
# Maker Advent Calendar Day #2: Let's Get Blinky!

By The Pi Hut • Dec 1, 2022 • 32 comments

Welcome to day two of your 12 Projects of Codemas Advent Calendar. Today we'll be playing with one of the most popular components for makers - LEDs!

**LEDs** (**L**ight **E**mitting **D**iodes) are a staple component for makers of all experience levels, handy for indication, feedback or just for a fun bit of *blinky*!

LEDs come in all sorts of shapes, sizes and ratings, and are everywhere in our daily lives – in your PC, your home, car dashboard, vending machines, spaceships and more.

Let's go ho ho!

# Box #2 Contents

In this box you will find:

- **1x** 5mm Red LED **(with a clear lens)**
- **1x** 5mm Amber LED **(with a clear lens)**
- **1x** 5mm Green LED **(with a clear lens)**
- **3x** 330 ohm resistors
- **4x** Male to male jumper wires


# Today's Projects

Today we'll be programming LEDs to light up, flash and display sequences, building on yesterday's code using GPIO pins to control them.

We'll also be learning some new functions in MicroPython to introduce some new elements to your code. The box includes three different colours to allow us to have some fun making light patterns.

## What is an LED?

An **LED** is a **L**ight **E**mitting **D**iode. These components emit light when electrical current flows through them.

Our LEDs have two legs, one longer than the other, as they have a specific **polarity** - which means that electrical current can only flow in one direction (and if not, the LEDs can be damaged!).

The long leg is the **Anode (+)** and the short leg is the **Cathode (-)**. Current must always flow from the anode to the cathode, so be sure to read our wiring instructions below carefully to make sure you get this bit right.

### Resistors

LEDs usually require a **current-limiting resistor** when using them with a microcontroller.

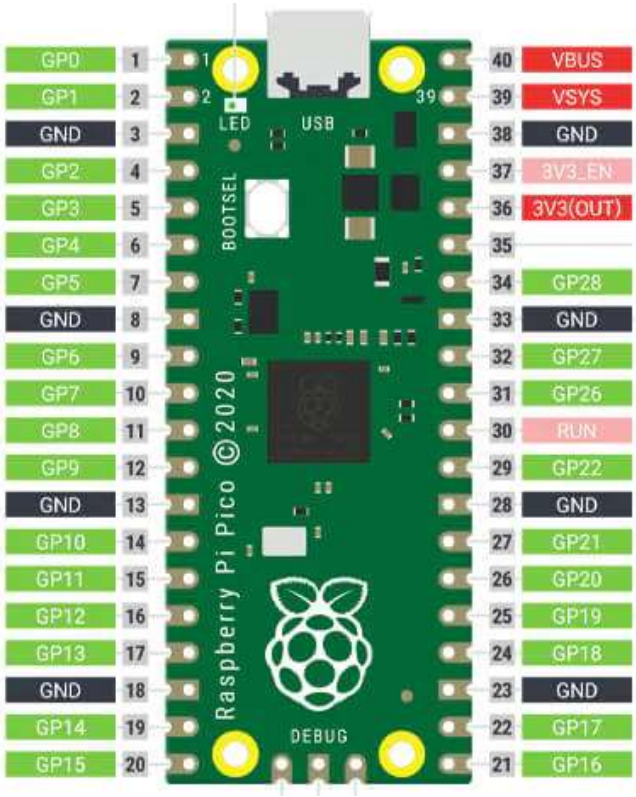
**Resistors** limit the amount of current that can pass through a circuit, which helps avoid the LED trying to pull more current than our Pico's GPIO pins can safely provide, and equally protects the LED from too much current.

**It doesn't matter which side of the LED the resistor sits**, as long as it's there limiting the flow of current for the entire circuit (*take a look at the comment section for an example*).

## Raspberry Pi Pico Pin Map

Here's a ***simplified*** map of the pins on the Pico (known as a '*pinout*') to help you with the next steps and the rest of the calendar.

The numbers in the grey squares are the ***physical*** pin numbers which are numbered in order around the board. The ***GPIO*** pin numbers which we use in our code are in green. You can also download the **full** PDF version here.




# Construct the Circuit

First, **make sure your Pico is disconnected from the USB cable.** You should always do this when amending a circuit. Then grab the set of jumper wires, resistors and LEDs.

