

Embedded Linux Primer

Day 5:

Generate a Custom Raspberry Pi Compute Module 5 Yocto Image

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- Participate in ‘Attendee Chat’ by maximizing the chat widget in your dock.

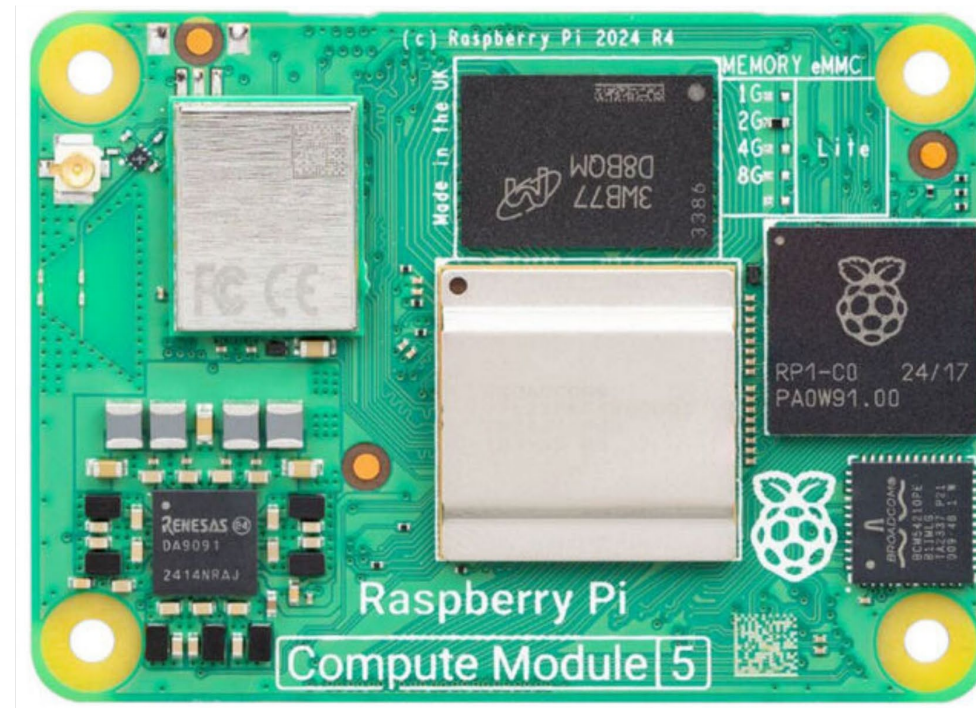


Fred Eady

Visit 'Lecturer Profile' in your console for more details.

AGENDA

- **Yocto CM5 Image Configuration**
- **Cook Our CM5 Yocto Base Image**
- **Load and Boot Our Yocto CM5 Image**
- **Setup and Enable the CM5 WiFi Radio**
- **Create a GPIO Yocto Application**
- **Create an LM75 Yocto Application**



bblayers.conf⚙️ *bblayers.conf* ✕

yocto > build-cm5spi > conf > ⚙️ bblayers.conf

```
1 # RASPBERRY PI COMPUTE MODULE 5
2 # 08/01/2025
3 # working
4 # base build with nano - ssh - libgpiod - systemd - spi - i2c
5 # optional /home/fred/pi5yoctoProject/yocto/meta-openembedded/meta-networking \
6 #
7 #
8 # POKY_BBLAYERS_CONF_VERSION is increased each time build/conf/bblayers.conf
9 # changes incompatibly
10 POKY_BBLAYERS_CONF_VERSION = "2"
11
12 BBPATH = "${TOPDIR}"
13 BBFILES ?= ""
14
15 BBLAYERS ?= " \
16 /home/fred/pi5yoctoProject/yocto/poky/meta \
17 /home/fred/pi5yoctoProject/yocto/poky/meta-poky \
18 /home/fred/pi5yoctoProject/yocto/poky/meta-yocto-bsp \
19 /home/fred/pi5yoctoProject/yocto/meta-openembedded/meta-oe \
20 /home/fred/pi5yoctoProject/yocto/meta-openembedded/meta-python \
21 /home/fred/pi5yoctoProject/yocto/meta-raspberrypi \
22 "
```

local.conf

⚙ local.conf ✕

yocto > build-cm5spi > conf > ⚙ local.conf

```
1 # Raspberry Pi CM5
2 # 08/01/2025
3 # working
4 # systemd - uart - i2c - spi - libgpiod - SSH
5
6
7 # There are also the following hardware board target machines included for
8 # demonstration purposes:
9 #
10 #MACHINE ?= "beaglebone-yocto"
11 #MACHINE ?= "genericarm64"
12 #MACHINE ?= "genericx86"
13 #MACHINE ?= "genericx86-64"
14 #
15 # This sets the default machine to be qemux86-64 if no other machine is selected:
16 MACHINE ??= "raspberrypi5"
```

local.conf

```
local.conf x
yocto > build-cm5spi > conf > local.conf
289 # CONF_VERSION is increased each time build/conf/ changes incompatibly and is used to
290 # track the version of this file when it was generated. This can safely be ignored if
291 # this doesn't mean anything to you.
292 CONF_VERSION = "2"
293
294 # Enable WiFi configuration via networkctl
295 INIT_MANAGER = "systemd"
296 PREFERRED_PROVIDER_udev = "systemd"
297 PREFERRED_PROVIDER_udev_utils = "systemd"
298 DISTRO_FEATURES_BACKFILL_CONSIDERED = "sysvinit"
299 IMX_DEFAULT_DISTRO_FEATURES += "systemd"
300
301 # Enable the UART
302 # Enable SPI Support
303 # Enable I2C Support
304 # Enable nano text editor
305 # synaptics-killswitch is required
306 ENABLE_UART = "1"
307 ENABLE_I2C = "1"
308 ENABLE_SPI_BUS = "1"
309 KERNEL_MODULE_AUTOLOAD:rpi += " i2c-dev"
310 IMAGE_INSTALL:append = " \
311     i2c-tools \
312     nano \
313     libgpod \
314     libgpod-dev \
315     libgpod-tools \
316     openssh \
317     "
318 LICENSE_FLAGS_ACCEPTED = "synaptics-killswitch"
```

Invoke BitBake

```
fred@pi5-yocto: ~/pi5yoctoProject/yocto/build-cm5spi
File Edit View Search Terminal Help

fred@pi5-yocto:~/pi5yoctoProject/yocto/build-cm5spi$ bitbake core-image-base
Loading cache: 100% | ETA: --:--:--
Loaded 0 entries from dependency cache.
Parsing recipes: 100% |#####| Time: 0:00:29
Parsing of 2513 .bb files complete (0 cached, 2513 parsed). 4353 targets, 124 sk
ipped, 0 masked, 0 errors.
NOTE: Resolving any missing task queue dependencies

Build Configuration:
BB_VERSION           = "2.8.0"
BUILD_SYS            = "x86_64-linux"
NATIVELSBSTRING     = "universal"
TARGET_SYS           = "aarch64-poky-linux"
MACHINE              = "raspberrypi5"
DISTRO               = "poky"
DISTRO_VERSION       = "5.0.10"
TUNE_FEATURES        = "aarch64 crypto cortexa76"
TARGET_FPU           = ""
meta
meta-poky
meta-yocto-bsp       = "scarthgap:ac257900c33754957b2696529682029d997a8f28"
meta-oe
meta-python          = "scarthgap:491671faee11ea131feab5a3a451d1a01deb2ab1"
```

Load the microSD Card With Our New CM5 Image

fred@pi5-yocto: ~/pi5yoctoProject/yocto/build-cm5spi/tmp/deploy/images/raspberrypi5

Q ☰ - □ ×

File Edit View Search Terminal Help

```
fred@pi5-yocto:~/pi5yoctoProject/yocto/build-cm5spi/tmp/deploy/images/raspberrypi5$ sudo bmaptool copy core-image-base-raspberrypi5.rootfs.wic.bz2 /dev/sdb
[sudo] password for fred:
bmaptool: info: discovered bmap file 'core-image-base-raspberrypi5.rootfs.wic.bmap'
bmaptool: info: block map format version 2.0
bmaptool: info: 242483 blocks of size 4096 (947.2 MiB), mapped 130166 blocks (508.5 MiB or 53.7%)
bmaptool: info: copying image 'core-image-base-raspberrypi5.rootfs.wic.bz2' to block device '/dev/sdb' using bmap file 'core-image-base-raspberrypi5.rootfs.wic.bmap'
bmaptool: info: 100% copied
bmaptool: info: synchronizing '/dev/sdb'
bmaptool: info: copying time: 23.6s, copying speed 21.6 MiB/sec
fred@pi5-yocto:~/pi5yoctoProject/yocto/build-cm5spi/tmp/deploy/images/raspberrypi5$
```

microSD Card root Partition (rootfs)

Name	Size	Modified
bin	777 items	9 Mar 2018
boot	2 items	9 Mar 2018
dev	0 items	9 Mar 2018
etc	80 items	29 Jul
home	0 items	9 Mar 2018
lib	559 items	9 Mar 2018
media	0 items	9 Mar 2018
mnt	0 items	9 Mar 2018
proc	0 items	9 Mar 2018
root	—	29 Jul

microSD Card boot Partition (bootfs)

The screenshot shows a file manager window titled "boot" displaying the contents of the boot partition. The files are listed in a table with columns for Name, Size, and Modified. Red arrows point to specific files: bcm2712-rpi-cm5-cm5io.dtb, bcm2712-rpi-cm5l-cm5io.dtb, and config.txt.

