end of a line of code. To find these trailing spaces in a line, move the cursor to the line and press [2nd] [▸]. Adjacent spaces in code can also cause a syntax error.

How do I stop a program that becomes unresponsive?

- TI CE graphing calculator: Press the [on] key.
- TI-Nspire™ CX Handheld: Hold down the [⌂on] key and press [enter] repeatedly.
- Windows®: Hold down the **F12** key and press **Enter** repeatedly.
- Mac®: Hold down the **F5** key and press **Enter** repeatedly.

Why do I get an error when I try to update the TI-Innovator™ Sketch?

- For sketch updating, make sure you are using the USB Standard A to Micro cable, not the USB Standard A to Mini-B cable. Connect the micro end of the cable to the **PWR** connector at the top of the Hub.
- Make sure you are using one of the Web browsers required for updating. See Updating the Hub Software (page 7).

Learn More

To find more troubleshooting information, see the TI-Innovator™ Technology eGuide (page ii).

General Precautions

TI-Innovator™ Hub

- Do not expose the Hub to temperatures above 140˚F (60˚C).
- Do not disassemble or mistreat the Hub.
- Do not chain together multiple Hubs through the I/O ports or the Breadboard Connector.
- Use only the USB cables provided with the Hub.
- Use only the TI provided power supplies:
  - TI Wall Charger included with the TI-Innovator™ Hub
  - Optional External Battery Pack
  - 4AA battery holder included in the TI-Innovator™ Breadboard Pack
- Ensure that the components receiving power from the Hub do not exceed the Hub's 1-amp power limit.
- Avoid using the Hub to control AC electricity.

Breadboard Connector on the Hub

- Do not insert the leads of LEDs and other components directly into the Hub’s Breadboard Connector. Assemble the components on the breadboard and use the provided jumper cables to connect the breadboard to the Hub.
- Do not connect the 5V receptacle pin on the Hub's Breadboard Connector to any of the other pins, especially the ground pins. Doing so could damage the Hub.
- Connecting the top row of receptacle pins (BB1-10) to the bottom row (grounding and power pins) is not recommended.
- No pin on the Hub's Breadboard Connector can sink or source greater than 4 mA.

Breadboard

- Do not connect the positive and negative leads of a power source to the same group of 5 pins on the breadboard. Doing so could damage the breadboard and the power source.
- Observe the correct polarity:
  - When connecting the breadboard to the Hub.
  - When connecting components that are sensitive to polarity, such as LEDS and the TTL Power MOSFET.

I/O Modules

- Use the correct Input or Output port as required for each module.
  - Vibration Motor – supported on **OUT 1**, **OUT 2**, and **OUT 3**.
  - Servo Motor – use **OUT 3** only.
  - White LED – supported on **OUT 1**, **OUT 2**, and **OUT 3**.
  - Analog Light Sensor – supported on **IN 1**, **In 2**, and **IN 3**.
  - Ultrasonic Ranger – supported on **IN 1**, **IN 2**.

- Use an Auxiliary Power Source for modules that require more than 50 mA, including:
  - Vibration Motor
  - Servo Motor
- Do not hold the Servo Motor’s shaft while it is rotating. Also, do not rotate the Servo Motor by hand.
- White LED:
  - Do not bend the leads repeatedly; this will weaken the wires and may cause them to break.
  - The LED requires the correct polarity when inserted into its socket. For details, refer to the instructions for assembling the LED in the TI-Innovator™ Technology eGuide (page ii).
  - The LED requires the correct polarity when inserted into its socket. For details, refer to the instructions for assembling the LED (page 63).
- No I/O module can sink or source greater than 4 mA.

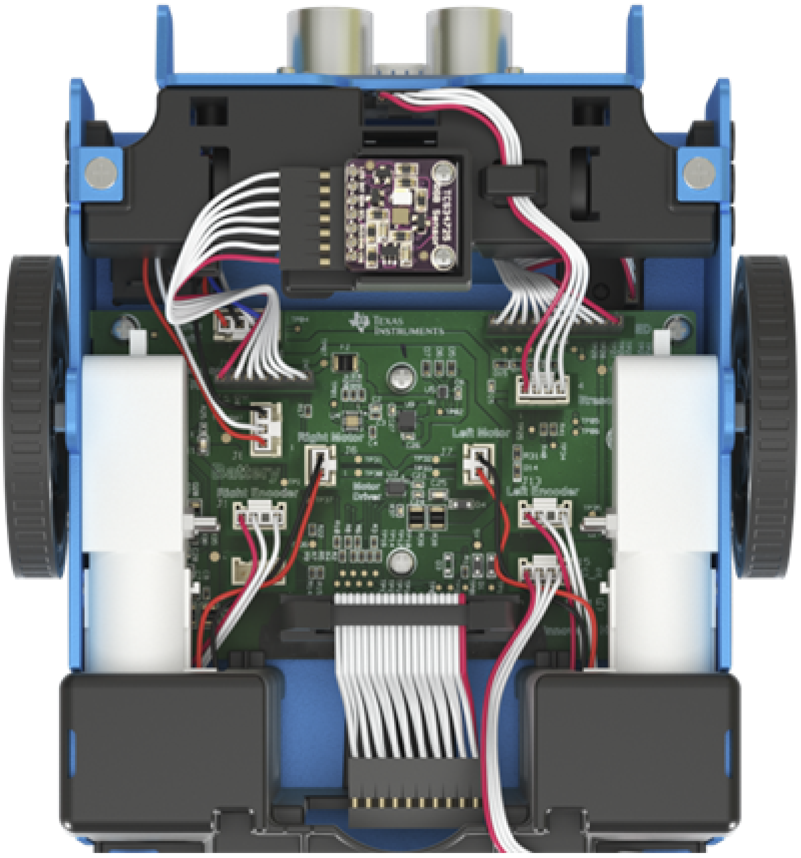
TI-Innovator™ Rover

- Do not expose the Rover to temperatures above 140˚F (60˚C).
- Do not disassemble or mistreat the Rover.
- Do not put anything heavier than 1 Kg or 2.2 lbs on the Rover platform.
- Use only the USB cables provided with the TI-Innovator™ Hub.
- Use only the Ribbon cables provided with the Rover.
- Use only the TI provided wall charger included with the Hub.
- The front-mounted Ultrasonic Ranger will detect objects within 4 meters of the Rover. For best results make sure the object's surface is bigger than a folder. If used to detect small objects, such as a cup, place the Rover within 1 meter of the object.
- For best results, leave the Slide Case off of your graphing calculator.
- For best performance, use Rover on the floor, not on tables. Damage may occur from Rover falling off a table.
- For best performance, use Rover on a hard surface. Carpet may cause the Rover wheels to catch or drag.
- Do not turn the Holder pegs on the Calculator Platform without lifting them first. They could break.
- When securing a marker in the Marker Holder avoid over-tightening the screw.
- Do not use the marker as a lever to pull or push the Rover.
- Do not unscrew the case enclosure on the bottom of the Rover. Encoders have sharp edges that should not be exposed.
- Do not move Rover after executing a program. The internal gyroscope may unintentionally try to get the Rover back on track using the initial location.

- When inserting the Breadboard Ribbon Cable into the Hub Breadboard Connector, it is critical that you insert the cable correctly. Make sure the red (dark) wire pin is inserted into the 5v hole on the Hub's Breadboard Connector.

Caution: If you dislodge or disconnect any of the cables, use this image as a reference for correct hookups.

Reference to Bottom View



TI-Innovator™ Hub Commands version 1.2

Use the Hub menus to create or edit a program. They can save you time building commands and help you with correct command spelling and syntax.

When you see "**Code Sample**" in a command table, this "**Code Sample**" may be copied and pasted *as is* to send to your graphing calculator to use in your calculations.

Example:

Code Sample:	`Send("RV FORWARD")`
	`Send("RV FORWARD SPEED 0.2 M/S TIME 10")`

Note: To build a command from the Hub menu, you need to know:

- The unique name of the component that you are addressing, such as "SOUND" for the on-board speaker.
- The command parameters that apply to the component, such as sound frequency and duration. Some parameters are optional, and you might need to know the value range of a parameter.

Understanding Syntax

- Capitalized words are keywords
- Lower case words are placeholders for numbers
- Commands within brackets are optional parameters

For example in: SET LIGHT ON [[BLINK|TOGGLE] frequency] [[TIME] seconds], "frequency" is entered as "**1**" and "seconds" is entered as "**10**".

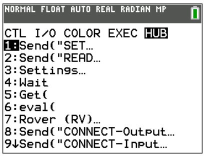
```
Send("SET LIGHT 1 BLINK 2 TIME 10")
```

NOTE: The commands listed below are for the TI-84 Plus CE Hub Menu. If you are using TI-Nspire™ CX technology the parentheses are omitted. In addition, you will notice some other minor differences in the commands such as "**Endfor**" instead of "**End**" with the TI-Nspire™ CX technology. Screenshots are provided for reference.

HUB Menus

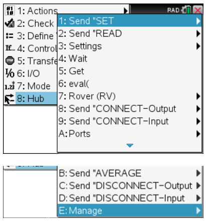
- Send("SET...
- Send("READ...
- Settings
- Wait
- Get(
- eval(
- Rover (RV) ...

TI-84 Plus CE



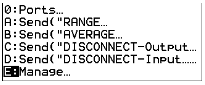
```
NORMAL FLOAT AUTO REAL RADIAN MP
CTL I/O COLOR EXEC HUB
1:Send("SET…
2:Send("READ…
3:Settings…
4:Wait
5:Get(
6:eval(
7:Rover (RV)…
8:Send("CONNECT-Output…
9↓Send("CONNECT-Input…
```

TI-Nspire™ CX



```
1: Actions      1: Send "SET
2: Check        2: Send "READ
3: Define       3: Settings
4: Control      4: Wait
5: Transfer     5: Get
6: I/O          6: eval(
7: Mode         7: Rover (RV)
8: Hub          8: Send "CONNECT-Output
                9: Send "CONNECT-Input
                A: Ports
                B: Send "AVERAGE
                C: Send "DISCONNECT-Output
                D: Send "DISCONNECT-Input
                E: Manage
```

- Send("CONNECT-Output...
- Send("CONNECT-Input...
- Ports...
- Send("RANGE...
- Send("AVERAGE...
- Send("DISCONNECT-Output...
- Send("DISCONNECT-Input...
- Manage...



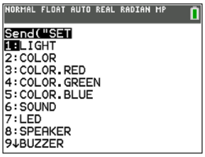
```
0:Ports…
A:Send("RANGE…
B:Send("AVERAGE…
C:Send("DISCONNECT-Output…
D:Send("DISCONNECT-Input……
E:Manage…
```

Send("SET...

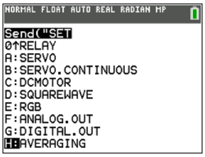
- SET
  - LIGHT
  - COLOR
  - COLOR.RED
  - COLOR.GREEN
  - COLOR.BLUE
  - SOUND
  - LED
  - SPEAKER
  - BUZZER
  - RELAY
  - SERVO
  - SERVO.CONTINOUS
  - DCMOTOR
  - VIB.MOTOR
  - SQUAREWARE
  - RGB
  - ANALOG.OUT
  - DIGITAL.OUT
  - AVERAGING

Additional **Set** Commands

TI-84 Plus CE

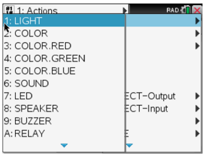


```
NORMAL FLOAT AUTO REAL RADIAN MP
Send("SET
1:LIGHT
2:COLOR
3:COLOR.RED
4:COLOR.GREEN
5:COLOR.BLUE
6:SOUND
7:LED
8:SPEAKER
9↓BUZZER
```

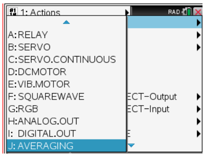


```
NORMAL FLOAT AUTO REAL RADIAN MP
Send("SET
0↑RELAY
A:SERVO
B:SERVO.CONTINUOUS
C:DCMOTOR
D:SQUAREWAVE
E:RGB
F:ANALOG.OUT
G:DIGITAL.OUT
H:AVERAGING
```

TI-Nspire™ CX



```
1: Actions
1: LIGHT
2: COLOR
3: COLOR.RED
4: COLOR.GREEN
5: COLOR.BLUE
6: SOUND
7: LED
8: SPEAKER
9: BUZZER
A: RELAY
ECT–Output
ECT–Input
```



```
1: Actions
A:RELAY
B:SERVO
C:SERVO.CONTINUOUS
D:DCMOTOR
E:VIB.MOTOR
F: SQUAREWAVE
G:RGB
H:ANALOG.OUT
I: DIGITAL.OUT
J: AVERAGING
ECT–Output
ECT–Input
```

Send("READ...

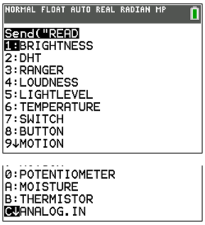
TI-84 Plus CE

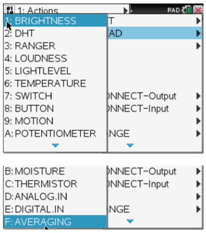
TI-Nspire™ CX

- READ
  - BRIGHTNESS
  - DHT
  - RANGER

  - LOUDNESS
  - LIGHTLEVEL
  - TEMPERATURE
  - SWITCH
  - BUTTON
  - MOTION
  - POTENTIOMETER
  - MOISTURE
  - THERMISTOR
  - ANALOG.IN
  - DIGITAL.IN
  - AVERAGING

Additional **READ** Commands

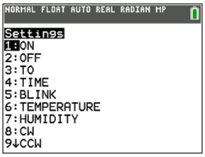




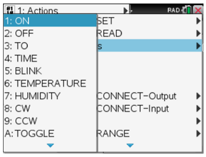
Settings…

- Settings
  - ON
  - OFF
  - TO
  - TIME
  - BLINK
  - TEMPERATURE
  - HUMIDITY
  - CW
  - CCW
  - TOGGLE

TI-84 Plus CE



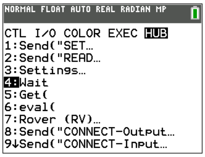
TI-Nspire™ CX



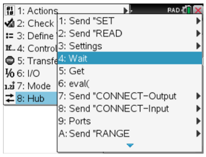
Wait

- Wait

TI-84 Plus CE



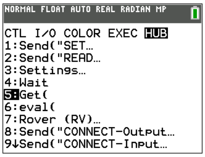
TI-Nspire™ CX



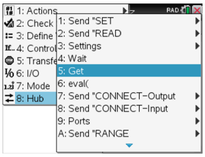
Get(

- Get(

TI-84 Plus CE **TI-Nspire™ CX**



```
NORMAL FLOAT AUTO REAL RADIAN MP
CTL I/O COLOR EXEC HUB
1:Send("SET…
2:Send("READ…
3:Settings…
4:Wait
5:Get(
6:eval(
7:Rover (RV)…
8:Send("CONNECT-Output…
9↓Send("CONNECT-Input…
```

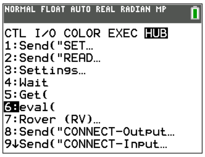


```
1: Actions     1: Send "SET
2: Check       2: Send "READ
3: Define      3: Settings
4: Control     4: Wait
5: Transfer    5: Get
6: I/O         6: eval(
7: Mode        7: Send "CONNECT-Output
8: Hub         8: Send "CONNECT-Input
               9: Ports
               A: Send "RANGE
```

eval(

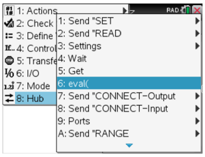
- eval(

TI-84 Plus CE



```
NORMAL FLOAT AUTO REAL RADIAN MP
CTL I/O COLOR EXEC HUB
1:Send("SET…
2:Send("READ…
3:Settings…
4:Wait
5:Get(
6:eval(
7:Rover (RV)…
8:Send("CONNECT-Output…
9↓Send("CONNECT-Input…
```

TI-Nspire™ CX

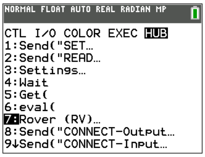


```
1: Actions     1: Send "SET
2: Check       2: Send "READ
3: Define      3: Settings
4: Control     4: Wait
5: Transfer    5: Get
6: I/O         6: eval(
7: Mode        7: Send "CONNECT-Output
8: Hub         8: Send "CONNECT-Input
               9: Ports
               A: Send "RANGE
```

Rover (RV)…

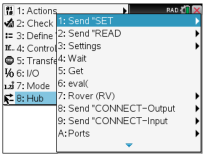
- Drive RV…
- Read RV Sensors…
- RV Settings…
- Read RV Path…
- RV Color…
- RV Setup…
- RV Control…
- Send "CONNECT RV"
- Send "DISCONNECT RV"

TI-84 Plus CE



```
NORMAL FLOAT AUTO REAL RADIAN MP
CTL I/O COLOR EXEC HUB
1:Send("SET…
2:Send("READ…
3:Settings…
4:Wait
5:Get(
6:eval(
7:Rover (RV)…
8:Send("CONNECT-Output…
9↓Send("CONNECT-Input…
```

TI-Nspire™ CX

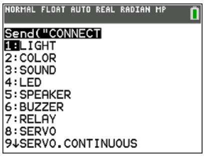


```
1: Actions     1: Send "SET
2: Check       2: Send "READ
3: Define      3: Settings
4: Control     4: Wait
5: Transfer    5: Get
6: I/O         6: eval(
7: Mode        7: Rover (RV)
8: Hub         8: Send "CONNECT-Output
               9: Send "CONNECT-Input
               A:Ports
```

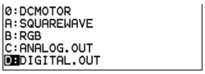
Send("CONNECT-Output…

- CONNECT-Output
  - LIGHT
  - COLOR
  - SOUND
  - LED
  - SPEAKER
  - BUZZER
  - RELAY
  - SERVO
  - SERVO.CONTINUOUS
  - DCMOTOR
  - SQUAREWAVE
  - RGB

TI-84 Plus CE

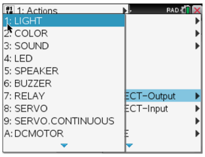


```
NORMAL FLOAT AUTO REAL RADIAN MP
Send("CONNECT
1:LIGHT
2:COLOR
3:SOUND
4:LED
5:SPEAKER
6:BUZZER
7:RELAY
8:SERVO
9↓SERVO.CONTINUOUS
```

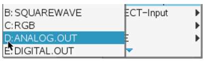


```
0:DCMOTOR
A:SQUAREWAVE
B:RGB
C:ANALOG.OUT
D:DIGITAL.OUT
```

TI-Nspire™ CX



```
1: Actions
1: LIGHT
2: COLOR
3: SOUND
4: LED
5: SPEAKER
6: BUZZER
7: RELAY               ECT-Output
8: SERVO               ECT-Input
9: SERVO.CONTINUOUS
A: DCMOTOR             E
```

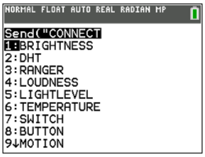


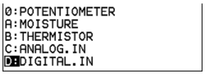
```
B: SQUAREWAVE          ECT-Input
C:RGB
D:ANALOG.OUT
E:DIGITAL.OUT
```

- ANALOG.OUT
- DIGITAL.OUT

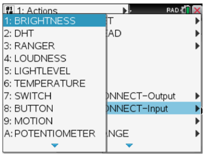
Send("CONNECT-Input...

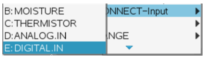
TI-84 Plus CE





TI-Nspire™ CX

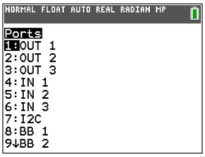


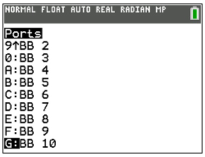


- CONNECT-Input
  - BRIGHTNESS
  - DHT
  - RANGER
  - LOUDNESS
  - LIGHTLEVEL
  - TEMPERATURE
  - SWITCH
  - BUTTON
  - MOTION
  - POTENTIOMETER
  - MOISTURE
  - THERMISTOR
  - ANALOG.IN
  - DIGITAL.IN

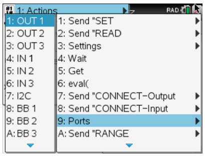
Ports...

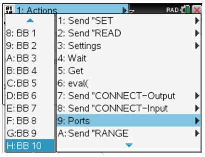
TI-84 Plus CE





TI-Nspire™ CX





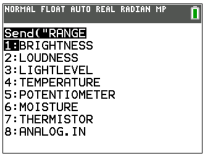
- Ports
  - OUT 1
  - OUT 2
  - OUT 3
  - IN 1
  - IN 2
  - IN: 3
  - I2C
  - BB 1
  - BB 2
  - BB 3
  - BB 4
  - BB 5
  - BB 6
  - BB 7
  - BB 8
  - BB 9

– BB 10

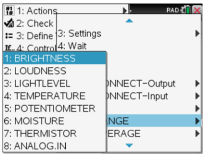
Send("RANGE…

- RANGE
  - BRIGHTNESS
  - LOUDNESS
  - LIGHTLEVEL
  - TEMPERATURE
  - POTENTIOMETER
  - MOISTURE
  - THERMISTOR
  - ANALOG.IN

TI-84 Plus CE



TI-Nspire™ CX

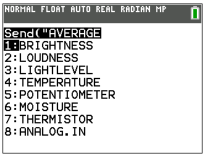


Send("AVERAGE…

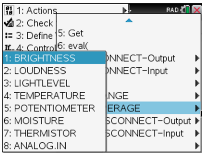
- AVERAGE
  - BRIGHTNESS
  - LOUDNESS
  - LIGHTLEVEL
  - TEMPERATURE
  - POTENTIOMETER
  - MOISTURE
  - THERMISTOR
  - ANALOG.IN

Additional **AVERAGE** Commands

TI-84 Plus CE



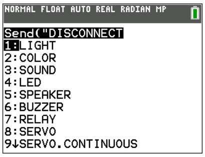
TI-Nspire™ CX

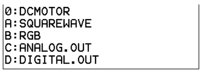


Send("DISCONNECT-Output…

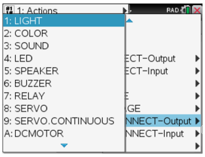
- DISCONNECT-Output…
  - LIGHT
  - COLOR
  - SOUND
  - LED
  - SPEAKER
  - BUZZER
  - RELAY
  - SERVO
  - SERVO.CONTINUOUS
  - DCMOTOR

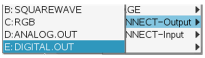
TI-84 Plus CE





TI-Nspire™ CX



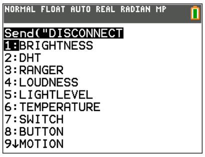


– SQUAREWAVE
– RGB
– ANALOG.OUT
– DIGITAL.OUT

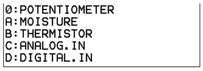
Send("DISCONNECT-INPUT...

- DISCONNECT-Input...
  – BRIGHTNESS
  – DHT
  – RANGER
  – LOUDNESS
  – LIGHTLEVEL
  – TEMPERATURE
  – SWITCH
  – BUTTON
  – MOTION
  – POTENTIOMETER
  – MOISTURE
  – THERMISTOR
  – ANALOG.IN
  – DIGITAL.IN

TI-84 Plus CE

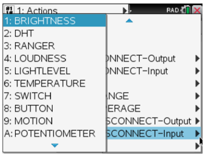


```
NORMAL FLOAT AUTO REAL RADIAN MP
Send("DISCONNECT
1:BRIGHTNESS
2:DHT
3:RANGER
4:LOUDNESS
5:LIGHTLEVEL
6:TEMPERATURE
7:SWITCH
8:BUTTON
9↓MOTION
```

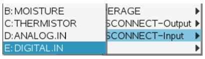


```
0:POTENTIOMETER
A:MOISTURE
B:THERMISTOR
C:ANALOG.IN
D:DIGITAL.IN
```

TI-Nspire™ CX



```
1: Actions
1: BRIGHTNESS
2: DHT
3: RANGER
4: LOUDNESS        NNECT−Output
5: LIGHTLEVEL      NNECT−Input
6: TEMPERATURE
7: SWITCH          NGE
8: BUTTON          ERAGE
9: MOTION          SCONNECT−Output
A: POTENTIOMETER   SCONNECT−Input
```

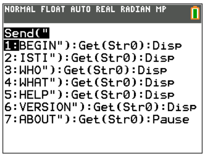


```
B: MOISTURE        ERAGE
C: THERMISTOR      SCONNECT−Output
D: ANALOG.IN       SCONNECT−Input
E: DIGITAL.IN
```

MANAGE

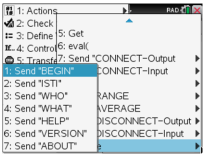
- MANAGE
  – BEGIN
  – ISTI
  – WHO
  – WHAT
  – HELP
  – VERSION
  – ABOUT

TI-84 Plus CE



```
NORMAL FLOAT AUTO REAL RADIAN MP
Send("
1:BEGIN"):Get(Str0):Disp
2:ISTI"):Get(Str0):Disp
3:WHO"):Get(Str0):Disp
4:WHAT"):Get(Str0):Disp
5:HELP"):Get(Str0):Disp
6:VERSION"):Get(Str0):Disp
7:ABOUT"):Get(Str0):Pause
```

TI-Nspire™ CX



```
1: Actions
2: Check
3: Define     5: Get
4: Control    6: eval(
5: Transfe    7: Send "CONNECT−Output
1: Send "BEGIN"     CONNECT−Input
2: Send "ISTI"
3: Send "WHO"       RANGE
4: Send "WHAT"      AVERAGE
5: Send "HELP"      DISCONNECT−Output
6: Send "VERSION"   DISCONNECT−Input
7: Send "ABOUT"
```

Additional Supported Commands Not Found in the Hub Menu

- Additional **SET** Commands
  – FORMAT ERROR STRING/NUMBER
  – FORMAT ERROR NOTE/QUIET
  – FLOW [TO] ON/OFF

- OUT1/2/3 [TO]

- Additional **READ** Commands
  - ANALOG.OUT
  - BUZZER
  - COLOR
    - RED
    - GREEN
    - BLUE
  - DCMOTOR i
  - DIGITAL.OUT i
  - FORMAT
  - FLOW
  - IN1/IN2/IN3
  - LAST ERROR
  - LED i
  - LIGHT
  - OUT1/2/3
  - PWR
  - RELAY i
  - RESOLUTION
  - RGB i
    - RED i
    - GREEN i
    - BLUE i
  - SERVO i
  - SERVO i CALIBRATION
  - SOUND
  - SPEAKER i
  - SQUAREWAVE i

- Additional **AVERAGE** Commands
  - PERIOD

- Additional **CALIBRATE** Commands
  - CALIBRATE
    - SERVO i minimum maximum
    - TEMPERATURE i c1 c2 c3 r
    - THERMISTOR i c1 c2 c3 r

SET

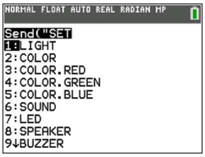
The **SET** command is used to generate outputs on pins or ports, or control output devices such as **LED**s, Servo motors, speaker tones, or other output operations. It is also used to control a variety of system settings. These include formatting of error information, and communications flow control. **SET** does NOT generate any response that requires reading. The success or failure of a **SET** command may be determined by sending a **READ LAST ERROR** command and obtaining the response to that command. The sensors, controls, and settings that **SET** can operate against are in the following table.

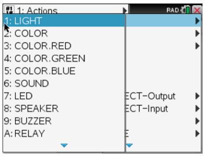
SET something'

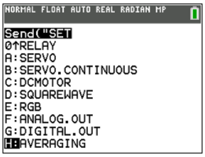
Command:	**SET**
Command Syntax:	**SET**
Code Sample:	
Range:	
Describe:	Used to set options, or output states, or provide information used to control an external actuator or output device, such as turning on a **RELAY**.
Result:	
Type or Addressable Component:	

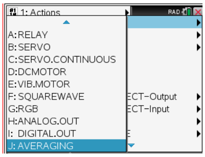
TI-84 Plus CE

TI-Nspire™ CX









LIGHT [TO] ON/OFF

Command:	**LIGHT [TO] ON/OFF**

Command Syntax:	**SET LIGHT ON [[BLINK|TOGGLE] frequency] [[TIME] seconds]**
	SET LIGHT OFF
	- same as **LED**, but for on-board red **LED**.

Range:	

Describe:	Provides control over the on-board digital **RED LED**. Set optional blink frequency and duration.
	SET LIGHT ON [[BLINK|TOGGLE] frequency] [[TIME] seconds]
	SET LIGHT OFF

Result:	Turns on LIGHT. Turns off LIGHT
Type or Addressable Component:	Control

COLOR [TO] r g b [[BLINK|TOGGLE] frequency] [[TIME] seconds]

Command:	**COLOR [TO] r g b [[BLINK|TOGGLE] frequency] [[TIME] seconds]**

Command Syntax:	**SET COLOR r g b [[BLINK|TOGGLE] frequency] [[TIME]seconds]**
	SET COLOR.component x [[BLINK|TOGGLE] frequency] [[TIME]seconds]

Range:	
Describe:	On-board **COLOR RGB LED** with sub-components **.RED**, **.GREEN**, **.BLUE**. Can have a blink frequency, and blink time for entire item, or for each component individually, as well as PWM levels given individually, or at one time.
Result:	Where r g b is r-value g-value b-value respectively, or operators from ON/OFF/UP/DOWN/STOP.
Type or Addressable Component:	Control

See Also:

COLOR.RED [TO] r [[BLINK|TOGGLE] frequency] [[TIME] seconds]

Command:	**COLOR.RED [TO] r [[BLINK|TOGGLE] frequency] [[TIME] seconds]**
Command Syntax:	**Send("SET COLOR.RED...")** **ON/OFF/UP/DOWN/STOP/0-255 (red element)** **[BLINK frequency] (in Hz)** **[TIME duration] (in secs)**
Range:	
Describe:	RED component of On-board **COLOR RGB LED**. Can have a blink frequency, and blink time for entire item, or for each component individually, as well as PWM levels given individually, or at one time.
Result:	Where r is red level, or operators from ON/OFF/UP/DOWN/STOP.
Type or Addressable Component:	Control

COLOR.GREEN [TO] g [[BLINK|TOGGLE] frequency] [[TIME] seconds]

Command:	**COLOR.GREEN [TO] g [[BLINK|TOGGLE] frequency] [[TIME] seconds]**
Command Syntax:	**SET COLOR.GREEN [TO] g [[BLINK|TOGGLE] frequency] [[TIME] seconds]**
Range:	
Describe:	GREEN component of On-board **COLOR RGB LED**. Can have a blink frequency, and blink time for entire item, or for each component individually, as well as PWM levels given individually, or at one time.
Result:	Where g is green level, or operators from ON/OFF/UP/DOWN/STOP.
Type or Addressable Component:	Control

COLOR.BLUE [TO] b [[BLINK|TOGGLE] frequency] [[TIME] seconds]

Command:	**COLOR.BLUE [TO] b [[BLINK|TOGGLE] frequency] [[TIME] seconds]**
Command Syntax:	**SET COLOR.BLUE [TO] b [[BLINK|TOGGLE] frequency] [[TIME] seconds]**
Range:	
Describe:	BLUE component of On-board **COLOR RGB LED**. Can have a blink frequency, and blink time for entire item, or for each component individually, as well as PWM levels given individually, or at one time.
Result:	Where b is blue level, or operators from ON/OFF/UP/DOWN/STOP.
Type or Addressable Component:	Control

SOUND [TO] frequency [[TIME] seconds]

Command:	**SOUND [TO] frequency [[TIME] seconds]**
Command Syntax:	**SET SOUND frequency [[TIME] seconds]**
Range:	
Describe:	**SOUND** is the on-board speaker and can generate a sound with a specified frequency. If not specified, sound will play for 1 second default. **SET SOUND frequency [[TIME] seconds]**
Result:	Play tone through on-board speaker.
Type or Addressable Component:	Control

SOUND OFF/0

Command:	**SOUND OFF/0**
Command Syntax:	**SET SOUND 0**

Command:	**SOUND OFF/0**
Range:	
Describe:	**SOUND** is the on-board speaker and can generate a sound with a specified frequency. If not specified, sound will play for 1 second default. **SET SOUND 0** – turns off sound on internal speaker immediately.
Result:	Stop playing sound.
Type or Addressable Component:	Control

LED i [TO] ON/OFF

Command:	**LED i [TO] ON/OFF**
Command Syntax:	**SET LED i ON/ OFF [[BLINK|TOGGLE] frequency] [[TIME] seconds]** – digital LED (on or off only)
Range:	
Describe:	Provides control over an external **LED** to set optional blink frequency and duration, as well as **PWM** capability if the associated pin connected to the **LED** supports it. **SET LED i ON [[BLINK|TOGGLE] frequency] [[TIME] seconds]** – digital LED (on or off only) **SET LED i OFF** – turns off LED (same as SET LED i 0).
Result:	Turns on LED. Turns off LED When connected to an Analog-PWM pin.
Type or Addressable Component:	Control

LED i [TO] 0-255

Command:	**LED i [TO] 0-255**
Command Syntax:	**SET LED i 0-255 [[BLINK|TOGGLE] frequency] [[TIME] seconds]** – analog LED (pwm duty cycyle)
Range:	
Describe:	Provides control over an external **LED** to set optional blink frequency and duration, as well as **PWM** capability if the associated pin connected to the **LED** supports it. **SET LED i 0-255 [[BLINK|TOGGLE] frequency] [[TIME] seconds]** – analog LED (pwm duty cycyle)
Result:	When connected to an Analog-PWM pin.
Type or Addressable Component:	Control

SPEAKER i [TO] frequency [[TIME] seconds]

Command:	**SPEAKER i [TO] frequency [[TIME] seconds]**
Command Syntax:	**SET SPEAKER i [TO] frequency [[TIME] seconds]**
Range:	
Describe:	Same as **SOUND** above, except sound is played on an external speaker attached to a digital output pin, available on any **IN/OUT** port, or the breadboard connector port. **Note**: On-board SOUND and external SPEAKER cannot be used concurrently.
Result:	Play tone with frequency given, optional duration in milliseconds, default = 1 second.
Type or Addressable Component:	Control

BUZZER i [TO] ON [TIME seconds]

Command:	**BUZZER i [TO] ON [TIME seconds]**
Command Syntax:	**SET BUZZER i ON [[TIME] seconds]**
Range:	
Describe:	Used to turn ON or OFF a tone on an active BUZZER for either 1 second default, or given length of time. **SET BUZZER i ON [[TIME] seconds]**
Result:	Sound tone on **ACTIVE** buzzer for 1 second, or specified duration in seconds.
Type or Addressable Component:	Control

BUZZER i [TO] OFF

Command:	**BUZZER i [TO] OFF**
Command Syntax:	**SET BUZZER i OFF**
Range:	
Describe:	Used to turn ON or OFF a tone on an active BUZZER for either 1 second default, or given length of time. **SET BUZZER i OFF**
Result:	Turn off tone on active buzzer.
Type or Addressable Component:	Control

RELAY i [TO] ON/OFF

Command:	**RELAY i [TO] On/Off**
Command Syntax:	**SET RELAY i ON/OFF /0/1 [[TIME] seconds]**.

Command:	**RELAY i [TO] On/Off**
Range:	Turns the specified **RELAY ON** or **OFF** for the given specified **TIME** in seconds.
Describe:	Control interface to an external RELAY control. **SET RELAY i ON/OFF/1/0 [[TIME] seconds]**
Result:	Turns RELAY on or off
Type or Addressable Component:	Control RELAY

SERVO i [TO] position

Command:	**SERVO i [TO] position**
Command Syntax:	**SET SERVO i [TO] position**.
Code Sample:	
Range:	
Describe:	Servo motor control interface. Servos can be either continuous or sweep style servos. Position = value from -90 to 90, ranged to -90 to 90) - used with **SWEEP SERVOS**
Result:	Sweep servos: position is a value from -90 to 90. Value 0 is same as specifying **ZERO**.
Type or Addressable Component:	Control

SERVO i [TO] STOP

Command:	**SERVO i [TO] STOP**
Command Syntax:	**SET SERVO i STOP**
Code Sample:	`Send("SET SERVO 1 STOP")`
Range:	
Describe:	Servo motor control interface. Servos can be either continuous or sweep style servos. **Note**: Sweep style servos will stop automatically at the end of the sweep. **SET SERVO i STOP** – stops motion on servo
Result:	Halt any continuous servo operation in progress. Turn **SERVO** Off
Type or Addressable Component:	Control

SERVO i [TO] ZERO

Command:	**SERVO i [TO] ZERO**
Command Syntax:	**SET SERVO i ZERO/position**
Code Sample:	`Send("SET SERVO 1 ZERO")`
Range:	
Describe:	Set servo to zero position on sweep servo, or no motion on continuous servo.
Result:	Sweep servos: position is a value from -90 to 90. Value 0 is same as specifying **ZERO**.
Type or Addressable Component:	Control

SERVO i [TO] [CW/CCW] speed [[TIME] seconds]

Command:	**SERVO i [TO] [CW/CCW] speed [[TIME] seconds]**
Command Syntax:	**SET SERVO i CW/CCW speed [[TIME] seconds]**

Code Sample:	`Send("SET SERVO.CONTINUOUS 1 CW 100 TIME 3")`
	`Wait 3`

Range:	
Describe:	Speed from -100 to 100, **CW/CCW** optional, if speed <0, **CCW**, else **CW** unless **CW/CCW** keyword is specified, TIME optional, in seconds, default=1 second (for continuous servo operation) (**CW/CCW** required if TIME/seconds NOT specified.)
Result:	Continuous servo where direction of rotation is specified, along with speed, from 0 (no motion) to 100 (fastest). Optional time parameter used to specify how long the servo should rotate in seconds.
Type or Addressable Component:	Control

DCMOTOR i [TO] frequency [duty [[TIME] seconds]]

Command:	**DCMOTOR i [TO] frequency [duty [[TIME] seconds]]**
Command Syntax:	**SET DCMOTOR i frequency [duty]**
Range:	
Describe:	Generates a specific frequency and duty cycle digital pulse to a motor. **SET DCMOTOR i frequency [duty]**
Result:	Generate a digital pulse at given frequency from 1 to 500 hz at 1-99 % duty cycle; shares number-space with SQUAREWAVE. duty=50% default, seconds=1.0 default.
Type or Addressable Component:	Control

DCMOTOR i OFF

Command:	**DCMOTOR i OFF**
Command Syntax:	**SET DCMOTOR i OFF**
Range:	
Describe:	Generates a specific frequency and duty cycle digital pulse to a motor. **SET DCMOTOR i OFF**
Result:	Stop motor.
Type or Addressable Component:	Control

VIB.MOTOR i [TO] PWM

Command:	**VIB.MOTOR i [TO] PWM**
Command Syntax:	**SET VIB.MOTOR i [TO] PWM**
Range:	PWM from 0 (none) and 255 (full on)
Describe:	Vibration motor control interface.
Result:	Vibrations : intensity is a value from 0 to 255.
Type or Addressable Component:	Control

VIB.MOTOR i [TO] OFF|STOP

Command:	**VIB.MOTOR i [TO] OFF|STOP**
Command Syntax:	**SET VIB.MOTOR i OFF|STOP**

Command:	**VIB.MOTOR i [TO] OFF|STOP**
Range:	
Describe:	Vibration motor control interface. **SET VIB.MOTOR i OFF|STOP** – stops motion on vibrations
Result:	Shut down vibration motor.
Type or Addressable Component:	Control

VIB.MOTOR i [TO] 0-255/UP/DOWN/ON/OFF [[BLINK|TOGGLE] freq] [[TIME] seconds]

Command:	**VIB.MOTOR i [TO] 0-255/UP/DOWN/ON/OFF [[BLINK|TOGGLE] freq] [[TIME] seconds]**
Command Syntax:	**SET VIB.MOTOR i 0-255/UP/DOWN/ON/OFF [[BLINK|TOGGLE] freq] [[TIME] seconds]**
Range:	PWM from 0 (none) and 255 (full on)
Describe:	Run vibration motor with numerous options
Result:	Run vibration motor with numerous options Optional time parameter used to specify how long the vibration should rotate in seconds.
Type or Addressable Component:	Control

SQUAREWAVE i [TO] frequency [duty [[TIME] seconds]]

Command:	**SQUAREWAVE i [TO] frequency [duty [[TIME] seconds]]**
Command Syntax:	**SET SQUAREWAVE i frequency [duty]**
Range:	

Command:	**SQUAREWAVE i [TO] frequency [duty [[TIME] seconds]]**
Describe:	**SQUAREWAVE** is used to generate a square wave form with a default duty cycle of 50% with frequencies from 0.1 Hz to 500 Hz. frequencies slower than 0.1 Hz are set to 0.1 Hz. frequencies above 500 Hz are set to 500 Hz. The optional duty cycle is a value from 1 to 99. **SET SQUAREWAVE i frequency [duty]**
Result:	Generate a digital squarewave from 1 to 500 hz at 1-99 duty cycle on up to 6 pins (i=1-4) duty=50% default, seconds=1.0 default.
Type or Addressable Component:	Control

SQUAREWAVE i OFF

Command:	**SQUAREWAVE i OFF**
Command Syntax:	**SET SQUAREWAVE i OFF** **frequency [duty]**
Range:	
Describe:	**SQUAREWAVE** is used to generate a square wave form with a default duty cycle of 50% with frequencies from 0.1 Hz to 500 Hz. frequencies slower than 0.1 Hz are set to 0.1 Hz. frequencies above 500 Hz are set to 500 Hz. The optional duty cycle is a value from 1 to 99. **SET SQUAREWAVE i OFF** – turn off squarewave generation
Result:	Stop generating squarewave output.
Type or Addressable Component:	Control

RGB i [TO] r g b [[BLINK|TOGGLE] frequency] [[TIME] seconds]

Command:	**RGB i [TO] r g b [[BLINK|TOGGLE] frequency] [[TIME] seconds]**
Command Syntax:	**SET RGB i r g b [[BLINK|TOGGLE] frequency] [[TIME]seconds]**
Range:	
Describe:	External **RGB LED** controls, with same options as available for the on-board COLOR object. Individual color components can be addressed with the same index value i by name, **RED i**, **GREEN i**, **BLUE i**.
Result:	Where r g b is r-value g-value b-value respectively, or operators from ON/OFF/STOP.
Type or Addressable Component:	Control

RED i [TO] ON/OFF/UP/DOWN/value [[BLINK|TOGGLE] frequency] [[TIME] seconds]

Command:	**RED i [TO] ON/OFF/UP/DOWN/value [[BLINK|TOGGLE] frequency] [[TIME] seconds]**
Command Syntax:	**SET.RED i [TO] ON/OFF/UP/DOWN/value [[BLINK|TOGGLE] frequency] [[TIME] seconds]**
Range:	
Describe:	RED component of External RGB LED controls, with same options as available for the on-board COLOR object. Individual color components can be addressed with the same index value i by name, RED i, GREEN i, BLUE i.
Result:	
Type or Addressable Component:	Control

GREEN i [TO] ON/OFF/UP/DOWN/value [[BLINK|TOGGLE] frequency] [[TIME] seconds]

Command:	**GREEN i [TO] ON/OFF/UP/DOWN/value [[BLINK|TOGGLE] frequency] [[TIME] seconds]**
Command Syntax:	**SET.GREEN i [TO] ON/OFF/UP/DOWN/value [[BLINK|TOGGLE] frequency] [[TIME] seconds]**
Range:	
Describe:	GREEN component of External RGB LED controls, with same options as available for the on-board COLOR object. Individual color components can be addressed with the same index value i by name, RED i, GREEN i, BLUE i.
Result:	
Type or Addressable Component:	Control

BLUE i [TO] ON/OFF/UP/DOWN/value [[BLINK|TOGGLE] frequency] [[TIME] seconds]

Command:	**BLUE i [TO] ON/OFF/UP/DOWN/value [[BLINK|TOGGLE] frequency] [[TIME] seconds]**
Command Syntax:	**SET.BLUE i [TO] ON/OFF/UP/DOWN/value [[BLINK|TOGGLE] frequency] [[TIME] seconds]**
Range:	
Describe:	BLUE component of External RGB LED controls, with same options as available for the on-board COLOR object. Individual color components can be addressed with the same index value i by name, RED i, GREEN i, BLUE i.
Result:	
Type or Addressable Component:	Control

ANALOG.OUT i [TO]

Command:	**ANALOG.OUT i [TO]**
Command Syntax:	**SET ANALOG.OUT i 0-255 [[BLINK|TOGGLE] frequency] [[TIME] seconds]**
Range:	
Describe:	Software (or hardware, if available) generated pulse-width modulation output at 490 Hz with the specified duty cycle between 0 (off) and 255 (on). The PWM output can be toggled at a frequency from 0.1 to 20.0 Hz for a given duration. If no duration is given, the PWM continues until stopped or turned off. **SET ANALOG.OUT i 0-255 [[BLINK|TOGGLE] frequency] [[TIME] seconds]**
Result:	Generate pwm value (hw or sw) on analog output object.
Type or Addressable Component:	Control

ANALOG.OUT i OFF|STOP

Command:	**ANALOG.OUT** i OFF|STOP

Command Syntax:	**SET ANALOG.OUT i OFF**
	SET ANALOG.OUT i STOP

Range:	

Describe:	Software (or hardware, if available) generated pulse-width modulation output at 490 Hz with the specified duty cycle between 0 (off) and 255 (on). The PWM output can be toggled at a frequency from 0.1 to 20.0 Hz for a given duration. If no duration is given, the PWM continues until stopped or turned off.
	SET ANALOG.OUT i OFF
	SET ANALOG.OUT i STOP

Result:	Turn off pwm on associated pin, including blinking, etc.
Type or Addressable Component:	Control

DIGITAL.OUT i [TO] ON/OFF/HIGH/LOW/[[BLINK|TOGGLE] frequency] [[TIME] seconds]

Command:	**DIGITAL.OUT i [TO] ON/OFF/HIGH/LOW/[[BLINK|TOGGLE] frequency] [[TIME] seconds]**
Command Syntax:	**SET DIGITAL.OUT i [TO] ON/OFF/HIGH/LOW [[BLINK|TOGGLE] frequency] [[TIME] seconds]**
Range:	
Describe:	Used to generate output digital signal(s). **SET DIGITAL.OUT i ON/OFF/HIGH/LOW [[BLINK|TOGGLE] frequency] [[TIME] seconds]**
Result:	Digital.out operations.
Type or Addressable Component:	Control

DIGITAL.OUT i [TO] OUTPUT/CLOCK

Command:	**DIGITAL.OUT i [TO] OUTPUT/CLOCK**
Command Syntax:	**SET DIGITAL.OUT i [TO] OUTPUT/CLOCK**
Range:	
Describe:	Output or drive a clock pulse - digital.out other operations.
Result:	Output or drive a clock pulse - digital.out other operations.
Type or Addressable Component:	Control

DIGITAL.IN i [TO] INPUT/PULLUP/PULLDOWN

Command:	**DIGITAL.IN i [TO] INPUT/PULLUP/PULLDOWN**
Command Syntax:	**SET DIGITAL.IN i [TO] INPUT/PULLUP/PULLDOWN**
Range:	
Describe:	Used for Pulldown and/or pullup control for digital.in operations.

