

# Meet the TI-Innovator Hub

TI-84 Plus CE

TI-Basic

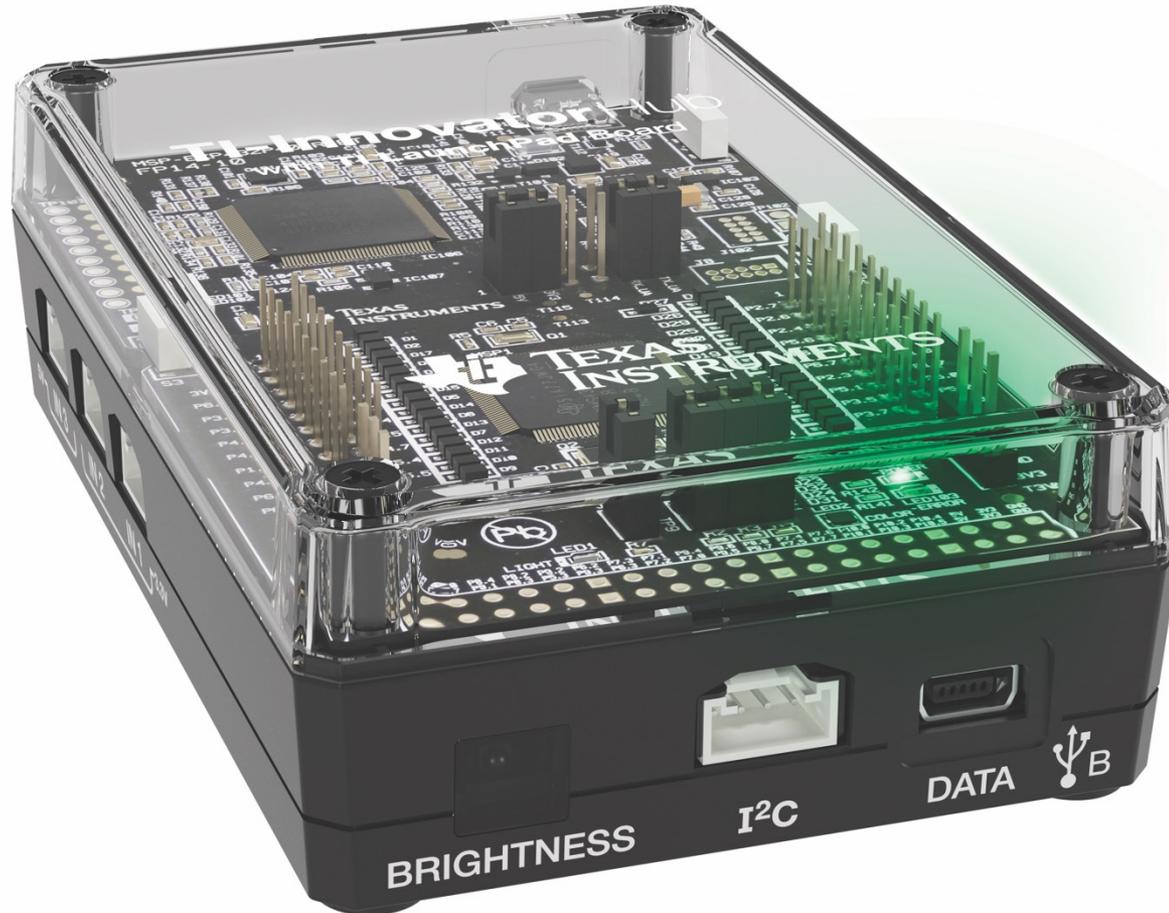
Texas Instruments

@ticalculators



[www.TIstemProjects.com](http://www.TIstemProjects.com)

# Meet the TI-Innovator Hub

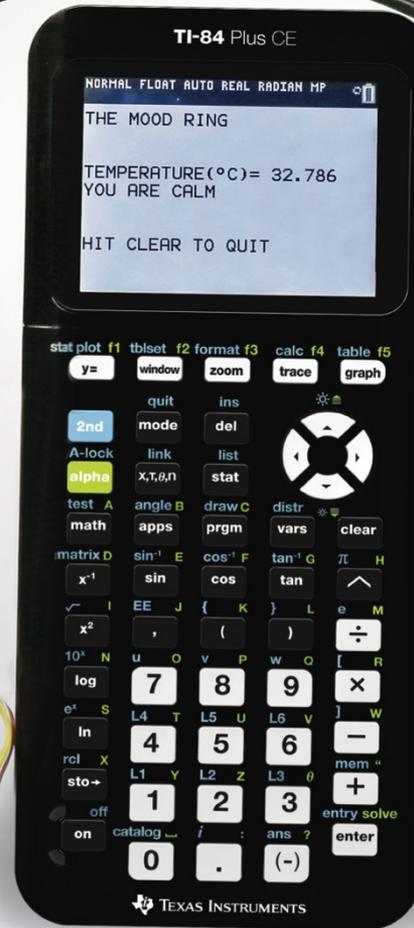


TI-Innovator™  
Hub

Built-in  
RGB LED  
Output

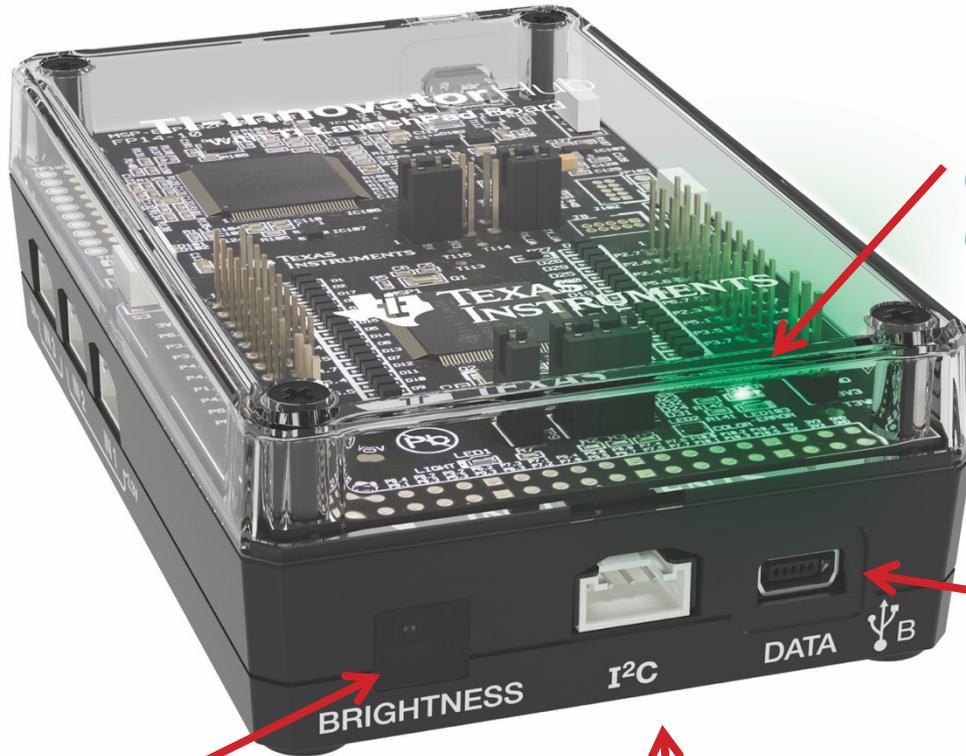


External Sensor Input



TI Graphing  
Calculator

# Hub from the Front



Red-Green-Blue (RGB) Color LED (Built-in)