Name	Size	Modified
bcm2712-rpi-5-b.dtb	81.2 kB	5 Apr 2011
bcm2712-rpi-cm5-cm4io.dtb	81.6 kB	5 Apr 2011
bcm2712-rpi-cm5-cm5io.dtb	81.6 kB	5 Apr 2011
bcm2712-rpi-cm5l-cm4io.dtb	81.6 kB	5 Apr 2011
bcm2712-rpi-cm5l-cm5io.dtb	81.7 kB	5 Apr 2011
bootcode.bin	52.5 kB	5 Apr 2011
cmdline.txt	104 bytes	5 Apr 2011
config.txt	2.6 kB	5 Apr 2011
fixup.dat	7.3 kB	5 Apr 2011
fixup4.dat	5.4 kB	5 Apr 2011

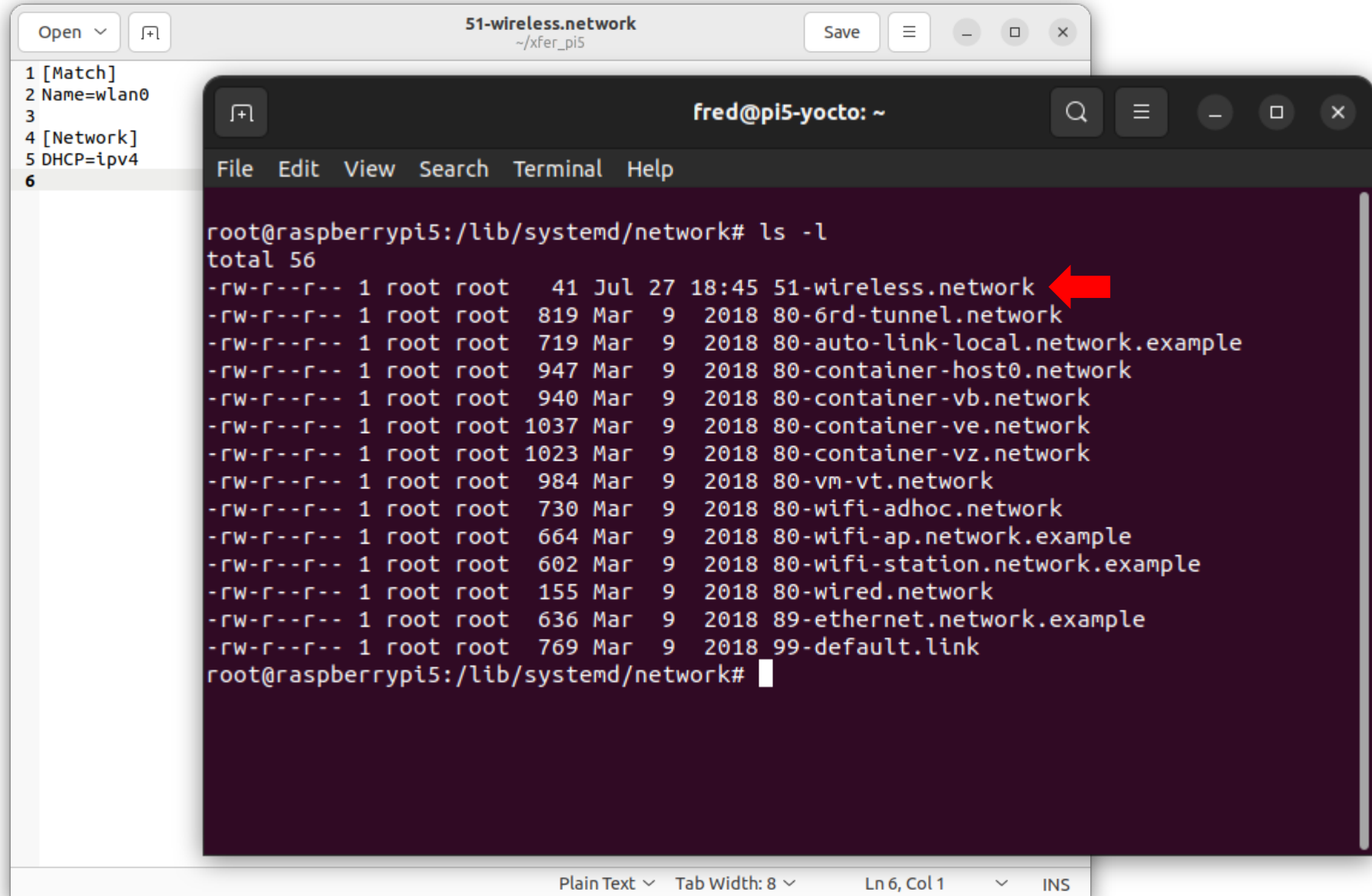
microSD Card boot Partition (bootfs) – config.txt

```
Open  config.txt  Save  Save  -  □  ×
boot /media/fred/boot
217
218 #dtparam=i2c_vc_baudrate=100000
219
220 #dtparam=i2s=off
221
222 #dtparam=spi=off
223
224 #dtparam=random=off
225
226 #dtparam=uart0=on
227
228 #dtparam=watchdog=off
229
230 #dtparam=act_led_trigger=mmc
231
232 #dtparam=act_led_activelow=off
233
234 #dtparam=act_led_gpio=47
235
236 #dtparam=pwr_led_trigger=mmc
237
238 #dtparam=pwr_led_activelow=off
239
240 #dtparam=pwr_led_gpio=35
241
242
243 #dtoverlay=act-led,activelow=off
244 # Enable SPI bus
245 dtparam=spi=on
246 # Enable I2C
247 dtparam=i2c1=on
248 dtparam=i2c_arm=on
249 # Enable UART
250 enable_uart=1
251 # Enable VC4 Graphics
252 dtoverlay=vc4-kms-v3d
253
```

Plain Text Tab Width: 8 Ln 1, Col 10 INS



Create and Place 51-wireless.network



```
Open 51-wireless.network Save
~/xfer_pi5

1 [Match]
2 Name=wlan0
3
4 [Network]
5 DHCP=ipv4
6

fred@pi5-yocto: ~
File Edit View Search Terminal Help

root@raspberrypi5:/lib/systemd/network# ls -l
total 56
-rw-r--r-- 1 root root  41 Jul 27 18:45 51-wireless.network
-rw-r--r-- 1 root root 819 Mar  9 2018 80-6rd-tunnel.network
-rw-r--r-- 1 root root 719 Mar  9 2018 80-auto-link-local.network.example
-rw-r--r-- 1 root root 947 Mar  9 2018 80-container-host0.network
-rw-r--r-- 1 root root 940 Mar  9 2018 80-container-vb.network
-rw-r--r-- 1 root root 1037 Mar  9 2018 80-container-ve.network
-rw-r--r-- 1 root root 1023 Mar  9 2018 80-container-vz.network
-rw-r--r-- 1 root root  984 Mar  9 2018 80-vm-vt.network
-rw-r--r-- 1 root root  730 Mar  9 2018 80-wifi-adhoc.network
-rw-r--r-- 1 root root  664 Mar  9 2018 80-wifi-ap.network.example
-rw-r--r-- 1 root root  602 Mar  9 2018 80-wifi-station.network.example
-rw-r--r-- 1 root root  155 Mar  9 2018 80-wired.network
-rw-r--r-- 1 root root  636 Mar  9 2018 89-ethernet.network.example
-rw-r--r-- 1 root root  769 Mar  9 2018 99-default.link
root@raspberrypi5:/lib/systemd/network#
```

Create and Place wpa_supplicant-wlan0.conf

```
Open ▾ [⌘] *wpa_supplicant-wlan0.conf ~/xfer_pi5 Save Open ▾ [⌘] *wpa_supplicant-wlan0.conf ~/xfer_pi5 Save [≡] [−] [□] [×]
1 ctrl_interface=/var/run/wpa_supplicant
2 eapol_version=1
3 ap_scan=1
4 fast_reauth=1
5
6
1 ctrl_interface=/var/run/wpa_supplicant
2 eapol_version=1
3 ap_scan=1
4 fast_reauth=1
5
6 network={
7     ssid="SSID_OF_NETWORK "
8     #psk="PASSWORD_OF_NETWORK"
9     psk=9c792aa9d02f7054501f156a58f9c73478f81f82b972a73da347fb19971bf045
10 }
11
```

wpa_passphrase SSID_OF_NETWORK PASSWORD_OF_NETWORK >> /etc/wpa_supplicant/wpa_supplicant-wlan0.conf

```
[⌘] fred@pi5-yocto: ~ [🔍] [≡]
File Edit View Search Terminal Help
root@raspberrypi5:~# cd /etc/wpa_supplicant
root@raspberrypi5:/etc/wpa_supplicant# ls -l
total 4
-rw-r--r-- 1 root root 202 Jul 29 22:40 wpa_supplicant-wlan0.conf
root@raspberrypi5:/etc/wpa_supplicant#
```

