## Getting started with MicroPython and CBUS

There are many ways to get started, depending on your existing programming skills and what you hope to achieve.

For beginners – and even experienced programmer who are new to Python – I would suggest you first get comfortable with the Python language itself, its structure and syntax. You can do this using the ‘big’ Python interpreter that is almost certainly already installed on your PC. If it isn’t, you can download it from <https://www.python.org/downloads/>. Make sure you get version 3 as version 2 is now deprecated.

The next step is to get yourself a Pico (or another supported board) and follow one of the many tutorials on how to get started with it. This will almost certainly involve downloading a simple IDE called Thonny and using this to install MicroPython on your Pico. Then get comfortable with this environment, editing programs, uploading them to the Pico and running them.

Once you’re ready to experiment with CBUS, simply download the .py files (and all sub-folders) from my GitHub repo (see links below) and upload them to your Pico. Upload everything even if you don’t have a need to use them all just yet. There’s plenty of storage space and they don’t consume memory until explicitly imported into a program

Depending on your CAN bus hardware and its pin configuration, you may need to edit a few lines. If you are using one of my CBUS shield designs, the example code’s defaults are already correct, and no changes are required. Otherwise, you may need to change the SPI bus pins connected to the MCP2515, and the pins for the CBUS switch and LEDs, if fitted.

I recommend you start with the file module\_example\_configurable.py.

You can also change the module’s configuration setting, including its name, module ID, and numbers of events, event variables (EVs) and node variables (NVs). Do this before setting FLiM mode as changing things later will require a reset of the config.

Upload the edited program to your Pico.

Then, just type at the >>> prompt:

>>> import module\_example\_configurable

Or whatever you have renamed it to.

After a few seconds, the program will load and run, and you will be presented with a new prompt. If you don’t see “mcp2515 device is present” then double-check your pin numbers.

At this point CBUS message processing is running ‘in the background’ but you can type Python code and commands at the interactive --> (REPL) prompt, e.g.

--> 2+2

4

--> print('hello world!')

hello world!

If you misspent your teenage Saturday mornings in the local Curry’s typing infinitely looping programs into all their microcomputers, the equivalent today is:

--> while True: print(‘hello’)

(You will probably need to power cycle the board to get out of that!)

The --> prompt is provided by a ‘mini’ REPL within the application. If you inadvertently start a long running command, you can use control-C to interrupt it.

To stop the application and return to the main >>> prompt, just type control-D at the --> prompt. Further presses of control-D will reset the board and return it to a known state. You will also need to return to the >>> prompt before uploading files as the mini-REPL doesn’t have this capability.

I’ll presume you are familiar with the basic concepts of CBUS and have a copy of the CBUS Developers’ Guide to hand.

If your module is connected to a CBUS along with other CBUS modules, just send a message or event from one of them, or from FCU or JMRI. This will be displayed, as if out of nowhere, because CBUS processing is happening in a concurrent task running ‘in the background’, e.g.

199175299 -- received message handler: [5ff] [5] [ 90 00 16 00 32 ]

The number at the beginning of the line is the number of milliseconds that have elapsed since the board was powered on and is useful for timing and performance testing.

You can now send a CBUS event, by creating a message object and then sending it, e.g., to send an ‘on’ event with node number 22 and event number 24:

--> import canmessage

-->

--> evt = canmessage.cbusevent(mod.cbus, 1, 22, 24)

-->

--> evt.send()

199379683 -- sent message handler: [585] [5] [ 90 00 16 00 18 ]

-->

The library code updates the message’s CAN ID field, including the default message priority, and calculates the correct CBUS opcode for you, depending on whether it’s a short or long event, and whether there are additional data bytes.

At this point, with everything working well, you can set your device into FLiM mode and introduce it to FCU (or JMRI). The time-honoured way is to hold down the CBUS switch for 6+ seconds until the yellow LED flashes and then release it. But, as we have a handy command line, we can instead just type:

--> mod.cbus.init\_flim()

Then, provide FCU with the desired node number for your module, and you’ll see the exchange of CBUS messages fly by as FCU interrogates the module.

Once you have completed development, you can get the Pico to execute your application code automatically at power on. To do this, create and upload a file named main.py with the single line: import my\_module, or whatever you have named your program. However, it’s best not to do this until you are certain your program can be interrupted from the command line. If you do ‘brick’ your Pico, there are ways to ‘nuke’ it and start over afresh. (Just do a Google search with these two magic words).

(Note: you’ll have noticed that it takes a few seconds for the Python code to load, compile and run. This may or may not have an impact on your layout’s start-of-day processing. It’s still significantly faster than a PC or Pi).

# A word about CBUS events

CBUS events are a specific kind of CBUS message. All events are messages but not all messages are events ☺. In our code, a cbusevent object is a sub-class of the canmessage class.

There are a number of ways to represent CBUS messages as Python variables. In order to send a CBUS message (or event) we need to create a full object of the class canmessage. e.g.,

--> import canmessage

--> import cbusdefs

# as a generic CBUS message

--> msg = canmessage.canmessage(0, 5, (cbusdefs.OPC\_ACON, 0, 22, 0, 23))

--> mod.cbus.send\_cbus\_message(msg)

# as a CBUS event

--> evt = canmessage.cbusevent(mod.cbus, 1, 22, 23)

--> evt.send()

However, these are fairly heavyweight objects, and we’d like to conserve memory wherever possible.