BRIGHTNESS

Brightness Sensor (Built-in)

I<sup>2</sup>C

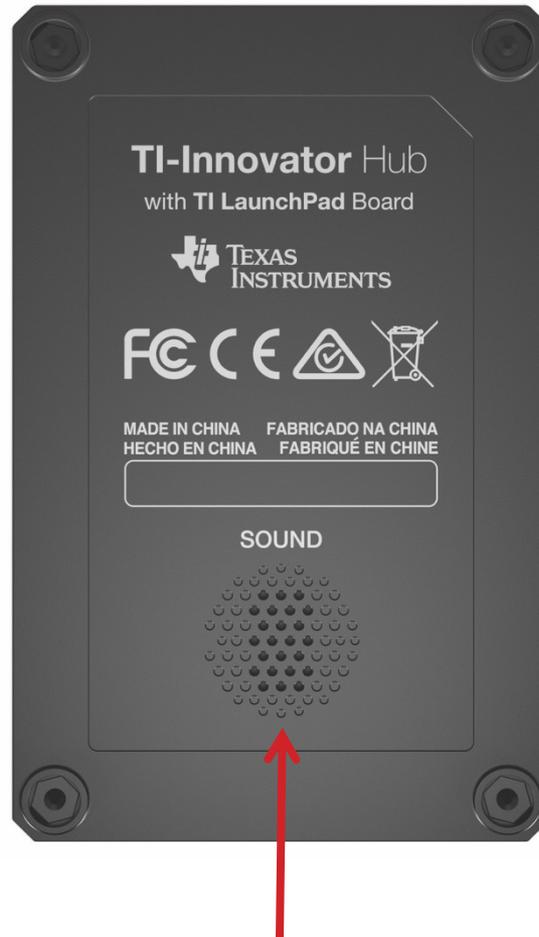
I<sup>2</sup>C Port used to connect to Rover

DATA



USB Port (mini) to connect to calculator and computer

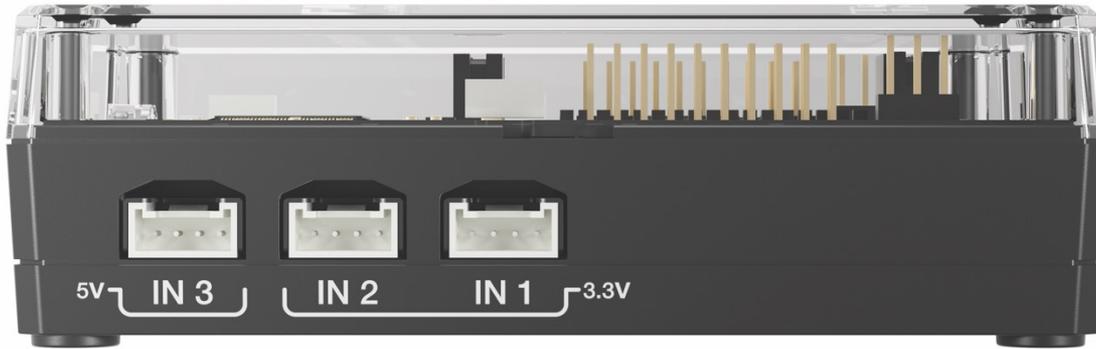
# Hub from the Bottom



**Speaker  
(Built-in)**

# Hub from the side – input ports

Input ports for external sensors with Grove connectors



3.3 Volt ports, IN 1 and IN 2, required for Ranger and DHT



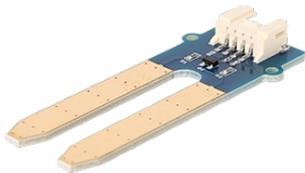
Magnetic Field (Hall Effect)



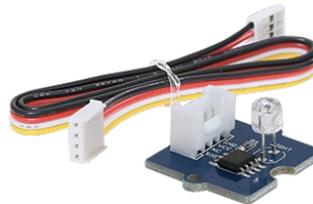
Vernier SensorLink Adaptor



Temperature



Moisture



Light Level



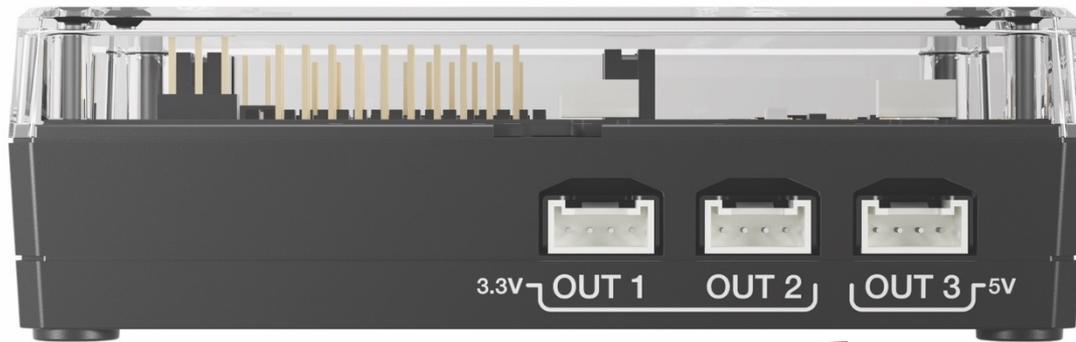
Digital Temperature and Humidity (DHT)



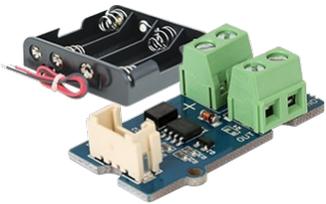
Ranger

# Hub from the side – Output ports

Output ports for external motors and other outputs with Grove connectors



5 Volt port, OUT 3, required for motors



MOSFET controls power level to pump and other devices



Pump



External LED



Continuous Servo Motor

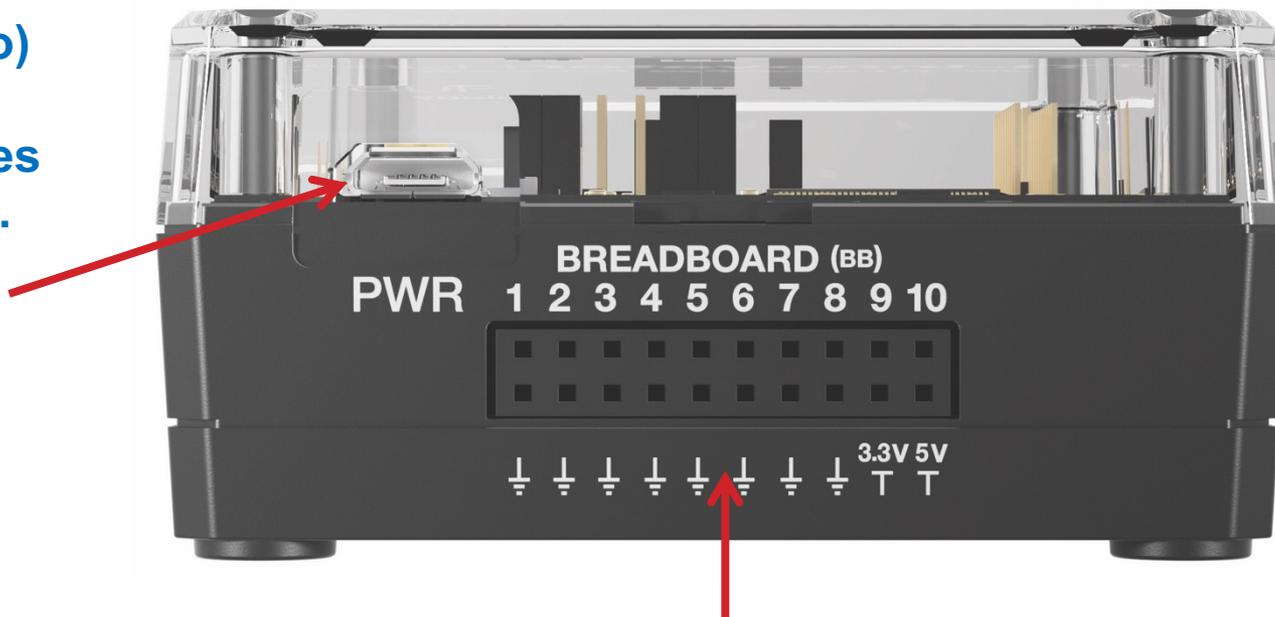


Vibration Motor

# Hub from the Back – breadboard ports

USB Port (micro) connects to external batteries and wall socket.