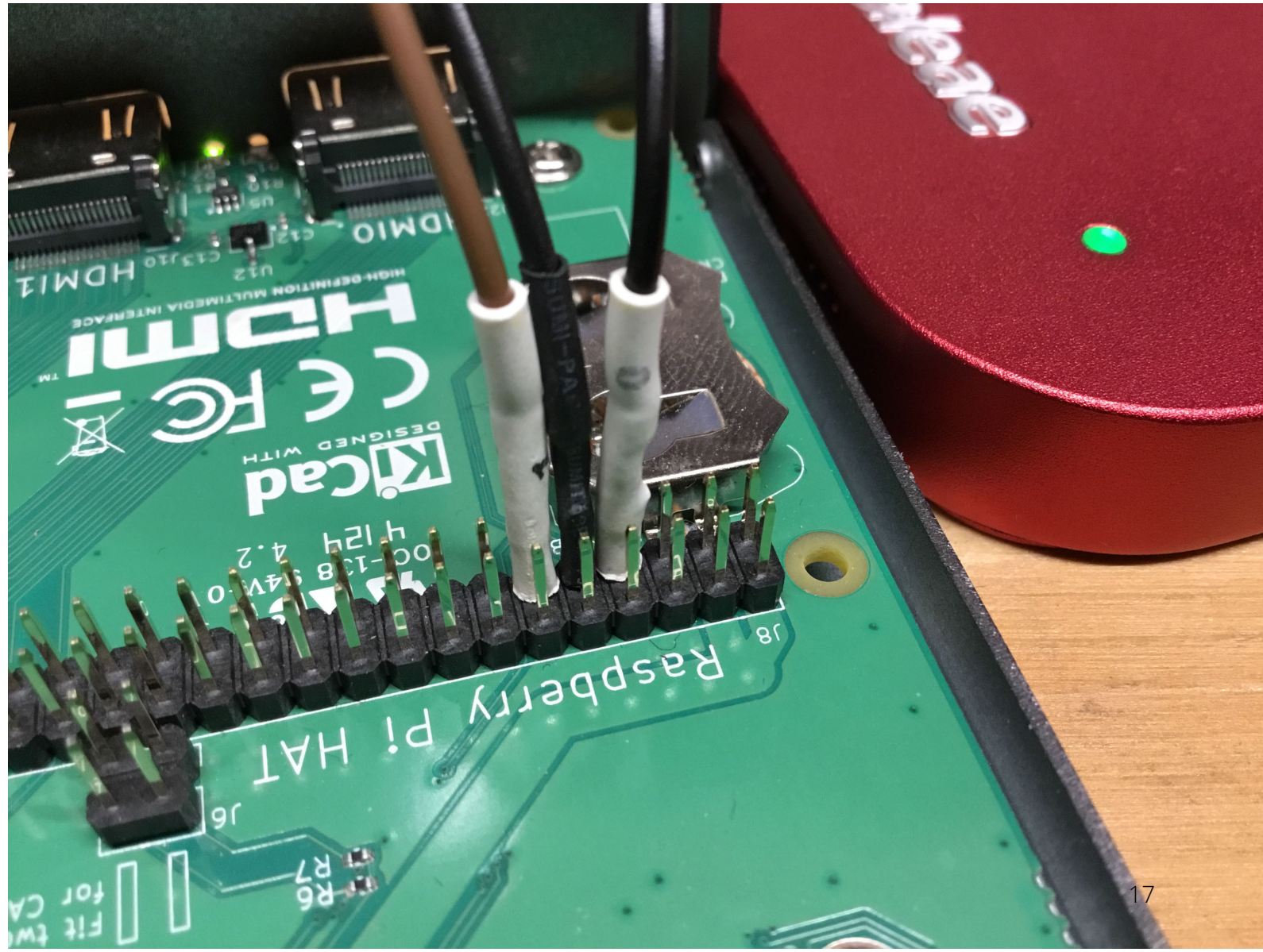
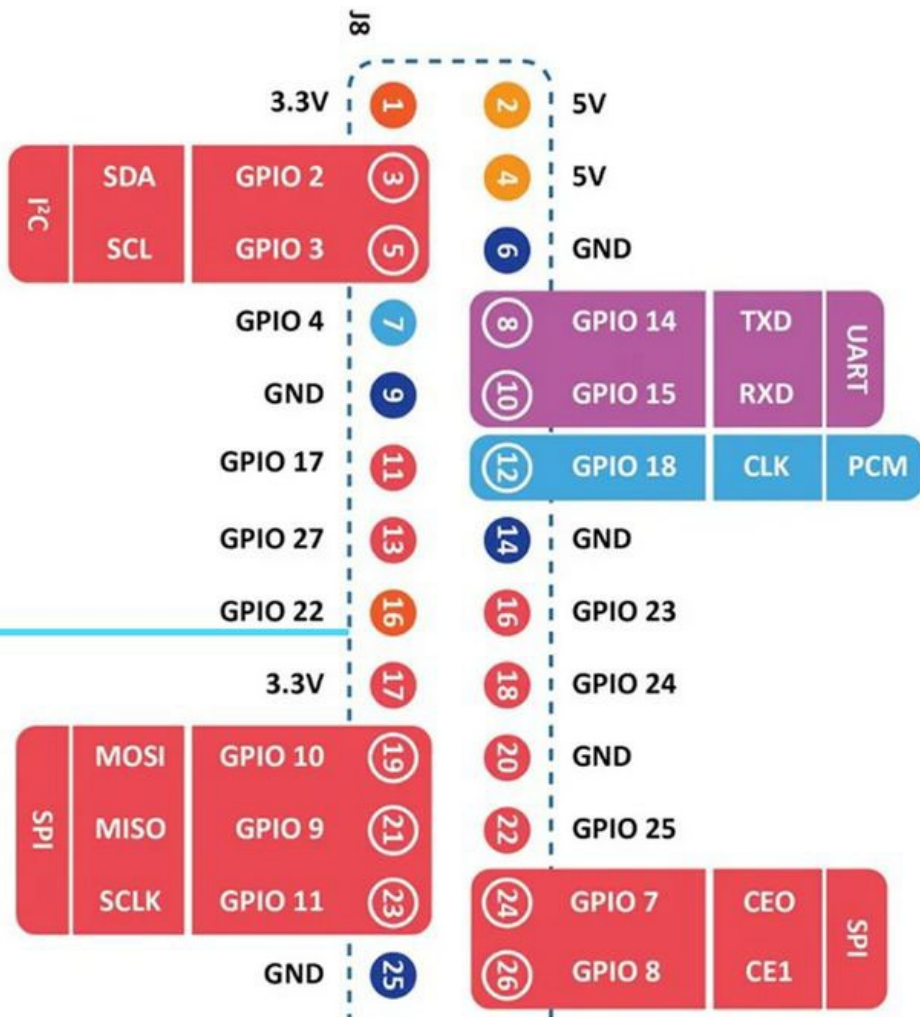
Enable the Compute Module 5 WiFi Radio

```
fred@pi5-yocto: ~  
eth0  Link encap:Ethernet  HWaddr 2C:CF:67:C2:E4:A6  
       inet addr:192.168.1.51  Bcast:192.168.1.255  Mask:255.255.255.0  
       inet6 addr: 2600:6c5a:c7f:f2a6:2ecf:67ff:fec2:e4a6/64 Scope:Global  
       inet6 addr: fe80::2ecf:67ff:fec2:e4a6/64 Scope:Link  
       UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1  
       RX packets:226 errors:0 dropped:1 overruns:0 frame:0  
       TX packets:51 errors:0 dropped:0 overruns:0 carrier:0  
       collisions:0 txqueuelen:1000  
       RX bytes:79905 (78.0 KiB)  TX bytes:6418 (6.2 KiB)  
       Interrupt:107  
  
lo    Link encap:Local Loopback  
       inet addr:127.0.0.1  Mask:255.0.0.0  
       inet6 addr: ::1/128 Scope:Host  
       UP LOOPBACK RUNNING  MTU:65536  Metric:1  
       RX packets:10 errors:0 dropped:0 overruns:0 frame:0  
       TX packets:10 errors:0 dropped:0 overruns:0 carrier:0  
       collisions:0 txqueuelen:1000  
       RX bytes:1606 (1.5 KiB)  TX bytes:1606 (1.5 KiB)  
  
wlan0 Link encap:Ethernet  HWaddr 2C:CF:67:C2:E4:A7  
       inet addr:192.168.1.52  Bcast:192.168.1.255  Mask:255.255.255.0  
       inet6 addr: 2600:6c5a:c7f:f2a6:2ecf:67ff:fec2:e4a7/64 Scope:Global  
       inet6 addr: fe80::2ecf:67ff:fec2:e4a7/64 Scope:Link  
       UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1  
       RX packets:54 errors:0 dropped:0 overruns:0 frame:0  
       TX packets:25 errors:0 dropped:0 overruns:0 carrier:0  
       collisions:0 txqueuelen:1000  
       RX bytes:24240 (23.6 KiB)  TX bytes:3978 (3.8 KiB)  
  
root@raspberrypi5:~# ifconfig
```