## Breadboards

We're going to be adding components to our **breadboard**. Breadboards allow you to connect and prototype a circuit without soldering, using wires with pins at the end called **jumper wires** (*sometimes called DuPont wires*).

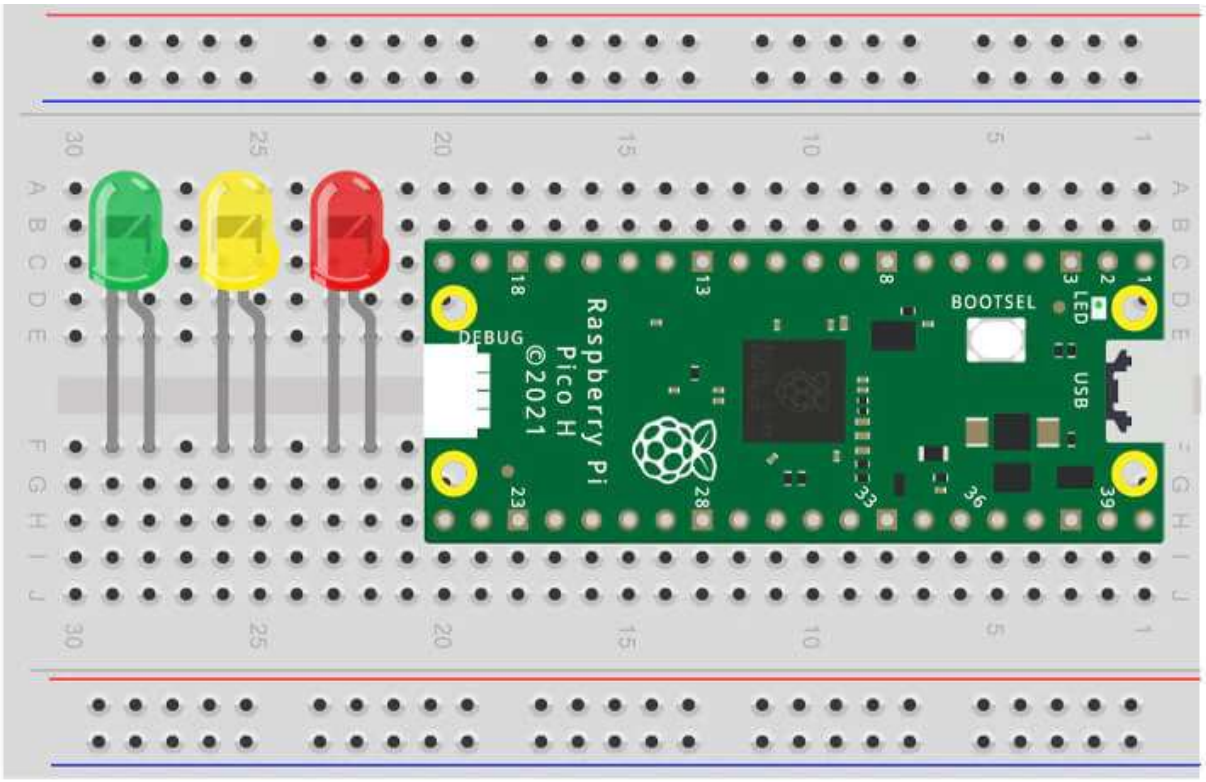
These breadboards have two sets of **horizontal** channels (red/blue) on both sides. All the red pins are connected, as are the blue (but each side is disconnected from the other). We use these to create 'rails' of connections for us to use, such as Ground (GND) for the blue channel and 3.3V for the red.

The holes in the middle are connected in **vertical** lanes, with each lane having 5 connected pins either side of the divider. The divider stops both sides connecting together.

## The Circuit

Place the three LEDs into the lower section of the breadboard, 1 hole apart, with the **longest leg to the right** as seen in the image below.