Command:	**DIGITAL.IN i [TO] INPUT/PULLUP/PULLDOWN**
Result:	Pulldown and pullup control for digital.in operations.
Type or Addressable Component:	Control

AVERAGING [TO] n

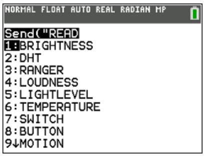
Command:	**AVERAGING [TO] n** **Advanced user**
Command Syntax:	**AVERAGING.[TO] n**
Range:	
Describe:	Global setting for how many times we sample analog inputs when obtaining a reading from a sensor using analog input **n** - (global default)
Result:	Sample analog inputs '**n**' times, averaging results (default is 3 unless changed; sets "global" averaging value.)
Type or Addressable Component:	Setting Default if not set with this command is 3
Note:	Global averaging value can be individually overridden by sensor by using the **AVERAGING** command on an item.

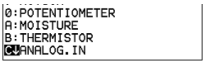
READ

The **READ** command generates responses based on what is being requested.

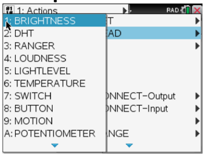
Tells the Innovator to obtain data from the specified sensor, control, port, pin, or status information including the setup of the hub, such as flow control, error settings, etc. Must be followed by a Get() operation to receive the requested data.

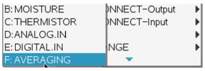
TI-84 Plus CE





TI-Nspire™ CX





BRIGHTNESS

Command:	**BRIGHTNESS**
Command Syntax:	**READ BRIGHTNESS**
Range:	
Describe:	Returns the current internal reading from the on-board ambient light sensor. Note the optional keywords of RANGE and AVERAGE can be appended to the command to return the current **RANGE** setting for the **BRIGHTNESS** sensor if set or the current **AVERAGE** value applied when reading the ADC to obtain the reading. **READ BRIGHTNESS**
Result:	Read on-board light sensor level.
Type or Addressable Component:	Control

BRIGHTNESS AVERAGE

Command:	**BRIGHTNESS AVERAGE** **Advanced user**
Command Syntax:	**READ BRIGHTNESS.AVERAGE**
Range:	
Describe:	Returns the current internal reading from the on-board ambient light sensor. Note the optional keywords of **RANGE** and **AVERAGE** can be appended to the command to return the current **RANGE** setting for the **BRIGHTNESS** sensor if set or the current **AVERAGE** value applied when reading the ADC to obtain the reading. **READ BRIGHTNESS AVERAGE**
Result:	Read on-board light sensor level.
Type or Addressable Component:	Control

BRIGHTNESS RANGE

Command:	**BRIGHTNESS RANGE** **Advanced user**
Command Syntax:	**READ BRIGHTNESS.RANGE**
Range:	
Describe:	Returns the current internal reading from the on-board ambient light sensor. Note the optional keywords of **RANGE** and **AVERAGE** can be appended to the command to return the current **RANGE** setting for the **BRIGHTNESS** sensor if set or the current **AVERAGE** value applied when reading the ADC to obtain the reading. **READ BRIGHTNESS RANGE**
Result:	Read on-board light sensor level.
Type or Addressable Component:	Control

DHT i

Command:	**DHT i**
Command Syntax:	**READ DHT i**
Range:	Temperature reading default is in Celsius Humidity reading from 0 to 100 %
Describe:	Returns a list consisting of the current temperature, humidity, type of sensor, and last cached read status. The temperature and humidity can be obtained by themselves by appending the TEMPERATURE or HUMIDITY keywords to the end of the command. The type of sensor is indicated by a 1 for a DHT11, and a 2 for DHT22 style sensors. The status values are: 1=OK, 2=Timeout, 3=Checksum/bad reading. **READ DHT i** – returns full cached information from last reading the DHT task obtained. **READ DHT i TEMPERATURE** – returns latest temperature reading. **READ DHT i HUMIDITY** – returns latest humidity reading.
Result:	Return list with current temperature in C, humidity in %, type(1=DHT11, 2=DHT22), and status (type/status only available in full list). Where the status = 1:OK, =2:Timeout, =3:Checksum.
Type or Addressable Component:	Sensor

DHT i TEMPERATURE

Command:	**DHT i TEMPERATURE**
Command Syntax:	**READ DHT i TEMPERATURE**
Range:	Temperature reading default is in Celsius Humidity reading from 0 to 100 %
Describe:	Returns a list consisting of the current temperature, humidity, type of sensor, and last cached read status. The temperature and humidity can be obtained by themselves by appending the TEMPERATURE or HUMIDITY keywords to the end of the command. The type of sensor is indicated by a 1 for a DHT11, and a 2 for DHT22 style sensors. The status values are:

Command:	**DHT i TEMPERATURE**
	1=OK, 2=Timeout, 3=Checksum/bad reading. **READ DHT i** – returns full cached information from last reading the DHT task obtained. **READ DHT i TEMPERATURE** – returns latest temperature reading. **READ DHT i HUMIDITY** – returns latest humidity reading.
Result:	Returns temperature component.
Type or Addressable Component:	Sensor

DHT i HUMIDITY

Command:	**DHT i HUMIDITY**
Command Syntax:	**READ DHT i HUMIDITY**
Range:	Temperature reading default is in Celsius Humidity reading from 0 to 100 %
Describe:	Returns a list consisting of the current temperature, humidity, type of sensor, and last cached read status. The temperature and humidity can be obtained by themselves by appending the TEMPERATURE or HUMIDITY keywords to the end of the command. The type of sensor is indicated by a 1 for a DHT11, and a 2 for DHT22 style sensors. The status values are: 1=OK, 2=Timeout, 3=Checksum/bad reading. **READ DHT i** – returns full cached information from last reading the DHT task obtained. **READ DHT i TEMPERATURE** – returns latest temperature reading. **READ DHT i HUMIDITY** – returns latest humidity reading.
Result:	Returns humidity component.
Type or Addressable Component:	Sensor

RANGER i

Command:	**RANGER i**
Command Syntax:	**READ RANGER i**
Range:	
Describe:	Return the current distance measurement from the specified ultrasonic ranging device; distance in meters. If no measurement is made due to the distance being too far; a value of 0 will be returned. Valid measurements are in +meters.
Result:	Read distance in meters from distance sensor.
Type or Addressable Component:	Sensor

LOUDNESS i

Command:	**LOUDNESS i**
Command Syntax:	**READ LOUDNESS i**
Range:	
Describe:	Return the current analog level reported by the sound loudness level sensor specified. Supports the **AVERAGE** and **RANGE** options. **READ LOUDNESS i** **READ LOUDNESS i AVERAGE** **READ LOUDNESS i RANGE**
Result:	Return level of sound detected by sound sensor.
Type or Addressable Component:	Sensor

LOUDNESS i AVERAGE

Command:	**LOUDNESS i** **Advanced user**
Command Syntax:	**READ LOUDNESS i AVERAGE**
Range:	
Describe:	Return the current analog level reported by the sound loudness level sensor specified. Supports the **AVERAGE** and **RANGE** options. **READ LOUDNESS i AVERAGE**
Result:	Return level of sound detected by sound sensor.
Type or Addressable Component:	Sensor

LOUDNESS i RANGE

Command:	**LOUDNESS i RANGE** **Advanced user**
Command Syntax:	**READ LOUDNESS i.RANGE**
Range:	
Describe:	Return the current analog level reported by the sound loudness level sensor specified. Supports the **AVERAGE** and **RANGE** options. **READ LOUDNESS i** **READ LOUDNESS i AVERAGE** **READ LOUDNESS i RANGE**
Result:	Return level of sound detected by sound sensor.
Type or Addressable Component:	Sensor

LIGHTLEVEL i

Command:	**LIGHTLEVEL i**
Command Syntax:	**READ LIGHTLEVEL i**
Range:	An integer value between 0 and 16383 (14 bit resolution)
Describe:	Returns the current **ADC** value from the specified external light sensor. External light sensors may be analog, or I2C (BH1750FVI I2C Light sensor). When an analog sensor is present, it is generally assumed to be a photodiode. Additionally, the light level sensor may have **AVERAGE** and/or **RANGE** values specified. These can be obtained by appending the **AVERAGE** or **RANGE** keywords to the **READ** command. **READ LIGHTLEVEL i** **READ LIGHTLEVEL i AVERAGE** **READ LIGHTLEVEL i RANGE**
Result:	Read analog value of light sensor (uses averaging), or I2C (value in **LUX** returned).
Type or Addressable Component:	Sensor

LIGHTLEVEL i AVERAGE

Command:	**LIGHTLEVEL i AVERAGE** **Advanced user**
Command Syntax:	**READ LIGHTLEVEL i AVERAGE**
Range:	An integer value between 0 and 16383 (14 bit resolution)
Describe:	Returns the current **ADC** value from the specified external light sensor. External light sensors may be analog, or I2C (BH1750FVI I2C Light sensor). When an analog sensor is present, it is generally assumed to be a photodiode. Additionally, the light level sensor may have **AVERAGE** and/or **RANGE** values specified. These can be obtained by appending the **AVERAGE** or **RANGE** keywords to the **READ** command. **READ LIGHTLEVEL i AVERAGE**
Result:	Read analog value of light sensor (uses averaging), or I2C (value in **LUX**

Command:	**LIGHTLEVEL i AVERAGE** **Advanced user**
	returned).
Type or Addressable Component:	Sensor

LIGHTLEVEL i RANGE

Command:	**LIGHTLEVEL i RANGE** **Advanced user**
Command Syntax:	**READ LIGHTLEVEL i RANGE**
Range:	An integer value between 0 and 16383 (14 bit resolution)
Describe:	Returns the current **ADC** value from the specified external light sensor. External light sensors may be analog, or I2C (BH1750FVI I2C Light sensor). When an analog sensor is present, it is generally assumed to be a photodiode. Additionally, the light level sensor may have **AVERAGE** and/or **RANGE** values specified. These can be obtained by appending the **AVERAGE** or **RANGE** keywords to the **READ** command. **READ LIGHTLEVEL i RANGE**
Result:	Read analog value of light sensor (uses averaging), or I2C (value in **LUX** returned).
Type or Addressable Component:	Sensor

TEMPERATURE i

Command:	**TEMPERATURE i**
Command Syntax:	**READ TEMPERATURE i**

Command:	**TEMPERATURE i**
Range:	Temperature reading default is in Celsius. The range depends on the specific temperature sensor being used. Humidity reading from 0 to 100 %
Describe:	Returns the current temperature reading from the associated temperature sensor. The temperature is given, by default, in Celsius. **READ TEMPERATURE i**
Result:	Return current temperature reading in Celsius.
Type or Addressable Component:	Sensor

TEMPERATURE i AVERAGE

Command:	**TEMPERATURE i AVERAGE** **Advanced user**
Command Syntax:	**READ TEMPERATURE i AVERAGE**
Range:	Temperature reading default is in Celsius. The range depends on the specific temperature sensor being used. Humidity reading from 0 to 100 %
Describe:	Returns the current temperature reading from the associated temperature sensor. The temperature is given, by default, in Celsius. **READ TEMPERATURE i AVERAGE**
Result:	Return current temperature reading in Celsius.
Type or Addressable Component:	Sensor

TEMPERATURE i CALIBRATION

Command:	**TEMPERATURE i CALIBRATION** **Advanced user**
Command Syntax:	**READ TEMPERATURE i CALIBRATION**
Range:	Temperature reading default is in Celsius. The range depends on the specific temperature sensor being used. Humidity reading from 0 to 100 %
Describe:	Returns the current temperature reading from the associated temperature sensor. The temperature is given, by default, in Celsius.
Result:	Returns list with current {c1,c2,c3,r} values used for connected analog temperature sensor.
Type or Addressable Component:	Sensor

SWITCH i

Command:	**SWITCH i**
Command Syntax:	**READ SWITCH i**
Range:	
Describe:	Returns the current state of the associated switch. If the switch is connected, a value of 1 is returned. Not connected returns a value of 0. If the switch was connected since the last reading, but is no longer connected, a value of 2 is returned. **READ SWITCH i**
Result:	Returns state of switch (same status as **BUTTON** object, 0=not pressed, 1=pressed, 2=was pressed).
Type or Addressable Component:	Sensor

BUTTON i

Command:	**BUTTON i**
Command Syntax:	**READ BUTTON i**
Range:	
Describe:	Reads the current cached state of the button. A return value of 0 = *not pressed*, 1 = *currently pressed*, 2 = *was pressed* and released since the last reading. **READ BUTTON i**
Result:	Read state of button/switch n - 0=not pressed, 1=pressed, 2=was pressed.
Type or Addressable Component:	Sensor

MOTION i

Command:	**MOTION i**
Command Syntax:	**READ MOTION i**
Range:	
Describe:	Return the current **PIR Motion sensor** information. **PIR Motion sensors** are digital in nature, so are treated similar to a button in that the value returned indicates motion presence or not. **0**=*no motion detected.* **1**=*motion detected.* **2**=*motion was detected.*
Result:	Read state of **PIR Motion detector** - 0=no motion, 1=motion, 2=motion was detected but none now.
Type or Addressable Component:	Sensor

POTENTIOMETER i

Command:	**POTENTIOMETER i**
Command Syntax:	**READ POTENTIOMETER i**
Range:	
Describe:	Read analog value of the potentiometer (linear or rotary). The optional **AVERAGE** and **RANGE** keywords can be appended to the command to obtain the current average count, or mapped range being used, if present, for the given potentiometer. **READ POTENTIOMETER i** **READ POTENTIOMETER i RANGE** **READ POTENTIOMETER i AVERAGE**
Result:	Read analog value of rotary encoder / potentiometer (uses averaging).
Type or Addressable Component:	Sensor

POTENTIOMETER i AVERAGE

Command:	**POTENTIOMETER i AVERAGE** **Advanced user**
Command Syntax:	**READ POTENTIOMETER i AVERAGE**
Range:	
Describe:	Read analog value of the potentiometer (linear or rotary). The optional **AVERAGE** and **RANGE** keywords can be appended to the command to obtain the current average count, or mapped range being used, if present, for the given potentiometer. **READ POTENTIOMETER i AVERAGE**
Result:	Read analog value of rotary encoder / potentiometer (uses averaging).
Type or Addressable Component:	Sensor

POTENTIOMETER i RANGE

Command:	POTENTIOMETER i RANGE **Advanced user**
Command Syntax:	**READ POTENTIOMETER i RANGE**
Range:	
Describe:	Read analog value of the potentiometer (linear or rotary). The optional **AVERAGE** and **RANGE** keywords can be appended to the command to obtain the current average count, or mapped range being used, if present, for the given potentiometer. **READ POTENTIOMETER i RANGE**
Result:	Read analog value of rotary encoder / potentiometer (uses averaging).
Type or Addressable Component:	Sensor

MOISTURE i

Command:	MOISTURE i
Command Syntax:	**READ MOISTURE i**
Range:	An integer value between 0 and 16383 (14 bit resolution)
Describe:	Return the current analog level reported by the moisture sensor specified. Supports the **AVERAGE** and **RANGE** options. **READ MOISTURE i** **READ MOISTURE i AVERAGE** **READ MOISTURE i RANGE**
Result:	Read analog value of moisture sensor (uses averaging).
Type or Addressable Component:	Sensor

MOISTURE i AVERAGE

Command:	**MOISTURE i AVERAGE** **Advanced user**
Command Syntax:	**READ MOISTURE i AVERAGE**
Range:	
Describe:	Return the current analog level reported by the moisture sensor specified. Supports the **AVERAGE** and **RANGE** options. **READ MOISTURE i AVERAGE**
Result:	Read analog value of moisture sensor (uses averaging).
Type or Addressable Component:	Sensor

MOISTURE i RANGE

Command:	**MOISTURE i RANGE**
Command Syntax:	**READ MOISTURE i RANGE**
Range:	
Describe:	Return the current analog level reported by the moisture sensor specified. Supports the **AVERAGE** and **RANGE** options. **READ MOISTURE i RANGE**
Result:	Read analog value of moisture sensor (uses averaging).
Type or Addressable Component:	Sensor

THERMISTOR i

Command:	**THERMISTOR i**
Command Syntax:	**READ THERMISTOR i**
Range:	
Describe:	Returns the current temperature reading from the associated thermistor sensor. Temperature is returned in Celsius.
Result:	Return current thermistor temperature in Celsius.
Type or Addressable Component:	Sensor

THERMISTOR i AVERAGE

Command:	**THERMISTOR i AVERAGE** **Advanced user**
Command Syntax:	**READ THERMISTOR i AVERAGE**
Range:	
Describe:	Returns the current temperature reading from the associated thermistor sensor. Temperature is returned in Celsius.
Result:	Return current thermistor temperature in Celsius.
Type or Addressable Component:	Sensor

THERMISTOR i CALIBRATION

Command:	**THERMISTOR i CALIBRATION** **Advanced user**
Command	**READ THERMISTOR i CALIBRATION**

Command:	**THERMISTOR i CALIBRATION** **Advanced user**
Syntax:	
Range:	
Describe:	Returns the current temperature reading from the associated thermistor sensor. Temperature is returned in Celsius.
Result:	Returns list with current {c1,c2,c3,r} values used for connected thermistor.
Type or Addressable Component:	Sensor

ANALOG.IN i

Command:	**ANALOG.IN i**
Command Syntax:	**READ.ANALOG.IN i**
Range:	
Describe:	Generic analog input sensor. **READ ANALOG.IN i** – will return the ADC reading on the analog input associated with the object.
Result:	Reads generic **ANALOG.IN** input object
Type or Addressable Component:	Sensor

ANALOG.IN i AVERAGE

Command:	**ANALOG.IN i AVERAGE** **Advanced user**
Command Syntax:	**READ.ANALOG.IN i AVERAGE**

Command:	**ANALOG.IN i AVERAGE** **Advanced user**
Range:	
Describe:	**READ ANALOG IN i AVERAGE** – gets the current averaging value for the object.
Result:	Reads generic **ANALOG.IN** input object
Type or Addressable Component:	Sensor

ANALOG.IN i RANGE

Command:	**ANALOG.IN i RANGE** **Advanced user**
Command Syntax:	**READ.ANALOG.IN i RANGE**
Range:	
Describe:	**READ ANALOG IN i RANGE** – returns the upper and lower range values associated with the object if specified, or error otherwise
Result:	Reads generic **ANALOG.IN** input object
Type or Addressable Component:	Sensor

ANALOG.OUT i

Command:	**ANALOG.OUT i**
Command Syntax:	**READ ANALOG.OUT i**
Range:	
Describe:	Returns current PWM duty cycle if the output is on, or 0 if not on.
Result:	Reads current PWM duty cycle on pin, 0 if none.

Command:	**ANALOG.OUT i**
Type or Addressable Component:	Control

DIGITAL.IN i

Command:	**DIGITAL.IN i**
Command Syntax:	**READ DIGITAL.IN i**
Range:	
Describe:	Returns the current state of the digital pin connected to the DIGITAL object, or the cached state of the digital output value last SET to the object.
Result:	Return 0 (low), 1 (high).
Type or Addressable Component:	Control/Sensor

AVERAGING

Command:	**AVERAGING** **Advanced user**
Command Syntax:	**READ AVERAGING**
Range:	
Describe:	Returns the current global setting for the analog averaging default value.
Result:	Return current oversampling/averaging count for sampling analog inputs (this is the GLOBAL default value currently in use).
Type or Addressable Component:	Setting

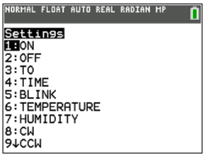
Settings

Settings menu contains operations to set the state of digital and analog pin operations such as the **LED** in the TI-Innovator™ Hub or a connected servo motor movement to states such as ON, OFF, CW (clockwise), and CCW (counterclockwise).

- 1: ON
- 2: OFF
- 3: TO
- 4: TIME
- 5: BLINK
- 6: TEMPERATURE
- 7: HUMIDITY
- 8: CW
- 9: CCW
- 0: TOGGLE

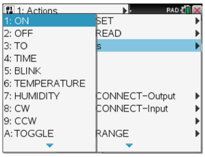
TI-84 Plus CE

See : TI-84 Plus CE Programming



TI-Nspire™ CX

See: TI-Nspire™ CX Programming



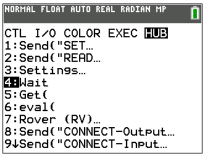
Wait

Wait suspends execution of a program for a given time. Maximum time is 100 seconds. During the wait time, the busy indicator is on in the top-right corner of the screen.

Wait may be used in TI-Innovator™ Hub programs to allow time for sensor or control communications prior to the program executing the next command line.

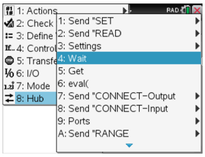
TI-84 Plus CE

See: TI-84 Plus CE Programming



TI-Nspire™ CX

See: TI-Nspire™ CX Programming



Wait

Command:	**Wait**
Command Syntax:	Wait *timeInSeconds* Suspends execution for a period of *timeInSeconds* seconds.

Command:	**Wait**
Range	0 through 100
Describe:	**Wait** may be used in TI-Innovator™ Hub programs to allow time for sensor or control communications prior to the program executing the next command line. **Wait** is particularly useful in a program that needs a brief delay to allow requested data to become available. The argument *timeInSeconds* must be an expression that simplifies to a decimal value in the range 0 through 100. The command rounds this value up to the nearest 0.1 seconds. **Note**: You can use the **Wait** command within a user-defined program but not within a function.
Result:	**Wait** suspends execution of a program for a given time. Maximum time is 100 seconds. During the wait time, the busy indicator is on in the top-right corner of the screen.
Type or Addressable Component:	Not Applicable

Get(

Get(Retrieves a value from a connected TI-Innovator™ Hub and stores the data to a variable on the receiving CE calculator.

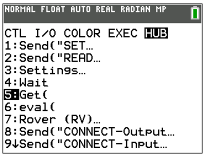
TI-84 Plus CE

Get(command definition is specific to the TI-8x calculator and the cable connection via DBus or USB. The CE calculator is USB connectivity only and here, **Get(** is designed for communication with the TI-Innovator™ Hub.

TI-Nspire™ CX

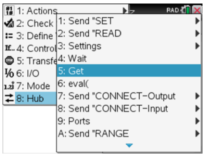
TI-84 Plus CE

See: TI-84 Plus CE Programming



TI-Nspire™ CX

See: TI-Nspire™ CX Programming



Get(

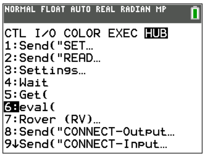
Command:	**Get(**
Command Syntax:	**TI-84 Plus CE**: **Get(***variable***)** **TI-Nspire™ CX** platform: **Get** [*promptString*,] *var*[, *statusVar*] **Get** [*promptString*,] *func*(*arg1, ...argn*) [, *statusVar*]
Range	
Describe:	
Result:	Programming command: Retrieves a value from a connected TI-Innovator™ Hub and assigns the value to variable *var*. The value must be requested: • In advance, through a **Send "READ ..."** command. — or — • By embedding a **"READ ..."** request as the optional *promptString* argument. This method lets you use a single command to request the value and retrieve it. (**TI-Nspire™ CX** platform only). Implicit simplification takes place. For example, a received string of "123" is interpreted as a numeric value. **The information below applies only on the TI-Nspire CX platform**: To preserve the string, use **GetStr** instead of **Get**. If you include the optional argument *statusVar*, it is assigned a value based on the success of the operation. A value of zero means that no data was received. In the second syntax, the *func()* argument allows a program to store the received string as a function definition. This syntax operates as if the program executed the command: Define *func(arg1, ...argn) = received string* The program can then use the defined function *func()*. **Note**: You can use the **Get** command within a user-defined program but not within a function.
Type or Addressable Component:	All input devices.

eval(

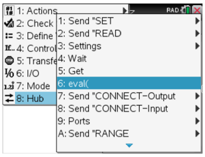
The software evaluates expression *Expr* and replaces the **eval()** statement with the result as a character string.

The argument *Expr* must simplify to a real number.

TI-84 Plus CE	**TI-Nspire™ CX**
See: TI-84 Plus CE Programming	See: TI-Nspire™ CX Programming



```
NORMAL FLOAT AUTO REAL RADIAN MP
CTL I/O COLOR EXEC HUB
1:Send("SET…
2:Send("READ…
3:Settings…
4:Wait
5:Get(
6:eval(
7:Rover (RV)…
8:Send("CONNECT-Output…
9↓Send("CONNECT-Input…
```

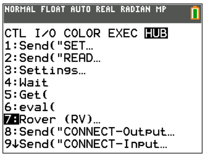
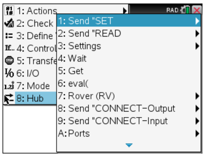


eval(

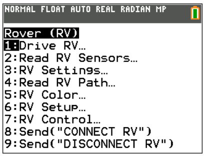
Command:	**eval(**
Command Syntax:	**eval(***Expr***) ⇒ string**
Range	
Describe:	The software evaluates expression *Expr* and replaces the **eval()** statement with the result as a character string. The argument *Expr* must simplify to a real number. **TI-84 Plus CE**: **eval()** can be used as a standalone command outside a TI-Innovator™ Hub command. **TI-Nspire™ CX** platform: **eval()** is valid only in the TI-Innovator™ Hub Command argument of programming commands **Get**, **GetStr**, and **Send**.
Result:	**TI-84 Plus CE**: For debugging purposes, using the command line Disp Ans immediately after a command line using Send(displays the complete string being sent. **TI-Nspire™ CX** platform: Although **eval()** does not display its result, you can view the resulting Hub command string after executing the command by inspecting any of the following special variables. *iostr.SendAns* *iostr.GetAns* *iostr.GetStrAns*
Type or	Not Applicable

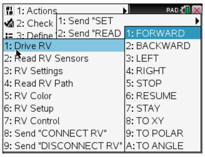
Command:	**eval(**
Addressable Component:	

ROVER (RV) Menu

Rover (RV)…	**TI-84 Plus CE**	**TI-Nspire™ CX**
		

- Drive RV…
- Read RV Sensors…
- RV Settings…
- Read RV Path…
- RV Color…
- RV Setup…
- RV Control…
- Send("CONNECT RV")
- Send("DISCONNECT RV")





Drive RV...

RV Drive Command Families

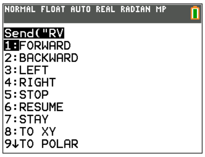
- Base Drive Commands (in the spirit of Turtle Graphics)
  - FORWARD, BACKWARD, RIGHT, LEFT, STOP, STAY
- Math Coordinate Drive Commands
  - Turn to Angle

Note: Drive commands have options for Speed, Time and Distance as appropriate

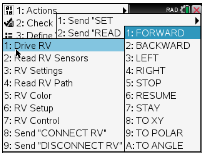
- See RV Settings for Machine-Level Control Commands
  - Set Left and Right Motor values for direction (CW/CCW) and level (0-255,Coast)
  - Read accumulated values for wheel encoder edges and gyro heading change.

- **Drive RV...**
  – Send("RV
    – FORWARD
    – BACKWARD
    – LEFT
    – RIGHT
    – STOP
    – RESUME
    – STAY
    – TO XY (INACTIVE in v1.2 Release)
    – TO POLAR (INACTIVE in v1.2 Release)
    – TO ANGLE

TI-84 PlusCE



TI-Nspire™ CX



RV FORWARD

Command:	RV FORWARD
Command Syntax:	**RV FORWARD [[SPEED s] [DISTANCE d] [TIME t]]**

Code Samples:	`Send ("RV FORWARD 0.5 M")`
	`Send ("RV FORWARD SPEED 0.22 M/S TIME 10")`
	
	`[SET] RV FORWARD`
	`[SET] RV FORWARD [DISTANCE] d [M|UNIT|REV]`
	`[SET] RV FORWARD [DISTANCE] d [M|UNIT|REV] SPEED s.ss [M/S|[UNIT/S]|REV/S]`
	`[SET] RV FORWARD [DISTANCE] d [M|UNIT|REV] TIME t`
	`[SET] RV FORWARD SPEED s [M/S|UNIT/S|REV/S] [TIME t]`
	`[SET] RV FORWARD TIME t [SPEED s.ss [M/S|[UNIT/S]|REV/S]]`

Range:	N/A
Describe:	RV moves forward a given distance (default 0.75 m). Default distance if specified is in UNIT (grid units). Optional M=meters, UNIT=grid-unit, REV=wheel-revolution. Default speed is 0.20 m/sec, max is 0.23 m/sec, min is 0.14 m/sec. Speed may be given and specified in meters/second, unit/second, revolutions/second.
Result:	Action to make the RV move in a forward direction
Type or Addressable Component:	Control **Note:** This Rover control command is sent and executed in a queue.

RV BACKWARD

Command:	**RV BACKWARD**
Command Syntax:	**RV BACKWARD**

Code Sample:	`Send("RV BACKWARD 0.5 M")`
	`Send("RV BACKWARD SPEED 0.22 M/S TIME 10")`
	--- 	
	`[SET] RV BACKWARD`
	`[SET] RV BACKWARD [DISTANCE] d [M|UNIT|REV]`
	`[SET] RV BACKWARD [DISTANCE] d [M|UNIT|REV]`
	`      SPEED s.ss [M/S|[UNIT/S]|REV/S]`
	`[SET] RV BACKWARD [DISTANCE] d [M|UNIT|REV]`
	`      TIME t`
	`[SET] RV BACKWARD SPEED s.ss`
	`      [M/S|UNIT/S|REV/S] [TIME t]`
	`[SET] RV BACKWARD TIME t`
	`      [SPEED s.ss [M/S|UNIT/S|REV/S]]`

Range:	N/A
Describe:	RV moves backward a given distance (default 0.75 m). Default distance if specified is in UNIT (grid units). Optional M=meters, UNIT=grid-unit, REV=wheel-revolution. Default speed is 0.20 m/sec, max is 0.23 m/sec, min is 0.14 m/sec. Speed may be given and specified in meters/second, unit/second, revolutions/second.
Result:	Action to make the RV move in a backward direction.
Type or Addressable Component:	Control **Note:** This Rover control command is sent and executed in a queue.

RV LEFT

Command:	**RV LEFT**
Command Syntax:	**RV LEFT**

Code Sample:	`Send "RV LEFT"`
	
	`[SET] RV LEFT [ddd [DEGREES]]`
	`[SET] RV LEFT [rrr RADIANS]`
	`[SET] RV LEFT [ggg GRADIANS]`

Range:	N/A
Describe:	Default turn is 90 degrees unless DEGREES, RADIANS, or GRADIANS keyword is present, and then the value is converted internally to degrees format from the specified units. Value given is ranged to a value between 0.0 and 360.0 degrees. The turn will be executed as a SPIN motion.
Result:	Turn Rover to the LEFT.
Type or Addressable Component:	Control **Note:** This Rover control command is sent and executed in a queue.

RV RIGHT

Command:	**RV RIGHT**
Command Syntax:	**RV RIGHT**

Code Sample:	`Send "RV RIGHT"`
	
	`[SET] RV RIGHT [ddd [DEGREES]]`
	`[SET] RV RIGHT [rrr RADIANS]`
	`[SET] RV RIGHT [ggg GRADIANS]`

Range:	N/A
Describe:	Default turn is 90 degrees unless DEGREES, RADIANS, or GRADIANS keyword is present, and then the value is converted internally to degrees format from the specified units. Value given is ranged to a value between 0.0 and 360.0 degrees. The turn will be executed as a SPIN motion.
Result:	Turn Rover to the RIGHT.
Type or	Control

Command:	**RV RIGHT**
Addressable Component:	**Note:** This Rover control command is sent and executed in a queue.

RV STOP

Command:	**RV STOP**
Command Syntax:	**RV STOP**

Code Sample:	`Send "RV STOP"`
	
	`[SET] RV STOP`
	
	`[SET] RV STOP CLEAR`

Range:	N/A
Describe:	The **RV** will stop any current movement immediately. That movement can be resumed from where it left off with a **RESUME** operation. Any movement commands will cause the queue to flush immediately, and begin the just-posted new movement operation
Result:	Stop processing Rover commands from the command queue, and leave pending operations in the queue. (immediate action). Queue can be resumed by **RESUME**.The **RV** will stop any current movement immediately. That movement can be resumed from where it left off with a **RESUME** operation. Any movement commands will cause the queue to flush immediately, and begin the just-posted new movement operation. Stop processing Rover commands from the command queue, and flush any pending operations left in the queue. (immediate action).
Type or Addressable Component:	Control **Note:** This Rover control command is executed immediately.

RV RESUME

Command:	**RV RESUME**
Command Syntax:	**RV RESUME**

Command:	**RV RESUME**

Code Sample:	`Send "RV RESUME"`
	
	`[SET] RV RESUME`

Range:	N/A
Describe:	Enable processing of Rover commands from the command queue. (immediate action), or resume (see RV STAY) operation.
Result:	Resume operation.
Type or Addressable Component:	Control **Note:** This Rover control command is sent and executed in a queue.

RV STAY

Command:	**RV STAY**
Command Syntax:	**RV STAY**

Code Sample:	`Send "RV STAY"`
	
	`[SET] RV STAY [[TIME] s.ss]`

Range:	N/A
Describe:	Tells RV to "stay" in place for an optionally specified amount of time in seconds. Default is 30.0 seconds.
Result:	RV stays in position.
Type or Addressable Component:	Control **Note:** This Rover control command is sent and executed in a queue.

RV TO XY (INACTIVE in v1.2 Release)

RV TO POLAR (INACTIVE in v1.2 Release)

RV TO ANGLE

Command:	**RV TO ANGLE**
Command Syntax:	**RV TO ANGLE**

Code Sample:	`Send "RV TO ANGLE"`
	
	`[SET] RV TO ANGLE rr.rr`
	`      [[DEGREES]|RADIANS|GRADIANS]`

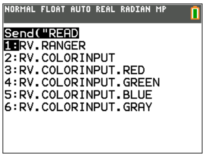
Range:	N/A
Describe:	
Result:	Spins the RV to the specified angle from current heading.
Type or Addressable Component:	Control **Note:** This Rover control command is sent and executed in a queue.

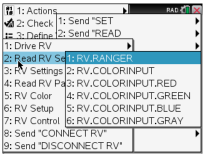
READ RV Sensors...

SEND("Read Sensor Commands

- Reading of low level sensors for learning foundations of robotics.

- **Read RV Sensors...**
  - Send("READ
    - RV.RANGER
    - RV.COLORINPUT
    - RV.COLORINPUT.RED
    - RV.COLORINPUT.GREEN
    - RV.COLORINPUT.BLUE
    - RV.COLORINPUT.GRAY





- **RV.RANGER:** Returns value in Meters.
- **RV.COLORINPUT:** Reads color sensor that is built into the RV.

RV.RANGER

Command:	**RV.RANGER**
Command Syntax:	**RV.RANGER**

Code Sample:	`Send("READ RV.RANGER")`
	`Get(R)`

Connects the Rover Vehicle to the TI-Innovator™ Hub. This establishes connections with the motor driver, color sensor, gyroscope, ultrasonic ranger, and proximity sensors.	`CONNECT RV`

Returns the current distance from the front of the RV to an obstacle. If there is no obstacle detected, a range of 10.00 meters is reported	`READ RV.RANGER`
	`Get(R)`

Command:	**RV.RANGER**
Range:	N/A
Describe:	The front-facing ultrasonic distance sensor. Returns measurements in meters. ~10.00 meters means no obstacle was detected.
Result:	Returns value in Meters.
Type or Addressable Component:	Sensor **Note:** This Rover sensor command is executed immediately.

RV.COLORINPUT

Command:	**RV.COLORINPUT**
Command Syntax:	**RV.COLORINPUT**

Code Sample:	`Send("READ RV.COLORINPUT")`
	`Get(C)`

Range:	1 thru 9
Describe:	Bottom-mounted color sensor detects the color of the surface. Can also detect gray-level scale of black (0) to white (255).
Result:	Returns current color sensor information. The return value is in the 1 – 9 range which maps to the colors below: **Color** — **Return value** Red — 1 Green — 2 Blue — 3 Cyan — 4 Magenta — 5 Yellow — 6 Black — 7 White — 8 Gray — 9
Type or Addressable Component:	Sensor **Note:** This Rover sensor command is executed immediately.

RV.COLORINPUT.RED

Command:	RV.COLORINPUT.RED
Command Syntax:	**RV.COLORINPUT.RED**

Code Sample:	`Send("READ RV.COLORINPUT.RED")`
	`Get(R)`

Range:	0 - 255
Describe:	Detect intensity of individual red components of surface. The results are in 0-255 range.
Result:	Returns current color sensor "red value".
Type or Addressable Component:	Sensor **Note:** This Rover sensor command is executed immediately.

RV.COLORINPUT.GREEN

Command:	RV.COLORINPUT.GREEN
Command Syntax:	**RV.COLORINPUT.GREEN**

Code Sample:	`Send("READ RV.COLORINPUT.GREEN")`
	`Get(G)`

Range:	0 - 255
Describe:	Detect intensity of individual green components of surface. The results are in 0-255 range.
Result:	Returns current color sensor "green" value.
Type or Addressable Component:	Sensor **Note:** This Rover sensor command is executed immediately.

RV.COLORINPUT.BLUE

Command:	**RV.COLORINPUT.BLUE**
Command Syntax:	**RV.COLORINPUT.BLUE**

Code Sample:	`Send("READ RV.COLORINPUT.BLUE")`
	`Get(B)`

Range:	0 - 255
Describe:	Detect intensity of individual blue components of surface. The results are in 0-255 range.
Result:	Returns current color sensor "blue" value.
Type or Addressable Component:	Sensor **Note:** This Rover sensor command is executed immediately.

RV.COLORINPUT.GRAY

Command:	**RV.COLORINPUT.GRAY**
Command Syntax:	**RV.COLORINPUT.GRAY**

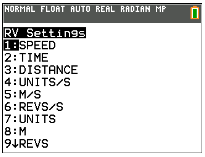
Code Sample:	`Send("READ RV.COLORINPUT.GRAY")`
	`Get(G)`

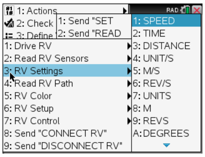
Range:	0 - 255
Describe:	Detect grayness of surface. The result will be in 0-255 range.
Result:	Returns an interpolated "grayscale" value based on 0.3*red + 0.59*green + 0.11*blue 0-black, 255 - white.
Type or Addressable Component:	Sensor **Note:** This Rover sensor command is executed immediately.

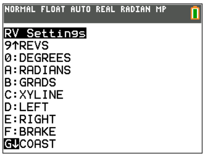
RV Settings...

RV Settings Commands

Settings menu for Rover contains other commands that support RV commands such as FORWARD or BACKWARD.







- **RV Settings...**
  - RV Settings
    - SPEED
    - TIME
    - DISTANCE
    - UNIT/S
    - M/S
    - REV/S
    - UNITS
    - M
    - REVS
    - DEGREES
    - RADIANS
    - GRADS
    - XYLINE
    - LEFT
    - RIGHT
    - BRAKE
    - COAST
    - CW
    - CCW

SPEED

Command:	**SPEED**
Command Syntax:	**SPEED**
Code Sample:	`SPEED`
Range:	N/A
Describe:	Speed may be given (default is 0.20 m/sec, max is 0.23 m/sec, min is 0.14 m/sec) and specified in meters/second, unit/second, revolutions/second,

Command:	SPEED
	or feet/second.
Result:	
Type or Addressable Component:	Setting

TIME

Command:	TIME
Command Syntax:	**TIME**
Code Sample:	`TIME`
Range:	N/A
Describe:	.
Result:	
Type or Addressable Component:	Setting

DEGREES

Command:	DISTANCE
Command Syntax:	**DISTANCE**
Code Sample:	`DISTANCE`
Range:	N/A
Describe:	
Result:	
Type or Addressable Component:	Setting

UNIT/S

Command:	**UNIT/S**
Command Syntax:	**UNIT/S**
Code Sample:	`UNIT/S`
Range:	N/A
Describe:	
Result:	
Type or Addressable Component:	Setting

M/S

Command:	**M/S**
Command Syntax:	**M/S**
Code Sample:	`M/S`
Range:	N/A
Describe:	
Result:	
Type or Addressable Component:	Setting

REV/S

Command:	**REV/S**
Command Syntax:	**REV/S**
Code Sample:	`REV/S`

Command:	**REV/S**
Range:	N/A
Describe:	
Result:	
Type or Addressable Component:	Setting

UNITS

Command:	**UNITS**
Command Syntax:	**UNITS**
Code Sample:	`UNITS`
Range:	N/A
Describe:	
Result:	
Type or Addressable Component:	Setting

M

Command:	**M**
Command Syntax:	**M**
Code Sample:	`M`
Range:	N/A
Describe:	
Result:	
Type or Addressable Component:	Setting

REVS

Command:	**REVS**
Command Syntax:	**REVS**
Code Sample:	`REVS`
Range:	N/A
Describe:	Return list of wheel revolutions traveled.
Result:	
Type or Addressable Component:	Setting

DEGREES

Command:	**DEGREES**
Command Syntax:	**DEGREES**
Code Sample:	`DEGREES`
Range:	N/A
Describe:	
Result:	
Type or Addressable Component:	Setting

RADIANS

Command:	**RADIANS**
Command Syntax:	**RADIANS**
Code Sample:	`RADIANS`

Command:	**RADIANS**
Range:	N/A
Describe:	
Result:	
Type or Addressable Component:	Setting

GRADS

Command:	**GRADS**
Command Syntax:	**GRADS**
Code Sample:	`GRADS`
Range:	N/A
Describe:	
Result:	
Type or Addressable Component:	Setting

XYLINE

Command:	**XYLINE**
Command Syntax:	**XYLINE**
Code Sample:	`XYLINE`
Range:	N/A
Describe:	
Result:	
Type or Addressable Component:	Setting

LEFT

Command:	LEFT
Command Syntax:	**LEFT**
Code Sample:	`LEFT`
Range:	N/A
Describe:	
Result:	
Type or Addressable Component:	Setting

RIGHT

Command:	RIGHT
Command Syntax:	**RIGHT**
Code Sample:	`RIGHT`
Range:	N/A
Describe:	
Result:	
Type or Addressable Component:	Setting

BRAKE

Command:	BRAKE
Command Syntax:	**BRAKE**
Code Sample:	`BRAKE`

Command:	BRAKE
Range:	N/A
Describe:	
Result:	
Type or Addressable Component:	Setting

COAST

Command:	COAST
Command Syntax:	**COAST**
Code Sample:	`COAST`
Range:	N/A
Describe:	
Result:	
Type or Addressable Component:	Setting

CW

Command:	CW
Command Syntax:	**CW**
Code Sample:	`CW`
Range:	N/A
Describe:	CW.b (value is positive) = Wheel rotate clockwise, backward direction CW.f (value is positive) = Wheel rotates clockwise, forward direction CW.f (value is negative) = Wheel rotates clockwise, forward direction

Command:	CW
Result:	
Type or Addressable Component:	Setting

CCW

Command:	CCW
Command Syntax:	**CCW**
Code Sample:	`CCW`
Range:	N/A
Describe:	CCW.f (value is positive) = Wheel rotates counter-clockwise, forward direction CCW.b (value is positive) = Wheel rotates counter-clockwise, backward direction CWW.b (value is negative) = Wheel rotates counter-clockwise, backward direction
Result:	
Type or Addressable Component:	Setting

Read RV Path…

Reading WAYPOINT and PATH

Tracking the RV's Path

In order to support analysis of the Rover during and after a run, the sketch will automatically measure the following information for each Drive command:

- X Coordinate on virtual grid
- Y Coordinate on virtual grid
- Time in seconds that the current command has been executing.
- Distance in coordinate units for the path segment.
- Heading in degrees (absolute terms measured Counter Clockwise with the X-axis as 0 degrees.
- Revolutions by the wheel in executing the current command
- Command number, tracks the number of commands executed, begins with 0.

The Path values will be stored in lists, starting with the segments associated with the earliest commands and going to the segments associated with the latest commands.

The drive command in progress, the **WAYPOINT**, will repeatedly update the last element in the Path lists as the Rover progresses toward the last waypoint.

When a drive command is completed a new waypoint is initiated and the dimension of the Path lists are incremented.

> **Note:** This implies that when all the drive commands in the queue are completed that another waypoint for the stopped state is automatically started. This is similar to the initial position where the RV is stationary and counting time.

Max number of waypoints: 80

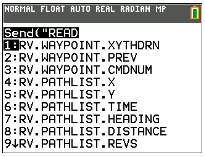
RV Position and Path

- Ability to read X,Y coordinate, Heading, Time and Distance for each drive command in execution.
- Will store path history in lists for plotting and analysis

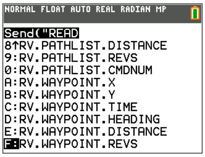
Note: Coordinate grid scale can be set by the user, default is 10cm per unit. The user will have options to set the origin of the grid.

- **Read RV Path…**
  - Send("READ
    - RV.WAYPOINT.XYTHDRN
    - RV.WAYPOINT.PREV
    - RV.WAYPOINT.CMDNUM
    - RV.PATHLIST.X
    - RV.PATHLIST.Y
    - RV.PATHLIST.TIME
    - RV.PATHLIST.HEADING
    - RV.PATHLIST.DISTANCE
    - RV.PATHLIST.REVS
    - RV.PATHLIST.CMDNUM
    - RV.WAYPOINT.X
    - RV.WAYPOINT.Y
    - RV.WAYPOINT.TIME
    - RV.WAYPOINT.HEADING
    - RV.WAYPOINT.DISTANCE
    - RV.WAYPOINT.REVS

TI-84 PlusCE

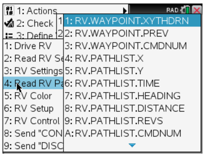


```
NORMAL FLOAT AUTO REAL RADIAN MP
Send("READ
1:RV.WAYPOINT.XYTHDRN
2:RV.WAYPOINT.PREV
3:RV.WAYPOINT.CMDNUM
4:RV.PATHLIST.X
5:RV.PATHLIST.Y
6:RV.PATHLIST.TIME
7:RV.PATHLIST.HEADING
8:RV.PATHLIST.DISTANCE
9↓RV.PATHLIST.REVS
```



```
NORMAL FLOAT AUTO REAL RADIAN MP
Send("READ
8↑RV.PATHLIST.DISTANCE
9:RV.PATHLIST.REVS
0:RV.PATHLIST.CMDNUM
A:RV.WAYPOINT.X
B:RV.WAYPOINT.Y
C:RV.WAYPOINT.TIME
D:RV.WAYPOINT.HEADING
E:RV.WAYPOINT.DISTANCE
F:RV.WAYPOINT.REVS
```

TI-Nspire™ CX



```
1: Actions
2: Check
3: Define
1: Drive RV
2: Read RV Se
3: RV Settings
4: Read RV Pa
5: RV Color
6: RV Setup
7: RV Control
8: Send "CON
9: Send "DISC

1: RV.WAYPOINT.XYTHDRN
2: RV.WAYPOINT.PREV
3: RV.WAYPOINT.CMDNUM
4: RV.PATHLIST.X
5: RV.PATHLIST.Y
6: RV.PATHLIST.TIME
7: RV.PATHLIST.HEADING
8: RV.PATHLIST.DISTANCE
9: RV.PATHLIST.REVS
A: RV.PATHLIST.CMDNUM
```

RV.WAYPOINT.XYTHDRN

Command:	**RV.WAYPOINT.XYTHDRN**
Command Syntax:	**RV.WAYPOINT.XYTHDRN**
Code Sample:	`Send("READ RV.WAYPOINT.XYTHDRN")`
Example:	Getting the distance traveled toward the current way-point from the last way-point

Code Sample:	`Send("READ RV.WAYPOINT.XYTHDRN")`
	Get(L_1)
	(L_1)(5)->D

Range:	N/A
Describe:	READ RV.WAYPOINT.XYTHDRN - read the x-coord, y-coord, time, heading, distance traveled, number of wheel revolutions, command number of the current waypoint. Returns a list with all these values as elements.
Result:	Return list of current way-point X, Y coordinates, Time, Heading, Distance, Revolutions, and command number.
Type or Addressable Component:	Returns Data

RV.WAYPOINT.PREV

Command:	**RV.WAYPOINT.PREV**
Command Syntax:	**RV.WAYPOINT.PREV**
Code Sample:	`Send("READ RV.WAYPOINT.PREV")`
Example:	Getting the distance traveled during the previous way-point.