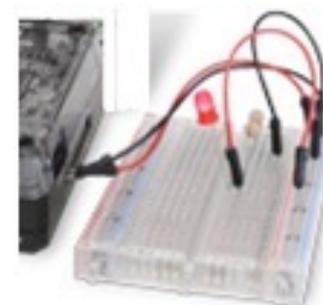
Connects to computer for updating Hub firmware.



Breadboard ports



RGB Array



Path to STEM Projects with breadboard

# Connecting the Hub to your calculator



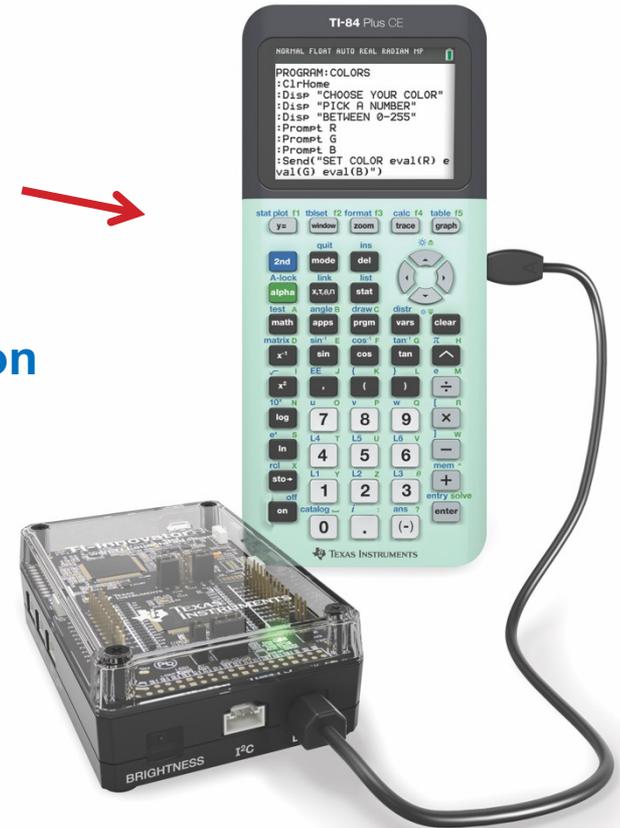
**Note:** The Hub is powered by the calculator. When the cables are connected the Hub goes through a brief “boot-up” process. During the boot-up the RGB LED displays a color that indicates the Hub firmware release, in this case, orange.

1  
Plug B side of cable into USB B port of the Hub.

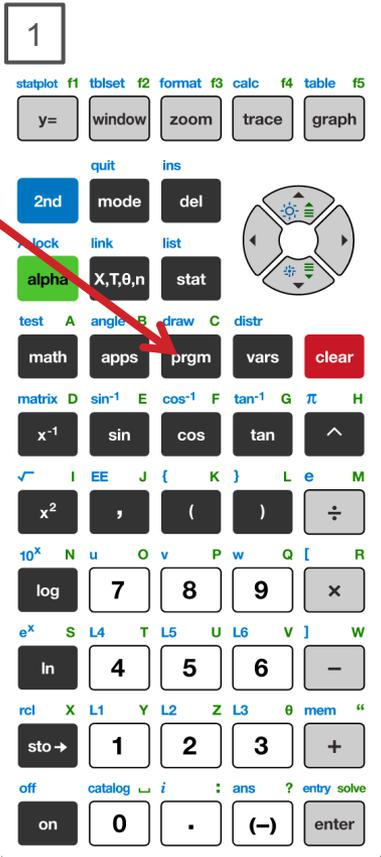
2  
Plug A side of cable into port on calculator.



Unit-to-unit cable



# Creating a new Hub Program



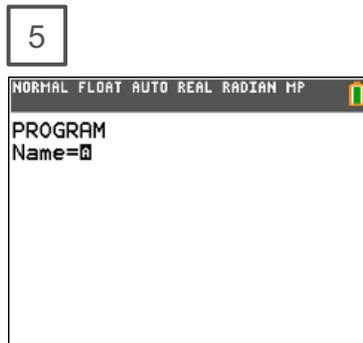
Press the **[prgm]** key to create, edit and execute TI-Basic programs.



You have the option to execute (run), edit or create programs.



Use **right arrow** key to move to NEW 1:Create New  
Press **[1]** or **[enter]** to select.



You are prompted to enter a program name. The blinking A cursor shows that you are in alpha entry mode. The green alpha labels on the keys are active.



Type your program name and press **[enter]**.



You are now in position to begin entering commands to your program.

# Entering a Hub Program

1

```
NORMAL FLOAT AUTO REAL RADIAN MP
CTL I/O COLOR EXEC HUB
1: If
2: Then
3: Else
4: For(
5: While
6: Repeat
7: End
8: Pause
9: Lbl
```

Press the **[prgm]** key again to bring up the program edit menu. You will see this menu when you are editing a program.

2

```
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...
```

Press **right arrow** repeatedly or **left arrow** to move to the HUB menu.

3

```
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...
```

Press **[enter]** or press **[1]** to select the 1:Send ("Set... menu.

4

```
NORMAL FLOAT AUTO REAL RADIAN MP
Send("SET
1: LIGHT
2: COLOR
3: SOUND
4: LED
5: RGB
6: SPEAKER
7: POWER
8: SERVO. CONTINUOUS
9: ANALOG. OUT
```

Use down arrow to move to 2: COLOR and press **[enter]** or press **[2]** to select 2:COLOR.

5

```
NORMAL FLOAT AUTO REAL RADIAN MP
EDIT MENU: [a,Tpha] [f5]
PROGRAM: HUB
: Send("SET COLOR █
```

The command is pasted to your program. Send("SET COLOR is the command that controls the Red-Green-Blue (RGB) LED of the Hub.

6

```
NORMAL FLOAT AUTO REAL RADIAN MP
EDIT MENU: [a,Tpha] [f5]
PROGRAM: HUB
: Send("SET COLOR 255 0 0 █
```

Enter values for Red, Green and Blue by typing **255** for Red, **[alpha]** **[0]** for a space to separate red from green, **0** for Green, **[alpha]** **[0]** for a space and **0** for Blue.  
**Note:** 255 is the maximum value (full power) and 0 is off.