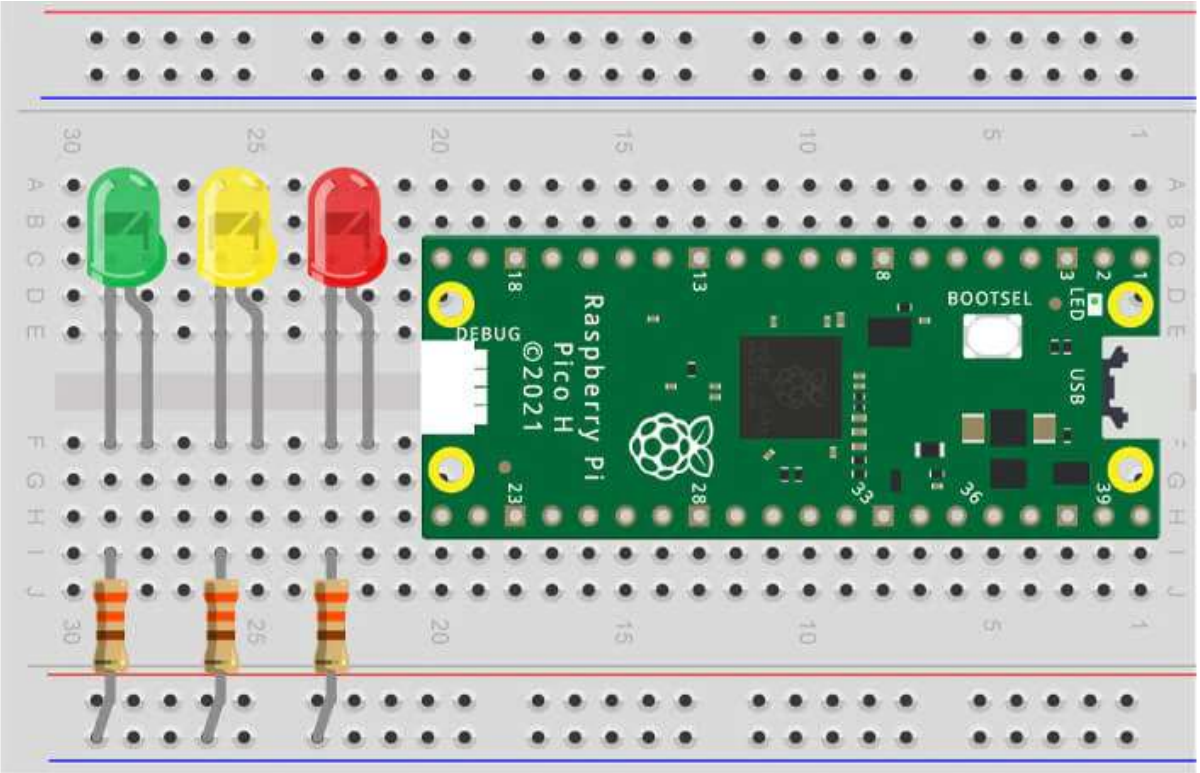
**You won't know which colour is which yet as these LEDs have clear lenses**, but that doesn't matter and we'll come back that in a moment. Your breadboard should look like this:




***Tip**: The short leg is the Cathode (-) and the long leg is the Anode (+).*

We now need to add a resistor to limit the current that the LED can draw from our GPIO pins.