Code Sample:	`Send("READ RV.WAYPOINT.PREV")`
	Get(L_1)
	(L_1)(5)->D

Command:	**RV.WAYPOINT.PREV**
Range:	N/A
Describe:	READ RV.WAYPOINT.PREV - read the x-coord, y-coord, time, heading, distance traveled, number of wheel revolutions, command number of the previous waypoint. Returns a list with all these values as elements.
Result:	Return list of the previous way-point X, Y coordinates, time, heading, distance, revolutions, and command number.
Type or Addressable Component:	Returns Data

RV.WAYPOINT.CMDNUM

Command:	**RV.WAYPOINT.CMDNUM**
Command Syntax:	**RV.WAYPOINT.CMDNUM**
Code Sample:	`Send("READ RV.WAYPOINT.CMDNUM")`
Example:	Program to determine if a drive command has completed without referring to a specific command number. **Note:** the **Wait** is intended to increase the probability of catching a difference in the Command Number.

Code Sample:	`Send("RV FORWARD 10")`
	`Send("READ RV.WAYPOINT.CMDNUM")`
	`Get(M)`
	`M->N`
	
	While M=N
	
	`Send("READ RV.WAYPOINT.CMDNUM")`
	`Get(N)`
	`End`
	
	Disp "Drive Command is completed"

Range:	N/A
Describe:	READ RV.WAYPOINT.CMDNUM - returns the last command number of

Command:	**RV.WAYPOINT.CMDNUM**
	the current waypoint.
Result:	Returns a value of 0 if the RV is currently "working" on a command and is either in motion, or running a STAY operation. This command will return a value of 1 when ALL queued operations are completed, nothing is remaining in the command queue, and the current operation has completed (and immediately after CONNECT RV).
Type or Addressable Component:	Returns Data

RV.PATHLIST.X

Command:	**RV.PATHLIST.X**
Command Syntax:	**RV.PATHLIST.X**
Code Samples:	`Send("READ RV.PATHLIST.X")`
Example:	Program to plot the RV path on the graph screen

Code Samples:	Plot1(xyLine, L_1, L_2,▫,BLUE)
	`Send("READ RV.PATHLIST.X")`
	`Get(L1)`
	`Send("READ RV.PATHLIST.Y")`
	`Get(L2)`
	`DispGraph`

Range:	N/A
Describe:	READ RV.PATHLIST.X - returns a list of X values from the beginning to and including the current Waypoint X value.
Result:	Return list of X coordinates traversed since last **RV.PATH CLEAR** or initial **CONNECT RV**.
Type or Addressable Component:	Returns Data

RV.PATHLIST.Y

Command:	**RV.PATHLIST.Y**
Command Syntax:	**RV.PATHLIST.Y**
Code Sample:	`Send("READ RV.PATHLIST.Y")`
Example:	Program to plot the RV path on the graph screen

Code Sample:	Plot1(xyLine, L_1, L_2,▫,BLUE)
	`Send("READ RV.PATHLIST.Y")`
	`Get(L1)`
	`Send("READ RV.PATHLIST.X")`
	`Get(L2)`
	`DispGraph`

Range:	N/A
Describe:	READ RV.PATHLIST.Y - returns a list of Y values from the beginning to and including the current Waypoint Y value.
Result:	Return list of Y coordinates traversed since last **RV.PATH CLEAR** or initial **CONNECT RV**.
Type or Addressable Component:	Returns Data

RV.PATHLIST.TIME

Command:	**RV.PATHLIST.TIME**
Command Syntax:	**RV.PATHLIST.TIME**
Code Sample:	`Send "READ RV.PATHLIST.TIME"`
Range:	N/A
Describe:	READ RV.PATHLIST.TIME - returns a list of the time in seconds from the beginning to and including the current Waypoint time value.

Command:	**RV.PATHLIST.TIME**
Result:	Return list of cumulative travel times for each successive way-point.
Type or Addressable Component:	Returns Data

RV.PATHLIST.HEADING

Command:	**RV.PATHLIST.HEADING**
Command Syntax:	**RV.PATHLIST.HEADING**
Code Sample:	`Send "READ RV.PATHLIST.HEADING"`
Range:	N/A
Describe:	READ RV.PATHLIST.HEADING - returns a list of the headings from the beginning to and including the current Waypoint heading value.
Result:	Return list of cumulative angular headings taken.
Type or Addressable Component:	Returns Data

RV.PATHLIST.DISTANCE

Command:	**RV.PATHLIST.DISTANCE**
Command Syntax:	**RV.PATHLIST.DISTANCE**
Example:	Getting the cumulative distance traveled since the beginning of a journey by the RV

Code Sample:	`Send "READ RV.PATHLIST.DISTANCE"`
	Get(L_1)
	sum(L_1)

Range:	N/A
Describe:	READ RV.PATHLIST.DISTANCE - returns a list of the distances traveled from the beginning to and including the current Waypoint distance value.

Command:	**RV.PATHLIST.DISTANCE**
Result:	Return list of cumulative distances traveled.
Type or Addressable Component:	Returns Data

RV.PATHLIST.REVS

Command:	**RV.PATHLIST.REVS**
Command Syntax:	**RV.PATHLIST.REVS**
Code Sample:	`Send "READ RV.PATHLIST.REVS"`
Range:	N/A
Describe:	READ RV.PATHLIST.REVS - returns a list of the number of revolutions traveled from the beginning to and including the current Waypoint revolutions value.
Result:	Return list of wheel revolutions traveled.
Type or Addressable Component:	Returns Data

RV.PATHLIST.CMDNUM

Command:	**RV.PATHLIST.CMDNUM**
Command Syntax:	**RV.PATHLIST.CMDNUM**
Code Sample:	`Send "READ RV.PATHLIST.CMDNUM"`
Range:	N/A
Describe:	READ RV.PATHLIST.CMDNUM - returns a list of command numbers for the path

Command:	**RV.PATHLIST.CMDNUM**
Result:	Return list of commands used to travel to the current way-point entry. 0 - Start of Way-points (if first action is a STAY, then no START is given, but a STAY will be shown instead.) 1 - Travel forward 2 - Travel backward 3 - Left spin motion 4 - Right spin motion 5 - Left turn motion 6 - Right turn motion 7 - Stay (no motion) the time the RV stays at the current position is given in the TIME list. 8 - RV is currently in motion on this way-point traversal.
Type or Addressable Component:	Returns Data

RV.WAYPOINT.X

Command:	**RV.WAYPOINT.X**
Command Syntax:	**RV.WAYPOINT.X**
Code Samples:	`Send("READ RV.WAYPOINT.X")`
Range:	N/A
Describe:	READ RV.WAYPOINT.X - returns x coordinate of current waypoint.
Result:	Return current way-point X coordinate.
Type or Addressable Component:	Returns Data

RV.WAYPOINT.Y

Command:	**RV.WAYPOINT.Y**
Command Syntax:	**RV.WAYPOINT.Y**

Command:	**RV.WAYPOINT.Y**
Code Samples:	`Send("READ RV.WAYPOINT.Y")`
Range:	N/A
Describe:	READ RV.WAYPOINT.Y - returns x coordinate of current waypoint.
Result:	Return current way-point Y coordinate.
Type or Addressable Component:	Returns Data

RV.WAYPOINT.TIME

Command:	**RV.WAYPOINT.TIME**
Command Syntax:	**RV.WAYPOINT.TIME**
Code Sample:	`Send("READ RV.WAYPOINT.TIME")`
Range:	N/A
Describe:	READ RV.WAYPOINT.TIME - returns time spent traveling from previous to current waypoint
Result:	Return total cumulative way-point travel time value in seconds.
Type or Addressable Component:	Returns Data

RV.WAYPOINT.HEADING

Command:	**RV.WAYPOINT.HEADING**
Command Syntax:	**RV.WAYPOINT.HEADING**
Code Sample:	`Send("READ RV.WAYPOINT.HEADING")`

Command:	**RV.WAYPOINT.HEADING**
Range:	N/A
Describe:	READ RV.WAYPOINT.HEADING - returns absolute heading of current waypoint
Result:	Return current absolute heading in degrees. (+h = counter-clockwise, -h = clockwise.)
Type or Addressable Component:	Returns Data

RV.WAYPOINT.DISTANCE

Command:	**RV.WAYPOINT.DISTANCE**
Command Syntax:	**RV.WAYPOINT.DISTANCE**
Code Sample:	`Send("READ RV.WAYPOINT.DISTANCE")`
Range:	N/A
Describe:	READ RV.WAYPOINT.DISTANCE - returns distance traveled between previous and current waypoint
Result:	Return cumulative total distance traveled in meters.
Type or Addressable Component:	Returns Data

RV.WAYPOINT.REVS

Command:	**RV.WAYPOINT.REVS**
Command Syntax:	**RV.WAYPOINT.REVS**
Code Sample:	`Send("READ RV.WAYPOINT.REVS")`
Range:	N/A

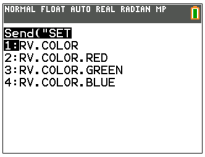
Command:	**RV.WAYPOINT.REVS**
Describe:	READ RV.WAYPOINT.REVS - returns number of revolutions needed to travel between previous and current waypoint
Result:	Return total revolutions of the wheels performed to travel the cumulative distance to the current way-point.
Type or Addressable Component:	Returns Data

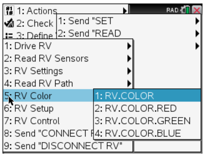
RV Color…

Send("SET Commands

RGB LED on Rover - This supports the same commands and parameters as the RGB LED on the TI-Innovator™ Hub.

- **RV Color…**
  - Send("SET
    - RV.COLOR
    - RV.COLOR.RED
    - RV.COLOR.GREEN
    - RV.COLOR.BLUE





RV.COLOR

Command:	**RV.COLOR**
Command Syntax:	**RV.COLOR**

Code Sample:	`Send "SET RV.COLOR`
	
	`[SET] RV.COLOR rr gg bb [[BLINK] b [[TIME] s.ss]]`

Range:	N/A
Describe:	Set the RGB color to be displayed on the Rover's RGB LED. Same syntax as for all RGB LED operations with COLOR, etc.
Result:	Return the current RGB color, as a three-element list, that is being displayed on the Rover's RGB LED
Type or Addressable Component:	Control **Note:** This Rover control command is sent and executed in a queue.

RV.COLOR.RED

Command:	**RV.COLOR.RED**
Command Syntax:	**RV.COLOR.RED**
Code Sample:	`Send "SET RV.COLOR.RED`

Command:	RV.COLOR.RED
	`[SET] RV.COLOR.RED rr [[BLINK] b [[TIME] s.ss]]`
Range:	N/A
Describe:	
Result:	Set the RED color to be displayed on the Rover's RGB LED.
Type or Addressable Component:	Control **Note:** This Rover control command is sent and executed in a queue.

RV.COLOR.GREEN

Command:	RV.COLOR.GREEN
Command Syntax:	**RV.COLOR.GREEN**

Code Sample:	`Send "SET RV.COLOR.GREEN`
	
	`[SET] RV.COLOR.GREEN gg [[BLINK] b [[TIME] s.ss]]`

Range:	N/A
Describe:	
Result:	Set the GREEN color to be displayed on the Rover's RGB LED.
Type or Addressable Component:	Control **Note:** This Rover control command is sent and executed in a queue.

RV.COLOR.BLUE

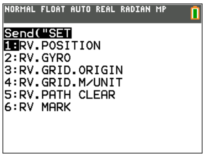
Command:	RV.COLOR.BLUE
Command Syntax:	**RV.COLOR.BLUE**
Code Sample:	`Send "SET RV.COLOR.BLUE`

Command:	**RV.COLOR.BLUE**
	`[SET] RV.COLOR.BLUE bb [[BLINK] b [[TIME] s.ss]]`
Range:	N/A
Describe:	
Result:	Set the BLUE color to be displayed on the Rover's RGB LED.
Type or Addressable Component:	Control **Note:** This Rover control command is sent and executed in a queue.

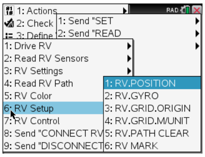
RV Setup…

Send("SET Commands

- **RV Setup…**
  - Send("SET
    - RV.POSITION
    - RV.GYRO
    - RV.GRID.ORIGIN
    - RV.GRID.M/UNIT
    - RV.PATH CLEAR
    - RV MARK



```
NORMAL FLOAT AUTO REAL RADIAN MP
Send("SET
1:RV.POSITION
2:RV.GYRO
3:RV.GRID.ORIGIN
4:RV.GRID.M/UNIT
5:RV.PATH CLEAR
6:RV MARK
```



```
1: Actions          1: Send "SET
2: Check            2: Send "READ
3: Define
1: Drive RV
2: Read RV Sensors
3: RV Settings
4: Read RV Path     1: RV.POSITION
5: RV Color         2: RV.GYRO
6: RV Setup         3: RV.GRID.ORIGIN
7: RV Control       4: RV.GRID.M/UNIT
8: Send "CONNECT RV 5: RV.PATH CLEAR
9: Send "DISCONNECT 6: RV MARK
```

RV.POSITION

Command:	RV.POSITION
Command Syntax:	**RV.POSITION**

Code Sample:	`Send "SET RV.POSITION"`
	
	`[SET] RV.POSITION xxx yyy`
	`      [hhh [[DEGREES]|RADIANS|GRADIANS]]`

Range:	N/A
Describe:	Sets the coordinate position and optionally the heading of the Rover on the virtual grid.
Result:	Rover configuration is updated.
Type or Addressable Component:	Setting

RV.GYRO

Command:	RV.GYRO
Command Syntax:	**RV.GYRO**
Code Sample:	`Send "SET RV.GYRO"`

Command:	RV.GYRO
Range:	N/A
Describe:	Sets the on-board Gyroscope.
Result:	
Type or Addressable Component:	Control (for Gyroscope)

RV.GRID.ORIGIN

Command:	RV.GRID.ORIGIN
Command Syntax:	**RV.GRID.ORIGIN**

Code Sample:	`Send "SET RV.GRID.ORIGIN"`
	
	`[SET} RV.GRID.ORIGIN`

Range:	N/A
Describe:	Sets RV as being at current grid origin point of (0,0). The "heading" is set to 0.0 resulting in the current position of the RV now set to pointing down a virtual x-axis toward positive x values.
Result:	
Type or Addressable Component:	Setting

RV.GRID.M/UNIT

Command:	RV.GRID.M/UNIT
Command Syntax:	**RV.GRID.M/UNIT**

Code Sample:	`Send "SET RV.GRID.M/UNIT"`
	
	`[SET] RV.GRID.M/UNIT nnn`

Command:	**RV.GRID.M/UNIT**
Range:	N/A
Describe:	Set the size of a "grid unit" on the virtual grid. Default is 10 units per meter (100 mm / 10 cm per unit grid). A value of 5 means 5 units per meter or 200 mm / 20 cm per unit grid). A value of 20 means 20 units per meter, or 50 mm / 5 cm per unit grid.
Result:	
Type or Addressable Component:	Setting

RV.PATH CLEAR

Command:	**RV.PATH CLEAR**
Command Syntax:	**RV.PATH CLEAR**

Code Sample:	`Send "SET RV.PATH CLEAR"`
	
	`[SET] RV.PATH CLEAR`

Range:	N/A
Describe:	Clears any pre-existing path / waypoint information. Recommended before doing a sequence of movement operations where waypoint / path-list information is desired.
Result:	
Type or Addressable Component:	Setting

RV MARK

Command:	**RV MARK**
Command Syntax:	**RV MARK**

Code Sample:	`Send "SET RV MARK"`
	
	`[SET] RV MARK [[TIME] s.ss]`

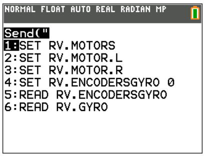
Command:	**RV MARK**
Range:	N/A
Describe:	Enable RV to make a "mark" with a pen at the specified time interval (default is 1 second if not specified). A time value of 0.0 turns OFF marking. Marking ONLY happens if the Rover is moving in a forward direction.
Result:	
Type or Addressable Component:	Setting (for Rover)

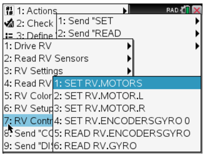
RV Control…

SEND(" Commands

Wheel commands and other commands relevant for learning foundations of the Rover vehicle.

- **RV Control …**
  - Send("
    - SET RV.MOTORS
    - SET RV.MOTOR.L
    - SET RV.MOTOR.R
    - SET RV.ENCODERSGYRO 0
    - READ RV.ENCODERSGYRO
    - READ RV.GYRO





SET RV.MOTORS

Command:	**SET RV.MOTORS**
Command Syntax:	**SET RV.MOTORS**

Code Sample:	`Send "SET RV.MOTORS"`
	
	`[SET] RV.MOTORS [LEFT][CW|CCW]`
	`    <pwm value|BRAKE|COAST>`
	`    [RIGHT][CW|CCW]`
	`    <pwm value|BRAKE|COAST>`
	`    [DISTANCE ddd [M|[UNITS]|REV|FT]]`
	`    | [TIME s.ss]`

Range:	N/A
Describe:	Set left or right or both motor PWM values. Negative values imply **CCW** and Positive values imply **CW**. Left **CW**=backward motion. Left **CCW**=forward motion. Right CW=forward motion, Right **CCW**=backward motion. PWM values may be numeric from -255 to +255, or keywords "**COAST**" or "**BRAKE**". Value of 0 is stop (coast). Use of the **DISTANCE** option is only available if the **RV** is connected with all sensors. **CONNECT RV MOTORS** means no sensors are available to measure distance, so the **DISTANCE** option is an error in this instance.
Result:	Both the LEFT and RIGHT motor, managed as a single object for direct control (advanced) use.

Command:	**SET RV.MOTORS**
Type or Addressable Component:	Control **Note:** This Rover control command is sent and executed in a queue.

SET RV.MOTOR.L

Command:	**SET RV.MOTOR.L**
Command Syntax:	**SET RV.MOTOR.L**

Code Sample:	`Send "SET RV.MOTOR.L"`
	`[SET] RV.MOTOR.L [CW|CCW] <+/-pwm value|BRAKE|COAST>`
	`[TIME s.ss] | [DISTANCE ddd [[UNITS] |M|REV|FT]]`

Range:	N/A
Describe:	Set left motor direct PWM value. **CCW** = forward, **CW** = backward, pwm value negative = forward, positive = backward. **TIME** option available in all modes, **DISTANCE** option available only when **RV** is fully connected (not the **RV MOTORS** option).
Result:	Left wheel motor and control for direct control (advanced) use.
Type or Addressable Component:	Control **Note:** This Rover control command is sent and executed in a queue.

SET RV.MOTOR.R

Command:	**SET RV.MOTOR.R**
Command Syntax:	**SET RV.MOTOR.R**

Code Sample:	`Send "SET RV.MOTOR.R"`
	
	`[SET] RV.MOTOR.R [CW|CCW] <+/-pwm value|BRAKE|COAST>`
	`[TIME s.ss] | [DISTANCE ddd [[UNITS] |M|REV|FT]]`

Command:	**SET RV.MOTOR.R**
Range:	N/A
Describe:	Set right motor direct PWM value. **CW** = forward, **CCW** = backward, pwm value positive = forward, negative = backward. **TIME** option available in all modes, **DISTANCE** option available only when **RV** is fully connected (not the **RV MOTORS** option).
Result:	Right wheel motor and control for direct control (advanced) use.
Type or Addressable Component:	Control **Note:** This Rover control command is sent and executed in a queue.

SET RV.ENCODERSGYRO 0

Command:	**SET RV.ENCODERSGYRO 0**
Command Syntax:	**SET RV.ENCODERSGYRO 0**
Code Sample:	`Send "SET RV.ENCODERSGYRO 0"`
Range:	N/A
Describe:	Reset the left and right encoder, coupled with the gyro and operating time information.
Result:	
Type or Addressable Component:	Control **Note:** This Rover control command is sent and executed in a queue.

READ RV.ENCODERSGYRO

Command:	**READ RV.ENCODERSGYRO**
Command Syntax:	**READ RV.ENCODERSGYRO**
Code Sample:	`Send "READ RV.ENCODERSGYRO"`
Range:	N/A

Command:	**READ RV.ENCODERSGYRO**
Describe:	The left and right encoder, coupled with the gyro and operating time information.
Result:	List of values of current left and right encoder, coupled with gyro and operating time information
Type or Addressable Component:	Control **Note:** This Rover READ command is executed immediately.

READ RV.GYRO

Command:	**READ RV.GYRO**
Command Syntax:	**READ RV.GYRO**

Code Sample:	`Send "READ RV.GYRO"`
	
	`READ RV.GYRO [[DEGREES]|RADIANS|GRADIANS]`

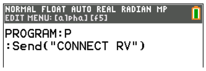
Range:	N/A
Describe:	The gyroscope is used to maintain the heading of Rover while it's in motion. It can also be used to measure the change in angle during turns. The gyroscope is ready to use after the **CONNECT RV** command is processed. The GYRO object shall be usable even when the RV is not in motion.
Result:	Returns current gyro sensor angular deviation from 0.0, reading partially drift-offset compensated.
Type or Addressable Component:	Control **Note:** This Rover READ command is executed immediately.

Send "CONNECT RV"

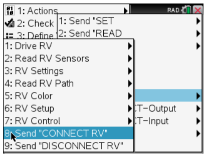
SEND("CONNECT RV") Commands

CONNECT RV - initializes the hardware connections.

- Connects RV and inputs and outputs built into the RV.
- Resets the Path and the Grid Origin.
- Sets the units per meter to default value.
- **Send("CONNECT RV")**



```
NORMAL FLOAT AUTO REAL RADIAN MP
EDIT MENU: [alpha] [f5]
PROGRAM:P
:Send("CONNECT RV")
```



CONNECT RV

Command:	**CONNECT RV**
Command Syntax:	CONNECT RV [MOTORS]

Code Sample:	`Send "CONNECT RV"`
	`Send "CONNECT RV MOTORS"`

Range:	N/A
Describe:	The "**CONNECT RV**" command configures the TI-Innovator™ Hub software to work with the TI-Innovator™ Rover. It establishes the connections to the various devices on the Rover – two motors, two encoders, one gyroscope, one RGB LED and one color sensor. It also clears the various counters and sensor values. The optional 'MOTORS' parameter configures only the motors and allows direct control of motors without the additional peripherals.
Result:	Connects the Rover Vehicle to the TI-Innovator™ Hub. This establishes connections with the motor driver, color sensor, gyroscope, ultrasonic ranger, and RGB LED. The Rover is now ready to be programmed
Type or Addressable Component:	All components of the Rover - two motors, two encoders, one gyroscope, one RGB LED and one color sensor.

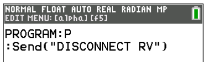
Send "DISCONNECT RV"

SEND("DISCONNECT RV") Commands

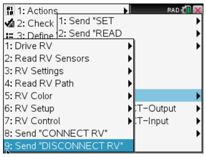
DISCONNECT RV - disconnects all the hardware peripherals from the Hub.

Format: Send("DISCONNECT RV")

- Send("DISCONNECT RV")



```
NORMAL FLOAT AUTO REAL RADIAN MP
EDIT MENU: [alpha] [f5]
PROGRAM:P
:Send("DISCONNECT RV")
```



DISCONNECT RV

Command:	DISCONNECT RV
Command Syntax:	DISCONNECT RV

Code Sample:	`Send "DISCONNECT RV"`
	
	`DISCONNECT RV`

Range:	N/A
Describe:	The "**DISCONNECT RV**" command removes the logical connections between the TI-Innovator™ Hub and the TI-Innovator™ Rover. It also clears the counters and sensor values. It allows the use of the breadboard port of the TI-Innovator™ Hub with other devices.
Result:	The TI-Innovator™ Hub is now logically disconnected from the TI-Innovator™ Rover
Type or Addressable Component:	N/A

CONNECT - Output

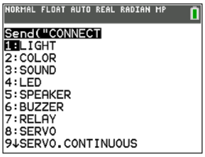
CONNECT associates a given control or sensor with a pin or port on the TI-Innovator. If the specified control or sensor is currently in use, an error will be generated. If the pin or port specified in the **CONNECT** command is currently in use, an error will be generated.

The **CONNECT** command does not generate an active response, but a variety of errors may occur during a connection attempt, such as pin-in-use, unsupported, invalid options, bad options, etc.

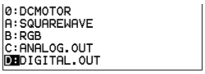
CONNECT 'something i' [TO] IN1/IN2/IN3/OUT1/OUT2/OUT3/BB1

Command:	**CONNECT**
Command Syntax:	**CONNECT**
Range:	
Describe:	Associates a sensor or control with a given port or pin(s). Places the respective pin(s) in use
Result:	
Type or Addressable Component:	

TI-84 Plus CE

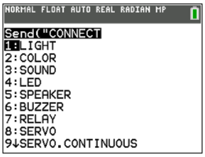


```
NORMAL FLOAT AUTO REAL RADIAN MP
Send("CONNECT
1:LIGHT
2:COLOR
3:SOUND
4:LED
5:SPEAKER
6:BUZZER
7:RELAY
8:SERVO
9↓SERVO.CONTINUOUS
```

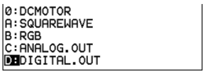


```
0:DCMOTOR
A:SQUAREWAVE
B:RGB
C:ANALOG.OUT
D:DIGITAL.OUT
```

TI-Nspire™ CX



```
NORMAL FLOAT AUTO REAL RADIAN MP
Send("CONNECT
1:LIGHT
2:COLOR
3:SOUND
4:LED
5:SPEAKER
6:BUZZER
7:RELAY
8:SERVO
9↓SERVO.CONTINUOUS
```



```
0:DCMOTOR
A:SQUAREWAVE
B:RGB
C:ANALOG.OUT
D:DIGITAL.OUT
```

LIGHT

Command:	**LIGHT**
Command Syntax:	**CONNECT LIGHT**
Range:	

Command:	**LIGHT**
Describe:	This command is not needed for typical use since the on-board LIGHT (i.e. RED LED) is automatically connected. Re-connect a previously disconnected on-board RED LED. The LIGHT is always connected when the system is reset, or powered-on, or the BEGIN command is used to restore system state. No pin number is required. **CONNECT LIGHT**
Result:	Connects on-board digital LED (red) to known fixed pin. Digital only.
Type or Addressable Component:	Control

COLOR

Command:	**COLOR**
Command Syntax:	**CONNECT COLOR**
Range:	
Describe:	This command is not needed for typical use since the on-board COLOR LED is automatically connected. (Re-)connect the internal **RGB LED**. No pins are required for this command to operate as the internal pins are known. This sensor is automatically connected when the TI-Innovator is initially powered, and when the **BEGIN** command is used. When disconnected, two **PWM** signals are freed for external use by other pins. **CONNECT COLOR**
Result:	Connects on-board **RGB LED** to fixed pins on board. Uses 3 **PWM**s.
Type or Addressable Component:	Control

SOUND

Command:	**SOUND**
Command Syntax:	**CONNECT SOUND**

Command:	**SOUND**
Range:	
Describe:	This command is not needed for typical use since the on-board object SOUND is automatically connected. Re-connect the on-board speaker for sound generation. No pin needed as it uses known, fixed pin for signal. **CONNECT SOUND**
Result:	Connects on-board speaker to fixed output digital pin.
Type or Addressable Component:	Control

LED i [TO] OUT n/BB n

Command:	**LED i [TO] OUT n/BB n**
Command Syntax:	**CONNECT LED i [TO] OUT n/BB n**
Range:	
Describe:	This object provides the ability to connect external **LED** objects. The **LED** object is either connected to a **PWM** function (if available, and the pin connecting to supports it), or a digital output pin which will be driven at 50% duty cycle; or the specified blink rate if one is specified in the **SET** operation. **CONNECT LED 1i [TO] BB3** **CONNECT LED 2i [TO] OUT1**
Result:	LED connected to specific port.
Type or Addressable Component:	Control

SPEAKER i [TO] OUT n/BB n

Command:	**SPEAKER i [TO] OUT n/BB n**
Command Syntax:	**CONNECT SPEAKER i [TO] OUT n/BB n**

Command:	**SPEAKER i [TO] OUT n/BB n**
Range:	
Describe:	Connect an external speaker for sound generation. Requires a digital output pin. **CONNECT SPEAKER 1 [TO] OUT 1** **CONNECT SPEAKER i [TO] BB 3**
Result:	Connect a speaker to a digital output port or pin.
Type or Addressable Component:	Control

BUZZER i [TO] OUT n/BB n

Command:	**BUZZER i [TO] OUT n/BB n**
Command Syntax:	**CONNECT BUZZER i [TO] OUT n/BB n**
Range:	
Describe:	Connect an external active buzzer to an output digital pin. Active buzzers play a tone when their signal is set high/on, and stop the tone when the signal is dropped to ground. For piezo or passive buzzers, use the **SPEAKER** object type to allow generation of multiple tones. **CONNECT BUZZER i [TO] OUT1**
Result:	**ACTIVE** buzzers connect to a digital pin.
Type or Addressable Component:	Control

RELAY i [TO] OUT n/BB n

Command:	**RELAY i [TO] OUT n/BB n**
Command Syntax:	**CONNECT RELAY i [TO] OUT n/BB n**
Range:	
Describe:	With external power required, connect a relay module to a given control

Command:	**RELAY i [TO] OUT n/BB n**
	signal pin. Since the control is digital, as long as external power is present, any pin may be used. **CONNECT RELAY 1 [TO] BB 3** **CONNECT RELAY 1 [TO] OUT 2**
Result:	Relays.
Type or Addressable Component:	Control

SERVO i [TO] OUT n

Command:	**SERVO i [TO] OUT n**
Command Syntax:	**CONNECT SERVO i [TO] OUT n**
Code Sample:	
Range:	
Describe:	Used to connect either a normal sweep servo motor, or a continuous servo motor. External power must be provided before attempting to connect the servo. **CONNECT SERVO 1 [TO] OUT 1**
Result:	Servo motor is connected to port.
Type or Addressable Component:	Control

SERVO.CONTINUOUS i [TO] BB 6

Command:	**SERVO.CONTINUOUS i [TO] BB 6**
Command Syntax:	**CONNECT SERVO.CONTINUOUS i [TO] BB 6**
Code Sample:	

Command:	SERVO.CONTINUOUS i [TO] BB 6
Range:	
Describe:	Used to connect either a normal sweep servo motor, or a continuous servo motor. External power must be provided before attempting to connect the servo. **CONNECT SERVO.CONTINUOUS i [TO] BB 6**
Result:	Servo motor with -90 to 90 degree movement.
Type or Addressable Component:	Control

DCMOTOR i [TO] OUT n/BB n

Command:	DCMOTOR i [TO] OUT n/BB n
Command Syntax:	**CONNECT DCMOTOR i [TO] OUT n/BB n**
Range:	
Describe:	Connect an external **DC Motor** object. This object requires the presence of power on the external power connector to allow operation. These objects share the number-space with the **SQUAREWAVE** output objects and **ANALOG.OUT** objects. The associated pin is configured as a digital output signal. **CONNECT DCMOTOR i [TO] OUT1**
Result:	Connect **DCMOTOR** to a digital output pin.
Type or Addressable Component:	Control

RGB i / COLOR [TO] BB r BB g BB b

Command:	RGB i / COLOR [TO] BB r BB g BB b
Command Syntax:	**CONNECT RGB i / COLOR [TO] BB r BB g BB b**
Range:	

Command:	**RGB i / COLOR [TO] BB r BB g BB b**
Describe:	Connects an external **RGB LED** to three **PWM**-capable pins. If insufficient PWM pins are available for mapping to PWM function, an error will be given. To connect an external RGB, the on-board **RGB LED** should be **DISCONNECT**ed before the attempt to connect the external RGB is performed. **CONNECT RGB 1 [TO] BB8 BB9 BB10**
Result:	Digital pins supporting PWM.
Type or Addressable Component:	Control

SQUAREWAVE i [TO] OUT n/BB n

Command:	**SQUAREWAVE i [TO] OUT n/BB n**
Command Syntax:	**CONNECT SQUAREWAVE i [TO] OUT n/BB n**
Range:	
Describe:	Connect a software generated digital waveform generator object. These objects share the number-space with the **DCMOTOR** and **ANALOG.OUT** output objects. The associated pin is configured as a digital output signal. **CONNECT SQUAREWAVE n [TO] BB 2**
Result:	Digital output squarewave from 1 to 500 hz.
Type or Addressable Component:	Control

ANALOG.OUT i [TO] OUT i/BB i

Command:	**ANALOG.OUT i [TO] OUT n/BB n**
Command Syntax:	**CONNECT ANALOG.OUT i [TO] OUT n/BB n**
Range:	
Describe:	Connect a generic "analog" output control to a pin/port that supports analog input. **ANALOG.OUT** shares number space with **DCMOTOR** and **SQUAREWAVE** objects.

Command:	**ANALOG.OUT i [TO] OUT n/BB n**
	CONNECT ANALOG.OUT i [TO] OUT 1 **CONNECT ANALOG.OUT i [TO] BB 4** **CONNECT ANALOG.OUT i [TO] BB 1**
Result:	Connect analog output to pin. If pin supports hardware pulse with modulation (**PWM**), the object uses. If the pin does not support hardware-generated **PWM**, the sketch will generate **PWM** in software at 490 Hz with the duty cycle specfic between 0 (none) and 255 (full on).
Type or Addressable Component:	Control

DIGITAL.OUT i [TO] OUT n/BB n [[AS] OUTPUT]

Command:	**DIGITAL.OUT i [TO] OUT n/BB n [[AS] OUTPUT]**
Command Syntax:	**CONNECT DIGITAL.OUT i [TO] OUT n/BB n**
Range:	
Describe:	Connects a generic digital object to a specified pin or port. The connected pin is configured either as a digital output signal, default LOW, or a digital input signal, default INPUT with no pullup or pulldown enabled. The index number can refer to either an input or output. The index is shared by both items since a **DIGITAL** signal can be either an input or output. **CONNECT DIGITAL.OUT 1 [TO] OUT n/BB n**
Result:	Connect pin to digital object default output state, default **OUTPUT**, low.
Type or Addressable Component:	Control/Sensor

CONNECT-Input

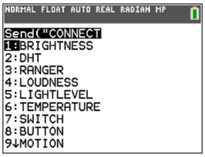
CONNECT associates a given control or sensor with a pin or port on the TI-Innovator. If the specified control or sensor is currently in use, an error will be generated. If the pin or port specified in the **CONNECT** command is currently in use, an error will be generated.

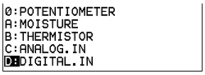
The **CONNECT** command does not generate an active response, but a variety of errors may occur during a connection attempt, such as pin-in-use, unsupported, invalid options, bad options, etc.

CONNECT 'something i' [TO] IN1/IN2/IN3/OUT1/OUT2/OUT3/BB1

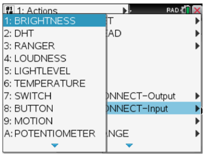
Command:	**CONNECT**
Command Syntax:	**CONNECT**
Range:	
Describe:	Associates a sensor or control with a given port or pin(s). Places the respective pin(s) in use
Result:	
Type or Addressable Component:	

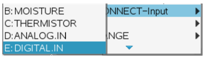
TI-84 PlusCE





TI-Nspire™ CX





BRIGHTNESS

Command:	**BRIGHTNESS**
Command Syntax:	**CONNECT BRIGHTNESS**
Range:	

Command:	**BRIGHTNESS**
Describe:	This command is not needed for typical use since the on-board BRIGHTNESS sensor is automatically connected. (Re-)connect the internal analog ambient light sensor. No pin or port name is used with this internal object.
Result:	Connects on-board light sensor to known analog input pin.
Type or Addressable Component:	Sensor

DHT i [TO] IN n

Command:	**DHT i [TO] IN n**
Command Syntax:	**CONNECT DHT i [TO] IN n**
Range:	Temperature reading default is in Celsius Humidity reading from 0 to 100 %
Describe:	The **DHT** digital temperature humidity sensor can be connected via this object. The **DHT** can be either a **DHT11** or **DHT22** and is identified automatically when connected to the system via a digital signal line. **CONNECT DHT i [TO] IN1**
Result:	Digital humidity/temperature sensors (DHT11/DHT22, type is auto-detected).
Type or Addressable Component:	Sensor

RANGER i [TO] IN n

Command:	**RANGER i [TO] IN n**
Command Syntax:	**CONNECT RANGER i [TO] IN n**
Range:	
Describe:	Connect an external ultrasonic distance ranging module to an input port. **CONNECT RANGER 1i [TO] IN 1**

Command:	**RANGER i [TO] IN n**
Result:	Ultrasonic ranging sensors with either individual trigger/echo pins, or same pin used for trigger/echo.
Type or Addressable Component:	Sensor

LOUDNESS i [TO] IN n

Command:	**LOUDNESS i [TO] IN n**
Command Syntax:	**CONNECT LOUDNESS i [TO] IN n**
Range:	
Describe:	The **LOUDNESS** object measure sound intensity (loudness). **CONNECT LOUDNESS i1 [TO] IN2**
Result:	Analog sound level sensors.
Type or Addressable Component:	Sensor

LIGHTLEVEL i [TO] IN n/BB n

Command:	**LIGHTLEVEL i [TO] IN n/BB n**
Command Syntax:	**CONNECT LIGHTLEVEL i [TO] IN n/BB n**
Range:	An integer value between 0 and 16383 (14 bit resolution)
Describe:	Connects an external light sensor. External light sensors can be analog sensors. **CONNECT LIGHTLEVEL 1i [TO] IN1**
Result:	Analog light level sensors is connected to the specific port.
Type or Addressable Component:	Sensor

TEMPERATURE i [TO] IN n/BB n

Command:	**TEMPERATURE i [TO] IN n/BB n**
Command Syntax:	**CONNECT TEMPERATURE i [TO] IN n/BB n**
Range:	Temperature reading default is in Celsius. The range depends on the specific temperature sensor being used. Humidity reading from 0 to 100 %
Describe:	Connects a temperature sensor to the system using either of several connection methods. **Note:** The default temperature sensor is included in the Breadboard pack If the sensor is based on a thermistor and provides an analog output, it uses a single analog input pin. If the sensor is a DS18B20 digital temperature sensor, it uses a single bi-directional digital GPIO pin. The analog thermistor temperature sensors is by default, assumed to be a PTC thermistor. If the thermistor is an NTC style, an optional keyword can be added to the connect command sequence to change the style of the thermistor. The analog thermistor temperature sensor uses a specific set of thermistor constants, different than those used by the THERMISTOR object, to convert the reading into a temperature reading. The constants are used in the Steinhart-Hart model to convert the analog reading to temperature.

Description	**Value**
C1	8.76741e-8
C2	2.34125e-4
C3	1.129148e-3
R1 – reference resistance	10000.0 ohms

CONNECT TEMPERATURE i [TO] IN 1 – thermistor sensor attached to analog input.

CONNECT TEMPERATURE i [TO] BB 1 – DS18B20 digital attached to digital pin.

CONNECT TEMPERATURE i [TO] I2 C – LM75A attached to I2C port.

CONNECT TEMPERATURE i [TO] BB 5 NTC – connect an analog temperature sensor to analog input and specifies an NTC style thermistor.

CONNECT TEMPERATURE i [TO] BB 6 PTC – connect an analog temperature sensor to analog input and specifies a PTC style thermistor.

Result:	Analog temperature sensor.
Type or	Sensor

Command:	**TEMPERATURE i [TO] IN n/BB n**
Addressable Component:	

SWITCH i [TO] IN n/BB n

Command:	**SWITCH i [TO] IN n/BB n**
Command Syntax:	**CONNECT SWITCH i [TO] IN n/BB n**
Range:	
Describe:	Connect an external switch to a digital input pin. The button task will monitor the state of the switch allowing reporting for the switch on, not on, and was on since last checked. The connected pin is set to a digital input state with its internal pulldown enabled. The other side of the switch is connected to a power supply (3.3v) pin (or 5v supply if using IN3 port). Switches share number space with Buttons. **CONNECT SWITCH 1 [TO] IN 1** **CONNECT SWITCH 2 [TO] BB 5**
Result:	Connect a switch object (similar to button, but connected to **Vcc** instead of **Gnd** when enabled.)
Type or Addressable Component:	Sensor

BUTTON i [TO] IN n/BB n

Command:	**BUTTON i [TO] IN n/BB n**
Command Syntax:	**CONNECT BUTTON i [TO] IN n/BB n**
Range:	
Describe:	Connect an external button to a digital input pin. The button task will monitor the state of the button allowing reporting for the button pressed, not pressed, and was pressed since last checked. The connected pin is set to a digital input state with its internal pullup enabled. The other side of the button is connected to a ground pin. Buttons share number space with Switches.

Command:	BUTTON i [TO] IN n/BB n
	CONNECT BUTTON i [TO] IN1
Result:	Digital button/switch/etc.
Type or Addressable Component:	Sensor

MOTION i [TO] IN n/BB n

Command:	MOTION i [TO] IN n/BB n
Command Syntax:	**CONNECT MOTION i [TO] IN n/BB n**
Range:	
Describe:	Connects a digital PIR (passive infrared) motion detection sensor to a digital input pin. This sensor is monitored the same as button objects for a three-state result. **CONNECT MOTION 1i [TO] IN 1**
Result:	Passive **I/R** motion detectors.
Type or Addressable Component:	Sensor

POTENTIOMETER i [TO] IN n/BB n

Command:	POTENTIOMETER i [TO] IN n/BB n
Command Syntax:	**CONNECT POTENTIOMETER i [TO] IN n/BB n**
Range:	
Describe:	Connect an external slide or rotary potentiometer to an analog input pin. **CONNECT POTENTIOMETER 1i [TO] IN 2** **CONNECT POTENTIOMETER 1 [TO] BB 2**
Result:	Rotary- potentiometer sensors.
Type or	Sensor

Command:	POTENTIOMETER i [TO] IN n/BB n
Addressable Component:	

MOISTURE i [TO] IN n/BB n

Command:	MOISTURE i [TO] IN n/BB n
Command Syntax:	**CONNECT MOISTURE i [TO] IN n/BB n**
Range:	An integer value between 0 and 16383 (14 bit resolution)
Describe:	Connect an analog moisture sensor to return relative moisture readings. **CONNECT MOISTURE 1i [TO] IN 1**
Result:	Analog moisture sensors.
Type or Addressable Component:	Sensor

THERMISTOR i [TO] IN n/BB n

Command:	THERMISTOR i [TO] IN n/BB n
Command Syntax:	**CONNECT THERMISTOR i [TO] IN n/BB n**
Range:	
Describe:	Connects a PTC thermistor to the system using a single analog input pin. The thermistor sensor uses the following values in the Steinhart-Hart model to convert the reading into a temperature. These values match those in the TI Temperature probe that came with the CBL™ System and TI Lab Cradle.

Description	Value
C1	1.33342e-7
C2	2.22468e-4

Command:	THERMISTOR i [TO] IN n/BB n
	<table><tr><th>Description</th><th>Value</th></tr><tr><td>C3</td><td>1.02119e-3</td></tr><tr><td>R1 – reference resistance</td><td>15000.0 ohms</td></tr></table> **CONNECT THERMISTOR i [TO] IN 1** **CONNECT THERMISTOR i [TO] BB 5**
Result:	Analog thermistor.
Type or Addressable Component:	Sensor

ANALOG.IN i [TO] IN n/BB n

Command:	ANALOG.IN i [TO] IN n/BB n
Command Syntax:	**CONNECT ANALOG.IN i [TO] IN n/BB n**
Range:	
Describe:	Connect a generic "analog" input sensor to a pin/port that supports analog input. **CONNECT ANALOG.IN i [TO] IN 1** **CONNECT ANALOG.IN i [TO] BB 5**
Result:	Connect analog input to pin that supports that function (error if pin is not analog-input capable).
Type or Addressable Component:	Sensor

DIGITAL.IN i [TO] IN n/BB n [[AS] INPUT|PULLUP|PULLDOWN]

Command:	DIGITAL.IN i [TO] IN n/BB n [[AS] INPUT|PULLUP|PULLDOWN]
Command Syntax:	**CONNECT DIGITAL.IN i [TO] IN n/OUT n/BB n**

Command:	**DIGITAL.IN i [TO] IN n/BB n [[AS] INPUT|PULLUP|PULLDOWN]**
Range:	
Describe:	Connects a generic digital object to a specified pin or port. The connected pin is configured either as a digital output signal, default LOW, or a digital input signal, default INPUT with no pullup or pulldown enabled. The index number can refer to either an input or output. The index is shared by both items since a **DIGITAL** signal can be either an input or output. **CONNECT DIGITAL.IN 1 [TO] IN 1**
Result:	Connect pin to digital object default input state, default **INPUT**.
Type or Addressable Component:	Control/Sensor

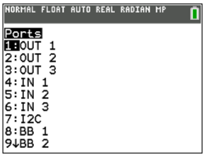
Ports

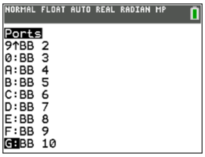
Settings menu contains operations to set the state of digital and analog pin operations such as the **LED** in the TI-Innovator™ Hub or a connected servo motor movement to states such as ON, OFF, CW (clockwise), and CCW (counterclockwise).

- 1: OUT 1
- 2: OUT 2
- 3: OUT 3
- 4: IN 1
- 5: IN 2
- 6: IN: 3
- 7: I2C
- 8: BB 1
- 9: BB 2
- 0: BB 3
- A: BB 4
- B: BB 5
- C: BB 6
- D: BB 7
- E: BB 8
- F: BB 9
- G: BB 10

TI-84 Plus CE

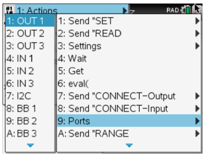
See TI-84 Plus CE Programming

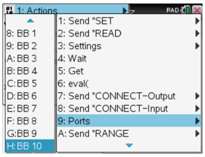




TI-Nspire™ CX

See: TI-Nspire™ CX Programming





See also: Breadboard Components and Usable Pins

RANGE

The **RANGE** command is used with several analog input sensors to re-map the internal ADC (Analog to Digital Converter) range of 0 to 16383 (14-bit ADC values) to a floating point range specified as the parameters to this command, along with the sensor to which the range is applied. The format for setting the range of a sensor is **RANGE sensor [i] minimum maximum**. To remove/reset to default the range from a given sensor, set the minimum and maximum value to zero. The minimum value must be less than the maximum value when setting a valid range.

