CEC Continuing Education Center

DesignNews

Bare Metal C Programming for STM32 Devices

Day 1:

Bare Metal NUCLEO-F207ZG :

The STM32CubeIDE Visual Studio Code Extension Package

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Webinar Logistics

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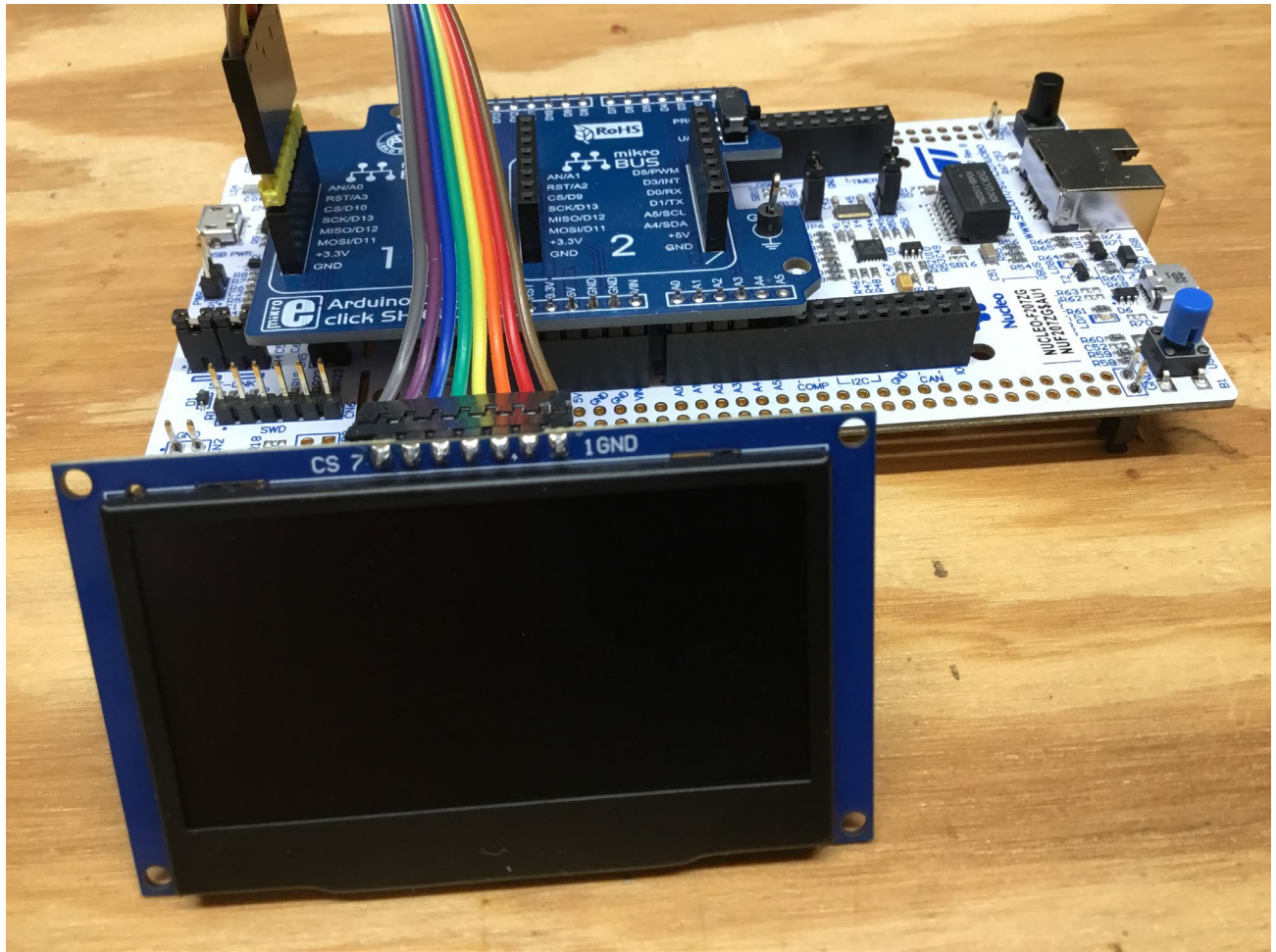
Fred Eady

Visit ‘Lecturer Profile’ in your console for more details.