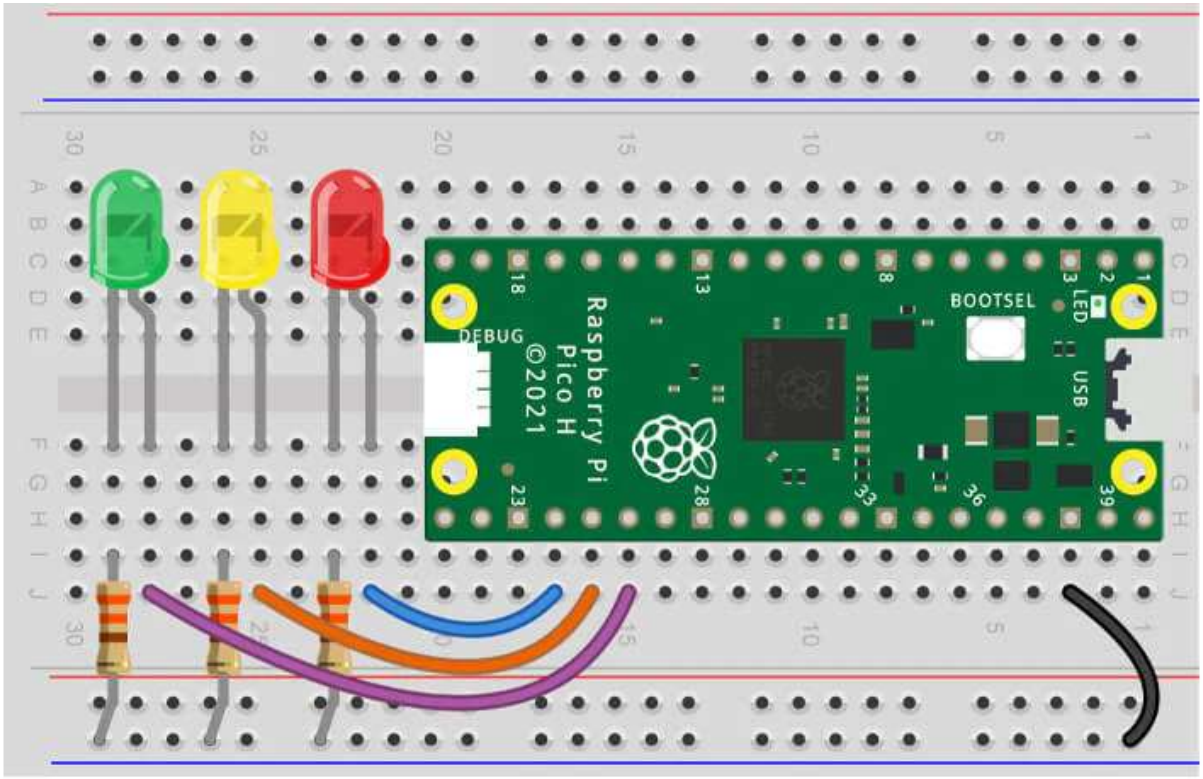
Place a resistor between the **left leg** of each LED and the lower blue channel, like below. We'll be connecting that blue channel to a Ground (-) pin shortly.




Now grab the jumper wires. You need one wire connecting the blue channel to a Ground pin on your Pico – we suggest using ***physical pin 38*** like we've done in the diagram below *(remember to refer to the Pico pinout if you need a reminder)*.

You also need to connect the **right leg** of each LED leg to a GPIO pin. Use **GPIO18 (physical pin 24)** for Red, **GPIO19 (physical pin 25)** for Amber, and **GPIO20 (physical pin 26)** for Green, like the diagram below.

***Tip**: It doesn't matter what colour jumper wires you use, they all work the same way. In an ideal world we would reserve black for ground connections and red for voltage, but for simple projects it's not essential.*




Everything's hooked up – let's code some blinky!

# Activity 1: Light each LED

A simple exercise first, using some of the code we learnt yesterday. We're going to light each LED, wait 5 seconds, then turn them off. To do this we need to introduce a new module to you: ***time***.

***Note**: assuming you turned off your computer after yesterday's box, you may need to jump back into Thonny and select **Run > Configure interpreter** again to tell it which device we're playing with.*

## The Time Module

The ***time*** module allows you to program delays in your code, making it wait for seconds or fractions of seconds before continuing. It's another fundamental module you'll use in most of your projects.

## The Code

Our code imports ***pin*** again, and also imports ***time***. We then define the pin number for each colour of LED (giving them a sensible name for each) and set them to ***outputs***.

After that it's a simple case of setting each LED pin ***HIGH***, waiting for 5 seconds using ***time.sleep(5)***, then setting them all ***LOW*** again.

Here's the code to copy into Thonny and then run in the usual way by hitting the green button. Once you've lit each LED and know which colour is which, unplug your USB cable and rearrange them to get the in the right order of green/amber/red:

```
from machine import Pin
import time

red = Pin(18, Pin.OUT)
amber = Pin(19, Pin.OUT)
green = Pin(20, Pin.OUT)

red.value(1)
amber.value(1)
green.value(1)

time.sleep(5)

red.value(0)
amber.value(0)
green.value(0)
```

# Activity 2: Flashing LEDs

Let's make things a little more interesting by making our LEDs flash!

To do this, we need to introduce ***while loops*** into our code. *Technically* you could just repeat the ON/OFF code above, but that would make your code very long indeed and would eventually end, so let's look at a better way (*but perhaps not the best way...we'll show you another way in a future box once we've got the hang of MicroPython*).

We also need to introduce ***variables***, ***indentation*** and ***code commentary***...