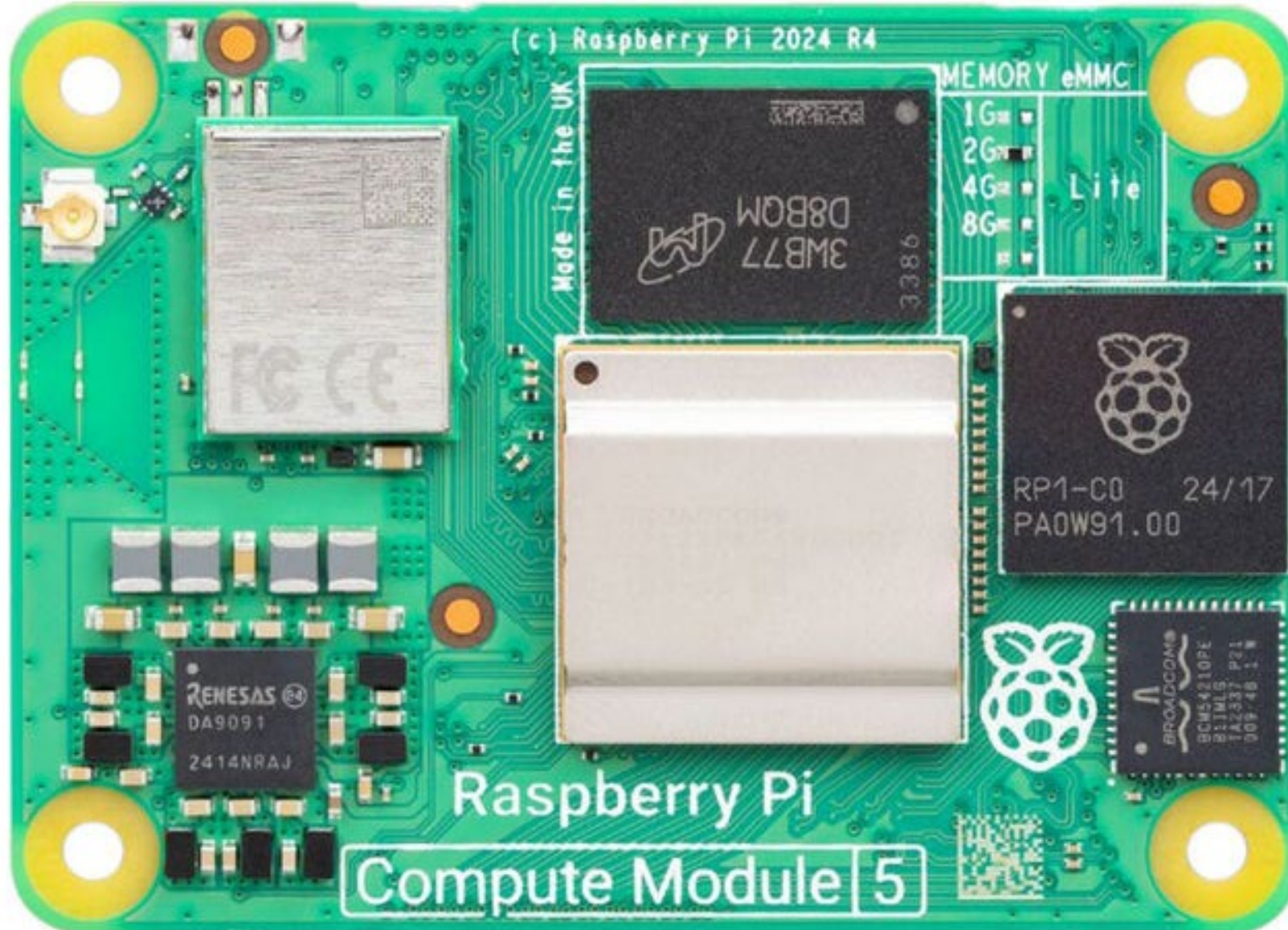
To enable WiFi , execute the following 3 commands from the Raspberry Pi Compute Module 5 Linux console :

```
systemctl enable wpa_supplicant@wlan0.service  
systemctl restart systemd-networkd.service  
systemctl restart wpa_supplicant@wlan0.service
```

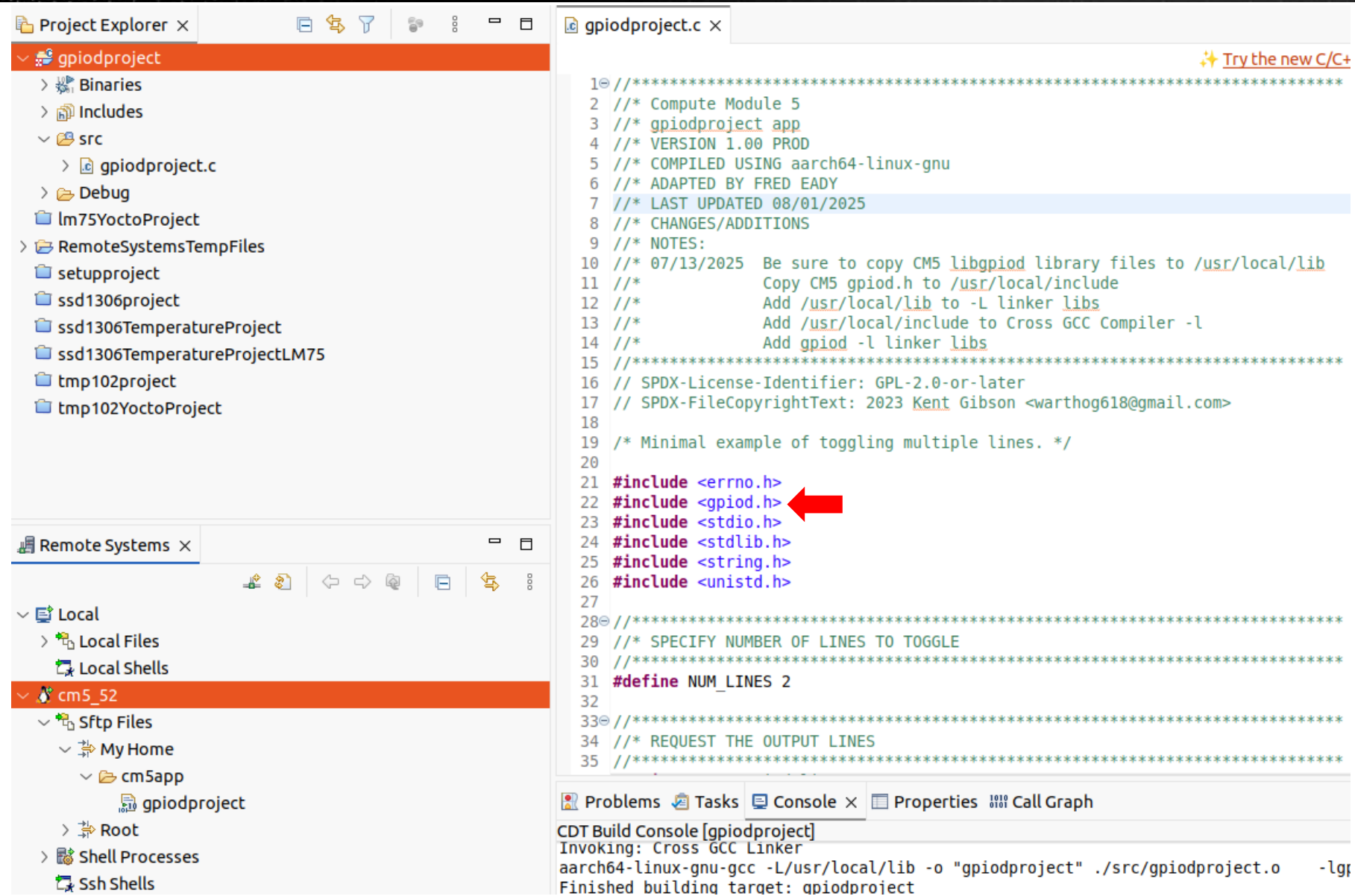

Assemble the Raspberry Pi Compute Module 5 Hardware



Eclipse Yocto Application Development



Create and Compile the Application Code



The screenshot displays an IDE interface with the following components:

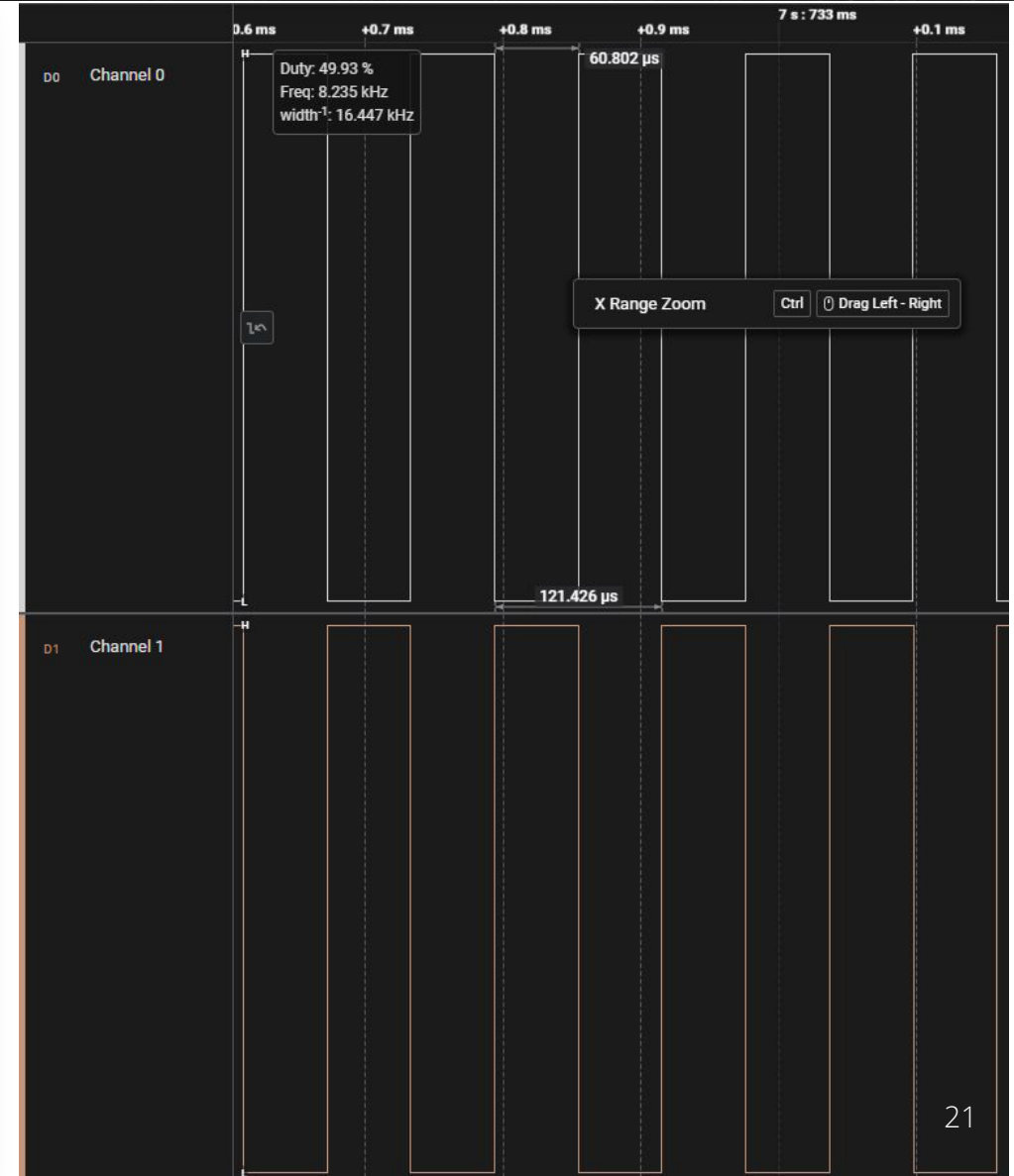
- Project Explorer:** Shows a project named 'gpiodproject' with a source file 'gpiodproject.c' under the 'src' directory.
- Remote Systems:** Shows a local system 'cm5_52' under 'Local'.
- Code Editor:** Displays the source code for 'gpiodproject.c'. A red arrow points to the line `#include <gpio.h>`.
- Console:** Shows the output of the compilation process, indicating that the target 'gpiodproject' was successfully built.

```
1 //*****
2 /** Compute Module 5
3 /** gpiodproject app
4 /** VERSION 1.00 PROD
5 /** COMPILED USING aarch64-linux-gnu
6 /** ADAPTED BY FRED EADY
7 /** LAST UPDATED 08/01/2025
8 /** CHANGES/ADDITIONS
9 /** NOTES:
10 /** 07/13/2025 Be sure to copy CM5 libgpiod library files to /usr/local/lib
11 /**          Copy CM5 gpio.h to /usr/local/include
12 /**          Add /usr/local/lib to -L linker libs
13 /**          Add /usr/local/include to Cross GCC Compiler -l
14 /**          Add gpiod -l linker libs
15 //*****
16 // SPDX-License-Identifier: GPL-2.0-or-later
17 // SPDX-FileCopyrightText: 2023 Kent Gibson <warthog618@gmail.com>
18
19 /* Minimal example of toggling multiple lines. */
20
21 #include <errno.h>
22 #include <gpio.h>
23 #include <stdio.h>
24 #include <stdlib.h>
25 #include <string.h>
26 #include <unistd.h>
27
28 //*****
29 /** SPECIFY NUMBER OF LINES TO TOGGLE
30 //*****
31 #define NUM_LINES 2
32
33 //*****
34 /** REQUEST THE OUTPUT LINES
35 //*****
```

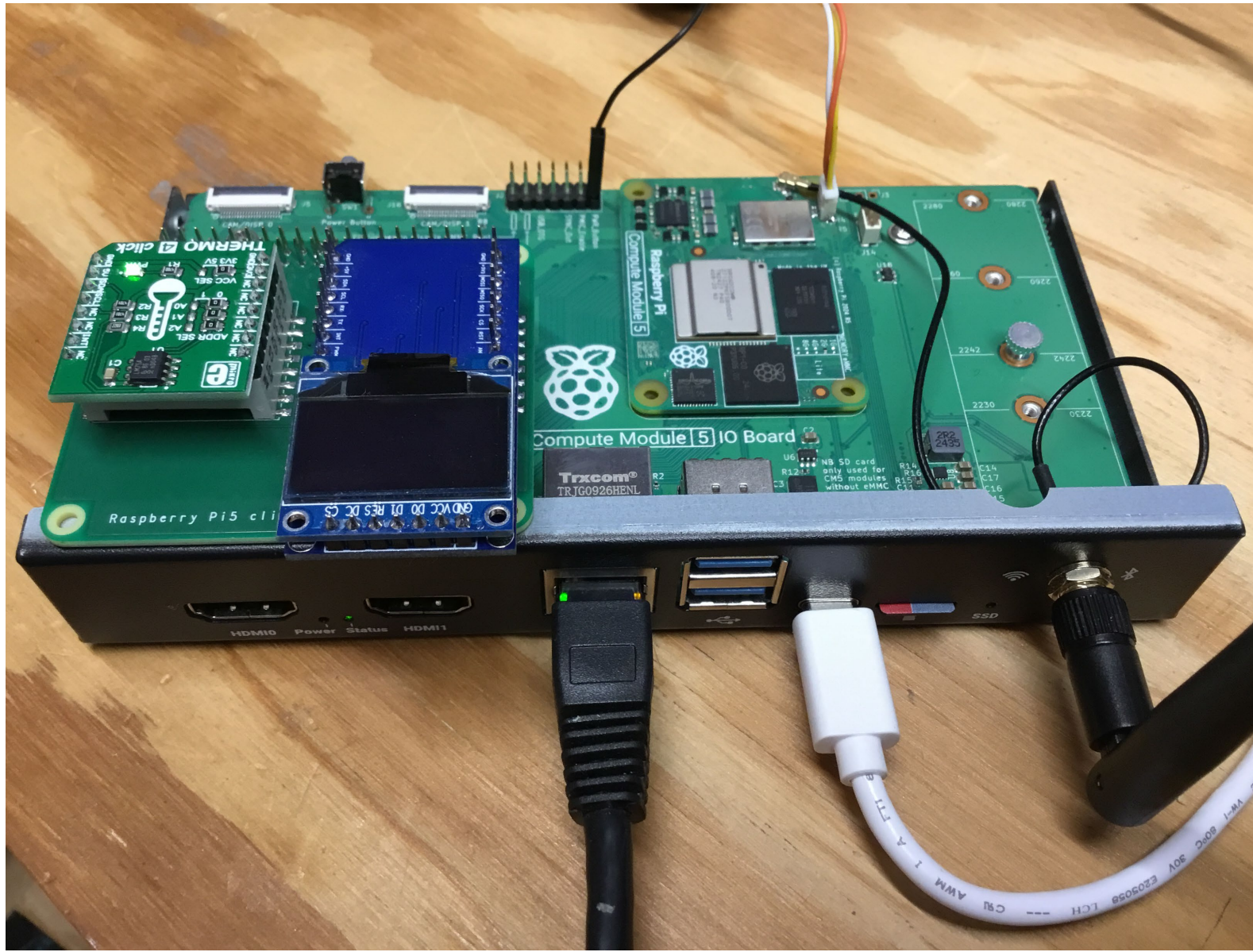
CDT Build Console [gpiodproject]
Invoking: Cross GCC Linker
aarch64-linux-gnu-gcc -L/usr/local/lib -o "gpiodproject" ./src/gpiodproject.o -lgp
Finished building target: gpiodproject