7

```
NORMAL FLOAT AUTO REAL RADIAN MP
EDIT MENU: [a,Tpha] [f5]
PROGRAM: HUB
: Send("SET COLOR 255 0 0")
: █
```

Close the quotes and parentheses by pressing **[alpha][+]** for a quote and **[)]**. Press **[Enter]** to move to the next line of the program.  
**Note:** Each program statement must start on a new line.

# Running (Executing) a Hub Program

1

```
NORMAL FLOAT AUTO REAL RADIAN MP
EDIT MENU: [alpha] [f5]
PROGRAM: HUB
:Send("SET COLOR 255 0 0")
:█
```

2

```
NORMAL FLOAT AUTO REAL RADIAN MP
█
```

3

```
NORMAL FLOAT AUTO REAL RADIAN MP
TI-BASIC
EXEC EDIT NEW
1:HUB
```

4

```
NORMAL FLOAT AUTO REAL RADIAN MP
prgmHUB█
```



You run programs on the home screen.

Press **[prgm]** to see a menu of programs to run.

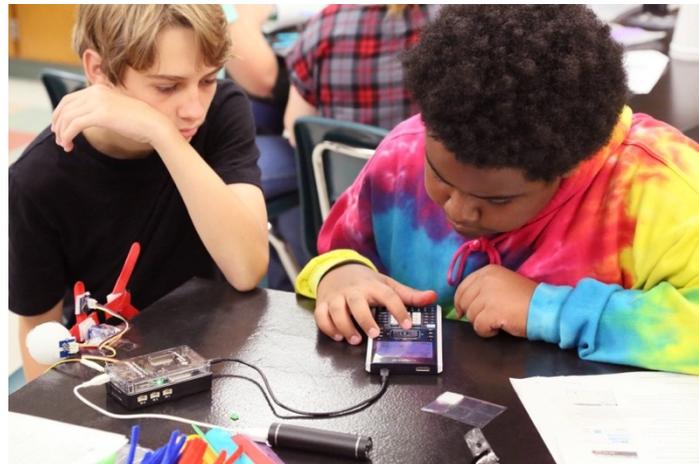
Select the program to run from the EXEC (execute) menu. In this case, press **[enter]** or **[1]**.

Your selection is pasted to the home screen.

Press **[2<sup>nd</sup>] [quit]** (mode key) to exit the program editor and return to home screen.

Make sure that your Hub is connected to the handheld.

Press **[enter]** to run the program. The Red-Green-Blue (RGB) LED will turn Red.





# TI-Innovator Hub Menu

## Hub Menu

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

Send("SET...  
Outputs

```
NORMAL FLOAT AUTO REAL RADIAN MP
Send("SET
1: LIGHT
2: COLOR
3: SOUND
4: LED
5: RGB
6: SPEAKER
7: POWER
8: SERVO. CONTINUOUS
9↓ANALOG. OUT
0: VIB. MOTOR
A: COLOR. RED
B: COLOR. GREEN
C: COLOR. BLUE
D: BUZZER
E: RELAY
F: SERVO
G↓SQUAREWAVE
H: DIGITAL. OUT
I: AVERAGING
J: BBPORT
K: Send("SET
```

Send("Read...  
Inputs

```
NORMAL FLOAT AUTO REAL RADIAN MP
Send("READ
1: BRIGHTNESS
2: DHT
3: RANGER
4: LIGHTLEVEL
5: TEMPERATURE
6: MOISTURE
7: MAGNETIC
8: VERNIER
9↓ANALOG. IN
0: DIGITAL. IN
A: SWITCH
B: BUTTON
C: MOTION
D: POTENTIOMETER
E: THERMISTOR
F: AVERAGING
G↓RGB
H: LOUDNESS
I: BBPORT
J: Send("READ
```

Settings

```
NORMAL FLOAT AUTO REAL RADIAN MP
Settings
1: ON
2: OFF
3: TO
4: TIME
5: BLINK
6: TEMPERATURE
7: HUMIDITY
8: CW
9↓CCW
0: NAMED
A: PULLDOWN
B: INPUT
C: PH
D: FORCE10
E: FORCE50
F: PRESSURE
G: PRESSURE2
```

Send("Connect  
Outputs

```
NORMAL FLOAT AUTO REAL RADIAN MP
Send("CONNECT
1: LED
2: RGB
3: SPEAKER
4: POWER
5: SERVO. CONTINUOUS
6: ANALOG. OUT
7: VIB. MOTOR
8: BUZZER
9↓RELAY
0: SERVO
A: SQUAREWAVE
B: DIGITAL. OUT
C: BBPORT
D: Send("CONNECT
```

Send("Connect  
Inputs

```
NORMAL FLOAT AUTO REAL RADIAN MP
Send("CONNECT
1: DHT
2: RANGER
3: LIGHTLEVEL
4: TEMPERATURE
5: MOISTURE
6: MAGNETIC
7: VERNIER
8: ANALOG. IN
9↓DIGITAL. IN
0: SWITCH
A: BUTTON
B: MOTION
C: POTENTIOMETER
D: THERMISTOR
E: RGB
F: LOUDNESS
G↓BBPORT
H: Send("CONNECT
```

# Copying and Pasting a Line of Code

1

```
NORMAL FLOAT AUTO REAL RADIAN MP
EDIT MENU: [alpha][graph] [f5]
PROGRAM:BLINK
:Send("SET COLOR █55 0 0")
:Wait 2
:
:
```

Use **arrow keys** to move the cursor to a position anywhere on the line that you would like to copy.

2

```
NORMAL FLOAT AUTO REAL RADIAN MP
PROGRAM:BLINK
:Sel1:Execute Program
2:Undo Clear
:Wa3:Insert Line Above
4:Cut Line
:5:Copy Line
6:Paste Line Below
7:Insert Comment Above
8:Quit Editor [2nd][quit]
[FRAC] [FUNC] [YVAR] [MENU]
```

Press **[alpha][graph] (f5)** then select **5:Copy Line** from the menu.

After you select you will be returned to the editor.

3

```
NORMAL FLOAT AUTO REAL RADIAN MP
EDIT MENU: [alpha][graph] [f5]
PROGRAM:BLINK
:Send("SET COLOR 255 0 0")
:Wait █
:
:
```

Use **arrow keys** to move the cursor to any location on the line above where you would like to insert the copied line.

4

```
NORMAL FLOAT AUTO REAL RADIAN MP
PROGRAM:BLINK
:Sel1:Execute Program
2:Undo Clear
:Wa3:Insert Line Above
4:Cut Line
:5:Copy Line
6:Paste Line Below
7:Insert Comment Above
8:Quit Editor [2nd][quit]
[FRAC] [FUNC] [YVAR] [MENU]
```

Press **[alpha][graph] (f5)** then select **6:Paste Line Below** from the menu. The copied line will be pasted.

5

```
NORMAL FLOAT AUTO REAL RADIAN MP
EDIT MENU: [alpha][graph] [f5]
PROGRAM:BLINK
:Send("SET COLOR 255 0 0")
:Wait 2
:Send("SET COLOR 255 0 0")
█
:
:
```

You can paste the copied line again by returning to the **[alpha][graph] (f5)** edit tools menu and then select **7:Paste Line Below**.

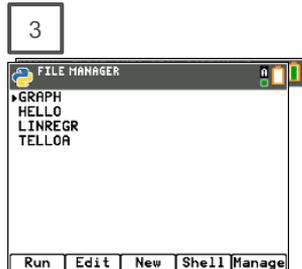
# Editing an existing Program File



Press the **[prgm]** key to create, edit and execute TI-Python programs.