## While Loops

***While loops*** are used to repeat a block of code as long as the ***condition*** remains true.

Imagine you're bouncing a ball whilst your friend counts how many bounces you've completed. Your condition might be "*bounce the ball until you count five bounces*". After five bounces, you would stop.

We can tell a while loop to run a block of code until a count or certain condition is met, or we can just make it repeat forever by using '***while True***' which is useful for projects intended to keep running.

So, we're now going to make our LEDs flash 10 times then stop, and we'll show you how in just a moment.

## Code Commentary

We're also going to start adding **commentary** in our code examples.

You can add comments in MicroPython code by adding a **#** before the comment. This will be ignored by MicroPython.

Adding commentary makes explaining your code easier to others or even as a reminder to yourself when you return to a project a number of weeks or months later. It's a very good habit to get in to and allows us to explain each line clearly:

```
# Imports
from machine import Pin
import time

#Set up our LED names and GPIO pin numbers
red = Pin(18, Pin.OUT)
amber = Pin(19, Pin.OUT)
green = Pin(20, Pin.OUT)

counter = 1 # Set the counter to start at 1

while counter < 11: # While count is less than 11...

    print(counter) # Print the current counter

    # LEDs all on
    red.value(1)
```

## Variables

A ***variable*** is just somewhere to store a value (a '*container*'), which we can also update when we want to. When we need to use the variable in a line of code, we just use its name.

In our example below our variable is called ***counter***. We create this before the ***while loop*** and set an initial value of ***1***.

In programming, a variable can be a whole number (an '***integer***'), a number with a decimal place (a '***floating-point value***' or '***float***') or a word/text (a '***string***').

## Indentation

Our ***while loop*** says "***If the counter is less than 11, run the the code indented below***".

***Indentation*** is a gap at the front of a line of code, usually a tab space or a number of spaces. It's very important in MicroPython as it tells Thonny that the lines belong to a particular block of code (in our example below, we've indented the lines under the while loop as the code belongs to that loop).

## The Code

The code below first imports the things we need as always, sets our pin numbers as we've done before, then creates a ***variable*** called '***counter***' which we'll use to count how many times we've run the block of code.

We start a while loop using ***while counter < 11:*** which is saying "***while the counter variable is less than 11...***".

Our code prints the counter to help us see the value changing in Thonny, then simply turns all the LEDs off then on again, with half-second pauses in-between. Without the pauses, it would be so fast we wouldn't see the flashes!

At the end of the block we add ***+1*** to our counter, then it starts the loop again. As soon as that counter variable reaches 11, the loop stops running and the program ends.

Copy this code over to Thonny and run it in the usual way using the green button:

```
# Imports
from machine import Pin
import time

#Set up our LED names and GPIO pin numbers
red = Pin(18, Pin.OUT)
amber = Pin(19, Pin.OUT)
green = Pin(20, Pin.OUT)
```

```
counter = 1 # Set the counter to start at 1

while counter < 11: # While count is less than 11...

    print(counter) # Print the current counter

    # LEDs all on
    red.value(1)
    amber.value(1)
    green.value(1)

    time.sleep(0.5) # Wait half a second

    # LEDs all off
    red.value(0)
    amber.value(0)
    green.value(0)

    time.sleep(0.5) # Wait half a second

    counter += 1 # Add 1 to our counter
```

Try changing both of the ***time.sleep*** values to different numbers and see what happens. It should change the speed of the flashing LEDs.

You can also change the while loop to run forever. Swap the line out with the line below to give that a try - the counter will still continue to increase and print but won't change what the code does:

```
while True:
```

# Activity 3: LED Sequence

We're now going to make our LEDs flash one after the other in a sequence – yes, like a festive decoration!

Whilst there are more advanced ways of achieving this (*using **lists** for example which we'll cover in a future box*), we're going to keep things simple whilst we continue to learn MicroPython.

The program for this is very similar, however we change the LED control section to turn each LED on one by one, turning off the others as we go.