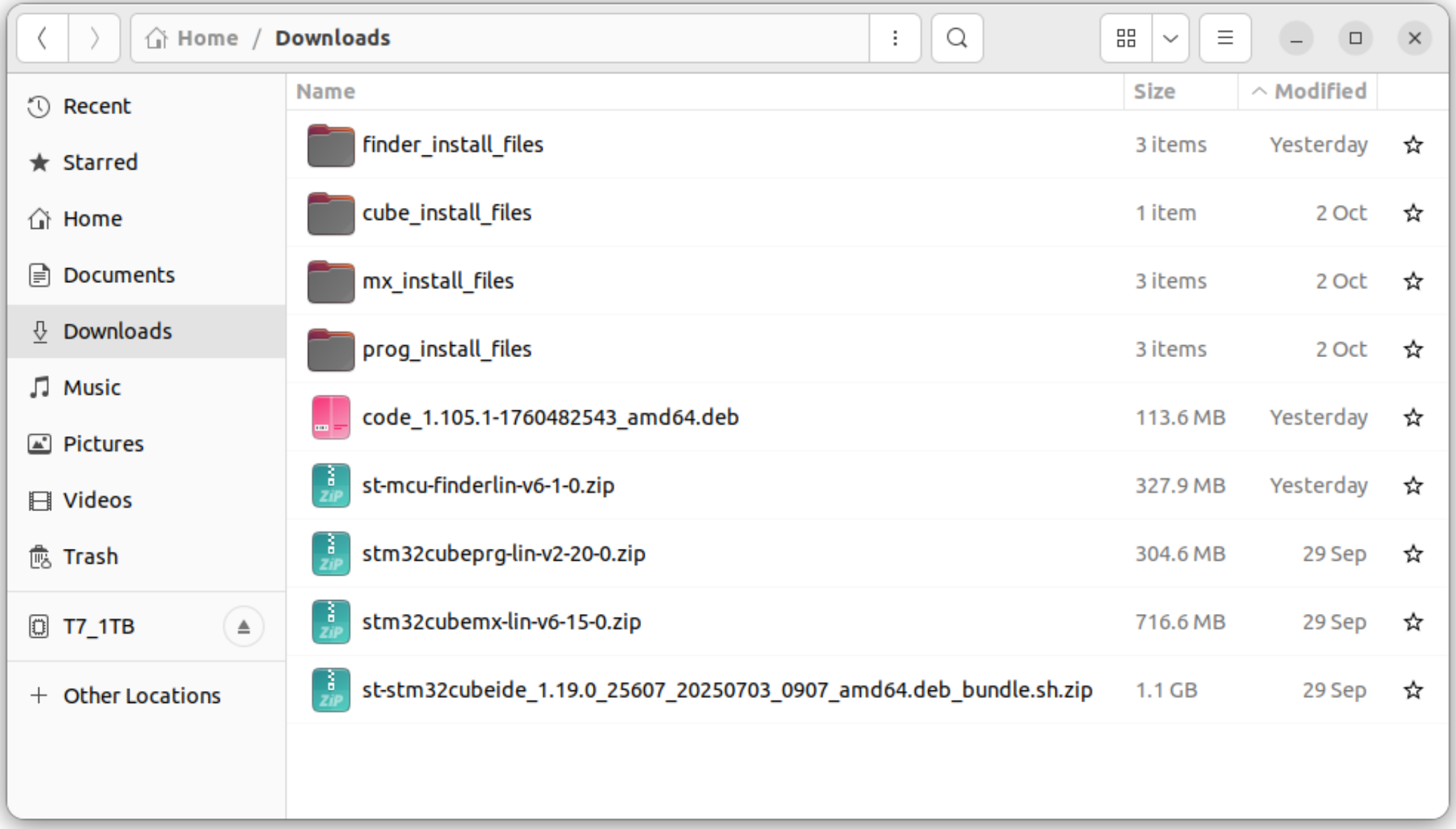
MAX

AGENDA

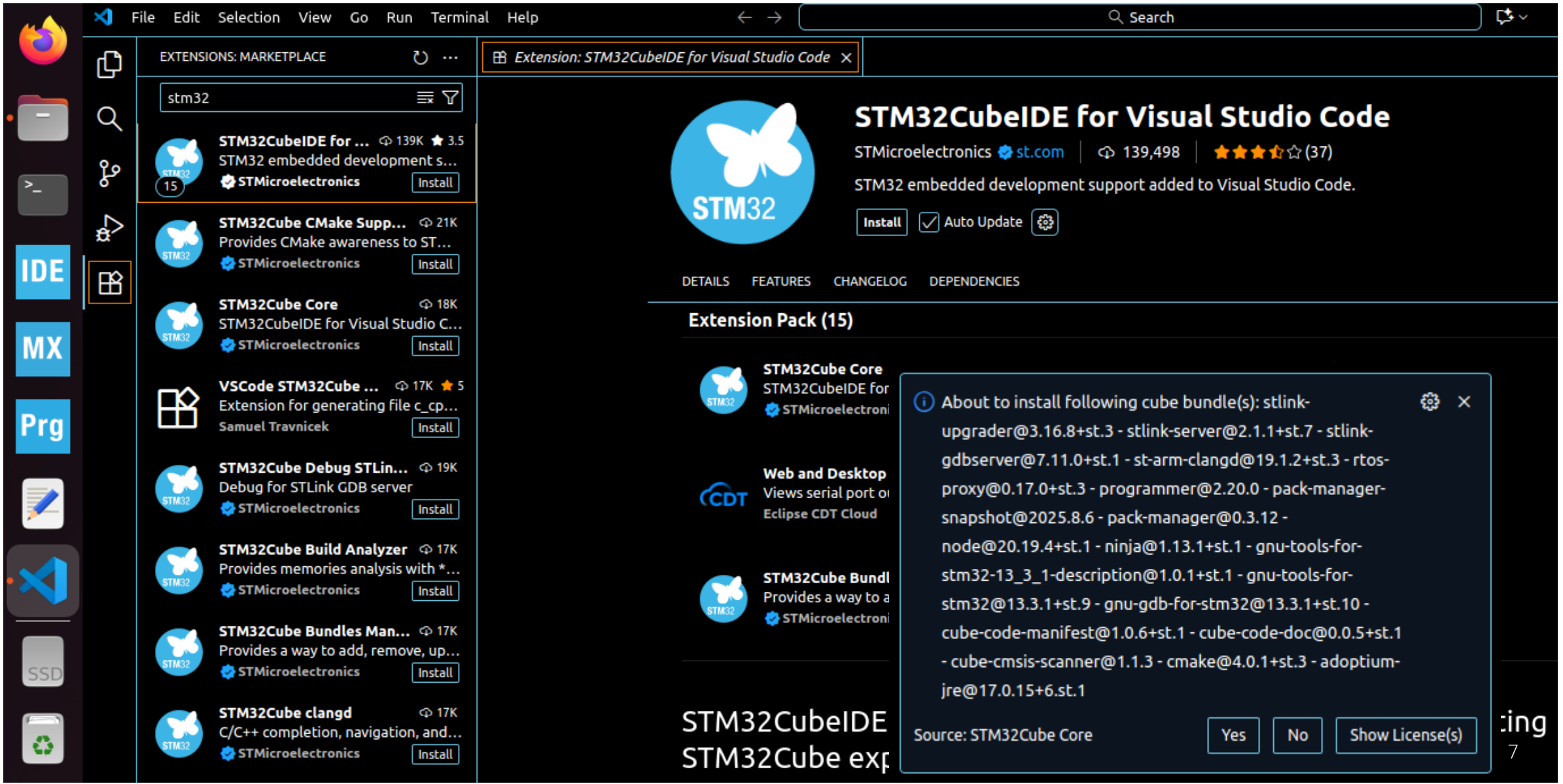
- **Install the Core STM32 Development Tools**
- **Create a Bare Metal SSD1309 Application**



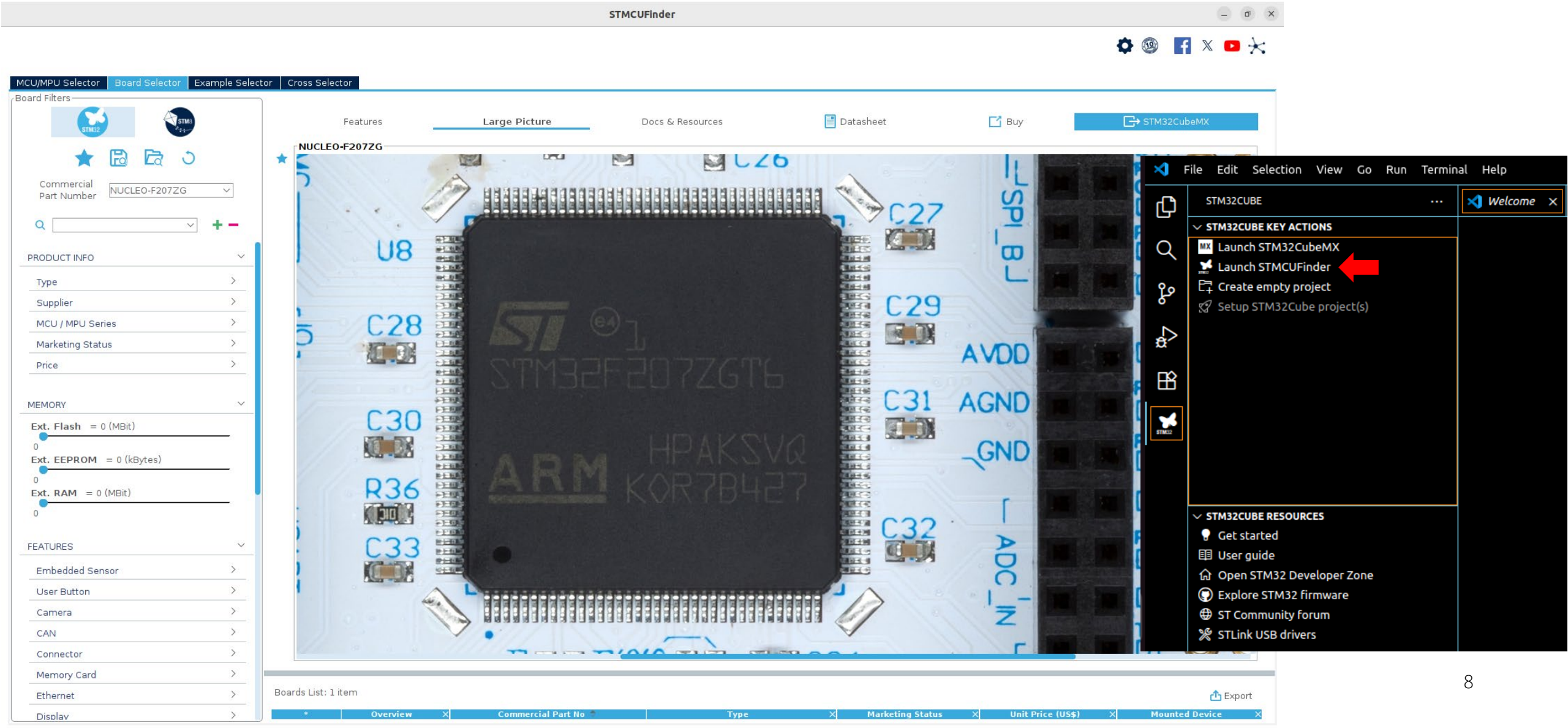
Download and Install the Core STM32 Development Tools