Execute the Application Code

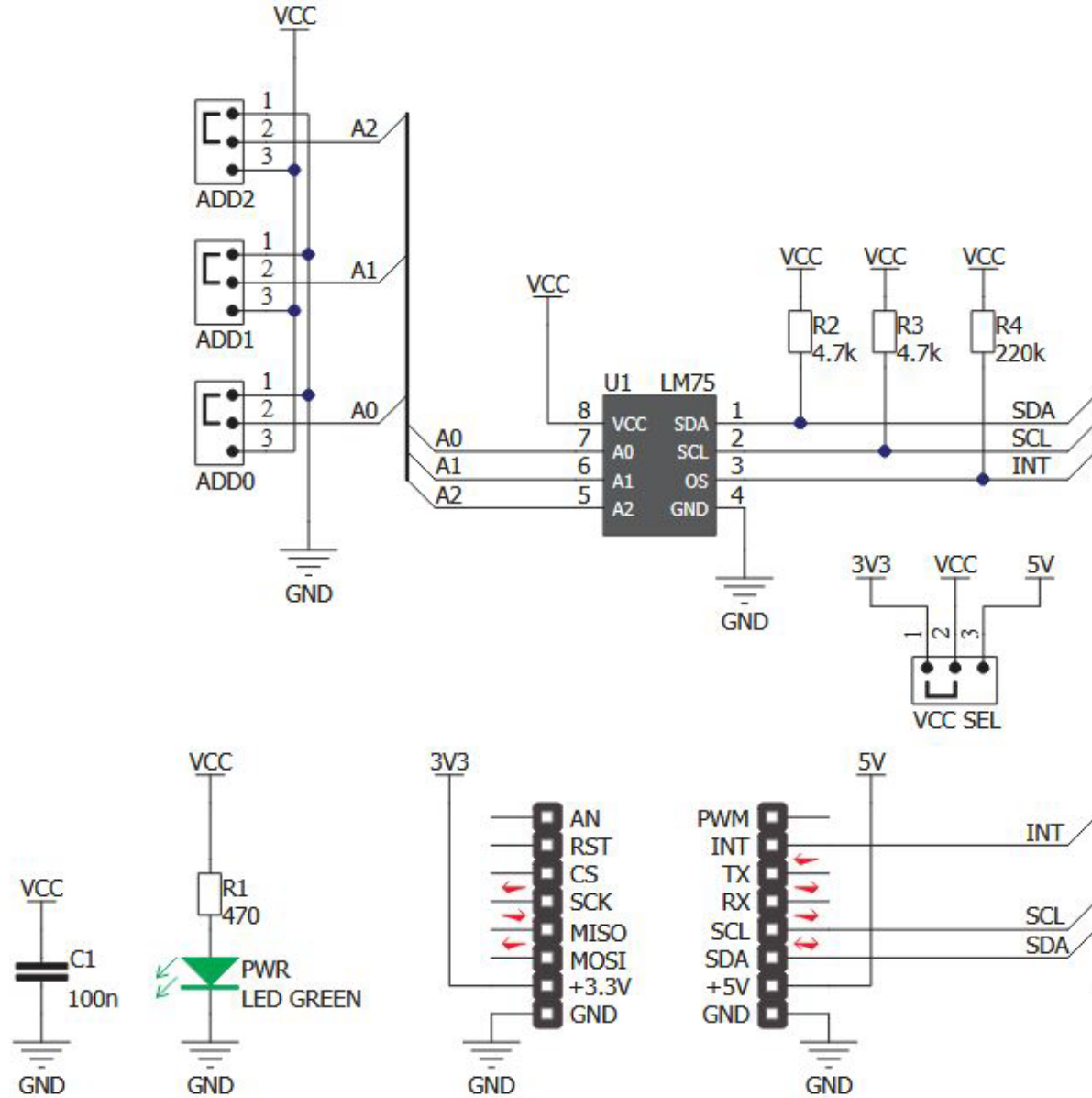
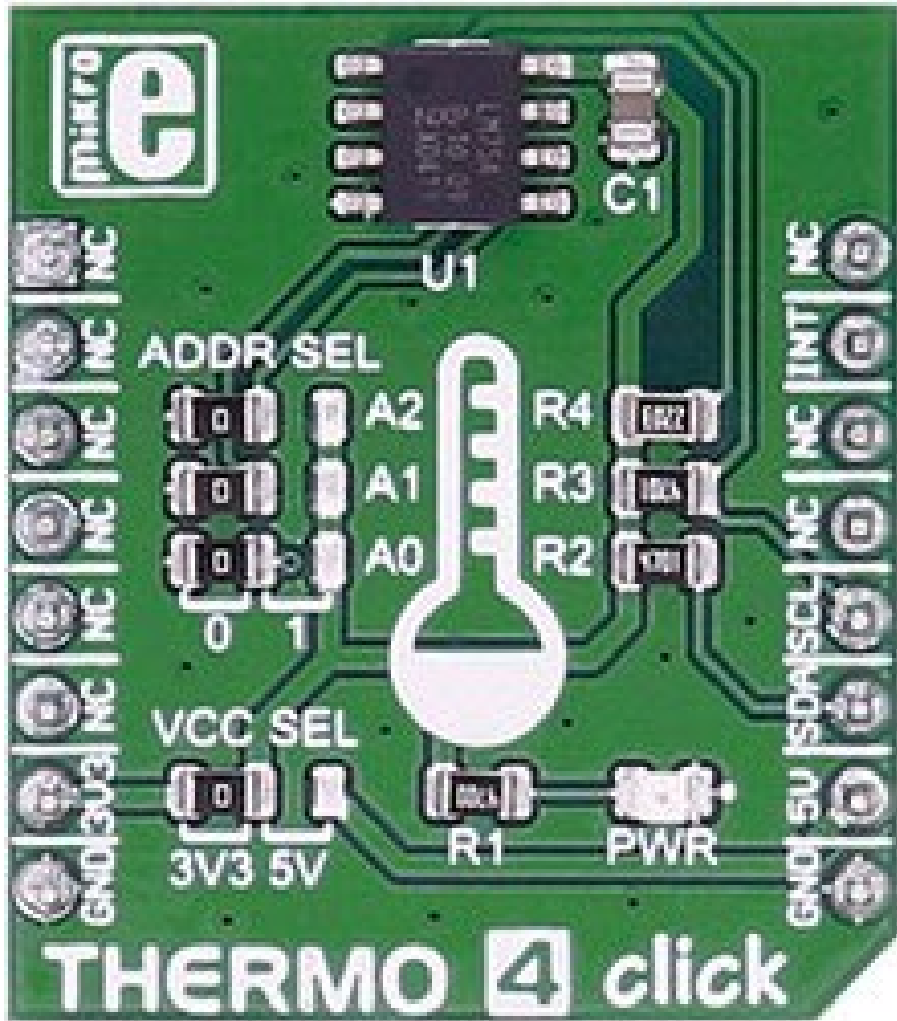
```
fred@pi5-yocto: ~  
File Edit View Search Terminal Help  
  
root@raspberrypi5:~/cm5app# ./gpiodproject  
4=Active 17=Inactive  
4=Inactive 17=Active  
4=Active 17=Inactive  
4=Inactive 17=Active  
4=Active 17=Inactive  
4=Inactive 17=Active  
4=Active 17=Inactive  
4=Inactive 17=Active  
4=Active 17=Inactive  
4=Inactive 17=Active  
4=Active 17=Inactive  
4=Inactive 17=Active  
4=Active 17=Inactive
```