Try the code below, paying attention to the OFF/ON comments next to each LED control line:

```
# Imports
from machine import Pin
import time

#Set up our LED names and GPIO pin numbers
red = Pin(18, Pin.OUT)
amber = Pin(19, Pin.OUT)
green = Pin(20, Pin.OUT)

counter = 1 # Set the counter to 1

while counter < 11: # While count is less than 11

    print(counter) # Print the current counter

    # Red ON
    red.value(1) # ON
    amber.value(0) # OFF
    green.value(0) # OFF

    time.sleep(0.5) # Wait half a second

    # Amber ON
    red.value(0) # OFF
    amber.value(1) # ON
    green.value(0) # OFF

    time.sleep(0.5) # Wait half a second

    # Green ON
    red.value(0) # OFF
    amber.value(0) # OFF
    green.value(1) # ON

    time.sleep(0.5) # Wait half a second
```

```
    counter += 1 # Add 1 to our counter
```

# Day #2 Complete!

Another great day of learning how to code with the Raspberry Pi Pico and MicroPython! Today you have:

- Created your first circuit!
- Learnt how to use the time module to add delays to programs
- Learnt how to use while loops and conditions
- Learnt about variables (*our counter*)
- Learnt about code commentary
- Created a dashing, flashing sequence of LEDs

**Please do not disassemble the circuit** as we're going to be using it again with the contents in the next box...see you all tomorrow!

---

*We used Fritzing to create the breadboard wiring diagram images for this page.*



## 32 comments

**LED**

December 15, 2022 at 11:50 am

Cool code

```
from machine import Pin

import time

red_ongus = Pin(18, Pin.OUT)

amber_bugus = Pin(19, Pin.OUT)

green_among = Pin(20, Pin.OUT)
```

```
loop code

counter1 = 0

while counter1 < 5:
counter = 1 while counter < 5: red_ongus.value(1) amber_bugus.value(0)
green_among.value(0) print(counter) time.sleep(0.5) red_ongus.value(0)
amber_bugus.value(1) green_among.value(0) print(counter) time.sleep(0.5)
red_ongus.value(0) amber_bugus.value(0) green_among.value(1) print(counter)
time.sleep(0.5) counter=counter+1 counter=0 while counter < 5:
red_ongus.value(1) amber_bugus.value(1) green_among.value(1) time.sleep(0.5)
red_ongus.value(0) amber_bugus.value(0) green_among.value(0) time.sleep(0.5)
counter=counter+1 counter1+=1
```

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**The Pi Hut**

December 12, 2022 at 10:45 am

@Matthew Hmm that's a new one. We've had a look around online but most of the reports of that error are when users are using the WebREPL. My first instinct (considering the lack of obvious causes from search results) would be to uninstall and re-install Thonny again, then perhaps try an alternative machine if you have access to one (just to rule out any kind of hardware error on the Pico or USB cable).

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**Matthew**

December 12, 2022 at 10:41 am

Hi ,
I keep getting the error message below despite hard reset. Day# 3 .Any idea as to the cause?

>>> %Run -c $EDITOR_CONTENT
PROBLEM IN THONNY'S BACK-END: Exception while handling 'Run' (ConnectionError: EOF).
See Thonny's backend.log for more info.
You may need to press "Stop/Restart" or hard-reset your MicroPython device and try again

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**AndrewC**

December 9, 2022 at 4:04 pm

My advent calendar arrived and I have a big smile on my face. I am a teacher and used many different microcontrollers in the past. I am finally learning about the 2040! Great instructions so far.

@thepihut – having a sideview photo of the 2040 seated on a breadboard would help beginners know how it should be seated. Lots of folks new to ucontrollers are timid about pushing down hard on a new setup to open up the breadboard clips.

To those with cables a bit too tight, you will appreciate the snugness later when they start to loosen up and connections don't work properly. Just keep wiggling for now!

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To those with cables a bit too tight, you will appreciate the snugness later when they start to loosen up and connections don't work properly. Just keep wiggling for now!

**The Pi Hut**

December 9, 2022 at 12:53 am

@Simon – Yes our Picos are the same. Given the choice, we prefer a tight fit as we tend to leave that end plugged in and just move the USB-A side between computers (plus it means a solid connection so one less place to look when a project isn't behaving). It should get a little looser over time.

@Simon – Yes our Picos are the same. Given the choice, we prefer a tight fit as we tend to leave that end plugged in and just move the USB-A side between computers (plus it means a solid connection so one less place to look when a project isn't behaving). It should get a little looser over time.