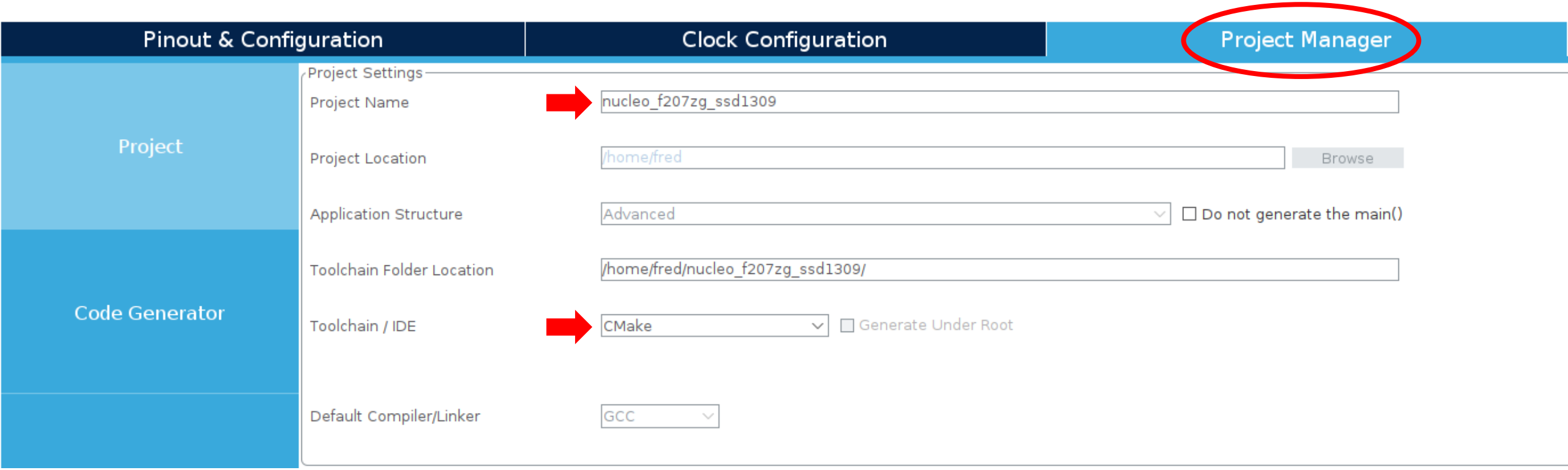
Install the STM32CubeIDE for Visual Studio Code Extension



Launch STM32CUFinder – Select NUCLEO-F207ZG



Run STM32CubeMX – Specify Project Name and Toolchain



Run STM32CubeMX – Configure the GPIO

Pinout & Configuration | Clock C | So

Categories | A->Z

System Core
- DMA
- GPIO
- IWDG
- NVIC
- RCC
- SYS
- WWDG

Analog

Timers

Connectivity

Multimedia

Security

GPIO Mode and Configuration

Mode

Configuration

Group By Peripherals

SYS | USART | USB | NVIC

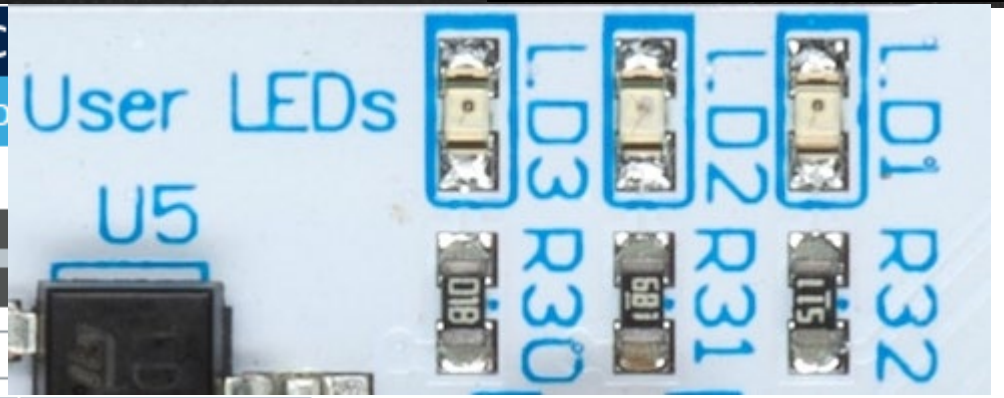
GPIO | Single Mapped Signals | I2C | RCC | SPI

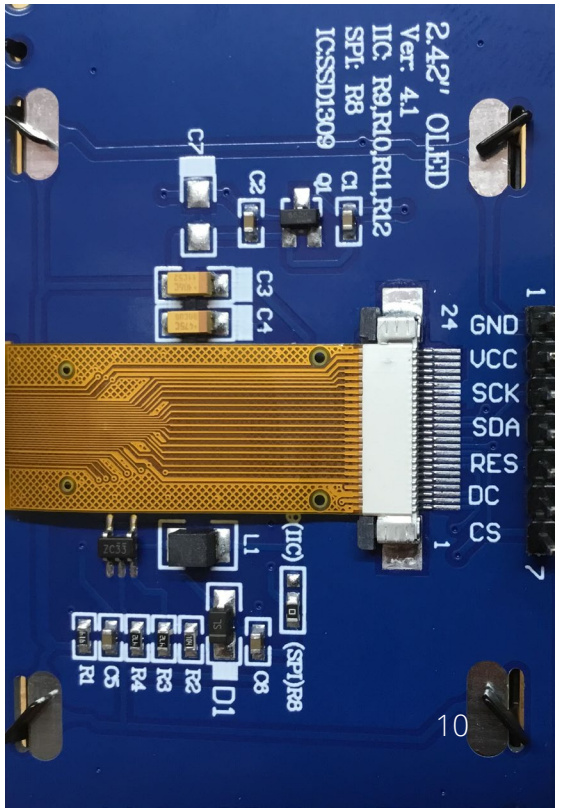
Search Signals

Search (Ctrl+F)

Show only Modified Pins

Pin ...	Signal ...	GPIO o...	GPIO m...	GPIO P...	Maximu...	User La...	Modified
PA3	n/a	Low	Output ...	No pull-...	Low	DC	☑
PB0	n/a	Low	Output ...	No pull-...	Low	LED1G	☑
PB7	n/a	Low	Output ...	No pull-...	Low	LED2B	☑
PB14	n/a	Low	Output ...	No pull-...	Low	LED3R	☑
PC13	n/a	n/a	Externa...	No pull-...	n/a	BTN1	☑
PD14	n/a	Low	Output ...	No pull-...	High	SPI1_CS	☑
PF3	n/a	High	Output ...	No pull-...	Low	RST	☑
PG6	n/a	Low	Output ...	No pull-...	Low	USB_P...	☑
PG7	n/a	n/a	Input m...	No pull-...	n/a	USB_O...	☑





Run STM32CubeMX – Configure SPI1

Pinout & Configuration | Clock Configuration | Software Packs

Categories | A->Z

System Core
- DMA
- GPIO
- IWDG
- NVIC
- RCC
- SYS
- WWDG

Analog

Timers

Connectivity

Multimedia

Security

GPIO Mode and Configuration

Mode

Configuration

Group By Peripherals

SYS | USART | USB | NVIC

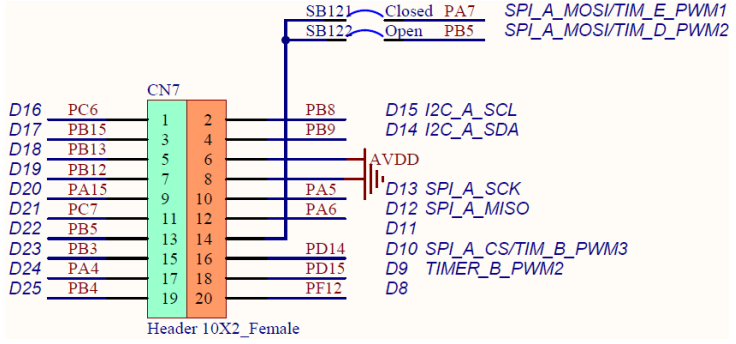
GPIO | Single Mapped Signals | I2C | RCC | SPI

Search Signals

Search (Ctrl+F)