A sensors current range, if present, can be obtained by **READ sensor [i] RANGE**. A two-element list of numbers in the form *{ minimum, maximum }* will be returned.

Note: If no range has been applied to the sensor, an error will be returned if an attempt to read the sensor range is performed .

An individual sensors averaging value may be obtained by **READ sensor [i] RANGE**.

RANGE 'something' (for analog devices, maps ADC range from 0 to 16383 to the range specified, min < max, min, max any values.)

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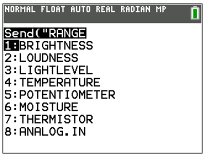
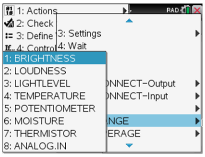


```
NORMAL FLOAT AUTO REAL RADIAN MP

Send("RANGE
1:BRIGHTNESS
2:LOUDNESS
3:LIGHTLEVEL
4:TEMPERATURE
5:POTENTIOMETER
6:MOISTURE
7:THERMISTOR
8:ANALOG.IN
```

TI-Nspire™ CX



```
1: Actions
2: Check
3: Define
4: Control
3: Settings
4: Wait
1: BRIGHTNESS
2: LOUDNESS
3: LIGHTLEVEL
4: TEMPERATURE
5: POTENTIOMETER
6: MOISTURE
7: THERMISTOR
8: ANALOG.IN
)NNECT–Output
)NNECT–Input
NGE
ERAGE
```

BRIGHTNESS minimum maximum

Command:	BRIGHTNESS minimum maximum **Advanced user**
Command Syntax:	**RANGE BRIGHTNESS minimum maximum**
Range:	
Describe:	Changes/Sets the mapping of ADC input values from the ADC 0-16383 range to a user-selected range. The resulting sensor reading is mapped to this and a floating point result is returned. By default, the on-board BRIGHTNESS sensor is ranged to a 0-100 range. **RANGE BRIGHTNESS minimum maximum**
Result:	Set mapping for on-board brightness/light sensor.
Type or	Sensor

Command:	**BRIGHTNESS minimum maximum** **Advanced user**
Addressable Component:	

LOUDNESS i minimum maximum

Command:	**LOUDNESS i minimum maximum** **Advanced user**
Command Syntax:	**RANGE LOUDNESS i minimum maximum**
Range:	
Describe:	Changes/Sets the mapping of ADC input values from the ADC 0-16383 range to a user-selected range. The resulting sensor reading is mapped to this and a floating point result is returned. **RANGE LOUDNESS i minimum maximum**
Result:	Set mapping for sound-level analog sensor.
Type or Addressable Component:	Sensor

LIGHTLEVEL i minimum maximum

Command:	**LIGHTLEVEL i minimum maximum** **Advanced user**
Command Syntax:	**RANGE LIGHTLEVEL i minimum maximum**
Range:	An integer value between 0 and 16383 (14 bit resolution)
Describe:	Changes/Sets the mapping of ADC input values from the ADC 0-16383 range to a user-selected range. The resulting sensor reading is mapped to this and a floating point result is returned. **RANGE LIGHTLEVEL i minimum maximum**

Command:	**LIGHTLEVEL i minimum maximum** **Advanced user**
Result:	Set mapping for off-board light sensor (analog).
Type or Addressable Component:	Sensor

TEMPERATURE i minimum maximum

Command:	**TEMPERATURE i minimum maximum** **Advanced user**
Command Syntax:	**RANGE TEMPERATURE i minimum maximum**
Range:	
Describe:	. **RANGE TEMPERATURE i minimum maximum**
Result:	Set mapping for soil moisture analog sensor.
Type or Addressable Component:	Sensor

POTENTIOMETER i minimum maximum

Command:	**POTENTIOMETER i minimum maximum** **Advanced user**
Command Syntax:	**RANGE POTENTIOMETER i minimum maximum**
Range:	
Describe:	Changes/Sets the mapping of ADC input values from the ADC 0-16383 range to a user-selected range. The resulting sensor reading is mapped to this and a floating point result is returned. **RANGE POTENTIOMETER i minimum maximum**

Command:	**POTENTIOMETER i minimum maximum** **Advanced user**
Result:	Set mapping for rotary/linear potentiometers.
Type or Addressable Component:	Sensor

MOISTURE i minimum maximum

Command:	**MOISTURE i minimum maximum** **Advanced user**
Command Syntax:	**RANGE MOISTURE i minimum maximum**
Range:	An integer value between 0 and 16383 (14 bit resolution)
Describe:	Changes/Sets the mapping of ADC input values from the ADC 0-16383 range to a user-selected range. The resulting sensor reading is mapped to this and a floating point result is returned. **RANGE MOISTURE i minimum maximum**
Result:	Set mapping for soil moisture analog sensor.
Type or Addressable Component:	Sensor

THERMISTOR i minimum maximum

Command:	**THERMISTOR i minimum maximum** **Advanced user**
Command Syntax:	**RANGE THERMISTOR i minimum maximum**
Range:	
Describe:	. **RANGE THERMISTOR i minimum maximum**

Command:	**THERMISTOR i minimum maximum** **Advanced user**
Result:	Set mapping for xxxxxxxxxx.
Type or Addressable Component:	Sensor

ANALOG.IN i minimum maximum

Command:	**ANALOG.IN i minimum maximum** **Advanced user**
Command Syntax:	**RANGE ANALOG.IN i minimum maximum**
Range:	
Describe:	Changes/Sets the mapping of ADC input values from the ADC 0-16383 range to a user-selected range. The resulting sensor reading is mapped to this and a floating point result is returned. **RANGE ANALOG.IN i minimum maximum**
Result:	Set mapping for generic analog input objects.
Type or Addressable Component:	Sensor

AVERAGE

The **AVERAGE** command is used to set the number of ADC (Analog to Digital converter) samples taken to represent a single analog sensor reading. By default, the TI-Innovator™ Hub sets a global value of three (3) readings to be taken for a sensor measurement. This is done to reduce variation due to noise etc. This default is adjustable between 1 and 25 by the **SET AVERAGING n** command. The current default can be obtained by the **READ AVERAGING** command.

For individual sensors, the default can be changed after the **CONNECT** operation by using the **AVERAGE** command. The format is **AVERAGE sensor [i] value** where sensor is a sensor from the table below, **[i]** is the index, if needed to identify the specific sensor, and value is a number from 1 to 25.

The sensor, when a sample is requested, will take value number of readings, 10 microseconds apart, summing the readings together and averaging them over the number of readings taken.

An individual sensors averaging value may be obtained by **READ sensor [i] AVERAGE**.

AVERAGE 'something' (for analog devices, sets the individual oversampling value for reading, from 1 to 25)

Command:	**AVERAGE**
Command Syntax:	**AVERAGE**
Describe:	Specifies the number of analog readings to take on a specific sensor to obtain a single reading of that sensor. Valid values are from 1 to 25 readings, taken 10 microseconds apart and averaged together. Sensors use the system default of 3 readings if not altered by changing the system global setting via a **SET AVERAGING** command.
Result:	
Type or Addressable Component:	

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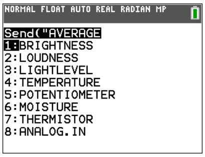
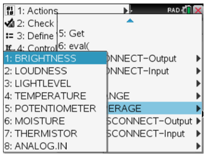


TI-Nspire™ CX



BRIGHTNESS n

Command:	**BRIGHTNESS n**
Command Syntax:	**AVERAGE BRIGHTNESS n**
Range:	Where **n** ranges from 1 to 25
Describe:	Set the number of readings from the ADC to be used for the on-board light sensor.
Result:	Set oversampling for on-board brightness/light sensor.
Type or Addressable Component:	Sensor

LOUDNESS i n

Command:	**LOUDNESS i n**
Command Syntax:	**AVERAGE LOUDNESS i n**
Range:	– where **n** ranges from 1 to 25
Describe:	Set the number of readings from the ADC to be used with an external sound loudness sensor.
Result:	Set oversampling for sound-level analog sensor.
Type or Addressable Component:	Sensor

LIGHTLEVEL i n

Command:	**LIGHTLEVEL i n**
Command Syntax:	**AVERAGE LIGHTLEVEL i n**
Range:	– where **n** ranges from 1 to 25
Describe:	Set the number of readings from the ADC to be used for the external light

Command:	**LIGHTLEVEL i n**
	sensor connected to an analog input. Does not support I^{2}C light sensors.
Result:	Set oversampling for off-board light sensor (analog).
Type or Addressable Component:	Sensor

TEMPERATURE i n

Command:	**TEMPERATURE i n**
Command Syntax:	**AVERAGE TEMPERATURE i n**
Range:	Where **n** ranges from 1 to 25
Describe:	Set the number of readings from the ADC to be used for the external temperature sensor connected to an analog input. Does not support I^{2}C or digital temperature sensors.
Result:	When using an analog-style thermistor temperature sensor, oversample this many times.
Type or Addressable Component:	Sensor

POTENTIOMETER i n

Command:	**POTENTIOMETER i n**
Command Syntax:	**AVERAGE POTENTIOMETER i n**
Range:	Where **n** ranges from 1 to 25
Describe:	Set the number of readings from the ADC to be used with an external potentiometer, either a linear or rotary model.
Result:	Set oversampling for rotary/linear potentiometers.
Type or Addressable Component:	Sensor

MOISTURE i n

Command:	MOISTURE i n
Command Syntax:	**AVERAGE MOISTURE i n**
Range:	– where **n** ranges from 1 to 25
Describe:	Set the number of readings from the ADC to be used with an external moisture sensor.
Result:	Set oversampling for soil moisture analog sensor.
Type or Addressable Component:	Sensor

THERMISTOR i n

Command:	THERMISTOR i n
Command Syntax:	**AVERAGE THERMISTOR i n**
Range:	Where **n** ranges from 1 to 25
Describe:	Set the number of readings from the ADC to be used with an external thermistor connected to an analog input.
Result:	Set oversampling for thermistor device analog input.
Type or Addressable Component:	Sensor

ANALOG.IN i n

Command:	ANALOG.IN i n
Command Syntax:	**AVERAGE ANALOG.IN i n**

Command:	**ANALOG.IN i n**
Range:	Where **n** ranges from 1 to 25
Describe:	Set the number of readings from the ADC to be used for the analog sensor attached to this generic analog item.
Result:	Sets oversampling count for generic analog input.
Type or Addressable Component:	Sensor

PERIOD n

Command:	**PERIOD n**
Command Syntax:	**PERIOD n**
Range:	
Describe:	The **AVERAGE** command is somewhat unique for **PERIOD** in that it specifies how many distinct periods are to be measured and averaged together to obtain the desired measurement. Up to 25 samples may be taken to obtain the period measurement for a given pin.
Result:	Set number of samples of frequency to take to be average together to generate period.
Type or Addressable Component:	Sensor

DISCONNECT-Output

DISCONNECT breaks the association between a specified control or sensor and the pin/port it is associated with. If the specified sensor or control is not currently connected to anything, an error is generated.

The **DISCONNECT** command does not generate an active response, other than possible error responses. Pins associated with an actively connected sensor, or control, are released from use and, in general, are set to a digital input state with no enabled pullup/pulldown.

DISCONNECT - disconnect something that has been connected, by index if needed.

Command:	**DISCONNECT-Output**
Command Syntax:	**DISCONNECT**
Range:	
Describe:	Removes the association of a sensor or control with a pin, or set of pins, if such association exists. Places the pin(s) back to an **OUTPUT** state.
Result:	.
Type or Addressable Component:	

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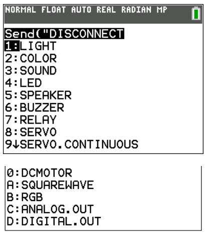

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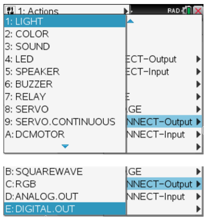


LIGHT

Command:	**LIGHT**
Command Syntax:	**DISCONNECT LIGHT**

Command:	**LIGHT**
Range:	
Describe:	Disconnect the on-board **RED LED** used for direct program control from the system.
Result:	On-board **LED** disconnected
Type or Addressable Component:	Control

COLOR

Command:	**COLOR**
Command Syntax:	**DISCONNECT COLOR**
Range:	
Describe:	Disconnects the on-board **RGB LED** item from use. This action (in the initial release of the TI-Innovator™) frees three (3) hardware map-able **PWM** signals for use on other pins..
Result:	Disconnect on-board **RGB LED**.
Type or Addressable Component:	Control

SOUND

Command:	**SOUND**
Command Syntax:	**DISCONNECT SOUND**
Range:	
Describe:	Disconnect the on-board speaker from its digital pin.
Result:	Disconnects on-board speaker.

Command:	**SOUND**
Type or Addressable Component:	Control

SPEAKER i

Command:	**SPEAKER i**
Command Syntax:	**DISCONNECT SPEAKER i**
Range:	
Describe:	Disconnect an external speaker from its digital pin.
Result:	Disconnect a speaker from a digital output pin.
Type or Addressable Component:	Control

BUZZER i

Command:	**BUZZER i**
Command Syntax:	**DISCONNECT BUZZER i**
Range:	
Describe:	Disconnect an active buzzer from the system. Active buzzers play a tone when their signal is set high/on, and stop the tone when the signal is dropped to ground. **DISCONNECT BUZZER i**
Result:	**ACTIVE** buzzers disconnected from a digital pin.
Type or Addressable Component:	Control

RELAY i

Command:	RELAY i
Command Syntax:	**DISCONNECT RELAY i**
Range:	
Describe:	Disconnect a digital relay interface from the system.
Result:	Relay disconnected.
Type or Addressable Component:	Control

SERVO i

Command:	SERVO i
Command Syntax:	**DISCONNECT SERVO i**
Code Sample:	
Range:	
Describe:	Disconnect a sweep or continuous **SERVO** motor from the digital pin associated with the motor.
Result:	Servo motor disconnected.
Type or Addressable Component:	Control

SERVO CONTINOUS i

Command:	SERVO CONTINOUSi
Command	**DISCONNECT SERVO CONTINOUSi**

Command:	**SERVO CONTINOUSi**
Syntax:	
Code Sample:	
Range:	
Describe:	Disconnect a sweep or continuous **SERVO** motor from the digital pin associated with the motor.
Result:	Servo motor disconnected.
Type or Addressable Component:	Control

DCMOTOR i

Command:	**DCMOTOR i**
Command Syntax:	**DISCONNECT DCMOTOR i**
Range:	
Describe:	Disconnects a **DCMOTOR** object from the system. **DCMOTOR**, **ANALOG.OUT**, and **SQUAREWAVE** all share the same number space of items. **DCMOTOR** requires external power.
Result:	Disconnect **DCMOTOR** from pin.
Type or Addressable Component:	Control

SQUAREWAVE i

Command:	**SQUAREWAVE i**
Command Syntax:	**DISCONNECT SQUAREWAVE i**

Command:	**SQUAREWAVE i**
Range:	
Describe:	Disconnect the software generated squarewave generator from an associated digital output pin. The pin reverts to digital input upon disconnect.
Result:	Disconnect squarewave function from pin(s), stops squarewave generation.
Type or Addressable Component:	Control

RGB i

Command:	**RGB i**
Command Syntax:	**DISCONNECT RGB i**
Range:	
Describe:	Disconnect an external **RGB LED** from the system. These objects use three hardware **PWM** signals to properly operate, so in the initial product release, the on-board **COLOR** object must be disconnected to connect one of these objects.
Result:	Disconnect **RGB** and free up **PWM** outputs for use elsewhere.
Type or Addressable Component:	Control

ANALOG.OUT i

Command:	**ANALOG.OUT i**
Command Syntax:	**DISCONNECT ANALOG.OUT i**
Range:	
Describe:	Disconnects the connected generic analog output device specified, freeing

Command:	**ANALOG.OUT i**
	a hardware map-able **PWM** if it is in use with the object.
Result:	Disconnect generic analog **PWM** output from pin.
Type or Addressable Component:	Control

DIGITAL.OUT i

Command:	**DIGITAL.OUT i**
Command Syntax:	**DISCONNECT DIGITAL.OUT i**
Range:	
Describe:	Disconnect a generic **DIGITAL** object. The associated pin is reverted to a digital **INPUT** pin with no enabled pullup or pulldown. The **DIGITAL** object number can be used to refer the same pin in either input, or output form…
Result:	Disconnect digital input object.
Type or Addressable Component:	Control/Sensor

DISCONNECT-Input

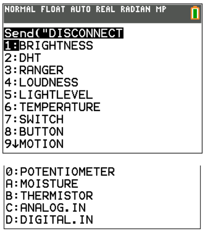
DISCONNECT breaks the association between a specified control or sensor and the pin/port it is associated with. If the specified sensor or control is not currently connected to anything, an error is generated.

The **DISCONNECT** command does not generate an active response, other than possible error responses. Pins associated with an actively connected sensor, or control, are released from use and, in general, are set to a digital input state with no enabled pullup/pulldown.

DISCONNECT - disconnect something that has been connected, by index if needed.

Command:	**DISCONNECT-Input...**
Command Syntax:	**DISCONNECT**
Range:	
Describe:	Removes the association of a sensor or control with a pin, or set of pins, if such association exists. Places the pin(s) back to an **INPUT** state.
Result:	.
Type or Addressable Component:	

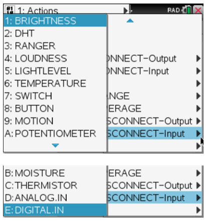
TI-84 Plus CE



```
NORMAL FLOAT AUTO REAL RADIAN MP
Send("DISCONNECT
1:BRIGHTNESS
2:DHT
3:RANGER
4:LOUDNESS
5:LIGHTLEVEL
6:TEMPERATURE
7:SWITCH
8:BUTTON
9↓MOTION

0:POTENTIOMETER
A:MOISTURE
B:THERMISTOR
C:ANALOG.IN
D:DIGITAL.IN
```

TI-Nspire™ CX



BRIGHTNESS

Command:	**BRIGHTNESS**
Command Syntax:	**DISCONNECT BRIGHTNESS**
Range:	

Command:	BRIGHTNESS
Describe:	Disconnects the internal connection to the on-board **BRIGHTNESS** (light sensor) object.
Result:	Disconnect on-board **LIGHT** sensor.
Type or Addressable Component:	Sensor

DHT i

Command:	DHT i
Command Syntax:	**DISCONNECT DHT i**
Range:	Temperature reading default is in Celsius Humidity reading from 0 to 100 %
Describe:	Disconnects the specified digital humidity **DHT** and temperature sensor from the system. This also removes that object from the period scan list of style sensors in the DHT task.
Result:	Digital humidity/temperature sensor(s) disconnected.
Type or Addressable Component:	Sensor

RANGER i

Command:	RANGER i
Command Syntax:	**DISCONNECT RANGER i**
Range:	
Describe:	Disconnect a digital ultrasonic ranging sensor from the two digital pins it uses.
Result:	Ultrasonic ranging sensor disconnected.

Command:	**RANGER i**
Type or Addressable Component:	Sensor

LOUDNESS i

Command:	**LOUDNESS i**
Command Syntax:	**DISCONNECT LOUDNESS i**
Range:	
Describe:	Disconnect an analog sound intensity (**LOUDNESS**) sensor.
Result:	Analog sound level sensor disconnected
Type or Addressable Component:	Sensor

LIGHTLEVEL i

Command:	**LIGHTLEVEL i**
Command Syntax:	**DISCONNECT LIGHTLEVEL i**
Range:	
Describe:	Disconnect an external light sensor.
Result:	Light sensor disconnected.
Type or Addressable Component:	Sensor

TEMPERATURE i

Command:	TEMPERATURE i
Command Syntax:	**DISCONNECT TEMPERATURE i**
Range:	Temperature reading default is in Celsius. The range depends on the specific temperature sensor being used. Humidity reading from 0 to 100 %
Describe:	Disconnect a connected temperature sensor from the system. **TEMPERATURE** sensors can be either analog (thermistor-style). Disconnecting from the analog or digital reverts the associated pins to INPUT.
Result:	Disconnect temperature sensor.
Type or Addressable Component:	Sensor

SWITCH

Command:	SWITCH
Command Syntax:	**DISCONNECT SWITCH i**
Range:	
Describe:	Disconnect a switch from its digital pin. The pin reverts to INPUT state, and the switch is removed from the scanning sequence in the BUTTON task.
Result:	disconnect switch object from pin
Type or Addressable Component:	Sensor

BUTTON i

Command:	BUTTON i
Command	**DISCONNECT BUTTON i**

Command:	**BUTTON i**
Syntax:	
Range:	
Describe:	Disconnects the specified button object from the system and removes it from the list of scanned buttons/switches in the **BUTTON** task.
Result:	Digital button/switch is disconnected.
Type or Addressable Component:	Sensor

MOTION i

Command:	**MOTION i**
Command Syntax:	**DISCONNECT MOTION i**
Range:	
Describe:	Disconnects a digital **PIR** (passive infrared) **MOTION** detector and removes the object from the scanning list in the **BUTTON** task.
Result:	Disconnect passive **I/R** motion detectors
Type or Addressable Component:	Sensor

POTENTIOMETER i

Command:	**POTENTIOMETER i**
Command Syntax:	**DISCONNECT POTENTIOMETER i**
Range:	
Describe:	Disconnect an analog variable resistor (**POTENTIOMETER**) from the system

Command:	POTENTIOMETER i
Result:	Disconnect a rotary/linear potentiometer sensors
Type or Addressable Component:	Sensor

MOISTURE i

Command:	MOISTURE i
Command Syntax:	**DISCONNECT MOISTURE i**
Range:	
Describe:	Disconnect an analog moisture sensor.
Result:	Disconnect analog moisture sensors
Type or Addressable Component:	Sensor

THERMISTOR i

Command:	THERMISTOR i
Command Syntax:	**DISCONNECT THERMISTOR i**
Range:	
Describe:	Disconnect an analog thermistor sensor from the associated pin.
Result:	disconnect analog thermistor
Type or Addressable Component:	Sensor

ANALOG.IN i

Command:	**ANALOG.IN i**
Command Syntax:	**DISCONNECT ANALOG.IN i**
Range:	
Describe:	Disconnects the connected generic analog input device specified.
Result:	Disconnect generic analog input from pin.
Type or Addressable Component:	Sensor

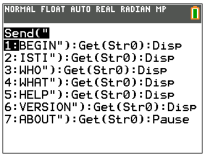
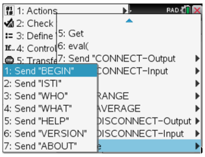
DIGITAL.IN i

Command:	**DIGITAL.IN i**
Command Syntax:	**DISCONNECT DIGITAL.IN i**
Range:	
Describe:	Disconnect a generic **DIGITAL** object. The associated pin is reverted to a digital **INPUT** pin with no enabled pullup or pulldown. The **DIGITAL** object number can be used to refer the same pin in either input, or output form.
Result:	Disconnect digital input object.
Type or Addressable Component:	Control/Sensor

MANAGE

The **Manage** menu pastes a **Send(** command with the following management items.

Str0 is displayed on Home Screen with information if requested in the command.

	TI-84 Plus CE	**TI-Nspire™ CX**
		

```
NORMAL FLOAT AUTO REAL RADIAN MP
Send("
1:BEGIN"):Get(Str0):Disp
2:ISTI"):Get(Str0):Disp
3:WHO"):Get(Str0):Disp
4:WHAT"):Get(Str0):Disp
5:HELP"):Get(Str0):Disp
6:VERSION"):Get(Str0):Disp
7:ABOUT"):Get(Str0):Pause
```

BEGIN

The **BEGIN** command disconnects all connected sensors and controls, re-initializes all sensor/control memory within the sketch, and resets the sensor average default value, error formatting, and flow control defaults. Additionally, all **IN***n* port pins, and the breadboard connector (**BB***n*) pins are set to the **INPUT** pin mode. All **OUT***n* port pins are set to the **INPUT** state, and allowed to float, including **OUT3** which will read as high due to a pullup resistor from the 5V supply on this pin.

When the entire process completes, a response of **READY** is sent to the host system. This response must be waited for by the host before any further operations are performed. Additional commands may be in the command queue to be executed, but will not be acted upon until this command completes.

BEGIN

Command:	**BEGIN**
Command Syntax:	**SEND("BEGIN"**
Describe:	Disassociates sensors from ports or pins, and resets all settings back to defaults. Disconnects any connected sensor objects and restores system to state as if **RESET** button pressed.
Result:	Responds with a "**READY**" when completed.
Type or Addressable Component:	Not Applicable

Note: The [:] is used to sequence command lines on one command line. The **Manage…** menu pastes a convenient set of commands to then display the information in **Str0** on the home screen.

ISTI

The **ISTI** command is used to synchronize communications with the sketch. The response to this command must be **TISTEM**. Responses may have a leading ***NUL*** (0) character on initial power-on of the Innovator hub. All responses from the Innovator hub will be followed with a *CR/LF* pair that may or may not be stripped by software layers in the host system prior to the response being received by the application layer on the host system.

ISTI

Command:	**ISTI**
Command Syntax:	**ISTI**
Describe:	Send "ISTI", and get response "TISTEM".
Result:	Handshake command used to determine presence of a supported "sketch" on the TI-Innovaotr™ Hub.
Type or Addressable Component:	

WHO

WHO is an identification command (similar to the ISTI handshake command below) that can be used to determine what product is present and running the sketch.

The correct response to **WHO** is "**TI INNOVATOR ON MSP432**" when this command is sent to the TI-Innovator Hub.

WHO

Command:	**WHO**
Command Syntax:	**WHO**
Describe:	Identification command to determine what product is running the sketch. Send ("WHO") Get Str0 Disp Str0
Result:	Identify the product - TI INNOVATOR ON MSP432.
Type or Addressable Component:	

WHAT

The **WHAT** command is an identification command. The response to **WHAT** for TI-Innovator is "**TI INNOVATOR HUB**".

WHAT

Command:	**WHAT**
Command Syntax:	**WHAT**
Describe:	Product name query. Identify the product - "**TI INNOVATOR HUB**" Send ("WHAT") Get Str0 Disp Str0
Result:	Identify the product.
Type or Addressable Component:	

HELP

HELP is used to obtain quick information about each of these commands. The **HELP command-name** is sent, and generates a string response with a one-line description of the given command.

HELP

Command:	**HELP**
Command Syntax:	**HELP**
Describe:	Provides per command quick help information. i.e. HELP SET, etc.
Result:	
Type or Addressable Component:	

VERSION

The **VERSION** command has a response that represents the current version of the sketch running on the TI-Innovator™ Hub.

The version will be of the *major.minor.patch.build* form in released products; for example, 1.0.0.

VERSION

Command:	**VERSION**
Command Syntax:	**VERSION**
Describe:	Returns version number (and possibly Accurev stream name from which sketch was built).
Result:	Report the version of the sketch in format *major.minor.patch.build*. Send ("VERSION") Get Str0 Disp Str0
Type or Addressable Component:	

ABOUT

The **ABOUT** command response is the product line name along with a copyright date and owner. The current response to this command is "**TI INNOVATOR (C)2015-2016 TEXAS INSTRUMENTS**".

ABOUT

Command:	**ABOUT**
Command Syntax:	**ABOUT**
Describe:	Product name and copyright information returned. Send ("ABOUT") Get Str0 Disp Str0
Result:	Returns copyright string. "**TI INNOVATOR (C)2015-2016 TEXAS INSTRUMENTS**"
Type or Addressable Component:	

Additional Supported Commands

The following sets of supported commands are not found in the Hub Menus.

Additional SET Commands

FORMAT ERROR STRING/NUMBER

Command:	**FORMAT ERROR STRING/NUMBER** **Advanced user**
Command Syntax:	**SET FORMAT ERROR STRING/NUMBER**
Range:	
Describe:	Used for setting error return format and optional audible tone on error. **SET FORMAT ERROR STRING/NUMBER** – returned error codes in string or numeric format.
Result:	Sets the format for the return of error information (numbers, or strings).
Type or Addressable Component:	Setting

FORMAT ERROR NOTE/QUIET

Command:	**FORMAT ERROR NOTE/QUIET** **Advanced user**
Command Syntax:	**SET FORMAT ERROR NOTE/QUIET**
Range:	
Describe:	Used for setting error return format and optional audible tone on error. **SET FORMAT ERROR NOTE/QUIET** – error display flash accompanied by speaker sound or no sound.
Result:	Enables tones, or disables tones in addition to the string/number reporting

Command:	FORMAT ERROR NOTE/QUIET **Advanced user**
	above.
Type or Addressable Component:	Setting

FLOW [TO] ON/OFF

Command:	FLOW [TO] ON/OFF **Advanced user**
Command Syntax:	**SET FLOW [TO] ON/OFF**
Range:	
Describe:	Enables (**ON**) or disables (**OFF**) the software flow control mechanism between the sketch and the communications hardware. **NOTE:** When the **SEGDISP** module is **CONNECT**ed, this setting determines whether or not the display module shows error information (flow control disabled), or command queue depth (flow control enabled).
Result:	Turn on xon/xoff flow control, or turn off (no flow control)
Type or Addressable Component:	Setting

OUT1/2/3 [TO]

Command:	OUT1/2/3 [TO]

Command Syntax:	**OUT1/2/3 [TO] ...**
	SET OUTn 0-255
	SET OUTn HIGH/ON
	SET OUTn LOW/OFF

Command:	**OUT1/2/3 [TO]**
Range:	Set analog PWM value on **OUT** port(s) of the TI-Innovator™Hub
Describe:	Direct output of information to a given output port. These are PWM outputs on the TI-Innovator™ Hub. Set analog PWM value on TI-Innovator™ Hub **OUT** port(s). **SET OUTn 0-255** – 0=off, 255=on, anything else is a PWM signal @ 500 Hz with duty cycle high from 1 to 254, where that range provides a percentage of the high-time signal of the waveform. **SET OUTn HIGH/ON** – same as 255 **SET OUTn LOW/OFF** – same as 0
Result:	Set analog **PWM** value on **OUT** port(s) of the TI-Innovator™ Hub
Type or Addressable Component:	Port

BUZZER i

Command:	BUZZER i
Command Syntax:	**READ BUZZER i**
Range:	
Describe:	Returns the current state of the active buzzer specified; 0 = *silent*, 1 = *playing tone*.
Result:	Returns state of active buzzer, 0=silent, 1=on
Type or Addressable Component:	Control

COLOR

Command:	COLOR
Command Syntax:	**READ COLOR**
Range:	
Describe:	Read the current output state of the on-board **COLOR RGB LED** with sub-components **.RED**, **.GREEN**, **.BLUE**. When reading the entire item, a list of three values is returned, with values between 0 and 255 where 0=off, 255=full on, and values in between indicate **PWM** levels. **READ COLOR** – returns list of 3 values representing { red, green, blue } PWM levels **READ COLOR.RED** **READ COLOR.GREEN** **READ COLOR.BLUE** See Also: **RGB i**
Result:	Returns list of 3 values representing { red, green, blue } **PWM** levels.

Command:	**COLOR**
	Returns **RED/GREEN/BLUE** values for on-board **RGB** (color) **LED**.
Type or Addressable Component:	Control

COLOR.RED

Command:	**COLOR RED**
Command Syntax:	**READ COLOR.RED**
Range:	
Describe:	Read the current output state of the on-board **COLOR RGB LED** with sub-components **.RED**, **.GREEN**, **.BLUE**. When reading the entire item, a list of three values is returned, with values between 0 and 255 where 0=off, 255=full on, and values in between indicate **PWM** levels. **READ COLOR.RED**
Result:	Returns values representing {red} **PWM** levels. Returns **RED** values for on-board **RGB** (color) **LED**.
Type or Addressable Component:	Control

COLOR.GREEN

Command:	**COLOR GREEN**
Command Syntax:	**READ COLOR.GREEN**
Range:	

Command:	**COLOR GREEN**
Describe:	Read the current output state of the on-board **COLOR RGB LED** with sub-components **.RED**, **.GREEN**, **.BLUE**. When reading the entire item, a list of three values is returned, with values between 0 and 255 where 0=off, 255=full on, and values in between indicate **PWM** levels. **READ COLOR.GREEN**
Result:	Returns list of 3 values representing { red, green, blue } **PWM** levels. Returns **RED/GREEN/BLUE** values for on-board **RGB** (color) **LED**.
Type or Addressable Component:	Control

COLOR.BLUE

Command:	**COLOR BLUE**
Command Syntax:	**READ COLOR.BLUE**
Range:	
Describe:	Read the current output state of the on-board **COLOR RGB LED** with sub-components **.RED**, **.GREEN**, **.BLUE**. When reading the entire item, a list of three values is returned, with values between 0 and 255 where 0=off, 255=full on, and values in between indicate **PWM** levels. **READ COLOR.BLUE**
Result:	Returns list of 3 values representing { red, green, blue } **PWM** levels. Returns **RED/GREEN/BLUE** values for on-board **RGB** (color) **LED**.
Type or Addressable Component:	Control

DCMOTOR i

Command:	**DCMOTOR i**
Command Syntax:	**READ DCMOTOR i**
Range:	
Describe:	Motor that converts direct current electrical power into mechanical power.
Result:	Returns whether dcmotor is running (1) or stopped (0).
Type or Addressable Component:	Control

DIGITAL.OUT i

Command:	**DIGITAL.OUT i**
Command Syntax:	**READ DIGITAL.OUT i**
Range:	
Describe:	Returns the current state of the digital pin connected to the DIGITAL object, or the cached state of the digital output value last SET to the object.
Result:	Return 0 (output low), 1 (output high).
Type or Addressable Component:	Control/Sensor

FORMAT

Command:	FORMAT **Advanced user**
Command Syntax:	**READ FORMAT**
Range:	
Describe:	Return the current formatting flags for error reporting. The value returned is a byte value indicating various flags. Masking with values indicates what error reporting options are active. 1 = ERROR strings reported 2 = ERROR numbers reported +4 = ERROR TONE enabled, if not set, errors are reported silently.
Result:	Read error format (1=strings, 2=numbers, +4 to either: tones enabled).
Type or Addressable Component:	Setting

FLOW

Command:	FLOW **Advanced user**
Command Syntax:	**READ FLOW**
Range:	
Describe:	Returns the current flow control setting; 0=*disabled*, 1=*enabled*.
Result:	Read current flow control, 0 = none, 1 = xon/xoff
Type or Addressable Component:	Setting

IN1/IN2/IN3

Command:	**IN1/IN2/IN3**
Command Syntax:	**READ IN1** **READ IN2** **READ IN3**
Range:	
Describe:	Read the value present on the indicated port, and return that value to the host.
Result:	Read value of analog port on TI STEM board
Type or Addressable Component:	Port

LAST ERROR

Command:	**LAST ERROR**
Command Syntax:	**READ LAST ERROR**
Range:	
Describe:	Returns the last reported error from the last operation. Depending on the **FORMAT ERROR** setting, the response may be a **STRING** or a **NUMBER**.
Result:	Return last encountered error, resets automatically to 0, no error.
Type or Addressable Component:	Setting

LED i

Command:	**LED i**
Command Syntax:	**READ LED i**
Range:	
Describe:	Read the current state of the specified **LED**. If the **LED** is digital, a 0 or 1 is returned indicating the **LED** is off or on. If the **LED** is connected to a **PWM** output, a value from 0 to 255 will be returned, indicating the current **PWM** level where 0 is off, 255 is full on, and values in between indicate the current **PWM** setting.
Result:	Get state of **LED**, 0 or 1 if digital, 0-255 if **PWM** on analog.
Type or Addressable Component:	Control

LIGHT

Command:	**LIGHT**
Command Syntax:	**READ LIGHT**
Range:	
Describe:	Returns the state of the on-board **RED LED** (digital only). A value of 0 is off, and 1 is on.
Result:	Get current state of on-board red **LED** (0=off, 1=on).
Type or Addressable Component:	Control

OUT1/2/3

Command:	**OUT1/2/3**
Command Syntax:	**READ OUT1** **READ OUT2** **READ OUT3**
Range:	
Describe:	Read value of current port as input (may be a digital read since these do not support analog-input. **READ OUT1/OUT2/OUT3**
Result:	Read value of analog port on **TI STEM** board.
Type or Addressable Component:	Port

PWR

Command:	**PWR**
Command Syntax:	**READ PWR**
Range:	
Describe:	Returns the current state of presence of external power connected to the **PWR** port. The **PWR** port is read, and a status value of 0 (not present) or 1 (present) is returned, based on whether or not external power is available. **READ PWR**
Result:	Returns state of external power presence on **PWR** port (0=not present, 1=ext pwr present).
Type or Addressable Component:	Status

RELAY i

Command:	**RELAY i**
Command Syntax:	**READ RELAY i**
Range:	
Describe:	Return the current state of the specified relay. 0 = OFF, 1 = ON.
Result:	Read state of relay - 0=not active 1=active.
Type or Addressable Component:	Control

RESOLUTION

Command:	**RESOLUTION**
Command Syntax:	**READ RESOLUTION**
Range:	
Describe:	Returns the bit resolution used by the system for ADC readings.
Result:	Returns ADC resolution in use, in bits (default is 14).
Type or Addressable Component:	Setting

RGB i

Command:	**RGB i**
Command Syntax:	**READ RGB i**

Command:	**RGB i**
Range:	
Describe:	Same as the **COLOR** object referenced above, and has sub-objects named **RED**, **GREEN**, and **BLUE**. This command returns the current **PWM** level that the specified object is using. **READ RGB i** – returns a 3 element list, consisting of the { red, green, blue } color level. **READ RED i** – returns just the current red-component level. **READ GREEN i** **READ BLUE i**
Result:	Get state of **RGB LED**, {r,g,b} list values
Type or Addressable Component:	Control

RED i

Command:	**RED i**
Command Syntax:	**READ RED i**
Range:	
Describe:	Same as the **COLOR** object referenced above, and has sub-objects named **RED**, **GREEN**, and **BLUE**. This command returns the current PWM level that the specified object is using. **READ RGB i** – returns a 3 element list, consisting of the { red, green, blue } color level. **READ RED i** – returns just the current red-component level.
Result:	Get state of **RGB RED** component.
Type or Addressable Component:	Control

GREEN i

Command:	GREEN i
Command Syntax:	**READ GREEN i**
Range:	
Describe:	Same as the **COLOR** object referenced above, and has sub-objects named **RED**, **GREEN**, and **BLUE**. This command returns the current PWM level that the specified object is using. **READ RGB i** – returns a 3 element list, consisting of the { red, green, blue } color level. **READ GREEN i** – returns just the current green-component level.
Result:	Get state of **RGB GREEN** component.
Type or Addressable Component:	Control

BLUE i

Command:	BLUE i
Command Syntax:	**READ BLUE i**
Range:	
Describe:	Same as the **COLOR** object referenced above, and has sub-objects named **RED**, **GREEN**, and **BLUE**. This command returns the current PWM level that the specified object is using. **READ RGB i** – returns a 3 element list, consisting of the { red, green, blue } color level. **READ BLUE i** – returns just the current blue-component level
Result:	Get state of **RGB BLUE** component.
Type or Addressable Component:	Control

SERVO i

Command:	**SERVO i**
Command Syntax:	**READ SERVO i**
Range:	
Describe:	Returns the current position of a sweep servo in the range -90 to 90, OR the current speed of rotation of a continuous servo motor. Additionally, the current “calibration” setting for the servo which consists of a 2-element list representing the lower and upper microsecond pulse widths corresponding to the sweep/rotation ranges may be read. **READ SERVO i** – get current sweep position or rotation speed/direction. **READ SERVO i CALIBRATION** – get current microsecond range for sweep or rotation.
Result:	Return current servo position in degrees from -90 to +90.
Type or Addressable Component:	Control

SERVO i CALIBRATION

Command:	**SERVO i CALIBRATION** **Advanced user**
Command Syntax:	**READ SERVO i CALIBRATION**
Range:	
Describe:	Returns the current position of a sweep servo in the range -90 to 90, OR the current speed of rotation of a continuous servo motor. Additionally, the current “calibration” setting for the servo which consists of a 2-element list representing the lower and upper microsecond pulse widths corresponding to the sweep/rotation ranges may be read. **READ SERVO i CALIBRATION** – get current microsecond range for sweep or rotation.
Result:	Return current servo position in degrees from -90 to +90.
Type or Addressable Component:	Control

SOUND

Command:	**SOUND**
Command Syntax:	**READ SOUND**
Range:	
Describe:	Returns a value indicating whether sound is currently being played (1) or not (0) through the on-board speaker.
Result:	Return whether on-board speaker is playing a tone (1) or is silent(0).
Type or Addressable Component:	Control

SPEAKER i

Command:	**SPEAKER i**
Command Syntax:	**READ SPEAKER i**
Range:	
Describe:	Returns a value indicating whether sound is currently being played (1) or not (0) through an external speaker.
Result:	Return whether speaker is playing a tone (1) or silent (0).
Type or Addressable Component:	Control

SQUAREWAVE i

Command:	**SQUAREWAVE i**
Command Syntax:	**READ SQUAREWAVE i**
Range:	
Describe:	Returns a 0 the current squarewave object is not active. A value of 1 is returned if the object is actively generating an output.
Result:	Returns whether squarewave is active (1) or not active (0).
Type or Addressable Component:	Control

PERIOD n

Command:	PERIOD n
Command Syntax:	**PERIOD n**
Range:	
Describe:	The **AVERAGE** command is somewhat unique for **PERIOD** in that it specifies how many distinct periods are to be measured and averaged together to obtain the desired measurement. Up to 25 samples may be taken to obtain the period measurement for a given pin.
Result:	Set number of samples of frequency to take to be average together to generate period.
Type or Addressable Component:	Sensor

CALIBRATE

CALIBRATE is used to set various sensor and control values that do not otherwise fit within a means of setting any other way. For thermistors and temperature sensors that use an analog input port, it can be used to adjust the coefficients of the Steinhart-Hart equation used to map thermistor readings to temperature values. For servo motors, it is used to adjust the PWM pulse width within the range for a servo motor, where the zero position is set at 1500 microseconds. It is also used to set the calibration frequency for the DDS signal generator module (default is 24MHz).

For sensors supporting calibration, the value(s) may be obtained by **READ sensor [i] CALIBRATION**.

SERVO i / SERVO.CONTINUOUS i

Command:	**SERVO i /SERVO.CONTINUOUS i minimum maximum** **Advanced user**
Command Syntax:	**CALIBRATE SERVO i minimum maximum**
Code Sample:	
Range:	
Describe:	Servos operate by using pulse modulation where the high pulse width determines both direction of servo operation and possibly the speed of operation. The time between pulses is generally 20 milliseconds and is not adjustable by this command. The pulse width generally varies around a mid-point of 1.5 milliseconds (1500 microseconds). Pulse widths less than 1.5 milliseconds cause servo operation in one direction, while pulse widths greater than 1.5 milliseconds cause operation in the opposite direction. The **CALIBRATE** command for **SERVO** allows programmable changes to the minimum and maximum pulse widths. Parameters are pulse width times in microseconds. Current defaults are minimum 600 and maximum 2400 microseconds.
Result:	Set minimum and maximum pulse width for servo motor, values in microseconds, default 600 and 2400.

Command:	**SERVO i /SERVO.CONTINUOUS i minimum maximum** **Advanced user**
Type or Addressable Component:	Control

TEMPERATURE i C1 C2 C3 R1

Command:	**TEMPERATURE i C1 C2 C3 R1** **Advanced user**
Command Syntax:	**CALIBRATE TEMPERATURE i C1 C2 C3 R1**
Range:	
Describe:	The **CALIBRATE** command for analog temperature sensors allows changing the default Steinhart-Hart equation coefficients to match those of the thermistor element in the sensor being used. The default values are: C1: 8.76741e-8 C2: 2.34125e-4 C3: 1.129148e-3 R1: 10000.0 (reference resistor value = 10kΩ)
Result:	When using an analog-style thermistor temperature sensor.
Type or Addressable Component:	Sensor

THERMISTOR i C1 C2 C3 R1

Command:	**THERMISTOR i C1 C2 C3 R1** **Advanced user**
Command Syntax:	**CALIBRATE THERMISTOR i C1 C2 C3 R1**
Range:	

Command:	THERMISTOR i C1 C2 C3 R1 **Advanced user**
Describe:	The **CALIBRATE** command for analog thermistors allows changing the default Steinhart-Hart equation coefficients to match those of the thermistor element in the sensor being used. The default values are: C1: 1.33342e-7 C2: 2.22468e-4 C3: 1.02119e-3 R1: 15000.0 (reference resistor value = 15kΩ)
Result:	Where c1/c2/c3 are float constants for the Steinhart-Hart equation. … that models the thermistor, and r is resistance for the reference. … resistor used to create a voltage divider with the thermistor.
Type or Addressable Component:	Sensor

TI-Innovator™ Hub Data Sheets

The TI-Innovator™ Hub Data Sheets include the following; a product name and number, a brief description, a product image, specifications, on-board components function, and Hub commands with simple code samples.

Topic Links

TI-Innovator™ Hub Data Sheet

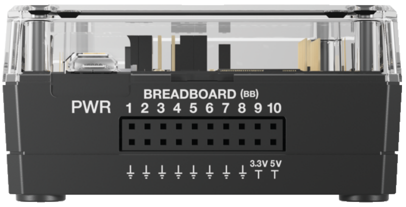
Title	**TI-Innovator™ Hub**
TI Item Name	STEM/BK/B
Quantity	1
Included in	TI-Innovator™ Hub
Description	Use the TI-Innovator™ Hub with your compatible TI graphing calculator or TI-Nspire™ software to control components, read sensors, and create powerful learning experiences.
Category	Hub
Hub Connection	Not Applicable
Assembly Instructions	Not Applicable
Precautions	Do not expose the Hub to temperatures above 140˚F (60˚C). Do not disassemble or mistreat the Hub. Do not chain together multiple Hubs through the I/O ports or the Breadboard Connector. Use only the USB cables provided with the Hub. Use only the TI provided power supplies: • TI Wall Charger included with the TI-Innovator™ Hub • Optional External Battery 4-AA battery holder included in the TI-Innovator™ Breadboard Pack Ensure that the components receiving power from the Hub do not exceed the Hub's 1-amp power limit. Avoid using the Hub to control AC electricity. **See also:** TI-Innovator™ Hub Ports and Breadboard Usable Pins

Title	TI-Innovator™ Hub
Specifications	See the TI-Innovator™ Hub specifications section of education.ti.com/go/innovator.

TI-Innovator™ Hub Ports and Breadboard Usable Pins

Breadboard Connector Characteristics

Different pins on the breadboard connector have different capabilities.