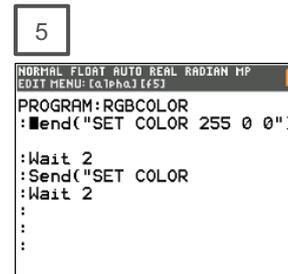
Right Arrow to the EDIT menu.



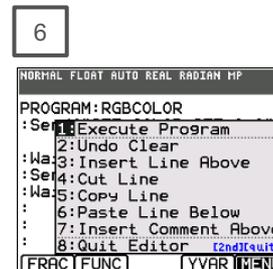
To edit an existing program, use the **Up and Down Arrow** keys to select a program.



Press **[enter]** to open a program in the editor..



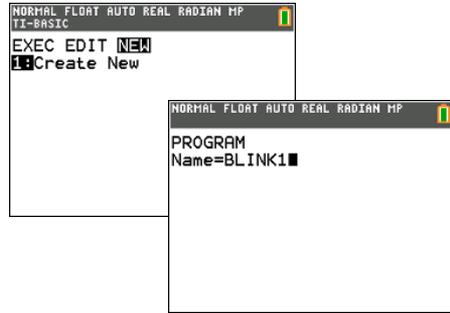
You can now make changes to the program or run the program.



Use the **[alpha][graph]** (**f5**) for the program edit tools menu.

# Copying/Replicating a TI-Basic Program File

1



```
NORMAL FLOAT AUTO REAL RADIAN MP
TI-BASIC
EXEC EDIT NEW
1:Create New

PROGRAM
Name=BLINK1
```

Press **[prgm]** then select Create New program. Enter a name for the program.

2



```
NORMAL FLOAT AUTO REAL RADIAN MP
EDIT MENU: [a,Tpha] [f5]
PROGRAM: BLINK1
: █
```

You are now in the program editor..

3



```
NORMAL FLOAT AUTO REAL RADIAN MP
EDIT MENU: [a,Tpha] [f5]
PROGRAM: BLINK1
:
Rc1 █
```

Press **[2nd][sto]** (**rcl**) to paste the contents of another program into the current program.

4



```
NORMAL FLOAT AUTO REAL RADIAN MP
CTL I/O COLOR EXEC HUB
1:BLINK
2:BLNKLOOP
3:RGCOLOR
```

Press **[prgm]** then **right arrow** to the EXEC menu. Select the program that you would like to copy. In this example, we will copy 1:BLINK.

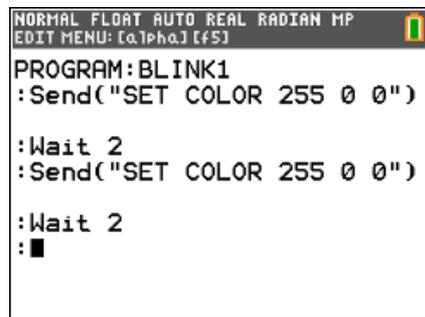
5



```
NORMAL FLOAT AUTO REAL RADIAN MP
EDIT MENU: [a,Tpha] [f5]
PROGRAM: BLINK1
:
Rc1 prgmBLINK
```

You now see the program that you will copy listed on the screen. Press **[enter]** to complete the copy process.

6

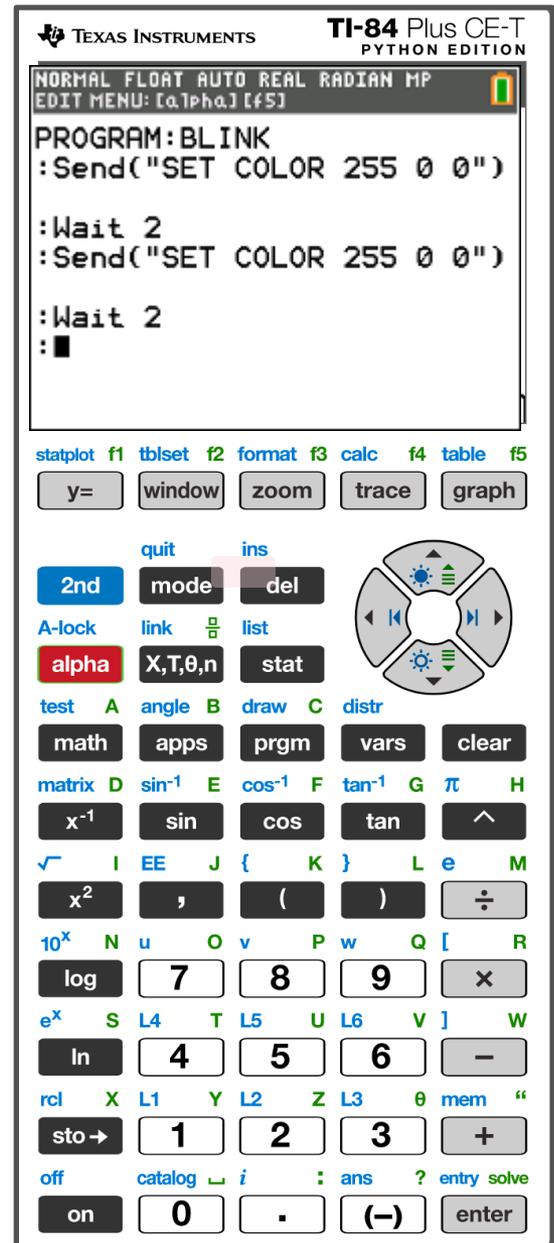


```
NORMAL FLOAT AUTO REAL RADIAN MP
EDIT MENU: [a,Tpha] [f5]
PROGRAM: BLINK1
:Send("SET COLOR 255 0 0")
:Wait 2
:Send("SET COLOR 255 0 0")
:Wait 2
: █
```

The new program is now ready to edit.

# Entry and Edit Tips

- » Use **number key shortcuts** or **arrow keys** and **[enter]** to select from menus
- » Use **arrow keys** to move the cursor around the screen.
- » Use **[alpha]** **repeatedly** to cycle from numeric, to lower case alpha to upper case alpha entry mode. The cursor indicates the current mode.
- » Use **[2<sup>nd</sup>] [A-lock]** to lock to alpha entry or to return to numeric entry.
- » Use **[prgm]** to select programs to run, edit or to create a new program.
- » Use **[prgm]** when editing a program to bring up the programming menus, including the **Hub** menu.
- » Use **[alpha][graph] (f5)** for the program edit tools menu (copy line, paste line, insert line, undo clear, etc.)
- » Use **[del]** to delete the character at the current cursor location.
- » Use **[2<sup>nd</sup>][del] (ins)** to insert at the current location.
- » Use **[clear]** to clear a line or to back out of a menu.
- » Use arrow keys to move to the end of a line and then press **[enter]** to complete a statement and move to the next line.
- » Use **[2<sup>nd</sup>] [quit]** to leave the program editor and return to the calculator home screen.



# COLOR OUTPUTS

**Task: Set the color output of the Red, Green, Blue (RGB) LED.**

Each color takes a value of (0-255).

**Challenge Tasks:**

Try to make **Yellow**

Try to make **Cyan**

Try to make **Magenta**

**New Program:**

```
NORMAL FLOAT AUTO REAL RADIAN MP
EDIT MENU: [alpha] [f5]

PROGRAM: RGBCOLOR
:Send("SET COLOR █
```

# Set the color

Press **[prgm]** then **right arrow** to NEW. Select 1:Create New.