Show only Modified Pins

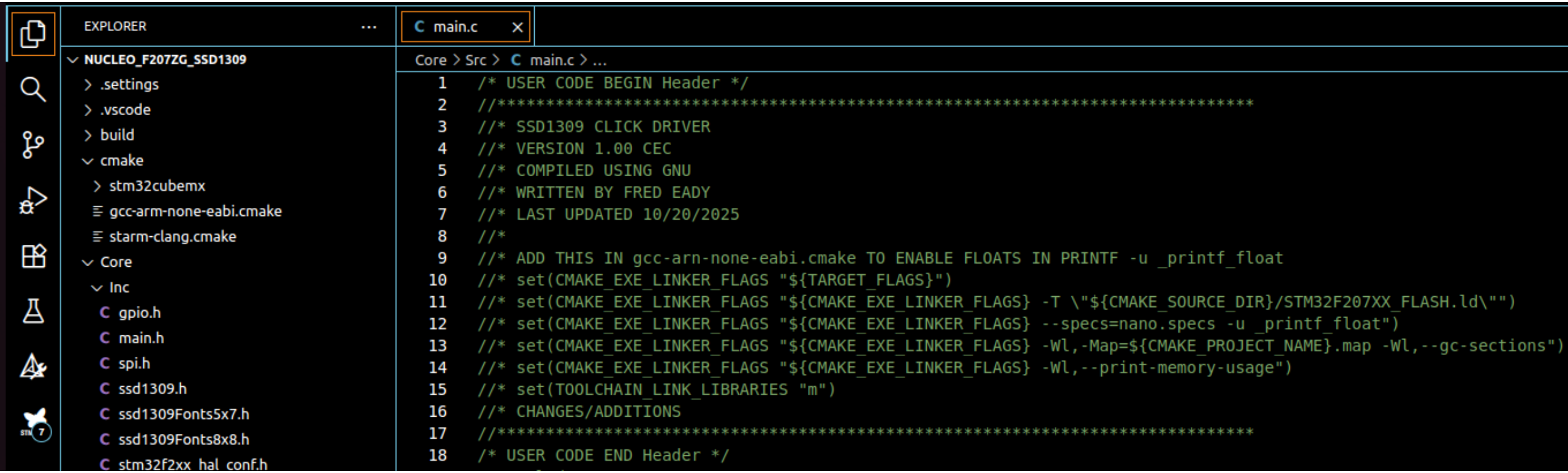
Pin ...	Signal on Pin	GPIO o...	GPIO m...	GPIO P...	Maxim...	User L...	Modified
PA5	SPI1_SCK	n/a	Alterna...	No pull...	High		
PA6	SPI1_MISO	n/a	Alterna...	No pull...	High		
PA7	SPI1_MOSI	n/a	Alterna...	No pull...	High		

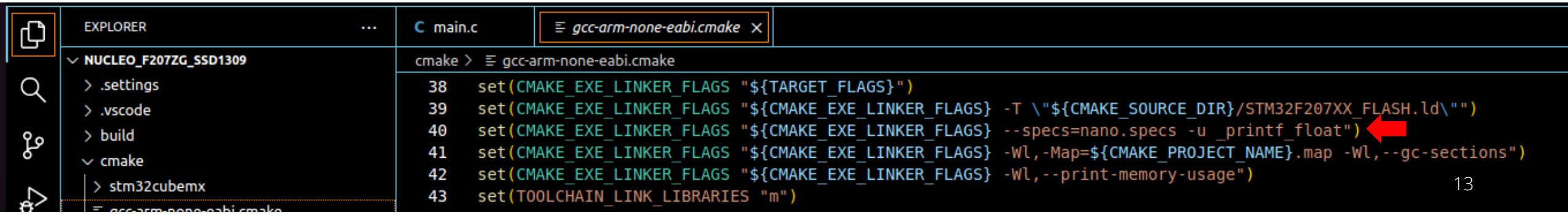


Run STM32CubeMX – Generate the Skeleton Code

GENERATE CODE

Enable Printf Floats and Rebuild



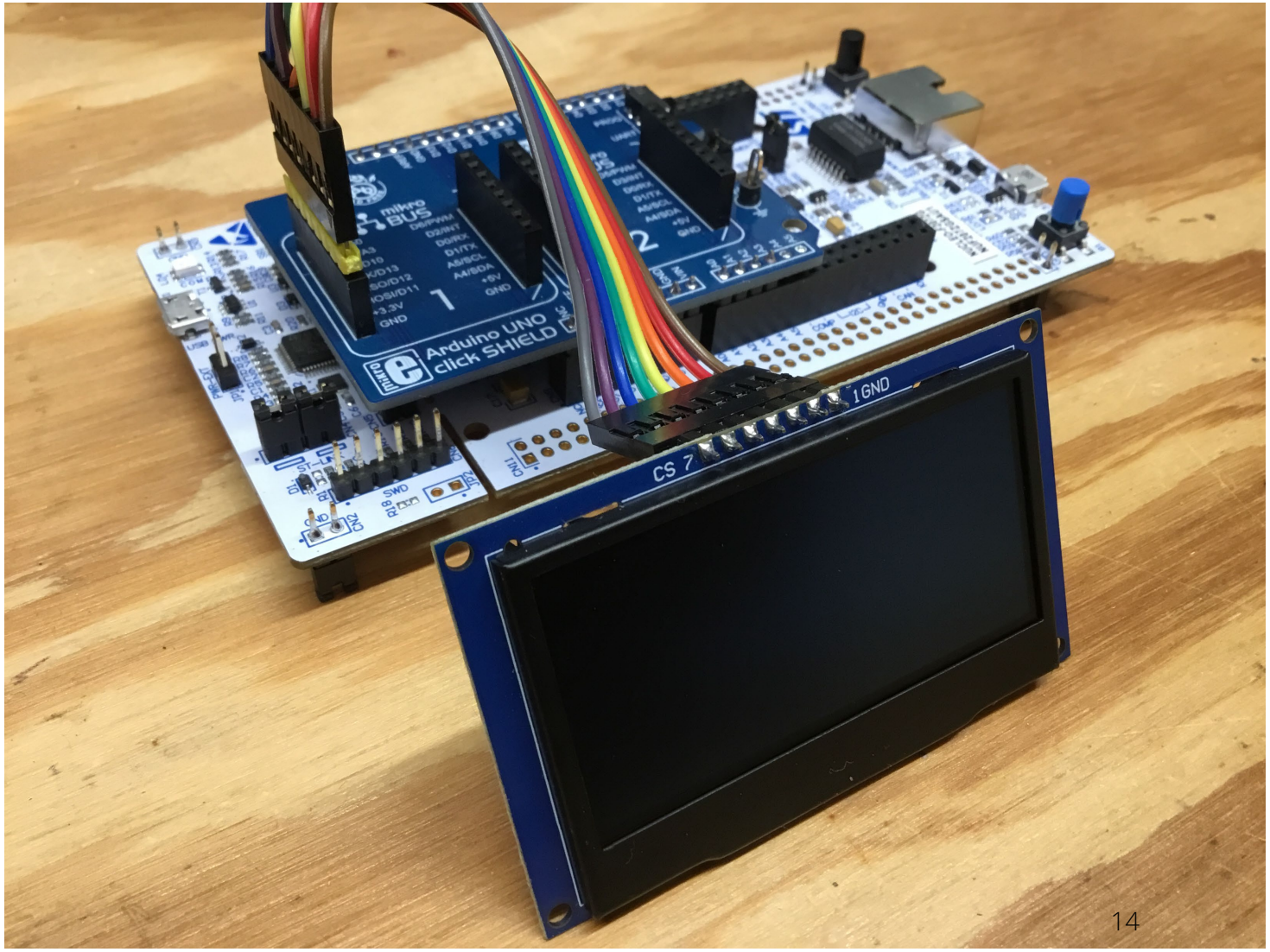


The Application Code – ssd1309.h

ssd1309.h

Core > Inc > ssd1309.h > ...

```
25  //*************************************************************
26  //* FUNCTION PROTOTYPES
27  //* PREVENTS HAVING TO MANAGE THE ORDER OF ssd1309.c FUNCTONS
28  //*************************************************************
29  void displayString(char *string);
30  void sendCmd(char cmd);
31  void sendData(char bite);
32  void setFont(char* font);
33  void displayChar(char ch);
34  void setTextXY(uint8_t row, uint8_t col);
35  void clearDisplay(void);
36  void resetSSD1309(void);
37  void initSSD1309(void);
38
39  #define ON                      1
40  #define OFF                     0
41
42  #define SSD1309_Max_X           127     //128 Pixels
43  #define SSD1309_Max_Y           63      //64  Pixels
44
45  #define PAGE_MODE               01
46  #define HORIZONTAL_MODE         02
47
48  #define SSD1309_Command_Mode        0x80
49  #define SSD1309_Data_Mode           0x40
50  #define SSD1309_Display_Off_Cmd     0xAE
51  #define SSD1309_Display_On_Cmd      0xAF
52  #define SSD1309_Normal_Display_Cmd  0xA6
53  #define SSD1309_Inverse_Display_Cmd 0xA7
54  #define SSD1309_Activate_Scroll_Cmd 0x2F
55  #define SSD1309_Dectivate_Scroll_Cmd 0x2E
56  #define SSD1309_Set_Brightness_Cmd  0x81
```



