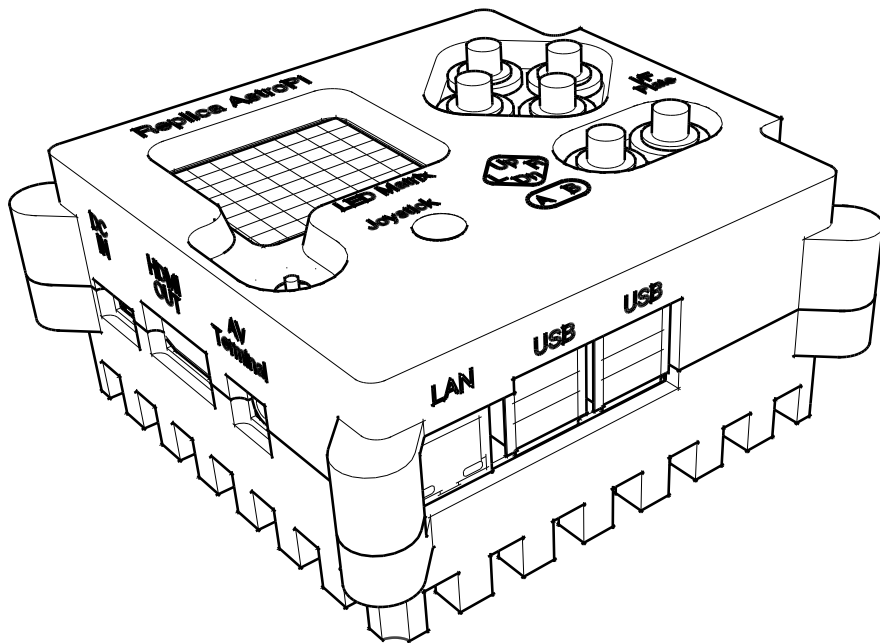


Replica AstroPi case Build Instructions

Please read this manual carefully before starting to assemble your Replica AstroPi case. Check you have all the parts listed available.



Parts list

Provided in the Replica AstroPi case package

- CNC machined case top & bottom
- Switchboard with RTC
- 4 off 11mm standoffs
- 4 off M4 screws
- 4 off M2.5 x 10 screws
- 4 off M@ self-tapping screws (for camera)
- 4 off 4mm spacer blocks
- 6 off button fly-leads JST ZR 2 wire connector

Required to complete the build

- A Pi B+, 2 or 3
- A SenseHAT
- A Pi camera module with standard cable
- A microSD card with a recent Raspbian release loaded
- A CR1220 battery for the RTC
- 6 off buttons - momentary off-(on) that can fit in a 10mm hole. The nicest option is the APEM 104350003, with APEM 8632A as a cheaper choice. Soldering or crimp-connector supplies to connect the buttons to their wiring
- Heat shrink insulation for the button wiring
- Tape; masking tape is suitable
- 3mm and 2mm allen keys
- Thin disposable gloves are useful to avoid getting dirt and grease on the case

Preparing the Pi, RTC and SenseHAT

We will assume you have installed a recent version of Raspbian on your microSD card; these instructions are based on the 2017-03-02 release. You must use `raspi-config` to enable i2c support¹ and since you will probably be using this Pi with a remote connection rather than a monitor and keyboard plugged in you should also enable the SSH server².

After doing that, shutdown your Pi and unplug the power before plugging the switchboard onto the gpio pins. Insert the CR1220 battery for the RTC - slide it in with the +ve side upwards

Reconnect the power and restart your Pi so we can configure the RTC and HAT.

We need to edit the device tree overlay file to include the RTC & SenseHAT support, so open a terminal window and use the following commands-

```
sudo i2cdetect -y 1
```

You should see a **68** appear in the 8 column and 60 row of the grid this displays.

```
cd /boot/overlays
```

Then fetch the dtoverlay file with

```
sudo wget https://github.com/raspberrypilearning/astro-pi-flight-case/raw/master/dtb/astropi-keys.dtbo --no-check-certificate
```

Use `ls` to check that you have a file named 'astropi-keys.dtbo'

¹ <https://www.raspberrypi.org/documentation/configuration/raspi-config.md>

² <https://www.raspberrypi.org/documentation/remote-access/ssh/README.md>

Then edit the config.txt file with

```
sudo nano /boot/config.txt
```

Scroll to the end of the file and add these three lines

```
dtoverlay=i2c-rtc,pcf8523
```

```
dtoverlay=rpi-sense
```

```
dtoverlay=astropi-keys
```

Save the file by pressing ctrl-o and answering 'y', then exit with ctrl-x.