Enter the program name by pressing the keys associated with the green letter labels.

```
NORMAL FLOAT AUTO REAL RADIAN MP
TI-BASIC
EXEC EDIT NEW
1:Create New

PROGRAM
Name=RGBCOLO█
```

Paste the Set Color command by pressing **[prgm]** then **right arrow** or **left arrow** to the Hub menu. Select 1:Send("SET...") then select 2:COLOR

```
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...

Send("SET
1:LIGHT
2:COLOR
3:SOUND
4:LED
5:RGB
6:SPEAKER
7:POWER
8:SERVO, CONTINUOUS
9:ANALOG, OUT

PROGRAM: RGBCOLOR
:Send("SET COLOR █
```

Enter values for Red, Green and Blue separated by spaces (**[alpha]** **[0]**).

Close the quotes (**[2<sup>nd</sup>][+]**) and parentheses. Press **[enter]** to complete the statement.

Run your program by selecting the program edit menu **[alpha]****[graph]** **f5**. Then select 1:Execute Program.

```
NORMAL FLOAT AUTO REAL RADIAN MP
EDIT MENU: [alpha] [f5]

PROGRAM: RGBCOLOR
:Send("SET COLOR 255 0 0")
:█

PROGRAM: RGBCOLOR
:Se█
1:Execute Program
2:Undo Clear
3:Insert Line Above
4:Cut Line
5:Copy Line
6:Paste Line Below
7:Insert Comment Above
8:Quit Editor [2nd][quit]
[FRAC] [FUNC] [YVAR] [MENU]
```

**Task: Create your own color and give it a name.**

**Challenge Tasks:**

Print the name of your color.

# Create and Name a Color

Press **[prgm]** then **right arrow** to edit then select your program to edit from the menu.

The Disp command is available from the **[prgm]** I/O menu.

Put your message in quotes using **[alpha][+]**.

Enter alpha characters by pressing **[alpha]** then the letter key associated with the green labels.”

**Add to previous Program:**

```
NORMAL FLOAT AUTO REAL RADIAN MP
EDIT MENU: [alpha][+] [f5]
PROGRAM:RGBCOLOR
:Send("SET COLOR 255 0 0")

:Disp "MY COOL COLOR"
:█
```

```
NORMAL FLOAT AUTO REAL RADIAN MP
TI-BASIC
EXEC EDIT NEW
1:HUB
2:RGBCOLOR
```

```
NORMAL FLOAT AUTO REAL RADIAN MP
CTL I/O COLOR EXEC HUB
1:Input
2:Prompt
3:Disp
4:DispGraph
5:DispTable
6:Output(
7:getKey
8:ClrHome
9:ClrTable
```

```
NORMAL FLOAT AUTO REAL RADIAN MP
EDIT MENU: [alpha][+] [f5]
PROGRAM:RGBCOLOR
:Send("SET COLOR 255 0 0")
:Disp "MY █
```

**Task: Display a sequence of colors for 2 seconds each.**

### Challenge Tasks:

Try to have your LED match the pattern of a traffic light.

### Edit previous Program:

```
NORMAL FLOAT AUTO REAL RADIAM MP
EDIT MENU: [a]pha] [f5]

PROGRAM:RGBCOLOR
:Send("SET COLOR 255 0 0")

:Wait 2
:Send("SET COLOR
:Wait 2
:Send("SET COLOR
:Wait 2
:█
```

# Display a series of colors

To remove the Disp statement, move your cursor to the row with Disp and press [clear].

The **Wait** command pauses the program for the number of seconds that you enter as an input. **Wait** is available at 4:Wait on the program Hub menu.

Press [prgm] Left Arrow to the HUB menu, select 4:Wait

Enter a value for the number of seconds to pause the program. You can use decimal values.

```
NORMAL FLOAT AUTO REAL RADIAM 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...
```

**Task: Set the RGB LED to a color then keep ON for 2 seconds then turn the LED OFF for 2 seconds.**

### Challenge Tasks:

Try to blink (turn on and turn off) 4 times

Try to blink 4 times in 8 seconds

### New Program:

```

NORMAL FLOAT AUTO REAL RADIAN MP
EDIT MENU: [a]Pha.] [f5]
PROGRAM:BLINK
:Send("SET COLOR
:Wait 2
:Send("SET COLOR
:Wait 2
:█

```

## Turn the LED ON and OFF

The **Wait** command pauses the program for the number of seconds that you enter as an input.

What values for the red, green and blue inputs to the color.rgb() function will turn the LED off?

Press **[prgm]** Left Arrow to the HUB menu, select 4:Wait

Enter a value for the number of seconds to pause the program. You can use decimal values.

You can copy and paste a line. Press **[alpha][graph](f5)** to see the edit tools menu. Use 5:Copy Line to copy the current line. Use 6:Paste Line Below to paste the copied line.

```

NORMAL FLOAT AUTO REAL RADIAN MP
PROGRAM:BLINK
:Se1:Execute Program
:Wa2:Undo Clear
:Se3:Insert Line Above
:Wa4:Cut Line
:
5:Copy Line
6:Paste Line Below
7:Insert Comment Above
8:Quit Editor [2nd][quit]
[FRAC] [FUNC] [YVAR] [MENU]

```

**Task: Set the RGB LED to a color then keep ON for 2 seconds then turn the LED OFF for 2 seconds.**

### Challenge Tasks:

Try to blink (turn on and turn off) 4 times

Try to blink 4 times in 8 seconds

### New Program:

```
NORMAL FLOAT AUTO REAL RADIAN MP
EDIT MENU: [a,Tpha.] [f5]

PROGRAM: BLNKLOOP
:For(N, 1, 10)
:Send("SET COLOR
:Wait 2
:Send("SET COLOR
:Wait 2
:End
:█
```

## Blink the LED Repeatedly

`For(N,1,10)` closed by an `End` command sets up a loop that will repeat the statements in a block of code.

**Note:** N is the loop counter variable. 1 is the first value for N and 10 is the last value for N.

Press **[prgm]**, then select `For(` from the CTL (Control) menu. To complete the block of code to repeat select `End` from the CTL menu.

```
NORMAL FLOAT AUTO REAL RADIAN MP
CTL I/O COLOR EXEC HUB
1:If
2:Then
3:Else
4:For(
5:While
6:Repeat
7:End
8:Pause
9:Lbl
```

```
NORMAL FLOAT AUTO REAL RADIAN MP
CTL I/O COLOR EXEC HUB
1:If
2:Then
3:Else
4:For(
5:While
6:Repeat
7:End
8:Pause
9:Lbl
```

# SOUND OUTPUTS

**Task: Play a sound tone by entering a value for frequency (sound vibrations per second) and a value for time in seconds to play the tone.**

**Note: Human voices tend to be in the 85 to 255 Hertz (vibrations per second) range.**

**What is the lowest tone that you can hear?**

**What is the highest tone that you can hear?**

## New Program:

```
NORMAL FLOAT AUTO REAL RADIAN MP
EDIT MENU: [alpha][f5]

PROGRAM: SOUND
:Send("SET SOUND █
```

# Play a Sound Tone

Press **[prgm]** then **right arrow** to NEW. Select 1:Create New.