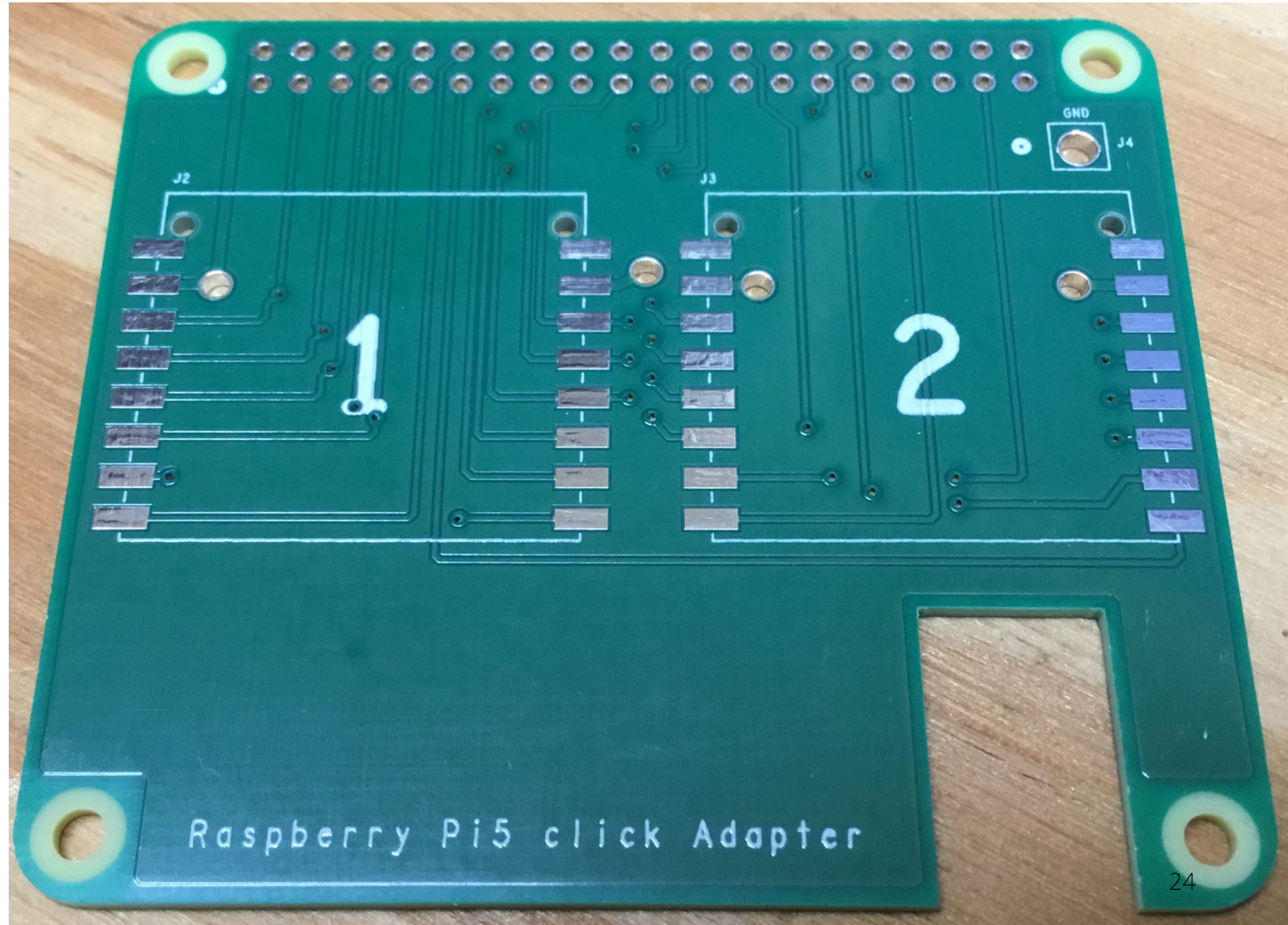
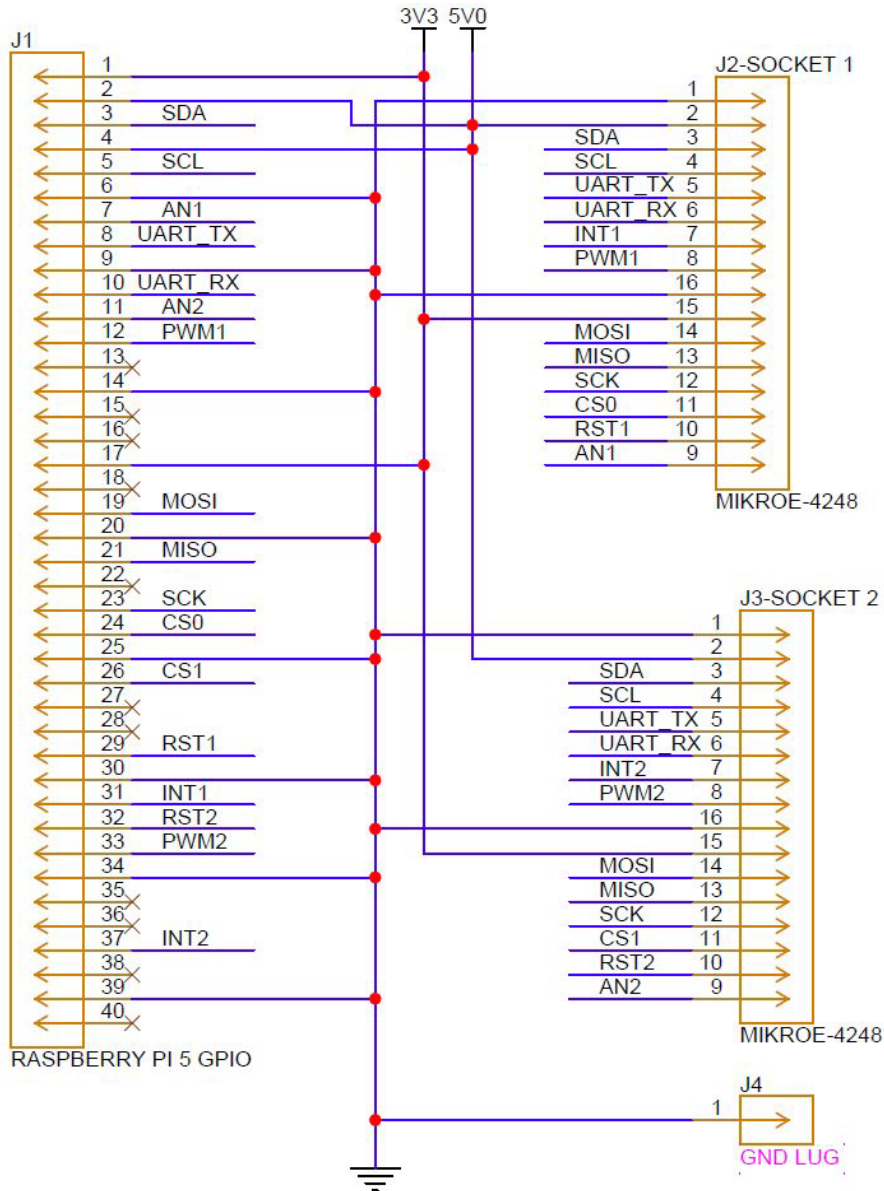
Assemble the Raspberry Pi Compute Module 5 Hardware



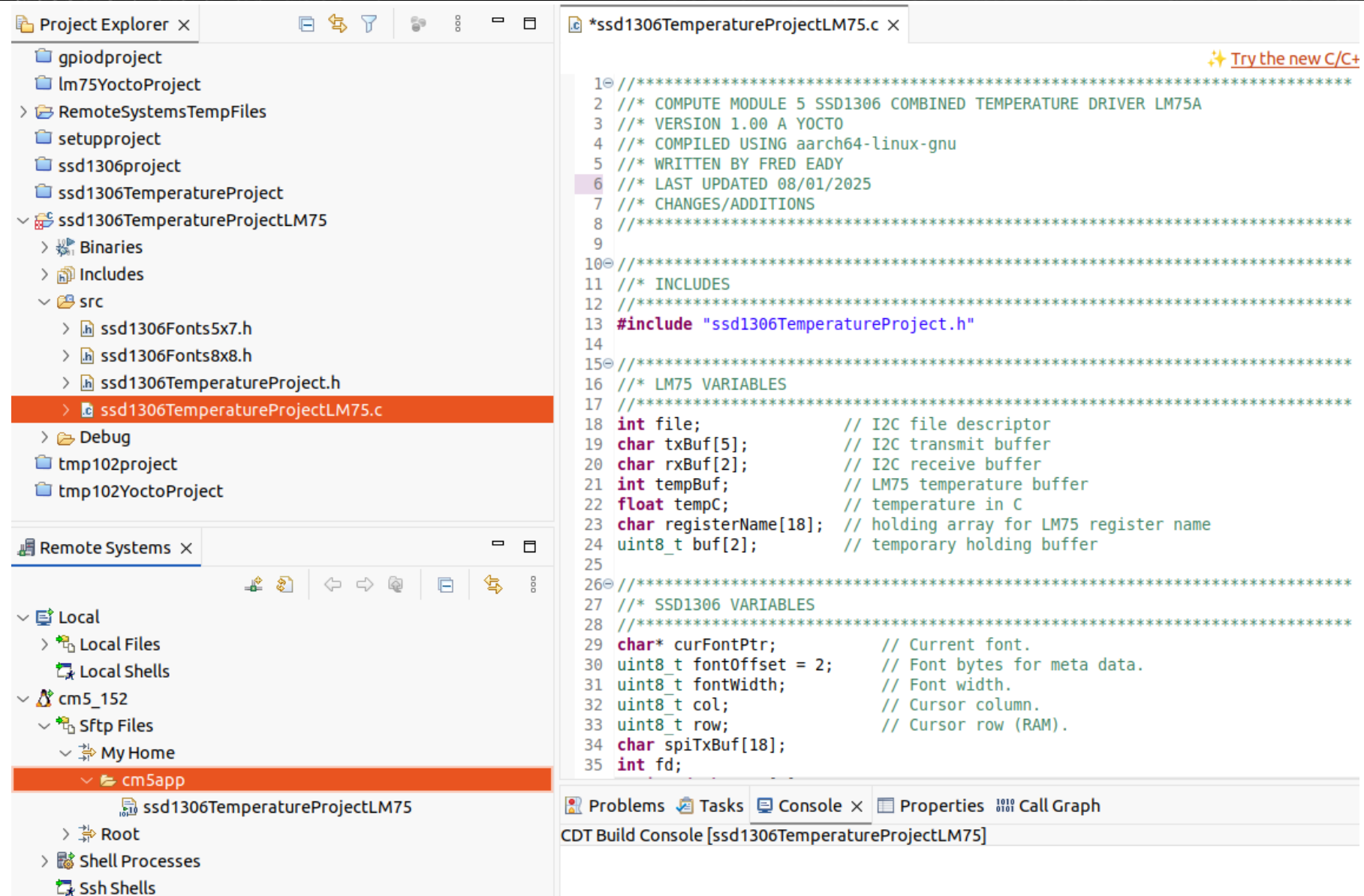
Assemble the Raspberry Pi 5 Hardware



Assemble the Raspberry Pi 5 Hardware



Create and Compile the Application Code



Project Explorer

- gpiodproject
- lm75YoctoProject
- RemoteSystemsTempFiles
- setupproject
- ssd1306project
- ssd1306TemperatureProject
- ssd1306TemperatureProjectLM75
 - Binaries
 - Includes
 - src
 - ssd1306Fonts5x7.h
 - ssd1306Fonts8x8.h
 - ssd1306TemperatureProject.h
 - ssd1306TemperatureProjectLM75.c
 - Debug
- tmp102project
- tmp102YoctoProject