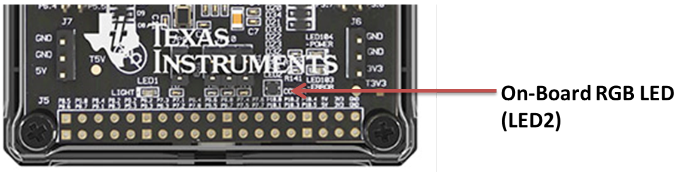


Pin	Digital I/O	Pulse Width Modulation (PWM)	ANALOG IN
BB1	Y		
BB2	Y		
BB3	Y		
BB4	Y	Y	
BB5	Y		Y
BB6	Y		Y
BB7	Y		Y
BB8	Y	Y	
BB9	Y	Y	
BB10	Y	Y	

TI-Innovator™ Hub On-Board Component Data Sheets

Topic Links

On-Board RGB LED Data Sheet



Title	**On-Board RGB LED**
TI Item Name	Built into the Hub
Quantity	1
Included in	TI-Innovator™ Hub
Description	Built-in light-emitting diode (LED) that is capable of emitting a variety of colors when current passes through it.
Category	LEDs and Displays
Hub Connection	on-board Hub
Assembly Instructions	Not Applicable
Precautions	Not Applicable
Specifications	Not Applicable

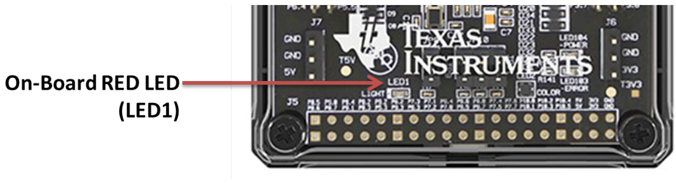
HUB Commands	
Sketch Object	COLOR
Command Syntax	Send("SET COLOR …") ON/OFF/0-255 (red element)

	ON/OFF/0-255 (green element) ON/OFF/0-255 (blue element) [BLINK frequency] (in Hz) [TIME duration] (in seconds)

Code Sample:

Desired Action	Code Sample
Turn ON Red and Green elements of tri-color LED	`Send("SET COLOR ON ON OFF")`
Set Red to full intensity, Green to half intensity, Blue to off	`Send("SET COLOR 255 128 0")`
Set Red to full intensity, Green to half intensity, Blue to off for 10 seconds	`Send("SET COLOR 255 128 0 TIME 10")`
Set Red to full intensity, Green to half intensity, Blue to off and blink them at 2 Hz (2 times a second) for 10 seconds	`Send("SET COLOR 255 128 0 BLINK 2 TIME 10")`
Turn OFF the Red element	`Send("SET COLOR.RED 0")`
Turn ON the Green element at half intensity and blink it at 2 Hz for 10 seconds	`Send("SET COLOR.GREEN 128 BLINK 2 TIME 10")`

On-Board Red LED Data Sheet



Title	**On-Board Red LED**
TI Item Name	Built into the Hub
Quantity	1
Included in	TI-Innovator™ Hub
Description	Built-in light-emitting diode (LED) that emits a red light when current passes through it.
Category	LEDs and Displays
Hub Connection	on-board Hub
Assembly Instructions	Not Applicable
Precautions	Not Applicable
Specifications	Not Applicable

HUB Commands	
Sketch Object	LIGHT
Command Syntax	Send("SET LIGHT …") ON/OFF [BLINK frequency] [TIME duration] (in seconds)

Code Sample:

Desired Action	**Code Sample**
Turn LED ON	`Send("SET LIGHT ON")`
Turn LED OFF	`Send("SET LIGHT OFF")`
Turn LED ON for 10 seconds	`Send("SET LIGHT ON TIME 10"`
Turn LED ON, blink it at 2 Hz for 10 seconds	`Send("SET LIGHT ON BLINK 2 TIME 10")`

See Also: ***Red LED - Error Indicator***

On-Board Speaker Data Sheet

Speaker (at back of Hub) is addressable as "SOUND" in Hub command strings.

Title	**On-Board Speaker**
TI Item Name	Built into the Hub
Quantity	1
Included in	TI-Innovator™ Hub
Description	Built-in speaker located at the back of the Hub. It converts electrical current into sound you can hear.
Category	Sound Output
Hub Connection	on-board Hub
Assembly Instructions	Not Applicable
Precautions	Not Applicable
Specifications	Not Applicable

HUB Commands	
Sketch Object	SOUND
Command Syntax	Send("SET SOUND …") Frequency in Hz or Note as C1, CS1, D2, ... [TIME duration in seconds]

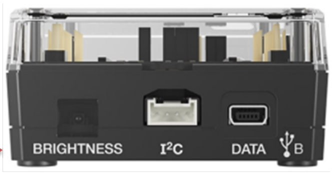
Code Sample:

Desired Action	**Code Sample**
Play tone at 261.23 Hz	`Send("SET SOUND 261.23")`
Evaluate the expression 2^8 (= 256) and play that tone	`Send("SET SOUND eval (2^8)")`

Desired Action	Code Sample
Evaluate the expression 2^8 (= 256) and play that tone for .25 seconds	`Send("SET SOUND eval (2^8) TIME .25")`
Evaluate the expression 2^9 (= 512) and play that tone for 0.25 seconds (result of evaluating 1/4)	`Send("SET SOUND eval (2^9) TIME eval(1/4)")`
Turn speaker off	`Send("SET SOUND OFF")`

On-Board Light Brightness Sensor Data Sheet

Light Brightness Sensor



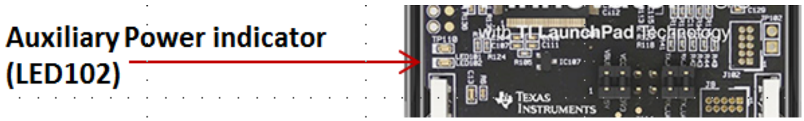
Title	**On-Board Light Brightness Sensor**
TI Item Name	Built into the Hub
Quantity	1
Included in	TI-Innovator™ Hub
Description	Built-in light brightness sensor located at the bottom of the Hub. The sensor detects light intensity.
Category	Environmental Sensors
Hub Connection	on-board Hub
Assembly Instructions	Not Applicable
Precautions	Not Applicable
Specifications	Not Applicable

HUB Commands	
Sketch Object	BRIGHTNESS
Command Syntax	Send("READ BRIGHTNESS")

Code Sample:

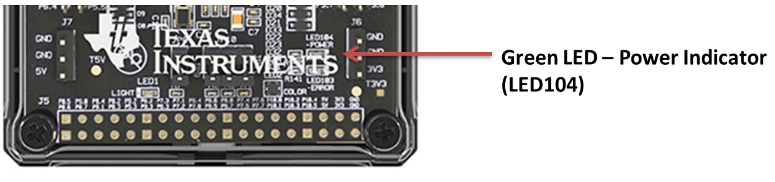
Desired Action	**Code Sample**
Read the built-in light brightness sensor	`Send("READ BRIGHTNESS")` `Get(B)`

On-Board - Auxiliary Power Indicator Data Sheet


Auxiliary Power indicator (LED102)
with TI LaunchPad Technology
Texas Instruments

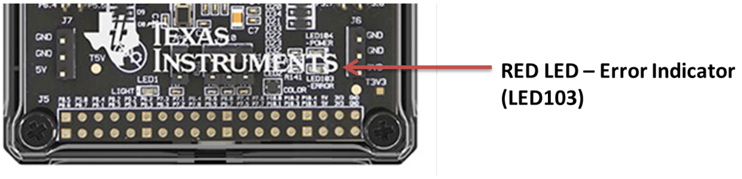
Title	Auxiliary Power Indicator (LED102)
TI Item Name	Built into the Hub
Quantity	1
Included in	TI-Innovator™ Hub
Description	Indicates a Auxiliary power connection.
Category	LEDs and Displays
Hub Connection	on-board
Assembly Instructions	Not Applicable
Precautions	Not Applicable
Specifications	Not Applicable

On-Board Green LED - Power Indicator Data Sheet



Title	**Green LED - Power Indicator**
TI Item Name	Built into the Hub
Quantity	1
Included in	TI-Innovator™ Hub
Description	Indicates a USB connection on the DATA port.
Category	LEDs and Displays
Hub Connection	on-board
Assembly Instructions	Not Applicable
Precautions	Not Applicable
Specifications	Not Applicable

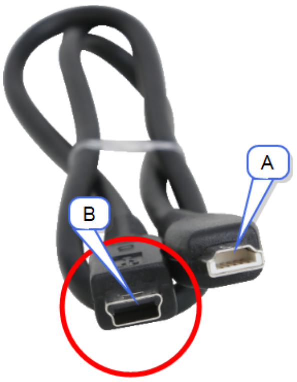
On-Board Red LED - Error Indicator Data Sheet



Title	**Red LED - Error Indicator**
TI Item Name	Built into the Hub
Quantity	1
Included in	TI-Innovator™ Hub
Description	Indicates an error in the sketch command.
Category	LEDs and Displays
Hub Connection	on-board Hub
Assembly Instructions	Not Applicable
Precautions	Not Applicable
Specifications	Not Applicable

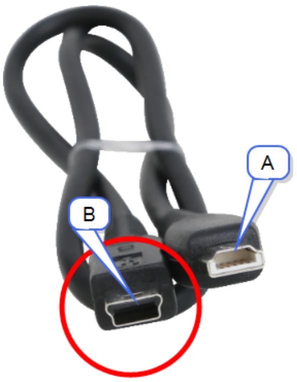
See Also: *On-Board Red LED*

USB Mini A to Mini B Cable Data Sheet



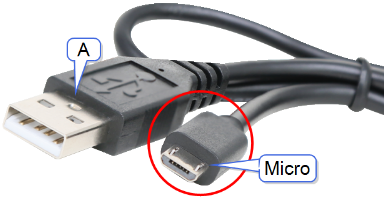
Title	**USB Mini A to Mini B Cable**
TI Item Name	XX/CA/USB15/A
Quantity	1
Included in	TI-Innovator™ Hub
Description	Connects the Hub to a TI-84 Plus CE Graphing Calculator or a TI-Nspire™ CX Handheld..
Category	Accessories
Hub Connection	Not Applicable
Assembly Instructions	Not Applicable
Precautions	Not Applicable
Specifications	Not Applicable

USB Standard A to Mini B Cable Data Sheet



Title	**USB Standard A to Mini B Cable**
TI Item Name	STEM/CA/USB20/A
Quantity	1
Included in	TI-Innovator™ Hub
Description	Connects the Hub to a computer running TI-Nspire™ CX Software.
Category	Accessories
Hub Connection	"B" connector to the USB Mini-B port
Assembly Instructions	Not Applicable
Precautions	Not Applicable
Specifications	Not Applicable

USB Standard A to Micro B Cable Data Sheet



Title	USB Standard A to Micro B Cable
TI Item Name	XX/CA/USB60/C
Quantity	1
Included in	TI-Innovator™ Hub
Description	Connects the Hub to a TI approved power source used with peripherals that require the 5V output port.
Category	Accessories
Hub Connection	"B" connector to the USB Mini-B port
Assembly Instructions	Not Applicable
Precautions	Not Applicable
Specifications	Not Applicable

TI Wall Charger Data Sheet

Title	**TI Wall Charger**
TI Item Name	XX/AD/9212USB/A
Quantity	1
Included in	TI-Innovator™ Hub
Description	Wall charger that supplies power through the TI-Innovator™ Hub for connected modules that require additional power.
Category	Accessories
Hub Connection	Micro connector of the USB Standard A to Micro B Cable to the PWR connector
Assembly Instructions	Not Applicable
Precautions	Not Applicable
Specifications	Not Applicable

External Battery Data Sheet

Title	**External Battery**
TI Item Name	STEMBT/A
Quantity	1
Included in	External Battery Pack
Description	External battery that supplies power through the TI-Innovator™ Hub for connected modules that require additional power.
Category	Accessories
Hub Connection	Micro connector of the USB Standard A to Micro B Cable to the PWR connector.
Assembly Instructions	Connect to PWR port on TI-Innovator™ Hub
Precautions	Not Applicable
Specifications	Not Applicable

TI-Innovator™ Rover Setup Guide

TI-Innovator™ Rover is a two-wheeled programmable robotic vehicle which works with the TI-Innovator™ Hub with TI LaunchPad™ Board. You communicate with the TI-Innovator™ Hub and control the Rover through TI Basic programming commands. Built-in components include two motors, color sensor, ultrasonic ranger, gyroscope, and RGB LED.

Topics to help you get started include:

TI-Innovator™ Rover Overview

TI-Innovator™ Rover is a two-wheeled programmable robotic vehicle which works with the TI-Innovator™ Hub with TI LaunchPad™ Board. You communicate with the Hub and control the Rover through TI Basic programs on one of these TI products:

- TI CE Family of Graphing Calculators (TI-83 Premium CE, TI-84 Plus CE, and TI-84 Plus CE-T) with operating system version 5.3 or later installed. You also need to install or update the Hub App, which contains the Hub menu.
- TI-Nspire™ CX or TI-Nspire™ CX CAS handheld with operating system version 4.5 or later installed
- TI-Nspire™ computer software version 4.5 or later

Follow this guide to setup your TI-Innovator™ Rover with your TI CE Graphing Calculator or TI-Nspire™ CX Handheld.

Learn More

Refer to the TI-Innovator™ Technology eGuide for more details.

The eGuide is a web-based source of TI-Innovator™ information, including:

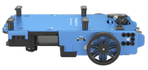
- Programming with the TI CE Family of Graphing Calculators and TI-Nspire™ Technology, including sample programs.
- Available I/O Modules and their commands.
- Available Breadboard components and their commands.
- TI-Innovator™ Rover and its commands.
- Link to update the TI-Innovator™ Sketch software.
- Free classroom activities for Hub and Rover.

To access the eGuide, visit https://education.ti.com/go/eguide/hub/EN.

For a list of precautions to take while using the Rover and its components, refer to *General Precautions* (page 228).

TI-Innovator™ Rover Setup Requirements

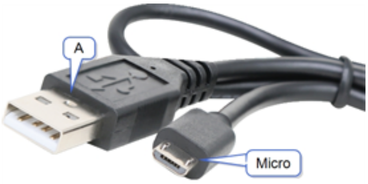
To set up your TI-Innovator™ Rover with your TI-Innovator™ Hub and graphing calculator you will need these materials.

Component	Image	Description
TI-Innovator™ Rover		A two-wheeled programmable robotic vehicle which works with the Hub.
Breadboard Ribbon Cable		Connects the Rover to the Hub's Breadboard Connector.
I^2C Cable		Connects the Rover to the Hub's I^2C port.
TI-Innovator™ Hub with TI LaunchPad™ Board		Controls the Rover through TI Basic programming commands.
USB Unit-to-Unit (Mini-A to Mini-B) Cable		Included with the Hub. Connects the Hub to a TI CE Graphing Calculator or a TI-Nspire™ CX Handheld.
USB Standard A to Micro Cable		Included with the Hub. Connects the **PWR** port of the Rover to a TI approved power source.
TI CE Graphing Calculator or TI-Nspire™ CX Handheld		Runs TI Basic programs to send commands to the Hub.
TI Wall Charger		Included with the Hub. Power source for charging the Rover.

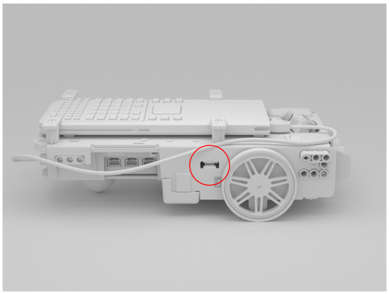
Preparing TI-Innovator™ Rover

Follow these steps to fully charge your TI-Innovator™ Rover.

1. Identify the Micro connector on the USB Standard A to Micro cable.

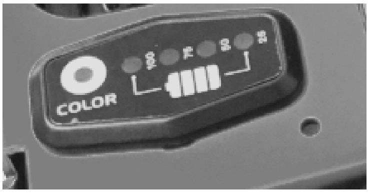


2. Insert the Micro connector into the **PWR** port on the side of the Rover.



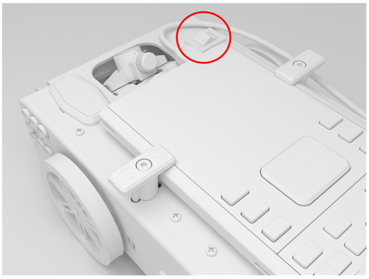
3. Insert the free end of the cable (the "**A**" connector) into the USB port on your computer or TI Wall Charger.

   Note: The Battery Level Indicator shows solid green when the battery is fully charged.



Make sure the TI-Innovator™ Rover is switched **OFF** before connecting to the TI-Innovator™ Hub.

- Flip the **On/Off (I/O)** switch to the **Off (O)** position.



Connecting TI-Innovator™ Rover

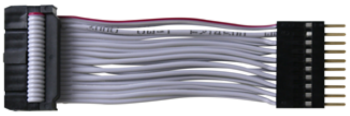
There are two sets of connection steps to use the TI-Innovator™ Rover.

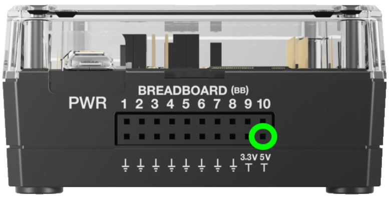
- First, connect the Rover to the TI-Innovator™ Hub, using the two ribbon cables provided.
- Second, connect the Hub to a graphing calculator, using the USB Unit-to-Unit (Mini-A to Mini-B) cable included with the Hub.

Connecting TI-Innovator™ Rover to TI-Innovator™ Hub

1. Insert the **Breadboard Ribbon Cable** into the **Breadboard Connector** on the Hub.

   Note: It is critical that you insert the cable correctly. Make sure the red (dark) wire pin is inserted into the 5v hole on the Hub's **Breadboard Connector**.

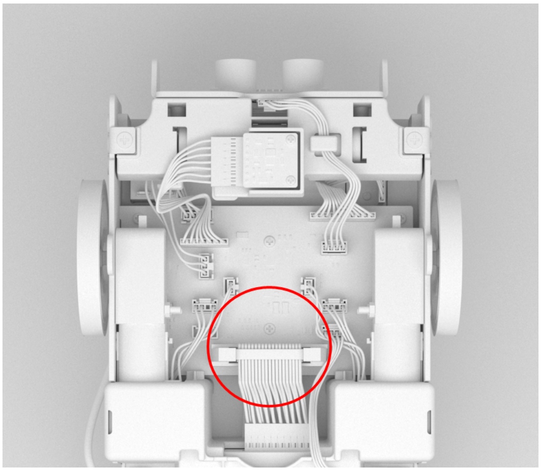




2. Carefully guide the attached Ribbon Cable through the opening at the back of the Rover.
3. As the cable comes through, slide the Hub into place using the **Guide Rails**.

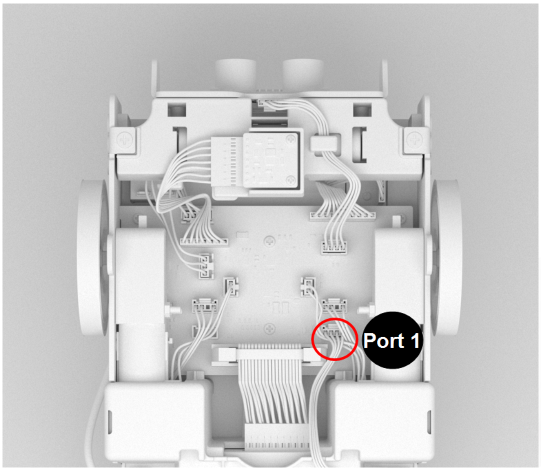
   You will hear a click when the Hub is properly inserted.

4. Open the two latches on the **Rover Circuit Board Ribbon Cable Connector**.
5. Align the notch in the ribbon cable with the slot on circuit board connector.
6. Insert the ribbon cable and close the latches.

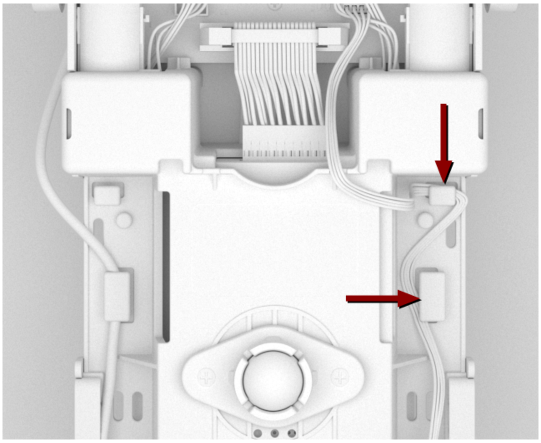


7. Insert one end of the **I^{2}C Cable** into the Rover circuit board.

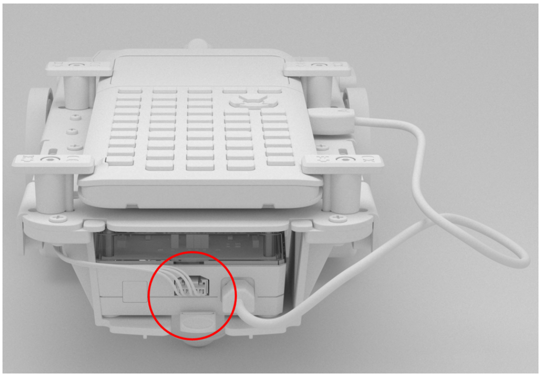
   Note: There are two possible **I^{2}C ports**. Use **Port 1**.



8. Insert the slack **I^{2}C Cable** into the side rails.



9. Align the tab on the **I^{2}C Cable** with the top of the **I^{2}C port**.
10. Insert the free end of the **I^{2}C Cable** connector into the **I^{2}C port** at the back of the Hub.

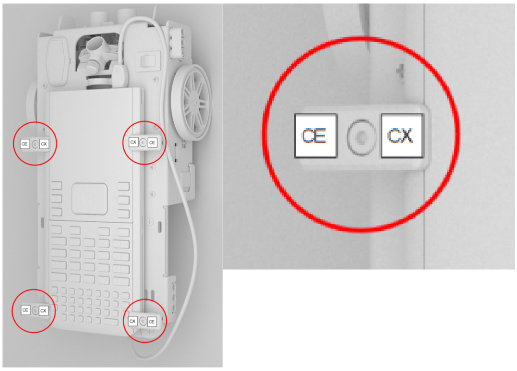


Connecting TI-Innovator™ Hub to a Graphing Calculator

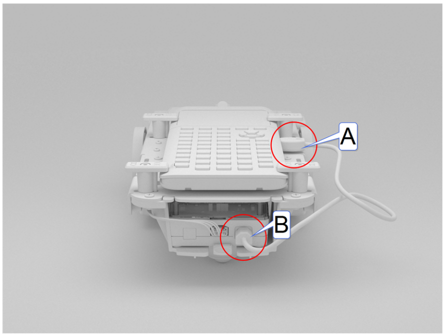
1. Turn the Rover right side up.
2. Lift and turn the **Calculator Holder Pegs** so that they are parallel with the side of the Rover.
3. Place the TI CE Graphing Calculator or TI-Nspire™ CX Handheld on the platform with the screen toward the **Marker Holder**.
4. Turn the pegs so that the CE or CX Label is positioned inward to match the graphing calculator.

   The pegs will snap into place when they are positioned correctly.

   Caution: Do not turn the **Calculator Holder Pegs** without lifting them first. They could break.



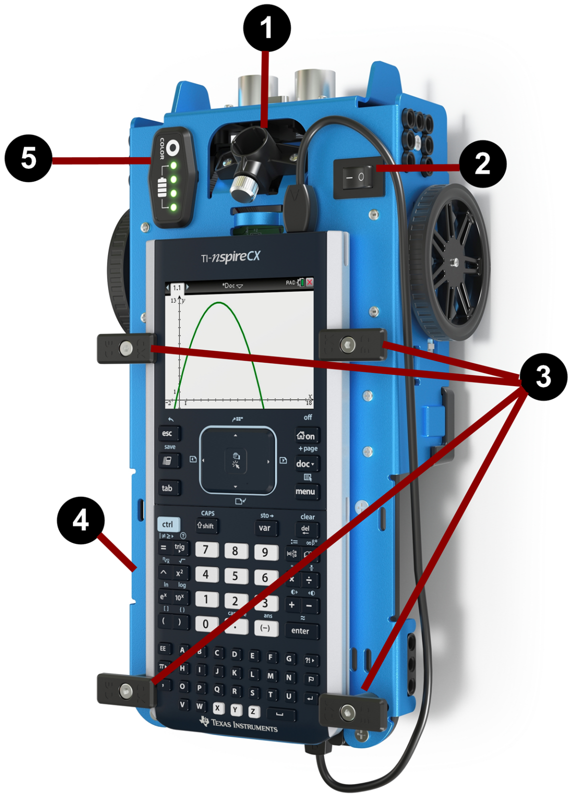
5. Identify the "**B**" connector on the **USB Unit-to-Unit (Mini-A to Mini-B) cable**. Each end of this cable is embossed with a letter.
6. Insert the "**B**" connector into the **DATA** port on the Hub.
7. Insert the free end of the cable (the "**A**" connector) into the USB port on the graphing calculator.



Exploring the Assembled TI-Innovator™ Rover

Explore all sides of the TI-Innovator™ Rover when assembled with the TI-Innovator™ Hub and TI CE Graphing Calculator or TI-Nspire™ CX Handheld connected.

Top Side of the Rover



1 **Marker Holder** - Holds a marker to draw paths.

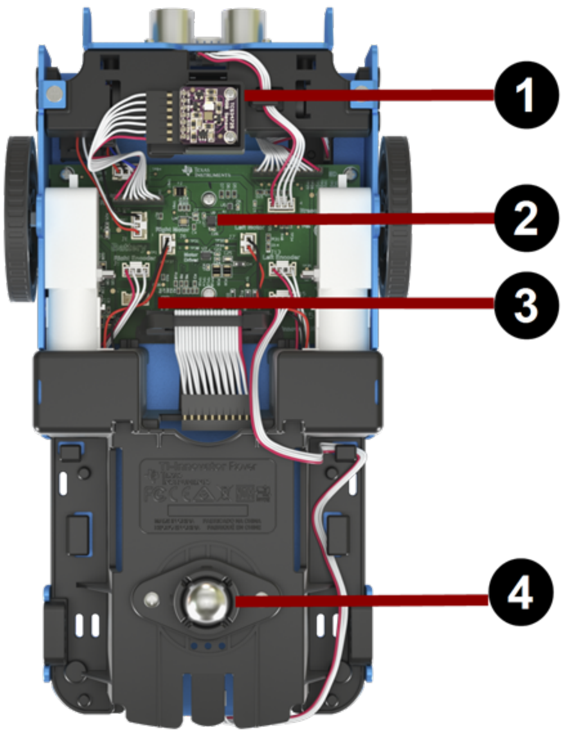
2 **ON/OFF (I/O) Switch** - Turns the Rover **ON (–)** or **OFF (O)**.

3 **Calculator Holder Pegs** - Secures a graphing calculator to the calculator platform.

4 **Calculator Platform** - Holds either a TI CE Graphing Calculator or TI-Nspire™ CX Handheld.

5 **LED Panel (RGB LED/Battery Level Indicator)** - Displays programmable feedback through the **Red-Green-Blue (RGB) LED**, and displays battery charge level.

Bottom Side of the Rover



❶ **Color Sensor** - Bottom-mounted color sensor detects the color of the surface. Can also detect gray-level scale of black (0) to white (255).

❷ **Gyroscope** - Measures or maintains orientation.

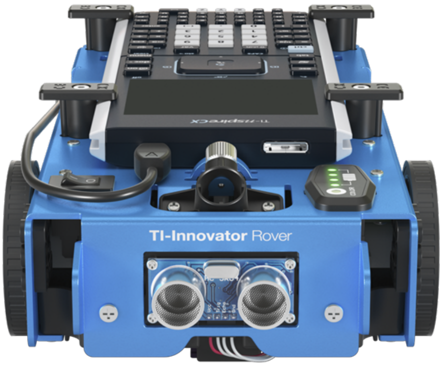
❸ **I^2C** expansion port.

❹ **Ball Caster** - Provides smooth movement on hard surface.
Note: Not recommended for use on carpet.

Caution: If you dislodge or disconnect any of the cables, use this image as a reference for correct hookups.

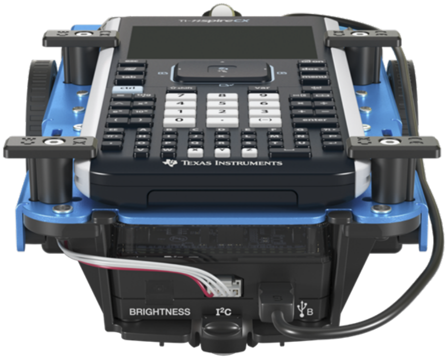
Front Side of the Rover

Ultrasonic Ranger - Measures distance to obstacles.



Back Side of the Rover

Guide Rails - Allows the Hub to slide easily into the Rover and connect to the Rover circuit board.



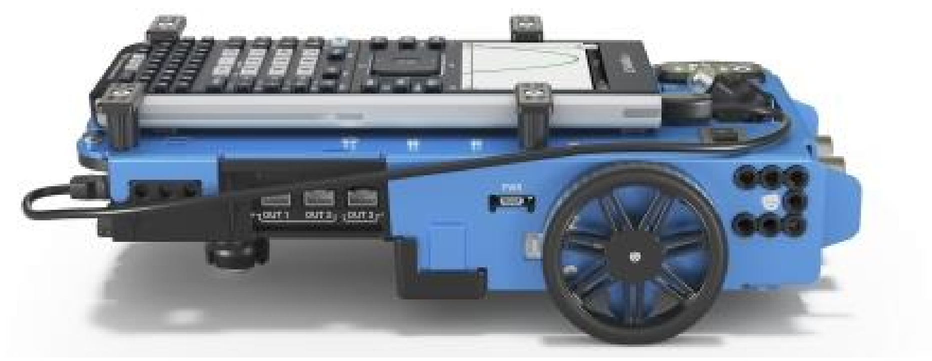
Note: With the TI-Innovator™ Hub inserted, access a sensor and two ports.

- **Light Brightness Sensor** - Reads as "BRIGHTNESS" in Hub command strings.
- **I^{2}C** port - Uses I^{2}C cable to connect the Hub to the Rover circuit board.
- **DATA** Mini-B port - Uses USB Unit-to-Unit (Mini-A to Mini-B) Cable to connect the Hub to a Graphing Calculator.

Right Side of the Rover

Access on the Rover:

- **PWR** port - Uses USB Standard A to Micro auxiliary power cable when charging the Rover's Rechargeable battery.
- **Front and Back Mounts** - For adding structures to the Rover using interlocking plastic blocks.



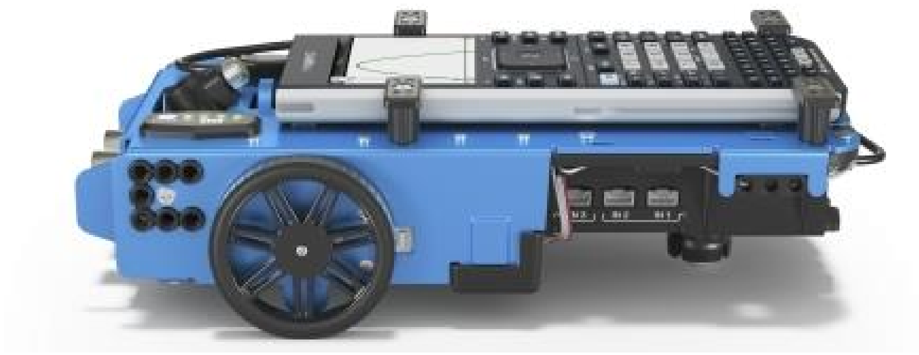
Note: With the Hub inserted, access three ports for controlling output modules.

- **OUT 1** and **OUT 2** provide 3.3V power.
- **OUT 3** provides 5V power.

Left Side of the Rover

Access on the Rover:

- **Front and Back Mounts** - For adding structures to the Rover using interlocking plastic blocks.



Note: With the Hub inserted, access three ports for collecting data or status from input modules.

- **IN 1** and **IN 2** provide 3.3V power.
- **IN 3** provides 5V power.

General Precautions

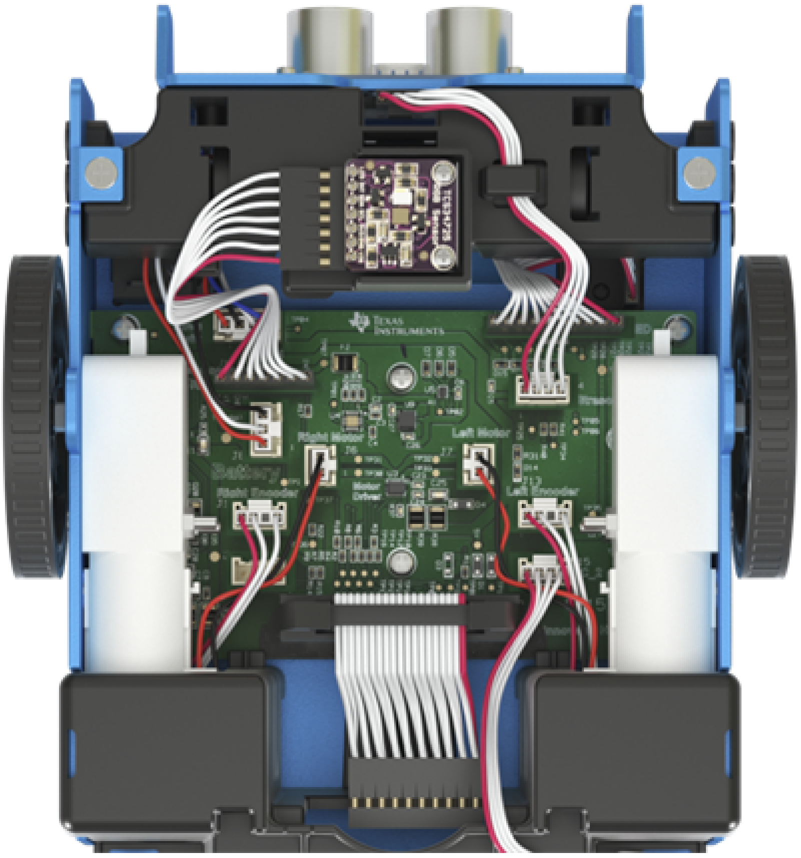
TI-Innovator™ Rover

- Do not expose the Rover to temperatures above 140˚F (60˚C).
- Do not disassemble or mistreat the Rover.
- Do not put anything heavier than 1 Kg or 2.2 lbs on the Rover platform.
- Use only the USB cables provided with the TI-Innovator™ Hub.
- Use only the Ribbon cables provided with the Rover.
- Use only the TI provided wall charger included with the Hub.
- The front-mounted Ultrasonic Ranger will detect objects within 4 meters of the Rover. For best results make sure the object's surface is bigger than a folder. If used to detect small objects, such as a cup, place the Rover within 1 meter of the object.
- For best results, leave the Slide Case off of your graphing calculator.
- For best performance, use Rover on the floor, not on tables. Damage may occur from Rover falling off a table.
- For best performance, use Rover on a hard surface. Carpet may cause the Rover wheels to catch or drag.

- Do not turn the Holder pegs on the Calculator Platform without lifting them first. They could break.
- When securing a marker in the Marker Holder avoid over-tightening the screw.
- Do not use the marker as a lever to pull or push the Rover.
- Do not unscrew the case enclosure on the bottom of the Rover. Encoders have sharp edges that should not be exposed.
- Do not move Rover after executing a program. The internal gyroscope may unintentionally try to get the Rover back on track using the initial location.
- When inserting the Breadboard Ribbon Cable into the Hub Breadboard Connector, it is critical that you insert the cable correctly. Make sure the red (dark) wire pin is inserted into the 5v hole on the Hub's Breadboard Connector.

Caution: If you dislodge or disconnect any of the cables, use this image as a reference for correct hookups.

Reference to Bottom View



TI-Innovator™ Rover Commands version 1.2

Prerequisite: Use the Send "Connect RV" Command First

The "**CONNECT RV**" command needs to be used first when using the Rover. The "**CONNECT RV**" command configures the TI-Innovator™ Hub software to work with the TI-Innovator™ Rover.

It establishes the connections to the various devices on the Rover – two motors, two encoders, one gyroscope, one RGB LED and one color sensor. It also clears the various counters and sensor values. The optional 'MOTORS' parameter configures only the motors and allows direct control of motors without the additional peripherals.

CONNECT RV - initializes the hardware connections.

- Connects RV and inputs and outputs built into the RV.
- Resets the Path and the Grid Origin.
- Sets the units per meter to default value of 10. Default Grid unit = 10cm.

Named RV Subsystems

The RV object contains several subsystems that are directly addressed by name. These subsystems consist of the wheels, and sensors that let the Rover sense the world.

The subsystems are listed by name in the following table.

Subsystem Name	Description of Subsystem
RV	The RV object as a whole.
RV.COLOR	The tri-color RGB LED on the top surface of the Rover can be controlled through user programs to display any color combination.
RV.COLORINPUT	The color sensor is on the bottom of the Rover and is used to detect the color of the surface.
RV.RANGER	The front-facing ultrasonic distance sensor. Returns measurements in meters. ~10.00 meters means no obstacle was detected.
RV.ENCODERGYRO	The rotary encoders – one on each motor – measure the distance traveled by the Rover. The left and right encoder, coupled with the gyroscope and operating time information.
RV.GYRO	The gyroscope is used to maintain the heading of Rover while it's in motion. It can also be used to measure the change in angle during turns.
RV.MOTOR.L	Left wheel motor and control for direct control (advanced) use.
RV.MOTOR.R	Right wheel motor and control for direct control (advanced) use.

Subsystem Name	Description of Subsystem
RV.MOTORS	Both the LEFT and RIGHT motor, managed as a single object for direct control (advanced) use.

Rover Command Categories

The Rover commands fall into two categories:

1. Queued execution: All of the Rover motion commands – FORWARD, BACKWARD, LEFT, RIGHT, ANGLE – are queued on the TI-Innovator Hub. They may execute at a future time.
2. Immediate execution: Other commands – like the ones to read the sensors or set the RGB LED on the Rover – are executed immediately.

This means that certain statements in your program will execute before statements that appear earlier in the program especially if the latter commands are part of the queued family.

For example, in the program below, the RGB LED will turn RED before the Rover stops moving:

`Send "SET RV.COLOR 255 0 255"` – immediately executed

`Send "RV FORWARD 5"` – queued command

`Send "RV LEFT 45"` – queued command

`Send "RV RIGHT 90"` – queued command

`Send "SET RV.COLOR 255 0 0"` – immediately executed

Example:

To change color after a "FORWARD" movement, use "TIME" parameter with "WAIT".

```
Send "RV FORWARD TIME 5"

WAIT 5

Send "SET RV.COLOR 255 0 255"
```

RV Commands, Code Samples, and Syntax

The following examples show how various commands for the RV are used. Anywhere a **SET** command is used, the **SET** may be left off (optional use).

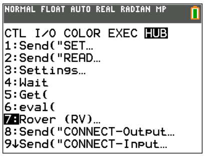
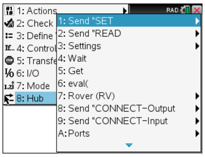
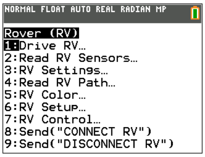
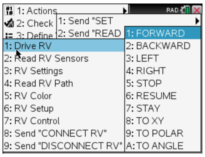
Code Samples

When you see "**Code Sample**" in a command table, this "**Code Sample**" may be copied and pasted *as is* to send to your graphing calculator to use in your calculations.

Example:

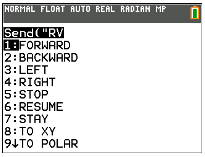
Code Sample:	`Send ("RV FORWARD 5")`
	`Send ("RV FORWARD SPEED 0.2 M/S TIME 10")`

TI-Innovator™ Rover Menu

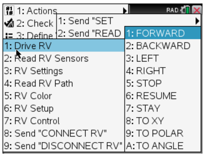
Rover (RV)...	**TI-84 Plus CE**	**TI-Nspire™ CX**
		
• Drive RV... • Read RV Sensors... • RV Settings... • Read RV Path... • RV Color... • RV Setup... • RV Control... • Send("CONNECT RV") • Send("DISCONNECT RV")		

- **Drive RV…**
  - Send("RV
    - FORWARD
    - BACKWARD
    - LEFT
    - RIGHT
    - STOP
    - RESUME
    - STAY
    - TO XY (INACTIVE in v1.2 Release)
    - TO POLAR (INACTIVE in v1.2 Release)
    - TO ANGLE

TI-84 Plus CE

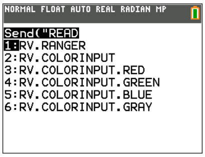


TI-Nspire™ CX

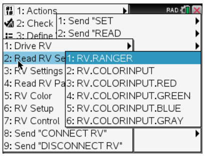


- **Read RV Sensors…**
  - Send"READ"
    - RV.RANGER
    - RV.COLORINPUT
    - RV.COLORINPUT.RED
    - RV.COLORINPUT.GREEN
    - RV.COLORINPUT.BLUE
    - RV.COLORINPUT.GRAY

TI-84 Plus CE

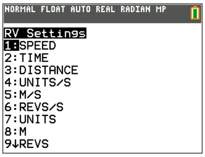


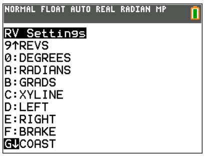
TI-Nspire™ CX



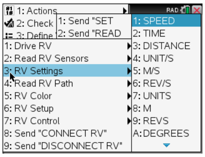
- **RV Settings…**
  - RV Settings
    - SPEED
    - TIME
    - DISTANCE
    - UNIT/S
    - M/S
    - REV/S
    - UNITS
    - M
    - REVS
    - DEGREES
    - RADIANS
    - GRADS

TI-84 Plus CE





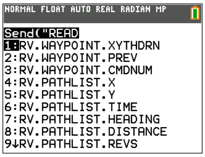
TI-Nspire™ CX



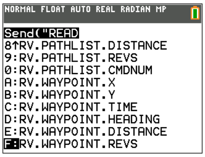
  - XYLINE
  - LEFT
  - RIGHT
  - BRAKE
  - COAST
  - CW
  - CCW

- **Read RV Path…**
  - Send "READ
    - RV.WAYPOINT.XYTHDRN
    - RV.WAYPOINT.PREV
    - RV.WAYPOINT.CMDNUM
    - RV.PATHLIST.X
    - RV.PATHLIST.Y
    - RV.PATHLIST.TIME
    - RV.PATHLIST.HEADING
    - RV.PATHLIST.DISTANCE
    - RV.PATHLIST.REVS
    - RV.PATHLIST.CMDNUM
    - RV.WAYPOINT.X
    - RV.WAYPOINT.Y
    - RV.WAYPOINT.TIME
    - RV.WAYPOINT.HEADING
    - RV.WAYPOINT.DISTANCE
    - RV.WAYPOINT.REVS

TI-84 Plus CE

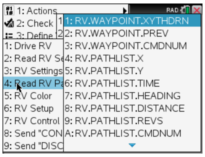


```
NORMAL FLOAT AUTO REAL RADIAN MP
Send("READ
1:RV.WAYPOINT.XYTHDRN
2:RV.WAYPOINT.PREV
3:RV.WAYPOINT.CMDNUM
4:RV.PATHLIST.X
5:RV.PATHLIST.Y
6:RV.PATHLIST.TIME
7:RV.PATHLIST.HEADING
8:RV.PATHLIST.DISTANCE
9↓RV.PATHLIST.REVS
```



```
NORMAL FLOAT AUTO REAL RADIAN MP
Send("READ
8↑RV.PATHLIST.DISTANCE
9:RV.PATHLIST.REVS
0:RV.PATHLIST.CMDNUM
A:RV.WAYPOINT.X
B:RV.WAYPOINT.Y
C:RV.WAYPOINT.TIME
D:RV.WAYPOINT.HEADING
E:RV.WAYPOINT.DISTANCE
F:RV.WAYPOINT.REVS
```

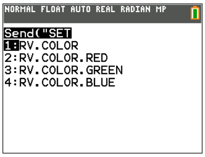
TI-Nspire™ CX



```
1: Actions              1: RV.WAYPOINT.XYTHDRN
2: Check                2: RV.WAYPOINT.PREV
3: Define               3: RV.WAYPOINT.CMDNUM
1: Drive RV             4: RV.PATHLIST.X
2: Read RV Se           5: RV.PATHLIST.Y
3: RV Settings          6: RV.PATHLIST.TIME
4: Read RV Pa           7: RV.PATHLIST.HEADING
5: RV Color             8: RV.PATHLIST.DISTANCE
6: RV Setup             9: RV.PATHLIST.REVS
7: RV Control           A: RV.PATHLIST.CMDNUM
8: Send "CON
9: Send "DISC
```

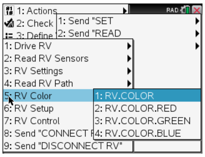
- **RV Color…**
  - Send "SET
    - RV.COLOR
    - RV.COLOR.RED
    - RV.COLOR.GREEN
    - RV.COLOR.BLUE

TI-84 Plus CE



```
NORMAL FLOAT AUTO REAL RADIAN MP
Send("SET
1:RV.COLOR
2:RV.COLOR.RED
3:RV.COLOR.GREEN
4:RV.COLOR.BLUE
```

TI-Nspire™ CX



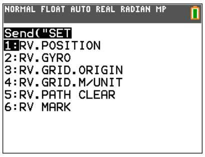
```
1: Actions
2: Check         1: Send "SET
3: Define        2: Send "READ
1: Drive RV
2: Read RV Sensors
3: RV Settings
4: Read RV Path
5: RV Color          1: RV.COLOR
6: RV Setup          2: RV.COLOR.RED
7: RV Control        3: RV.COLOR.GREEN
8: Send "CONNECT R   4: RV.COLOR.BLUE
9: Send "DISCONNECT RV"
```

- **RV Setup…**
  - Send "SET
    - RV.POSITION

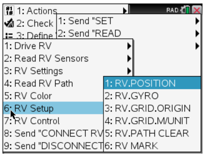
TI-84 Plus CE

TI-Nspire™ CX

- RV.GYRO
- RV.GRID.ORIGIN
- RV.GRID.M/UNIT
- RV.PATH CLEAR
- RV MARK



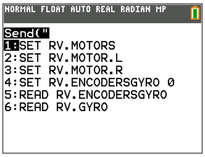
```
NORMAL FLOAT AUTO REAL RADIAN MP
Send("SET
1:RV.POSITION
2:RV.GYRO
3:RV.GRID.ORIGIN
4:RV.GRID.M/UNIT
5:RV.PATH CLEAR
6:RV MARK
```



```
1: Actions            1: Send "SET
2: Check              2: Send "READ
3: Define
1: Drive RV
2: Read RV Sensors
3: RV Settings
4: Read RV Path       1: RV.POSITION
5: RV Color           2: RV.GYRO
6: RV Setup           3: RV.GRID.ORIGIN
7: RV Control         4: RV.GRID.M/UNIT
8: Send "CONNECT RV   5: RV.PATH CLEAR
9: Send "DISCONNECT   6: RV MARK
```

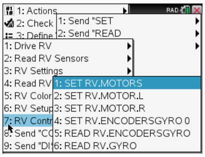
- **RV Control…**
  - Send "
    - SET RV.MOTORS
    - SET RV.MOTOR.L
    - SET RV.MOTOR.R
    - SET RV.ENCODERSGYRO 0
    - READ RV.ENCODERSGYRO
    - READ RV.GYRO

TI-84 Plus CE



```
NORMAL FLOAT AUTO REAL RADIAN MP
Send("
1:SET RV.MOTORS
2:SET RV.MOTOR.L
3:SET RV.MOTOR.R
4:SET RV.ENCODERSGYRO 0
5:READ RV.ENCODERSGYRO
6:READ RV.GYRO
```

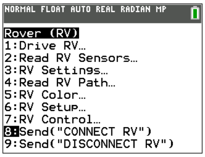
TI-Nspire™ CX



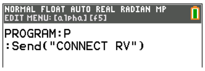
```
1: Actions         1: Send "SET
2: Check           2: Send "READ
3: Define
1: Drive RV
2: Read RV Sensors
3: RV Settings
4: Read RV   1: SET RV.MOTORS
5: RV Color  2: SET RV.MOTOR.L
6: RV Setup  3: SET RV.MOTOR.R
7: RV Contr  4: SET RV.ENCODERSGYRO 0
8: Send "C   5: READ RV.ENCODERSGYRO
9: Send "DI  6: READ RV.GYRO
```

- **Send "CONNECT RV"**
  - Send "CONNECT RV"
    - CONNECT RV

TI-84 Plus CE

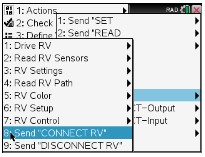


```
NORMAL FLOAT AUTO REAL RADIAN MP
Rover (RV)
1:Drive RV…
2:Read RV Sensors…
3:RV Settings…
4:Read RV Path…
5:RV Color…
6:RV Setup…
7:RV Control…
8:Send("CONNECT RV")
9:Send("DISCONNECT RV")
```



```
NORMAL FLOAT AUTO REAL RADIAN MP
EDIT MENU: [alpha] [f5]
PROGRAM:P
:Send("CONNECT RV")
```

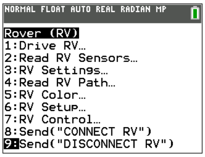
TI-Nspire™ CX



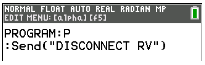
```
1: Actions           1: Send "SET
2: Check             2: Send "READ
3: Define
1: Drive RV
2: Read RV Sensors
3: RV Settings
4: Read RV Path
5: RV Color
6: RV Setup          T–Output
7: RV Control        T–Input
8: Send "CONNECT RV"
9: Send "DISCONNECT RV"
```

- **Send "DISCONNECT RV"**
  - Send "DISCONNECT RV"
    - DISCONNECT RV

TI-84 Plus CE

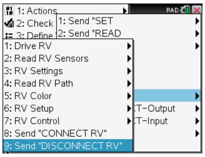


```
NORMAL FLOAT AUTO REAL RADIAN MP
Rover (RV)
1:Drive RV…
2:Read RV Sensors…
3:RV Settings…
4:Read RV Path…
5:RV Color…
6:RV Setup…
7:RV Control…
8:Send("CONNECT RV")
9:Send("DISCONNECT RV")
```



```
NORMAL FLOAT AUTO REAL RADIAN MP
EDIT MENU: [alpha] [f5]
PROGRAM:P
:Send("DISCONNECT RV")
```

TI-Nspire™ CX



```
1: Actions           1: Send "SET
2: Check             2: Send "READ
3: Define
1: Drive RV
2: Read RV Sensors
3: RV Settings
4: Read RV Path
5: RV Color
6: RV Setup          T–Output
7: RV Control        T–Input
8: Send "CONNECT RV"
9: Send "DISCONNECT RV"
```

Drive RV...