Enter the program name by pressing the keys associated with the green letter labels.

```
NORMAL FLOAT AUTO REAL RADIAN MP
TI-BASIC
EXEC EDIT NEW
1:Create New
```

```
NORMAL FLOAT AUTO REAL RADIAN MP
PROGRAM
Name=SOUND█
```

Paste the Set Sound command by pressing **[prgm]** then **right arrow** or **left arrow** to the Hub menu. Select 1:Send("SET...") then select 3:SOUND

```
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...
```

```
NORMAL FLOAT AUTO REAL RADIAN MP
Send("SET
1:LIGHT
2:COLOR
3:SOUND
4:LED
5:RGB
6:SPEAKER
7:POWER
8:SERVO, CONTINUOUS
9:ANALOG, OUT
```

```
NORMAL FLOAT AUTO REAL RADIAN MP
EDIT MENU: [alpha][f5]
PROGRAM: SOUND
:Send("SET SOUND █
```

Enter values for the sound frequency and the time to play the sound separated by a space (**[alpha]** [0]).

Close the quotes (**[2<sup>nd</sup>][+]**) and parentheses. Press **[enter]** to complete the statement.

Run your program by selecting the program edit menu **[alpha][graph]** f5. Then select 1:Execute Program

```
NORMAL FLOAT AUTO REAL RADIAN MP
EDIT MENU: [alpha][f5]
PROGRAM: SOUND
:Send("SET SOUND 440 1")
:█
```

```
NORMAL FLOAT AUTO REAL RADIAN MP
PROGRAM: SOUND
:Se█
1:Execute Program
2:Undo Clear
3:Insert Line Above
4:Cut Line
5:Copy Line
6:Paste Line Below
7:Insert Comment Above
8:Quit Editor [2nd][quit]
[FRAC][FUNC] [YVAR][MENU]
```

**Task:** Play a sound tone by entering a value for frequency (sound vibrations per second) and a value for time in seconds to play the tone.

**Find your favorite frequency.**

**Challenge Tasks:**

**Give your frequency a name and print the name.**

# Find your favorite sound tone, and give it a name.

Press **[prgm]** then **right arrow** to edit then select your program to edit from the menu.

The Disp command is available from the **[prgm]** I/O menu.

Put your message in quotes using **[alpha][+]**.

Enter alpha characters by pressing **[alpha]** then the letter key associated with the green labels."

## Add to previous Program:

```
NORMAL FLOAT AUTO REAL RADIAN MP
EDIT MENU: [alpha][f5]

PROGRAM: SOUND
:Send("SET SOUND 440 1")
:Disp "MY COOL SOUND"
:█
```

```
NORMAL FLOAT AUTO REAL RADIAN MP
TI-BASIC

EXEC EDIT NEW
1:BLINK
2:BLINK1
3:BLNKLOOP
4:RGBCOLOR
5: SOUND
```

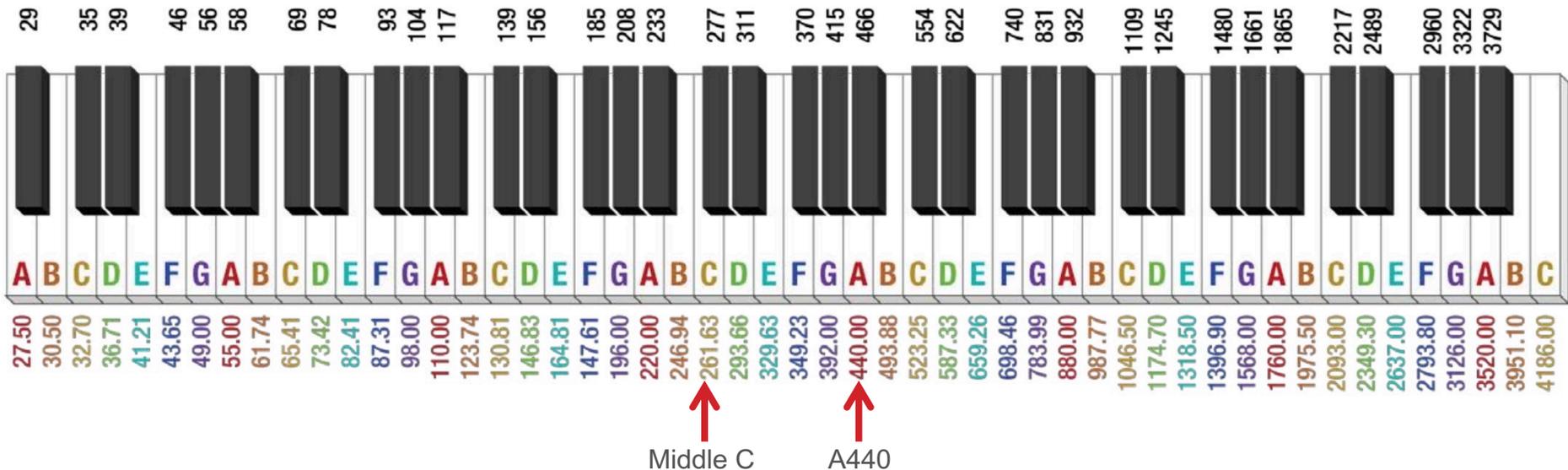
```
NORMAL FLOAT AUTO REAL RADIAN MP

CTL I/O COLOR EXEC HUB
1:Input
2:Prompt
3:Disp
4:DispGraph
5:DispTable
6:Output(
7:getKey
8:ClrHome
9:ClrTable
```

```
NORMAL FLOAT AUTO REAL RADIAN MP
EDIT MENU: [alpha][f5]

PROGRAM: SOUND
:Send("SET SOUND 440 1")
:Disp "MY COOL SOUND"
:█
```

# Sound Frequencies and Musical Notes



Sound tone frequencies map to musical notes.

Middle C (C4) on the piano keyboard has a frequency of 261.6 Hertz.

A440 (A4) is used by orchestras for tuning.

See Making Music with Code project for an in-depth treatment of digital music with the Hub. [https://resources.tistemprojects.com/tistemprojects-home/?resource\\_id=2403](https://resources.tistemprojects.com/tistemprojects-home/?resource_id=2403)

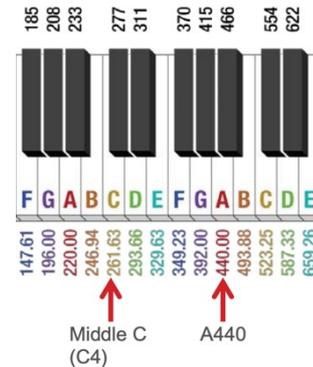
**Task: Enter and play doorbell tones using the Set Sound command and sound frequencies matched to piano notes.**

**Start with E4 followed by C4.**

**Create your own doorbell tone.**

## Play musical notes

Use the piano graphic to match musical notes to sound frequencies.



It is important to pause the program with a Wait command between sounds.

This allows the sound to play completely before the program starts the next sound. (Try playing multiple sounds without sleep() functions.)

If you want to have a short silence between sounds add an additional .1 seconds to the Wait command, Wait .5+.1 or insert an additional Wait command, Wait .1, between sounds.

Wait is on the [prgm] Hub menu.



**Note:** 5:Copy Line and 6:Paste to Line Below from the [alpha][graph] (f5) program edit tools menu may help you enter your program faster.

