TEXAS INSTRUMENTS

TI-Innovator™ Hub with TI LaunchPad™ Board Getting Started Guide

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.

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

Contents

TI-Innovator™ Hub Overview

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 27).

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:

Ⓐ Green auxiliary power LED

Ⓑ Green power LED,

Ⓒ Red error LED.
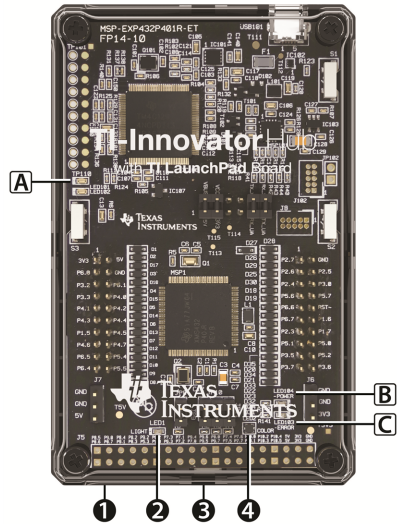
Built-in Ports

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.
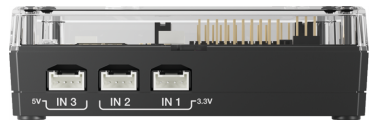
Right side - Three ports for controlling output modules:
- **OUT 1** and **OUT 2** provide 3.3V power.
- **OUT 3** provides 5V power.
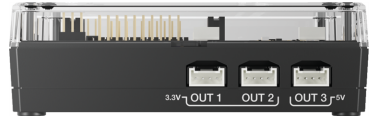
Bottom - Light Brightness Sensor (described earlier) and two ports:
- **I²C** port connects to peripherals that use the I²C communication protocol.
- **DATA** Mini-B port, used with the appropriate cable, connects to a compatible graphing calculator or computer for data and power.
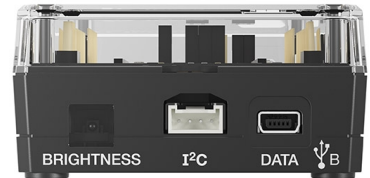
Top - Two connectors:

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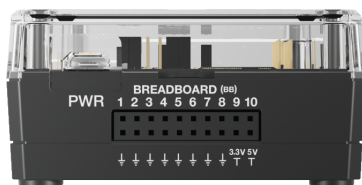
USB Cables
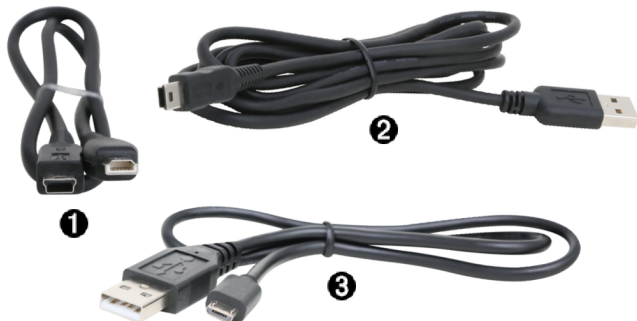
❶ USB Unit-to-Unit (Mini-A to Mini-B) - Connects the Hub to a TI CE Graphing
   Calculator or a TI-Nspire™ CX Handheld.

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 23).

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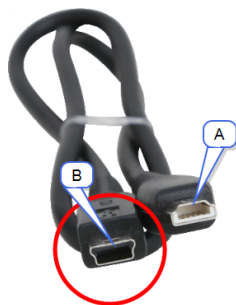
3. Insert the free end of the cable (the "**A**" connector) into the USB port on the calculator.

Hub connected to TI CE Graphing Calculator

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

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 12).

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
```

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 1), 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.