Remote Systems

- Local
 - Local Files
 - Local Shells
- cm5_152
 - Sftp Files
 - My Home
 - cm5app
 - ssd1306TemperatureProjectLM75
- Root
- Shell Processes
- Ssh Shells

```
*ssd1306TemperatureProjectLM75.c *  
  
1 //*****  
2 /** COMPUTE MODULE 5 SSD1306 COMBINED TEMPERATURE DRIVER LM75A  
3 /** VERSION 1.00 A YOCTO  
4 /** COMPILED USING aarch64-linux-gnu  
5 /** WRITTEN BY FRED EADY  
6 /** LAST UPDATED 08/01/2025  
7 /** CHANGES/ADDITIONS  
8 /*******  
9  
10 //*****  
11 /** INCLUDES  
12 /*******  
13 #include "ssd1306TemperatureProject.h"  
14  
15 //*****  
16 /** LM75 VARIABLES  
17 /*******  
18 int file;           // I2C file descriptor  
19 char txBuf[5];      // I2C transmit buffer  
20 char rxBuf[2];      // I2C receive buffer  
21 int tempBuf;        // LM75 temperature buffer  
22 float tempC;        // temperature in C  
23 char registerName[18]; // holding array for LM75 register name  
24 uint8_t buf[2];     // temporary holding buffer  
25  
26 //*****  
27 /** SSD1306 VARIABLES  
28 /*******  
29 char* curFontPtr;   // Current font.  
30 uint8_t fontOffset = 2; // Font bytes for meta data.  
31 uint8_t fontWidth;  // Font width.  
32 uint8_t col;        // Cursor column.  
33 uint8_t row;        // Cursor row (RAM).  
34 char spiTxBuf[18];  
35 int fd;
```

Problems Tasks Console x Properties Call Graph
CDT Build Console [ssd1306TemperatureProjectLM75]

Main Application Flow

```
//*****  
// INITIALIZE THE SSD1306 DISPLAY  
//*****  
initSSD1306();  
  
//*****  
// Read the temperature  
//*****  
if(read(file,rxBuf,2) != 2)  
{  
    printf("Could not read from I2C device.\n");  
    exit(1);  
}  
printf("INFO: 2 bytes were read-> rxBuf[0] 0x%02X -- rxBuf[1] 0x%02X\n",rxBuf[0],rxBuf[1]);  
  
//*****  
// Convert temperature bytes to 16-bit value  
//*****  
tempBuf = (rxBuf[0] << 4) | (rxBuf[1] >> 4);  
printf("INFO: 16-bit value = 0x%04X\n",tempBuf);
```

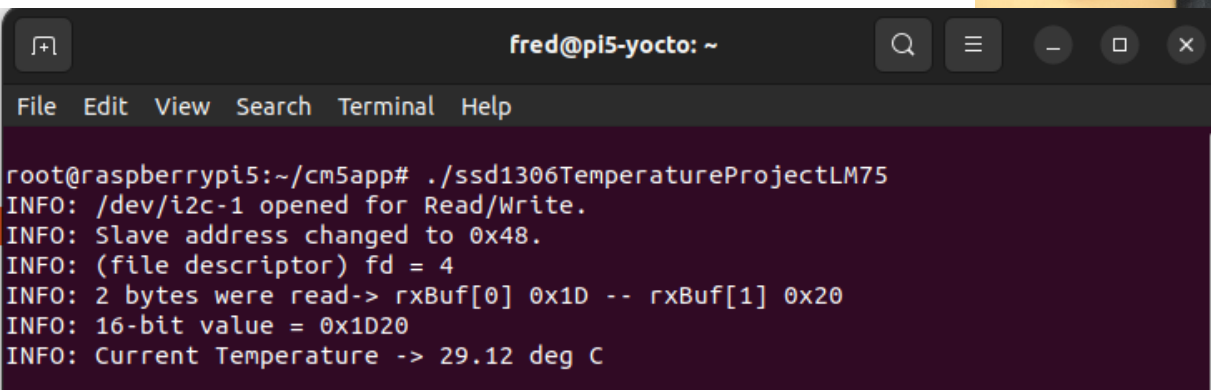
Main Application Flow

C ssd1306TemperatureProjectLM75.c ×

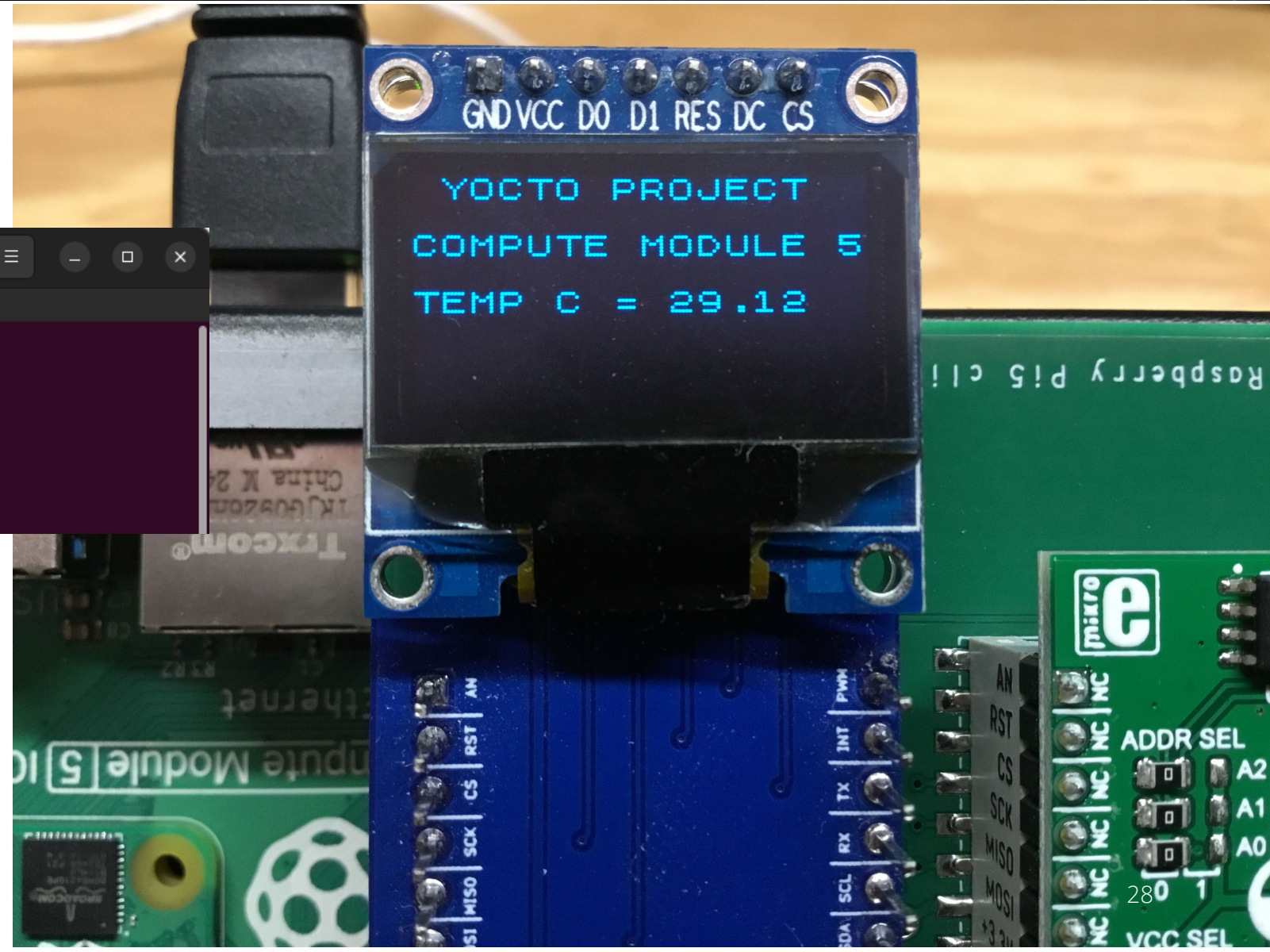
ssd1306TemperatureProjectLM75 > src > C ssd1306TemperatureProjectLM75.c

```
345 //*****
346 // Compute and print the temperature
347 //*****
348 buf[0] = (uint8_t)(tempBuf >> 5);
349 buf[0] &= 0x07;
350 buf[1] = (uint8_t)(tempBuf >> 8);
351
352 if(buf[1] > 0x80)
353 {
354     buf[1] = (~buf[1]) + 1;
355     tempC = (float)buf[1] + ((float)buf[0] * 0.125);
356     tempC *= -1.0;
357 }
358 else
359 {
360     tempC = (float)buf[1] + ((float)buf[0] * 0.125);
361 }
362
363 printf("INFO: Current Temperature -> %.2f deg C\n\n",tempC);
364
365 setTextXY(0,0);
366 sprintf(spiTxBuf," YOCTO PROJECT");
367 displayString(spiTxBuf);
368 setTextXY(2,0);
369 sprintf(spiTxBuf,"COMPUTE MODULE 5" );
370 displayString(spiTxBuf);
371 setTextXY(4,0);
372 sprintf(spiTxBuf,"TEMP C = %3.2F",tempC);
373 displayString(spiTxBuf);
374 }
```

Execute the Application Code



```
fred@pi5-yocto: ~  
File Edit View Search Terminal Help  
root@raspberrypi5:~/cm5app# ./ssd1306TemperatureProjectLM75  
INFO: /dev/i2c-1 opened for Read/Write.  
INFO: Slave address changed to 0x48.  
INFO: (file descriptor) fd = 4  
INFO: 2 bytes were read-> rxBuf[0] 0x1D -- rxBuf[1] 0x20  
INFO: 16-bit value = 0x1D20  
INFO: Current Temperature -> 29.12 deg C
```



Next Time...

LET'S EAT!

Thank you for attending!!!

Please consider the resources below:

- [Today's Download Package](#)
- digikey.com





Thank You

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