Reboot your Pi and open a terminal window again.

Now when you use -

```
sudo i2cdetect -y 1`
```

You should see a 'UU' where the 68 previously appeared; this indicates the RTC is correctly installed.

We need to disable the 'fake' hardware clock in order to let the real hardware take over. So, back in the terminal window

```
sudo apt-get -y remove fake-hwclock
```

```
sudo update-rc.d -f fake-hwclock remove
```

The next step is to comment out three lines in the hardware clock script -

```
sudo nano /lib/udev/hwclock-set
```

and comment out (by adding a # character at the beginning of each line) three lines near the bottom so that they read as

```
#if [ -e /run/systemd/system ] ; then
```

```
# exit 0
```

```
#fi
```

Again, save with ctrl-o etc. just as for the config.txt file.

The last step is to set the RTC time to match real time. In the terminal, you can try

```
sudo hwclock -D -r
```

to read the RTC's idea of the time, which will almost certainly be completely wrong. Use

```
date
```

to see what time your Pi has set - as long as you are connected to the internet this should be correct. If your Pi is not connected you will need to set the time manually with

```
sudo date --set 'YYYY-MM-DD HH:MM:SS'
```

for example :-

```
sudo date --set '2017-05-21 14:23:45'
```

Now use

```
sudo hwclock -w`
```

to write the time to the RTC. Try

```
sudo hwclock -D -r
```

again to check that things have worked.

Finally, shutdown your Pi, disconnect the power and unplug the switchboard in preparation for assembling the boards into the case

Assembly

Case preparation

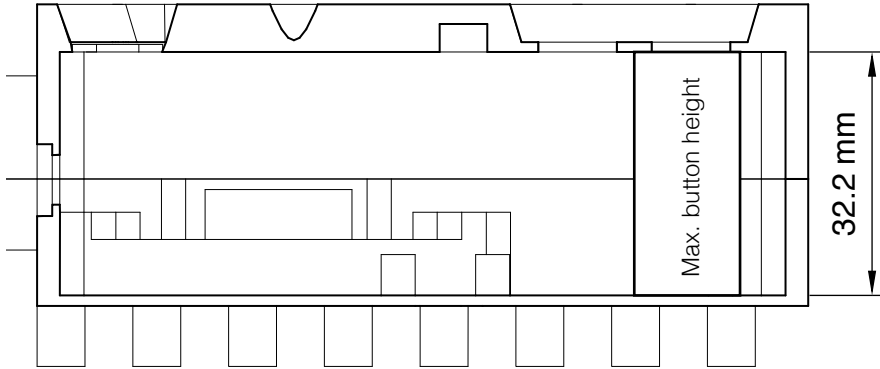
We strongly recommend using some tape (masking tape is fine, kapton tape is very nice) on the inside of the case top to reduce the risk of shorting anything out if screws loosen and boards move around later.

It's also a very good idea to put some masking tape over much of the outside of the case halves during assembly to protect them from scratching. Wearing some disposable gloves when handling the case during assembly is a good idea as well; fingers get amazingly mucky when assembling computer components and oily dirt will tend to stick. Working on a soft surface is also advisable, just in case you drop the case whilst juggling it to install items.

Button wiring & connecting

The APEM type buttons can be mounted into the case top from below since they have a threaded barrel and nuts for both sides of the case. Other buttons may have a solid top that requires installing them from the top of the case. In either case you should connect your switches to the fly leads and test for continuity before going any further. The fly lead connectors will easily fit through the case top holes if you need to fit your buttons from the top.

It's worth test fitting one of your buttons to check that there is sufficient depth for it to fit correctly; some buttons are surprisingly long. You can also check buttons and their wiring against the printed cross section template here.