```
NORMAL FLOAT AUTO REAL RADIAN MP

PROGRAM:SOUNDTST
:Send("SET SOUND 440 TIME
2")
```
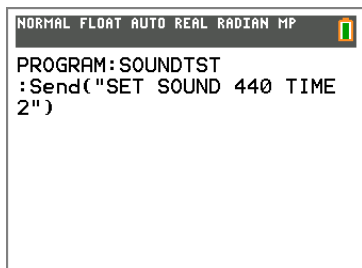
1. Open (or create) the program that you will use to communicate with the Hub.

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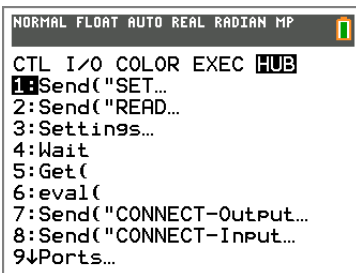
6. On the Hub menu, select **Settings > TIME**.

```
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 $\leq$, 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 7).

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
```
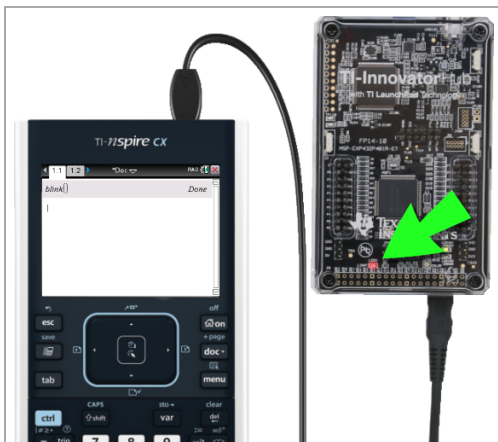

How to Create and Execute a Program

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 1), 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.
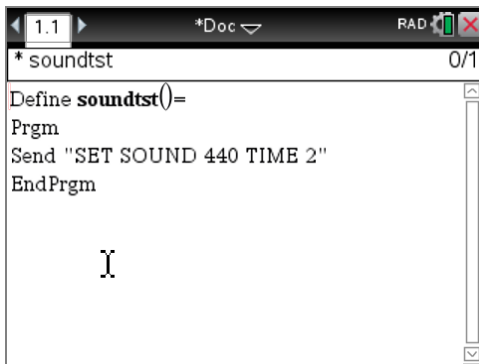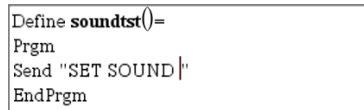

1. Open (or create) the program that you will use to communicate with the Hub.

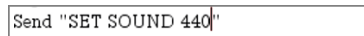2. Position the cursor where you want to place the command.

3. On the handheld, press `menu` and select **Hub**.
    In the Program Editor menu, select **Hub**.
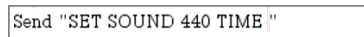
    The Hub menu appears.
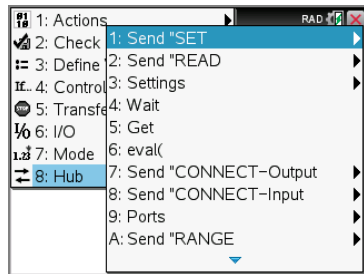
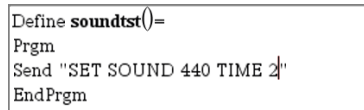4. Select **Send "SET**, and then select **SOUND** to insert the first part of the command.

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

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

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

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` `x`.

- To clear the current line of code, press `ctrl` `clear`.

- To type relational operators such as $=$, $<$, and $\leq$, press `ctrl` `=`.

- To type a space, press `⎵`.

- If your program becomes unresponsive while running:
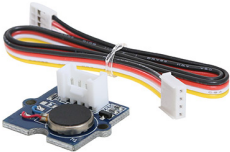