The Application Code – ssd1309.c

ssd1309.c 4

Core > Src > ssd1309.c > sendCmd

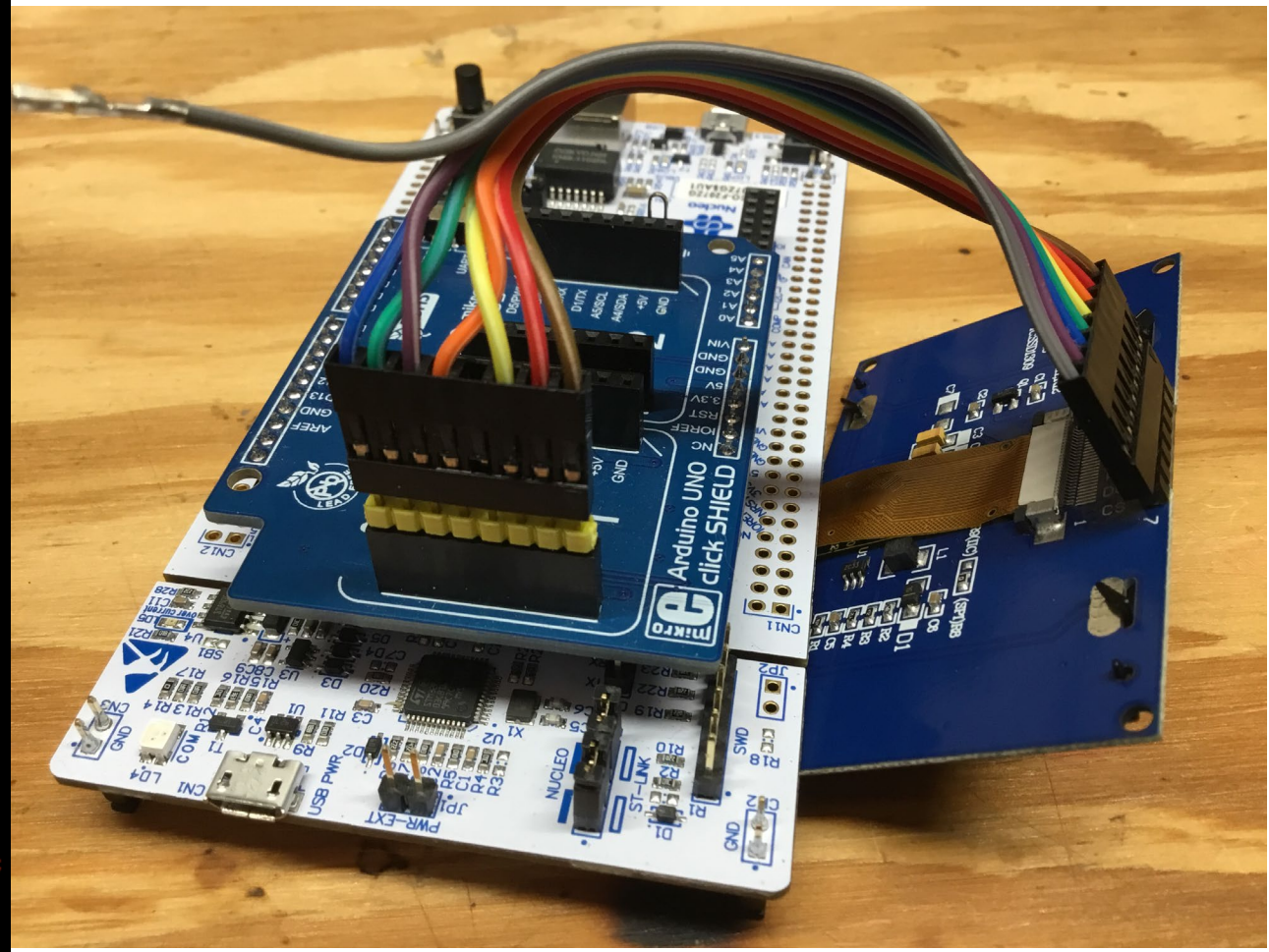
```c
//*****************************************************************************
//* SSD1306 CLICK DRIVER
//* VERSION 1.00 A CEC
//* COMPILED USING GNU
//* WRITTEN BY FRED EADY
//* LAST UPDATED 10/20/2025
//* CHANGES/ADDITIONS
//*****************************************************************************
//*****************************************************************************
//* INCLUDES
//*****************************************************************************
#include "main.h"
#include "stm32f2xx_hal_def.h"
#include "ssd1309.h"

//*****************************************************************************
//* SSD1309 VARIABLES
//*****************************************************************************
char* curFontPtr;           // Current font.
uint8_t fontOffset = 2;     // Font bytes for meta data.
uint8_t fontWidth;          // Font width.
uint8_t col;                // Cursor column.
uint8_t row;                // Cursor row (RAM).

extern char spiTxBuf[128];
extern SPI_HandleTypeDef hspi1;

void cmdMode(void)
{
    HAL_GPIO_WritePin(GPIOx: DC_GPIO_Port, GPIO_Pin: DC_Pin, PinState: GPIO_PIN_RESET);
}

void dataMode(void)
{
    HAL_GPIO_WritePin(GPIOx: DC_GPIO_Port, GPIO_Pin: DC_Pin, PinState: GPIO_PIN_SET);
}
```