RV Drive Command Families

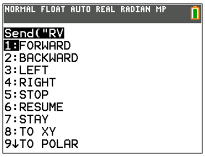
- Base Drive Commands (in the spirit of Turtle Graphics)
  - FORWARD, BACKWARD, RIGHT, LEFT, STOP, STAY
- Math Coordinate Drive Commands
  - Turn to Angle

Note: Drive commands have options for Speed, Time and Distance as appropriate

- See RV Settings for Machine-Level Control Commands
  - Set Left and Right Motor values for direction (CW/CCW) and level (0-255,Coast)
  - Read accumulated values for wheel encoder edges and gyro heading change.

- **Drive RV...**
  - Send("RV
    - FORWARD
    - BACKWARD
    - LEFT
    - RIGHT
    - STOP
    - RESUME
    - STAY
    - TO XY (INACTIVE in v1.2 Release)
    - TO POLAR (INACTIVE in v1.2 Release)
    - TO ANGLE

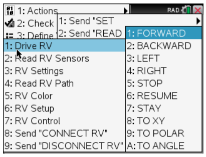
TI-84 PlusCE



```
NORMAL FLOAT AUTO REAL RADIAN MP

Send("RV
1:FORWARD
2:BACKWARD
3:LEFT
4:RIGHT
5:STOP
6:RESUME
7:STAY
8:TO XY
9↓TO POLAR
```

TI-Nspire™ CX



RV FORWARD

Command:	**RV FORWARD**
Command Syntax:	**RV FORWARD [[SPEED s] [DISTANCE d] [TIME t]]**
Code Samples:	`Send ("RV FORWARD 0.5 M")` `Send ("RV FORWARD SPEED 0.22 M/S TIME 10")` `[SET] RV FORWARD` `[SET] RV FORWARD [DISTANCE] d [M|UNIT|REV]` `[SET] RV FORWARD [DISTANCE] d [M|UNIT|REV] SPEED s.ss [M/S|[UNIT/S]|REV/S]` `[SET] RV FORWARD [DISTANCE] d [M|UNIT|REV] TIME t` `[SET] RV FORWARD SPEED s [M/S|UNIT/S|REV/S] [TIME t]` `[SET] RV FORWARD TIME t [SPEED s.ss [M/S|[UNIT/S]|REV/S]]`
Range:	N/A
Describe:	RV moves forward a given distance (default 0.75 m). Default distance if specified is in UNIT (grid units). Optional M=meters, UNIT=grid-unit, REV=wheel-revolution. Default speed is 0.20 m/sec, max is 0.23 m/sec, min is 0.14 m/sec. Speed may be given and specified in meters/second, unit/second, revolutions/second.
Result:	Action to make the RV move in a forward direction
Type or Addressable Component:	Control **Note:** This Rover control command is sent and executed in a queue.

RV BACKWARD

Command:	**RV BACKWARD**
Command Syntax:	**RV BACKWARD**

Code Sample:	`Send("RV BACKWARD 0.5 M")`
	`Send("RV BACKWARD SPEED 0.22 M/S TIME 10")`
	
	`[SET] RV BACKWARD`
	`[SET] RV BACKWARD [DISTANCE] d [M|UNIT|REV]`
	`[SET] RV BACKWARD [DISTANCE] d [M|UNIT|REV]`
	`      SPEED s.ss [M/S|[UNIT/S]|REV/S]`
	`[SET] RV BACKWARD [DISTANCE] d [M|UNIT|REV]`
	`      TIME t`
	`[SET] RV BACKWARD SPEED s.ss`
	`      [M/S|UNIT/S|REV/S] [TIME t]`
	`[SET] RV BACKWARD TIME t`
	`      [SPEED s.ss [M/S|UNIT/S|REV/S]]`

Range:	N/A
Describe:	RV moves backward a given distance (default 0.75 m). Default distance if specified is in UNIT (grid units). Optional M=meters, UNIT=grid-unit, REV=wheel-revolution. Default speed is 0.20 m/sec, max is 0.23 m/sec, min is 0.14 m/sec. Speed may be given and specified in meters/second, unit/second, revolutions/second.
Result:	Action to make the RV move in a backward direction.
Type or Addressable Component:	Control **Note:** This Rover control command is sent and executed in a queue.

RV LEFT

Command:	**RV LEFT**
Command Syntax:	**RV LEFT**

Code Sample:	`Send "RV LEFT"`
	
	`[SET] RV LEFT [ddd [DEGREES]]`
	`[SET] RV LEFT [rrr RADIANS]`
	`[SET] RV LEFT [ggg GRADIANS]`

Range:	N/A
Describe:	Default turn is 90 degrees unless DEGREES, RADIANS, or GRADIANS keyword is present, and then the value is converted internally to degrees format from the specified units. Value given is ranged to a value between 0.0 and 360.0 degrees. The turn will be executed as a SPIN motion.
Result:	Turn Rover to the LEFT.
Type or Addressable Component:	Control **Note:** This Rover control command is sent and executed in a queue.

RV RIGHT

Command:	**RV RIGHT**
Command Syntax:	**RV RIGHT**

Code Sample:	`Send "RV RIGHT"`
	
	`[SET] RV RIGHT [ddd [DEGREES]]`
	`[SET] RV RIGHT [rrr RADIANS]`
	`[SET] RV RIGHT [ggg GRADIANS]`

Range:	N/A
Describe:	Default turn is 90 degrees unless DEGREES, RADIANS, or GRADIANS keyword is present, and then the value is converted internally to degrees format from the specified units. Value given is ranged to a value between 0.0 and 360.0 degrees. The turn will be executed as a SPIN motion.
Result:	Turn Rover to the RIGHT.
Type or	Control

Command:	**RV RIGHT**
Addressable Component:	**Note:** This Rover control command is sent and executed in a queue.

RV STOP

Command:	**RV STOP**
Command Syntax:	**RV STOP**

Code Sample:	`Send "RV STOP"`
	
	`[SET] RV STOP`
	
	`[SET] RV STOP CLEAR`

Range:	N/A
Describe:	The **RV** will stop any current movement immediately. That movement can be resumed from where it left off with a **RESUME** operation. Any movement commands will cause the queue to flush immediately, and begin the just-posted new movement operation
Result:	Stop processing Rover commands from the command queue, and leave pending operations in the queue. (immediate action). Queue can be resumed by **RESUME**.The **RV** will stop any current movement immediately. That movement can be resumed from where it left off with a **RESUME** operation. Any movement commands will cause the queue to flush immediately, and begin the just-posted new movement operation. Stop processing Rover commands from the command queue, and flush any pending operations left in the queue. (immediate action).
Type or Addressable Component:	Control **Note:** This Rover control command is executed immediately.

RV RESUME

Command:	**RV RESUME**
Command Syntax:	**RV RESUME**

Command:	**RV RESUME**

Code Sample:	`Send "RV RESUME"`
	
	`[SET] RV RESUME`

Range:	N/A
Describe:	Enable processing of Rover commands from the command queue. (immediate action), or resume (see RV STAY) operation.
Result:	Resume operation.
Type or Addressable Component:	Control **Note:** This Rover control command is sent and executed in a queue.

RV STAY

Command:	**RV STAY**
Command Syntax:	**RV STAY**

Code Sample:	`Send "RV STAY"`
	
	`[SET] RV STAY [[TIME] s.ss]`

Range:	N/A
Describe:	Tells RV to "stay" in place for an optionally specified amount of time in seconds. Default is 30.0 seconds.
Result:	RV stays in position.
Type or Addressable Component:	Control **Note:** This Rover control command is sent and executed in a queue.

RV TO XY (INACTIVE in v1.2 Release)

RV TO POLAR (INACTIVE in v1.2 Release)

RV TO ANGLE

Command:	**RV TO ANGLE**
Command Syntax:	**RV TO ANGLE**

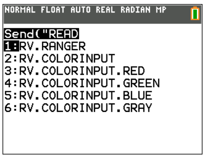
Code Sample:	`Send "RV TO ANGLE"`
	
	`[SET] RV TO ANGLE rr.rr`
	`      [[DEGREES]|RADIANS|GRADIANS]`

Range:	N/A
Describe:	
Result:	Spins the RV to the specified angle from current heading.
Type or Addressable Component:	Control **Note:** This Rover control command is sent and executed in a queue.

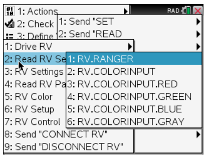
READ RV Sensors...

SEND("Read Sensor Commands

- Reading of low level sensors for learning foundations of robotics.
  - **Read RV Sensors...**
    - Send("READ
      - RV.RANGER
      - RV.COLORINPUT
      - RV.COLORINPUT.RED
      - RV.COLORINPUT.GREEN
      - RV.COLORINPUT.BLUE
      - RV.COLORINPUT.GRAY
  - **RV.RANGER:** Returns value in Meters.
  - **RV.COLORINPUT:** Reads color sensor that is built into the RV.



```
NORMAL FLOAT AUTO REAL RADIAN MP
Send("READ
1:RV.RANGER
2:RV.COLORINPUT
3:RV.COLORINPUT.RED
4:RV.COLORINPUT.GREEN
5:RV.COLORINPUT.BLUE
6:RV.COLORINPUT.GRAY
```



RV.RANGER

Command:	**RV.RANGER**
Command Syntax:	**RV.RANGER**

Code Sample:	`Send("READ RV.RANGER")`
	`Get(R)`
	
	Connects the Rover Vehicle to the TI-Innovator™ Hub. This establishes connections with the motor driver, color sensor, gyroscope, ultrasonic ranger, and proximity sensors. — `CONNECT RV`
	
	Returns the current distance from the front of the RV to an obstacle. If there is no obstacle detected, a range of 10.00 meters is reported — `READ RV.RANGER`
	`Get(R)`

Command:	**RV.RANGER**
Range:	N/A
Describe:	The front-facing ultrasonic distance sensor. Returns measurements in meters. ~10.00 meters means no obstacle was detected.
Result:	Returns value in Meters.
Type or Addressable Component:	Sensor **Note:** This Rover sensor command is executed immediately.

RV.COLORINPUT

Command:	**RV.COLORINPUT**
Command Syntax:	**RV.COLORINPUT**

Code Sample:	`Send("READ RV.COLORINPUT")`
	`Get(C)`

Range:	1 thru 9
Describe:	Bottom-mounted color sensor detects the color of the surface. Can also detect gray-level scale of black (0) to white (255).
Result:	Returns current color sensor information. The return value is in the 1 – 9 range which maps to the colors below: **Color** — **Return value** Red — 1 Green — 2 Blue — 3 Cyan — 4 Magenta — 5 Yellow — 6 Black — 7 White — 8 Gray — 9
Type or Addressable Component:	Sensor **Note:** This Rover sensor command is executed immediately.

RV.COLORINPUT.RED

Command:	**RV.COLORINPUT.RED**
Command Syntax:	**RV.COLORINPUT.RED**

Code Sample:	`Send("READ RV.COLORINPUT.RED")`
	`Get(R)`

Range:	0 - 255
Describe:	Detect intensity of individual red components of surface. The results are in 0-255 range.
Result:	Returns current color sensor "red value".
Type or Addressable Component:	Sensor **Note:** This Rover sensor command is executed immediately.

RV.COLORINPUT.GREEN

Command:	**RV.COLORINPUT.GREEN**
Command Syntax:	**RV.COLORINPUT.GREEN**

Code Sample:	`Send("READ RV.COLORINPUT.GREEN")`
	`Get(G)`

Range:	0 - 255
Describe:	Detect intensity of individual green components of surface. The results are in 0-255 range.
Result:	Returns current color sensor "green" value.
Type or Addressable Component:	Sensor **Note:** This Rover sensor command is executed immediately.

RV.COLORINPUT.BLUE

Command:	**RV.COLORINPUT.BLUE**
Command Syntax:	**RV.COLORINPUT.BLUE**

Code Sample:	`Send("READ RV.COLORINPUT.BLUE")`
	`Get(B)`

Range:	0 - 255
Describe:	Detect intensity of individual blue components of surface. The results are in 0-255 range.
Result:	Returns current color sensor "blue" value.
Type or Addressable Component:	Sensor **Note:** This Rover sensor command is executed immediately.

RV.COLORINPUT.GRAY

Command:	**RV.COLORINPUT.GRAY**
Command Syntax:	**RV.COLORINPUT.GRAY**

Code Sample:	`Send("READ RV.COLORINPUT.GRAY")`
	`Get(G)`

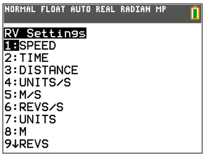
Range:	0 - 255
Describe:	Detect grayness of surface. The result will be in 0-255 range.
Result:	Returns an interpolated "grayscale" value based on 0.3*red + 0.59*green + 0.11*blue 0-black, 255 - white.
Type or Addressable Component:	Sensor **Note:** This Rover sensor command is executed immediately.

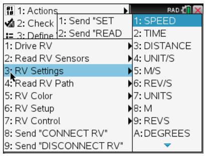
RV Settings...

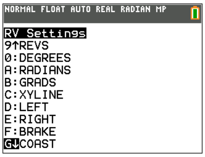
RV Settings Commands

Settings menu for Rover contains other commands that support RV commands such as FORWARD or BACKWARD.

- **RV Settings...**
  - RV Settings
    - SPEED
    - TIME
    - DISTANCE
    - UNIT/S
    - M/S
    - REV/S
    - UNITS
    - M
    - REVS
    - DEGREES
    - RADIANS
    - GRADS
    - XYLINE
    - LEFT
    - RIGHT
    - BRAKE
    - COAST
    - CW
    - CCW







Read RV Path…

Reading WAYPOINT and PATH

Tracking the RV's Path

In order to support analysis of the Rover during and after a run, the sketch will automatically measure the following information for each Drive command:

- X Coordinate on virtual grid
- Y Coordinate on virtual grid
- Time in seconds that the current command has been executing.
- Distance in coordinate units for the path segment.
- Heading in degrees (absolute terms measured Counter Clockwise with the X-axis as 0 degrees.
- Revolutions by the wheel in executing the current command
- Command number, tracks the number of commands executed, begins with 0.

The Path values will be stored in lists, starting with the segments associated with the earliest commands and going to the segments associated with the latest commands.

The drive command in progress, the **WAYPOINT**, will repeatedly update the last element in the Path lists as the Rover progresses toward the last waypoint.

When a drive command is completed a new waypoint is initiated and the dimension of the Path lists are incremented.

> **Note:** This implies that when all the drive commands in the queue are completed that another waypoint for the stopped state is automatically started. This is similar to the initial position where the RV is stationary and counting time.

Max number of waypoints: 80

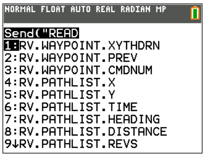
RV Position and Path

- Ability to read X,Y coordinate, Heading, Time and Distance for each drive command in execution.
- Will store path history in lists for plotting and analysis

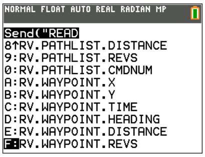
Note: Coordinate grid scale can be set by the user, default is 10cm per unit. The user will have options to set the origin of the grid.

- **Read RV Path…**
  - Send("READ
    - RV.WAYPOINT.XYTHDRN
    - RV.WAYPOINT.PREV
    - RV.WAYPOINT.CMDNUM
    - RV.PATHLIST.X
    - RV.PATHLIST.Y
    - RV.PATHLIST.TIME
    - RV.PATHLIST.HEADING
    - RV.PATHLIST.DISTANCE
    - RV.PATHLIST.REVS
    - RV.PATHLIST.CMDNUM
    - RV.WAYPOINT.X
    - RV.WAYPOINT.Y
    - RV.WAYPOINT.TIME
    - RV.WAYPOINT.HEADING
    - RV.WAYPOINT.DISTANCE
    - RV.WAYPOINT.REVS

TI-84 PlusCE

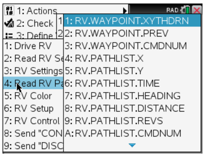


```
NORMAL FLOAT AUTO REAL RADIAN MP
Send("READ
1:RV.WAYPOINT.XYTHDRN
2:RV.WAYPOINT.PREV
3:RV.WAYPOINT.CMDNUM
4:RV.PATHLIST.X
5:RV.PATHLIST.Y
6:RV.PATHLIST.TIME
7:RV.PATHLIST.HEADING
8:RV.PATHLIST.DISTANCE
9↓RV.PATHLIST.REVS
```



```
NORMAL FLOAT AUTO REAL RADIAN MP
Send("READ
8↑RV.PATHLIST.DISTANCE
9:RV.PATHLIST.REVS
0:RV.PATHLIST.CMDNUM
A:RV.WAYPOINT.X
B:RV.WAYPOINT.Y
C:RV.WAYPOINT.TIME
D:RV.WAYPOINT.HEADING
E:RV.WAYPOINT.DISTANCE
F:RV.WAYPOINT.REVS
```

TI-Nspire™ CX



```
1: Actions
2: Check
3: Define
1: Drive RV
2: Read RV Se
3: RV Settings
4: Read RV Pa
5: RV Color
6: RV Setup
7: RV Control
8: Send "CON
9: Send "DISC
```

```
1: RV.WAYPOINT.XYTHDRN
2: RV.WAYPOINT.PREV
3: RV.WAYPOINT.CMDNUM
4: RV.PATHLIST.X
5: RV.PATHLIST.Y
6: RV.PATHLIST.TIME
7: RV.PATHLIST.HEADING
8: RV.PATHLIST.DISTANCE
9: RV.PATHLIST.REVS
A: RV.PATHLIST.CMDNUM
```

RV.WAYPOINT.XYTHDRN

Command:	**RV.WAYPOINT.XYTHDRN**
Command Syntax:	**RV.WAYPOINT.XYTHDRN**
Code Sample:	`Send("READ RV.WAYPOINT.XYTHDRN")`
Example:	Getting the distance traveled toward the current way-point from the last way-point

Code Sample:	`Send("READ RV.WAYPOINT.XYTHDRN")`
	Get(L_1)
	(L_1)(5)->D

Range:	N/A
Describe:	READ RV.WAYPOINT.XYTHDRN - read the x-coord, y-coord, time, heading, distance traveled, number of wheel revolutions, command number of the current waypoint. Returns a list with all these values as elements.
Result:	Return list of current way-point X, Y coordinates, Time, Heading, Distance, Revolutions, and command number.
Type or Addressable Component:	Returns Data

RV.WAYPOINT.PREV

Command:	**RV.WAYPOINT.PREV**
Command Syntax:	**RV.WAYPOINT.PREV**
Code Sample:	`Send("READ RV.WAYPOINT.PREV")`
Example:	Getting the distance traveled during the previous way-point.

Code Sample:	`Send("READ RV.WAYPOINT.PREV")`
	Get(L_1)
	(L_1)(5)->D

Command:	**RV.WAYPOINT.PREV**
Range:	N/A
Describe:	READ RV.WAYPOINT.PREV - read the x-coord, y-coord, time, heading, distance traveled, number of wheel revolutions, command number of the previous waypoint. Returns a list with all these values as elements.
Result:	Return list of the previous way-point X, Y coordinates, time, heading, distance, revolutions, and command number.
Type or Addressable Component:	Returns Data

RV.WAYPOINT.CMDNUM

Command:	**RV.WAYPOINT.CMDNUM**
Command Syntax:	**RV.WAYPOINT.CMDNUM**
Code Sample:	`Send("READ RV.WAYPOINT.CMDNUM")`
Example:	Program to determine if a drive command has completed without referring to a specific command number. **Note:** the **Wait** is intended to increase the probability of catching a difference in the Command Number.

Code Sample:	`Send("RV FORWARD 10")`
	`Send("READ RV.WAYPOINT.CMDNUM")`
	`Get(M)`
	`M->N`
	
	While M=N
	
	`Send("READ RV.WAYPOINT.CMDNUM")`
	`Get(N)`
	`End`
	
	Disp "Drive Command is completed"

Range:	N/A
Describe:	READ RV.WAYPOINT.CMDNUM - returns the last command number of

Command:	**RV.WAYPOINT.CMDNUM**
	the current waypoint.
Result:	Returns a value of 0 if the RV is currently "working" on a command and is either in motion, or running a STAY operation. This command will return a value of 1 when ALL queued operations are completed, nothing is remaining in the command queue, and the current operation has completed (and immediately after CONNECT RV).
Type or Addressable Component:	Returns Data

RV.PATHLIST.X

Command:	**RV.PATHLIST.X**
Command Syntax:	**RV.PATHLIST.X**
Code Samples:	`Send("READ RV.PATHLIST.X")`
Example:	Program to plot the RV path on the graph screen

Code Samples:	`Plot1(xyLine, L₁, L₂,▫,BLUE)`
	`Send("READ RV.PATHLIST.X")`
	`Get(L1)`
	`Send("READ RV.PATHLIST.Y")`
	`Get(L2)`
	`DispGraph`

Range:	N/A
Describe:	READ RV.PATHLIST.X - returns a list of X values from the beginning to and including the current Waypoint X value.
Result:	Return list of X coordinates traversed since last **RV.PATH CLEAR** or initial **CONNECT RV**.
Type or Addressable Component:	Returns Data

RV.PATHLIST.Y

Command:	**RV.PATHLIST.Y**
Command Syntax:	**RV.PATHLIST.Y**
Code Sample:	`Send("READ RV.PATHLIST.Y")`
Example:	Program to plot the RV path on the graph screen

Code Sample:	Plot1(xyLine, L_1, L_2,▫,BLUE)
	`Send("READ RV.PATHLIST.Y")`
	`Get(L1)`
	`Send("READ RV.PATHLIST.X")`
	`Get(L2)`
	`DispGraph`

Range:	N/A
Describe:	READ RV.PATHLIST.Y - returns a list of Y values from the beginning to and including the current Waypoint Y value.
Result:	Return list of Y coordinates traversed since last **RV.PATH CLEAR** or initial **CONNECT RV**.
Type or Addressable Component:	Returns Data

RV.PATHLIST.TIME

Command:	**RV.PATHLIST.TIME**
Command Syntax:	**RV.PATHLIST.TIME**
Code Sample:	`Send "READ RV.PATHLIST.TIME"`
Range:	N/A
Describe:	READ RV.PATHLIST.TIME - returns a list of the time in seconds from the beginning to and including the current Waypoint time value.

Command:	**RV.PATHLIST.TIME**
Result:	Return list of cumulative travel times for each successive way-point.
Type or Addressable Component:	Returns Data

RV.PATHLIST.HEADING

Command:	**RV.PATHLIST.HEADING**
Command Syntax:	**RV.PATHLIST.HEADING**
Code Sample:	`Send "READ RV.PATHLIST.HEADING"`
Range:	N/A
Describe:	READ RV.PATHLIST.HEADING - returns a list of the headings from the beginning to and including the current Waypoint heading value.
Result:	Return list of cumulative angular headings taken.
Type or Addressable Component:	Returns Data

RV.PATHLIST.DISTANCE

Command:	**RV.PATHLIST.DISTANCE**
Command Syntax:	**RV.PATHLIST.DISTANCE**
Example:	Getting the cumulative distance traveled since the beginning of a journey by the RV

Code Sample:	`Send "READ RV.PATHLIST.DISTANCE"`
	Get(L_1)
	sum(L_1)

Range:	N/A
Describe:	READ RV.PATHLIST.DISTANCE - returns a list of the distances traveled from the beginning to and including the current Waypoint distance value.

Command:	**RV.PATHLIST.DISTANCE**
Result:	Return list of cumulative distances traveled.
Type or Addressable Component:	Returns Data

RV.PATHLIST.REVS

Command:	**RV.PATHLIST.REVS**
Command Syntax:	**RV.PATHLIST.REVS**
Code Sample:	`Send "READ RV.PATHLIST.REVS"`
Range:	N/A
Describe:	READ RV.PATHLIST.REVS - returns a list of the number of revolutions traveled from the beginning to and including the current Waypoint revolutions value.
Result:	Return list of wheel revolutions traveled.
Type or Addressable Component:	Returns Data

RV.PATHLIST.CMDNUM

Command:	**RV.PATHLIST.CMDNUM**
Command Syntax:	**RV.PATHLIST.CMDNUM**
Code Sample:	`Send "READ RV.PATHLIST.CMDNUM"`
Range:	N/A
Describe:	READ RV.PATHLIST.CMDNUM - returns a list of command numbers for the path

Command:	**RV.PATHLIST.CMDNUM**
Result:	Return list of commands used to travel to the current way-point entry. 0 - Start of Way-points (if first action is a STAY, then no START is given, but a STAY will be shown instead.) 1 - Travel forward 2 - Travel backward 3 - Left spin motion 4 - Right spin motion 5 - Left turn motion 6 - Right turn motion 7 - Stay (no motion) the time the RV stays at the current position is given in the TIME list. 8 - RV is currently in motion on this way-point traversal.
Type or Addressable Component:	Returns Data

RV.WAYPOINT.X

Command:	**RV.WAYPOINT.X**
Command Syntax:	**RV.WAYPOINT.X**
Code Samples:	`Send("READ RV.WAYPOINT.X")`
Range:	N/A
Describe:	READ RV.WAYPOINT.X - returns x coordinate of current waypoint.
Result:	Return current way-point X coordinate.
Type or Addressable Component:	Returns Data

RV.WAYPOINT.Y

Command:	**RV.WAYPOINT.Y**
Command Syntax:	**RV.WAYPOINT.Y**

Command:	RV.WAYPOINT.Y
Code Samples:	`Send("READ RV.WAYPOINT.Y")`
Range:	N/A
Describe:	READ RV.WAYPOINT.Y - returns x coordinate of current waypoint.
Result:	Return current way-point Y coordinate.
Type or Addressable Component:	Returns Data

RV.WAYPOINT.TIME

Command:	RV.WAYPOINT.TIME
Command Syntax:	**RV.WAYPOINT.TIME**
Code Sample:	`Send("READ RV.WAYPOINT.TIME")`
Range:	N/A
Describe:	READ RV.WAYPOINT.TIME - returns time spent traveling from previous to current waypoint
Result:	Return total cumulative way-point travel time value in seconds.
Type or Addressable Component:	Returns Data

RV.WAYPOINT.HEADING

Command:	RV.WAYPOINT.HEADING
Command Syntax:	**RV.WAYPOINT.HEADING**
Code Sample:	`Send("READ RV.WAYPOINT.HEADING")`

Command:	**RV.WAYPOINT.HEADING**
Range:	N/A
Describe:	READ RV.WAYPOINT.HEADING - returns absolute heading of current waypoint
Result:	Return current absolute heading in degrees. (+h = counter-clockwise, -h = clockwise.)
Type or Addressable Component:	Returns Data

RV.WAYPOINT.DISTANCE

Command:	**RV.WAYPOINT.DISTANCE**
Command Syntax:	**RV.WAYPOINT.DISTANCE**
Code Sample:	`Send("READ RV.WAYPOINT.DISTANCE")`
Range:	N/A
Describe:	READ RV.WAYPOINT.DISTANCE - returns distance traveled between previous and current waypoint
Result:	Return cumulative total distance traveled in meters.
Type or Addressable Component:	Returns Data

RV.WAYPOINT.REVS

Command:	**RV.WAYPOINT.REVS**
Command Syntax:	**RV.WAYPOINT.REVS**
Code Sample:	`Send("READ RV.WAYPOINT.REVS")`
Range:	N/A

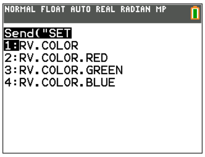
Command:	RV.WAYPOINT.REVS
Describe:	READ RV.WAYPOINT.REVS - returns number of revolutions needed to travel between previous and current waypoint
Result:	Return total revolutions of the wheels performed to travel the cumulative distance to the current way-point.
Type or Addressable Component:	Returns Data

RV Color…

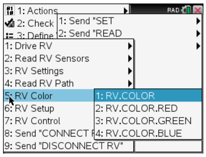
Send("SET Commands

RGB LED on Rover - This supports the same commands and parameters as the RGB LED on the TI-Innovator™ Hub.

- **RV Color…**
  - Send("SET
    - RV.COLOR
    - RV.COLOR.RED
    - RV.COLOR.GREEN
    - RV.COLOR.BLUE



```
NORMAL FLOAT AUTO REAL RADIAN MP
Send("SET
1:RV.COLOR
2:RV.COLOR.RED
3:RV.COLOR.GREEN
4:RV.COLOR.BLUE
```



RV.COLOR

Command:	**RV.COLOR**
Command Syntax:	**RV.COLOR**

Code Sample:	`Send "SET RV.COLOR`
	
	`[SET] RV.COLOR rr gg bb [[BLINK] b [[TIME] s.ss]]`

Range:	N/A
Describe:	Set the RGB color to be displayed on the Rover's RGB LED. Same syntax as for all RGB LED operations with COLOR, etc.
Result:	Return the current RGB color, as a three-element list, that is being displayed on the Rover's RGB LED
Type or Addressable Component:	Control **Note:** This Rover control command is sent and executed in a queue.

RV.COLOR.RED

Command:	**RV.COLOR.RED**
Command Syntax:	**RV.COLOR.RED**
Code Sample:	`Send "SET RV.COLOR.RED`

Command:	**RV.COLOR.RED**
	`[SET] RV.COLOR.RED rr [[BLINK] b [[TIME] s.ss]]`
Range:	N/A
Describe:	
Result:	Set the RED color to be displayed on the Rover's RGB LED.
Type or Addressable Component:	Control **Note:** This Rover control command is sent and executed in a queue.

RV.COLOR.GREEN

Command:	**RV.COLOR.GREEN**
Command Syntax:	**RV.COLOR.GREEN**

Code Sample:	`Send "SET RV.COLOR.GREEN`
	
	`[SET] RV.COLOR.GREEN gg [[BLINK] b [[TIME] s.ss]]`

Range:	N/A
Describe:	
Result:	Set the GREEN color to be displayed on the Rover's RGB LED.
Type or Addressable Component:	Control **Note:** This Rover control command is sent and executed in a queue.

RV.COLOR.BLUE

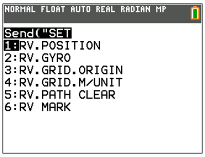
Command:	**RV.COLOR.BLUE**
Command Syntax:	**RV.COLOR.BLUE**
Code Sample:	`Send "SET RV.COLOR.BLUE`

Command:	**RV.COLOR.BLUE**
	`[SET] RV.COLOR.BLUE bb [[BLINK] b [[TIME] s.ss]]`
Range:	N/A
Describe:	
Result:	Set the BLUE color to be displayed on the Rover's RGB LED.
Type or Addressable Component:	Control **Note:** This Rover control command is sent and executed in a queue.

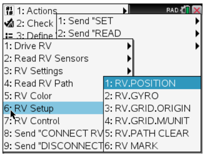
RV Setup…

Send("SET Commands

- **RV Setup…**
  - Send("SET
    - RV.POSITION
    - RV.GYRO
    - RV.GRID.ORIGIN
    - RV.GRID.M/UNIT
    - RV.PATH CLEAR
    - RV MARK



```
NORMAL FLOAT AUTO REAL RADIAN MP
Send("SET
1:RV.POSITION
2:RV.GYRO
3:RV.GRID.ORIGIN
4:RV.GRID.M/UNIT
5:RV.PATH CLEAR
6:RV MARK
```



```
1: Actions
2: Check   1: Send "SET
3: Define  2: Send "READ
1: Drive RV
2: Read RV Sensors
3: RV Settings
4: Read RV Path         1: RV.POSITION
5: RV Color             2: RV.GYRO
6: RV Setup             3: RV.GRID.ORIGIN
7: RV Control           4: RV.GRID.M/UNIT
8: Send "CONNECT RV     5: RV.PATH CLEAR
9: Send "DISCONNECT     6: RV MARK
```

RV.POSITION

Command:	**RV.POSITION**
Command Syntax:	**RV.POSITION**

Code Sample:	`Send "SET RV.POSITION"`
	
	`[SET] RV.POSITION xxx yyy`
	`[hhh [[DEGREES]|RADIANS|GRADIANS]]`

Range:	N/A
Describe:	Sets the coordinate position and optionally the heading of the Rover on the virtual grid.
Result:	Rover configuration is updated.
Type or Addressable Component:	Setting

RV.GYRO

Command:	**RV.GYRO**
Command Syntax:	**RV.GYRO**
Code Sample:	`Send "SET RV.GYRO"`

Command:	RV.GYRO
Range:	N/A
Describe:	Sets the on-board Gyroscope.
Result:	
Type or Addressable Component:	Control (for Gyroscope)

RV.GRID.ORIGIN

Command:	RV.GRID.ORIGIN
Command Syntax:	**RV.GRID.ORIGIN**

Code Sample:	`Send "SET RV.GRID.ORIGIN"`
	
	`[SET} RV.GRID.ORIGIN`

Range:	N/A
Describe:	Sets RV as being at current grid origin point of (0,0). The "heading" is set to 0.0 resulting in the current position of the RV now set to pointing down a virtual x-axis toward positive x values.
Result:	
Type or Addressable Component:	Setting

RV.GRID.M/UNIT

Command:	RV.GRID.M/UNIT
Command Syntax:	**RV.GRID.M/UNIT**

Code Sample:	`Send "SET RV.GRID.M/UNIT"`
	
	`[SET] RV.GRID.M/UNIT nnn`

Command:	**RV.GRID.M/UNIT**
Range:	N/A
Describe:	Set the size of a "grid unit" on the virtual grid. Default is 10 units per meter (100 mm / 10 cm per unit grid). A value of 5 means 5 units per meter or 200 mm / 20 cm per unit grid). A value of 20 means 20 units per meter, or 50 mm / 5 cm per unit grid.
Result:	
Type or Addressable Component:	Setting

RV.PATH CLEAR

Command:	**RV.PATH CLEAR**
Command Syntax:	**RV.PATH CLEAR**

Code Sample:	`Send "SET RV.PATH CLEAR"`
	
	`[SET] RV.PATH CLEAR`

Range:	N/A
Describe:	Clears any pre-existing path / waypoint information. Recommended before doing a sequence of movement operations where waypoint / path-list information is desired.
Result:	
Type or Addressable Component:	Setting

RV MARK

Command:	**RV MARK**
Command Syntax:	**RV MARK**

Code Sample:	`Send "SET RV MARK"`
	
	`[SET] RV MARK [[TIME] s.ss]`

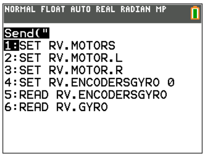
Command:	RV MARK
Range:	N/A
Describe:	Enable RV to make a "mark" with a pen at the specified time interval (default is 1 second if not specified). A time value of 0.0 turns OFF marking. Marking ONLY happens if the Rover is moving in a forward direction.
Result:	
Type or Addressable Component:	Setting (for Rover)

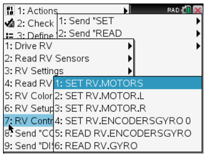
RV Control…

SEND(" Commands

Wheel commands and other commands relevant for learning foundations of the Rover vehicle.

- **RV Control …**
  - Send("
    - SET RV.MOTORS
    - SET RV.MOTOR.L
    - SET RV.MOTOR.R
    - SET RV.ENCODERSGYRO 0
    - READ RV.ENCODERSGYRO
    - READ RV.GYRO





SET RV.MOTORS

Command:	**SET RV.MOTORS**
Command Syntax:	**SET RV.MOTORS**

Code Sample:	`Send "SET RV.MOTORS"`
	
	`[SET] RV.MOTORS [LEFT][CW|CCW]`
	`    <pwm value|BRAKE|COAST>`
	`    [RIGHT][CW|CCW]`
	`    <pwm value|BRAKE|COAST>`
	`    [DISTANCE ddd [M|[UNITS]|REV|FT]]`
	`
		[TIME s.ss]`

Range:	N/A
Describe:	Set left or right or both motor PWM values. Negative values imply **CCW** and Positive values imply **CW**. Left **CW**=backward motion. Left **CCW**=forward motion. Right CW=forward motion, Right **CCW**=backward motion. PWM values may be numeric from -255 to +255, or keywords "**COAST**" or "**BRAKE**". Value of 0 is stop (coast). Use of the **DISTANCE** option is only available if the **RV** is connected with all sensors. **CONNECT RV MOTORS** means no sensors are available to measure distance, so the **DISTANCE** option is an error in this instance.
Result:	Both the LEFT and RIGHT motor, managed as a single object for direct

Command:	**SET RV.MOTORS**
	control (advanced) use.
Type or Addressable Component:	Control **Note:** This Rover control command is sent and executed in a queue.

SET RV.MOTOR.L

Command:	**SET RV.MOTOR.L**
Command Syntax:	**SET RV.MOTOR.L**

Code Sample:	`Send "SET RV.MOTOR.L"`
	`[SET] RV.MOTOR.L [CW|CCW] <+/-pwm value|BRAKE|COAST>`
	`[TIME s.ss] | [DISTANCE ddd [[UNITS]|M|REV|FT]]`

Range:	N/A
Describe:	Set left motor direct PWM value. **CCW** = forward, **CW** = backward, pwm value negative = forward, positive = backward. **TIME** option available in all modes, **DISTANCE** option available only when **RV** is fully connected (not the **RV MOTORS** option).
Result:	Left wheel motor and control for direct control (advanced) use.
Type or Addressable Component:	Control **Note:** This Rover control command is sent and executed in a queue.

SET RV.MOTOR.R

Command:	**SET RV.MOTOR.R**
Command Syntax:	**SET RV.MOTOR.R**

Code Sample:	`Send "SET RV.MOTOR.R"`
	
	`[SET] RV.MOTOR.R [CW|CCW] <+/-pwm value|BRAKE|COAST>`
	`[TIME s.ss] | [DISTANCE ddd [[UNITS]|M|REV|FT]]`

Command:	**SET RV.MOTOR.R**
Range:	N/A
Describe:	Set right motor direct PWM value. **CW** = forward, **CCW** = backward, pwm value positive = forward, negative = backward. **TIME** option available in all modes, **DISTANCE** option available only when **RV** is fully connected (not the **RV MOTORS** option).
Result:	Right wheel motor and control for direct control (advanced) use.
Type or Addressable Component:	Control **Note:** This Rover control command is sent and executed in a queue.

SET RV.ENCODERSGYRO 0

Command:	**SET RV.ENCODERSGYRO 0**
Command Syntax:	**SET RV.ENCODERSGYRO 0**
Code Sample:	`Send "SET RV.ENCODERSGYRO 0"`
Range:	N/A
Describe:	Reset the left and right encoder, coupled with the gyro and operating time information.
Result:	
Type or Addressable Component:	Control **Note:** This Rover control command is sent and executed in a queue.

READ RV.ENCODERSGYRO

Command:	**READ RV.ENCODERSGYRO**
Command Syntax:	**READ RV.ENCODERSGYRO**
Code Sample:	`Send "READ RV.ENCODERSGYRO"`
Range:	N/A

Command:	**READ RV.ENCODERSGYRO**
Describe:	The left and right encoder, coupled with the gyro and operating time information.
Result:	List of values of current left and right encoder, coupled with gyro and operating time information
Type or Addressable Component:	Control **Note:** This Rover READ command is executed immediately.

READ RV.GYRO

Command:	**READ RV.GYRO**
Command Syntax:	**READ RV.GYRO**

Code Sample:	`Send "READ RV.GYRO"`
	
	`READ RV.GYRO [[DEGREES]|RADIANS|GRADIANS]`

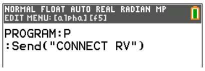
Range:	N/A
Describe:	The gyroscope is used to maintain the heading of Rover while it's in motion. It can also be used to measure the change in angle during turns. The gyroscope is ready to use after the **CONNECT RV** command is processed. The GYRO object shall be usable even when the RV is not in motion.
Result:	Returns current gyro sensor angular deviation from 0.0, reading partially drift-offset compensated.
Type or Addressable Component:	Control **Note:** This Rover READ command is executed immediately.

Send "CONNECT RV"

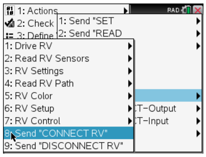
SEND("CONNECT RV") Commands

CONNECT RV - initializes the hardware connections.

- Connects RV and inputs and outputs built into the RV.
- Resets the Path and the Grid Origin.
- Sets the units per meter to default value.
    - **Send("CONNECT RV")**



```
NORMAL FLOAT AUTO REAL RADIAN MP
EDIT MENU: [alpha] [f5]
PROGRAM:P
:Send("CONNECT RV")
```



CONNECT RV

Command:	**CONNECT RV**
Command Syntax:	CONNECT RV [MOTORS]

Code Sample:	`Send "CONNECT RV"`
	`Send "CONNECT RV MOTORS"`

Range:	N/A
Describe:	The "**CONNECT RV**" command configures the TI-Innovator™ Hub software to work with the TI-Innovator™ Rover. It establishes the connections to the various devices on the Rover – two motors, two encoders, one gyroscope, one RGB LED and one color sensor. It also clears the various counters and sensor values. The optional 'MOTORS' parameter configures only the motors and allows direct control of motors without the additional peripherals.
Result:	Connects the Rover Vehicle to the TI-Innovator™ Hub. This establishes connections with the motor driver, color sensor, gyroscope, ultrasonic ranger, and RGB LED. The Rover is now ready to be programmed
Type or Addressable Component:	All components of the Rover - two motors, two encoders, one gyroscope, one RGB LED and one color sensor.

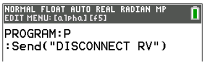
Send "DISCONNECT RV"

SEND("DISCONNECT RV") Commands

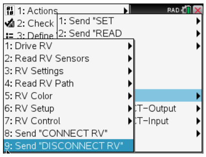
DISCONNECT RV - disconnects all the hardware peripherals from the Hub.

Format: Send("DISCONNECT RV")

- Send("DISCONNECT RV")



```
NORMAL FLOAT AUTO REAL RADIAN MP
EDIT MENU: [alpha] [f5]
PROGRAM:P
:Send("DISCONNECT RV")
```



DISCONNECT RV

Command:	**DISCONNECT RV**
Command Syntax:	DISCONNECT RV

Code Sample:	`Send "DISCONNECT RV"`
	
	`DISCONNECT RV`

Range:	N/A
Describe:	The "**DISCONNECT RV**" command removes the logical connections between the TI-Innovator™ Hub and the TI-Innovator™ Rover. It also clears the counters and sensor values. It allows the use of the breadboard port of the TI-Innovator™ Hub with other devices.
Result:	The TI-Innovator™ Hub is now logically disconnected from the TI-Innovator™ Rover
Type or Addressable Component:	N/A

TI-Innovator™ Rover – Programmable Component Data Sheets

The TI-Innovator™ Rover Programmable Component Data Sheets include the following; a product name or number, a brief description, a product image, specifications, how the component connects to the TI-Innovator™ Hub, and Rover commands with simple code samples.