   TI-Nspire™ CX Handheld: Hold down the `⌂on` key and press `enter` repeatedly.
   Windows®: Hold down the **F12** key and press **Enter** repeatedly.
   Mac®: Hold down the **F5** key and press **Enter** repeatedly.

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 23),

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 27).

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**.

Hub
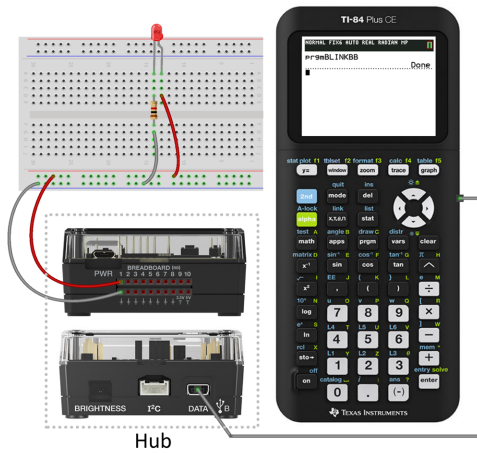
The Hub command string "CONNECT LED 1 TO BB1" tells the Hub that an LED on the breadboard is connected to pin **1** on the Hub. After sending this command, your code can address the LED as "LED 1." The CONNECT command is required only for I/O Modules and breadboard components. It does not apply to on-board 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.
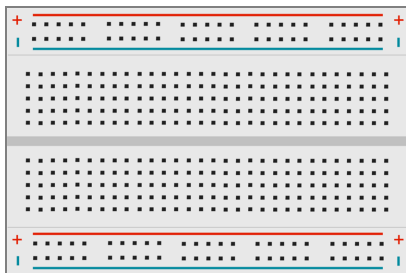
Front of board showing power rails and connection pins
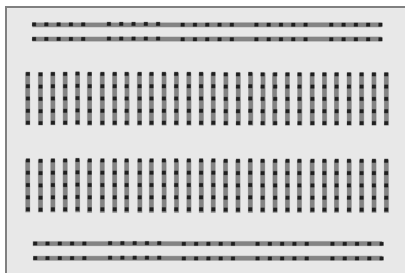
Interconnections at back of board (normally hidden). The 5-pin groups in each power rail are interconnected. All other 5-pin groups are isolated.

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 27).

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.
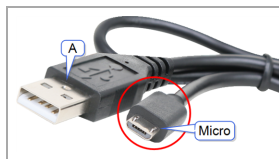
4. Turn on the power source:
    - If using the TI Wall Charger, plug it into a wall socket.
    - If using the External Battery Pack, press the power button.

    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 1).

- 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 6).

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 (here).
- 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.
- 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
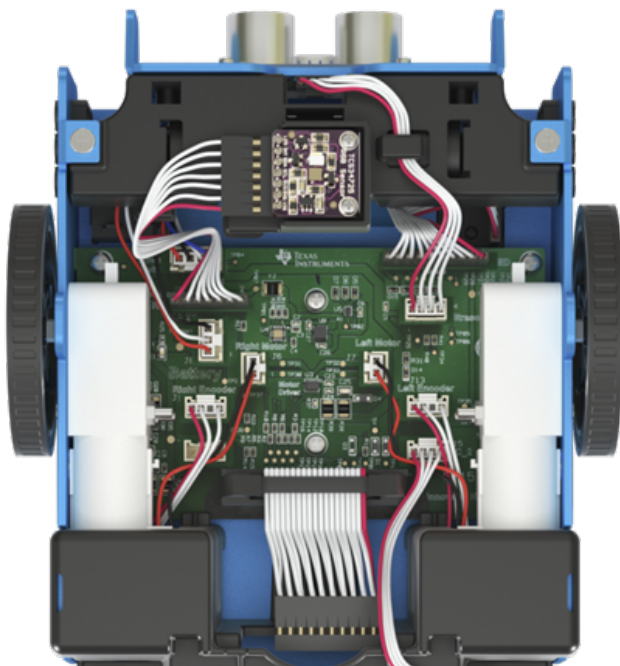
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