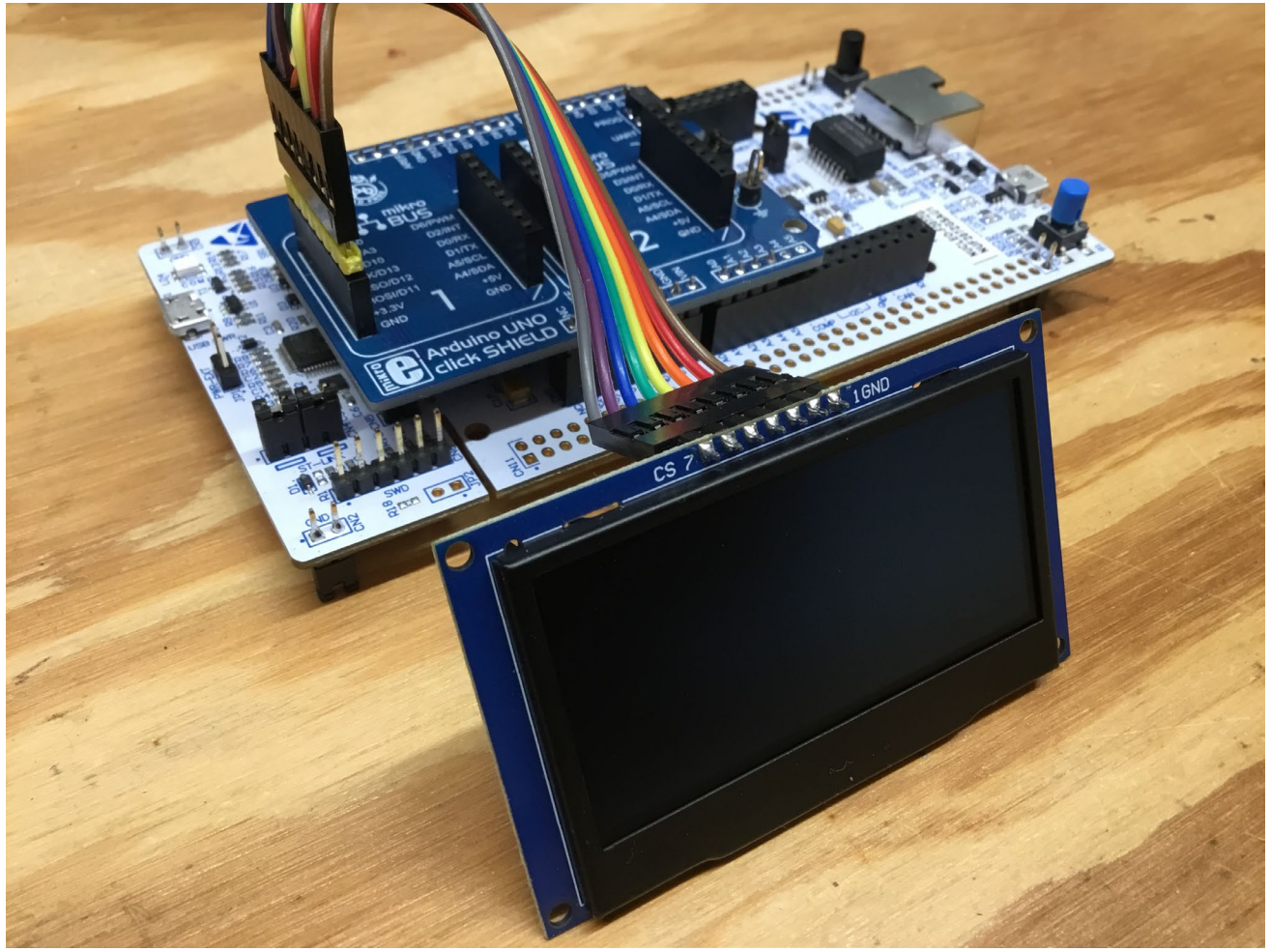


The Application Code – main.c

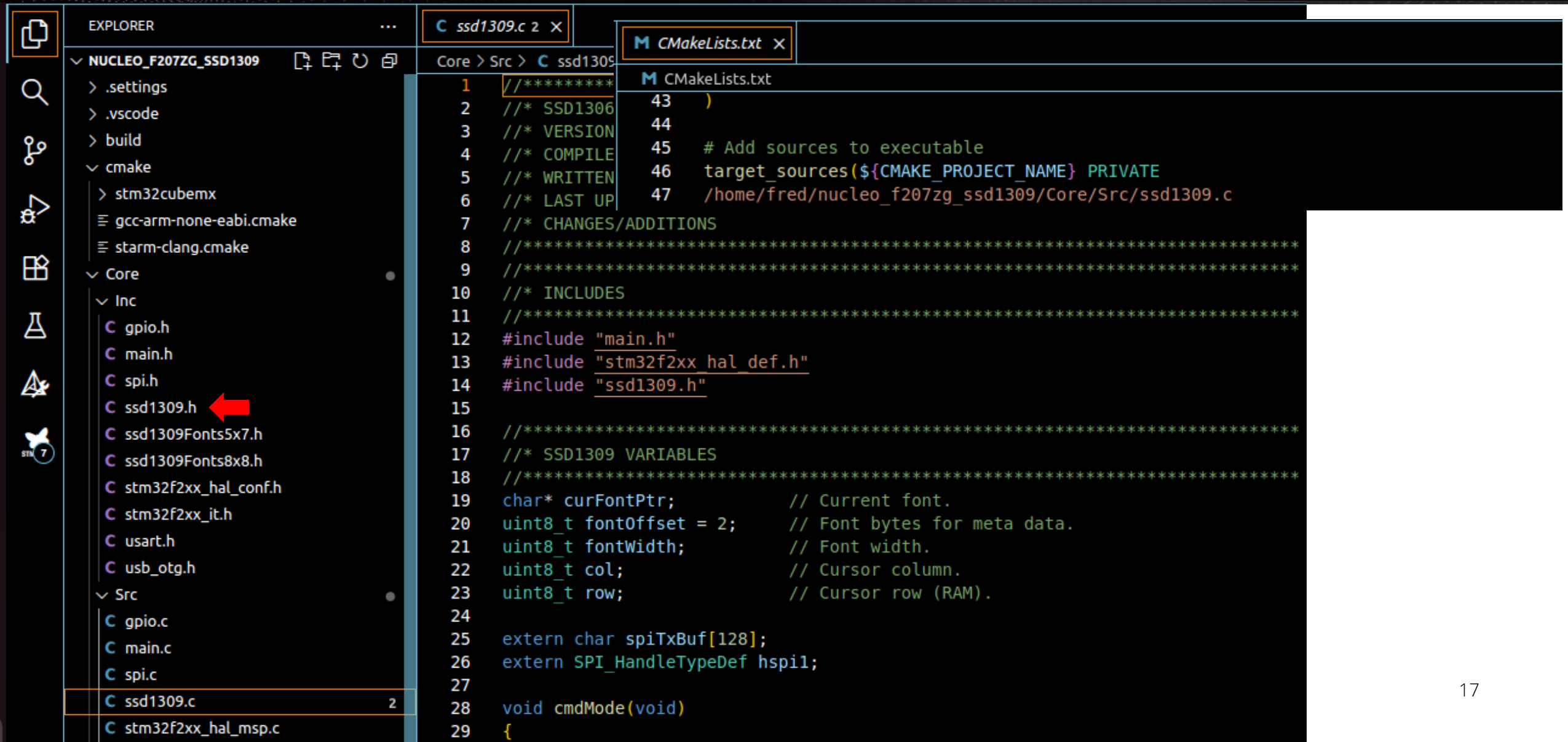
main.c

Core > Src > main.c > main

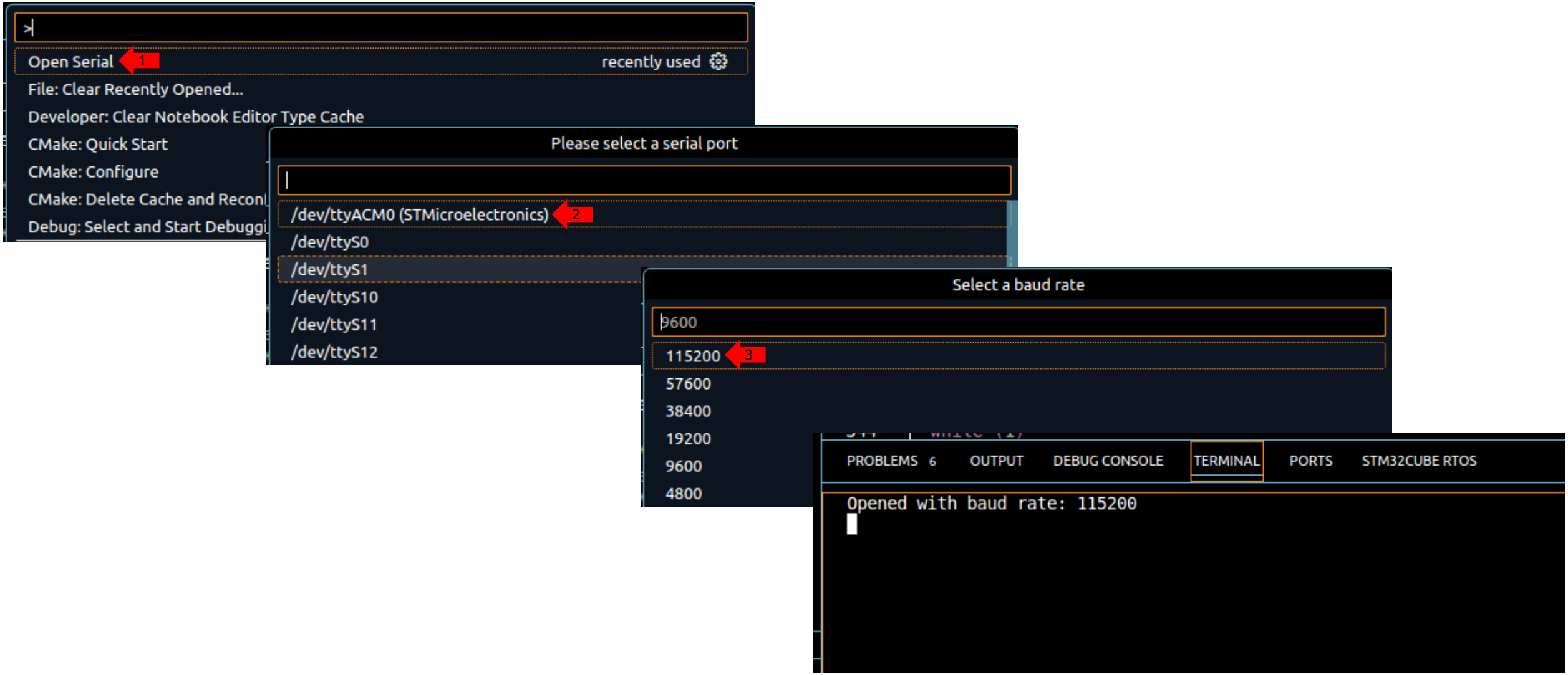
```
96   int main(void)
118  {
119    /* Initialize all configured peripherals */
120    MX_GPIO_Init();
121    MX_USART3_UART_Init();
122    MX_USB_OTG_FS_PCD_Init();
123    MX_SPI1_Init();
124    /* USER CODE BEGIN 2 */
125    //*****************************************************************************
126    // INITIALIZE THE SSD1309 DISPLAY AND PRINT TO THE SSD1309
127    //*****************************************************************************
128    initSSD1309();
129    setTextXY(row: 0,col: 0);
130    sprintf(spiTxBuf,"SSD1309 PROJECT");
131    displayString(string: spiTxBuf);
132    setTextXY(row: 2,col: 0);
133    sprintf(spiTxBuf,"NUCLEO-F207ZG" );
134    displayString(string: spiTxBuf);
135    setTextXY(row: 4,col: 0);
136    sprintf(spiTxBuf,"BareMetal App");
137    displayString(string: spiTxBuf);
138    setTextXY(row: 6,col: 0);
139    sprintf(spiTxBuf,"CEC ROCKS!");
140    displayString(string: spiTxBuf);
141    /* USER CODE END 2 */
142
143    /* Infinite loop */
144    /* USER CODE BEGIN WHILE */
145    while (1)
146    {
147      /* USER CODE END WHILE */
148
149      /* USER CODE BEGIN 3 */
150    }
151    /* USER CODE END 3 */
152  }
```