**The Pi Hut**

December 9, 2022 at 12:32 am

@Joe – Have you pushed the Pico fully into the breadboard so that you can't see any of the metal legs? The black plastic section should sit flush with the top of the breadboard. Breadboards aren't ever perfect (we find they sometimes need a wiggle here and there) but usually the metal internals settle into place after a few uses.

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**Joe Edwards**

December 9, 2022 at 12:29 am

The connectors to the breadboard are giving trouble. I can connect to GPIO18 but 19 and 20 are giving lots of trouble. I used 12 and 13 instead and this works but the patch cables don't seem to connect properly. Also the weight of the USB cable means that it pulls the PICO out of the board if you move it so I currently have it fixed with two rubber bands. I like the tutorial but the hardware be a real pain to a child or a beginner without my 78 years of experience. I may comment later on PYTHON but so far (day 3) the code is simple and clear.

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**Simon**

December 9, 2022 at 12:49 am

Is it normal for the PICO's USB port to be such a tight fit for the cable? I mean it is a really tight fit and takes a lot of wiggling to get the cable in and out :(

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**The Pi Hut**

December 4, 2022 at 10:50 pm

@Tom – Sorry about this, looks like a packing error. If you can fire over a quick message to support.thepihut.com, Billie will get a replacement pack sent out to you ASAP. Sorry for the inconvenience :(

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**Tom LC**

December 4, 2022 at 10:48 pm

Hi

My day 2 box seems to be missing the LEDs and resistors.

Tom

Hi

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Tom

**The Pi Hut**

December 4, 2022 at 1:25 pm

@Ben Thanks for your comment, and we agree! We're purposely being excessive with the code comments to ensure there's no confusion about what each line does to those who are very new to this. This came up in our testing, where one of our less-experienced testers mentioned that they preferred to run the code and read the comments first, rather than reading the descriptions – just their preferred learning style. We hope this approach caters for everyone. Thanks again.

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**Ben**

December 4, 2022 at 1:21 pm

Really enjoying playing with electronics — takes me back to when I studied GCSE electronics in school!

I'm not sure about the section on "code commentary" — it feels like the comments are simply repeating what the code says (e.g. "counter = 1 # Set the counter to start at 1"). In my opinion this is bad practice — if the code can explain itself (and Micro Python makes this quite easy) then it should — otherwise the code and the comments can disagree. See also thoughts from "Uncle Bob" on comments: either in video form (https://www.youtube.com/watch?v=2a_ytyt9sf8&t=296s) or within his book, "Clean Code".

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**Andy Lakin-Hall**

December 4, 2022 at 1:21 pm

I'm working through the projects and did box 2 today. My 18yo disappeared for half an hour with it and proudly came back with a text to morse code converter. "I did this project in computer science last year, but I was able to use the code 'cos it's Python and it's better with the lights."
My plan to get him interested in digital control is working! Thanks PiHut.

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**Si**

December 4, 2022 at 1:29 pm

Brilliant stuff – a big kid here (35 and first time coding!) and absolutely loving it. Great instructions and easy to follow. Even tweaked the final program to turn off all LEDS at the end… simple things please simple minds but definitely teaching a (slightly) old dog new tricks! Here's to tomorrow :)

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**Fran**

December 4, 2022 at 1:29 pm

Running a couple of days behind, fun little distraction, I have updated your code a little to turn it into a UK traffic light, even threw in the random module to make it a little more unpredictable

https://github.com/frantek/PiHut-Advent/blob/master/Day%202/led_traffic.py

Hopefully that will give people some more ideas

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**The Pi Hut**

December 3, 2022 at 9:58 pm

@Gerald Dachs Oh dear :( sorry about that. If you can send us a quick message via support.thepihut.com, Billie will get a replacement pack sent out to you ASAP. Don't worry, you will still be able to complete the upcoming boxes and activities whilst we get the right colour LEDs out to you.

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**The Pi Hut**

December 3, 2022 at 9:31 pm

@Eric Glad your daughter is enjoying it :) We're using variables for the time delay in one of the next boxes (where we use a time delay in multiple lines to make updates quicker/easier). The aim is to gradually increase the complexity and number of 'things going on' as we progress through each day :)

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**Eric**

December 3, 2022 at 9:28 pm

Hi,
Great exercise, my daughter liked it a lot!
I would suggest to define another variable for the sleep time (wait = 1 for example) in the time.sleep(wait) command, indeed it's funny for children to discover the impact of the wait time modification!