The shortest description of a CBUS event is (i) its polarity (on, off or neither), (ii) its node number and (iii) its event number, because the rest can be filled in by the library code when we come to send it. This can be represented by a Python tuple, which is a simple, read-only list type. For example, the same event could be written as (1, 22, 23). As and when we need to send this event, we can construct a full cbusevent object from it, e.g.,

--> t = (1, 22, 23)

--> evt = canmessage.event\_from\_tuple(mod.cbus, t)

# or even

--> evt = canmessage.event\_from\_tuple(mod.cbus, (1, 22, 23))

--> evt.send()

We can even create an event without a fixed polarity (polarity = -1) and then use its send\_on() or send\_off() methods. This saves having to carry around two tuples to represent the same event in two different states.

--> evt = canmessage.event\_from\_tuple(mod.cbus, (-1, 22, 23))

--> evt.send\_on()

You’ll see this approach used throughout the CBUS library code. Some methods take multiple events as arguments, represented by nested ‘tuples of tuples’, e.g.

((0,22,23),(1,22,23)) or even ((0,22,23),(0,22,24),(0,22,25)), etc.

# Adding functionality to your module

Module functionality can generally be divided into two parts:

1. Consumer modules receive CBUS events and act upon them
2. Producer modules react to events in the outside world and send CBUS events
3. Combi modules do both (that’s three parts)

There are a couple of ways for a consumer module to capture received events and act upon them. Similar to the approach used in my Arduino libraries, you can use the module object’s received\_message\_handler() and event\_handler() methods. The former receives all messages (by default), the latter only previously taught events.

Default implementations are provided by the base cbusmodule class (in cbusmodule.py) but you can override these and provide alternative implementations in your application class. (You can also override the default sent\_message\_handler() method if you don’t like the default behaviour). For example, you might write an event handler like:

def event\_handler(self, msg, idx: int) -> None:  
 self.logger.log(f'-- event handler: idx = {idx}: {msg}')  
 ev1 = self.cbus.config.read\_event\_ev(idx, 1)  
 self.logger.log(f'first EV = {ev1}')

(NB: don’t edit the library code. That’s not the object-oriented way of doing things and your changes will be overwritten by any library updates. Implement the same method in your own application class and it will override the default implementation inherited from the base class).

A more advanced approach is to create separate concurrent tasks which use a pubsub or history object to wait for specific messages of interest and act upon them. This approach is useful if your event handler method would get unmanageably messy and long-winded, and you’d like to separate things into smaller chunks of code. The example program module\_asyncio.py shows examples of each.

What a producer module does is of course specific to that module’s purpose. In this simple example, we imagine a few switches connected the Pico’s pins which it reads and then sends events based on their changed state. You can create code to do this in the module class’s module\_main\_loop\_coro() method. This is analogous to the loop() function in an Arduino sketch, except that it must yield to the scheduler each time around the loop, to allow other tasks some time to run. The example code does this by having it sleep for a few milliseconds.

For instance, you could update the example program, as follows:

*# \*\*\* user module application task - like Arduino loop()*async def module\_main\_loop\_coro(self) -> None:  
 self.logger.log('main loop coroutine start')  
 current\_pin\_state = Pin(10).value()  
 evt = canmessage.cbusevent(mod.cbus, -1, 22, 23)  
  
 while True:  
 await asyncio.sleep\_ms(25)  
 new\_pin\_state = Pin(10).value()  
 if new\_pin\_state != current\_pin\_state:  
 current\_pin\_state = new\_pin\_state  
 evt.polarity = current\_pin\_state  
 evt.send()

If you are using your module’s event table to store taught producer events, there are a couple of useful methods for looking these up, either by a single EV or multiples thereof:

def find\_event\_by\_ev(self, evnum: int, evval: int) -> int:

def find\_event\_by\_evs(self, query: tuple[tuple[int, int], ...]) -> int:

Both return the matching event table index, or -1 if not found. You can then use the canmessage.event\_from\_table() method to create an event to send:

--> mod.cbus.config.print\_events()

...

21 = 00 16 00 1b 02 04 06 08

22 = 00 16 00 1c 03 06 09 0c

23 = 00 16 00 18 02 04 08 10

...

--> idx = mod.cbus.config.find\_event\_by\_ev(1, 3)

--> idx

22

--> evt = canmessage.event\_from\_table(mod.cbus, idx)

--> print(evt)

[5] [5] [ 00 00 16 00 1c ]

To convert a canmessage or cbusevent object to a tuple, simply write:

--> t = tuple(evt)

--> t

(1, 22, 28)

-->

(Note how we use the ‘self’ object when adding code to the program’s class, but the ‘mod’ object when typing at the command line. This will make more sense as you get comfortable with object-oriented programming in Python).

(Note that printing an event will by default show its values in hex, whilst a tuple will display in decimal. It’s like that just to confuse you! Take a look at the print() and \_\_str\_\_() methods of the canmessage class in canmessage.py for options).

(The foregoing may prompt the question of why we would use the event table at all, now that we can represent a module’s configuration in code. I’ll leave the answer up to you).

(You may be wondering, as Python is a weakly-typed language, why method and function defiinitions show the expected argument and return types. This is known as ‘typing’ in Python and whilst the interpreter completely ignores it, this information is useful to some IDEs for code completion and error checking. This isn’t mandatory but it’s a good habit to get into).