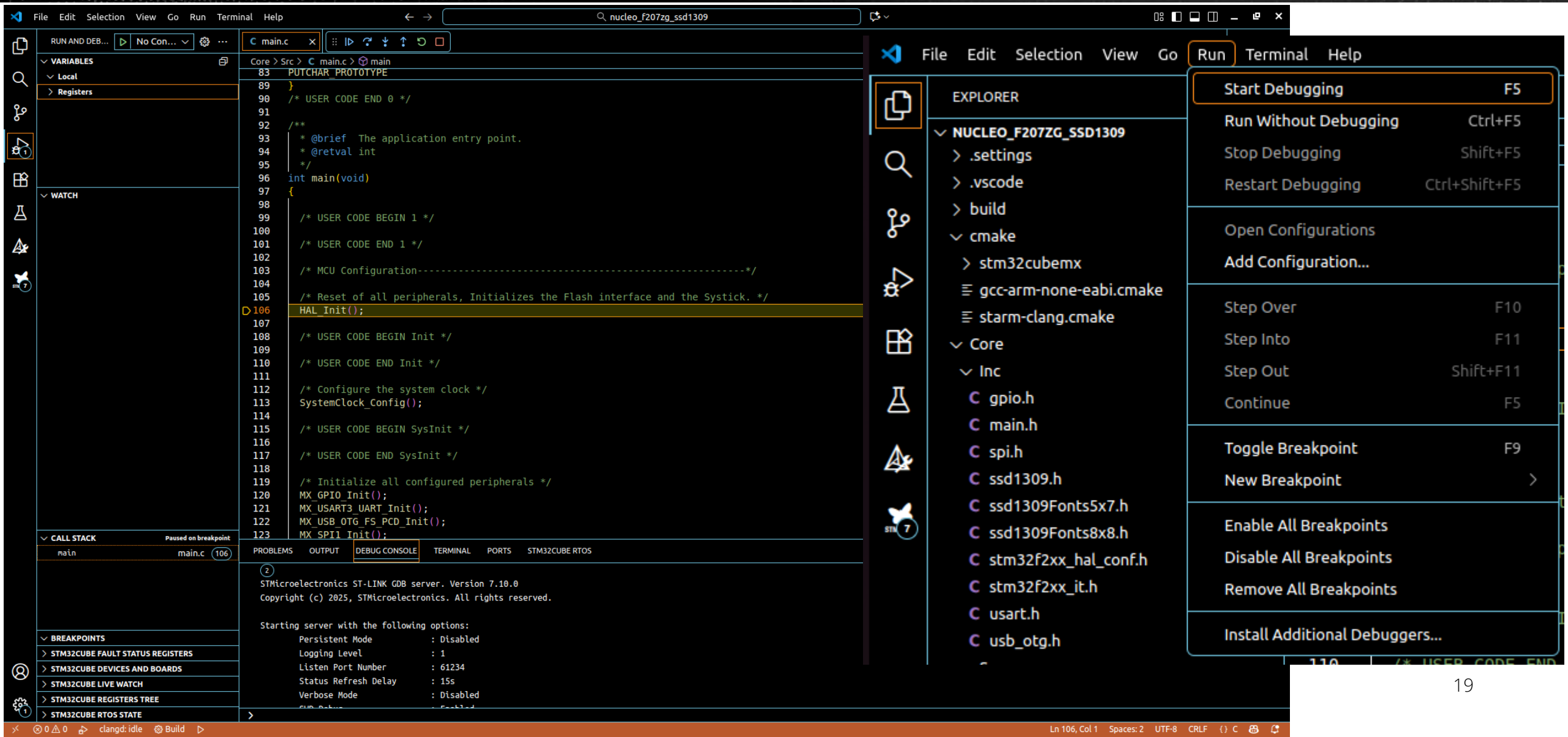
The Application Code – Add ssd1309.c to CMakeLists.txt



Open the Serial Port



Unleash MAX


File Edit Selection View Go Run Terminal Help
nucleo_f207zg_ssd1309
RUN AND DEB... No Con...
VARIABLES
Local
Registers
WATCH
CALL STACK Paused on breakpoint
main main.c 106
BREAKPOINTS
STM32CUBE FAULT STATUS REGISTERS
STM32CUBE DEVICES AND BOARDS
STM32CUBE LIVE WATCH
STM32CUBE REGISTERS TREE
STM32CUBE RTOS STATE
main.c
Core > Src > main.c > main
83 PUTCHAR_PROTOTYPE
89 }
90 /* USER CODE END 0 */
92 /**
93 * @brief The application entry point.
94 * @retval int
95 */
96 int main(void)
97 {
99 /* USER CODE BEGIN 1 */
101 /* USER CODE END 1 */
103 /* MCU Configuration--*/
105 /* Reset of all peripherals, Initializes the Flash interface and the Systick. */
106 HAL_Init();
108 /* USER CODE BEGIN Init */
110 /* USER CODE END Init */
112 /* Configure the system clock */
113 SystemClock_Config();
115 /* USER CODE BEGIN SysInit */
117 /* USER CODE END SysInit */
119 /* Initialize all configured peripherals */
120 MX_GPIO_Init();
121 MX_USART3_UART_Init();
122 MX_USB_OTG_FS_PCD_Init();
123 MX_SPI1_Init();
PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS STM32CUBE RTOS
STMicroelectronics ST-LINK GDB server. Version 7.10.0
Copyright (c) 2025, STMicroelectronics. All rights reserved.
Starting server with the following options:
Persistent Mode : Disabled
Logging Level : 1
Listen Port Number : 61234
Status Refresh Delay : 15s
Verbose Mode : Disabled
clangd: idle Build
Ln 106, Col 1 Spaces: 2 UTF-8 CRLF C
File Edit Selection View Go Run Terminal Help
EXPLORER
NUCLEO_F207ZG_SSD1309
.settings
.vscode
build
cmake
stm32cubemx
gcc-arm-none-eabi.cmake
starm-clang.cmake
Core
Inc
gpio.h
main.h
spi.h
ssd1309.h
ssd1309Fonts5x7.h
ssd1309Fonts8x8.h
stm32f2xx_hal_conf.h
stm32f2xx_it.h
usart.h
usb_otg.h
Start Debugging F5
Run Without Debugging Ctrl+F5
Stop Debugging Shift+F5
Restart Debugging Ctrl+Shift+F5
Open Configurations
Add Configuration...
Step Over F10
Step Into F11
Step Out Shift+F11
Continue F5
Toggle Breakpoint F9
New Breakpoint
Enable All Breakpoints
Disable All Breakpoints
Remove All Breakpoints
Install Additional Debuggers...