### New Program:

```

NORMAL FLOAT AUTO REAL RADIAN MP
EDIT MENU: [a.]Pha.] [f5]

PROGRAM:BELL
:Send("SET SOUND 329 .5")
:Wait .5+.1
:Send("SET SOUND 261 1")
:Wait 1+.1
:

```

**Task: Write a program to play each note of Do-Re-Mi-Fa-Sol-La-Si-Do as whole notes.**

**This is an entire octave.**

**At 100 Beats per Minute (BPM) a whole note lasts for 2.4 seconds. The first note Do is "c4" and the last note Do is "c5".**

**Include a .1 second rest between notes.**

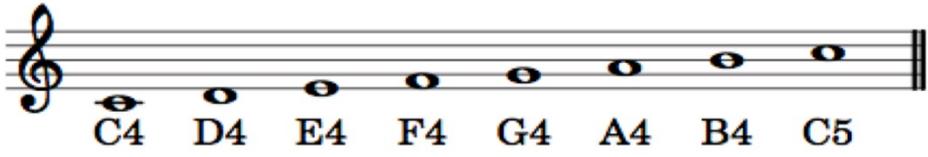
**New Program:**

```

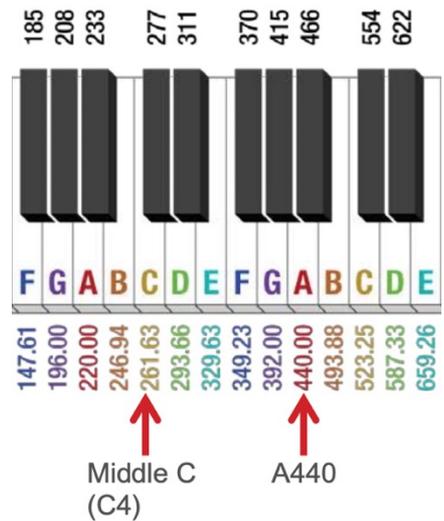
NORMAL FLOAT AUTO REAL RADIAN MP
EDIT MENU: [alpha][f5]
PROGRAM: OCTAVE
:Send("SET SOUND 261 2.4")

:Wait 2.4+.1
:
    
```

**Play the Notes of an Octave**



Use the piano graphic to match musical notes to sound frequencies.



Note: 5:Copy Line and 6:Paste to Line Below from the [alpha][graph] (f5) program edit tools menu may help you enter your program faster.

# **BRIGHTNESS (LIGHT LEVEL) INPUTS**

Task: Enter and run the program to measure brightness.

What is the light level in your room?

Try shining a light on the brightness sensor.

Try covering the brightness sensor.

## New Program:

```
NORMAL FLOAT AUTO REAL RADIAN MP
EDIT MENU: [a]pha [f5]

PROGRAM: BRIGHT
:For(N,1,20)
:Send("READ BRIGHTNESS ")
:Get(B)
:Disp "BRIGHTNESS LEVEL="
:Disp B
:Wait .25
:End
:█
```

# Measure Brightness Level

Brightness sensor



`For(N,1,10)` closed by an `End` command sets up a loop that will repeat the statements in a block of code.

**Note:** N is the loop counter variable. 1 is the first value for N and 10 is the last value for N.

Press `[prgm]`, then select `For` from the CTL (Control) menu. To complete the block of code to repeat select `End` from the CTL menu.

```
NORMAL FLOAT AUTO REAL RADIAN MP
CTL I/O COLOR EXEC HUB
1:If
2:Then
3:Else
4:For(
5:While
6:Repeat
7:End
8:Pause
9↓Lb1
```

```
NORMAL FLOAT AUTO REAL RADIAN MP
CTL I/O COLOR EXEC HUB
1:If
2:Then
3:Else
4:For(
5:While
6:Repeat
7:End
8:Pause
9↓Lb1
```

Use the `[prgm] Hub 2:Send(Read... menu` to paste the Read Brightness level command. Use the Get function from the Hub menu to store the reading into a variable, in this example, variable B.

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

```
NORMAL FLOAT AUTO REAL RADIAN MP
Send(READ
1:BRIGHTNESS
2:DHT
3:RANGER
4:LIGHTLEVEL
5:TEMPERATURE
6:MOISTURE
7:VERNIER
8:ANALOG_IN
```

```
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...
```

The `Disp` (Display) command is found on the `[prgm] I/O` menu.

# Control an RGB LED with Brightness Measurements



Brightness sensor

Insert a row at the top of the program by using the **[alpha][graph] (f5)** edit tools menu.

The RANGE command sets the set of values returned by a sensor. Without change, the BRIGHTNESS sensor returns values in the range 0-100. In this example, we will set the range to be 0-255 to match the values used to set the COLOR Red-Green-Blue LED. Send("RANGE is available from the bottom of the **[prgm] Hub** menu. Select 1:BRIGHTNESS from the RANGE menu.

```

NORMAL FLOAT AUTO REAL RADIAN MP
PROGRAM: BRIGHT
:For(1,Execute Program
:Sel2:Undo Clear
:Ge3:Insert Line Above
:Di4:Cut Line
:Di5:Copy Line
:Sel6:Paste Line Below
:0"17:Insert Comment Above
:Wa8:Quit Editor (2nd)(quit)
(FRAC)FUNC (YVAR)MENU
  
```

```

NORMAL FLOAT AUTO REAL RADIAN MP
CTL I/O COLOR EXEC HUB
9↑Send("CONNECT-Input...
0:Ports...
88Send("RANGE...
B:Send("AVERAGE...
C:Send("DISCONNECT-Output...
D:Send("DISCONNECT-Input...
E:Manage...
F:Send("COLLECT...
G:Send("READ LIST...
  
```

```

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
  
```

Insert a row in your program above the Wait command to add a SET COLOR command. Send("SET COLOR is available from the **[prgm] Hub** 1:Send("SET menu.

Use the eval() function from the **[prgm] Hub** menu to include a variable (or expression) as values for Red, Green and Blue in the SET COLOR command.

```

NORMAL FLOAT AUTO REAL RADIAN MP
CTL I/O COLOR EXEC HUB
18Send("SET...
2:Send("READ...
3:Settings...
4:Wait
5:Get(
6:eval(
7:Rover (RV)...
8:Send("CONNECT-Output...
9↓Send("CONNECT-Input...
  
```

```

NORMAL FLOAT AUTO REAL RADIAN MP
Send("SET
28COLOR
3:SOUND
4:LED
5:RGB
6:SPEAKER
7:POWER
8:SERVO,CONTINUOUS
9↓ANALOG.OUT
  
```

```

NORMAL FLOAT AUTO REAL RADIAN MP
CTL I/O COLOR EXEC HUB
1:Send("SET...
2:Send("READ...
3:Settings...
4:Wait
5:Get(
68eval(
7:Rover (RV)...
8:Send("CONNECT-Output...
9↓Send("CONNECT-Input...
  
```

**Task:** Add Send("RANGE BRIGHTNESS 0 255") to the program to set brightness measurements to 0 to 255 instead of 0 to 100.

Use the brightness values stored in variable B as inputs for some or all of the Send("SET COLOR inputs: Red Green Blue. Use the eval() function to convert the variable value to a form that SET COLOR can use.

Try shining a light onto the Brightness sensor.

## Challenge Task:

Try Send("SET COLOR eval(B-255) 0 0"). How does the behavior change?

## Add to previous Program:

```

NORMAL FLOAT AUTO REAL RADIAN MP
EDIT MENU: [a]Pha] [f5]
PROGRAM: BRIGHT
:Send("RANGE BRIGHTNESS 0
255")
:For(N,1,20)
:Send("READ BRIGHTNESS ")
:Get(B)
:Disp "BRIGHTNESS LEVEL="
:Disp B
:Send("SET COLOR eval(B) 0
0")
:Wait .25
:End
  
```

# Thank You



[www.TIstemProjects.com](http://www.TIstemProjects.com)

Contact [stem-team@ti.com](mailto:stem-team@ti.com) with questions