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**Paul**

December 3, 2022 at 9:27 pm

I'm not new to coding or circuits, so I created a traffic light sequence, and learned about Tuples in the process! These projects offer challenge to everyone including people with previous experience – it's just brilliant!

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**Ryan**

December 3, 2022 at 8:52 am

Enjoying the advent so far, i have played around before with some raspberry pi stuff but havent done any coding in a while. The advent is a really good way to get back into it, the instructions are simple and easy to follow. Excited to see where the next few days go.

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**Giles Knap**

December 3, 2022 at 8:52 am

Best advent calendar ever. It has had the desired effect of getting my 10 year old interested in electronics and programming.

For today I've done a binary counter using the 4 available LEDs https://github.com/gilesknap/pico-xmas#day-2-project.

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**stephen**

December 3, 2022 at 8:52 am

Love it so far, great job.
added amber on at the top so it goes forwards and backwards.
Like being a kid with a new toy.

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**Richie**

December 2, 2022 at 6:53 pm

@The Pi Hut Thanks for the answer, it makes complete sense and if i'd thought about it a bit more i'd like to think i'd have come to that conclusion. thanks again

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**The Pi Hut**

December 2, 2022 at 6:07 pm

@Richie @Jay Thanks for the comments. So the resistor restricts the amount of current that can flow through your circuit, but it doesn't matter what side of the circuit it sits on – it reduces the flow of current for the entire circuit like a bottleneck.

We always like to think of current as water in a pipe. If you had a wide pipe passing water from one end to the other, but a narrow section of pipe in the middle (our resistor), the narrow section is then the bottleneck that determines how much water the entire pipe system can pass through (flow).

Hopefully that helps, but you'll find lots of other examples describing this online if that didn't quite hit the spot :)

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Hopefully that helps, but you'll find lots of other examples describing this online if that didn't quite hit the spot :)

**jay**

December 2, 2022 at 6:00 pm

I'm having so much fun already!

I was wondering why the resistors are placed on the cathode side of each LED, when your preamble says that current should always flow from anode to cathode

and that one of the purposes of the resistors is to protect the LEDs.

(I ended up getting a pretty good answer on stackexchange after doing a search on that question, but wondered if you could clarify here in case it also confuses anyone else)

Thanks and looking forward to day 3!

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Thanks and looking forward to day 3!

**Richie**

December 2, 2022 at 6:00 pm

I have to ask, why are you connecting the resistors to the ground side of the LED's? I have always connected them them in the following order… GPIO pin —> Resistor —> LED —> GND. Does it matter the order they are connected or have I been doing it wrong the last however many months? Thanks

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**T**

December 2, 2022 at 2:40 pm

loving it so far :)

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**The Pi Hut**

December 2, 2022 at 2:40 pm

@Steve K – Thanks Steve, really glad you're enjoying it so far. We're keeping the code simple to start with to not overwhelm newer coders, so some of the early examples won't include some of the 'nice to have' elements, but we'll be adding things like that in the upcoming days.

@Steve K – Thanks Steve, really glad you're enjoying it so far. We're keeping the code simple to start with to not overwhelm newer coders, so some of the early examples won't include some of the 'nice to have' elements, but we'll be adding things like that in the upcoming days.

**SteveK**

December 2, 2022 at 2:33 pm

Thank you PiHut. Great project and clear instructions.

Activity 3 leaves the green LED on when the program ends. You could ask the participant to consider how to stop this without unplugging the Pico. A hint button could reveal "Add the following line to the end of the program level with the while statement:"
green.value(0) # turn off before program ends

And then add a sentence to the end of activity 3 that is good idea (best practice) to reset everything before the program ends.

Looking forward to tomorrow's activity!

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Looking forward to tomorrow's activity!

**The Pi Hut**

December 2, 2022 at 1:11 pm

@Mar – feel free to ping us a message via our support portal (support.thepihut.com) at any time if you're having trouble. One of the team will be able to help :)

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**Mar**

December 2, 2022 at 1:09 pm

Hello, where can we reach out if we're stuck?

Hello, where can we reach out if we're stuck?

**Gerald Dachs**

December 3, 2022 at 9:54 pm

no red LED :(. 2 green instead.

no red LED :(. 2 green instead.

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