Device

Device	Category
Rover (RV)	Accessory

Sensors

Sensors	Category
Rotary Encoders	Motion and Distance Sensor
Gyroscope	Motion and Distance Sensor
Ultrasonic Ranger	Motion and Distance Sensor
Color Sensor	Environmental Sensor
On-Board Light Brightness Sensor (On Hub)	Environmental Sensor

Controllable Devices

Controllable Devices	Category
Electric Motors	Motors
RGB (Red-Green-Blue) LED	LEDs and Displays
On-Board Speaker (on Hub)	Sound Output

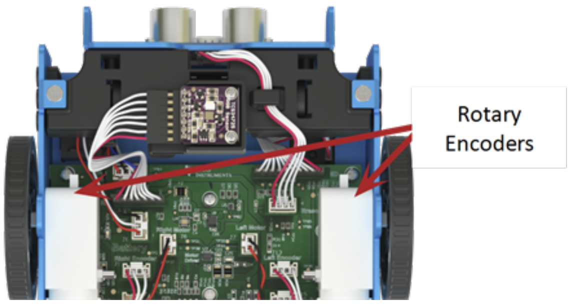
TI-Innovator™ Rover

Title	**TI-Innovator™ Rover Data Sheet**
TI Item Name	TI-Innovator™ Rover
Quantity	1
Included in	TI-Innovator™ Rover
Description	**TI-Innovator™ Rover** is a two-wheeled programmable robotic vehicle which works with the TI-Innovator™ Hub with TI LaunchPad™ Board.
Category	Accessory
Hub Connection	**See:** Connecting TI-Innovator™ Rover
Assembly Instructions	**See:** Exploring the Assembled TI-Innovator™ Rover
Precautions	**See:** General Precautions
Specifications	**See:** TI-Innovator™ Rover Setup Requirements

Rover Commands	
Sketch Object	RV
Command Syntax	
Code Sample:	

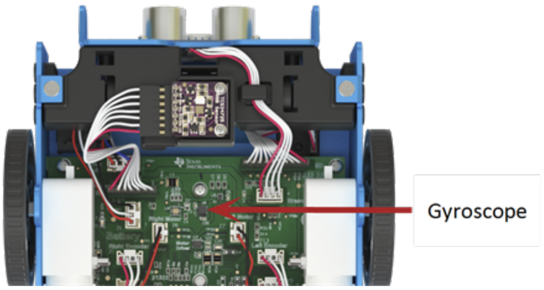
Desired Action	Code Sample
Configure Hub for additional commands such as: RV Forward 2 RV Left	`Send "CONNECT RV"`

TI-Innovator™ Rover On-Board Rotary Encoders Data Sheet



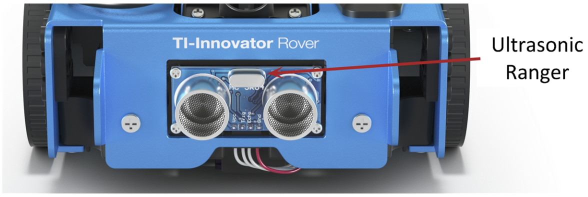
Title	**TI-Innovator™ Rover Rotary Encoders**
TI Item Name	Built into the TI-Innovator™ Rover
Quantity	2 - 1 for each wheel
Included in	TI-Innovator™ Rover
Description	Calculates linear distance by detecting how many rotations the wheels make as the Rover moves. Assists in balancing and aligning the wheels.
Category	Motion and Distance Sensors
Hub Connection	on-board Rover
Assembly Instructions	Not Applicable
Precautions	Do not unscrew the case enclosure. Encoder has sharp edges that should not be exposed.
Specifications	Not Applicable

TI-Innovator™ Rover On-Board Gyroscope Data Sheet



Title	TI-Innovator™ Rover Gyroscope
TI Item Name	Built into the TI-Innovator™ Rover
Quantity	1
Included in	TI-Innovator™ Rover
Description	Calculates angular displacement and heading as it maintains orientation.
Category	Motion and Distance Sensors
Hub Connection	on-board Rover
Assembly Instructions	Not Applicable
Precautions	Not Applicable
Specifications	Not Applicable

TI-Innovator™ Rover On-Board Ultrasonic Ranger Data Sheet



Title	**Ultrasonic Ranger**
TI Item Name	Built into the Rover
Quantity	1
Included in	TI-Innovator™ Rover
Description	Non-contact measurement module that reads distance from obstacle in meters.
Category	Motion and Distance Sensors
Hub Connection	On-board the Rover
Assembly Instructions	Not Applicable
Precautions	
Specifications	Measures distances up to 4 m

Rover Commands	
Sketch Object	RV.RANGER
Command Syntax	Send("READ RV.RANGER")

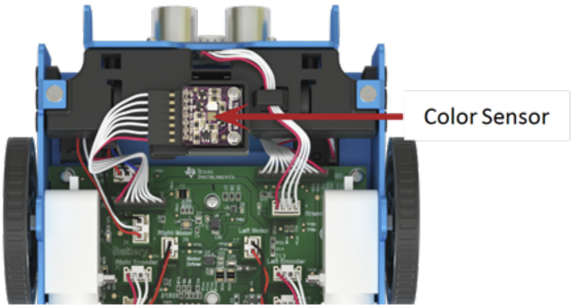
Code Sample:

Desired Action	Code Sample
Connects the Rover to the TI-Innovator Hub. This establishes connections with the motor driver, color sensor, gyroscope, ultrasonic ranger, and proximity sensors.	`CONNECT RV`

Returns the current distance from the front	`READ RV.RANGER`
	`Get (R)`

	Desired Action	Code Sample
	of the Rover to an obstacle. If there is no obstacle detected, a range of 10.00 meters is reported	

TI-Innovator™ Rover On-Board Color Sensor Data Sheet



Title	**TI-Innovator™ Rover Color Sensor**
TI Item Name	Built into the TI-Innovator™ Rover
Quantity	1
Included in	TI-Innovator™ Rover
Description	Bottom-mounted color sensor detects the color of the surface. Can also detect gray-level scale of black (0) to white (255). Measures surface color. Used to identify colors and execute Rover Hub commands based on color.
Category	Environmental Sensors
Hub Connection	on-board Rover
Assembly Instructions	Not Applicable
Precautions	Do not unplug the cable. If it becomes unattached see proper positioning as shown above.
Specifications	Not Applicable

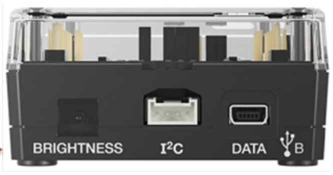
Rover Commands	
Sketch Object	RV.COLORINPUT RV.COLORINPUT.RED RV.COLORINPUT.GREEN RV.COLORINPUT.BLUE RV.COLORINPUT.GRAY
Command Syntax	

Code Sample:	**Desired Action**	**Code Sample**

		`Send "READ RV.COLORINPUT.RED"`
		`Get (C)`

On-Board Light Brightness Sensor Data Sheet

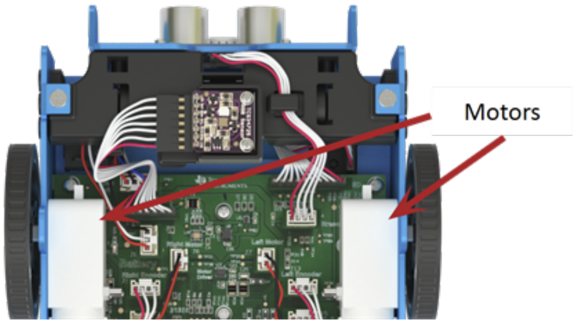
Light Brightness Sensor



Title	**On-Board Light Brightness Sensor**
TI Item Name	Built into the Hub
Quantity	1
Included in	TI-Innovator™ Hub
Description	Built-in light brightness sensor located at the bottom of the Hub. The sensor detects light intensity.
Category	Environmental Sensors
Hub Connection	on-board Hub
Assembly Instructions	Not Applicable
Precautions	Not Applicable
Specifications	Not Applicable

HUB Commands		
Sketch Object	BRIGHTNESS	
Command Syntax	Send("READ BRIGHTNESS")	
Code Sample:	**Desired Action**	**Code Sample**
	Read the built-in light brightness sensor	`Send("READ BRIGHTNESS")` `Get(B)`

TI-Innovator™ Rover On-Board Electric Motors Data Sheet



Title	**TI-Innovator™ Rover Motors**
TI Item Name	Built into the TI-Innovator™ Rover
Quantity	2 – 1 on each wheel with electric motor and rotary encoder to track rotations.
Included in	TI-Innovator™ Rover
Description	Motors that can be programmed to move the wheels independently and at variable speeds.
Category	Motors
Hub Connection	on-board Rover
Assembly Instructions	Not Applicable
Precautions	Not Applicable
Specifications	Not Applicable

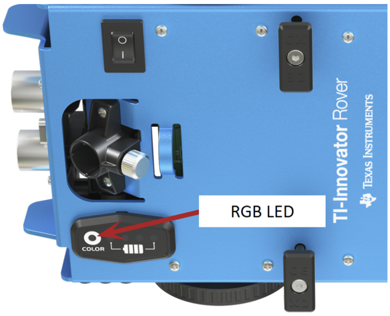
Rover Commands	**`Send "SET RV.MOTORS`**
Sketch Object	RV.MOTORS
Command Syntax	

Code Sample:	**Desired Action**	**Code Sample**
	Direct control of	`Send "SET RV.MOTORS"`

Desired Action	Code Sample

motors.	`[SET] RV.MOTORS [LEFT] [CW|CCW]`
	`<pwm value|BRAKE|COAST>`
	`[RIGHT][CW|CCW]`
	`<pwm value|BRAKE|COAST>`
	`[DISTANCE ddd [M|[UNITS]|REV|FT]]`
	`| [TIME s.ss]`

TI-Innovator™ Rover On-Board RGB (Red-Green-Blue) LED Data Sheet



Title	**TI-Innovator™ Rover RGB (Red-Green-Blue) LED**
TI Item Name	Built into the TI-Innovator™ Rover
Quantity	1
Included in	TI-Innovator™ Rover
Description	Light-emitting diode with independently adjustable red, green and blue elements. Can produce a wide variety of colors.
Category	LEDs and Displays
Hub Connection	on-board Rover
Assembly Instructions	Not Applicable
Precautions	Not Applicable
Specifications	Not Applicable

Rover Commands	
Sketch Object	RV.COLOR
Command Syntax	

Code Sample:

Desired Action	**Code Sample**
Configure LED **Note:** RV.COLOR supports the same functions	`Send("SET RV.COLOR 255 0 255")`

	Desired Action	Code Sample
	as the Hub COLOR object	

On-Board Speaker Data Sheet

Speaker (at back of Hub) is addressable as "SOUND" in Hub command strings.

Title	**On-Board Speaker**
TI Item Name	Built into the Hub
Quantity	1
Included in	TI-Innovator™ Hub
Description	Built-in speaker located at the back of the Hub. It converts electrical current into sound you can hear.
Category	Sound Output
Hub Connection	on-board Hub
Assembly Instructions	Not Applicable
Precautions	Not Applicable
Specifications	Not Applicable

HUB Commands	
Sketch Object	SOUND
Command Syntax	Send("SET SOUND ...") Frequency in Hz or Note as C1, CS1, D2, ... [TIME duration in seconds]

Code Sample:

Desired Action	**Code Sample**
Play tone at 261.23 Hz	`Send("SET SOUND 261.23")`
Evaluate the expression 2^8 (= 256) and play that tone	`Send("SET SOUND eval (2^8)")`

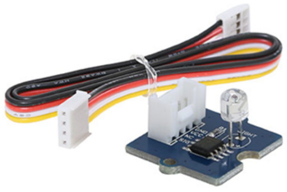
Desired Action	Code Sample
Evaluate the expression 2^8 (= 256) and play that tone for .25 seconds	`Send("SET SOUND eval (2^8) TIME .25")`
Evaluate the expression 2^9 (= 512) and play that tone for 0.25 seconds (result of evaluating 1/4)	`Send("SET SOUND eval (2^9) TIME eval(1/4)")`
Turn speaker off	`Send("SET SOUND OFF")`

I/O Modules Data Sheets

The TI-Innovator™ I/O Module Data Sheets include the following; a product name and number, a brief description, a product image, specifications, how the component connects to the TI-Innovator™ Hub, and Hub commands with simple code samples.

Topic Links

Analog Light Sensor Data Sheet



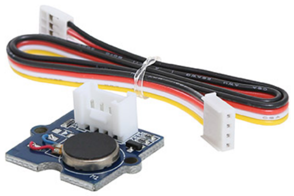
Title	**Analog Light Sensor**
TI Item Name	STEMKT/AC/A
Quantity	1
Included in	TI-Innovator™ I/O Module Pack
Description	Sensor that detects the light intensity of the environment.
Category	Environmental Sensors
Hub Connection	4-Pin Cable to any of these ports: IN 1, IN 2, IN 3
Assembly Instructions	Not applicable
Precautions	Light sensor leads may break if bent repeatedly
Specifications	Maximum voltage: 150, Maximum power: 100, Environmental Temp: -30~+70, Spectrum Peak Value: 540

HUB Commands	
Sketch Object	LIGHTLEVEL
Command Syntax	Send("READ LIGHTLEVEL n")

Code Sample:

Desired Action	**Code Sample**
Configure the program to use LIGHTLEVEL on port **IN 1**	`Send("CONNECT LIGHTLEVEL 1 TO IN 1")`
Read the light sensor	`Send("READ LIGHTLEVEL 1")` `Get(L)`

Vibration Motor Data Sheet



Title	**Vibration Motor**
TI Item Name	STEMKT/AC/B
Quantity	1
Included in	TI-Innovator™ I/O Module Pack
Description	Coin type motor that vibrates when the input logic is HIGH.
Category	Motors
Hub Connection	4-Pin Cable to any of these ports: OUT 1, OUT 2, OUT 3
Assembly Instructions	Not Applicable
Precautions	Use an Auxiliary Power Source
Specifications	Operate Voltage: 3.0V to 5.5V, Control Mode: Logic Level (When Logic HIGH, the motor is ON. When LOW, the motor is OFF.), Rated speed: 9000 rpm

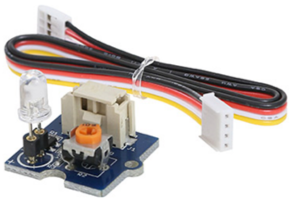
HUB Commands	
Sketch Object	VIB.MOTOR
Command Syntax	Send("SET VIB.MOTOR 1 TO pwm") - pwm from 0 to 255

Code Sample:

Desired Action	Code Sample
Configure the program to use ANALOG.OUT on port **OUT 1**	`Send("CONNECT VIB.MOTOR 1 TO OUT 1")`
Turn OFF vibration motor	`Send("SET VIB.MOTOR 1 TO 0")`
Turn ON vibration motor at full power	`Send("SET VIB.MOTOR 1 TO 255")`

Desired Action	Code Sample
Turn ON vibration motor at half power	`Send("SET VIB.MOTOR 1 TO 128")`

White LED Data Sheet



Title	**White LED**
TI Item Name	STEMKT/AC/C
Quantity	1
Included in	TI-Innovator™ I/O Module Pack
Description	White LED module that bends to any position.
Category	LEDs and Displays
Hub Connection	4-Pin Cable to any of these ports: OUT 1, OUT 2, OUT 3
Assembly Instructions	Insert LED into socket - longer leg (lead) is positive (anode). If both leads are of equal length, the lead adjacent to the flat edge on LED casing is the negative (cathode) lead.
Precautions	Do not bend the leads repeatedly; this will weaken the wires and may cause them to break.
Specifications	Operating voltage: 3.3v/5v, Emitting Color: White

HUB Commands	
Sketch Object	LED
Command Syntax	Send("SET LED 1 TO ON/OFF [[BLINK|TOGGLE] frequency] [[TIME] seconds]")

Code Sample:

Desired Action	**Code Sample**
Configure the program to use LED on port **OUT 1**	`Send("CONNECT LED 1 TO OUT 1")`
Turn LED ON	`Send("SET LED 1 ON")`
Turn LED OFF	`Send("SET LED 1 OFF")`
Turn external LED	`Send("SET LED 1 TO ON`

Desired Action	Code Sample
ON for 5 seconds	`TIME 5")`
Turn external LED ON and blink it at 2 Hz (2 times a second) for 5 seconds	`Send("SET LED 1 TO ON BLINK 2 TIME 5")`

Servo Motor Data Sheet

There are two types of Servo motors, continuous and sweep. More about SERVO Motors

Title	**Servo Motor**
TI Item Name	STEMKT/AC/D
Quantity	1
Included in	TI-Innovator™ I/O Module Pack
Description	360 degree, continuous rotation servo motor with gearing and feedback system; used in driving mechanism of robots.
Category	Motors
Hub Connection	4-Pin Cable to only this port: OUT 3
Assembly Instructions	Mount a gear to the top of the Servo Motor using one of the provided screws.
Precautions	Use an Auxiliary Power Source. Do not hold the Servo Motor's shaft while it is rotating. Also, do not rotate the Servo Motor by hand.
Specifications	Operating Speed: 110RPM (4.8V), 130RPM (6V); Stall Torque: 1.3kg.cm/18.09oz.in (4.8V), 1.5kg.cm/20.86oz.in (6V); Operating Voltage: 4.8V~6V

HUB Commands	
Sketch Object	SERVO
Command Syntax	Send("SET SERVO n TO [CW/CCW] speed [[TIME] seconds] -- speed from -100 to 100, CW/CCW (Clockwise/Counterclosewise) optional, if speed <0, CCW, else CW unless CW/CCW keyword is specified, TIME optional, in seconds, default=1 second (for continuous servo operation) (CW/CCW required if TIME/seconds NOT specified.)

HUB Commands

Code Samples:

Desired Action for the SERVO.CONTINOUS	**Code Sample**
Configure the program to use **SERVO** on port **OUT 3**	`Send("CONNECT SERVO 1 TO OUT 3")`
Set **SERVO** to turn Counterclockwise (CCW) at full (100%) speed for 2 seconds	`Send("SET SERVO 1 CCW 100 2")`
Set **SERVO** to turn Clockwise (CW) at half (50%) speed for 1 second (default time if not specified)	`Send("SET SERVO 1 CW 50")`
Turn **SERVO** Off	`Send("SET SERVO 1 ZERO")` **or** `Send("SET SERVO 1 STOP")`

More about SERVO Motors

There are two types of Servo motors, **continuous** and **sweep**.

- The motor in the I/O pack is a continuous motor. This motor rotates either clockwise (positive direction) or counter clockwise (negative direction) for a specified amount of time.
- Sweep servo motors turn only 90 degrees in each direction.

It is necessary to connect servo motors to the OUT 3 port. This port provides the 5 volts needed for these motors.

- You will also need to plug an external battery into the PWR micro USB port.
- You will also give a number, in this case 1, as part of identifying to an external device plugged into a port. (**Note:** In some cases you may have multiple devices of the same type connected to the TI-Innovator (e.g. temperature probes))

Code Sample:	`Send("CONNECT SERVO.CONTINUOUS 1 TO OUT 3")`

The first argument sets the speed and direction of the motor. You can use -100 to 100. Negative values are in the counter clockwise direction. Positive values are in the clockwise direction. Zero stops the motor.

The second argument is the amount of time in seconds to run the motor in the specified direction and speed. If there is no argument for time, then the motor will turn for one second.

The Wait command is used in the case to delay execution of commands on the calculator until the motor action is complete. This optional command is useful in delaying commands that might replace the current motor command before the desired end time.

Code Sample:

```
Send("SET SERVO.CONTINUOUS 1 ¬50 TIME 2")
Wait 2
```

You also have the options of using explicit CW and CCW settings with values for speed of 0 to 100.

Code Sample:

```
Send("SET SERVO.CONTINUOUS 1 CW 100 TIME
3")
Wait 3
```

This example prompts for the inputs to the **SERVO.CONTINUOUS** command.

The example also uses a While loop with getKey as a way for the user to control when the command to stop the motor is executed.

Code Sample:

```
ClrHome
Disp "S:SPEED AND DIRECTION"
Disp "ENTER VALUES ¬100 TO 100 FOR S"
Disp "T:TIME IN SECONDS"
Prompt S,T
Send("SET SERVO.CONTINUOUS 1 eval(S) TIME
eval(T)")
Disp "PRESS 1 TO STOP THE MOTOR AND END THE
PROGRAM"
0→K
While K≠92
getKey→K
End
Send("SET SERVO.CONTINUOUS 1 0”)
```

Ultrasonic Ranger Data Sheet

Title	**Ultrasonic Ranger**
TI Item Name	STEMKT/AC/E
Quantity	1
Included in	TI-Innovator™ Ultrasonic Ranger Module
Description	Non-contact measurement module that reads distance from sensor in meters.
Category	Motion and Distance Sensors
Hub Connection	4-Pin Cable to any of these ports: IN 1, IN 2
Assembly Instructions	Not Applicable
Precautions	Sold separately, not included in the I/O Modules Pack
Specifications	Operating voltage: 3.3~5V, Operating current: 15mA, Ultrasonic frequency: 42kHz, Measuring range: 3-400m, Resolution: 1m, Output: PWM

HUB Commands	
Sketch Object	RANGER

Command Syntax	Send("READ RANGER n")
	Get(R)

Code Sample:

Desired Action	**Code Sample**
Configure the program to use RANGER on port **IN 1**	`Send("CONNECT RANGER 1 TO IN 1")`

Read the Ultrasonic Ranger	`Send("READ RANGER 1")`
	`Get(R)`

TI-Innovator™ Breadboard Data Sheets

The TI-Innovator™ Breadboard Data Sheets include the following; a product name and number, a brief description, a product image, specifications, how the component connects to the TI-Innovator™ Hub, and simple code samples.

Topic Links

Breadboard Components and Usable Pins

Here is a list of all the components in our breadboard pack and the usable pins for each component.

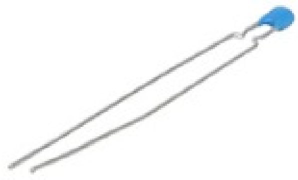
Component	Use with pins
1 Breadboard	N/A
10 Male/Female Breadboard Jumper Cables	N/A
40 Male/Male Breadboard Jumper Cables	N/A
5 Green LED	BB 1-10
10 Red LED	BB 1-10
2 RGB (Red-Green-Blue) LED	BB 8-10
10 Resistor 100 Ohm	N/A
10 Resistor 1K Ohm	N/A
10 Resistor 10K Ohm	N/A
10 Resistor 100K Ohm	N/A
10 Resistor 10M Ohm	N/A
1 Diode	BB 1-10
1 Thermistor	BB 5,6,7 (analog input required)
1 SPDT Slide Switch	BB 1-10
1 8 Position SIP DIP Switch	BB 1-10 (digital input)
1 8 100 Ohm Resistor SIP	N/A
1 Potentiometer with Knob	BB 5,6,7
1 Capacitor 100µF	N/A
1 Capacitor 10µF	N/A
1 Capacitor 1µF	N/A
1 7-Segment Display	BB 1-10
1 Small DC Motor	BB 1-10 (uses digital to generate software PWM)
2 TTL Power MOSFET	BB 1-10
1 TI Analog Temperature Sensor	BB 5,6,7 (analog input required)
1 Visible Light Sensor	BB 5,6,7 (analog input required)
1 4-AA Battery Holder	N/A
1 Infrared Receiver	BB 1-10 (digital input)
1 Infrared Transmitter	BB 1-10 (digital output)

Environmental Sensors

Topic Links

- Thermistor Data Sheet
- TI Analog Temperature Sensor Data Sheet
- Visible Light Sensor Data Sheet

Thermistor Data Sheet



Title	**Thermistor**
TI Item Name	STEMEE/AC/THERM/A
Quantity	1
Included in	TI-Innovator™ Breadboard Pack
Description	Resistor whose resistance changes based on temperature. Used for measurement and control.
Category	Environmental Sensors
Hub Connection	breadboard circuit
Assembly Instructions	No polarity
Precautions	Not Applicable
Specifications	Resistance in Ohms @ 25°C: 10k, Resistance Tolerance: ±1%, B Value Tolerance: ±1%, Operating Temperature: -40°C ~ 125°C, Power – Max: 7.5mW

HUB Commands	
Sketch Object	THERMISTOR
Command Syntax	Send("READ THERMISTOR n")

Code Sample:

Desired Action	**Code Sample**
Configure the program to use THERMISTOR on pin BB 1	`Send("CONNECT THERMISTOR 1 TO BB 1")`
Read the thermistor	`Send("READ THERMISTOR 1")` `Get(T):Disp T`

TI Analog Temperature Sensor Data Sheet

Title	**TI Analog Temperature Sensor**
TI Item Name	STEMEE/AC/TEMPSN/A
Quantity	1
Included in	TI-Innovator™ Breadboard Pack
Description	Sensor that reports a voltage proportional to the ambient temperature within a range of −55°C to 130°C.
Category	Environmental Sensors
Hub Connection	breadboard circuit
Assembly Instructions	Not Applicable
Precautions	Not Applicable
Specifications	Accuracy at +30°C ±2.5 °C (max)’ Accuracy at +130°C & −55°C ±3.5 to ±3.8 °C (max)’ Power Supply Voltage Range +2.4V to +5.5V’ Current Drain 10 µA (max), Nonlinearity ±0.4 % (typ), Output Impedance 160 Ω (max), Load Regulation0µA < IL< +16 µA **See**: Detailed Technical documentation.

HUB Commands	
Sketch Object	TEMPERATURE
Command Syntax	Send("READ TEMPERATURE n")
Code Sample:	

Desired Action	**Code Sample**
Configure the program to use TEMPERATURE on pin BB 1	`Send("CONNECT TEMPERATURE 1 TO BB 1")`

Read the temperature sensor	`Send("READ TEMPERATURE 1")`
	`Get (T):Disp T`

Visible Light Sensor Data Sheet

Title	**Visible Light Sensor**
TI Item Name	STEMEE/AC/LHTSEN/A
Quantity	1
Included in	TI-Innovator™ Breadboard Pack
Description	Sensor that reports the level of ambient light.
Category	Environmental Sensors
Hub Connection	breadboard circuit
Assembly Instructions	Not Applicable
Precautions	Not Applicable
Specifications	

HUB Commands	
Sketch Object	LIGHTLEVEL or ANALOG.IN
Command Syntax	Send("READ LIGHTLEVEL n")
Code Sample:	

Desired Action	**Code Sample**
Configure the program to use LIGHT LEVEL on pin BB 4	`Send("CONNECT LIGHTLEVEL 1 TO BB 4")`

Read the light sensor	`Send("READ LIGHTLEVEL 1")`
	`Get(L):Disp L`

LEDs and Displays

Topic Links

- Green LED Data Sheet
- RGB (Red-Green-Blue) LED Data Sheet
- Red LED Data Sheet
- Diode Data Sheet
- 7-segment Display Data Sheet
- Infrared Receiver Data Sheet
- Infrared Transmitter Data Sheet

Green LED Data Sheet

Title	**Green LED**
TI Item Name	STEMEE/AC/LED/A
Quantity	5
Included in	TI-Innovator™ Breadboard Pack
Description	Light-emitting diode that emits green light when current passes through it.
Category	LEDs and Displays
Hub Connection	breadboard circuit
Assembly Instructions	Longer leg (lead) is positive (anode). If both leads are of equal length, the lead adjacent to the flat edge on LED casing is the negative (cathode) lead.
Precautions	Do not insert the leads of LEDs directly into the Hub's Breadboard Connector. Assemble the components on the breadboard and use the provided jumper cables to connect the breadboard to the Hub.
Specifications	Voltage - Forward (Vf) (Typ): 2.1V, Current – Test: 10mA, Viewing Angle: 36°, Mounting Type: Through Hole.

HUB Commands	
Sketch Object	LED or DIGITAL.OUT
Command Syntax	Send("SET LED i [TO] 0-255 [[BLINK|TOGGLE] frequency] [[TIME] seconds]")

Code Sample:

Desired Action	**Code Sample**

	`Send("SET LED 1 TO ON")`
	`Send("SET LED 1 TO OFF")`
	`Send("SET LED 1 TO ON TIME 5")`

	Desired Action	Code Sample

		`Send("SET DIGITAL.OUT 1 TO ON")`
		`Send("SET DIGITAL.OUT 1 TO OFF")`
		`Send("SET DIGITAL.OUT 1 TO ON TIME 5")`

RGB (Red-Green-Blue) LED Data Sheet

Title	**RGB (Red-Green-Blue) LED**
TI Item Name	STEMEE/AC/LED/B
Quantity	2
Included in	TI-Innovator™ Breadboard Pack
Description	Light-emitting diode with independently adjustable red, green and blue elements. Can produce a wide variety of colors..
Category	LEDs and Displays
Hub Connection	breadboard circuit
Assembly Instructions	Not Applicable
Precautions	Do not insert the leads of LEDs directly into the Hub's Breadboard Connector. Assemble the components on the breadboard and use the provided jumper cables to connect the breadboard to the Hub.
Specifications	Not Applicable

HUB Commands	
Sketch Object	RGB
Command Syntax	Send("SET RGB 1 TO r g b") - r = red value, g = green value, b = blue value Send("SET RGB 1 TO r g b [[BLINK|TOGGLE] frequency] [[TIME] seconds]")
Code Sample:	

Desired Action	**Code Sample**

Configure LED	`Send("SET RGB 1 ON ON OFF")`
	`Send("SET RG 1 255 128 0")`
	`Send("SET RGB 1 255 128 0 TIME 10")`

HUB Commands

	Desired Action	Code Sample

		`Send("SET RGB 1 255 128 0 BLINK 20 TIME 10")`
		`Send("SET RED 1 0")`
		`Send("SET GREEN 1 128 BLINK 2 TIME 10")`

Red LED Data Sheet

Title	**Red LED**
TI Item Name	STEMEE/AC/LED/C
Quantity	10
Included in	TI-Innovator™ Breadboard Pack
Description	Light-emitting diode that emits red light when current passes through it.
Category	LEDs and Displays
Hub Connection	breadboard circuit
Assembly Instructions	Longer leg (lead) is positive (anode). If both leads are of equal length, the lead adjacent to the flat edge on LED casing is the negative (cathode) lead.
Precautions	Do not insert the leads of LEDs directly into the Hub's Breadboard Connector. Assemble the components on the breadboard and use the provided jumper cables to connect the breadboard to the Hub.
Specifications	Voltage - Forward (Vf) (Typ): 2V, Current – Test: 10mA, Viewing Angle: 60°, Mounting Type: Through Hole

HUB Commands	
Sketch Object	LED or DIGITAL.OUT
Command Syntax	Send("SET LED n …") ON/OFF [BLINK frequency] [TIME duration]

Code Sample:

Desired Action	**Code Sample**

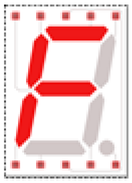
Configure LED	`Send("SET LED 1 TO ON")`
	`Send("SET LED 1 TO OFF")`
	`Send("SET LED 1 TO BLINK 2 TIME 5")`
	`Send("SET LED 1 TO ON`

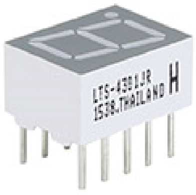
Desired Action	Code Sample
	TIME 5")
	Send("SET DIGITAL.OUT 1 TO ON") Send("SET DIGITAL.OUT 1 TO OFF") Send("SET DIGITAL.OUT 1 TO BLINK 2 TIME 5") Send("SET DIGITAL.OUT 1 TO ON TIME 5")

Diode Data Sheet

Title	**Diode**
TI Item Name	STEMEE/AC/DIO/A
Quantity	1
Included in	TI-Innovator™ Breadboard Pack
Description	Component that allows an electric current to pass in one direction, while blocking current in the opposite direction.
Category	LEDs and Displays
Hub Connection	breadboard circuit
Assembly Instructions	Lead near grey band is cathode (negative pin)
Precautions	Not Applicable
Specifications	Voltage - DC Reverse (Vr) (Max): 100V, Current - Average Rectified (Io): 200mA, Voltage - Forward (Vf) (Max) @ If: 1V @ 10mA, Speed: Small Signal =< 200mA (Io), Any Speed, Current - Reverse Leakage @ Vr: 5µA @ 75V, Capacitance @ Vr, F: 4pF @ 0V, 1MHz, Operating Temperature – Junction: -65°C ~ 175°C

7-segment Display Data Sheet





Title	**7-segment Display**
TI Item Name	STEMEE/AC/DISP/A
Quantity	1
Included in	TI-Innovator™ Breadboard Pack
Description	Array of LEDs arranged to display numbers and some alphabetic characters. Also has an LED for a decimal point.
Category	LEDs and Displays
Hub Connection	breadboard circuit
Assembly Instructions	Not Applicable
Precautions	Not Applicable
Specifications	20mA max per segment, Vf:2V

HUB Commands	
Sketch Object	DIGITAL.OUT
Command Syntax	Send("SET DIGITAL.OUT n ON") - n = 1 to 7

Code Sample:

Desired Action	**Code Sample**
Configure the program to use 7 DIGITAL.OUT on pins BB 1 - 7	**For (N, 1, 7)** `Send("CONNECT DIGITAL.OUT eval(N) TO BB eval(N)")` `Send("SET DIGITAL.OUT eval(N) ON")` `End`

Infrared Receiver Data Sheet

Title	Infrared Receiver
TI Item Name	STEMEE/AC/REC/A
Quantity	1
Included in	TI-Innovator™ Breadboard Pack
Description	Side emitting Infrared LED, designed to be paired with the LTR-301 Photo-Transistor.
Category	LEDs and Displays
Hub Connection	breadboard circuit
Assembly Instructions	Not Applicable
Precautions	Not Applicable
Specifications	Power Dissipation: 100mW, Peak Formard Current: 3A with 300 x 1µs pulses per second, Continuous Forward Current: 50 mA, Reverse Voltage: 5V, Forward Voltage: 1.2V, Operating Temperature Range: -55°C - 100°C, Peak Wavelength: 940 nM, Viewing Angle: 40°

HUB Commands	
Sketch Object	DIGITAL.IN
Command Syntax	Send("READ DIGITAL.IN n")
Code Sample:	

Desired Action	**Code Sample**
	`Send("CONNECT DIGITAL.IN 1 TO BB 2")`
	`Send("READ DIGITAL.IN 1")` `Get(D):Disp D`

Infrared Transmitter Data Sheet

Title	Infrared Transmitter
TI Item Name	STEMEE/AC/TRANS/A
Quantity	1
Included in	TI-Innovator™ Breadboard Pack
Description	Side sensing Infrared photo transistor, designed to be paired with the LTE-301 Infrared Emitter.
Category	LEDs and Displays
Hub Connection	breadboard circuit
Assembly Instructions	Not Applicable
Precautions	Not Applicable
Specifications	Power Dissipation: 100mW, Collector-Emitter Voltage: 30V, Emitter-Collector Voltage: 5V, Operating Temperature: -40°C to 85°C, Storage Temperature: -55°C to 100°

HUB Commands		
Sketch Object	DIGITAL.OUT	
Command Syntax	Send("SET DIGITAL.OUT n ON")	
Code Sample:	**Desired Action**	**Code Sample**
		`Send("CONNECT DIGITAL.OUT 1 TO BB 5")` `Send("SET DIGITAL.OUT 1 ON")`

Motors

Small DC Motor Data Sheet

Title	**Small DC Motor**
TI Item Name	STEMEE/AC/MOTOR/A
Quantity	1
Included in	TI-Innovator™ Breadboard Pack
Description	Motor that converts direct current electrical power into mechanical power.
Category	Motors
Hub Connection	breadboard circuit
Assembly Instructions	Not Applicable
Precautions	Not Applicable
Specifications	Nominal Voltage: 4.7V, Operating Voltage: 2.0-5.5V, No Load Speed: 19900 r/min, No Load Current: 0.11A, At Maximum Efficiency of Torque: 0.14mN.m (1.4g.cm), At Maximum Efficiency of Output: 0.23W, Stall Torque: 0.7mN.m(7.1g.cm), Stall Current: 0.42A

HUB Commands	
Sketch Object	DCMOTOR

Command Syntax	Send("SET DCMOTOR n TO frequency [duty [TIME] seconds] ")
	frequency - 1 to 500Hz duty - 1 to 99%
	duty cycle (default: 50%)
	seconds = 1s default

HUB Commands

Code Sample:	**Desired Action**	**Code Sample**
		`Send("SET DCMOTOR 1 TO 50 TIME 5")`

Power and Signal Control

Topic Links

- SPDT Slide Switch Data Sheet
- 8 Position DIP Switch Data Sheet
- 8 100 Ohm Resistor SIP Package Data Sheet
- TTL Power MOSFET Data Sheet

SPDT Slide Switch Data Sheet

Title	**SPDT Slide Switch**
TI Item Name	STEMEE/AC/SWIT/A
Quantity	1
Included in	TI-Innovator™ Breadboard Pack
Description	Single pole, double throw switch. Slide the switch knob back and forth to open and close contacts.
Category	Power and Signal Control
Hub Connection	breadboard circuit
Assembly Instructions	Not Applicable
Precautions	Not Applicable
Specifications	30V, 200mA

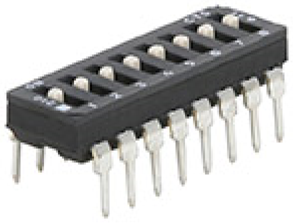
HUB Commands	
Sketch Object	SWITCH
Command Syntax	Send("READ SWITCH n")

Code Sample:

Desired Action	**Code Sample**

Configure the program to use SWITCH on port BB 1	`Send("CONNECT SWITCH 1 TO BB 1")`
	`Send("READ SWITCH 1")`
	`Get(T):Disp T`

8 Position DIP Switch Data Sheet



Title	**8 Position DIP Switch**
TI Item Name	STEMEE/AC/SWIT/B
Quantity	1
Included in	TI-Innovator™ Breadboard Pack
Description	Set of 8 slide switches used to customize the behavior of the circuit components for specific situations.
Category	Power and Signal Control
Hub Connection	breadboard circuit
Assembly Instructions	Not Applicable
Precautions	Not Applicable
Specifications	'0.100", 100mA, 20VDC

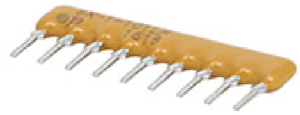
HUB Commands	
Sketch Object	DIGITAL.IN
Command Syntax	Send("READ DIGITAL.IN n") - n = 1 to 8 **or** Send("READ SWITCH n") - n = 1 to 8

Code Sample:

Desired Action	**Code Sample**

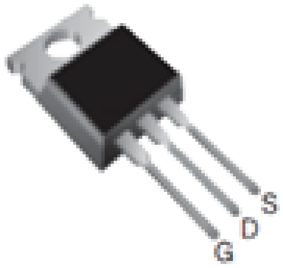
Configure the program to use 8 SWITCHs on pins BB 1 - 8	**For (N, 1, 8)**
	`Send("CONNECT SWITCH eval(N) TO BB eval(N)")`
	`Send("READ SWITCH eval(N)")`
	`Get(S):Disp S`
	`End`

8 100 Ohm Resistor SIP Package Data Sheet



Title	**8 100 Ohm resistor SIP Package**
TI Item Name	STEMEE/AC/RES/E
Quantity	1
Included in	TI-Innovator™ Breadboard Pack
Description	8 100 Ohm resistor SIP package for use with the 8 Position DIP Switch.
Category	Power and Signal Control
Hub Connection	breadboard circuit
Assembly Instructions	Not Applicable
Precautions	Not Applicable
Specifications	Bussed array

TTL Power MOSFET Data Sheet



Title	**TTL Power MOSFET**
TI Item Name	STEMEE/AC/MOSFET/A
Quantity	2
Included in	TI-Innovator™ Breadboard Pack
Description	Transistor used for amplifying or switching electronic signals.
Category	Power and Signal Control
Hub Connection	breadboard circuit
Assembly Instructions	Connect the G-GATE to the BB pin of the TI-Innovator™ Hub, the D-DRAIN to the load being controlled (e.g., DC motor) and the S-SINK to ground.
Precautions	If the metal plate on the MOSFET becomes hot during use, disconnect the battery immediately and re-check all connections.
Specifications	supports 100A

HUB Commands	
Sketch Object	RELAY **or** ANALOG.OUT

Command Syntax	Send("SET RELAY n TO ON/OFF [[TIME] seconds]")
	or
	Send("SET ANALOG.OUT n TO 0-255/ON/OFF [[BLINK] frequency] [[TIME] seconds]")

Code Sample:	**Note**: a MOSFET can either be used as an ON/OFF control (RELAY) or for finer control (ANALOG.OUT)

Desired Action	Code Sample
	`Send("CONNECT RELAY 1 TO BB 7")` `Send("SET RELAY 1 ON")`
	`Send("CONNECT ANALOG.OUT 1 TO BB 7")` `Send("SET ANALOG.OUT 1 127")`

Passive Components

Topic Links

- Accessories
- Breadboard
- Capacitors
- Resistors

Accessories

40-Pack Male to Male Breadboard Jumper Cable Data Sheet

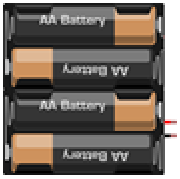
Title	**40-Pack Male to Male Breadboard Jumper Cables**
TI Item Name	STEMEE/AC/CABKT/A
Quantity	40
Included in	TI-Innovator™ Breadboard Pack
Description	Male to Male jumper cables for connecting components on the breadboard.
Category	Accessories
Hub Connection	breadboard circuit
Assembly Instructions	Not Applicable
Precautions	Cable lead may break if bent repeatedly
Specifications	Male to Male Pack of 40, 20cm

10-Pack Male to Female Breadboard Jumper Cable Data Sheet

Title	**10-Pack Male to Female Breadboard Jumper Cables**
TI Item Name	STEMEE/AC/CABKT/B
Quantity	10

Title	**10-Pack Male to Female Breadboard Jumper Cables**
Included in	Innovator™ Breadboard Pack
Description	Male to female jumper cables for connecting components on the breadboard.
Category	Accessories
Hub Connection	breadboard circuit
Assembly Instructions	Not Applicable
Precautions	Cable lead may break if bent repeatedly
Specifications	Male to Female Pack of 10, 20cm

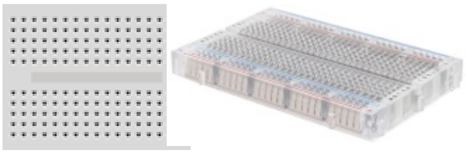
4-AA Battery Holder Data Sheet



Title	**4-AA Battery Holder**
TI Item Name	STEMEE/AC/BATHLD/A
Quantity	1
Included in	Innovator™ Breadboard Pack
Description	4-AA battery holder with tined solid leads for easy breadboard insertion.
Category	Accessories
Hub Connection	breadboard circuit
Assembly Instructions	Not Applicable
Precautions	Not Applicable

Title	**4-AA Battery Holder**
Specifications	BHC-341-1A with lead wires 150mm, Strip & Tin: 5mm+/-1mm, UL1007, AWG 26

Breadboard Data Sheet



Title	Breadboard
TI Item Name	STEMEE/AC/BRDBD/A
Quantity	1
Included in	TI-Innovator™ Breadboard Pack
Description	Platform for connecting the electronic components of a project by inserting component leads and jumper cables into pins.
Category	Breadboard
Hub Connection	breadboard circuit
Assembly Instructions	Not Applicable
Precautions	Do not connect the positive and negative leads of a power source to the same group of 5 pins on the breadboard. Doing so could damage the breadboard and the power source. Observe the correct polarity: When connecting the breadboard to the Hub. When connecting components that are sensitive to polarity, such as LEDs and the TTL Power MOSFET. **See also:** TI-Innovator™ Hub Ports and Breadboard Usable Pins
Specifications	45.7x35.6x9.4mm, 170 tie-point, POM plastic (150℃), Round Hole, with screwsx2pcs

Capacitors

Capacitor 100µF Data Sheet

Title	Capacitor 100µF
TI Item Name	STEMEE/AC/CAP/A
Quantity	1
Included in	TI-Innovator™ Breadboard Pack
Description	Capacitor that temporarily stores an electric charge of up to 100µF.
Category	Capacitors
Hub Connection	breadboard circuit
Assembly Instructions	Longer leg (lead) is positive (anode). If both leads are of equal length, the lead adjacent to the colored strip on the casing is the negative (cathode) lead.
Precautions	Not Applicable
Specifications	Capacitance: 100µF, Tolerance: ±20%, Voltage Rating: 16V

Capacitor 10µF Data Sheet

Title	Capacitor 10µF
TI Item Name	STEMEE/AC/CAP/B
Quantity	1
Included in	Innovator™ Breadboard Pack
Description	Capacitor that temporarily stores an electric charge of up to 10µF.
Category	Capacitors
Hub Connection	breadboard circuit

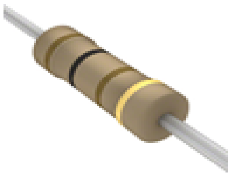
Title	**Capacitor 10µF**
Assembly Instructions	Longer leg (lead) is positive (anode). If both leads are of equal length, the lead adjacent to the colored strip on the casing is the negative (cathode) lead.
Precautions	Not Applicable
Specifications	Capacitance: 10µF, Tolerance: ±20%, Voltage Rating: 16V

Capacitor 1µF Data Sheet

Title	**Capacitor 1µF**
TI Item Name	STEMEE/AC/CAP/C
Quantity	1
Included in	Innovator™ Breadboard Pack
Description	Capacitor that temporarily stores an electric charge of up to 1µF.
Category	Capacitors
Hub Connection	breadboard circuit
Assembly Instructions	Longer leg (lead) is positive (anode). If both leads are of equal length, the lead adjacent to the colored strip on the casing is the negative (cathode) lead.
Precautions	Not Applicable
Specifications	Capacitance: 1µF, Tolerance: ±20%, Voltage Rating: 16V

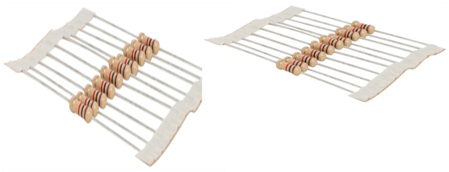
Resistors

Resistor 100 Ohm Data Sheet



Title	**Resistor 100 Ohm**
TI Item Name	STEMEE/AC/RES/A
Quantity	10
Included in	TI-Innovator™ Breadboard Pack
Description	Resistor that provides 100 Ohms of resistance in a circuit. Color Code Value: brown, black, brown.
Category	Resistors
Hub Connection	breadboard circuit
Assembly Instructions	No polarity
Precautions	Not Applicable
Specifications	'Resistance (Ohms): 100, Tolerance: ±5%, Power (Watts): 0.5W, 1/2W, Temperature Coefficient: 0/ -400ppm/°C, Operating Temperature: -55°C ~ 155°C

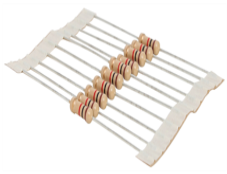
Resistor 1K Ohm Data Sheet

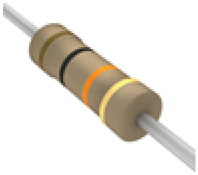


Title	**Resistor 1K Ohm**
TI Item Name	STEMEE/AC/RES/B

Title	Resistor 1K Ohm
Quantity	10
Included in	TI-Innovator™ Breadboard Pack
Description	Resistor that provides 1K Ohms of resistance in a circuit. Color Code Value: brown, black, red.
Category	Resistors
Hub Connection	breadboard circuit
Assembly Instructions	No polarity
Precautions	Not Applicable
Specifications	'Resistance (Ohms): 1K, Tolerance: ±5%, Power (Watts): 0.5W, 1/2W, Temperature Coefficient: 0/ -400ppm/°C, Operating Temperature: -55°C ~ 155°C

Resistor 10K Ohm Data Sheet

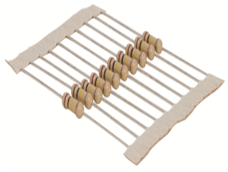
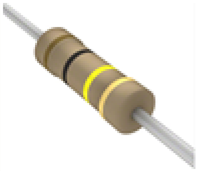




Title	Resistor 10K Ohm
TI Item Name	STEMEE/AC/RES/C
Quantity	10
Included in	TI-Innovator™ Breadboard Pack
Description	Resistor that provides 10K Ohms of resistance in a circuit. Color Code Value: brown, black, orange.
Category	Resistors
Hub Connection	breadboard circuit
Assembly Instructions	No polarity

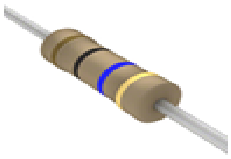
Title	Resistor 10K Ohm
Precautions	Not Applicable
Specifications	'Resistance (Ohms): 10K, Tolerance: ±5%, Power (Watts): 0.5W, 1/2W, Temperature Coefficient: 0/ -400ppm/°C, Operating Temperature: -55°C ~ 155°C

Resistor 100K Ohm Data Sheet

Title	Resistor 100K Ohm
TI Item Name	STEMEE/AC/RES/D
Quantity	10
Included in	TI-Innovator™ Breadboard Pack
Description	Resistor that provides 100K Ohms of resistance in a circuit. Color Code Value: brown, black, yellow.
Category	Resistors
Hub Connection	breadboard circuit
Assembly Instructions	No polarity
Precautions	Not Applicable
Specifications	'Resistance (Ohms): 100K, Tolerance: ±5%, Power (Watts): 0.5W, 1/2W, Temperature Coefficient: 0/ -400ppm/°C, Operating Temperature: -55°C ~ 155°C

Resistor 10M Ohm Data Sheet



Title	**Resistor 10M Ohm**
TI Item Name	STEMEE/AC/RES/F
Quantity	10
Included in	TI-Innovator™ Breadboard Pack
Description	Resistor that provides 10M Ohms of resistance in a circuit. Color Code Value: brown, black, blue.
Category	Resistors
Hub Connection	breadboard circuit
Assembly Instructions	No polarity
Precautions	Not Applicable
Specifications	'Resistance (Ohms): 10M, Tolerance: ±5%, Power (Watts): 0.5W, 1/2W, Temperature Coefficient: 0/ -400ppm/°C, Operating Temperature: -55°C ~ 155°C

Potentiometer with Knob Data Sheet

Title	**Potentiometer with Knob**
TI Item Name	STEMEE/AC/POTEN/A
Quantity	1
Included in	TI-Innovator™ Breadboard Pack
Description	Variable resistor with knob used to change the resistance in

Title	Potentiometer with Knob
	a circuit.
Category	Resistors
Hub Connection	breadboard circuit
Assembly Instructions	Not Applicable
Precautions	Not Applicable
Specifications	1 Turn, 10K

HUB Commands	
Sketch Object	POTENTIOMETER
Command Syntax	Send("READ POTENTIOMETER n")

Code Sample:

Desired Action	Code Sample
Read potentiometer	`Send("READ POTENTIOMETER 1")` `Get(P):Disp P`

Frequently Asked Questions

This section includes some of the frequently asked questions we have received about the
TI-Innovator™ Technology. Don’t see your question? Send feedback to the eGuide team.
hubeguide@list.ti.com

Topic Links

- Product Configuration Information
- Product Compatibility Information
- TI-Innovator™ Ports Information
- General TI-Innovator™ Rover Information
- TI-Innovator™ Hub App for the TI-84 Plus CE
- Updating Sketch on the TI-Innovator™ Hub
- TI LaunchPad™ Information
- General Activity Information
- General Power Information for TI-Innovator™ Hub
- External Battery Information for TI-Innovator™ Hub
- TI-Innovator™ Rover Battery Information
- TI-Innovator™ Hub On-Board Components Details
- TI-Innovator™ Rover On-Board Components Details
- I/O Module Details
- Breadboard Components Details

Product Configuration Information

What are the TI-Innovator™ configurations that are available for sale?