This is a full scale section of the case to show you the button height clearance. Make sure your choice of buttons will fit in the 32mm height available **including** the space needed for your wiring.

Unusually long buttons may require that you solder the connections cross-wise instead of the more obvious "sticking out" manner. Do **not** forget to insulate the connections. Shorting out the button wiring may damage your Pi.

Switchboard connection preparation

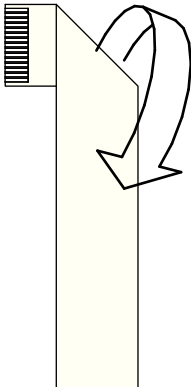
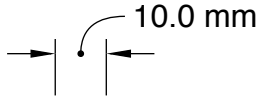
We have noticed that the SenseHAT connections can be very fussy. There is not a great deal of overlap between the header pins and the connector, which occasionally results in no electrical signal. The best answer to this is to gently bend the switchboard header pins out a *little*.

Install the camera

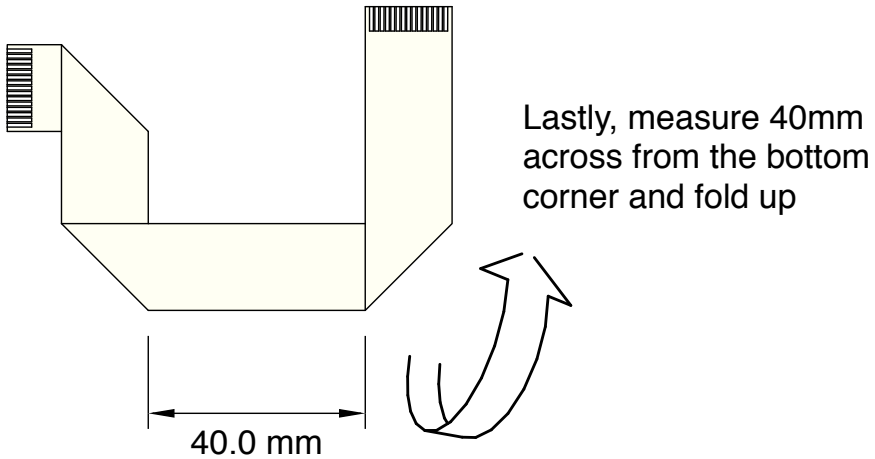
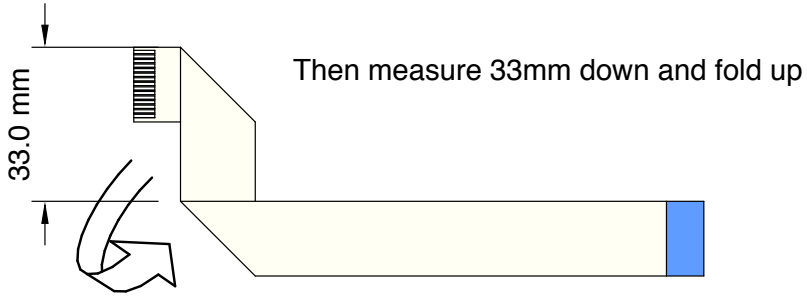
The camera cable needs to be folded according to the following instructions -

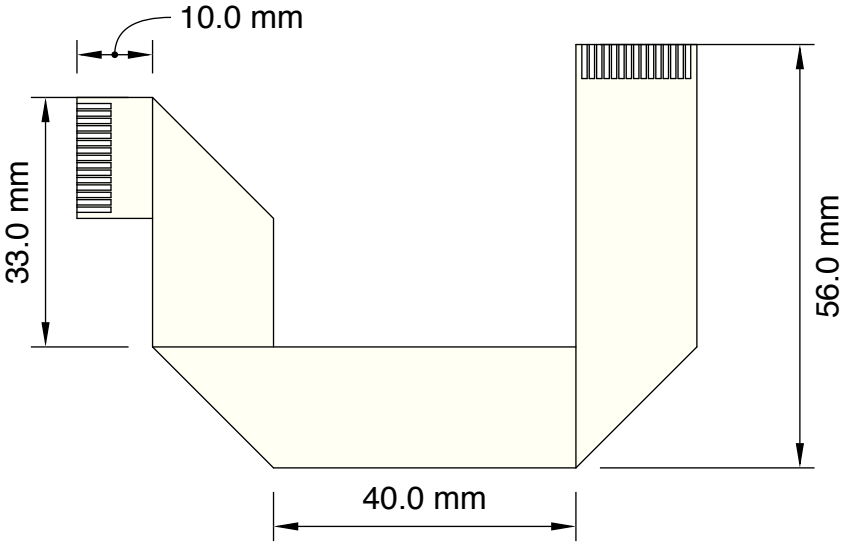


Start with your camera cable writing side up and the visible connector contacts on the left