MAX Delivers!

main.c

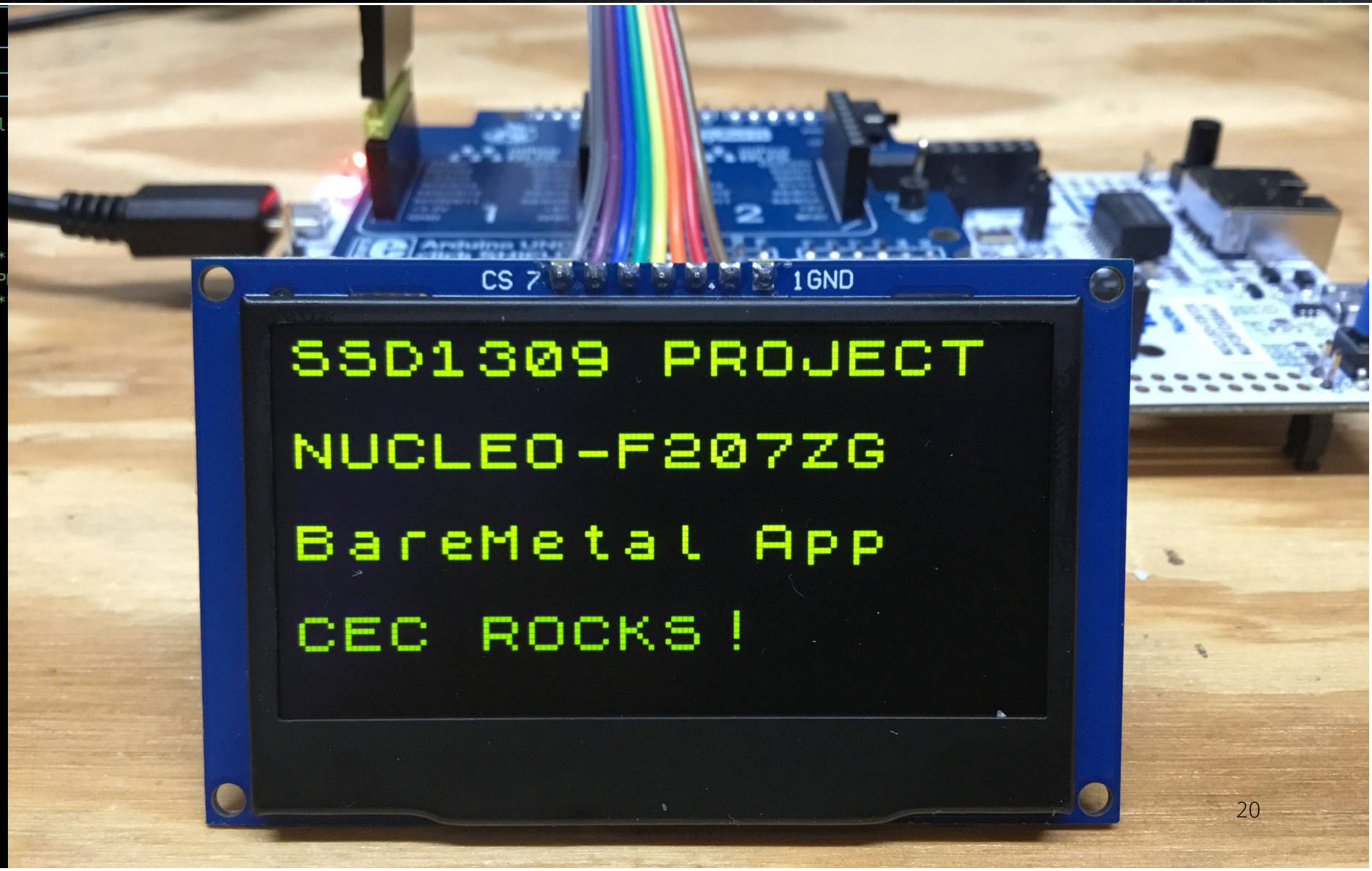
Core > Src > main.c > main

```c
int main(void)

  /* Initialize all configured peripheral
  MX_GPIO_Init();
  MX_USART3_UART_Init();
  MX_USB_OTG_FS_PCD_Init();
  MX_SPI1_Init();
  /* USER CODE BEGIN 2 */
  //************************************
  // INITIALIZE THE SSD1309 DISPLAY AND P
  //************************************
  initSSD1309();
  setTextXY(row: 0,col: 0);
  sprintf(spiTxBuf,"SSD1309 PROJECT");
  displayString(string: spiTxBuf);
  setTextXY(row: 2,col: 0);
  sprintf(spiTxBuf,"NUCLEO-F207ZG" );
  displayString(string: spiTxBuf);
  setTextXY(row: 4,col: 0);
  sprintf(spiTxBuf,"BareMetal App");
  displayString(string: spiTxBuf);
  setTextXY(row: 6,col: 0);
  sprintf(spiTxBuf,"CEC ROCKS!");
  displayString(string: spiTxBuf);
  /* USER CODE END 2 */

  /* Infinite loop */
  /* USER CODE BEGIN WHILE */
  while (1)
  {
    /* USER CODE END WHILE */

    /* USER CODE BEGIN 3 */
  }
  /* USER CODE END 3 */
}
```



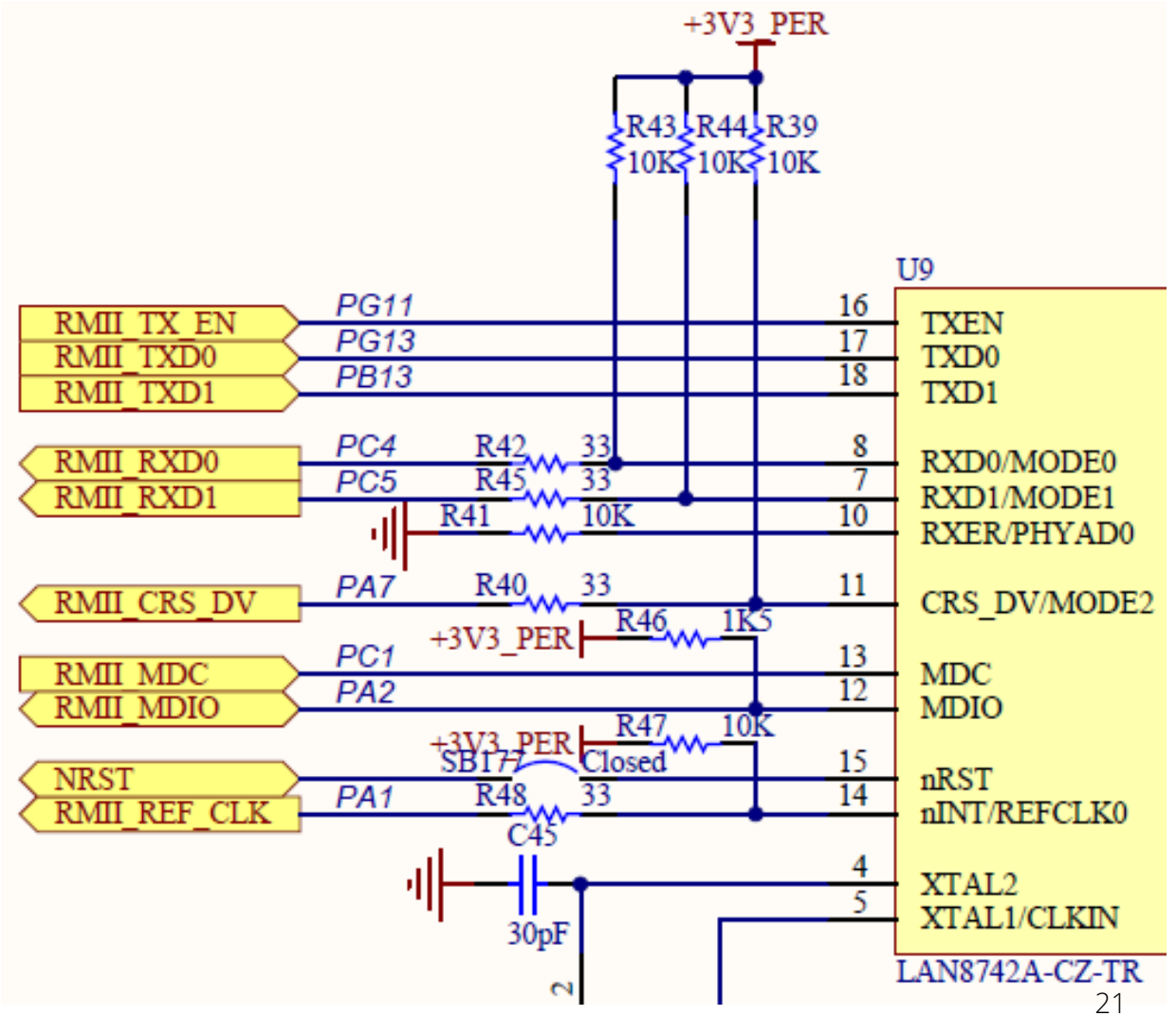
Next Time…

MORE TO COME..

Thank you for attending!!!

Please consider the resources below:

- Today's Download Package
- www.st.com
- digikey.com



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