- TI-Innovator™ Hub Kit
- TI-Innovator™ Rover
- TI-Innovator™ I/O Module Pack
- TI-Innovator™ Breadboard Pack
- Ultrasonic Ranger Module
- External Battery

What is included with the TI-Innovator™ Rover?

- TI-Innovator™ Rover
- Breadboard Ribbon Cable
- I^{2}C Cable

What is included in the TI-Innovator™ Hub Kit?

The TI-Innovator™ Hub Kit contains the following:

- TI-Innovator™ Hub
- TI Wall Charger
- USB Cable – Standard-A to Micro-B
- USB Cable – Mini-A to Mini-B
- USB Cable – Standard-A to Mini-B

What is included in the TI-Innovator™ I/O Module Pack?

The TI-Innovator™ I/O Module Pack contains the following:

- Light Sensor module with detachable cable
- LED module with detachable cable
- Vibration Motor module with detachable cable
- Servo Motor with attached cable

See I/O Module section for more detail.

What is included in the TI-Innovator™ Breadboard Pack?

The TI-Innovator™ Breadboard Pack contains the following:

– Breadboard 2 x 3 inches	– 940nm Infrared transmitter and receiver
– Forty (40) – Male to Male breadboard jumper cables (20 cm)	– Thermistor
– Ten (10) – Male to Female breadboard jumper cables	– Analog temperature sensor

- Assorted LEDs (five (5) green, ten (10) red, two (2) RGB)
- Assorted resistors (ten (10) each of 100 Ohm, 1K Ohm, 10K Ohm, 100K Ohm, 10M Ohm)
- Assorted capacitors (one (1) each of 100 µF, 10 µF, 1 µF)
- 7 segment display
- Potentiometer with knob
- Small DC motor
- Diode
- Light sensor
- SPDT slide switch
- 8-Position DIP switch
- 8 100 Ohm resistor SIP packages
- Two (2) Power MOSFET
- 4AA battery holder

See Breadboard section for more detail.

What is included with the Ultrasonic Ranger Module?

- Ultrasonic Ranger Module with detachable cable.

See I/O Module section for more detail.

What is included with the External Battery Kit?

- This kit only contains the External Battery (Model # MP-3000).

See Battery section for more detail.

Product Compatibility Information

What TI products will work with the TI-Innovator™ Hub?

The TI-Innovator™ Hub is compatible with the following TI products. For best results always use the latest version of the TI-Innovator sketch and compatible products.

- TI CE Graphing Calculator
- TI-Nspire™ CX handheld
- TI-Nspire™ CX CAS handheld
- TI-Nspire™ CX computer software (Student, Teacher, and TI-Nspire™ CX Navigator™)

What programming language is compatible with the TI-Innovator™ Hub?

The TI-Innovator™ Hub can be programmed through the programming language **TI BASIC** on both the TI CE graphing calculators and TI-Nspire™ CX calculators. This programming language is used in several TI CE graphing calculators and is based on the BASIC (Beginner's All-purpose Symbolic Instruction Code) programming language. BASIC is a family of general-purpose, high-level programming languages whose design philosophy emphasizes ease of use.

In addition, with TI-Nspire™ CX technology you can use **LUA programming** which is a powerful, fast scripting language.

> **See Also:** Hub Programming on TI CE Graphing Calculator for details.

> **See Also:** Hub Programming on TI-Nspire™ CX Technology for details.

What sensors, actuators, etc. can I connect to the TI-Innovator™ Hub?

The TI-Innovator™ Hub has two types of connectors:

- Universal 4-pin connector that is compatible with an array of modules.
- Breadboard connector that can be connected to a breadboard for prototyping projects.

To easily get started, we have convenient kits that contain all the components you need to complete the activities. See the sections related to the I/O Module and Breadboard for details.

Can the TI-Nspire™ Lab Cradle with Vernier™ sensors be used while using the TI-Innovator™ Hub?

Yes, the TI-Nspire™ Lab Cradle can be used concurrently with the TI-Innovator™ Hub on TI-Nspire™ CX Handheld or TI-Nspire™ CX software. To use both the TI-Innovator™ Hub and TI-Nspire™ Lab Cradle at the same time, they must be accessed via a LUA script.

Can I plug Vernier™ sensors directly into the TI-Innovator™ Hub?

The TI-Innovator™ Hub ports are not directly compatible with the Vernier™ sensors. The Vernier™ sensors can be connected to a TI-Nspire™ Lab Cradle. To use both the TI-Innovator™ Hub and TI-Nspire™ Lab Cradle at the same time, they must be accessed via a LUA script.

Can the TI-Nspire™ CX Navigator™ System be used while using the TI-Innovator™ Hub?

Yes, students can have their TI-Nspire™ CX handheld connected to the TI-Nspire™ CX Navigator™ system while using the TI-Innovator™ Hub. The teacher can use TI-Nspire™ CX Navigator™ functionality, including Live Presenter, Screen Capture, Quick Poll, etc. while students are using the TI-Innovator™ Hub.

Can TI Connect™ CE or TI-SmartView™ CE software communicate with the TI-Innovator™ Hub?

The TI-Innovator™ Hub cannot communicate directly with the TI Connect™ CE software or TI-SmartView™ CE software. However, you can use TI Connect™ CE software to write programs for use with the TI-Innovator™ Hub. TI-SmartView™ CE software is a great way to demo the programming steps to your students.

TI-Innovator™ Ports Information

What connection ports are available, and what can they connect to?

See What's in the Box for details.

What is the difference between the two USB ports?

- DATA: This is a mini-USB port, labeled "DATA B", that is used to connect to the TI graphing calculator, or a computer running TI-Nspire™ CX software. The USB port is located on the same side as the Light Sensor.
- POWER: This USB port, labeled “PWR,” is located on the same side as the Breadboard connector. This is a micro-USB port that is used for two purposes.

  1. Connect to external power source (TI Wall Adapter and TI-Innovator™ External Battery) when using components that require 5V (e.g., motor).

  2. Connect to computer USB port to update the TI-Innovator™ sketch.

General TI-Innovator™ Rover Information

What TI products will work with the TI-Innovator™ Rover?

The TI-Innovator™ Rover is compatible with the following TI products. For best results always use the latest version of the TI-Innovator sketch and compatible products.

- TI-84 Plus CE calculator
- TI-Nspire™ CX handheld
- TI-Nspire™ CX CAS handheld
- TI-Nspire™ CX computer software (Student, Teacher, and TI-Nspire™ CX Navigator™)

What are the features of the TI-Innovator™ Rover?

- Two independently controllable motors with high resolution motor shaft encoder sensors to count revolutions
- Front mounted ranger for measuring distance to obstacles
- Bottom mounted color sensor to measure color

- Red Green Blue (RGB) LED on top to display programmable feedback to user
- High-capacity, rechargeable battery to meet the needs of classroom use
- Calculator Holder Pegs - For securing a TI CE Graphing Calculator or a TI-Nspire™ CX Handheld to the calculator platform.
- Allows use of TI-Innovator speaker, light brightness sensor, and input and output ports
- Gyroscope to measure heading
- Tracks mathematical coordinates, time, heading, and distance for each segment in travel history for analysis
- Marker holder for drawing paths on paper

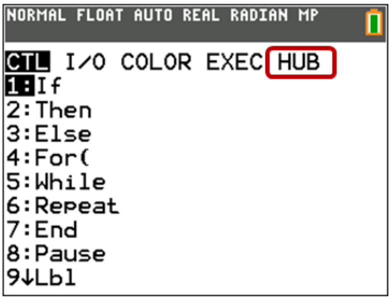
What type of marker does Rover work with?

Thin markers or dry erase markers should work with the Rover marker holder. Adding masking tape to markers that are too thin may improve performance.

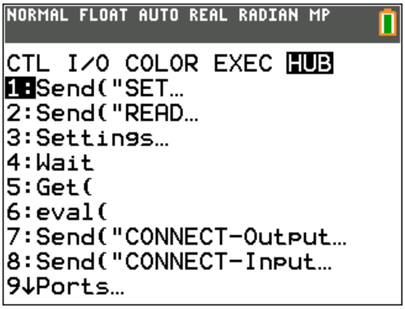
TI-Innovator™ Hub App for the TI CE Graphing Calculator(s)

What is the TI-Innovator™ Hub App?

The TI-Innovator™ Hub App adds the HUB menu to the programming menu on a TI CE graphing calculator.



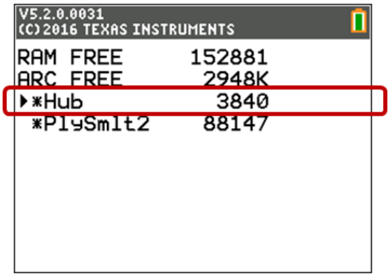
This menu option makes it easy to select commands that are commonly used when creating programs to use with the TI-Innovator™ Hub.



How do I know whether I have the TI-Innovator™ Hub App?

To determine if the Hub app is loaded on your TI CE graphing calculator, follow these steps.

1. Press 2nd [mem]
2. Select option "2: Mem Management/Delete…"
3. Select option "A: Apps"
4. The TI-Innovator™ Hub App is listed as "Hub" in the list of apps. Confirm that the Hub is listed.


```
V5.2.0.0031
(C)2016 TEXAS INSTRUMENTS
RAM FREE        152881
ARC FREE         2948K
▸*Hub             3840
 *PlySmlt2       88147
```

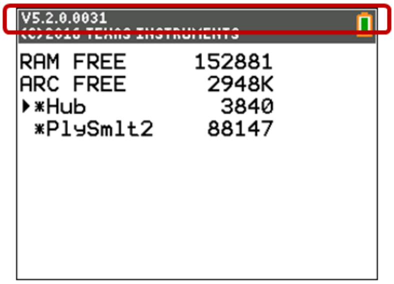
What version of the TI-Innovator™ Hub App do I need?

For best results always use the latest version of the TI-Innovator™ Hub App and TI-84 Plus CE. Visit education.ti.com/en/product-resources/whats-new-84-ce to get the latest.

How do I know what the version number of my TI-Innovator™ Hub App is?

To determine the version of the Hub App that is loaded on your TI CE Graphing Calculator, follow these steps.

1. Press 2nd [mem]
2. Select option "2: Mem Management/Delete..."
3. Select option "A: Apps"
4. Press the down arrow until the Hub app is selected.
5. Look at the title bar to view the version number of the Hub app.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V5.2.0.0031
(C)2016 TEXAS INSTRUMENTS
RAM FREE        152881
ARC FREE         2948K
▸*Hub             3840
 *PlySmlt2       88147
```

How do I get the TI-Innovator™ Hub App?

The TI-Innovator™ Hub App is available for download from the TI website at education.ti.com/latest.

Will I need to update the TI-Innovator™ Hub app every time I update the calculator OS?

The TI-Innovator™ Hub app would only need to be updated when new functionality is added to the app. However, it is strongly recommended that you always keep your TI products up to date with the latest OS and versions. When updating your OS always check to see if any apps have updates as well.

Do I need an app to use the TI-Innovator™ Hub with TI-Nspire™ CX technology?

No. TI-Nspire™ CX technology has all the commands to communicate with the TI-Innovator™ Hub built in. For best results always use the latest version of TI-Nspire™.

Updating Sketch on the TI-Innovator™ Hub

What is the TI-Innovator™ sketch?

The ‘sketch’ is the software on the TI-Innovator™ Hub that communicates with the graphing calculator, processes the commands, and controls the external components.

Do I need to update the sketch on the TI-Innovator™ Hub?

For best results always use the latest version of TI-Innovator™ sketch. To stay informed on any updates to the TI-Innovator™ Hub, make sure you register your product at education.ti.com/register or check the TI-Innovator™ website at education.ti.com/go/innovator.

What is the latest version of the sketch?

For best results always use the latest version of TI-Innovator sketch. You can always find the latest version of the sketch at education.ti.com/go/innovator.

Why would I update the sketch?

There are a couple of different reasons to upgrade the sketch.

1. To get the latest version from TI that may include new functionality.
2. To restore the TI sketch after loading a custom sketch – This is only needed by advanced users who use an alternative sketch.

How do I load the sketch on the TI-Innovator™ Hub?

The sketch can be updated through the TI-Innovator Hub Update Software. This software is a free download on the TI website.

Can I update multiple TI-Innovator Hubs at the same time?

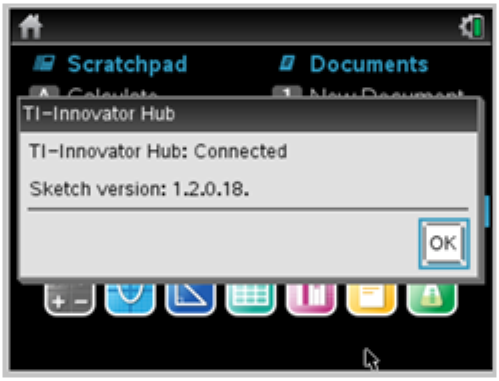
The TI-Innovator Hub Update Software only allows updating a single Hub at a time. However, the application is designed to allow you to update multiple Hubs without having to re-launch the software.

How do I know what version of the sketch I have?

The latest versions of the calculator operating systems have new functionality that will show you the version of sketch on a connected Hub.

TI-Nspire™ CX handhelds or software

1. Connect your TI-Innovator Hub to the handheld or the computer through a USB cable
2. Make sure to connect to the Hub’s DATA port
3. Click the ‘Home/On’ button, then “5: Settings” and “7:TI-Innovator Hub”. The dialog will show the version number of the sketch.


TI-Innovator Hub

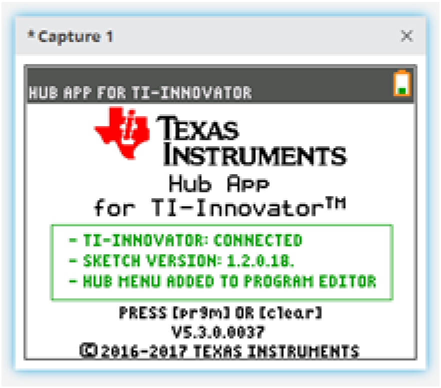
TI-Innovator Hub: Connected

Sketch version: 1.2.0.18.

TI-84 Plus CE:

1. Connect your TI-Innovator Hub to the graphing calculator through a USB cable
2. Make sure to connect to the Hub's DATA port
3. Click the APPS button and then select the 'Hub' app.

The app will display the sketch version of the connect TI-Innovator Hub.


HUB APP FOR TI-INNOVATOR

Hub App
for TI-Innovator™

- TI-INNOVATOR: CONNECTED
- SKETCH VERSION: 1.2.0.18.
- HUB MENU ADDED TO PROGRAM EDITOR

PRESS [prgm] OR [clear]
V5.3.0.0037
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For previous versions of calculator OSs, you can use programming commands to identify the version number of the sketch loaded on the TI-Innovator™ Hub. Use the "VERSION" command on the Hub Manage menu to return the version number of the sketch on the TI-Innovator™ Hub.

TI-Nspire™ CX handhelds or software:	**TI-84 Plus CE:**
GetStr "VERSIO	Send ("VERSIO

TI-Nspire™ CX handhelds or software:	TI-84 Plus CE:
N", ver	N")
Disp ver	Get(Str1)
	Disp Str1

What are the system requirements for upgrading?

Windows OS	Windows® 7 SP1 Windows 8.1 Update 1 Windows 8.1 Update 1 Pro Windows 10 Compatible with 32-bit and 64-bit Operating Systems
Processor	Intel Core i3 or higher generation processor (Except Intel Atom)
RAM	2GB
Free hard drive space	100 MB
Screen resolution	1024 x 768 (minimum) - 3840 x 2160 (maximum)
Other requirements:	Available USB Port Active internet connection for installation
Mac OS	Mac® OS X 10.11 macOS 10.12, 10.13
Processor	Any Mac 2008 or newer
RAM	2GB
Free hard drive space	100 MB
Screen resolution	1024 x 768 (minimum) - 3840 x 2160 (maximum)
Other requirements:	Available USB Port Active internet connection for installation

Can the sketch that comes on the TI-Innovator™ Hub be edited to add functionality but still work with the TI calculator? Is the sketch open source?

The code for sketch that is loaded on the TI-Innovator™ has not been published for others to modify or edit. To maintain compatibility between the TI-Innovator™ Hub and TI calculator products, only use the officially published sketch for TI-Innovator™ Hub.

TI LaunchPad™ Information

What is a TI LaunchPad™ development kit?

TI LaunchPad kits are a range of microcontroller development kits (also called evaluation boards) from Texas Instruments. To learn more there is a lot of detail regarding the TI LaunchPad ecosystem at http://www.ti.com/ww/en/launchpad/about.html.

What TI LaunchPad™ kit is used in the TI-Innovator™ Hub?

The TI-Innovator™ Hub is powered by a MSP432P401 TI LaunchPad kit. More information on the MSP432P401 LaunchPad is at http://www.ti.com/ww/en/launchpad/launchpads-msp430-msp-exp432p401r.html#tabs.

Can I use the TI-Innovator™ Hub as a TI LaunchPad™ development kit?

While the TI-Innovator™ Hub can be used as TI LaunchPad™ Board, the TI-Innovator™ Hub was specifically designed to be used by students learning how to code, build, and explore using electronics. More information on TI LaunchPad can be found at http://www.ti.com/ww/en/launchpad/about.html.

What resources are available for the TI LaunchPad?

If you are interested in the TI LaunchPad ecosystem, you can find resources at http://www.ti.com/ww/en/launchpad/about.html

How are development kits/engineering boards used by engineers in the real word?

Engineers use evaluation boards like the TI LaunchPad™ boards to prototype their designs and verify the suitability of a particular chip for their design. These boards allow engineers to try different approaches before finalizing their design. The boards also help the engineers measure other aspects of their designs, such as power consumption and speed of operations.

These evaluation boards are also used in universities to learn about microcontrollers, programming, and interfacing with sensors.

General Activity Information

What activities are available for the TI-Innovator™ Hub?

There are multiple activities available to use with the TI-Innovator™ Hub. Working with educators we have created activities around the following themes:

10 Minutes of Code for TI-Innovator™ Hub: Engage students in short activities that build understanding of math concepts, programming logic, and coding skills. Activities use the built-in RGB, LED, Speaker, and Light Brightness Sensor of the TI-Innovator™ Hub. Activities are available for the TI-84 Plus CE and TI-Nspire™ CX technology.

10 Minutes of Code for TI-Innovator™ Rover: Continue learning to code with the TI-Innovator™ Rover. Build on your knowledge of programming the TI-Innovator™ Hub and write programs to control the TI-Innovator™ Rover. Learn the commands to make the Rover move and use its built-in ranger and color sensor. Activities will be available for the TI-84 Plus CE and TI-Nspire™ CX technology.

Math and Science Classroom "Conversations" for TI-Innovator™ Rover: Ready-to-use programs for the TI-84 Plus CE and TI-Nspire™ CX technology. These programs will include a usage guide for the teacher that will provide suggestions on how to implement the TI-Innovator™ Rover with the program(s) provided to explore concepts in the math and/or science classroom.

Science through Engineering Design: Rich, interactive lessons for middle grades students in life and physical science. Uses components provided in the TI-Innovator™ I/O Module Pack. Activities are available for TI-Nspire™ CX technology.

Path to STEM Projects: Design, build, test, refine. These sequential activities engage middle grade and high school students in engineering principles, providing students with the basic knowledge and skills required to synthesize new and unique STEM projects. These activities require the components provided in the TI-Innovator™ Breadboard Pack. Activities are available for the TI-84 Plus CE and TI-Nspire™ CX technology.

Where can I download activities for the TI-Innovator™ Hub?

Activities for use with the TI-Innovator™ Hub can be found at the education.ti.com website, under the Activities tab at the top of each page. Direct links to each set of activities are as follows:

- 10 Minutes of Code with TI-Innovator™ Hub: education.ti.com/ticodes
- 10 Minutes of Code with TI-Innovator™ Rover: education.ti.com/ticodes
- Math and Science Classroom "Conversations" for TI-Innovator™ Rover:
- Science through Engineering Design: https://education.ti.com/en/tisciencenspired/us/stem
- Path to STEM Projects: **TBD**

When will the activities be available?

The activities for the TI-Innovator™ Hub are now available. Activities for the TI-Innovator™ Rover will be available in Fall 2017.

General Power Information for TI-Innovator™ Hub

How is the TI-Innovator™ Hub powered?

The TI-Innovator™ Hub is powered by the batteries in the TI CE graphing calculator or the TI-Nspire™ CX handheld. In certain activities with high-powered devices such as servo motors, you may need to use an auxiliary power source – either the TI Wall Adapter or External Battery.

How does the TI-Innovator™ Hub affect the TI CE Graphing Calculator or TI-Nspire™ CX battery life?

The TI-Innovator™ Hub has a minimal impact on the battery of the TI CE graphing calculator or TI-Nspire™ CX graphing calculators.

When do I need to use the external power?

When using the Input and Output ports:

> Certain I/O Modules require external power, as they use the 5V (OUT3 or IN3) ports on the TI-Innovator™ Hub. See the I/O Module section for details.

When using the Breadboard connector:

> A circuit that is powered from the 5V output of the breadboard connector will require external power.

What options are available for external power?

You can use the TI Wall Adapter or the External Battery for additional power. The TI Wall Adapter comes with the TI-Innovator™ Hub and is the same wall charger that is provided with the TI CE graphing calculator and TI-Nspire™ CX calculators. The External Battery is sold separately as an accessory for the TI-Innovator™ Hub.

Can I use a different battery/power supply with the TI-Innovator™ Hub?

You should only use the battery and power supply provided by TI to ensure safe operation.

External Battery Information for TI-Innovator™ Hub

What is the external battery?

The External Battery provides additional power for those components that require more power than can be provided via the TI graphing calculator. This battery (Model # MP-3000) was selected to meet TI-Innovator™ component power needs.

How do you use the External Battery with the TI-Innovator™ Hub?

Using the Standard-A to Micro-B USB cable provided with the TI-Innovator™ Hub, the external battery should be connected to the PWR USB port on the TI-Innovator™ Hub. The external battery has an On/Off switch that must be turned on to provide power the TI-Innovator™ Hub.

How long will the battery last on a full charge?

The battery life will depend on the components attached to the TI-Innovator™ Hub. For example, the Servo Motor Module that is used with the Science through Engineering Design activities can run for 8 hours of continuous use using the external battery. Other components could last longer or drain the battery more rapidly.

What is the expected lifetime of the battery?

As lithium-ion batteries age, they lose capacity. When properly maintained and under normal usage, batteries are expected to last about three years.

How do you recharge the battery?

The External Battery can be recharged using the TI Wall Adapter (included with the TI-Innovator™ Hub) or the USB cable that came with the TI-Innovator Hub plugged into a computer USB port.

How do I know how charged my battery is?

When you turn the external battery on, the LED battery indicators on the External Battery will display the approximate battery charge (25%, 50%, 75%, and 100%). The LEDs turn themselves off after 10 seconds.

Can I use the External Battery with other products?

The External Battery was specifically tested for use with the TI-Innovator™ Hub.

Rover Battery Information

How long will the battery last on a full charge?

The battery will last 8 hours of continuous driving. Typical use is expected to include frequent breaks for programming. In that scenario, a full charge will last several days of uses.

What is the expected lifetime of the battery?

As lithium-ion batteries age, they lose capacity. When properly maintained and under normal usage, batteries are expected to last about 3 years.

How do you recharge the battery?

Connect a micro-USB cable to the PWR port on the right front side of the Rover. The other end of the cable can be connected to a PC or a TI wall charger.

How do I know how charged my battery is?

The four battery level LEDs shows the battery capacity. When all four LEDs are solid green, the Rover battery is fully charged.

TI-Innovator™ Hub On-Board Components Details

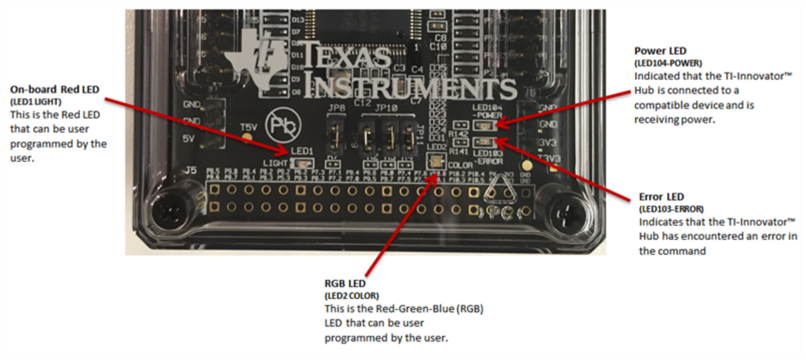
What are the capabilities of the on-board components?

Component	Capabilities	Details
RGB LED	Built-in light-emitting diode (LED) that is capable of emitting a variety of colors.	Can control red, blue, and green levels of intensity (0 to 255) to create a specific color.
Red LED	Built-in light-emitting diode (LED) that emits a red light.	Can set LED on or off, set LED to blink and determine frequency and duration.
Speaker	Built-in speaker located at the back of the Hub. It converts electrical current into sound you can hear.	The speaker can emit sounds from 40 to 4000 Hz.
Light Brightness Sensor	Built-in light brightness sensor located at the bottom of the Hub. The sensor detects light intensity.	Can detect ambient light brightness. Value is scaled from 0 (darkness) to 100 (bright sunlight).

What are some examples of using the on-board components?

Component	Desired Action	Program Code
RGB LED	Turn on blue element of on-board RGB LED ("COLOR") at 100% brightness.	`Send "SET COLOR.BLUE 255"`
Red LED	Turn on the on-board Red LED ("LIGHT").	`Send "SET LIGHT ON"`
Speaker	Play a 440Hz tone on the on-board speaker ("SOUND") for 2 seconds.	`Send "SET SOUND 440 TIME 2"`
Light Brightness Sensor	Read and display the current value of the on-board light sensor ("BRIGHTNESS"). Range is 0% to 100%.	`Send "READ BRIGHTNESS"` `Get a: Disp a`

What are all the LEDs that are built into the TI-Innovator™ Hub?


On-board Red LED
(LED1 LIGHT)
This is the Red LED that can be user programmed by the user.
Power LED
(LED104-POWER)
Indicated that the TI-Innovator™ Hub is connected to a compatible device and is receiving power.
Error LED
(LED103-ERROR)
Indicates that the TI-Innovator™ Hub has encountered an error in the command
RGB LED
(LED2 COLOR)
This is the Red-Green-Blue (RGB) LED that can be user programmed by the user.

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What are the full syntax options for the each of the on-board components?

Component	Command Syntax	Desired Action	Code Samples
RGB LED	Send("SET COLOR …") ON/OFF/0-255 (red element) ON/OFF/0-255 (green element) ON/OFF/0-255 (blue element) [BLINK frequency] (in Hz) [TIME duration] (in seconds)	Turn ON Red and Green elements of tri-color LED	`Send("SET COLOR ON ON OFF")`
		Set Red to full intensity, Green to half intensity, Blue to off	`Send("SET COLOR 255 128 0")`
		Set Red to full intensity, Green to half intensity, Blue to off for 10 seconds	`Send("SET COLOR 255 128 0 TIME 10")`
		Set Red to full intensity,	`Send("SET COLOR 255 128 0 BLINK 2 TIME 10")`

Component	Command Syntax	Desired Action	Code Samples
		Green to half intensity, Blue to off and blink at 2 Hz (2 times a second) for 10 seconds	
		Turn OFF the Red element	`Send("SET COLOR.RED 0")`
		Turn ON the Green element at half intensity and blink it at 2 Hz (2 times a second) for 10 seconds	`Send("SET COLOR.GREEN 128 BLINK 2 TIME 10")`
Red LED	Send("SET LIGHT …") ON/OFF [BLINK frequency] [TIME duration] (in seconds)	Turn LED ON	`Send("SET LIGHT ON")`
		Turn LED OFF	`Send("SET LIGHT OFF")`
		Turn LED ON for 10 seconds	`Send("SET LIGHT ON TIME 10")`
		Turn LED ON, blink LED at 2 Hz (2 times a second) for 10 seconds	`Send("SET LIGHT 1 BLINK 2 TIME 10")`
Speaker	Send("SET SOUND …") Frequency in Hz	Play tone at 261.23 Hz	`Send("SET SOUND 261.23")`

Component	Command Syntax	Desired Action	Code Samples
	[TIME duration in seconds]		
		Evaluate the expression 2^8 (= 256) and play that tone	`Send("SET SOUND eval (2^8)")`
		Evaluate the expression 2^8 (= 256) and play that tone for .25 sec	`Send("SET SOUND eval (2^8) TIME .25")`
		Evaluate the expression 2^9 (= 512) and play that tone for 0.25 s (result of evaluating 1/4)	`Send("SET SOUND eval( 2^9) TIME eval(1/4)")`
		Turn speaker off	`Send("SET SOUND OFF")`
Light Brightness Sensor	Send("READ BRIGHTNESS")	Read the built-in light brightness sensor	`Send("READ BRIGHTNESS")` `Get(B)`

TI-Innovator™ Rover On-Board Components Details

What are the capabilities of the Rover on-board components?

Component	Capabilities	Details
2 Motors with encoders	Move the Rover – forward, backward, turns – and measure the distance traveled.	The rotary encoders – one on each motor – measure the distance traveled by the Rover.
Ultrasonic Ranger	Measure the distance to an obstacle.	The front-facing ultrasonic ranger that measures the distance
Color Sensor	Sense the color of the surface that the Rover is driving on.	The color sensor is on the bottom of the Rover and is used to detect the color of the surface.
RGB light indicator	Display any combination of red green and blue colors.	The tri-color RGB LED on the top surface of the Rover can be controlled through user programs to display any color combination
Gyroscope	Measures the angular change in Rover motion	The gyroscope is used to maintain the heading of Rover while it's in motion. It can also be used to measure the change in angle during turns.

What are some examples of using the Rover on-board components?

Component	Desired Action	Program Code

2 Motors with encoders	Move RV Forward by .5 M
	Move RV Backward by .1 M
		`Send "RV FORWARD 0.5 M"`
		`Send "RV BACKWARD 0.1 M"`

Ultrasonic Ranger	Detect distance to object in front of Rover	`Send "READ RV.RANGER"`
		`Get r`
		`Disp r`

Color Sensor	Detect color of surface
	There are three different ways to detect the color:
		`Send "READ RV.COLORINPUT"`
		`Get c`

Component	Desired Action	Program Code

	1 As one of 9 pre-defined colors
	The return value is in the 1 – 9 range which maps to the colors below:
	Color **Return value**
	Red 1
	Green 2
	Blue 3
	Cyan 4
	Magenta 5
	Yellow 6
	Black 7
	White 8
	Gray 9
		`If c=1 Then`
		`Disp "Red detected"`
		`ElseIf c=2 Then`
		`Disp "Green detected"`
		`ElseIf c=3 Then`
		`Disp "Blue detected"`
		`EndIf`

	Detect intensity of individual red, green, blue components of surface
	
	The results are in 0-255 range
		`Send "READ RV.COLORINPUT.RED"`
		`Get r`
		
		`Send "READ RV.COLORINPUT.GREEN"`
		`Get g`
		
		`Send "READ RV.COLORINPUT.BLUE"`
		`Get g`
		
		r, g, b will be in 0-255 range

	Detect grayness of surface The result will be in 0-255 range	`Send "READ RV.COLORINPUT.GRAY"`
		`Get gr`

RGB light indicator	This supports the same commands and parameters as the **RGB LED** on the TI-Innovator™ Hub	`Send "SET RV.COLOR 255 0 255"`
		`Send "SET RV.COLOR.RED 100"`
		`Send "SET RV.COLOR.GREEN 255"`
		`Send "SET`

Component	Desired Action	Program Code
		`RV.COLOR.BLUE 150"`

Gyroscope	This component is used internally by the **FORWARD**, **BACKWARD** and **ANGLE** commands. It can also be used directly for machine-level programming.	`Send "SET RV.ENCODERSGYRO 0"`
		
		`Send "READ RV.ENCODERSGYRO"`
		`Get e`
		
		`Send "READ RV.GYRO"`
		`Get g`

What are the full syntax options for the each of the Rover on-board components

Componen t	Desired Action	Desired Action	Program Code
2 Motors with encoders	RV FORWARD RV BACKWARD Advanced: SET RV.MOTORS <left speed> <right speed> READ RV.ENCODERSGYRO	Drive in a straight line for a fixed distance/time	For all Rover Code Samples and Test Programs go to: education.ti.co m
		Drive/draw in a specific shape (circle, square, etc.) or function	
		Drive to a specific coordinate	
Ultrasonic Ranger	READ RV.RANGER	Drive until an obstacle is detected	
		Collect position versus time data	
Color Sensor	READ RV.COLORINPUT READ RV.COLORINPUT.RED READ RV.COLORINPUT.GREE N READ RV.COLORINPUT.BLUE READ RV.COLORINPUT.GRAY	Follow a line that is on the floor	
		Speed up when green is detected, slow down when red is detected	

Componen t	Desired Action	Desired Action	Program Code
RGB light indicator	SET RV.COLOR <r> <g> b>	Indicate different colors depending on how close to an object Provides visual feedback/confirmation during activity	
Gyroscope	READ RV.ENCODERSGYRO READ RV.GYRO	Angular positioning	

I/O Module Details

What are the capabilities of the TI-Innovator™ I/O Modules available from TI?

Component	Capabilities	Details
Servo Motor	360 degree, continuous rotation servo motor.	Can control direction and speed. Should only be connected to the OUT 3 port and requires external power.
Vibration motor	Coin type motor that vibrates.	Can control the intensity of the vibrations.
Light sensor	Sensor that detects the light intensity of the environment.	Can detect ambient light brightness. Value is scaled from 0 (darkness) to 100 (bright sunlight).
White LED	Light-emitting diode that emits white light.	Can set LED on or off, set LED to blink and determine frequency and duration.
Ultrasonic Ranger	Measures distance from the module in centimeters	Can measure distance from 1cm to 4 meters

What are some examples of using the TI-Innovator™ I/O Modules available from TI?

Component	Desired Action	Program Code (TI CE Graphing Calculator)
Servo Motor	Rotate the shaft of the Servo Motor connected to **OUT 3** counter clockwise by 90°	`Send("CONNECT SERVO 1 TO OUT 3")` `Send("SET SERVO 1 TO -90")`
Vibration motor	Turn on the Vibration Motor connected to **OUT 1**	`Send("CONNECT VIB.MOTOR 1 TO OUT 1)` `Send("SET VIB.MOTOR 1 TO ON")`
Light sensor	Read and display ambient light level from the sensor connected to **IN 2**	`Send("CONNECT LIGHTLEVEL 1 TO IN2")` `Send("READ LIGHTLEVEL 1")` `Get(L):Disp(L)`

Component	Desired Action	Program Code (TI CE Graphing Calculator)

White LED	Turn on the White LED module connected to **OUT 1**	`Send("CONNECT LED 1 TO OUT 1")`
		`Send("SET LED 1 ON")`

Ultrasonic Ranger	Read and display measured distance from the ranger connected to **IN 2**	`Send("CONNECT RANGER 1 TO IN2")`
		`Send("READ RANGER 1")`
		`Get(R):Disp (R)`

What are the full syntax options for the each of the TI-Innovator™ I/O Modules available from TI?

Component	Command Syntax	Desired Action	Code Samples
Servo Motor	Send("SET SERVO n [TO] [CW/CCW] speed [[TIME] seconds] -- speed from -100 to 100, CW/CCW (Clockwise/Counterclockwise) optional, if speed <0, CCW, else CW unless CW/CCW keyword is specified, TIME optional, in seconds, default=1 second (for continuous servo operation) (CW/CCW required if TIME/seconds NOT specified.)	Configure the program to use SERVO on port OUT 3	`Send ("CONNECT SERVO 1 TO OUT 3")`
		set SERVO to turn Counterclockwise (CCW) at full (100%) speed for 2 seconds	`Send("SET SERVO 1 CCW 100 2")`
		set SERVO to turn Clockwise (CW) at half (50%) speed for 1 second (default time if not specified)	`Send("SET SERVO 1 CW 50")`

		Turn SERVO Off	`Send("SET SERVO 1 ZERO")`
			or
			`Send("SET SERVO 1 STOP")`

Compone nt	Command Syntax	Desired Action	Code Samples
		Set SERVO to move to -90 degree position (CCW)	`Send("SET SERVO 1 TO -90")` **or** Equivalent code using a variable with eval(): angdeg:=-90 `Send ("CONNECT SERVO 1 TO OUT 3")` `Send("SET SERVO 1 TO eval (angdeg) ")`
Vibration motor	Send("SET VIB.MOTOR 1 TO pwm") - pwm from 0 to 255	Configure the program to use ANALOG.OUT on port OUT 2	`Send ("CONNECT VIB.MOTOR 1 TO OUT 2")`
		Turn OFF vibration motor	`Send("SET VIB.MOTOR 1 TO 0")`
		Turn ON vibration motor at full power	`Send("SET VIB.MOTOR 1 TO 255")`
		Turn ON vibration motor at half power	`Send("SET VIB.MOTOR 1 TO 128")`
Light sensor	Send("READ LIGHTLEVEL n")	Configure the program to use LIGHTLEVEL on port IN 1	`Send ("CONNECT LIGHTLEVEL 1 TO IN 1")`

Compone nt	Command Syntax	Desired Action	Code Samples
		Read the light sensor	`Send ("READ LIGHTLEVE L 1")` `Get(L)`
White LED	Send("SET LED 1 [TO] ON/OFF [[BLINK|TOGGLE] frequency] [[TIME] seconds] ")	Configure the program to use LED on port OUT 1	`Send ("CONNECT LED 1 TO OUT 1")`
		Turn LED ON	`Send("SET LED 1 ON")`
		Turn LED OFF	`Send("SET LED 1 OFF")`
		Turn external LED ON for 5 seconds	`Send("SET LED 1 TO ON TIME 5") --`
		Turn external LED ON and blink it at 2 Hz (2 times a second) for 5 seconds	`Send("SET LED 1 TO ON BLINK 2 TIME 5")`
Ultrasonic Ranger	Send("READ RANGER n") Get(R):Disp R	Configure the program to use RANGER on port IN 1	`Send ("CONNECT RANGER 1 TO IN 1")`
		Read the Ultrasonic Ranger	`Send ("READ RANGER 1") Get (R)`

What other I/O Modules could work with the TI-Innovator™ Hub?

The items contained in the TI-Innovator™ kits have all been verified to be fully compatible with the TI-Innovator™ Technology. The sketch of the TI-Innovator™ Hub can support other modules that are compatible with the universal 4-pin connector that is used for the input and output ports. Supported commands and potential modules are listed below. If there are specific components you think would be valuable for classroom activities, please contact TI-Cares and provide your feedback.

Example Module Component(s)	**Command/Sketch Object**
Barometer Sensor	BAROMETER
Button, Magnetic Switch	BUTTON
3-Axis Digital Compass	COMPASS
Fan	DCMOTOR
Temperature & Humidity Sensor	DHT
Single or variable color LEDs	LED
Light sensor	LIGHTLEVEL
Sound Sensor, Loudness Sensor	LOUDNESS
Moisture Sensor	MOISTURE
Collision Sensor, PIR Motion Sensor	MOTION
Slide Potentiometer, Rotary Angle Sensor	POTENTIOMETER
Electromagnet, Relay	RELAY
Servo Motor	SERVO
Buzzer, speaker	SPEAKER
Switch	SWITCH
Temperature Sensor	TEMPERATURE

Breadboard Components Details

What are the capabilities of the components in the TI-Innovator™ Breadboard Pack?

There are two types of components in the TI-Innovator™ Breadboard pack.

- Addressable components, such as LEDs and sensors, that responds to TI-Innovator™ Hub commands.
- Passive components, such as resistors, capacitors, and manual switches that are not directly addressable by the TI-Innovator™ Hub but are required in many breadboard projects.

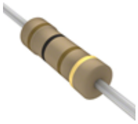
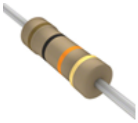
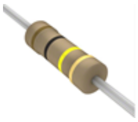
Addressable Components

Component	Image	Used with pins	Description
Red LEDs		BB 1-10	Light-emitting diode that emits light when current passes through it.
Green LEDs		BB 1-10	Light-emitting diode that emits light when current passes through it.
RGB (Red-Green-Blue) LEDs		BB 8-10	Light-emitting diode with independently adjustable red, green and blue elements. Can produce a wide variety of colors.
Thermistor		BB 5,6,7 (analog input required)	Resistor whose resistance changes based on temperature. Used for measurement and control.
7-segment Display		BB 1-10	Array of LEDs arranged to display numbers and some alphabetic characters. Also has an LED for a decimal point.
Small DC Motor		BB 1-10 (uses digital to generate software PWM)	Motor that converts direct current electrical power into mechanical power.
TTL Power MOSFET		BB 1-10	Transistor used for amplifying or switching electronic signals.

TI Analog Temperature Sensor		BB 5,6,7 (analog input required)	Sensor that reports a voltage proportional to the ambient temperature within a range of −55°C to 130°C.
Visible Light Sensor		BB 5,6,7 (analog input required)	Sensor that reports the level of ambient light.
Infrared Transmitter LTE-302, yellow dot		BB 1-10 (digital output)	Side emitting Infrared LED, designed to be paired with the LTR-301 Photo-Transistor.
Infrared Receiver LTR-301, red dot		BB 1-10 (digital input)	Side sensing Infrared photo transistor, designed to be paired with the LTE-302 Infrared Emitter.

See also: TI-Innovator™ Hub Ports and Breadboard Usable Pins

Passive Components

Component	Image	Used with pins	Description
Resistor 100 Ohm (10)		N/A	Resistor that provides 100 Ohms of resistance in a circuit. Color Code Value: brown, black, brown. (10X10 = 100)
Resistor 1K Ohm (10)		N/A	Resistor that provides 1K Ohms of resistance in a circuit. Color Code Value: brown, black, red (10X100 = 1,000)
Resistor 10K Ohm (10)		N/A	Resistor that provides 10K Ohms of resistance in a circuit. Color Code Value: brown, black, orange (10X1,000 = 10,000)
Resistor 100K Ohm (10)		N/A	Resister that provides 100K Ohms of resistance in a circuit. Color Code Value: brown, black, yellow (10X10,000 = 100,000)
Diode		BB 1-10	Allows an electric current to pass in one direction, while blocking current in the opposite direction.
SPDT Slide Switch		BB 1-10	Single pole, double throw switch. Slide the switch knob back and forth to open and close contacts.
8 Position DIP Switch		BB 1-10 (digital input)	Set of 8 slide switches used to customize the behavior of the

			circuit components for specific situations.
8 100 Ohm resistor SIP Package		N/A	8 100 Ohm resistor SIP package for use with 8 Position DIP Switch.
Potentiometer with Knob		BB 5,6,7	Variable resistor with knob used to change the resistance in a circuit..
Capacitor 100µF		N/A	Capacitor that temporarily stores an electric charge of up to 100µF.
Capacitor 10µF		N/A	Capacitor that temporarily stores an electric charge of up to 10µF.
Capacitor 1µF		N/A	Capacitor that temporarily stores an electric charge of up to 1µF.
40-Pack male/male Breadboard Jumper Cables		N/A	Male to Male jumper cables for connecting components on the breadboard.
10-Pack male/female Breadboard Jumper Cables		N/A	Male to female jumper cables for connecting components on the breadboard.
Breadboard		N/A	Platform for connecting the electronic components of a project by inserting component leads and jumper cables into pins.
4-AA Battery Holder		N/A	4-AA battery holder with tined solid leads for easy breadboard insertion.

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