Next, measure 10mm from the left and fold the right part of the ribbon down at 90 degrees



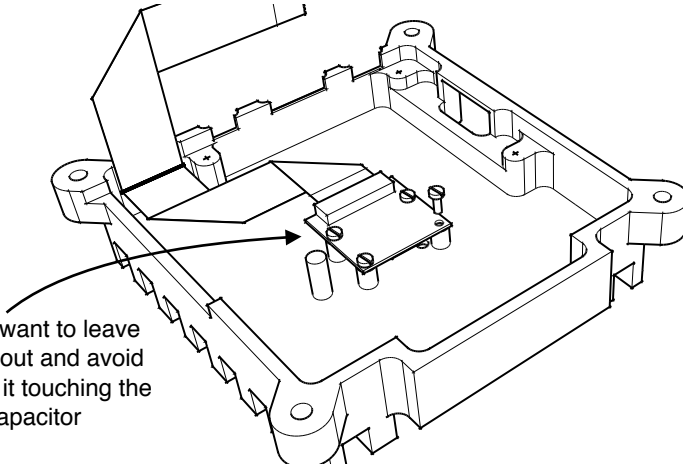


Your cable should fit neatly over this template.

Connect the camera end of cable to camera module - remember that the tinned side of the connector goes towards the camera circuit board and that the 10mm long leg is the one to insert into the camera.

If this is a brand new camera module do not forget to **remove the protective tape cover!** You would have to dismantle almost the entire case assembly to get to it later.

Install the camera module in the case bottom with the 4 small self-tapping screws.



You might want to leave this screw out and avoid any risk of it touching the adjacent capacitor

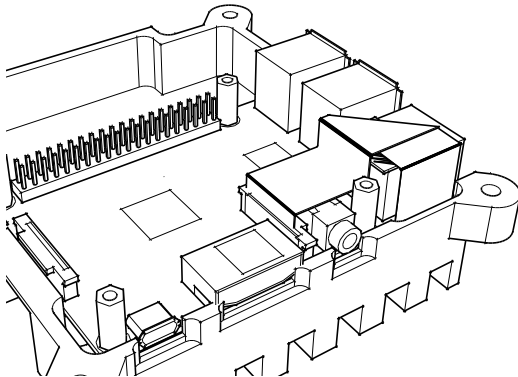
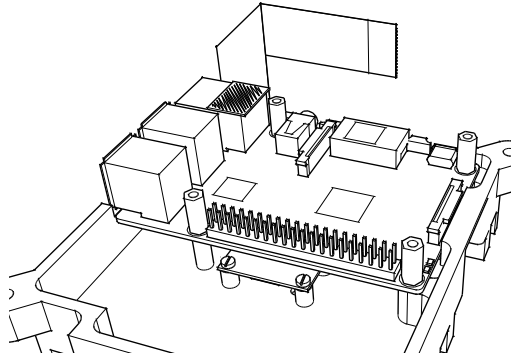
Use **gentle** pressure to push and twist them because such small screws are very fragile; the holes in the mounting posts are sized to just barely grab the screw threads and reduce the risk of snapping. As long as at least a couple of screws fit ok the camera will be ok!

On some camera modules one of the capacitors is very close to one of the screws and if you feel it might make contact it would be best to leave that screw off.

Install the Pi

Place the Pi in the case bottom over the mounting blocks, taking care to fold the camera cable around properly; it should stick up next to the ethernet socket.

Use the four 11mm long stand-offs to mount the Pi; again, don't apply too much force to the delicate small screw threads. A tiny drop of oil on each one wouldn't hurt. Route the camera cable over the ethernet socket; a strip of electrical tape across the top of the ethernet socket is not a bad idea.

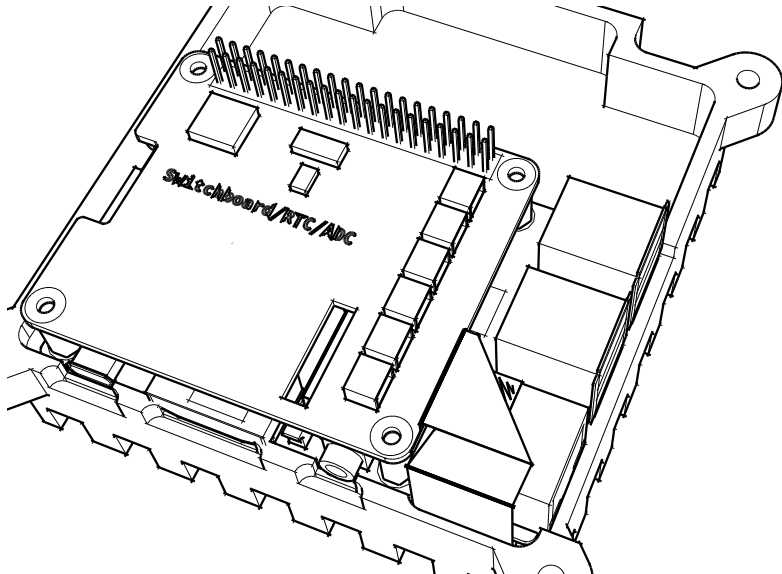


Connect the Pi end of the camera cable to the CSI connector. Remember to make sure the cable is not trapped between the standoff and the switchboard.

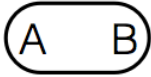
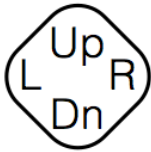
Install the Switchboard, buttons & fly leads

Press the switchboard onto the Pi gpio pins and check that the cable is not getting trapped.

It *is* possible to route the camera cable over the Switchboard and through the cable slot - but it is fiddly and has to be done after the button fly leads have been installed.

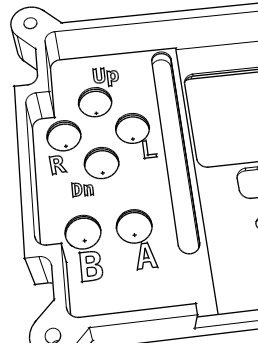


The buttons are arranged as follows, viewed from the top of the case and inside -



Buttons seen from the top

It's almost certainly a good idea to mark the button locations *inside* the case top to save time puzzling over the mirrored pattern as you insert the buttons. Of course, if you have buttons that mount from the front you won't likely have this confusion.



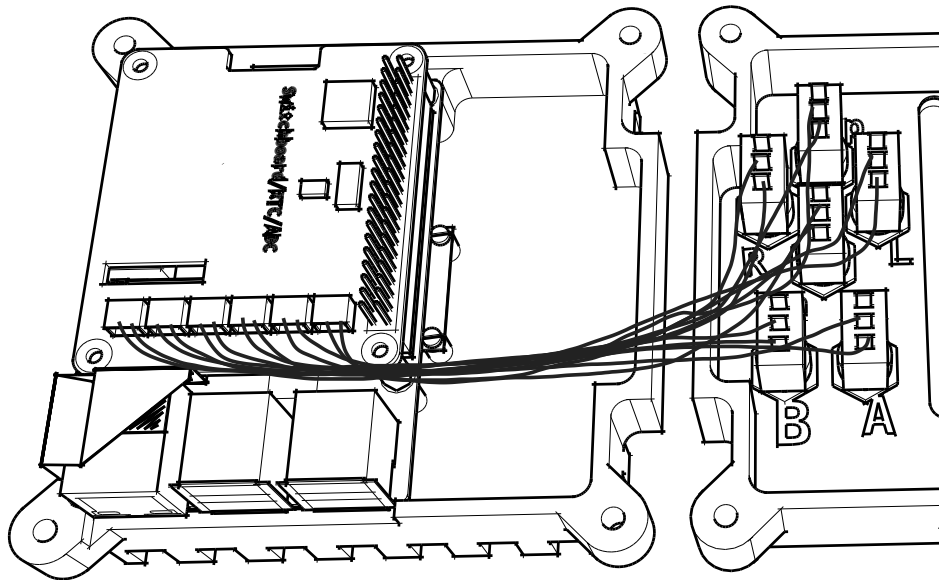
Buttons seen from inside the case top. Mark with Sharpie or felt-tip

The Switchboard connectors are labelled with the gpio pin they link to. For each button, plug the fly lead into the socket according to this table.

Label	Button
GPIO26	Up
GPIO21	B
GPIO20	L
GPIO19	R
GPIO16	A
GPIO13	Dn

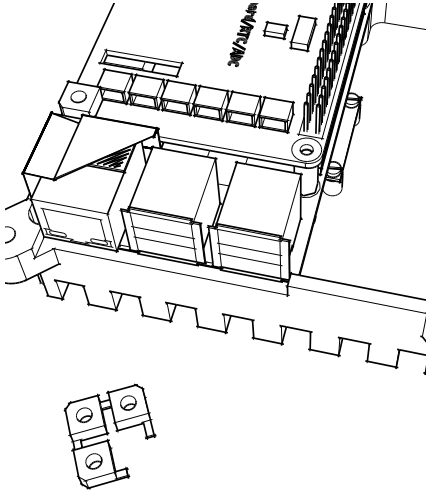
The fly lead wiring should be routed like this to clear the SenseHAT standoff.

Aim to gather your wires together neatly and fold them into the bottom part of the case when joining the two parts.



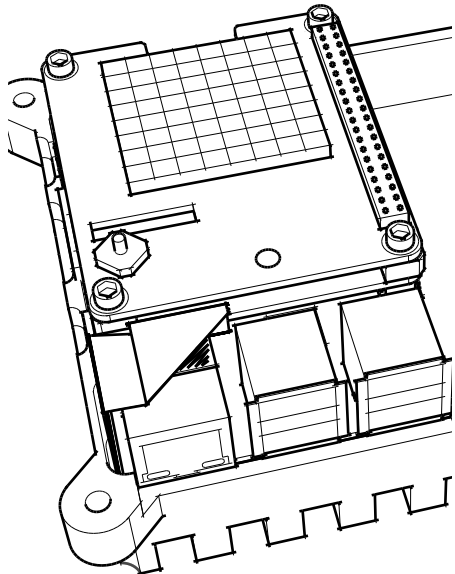
Install the SenseHAT

Separate the four small plastic spacers from the sprue and place them over the corners of the switchboard.



You can use a tiny drop of superglue or a small square of double-sided tape to secure them if you find things sliding around too much.

Install the SenseHAT, which will probably require some wiggling to get the pins all in their respective holes since we have spread the pins out a little as mentioned in the **Switchboard connection preparation** section. Use the four M2.5 screws to secure the HAT; again, do not apply too much force on such small screws.



Testing the functionality

This is a good time to test that the circuits are all connected properly and that nothing is loose. Connect a display, keyboard and mouse and power up the Pi; the LEDs on the SenseHAT should display a bright rainbow for a moment and then turn off in the usual way. You can test the system by opening a terminal window and typing

```
cd ~
```

```
wget https://github.com/raspberrypilearning/astro-pi-flight-case/raw/master/test_code/pygame_test.py --no-check-certificate
```

```
chmod +x pygame_test.py
```

```
./pygame_test.py
```

If you wiggle the joystick and press the various buttons you should see the directions indicated and letters on the LEDs. Hit the 'esc' key to exit the program and then shutdown and disconnect the power, keyboard, mouse and display cables.

Final assembly

All that is left is to join the case halves. Remember to remove any protective masking tape you applied earlier. Place the case top on the case bottom whilst guiding the button wiring into the cavity under the buttons. Take care not to trap any wires. Use the four M4 screws to close the case. Again, don't force anything. It is easy to strip threads in aluminium with too much enthusiasm on the end of an Allen key.

As a last task, check that nothing is left that ought to be inside the case, and nothing is rattling inside the case that ought not be in there!