This document is a generic user instruction on how to install software tools, what kind of peripherals are present in this board, the IO mapping for the different onboard components and the schematic block that each peripheral has. The scope of this document is pertaining to the controller STM32F405.

Revision History

Date	Version	Author	Description
23 January, 2023	1.0	Career Shaper	Baseline version

Release Note

Product(s) Name	**STM32F405 User Guide**
Release ID	**V1.0**
Release Type	**<Major / ~~Minor~~ /~~ Patch~~>**
Build Reference	**NA**
Release Date (dd-mmm-yyyy)	**23.01.2023**
Release Manager	

Release Package Contents

Release Package Contents	☐ Source Code ☐ Scripts ☐ Binaries ☐ Objects ☑ Others
File Format / Executables	☐ WinZip ☐ Tar ☐ exe ☐ Others
Delivery Mode	☐ FTP ☐ CD ☑ Web ☐ Others

Contents

Overview

This STM32f405 Development Board is designed to provide a development environment for CAN communication, I2C, SPI, UART and parallel communication.

Operational Requirements:

To communicate with STM32f Board, the following are hardware and software requirements:

- PC-compatible system with Windows® 7 or Window 10 (32-bit/ 64 bit Operating Systems).
- POWER supply through USB
- STM32CUBEIDE

Features

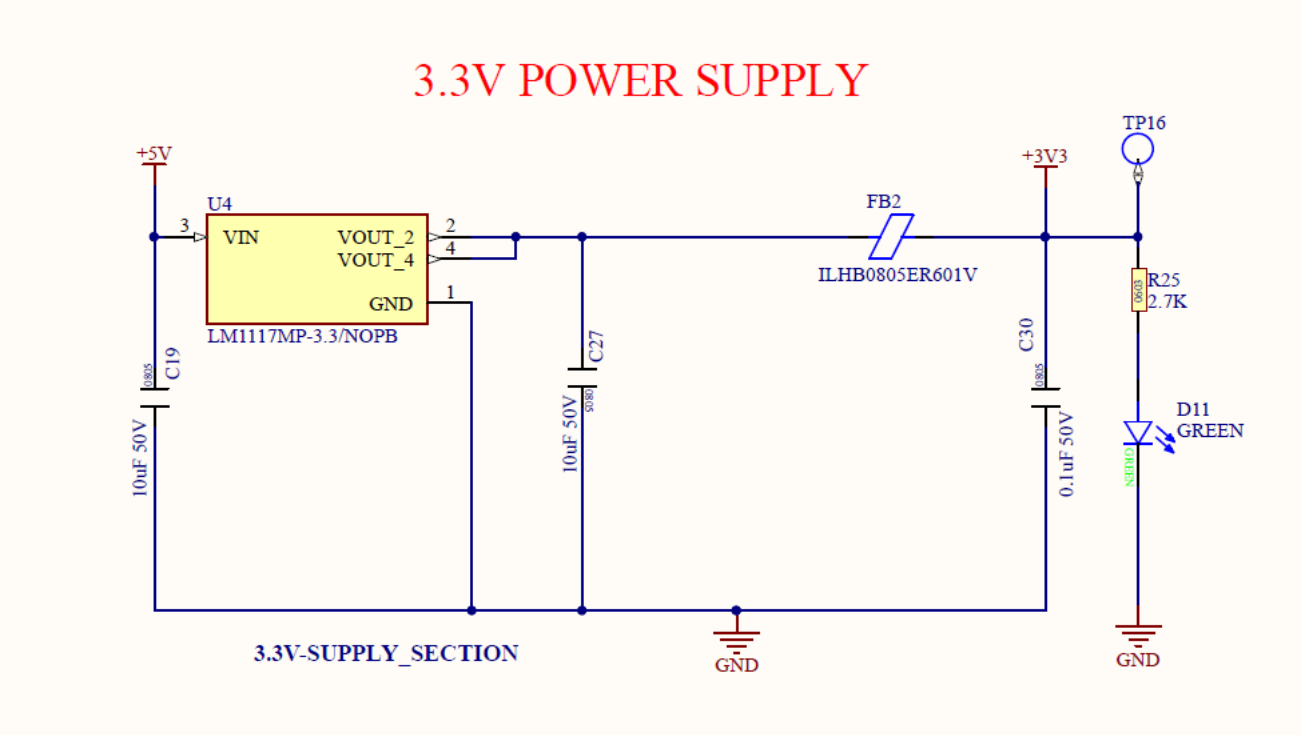
The board offers many unique features:

- The STM32f Development board comes with Flash program memory, up to 1 MB, Data SRAM up to 192+4Kbytes .
- 8.0000 MHz crystal for maximum execution speed and standard serial bit rates
  - Phase-locked loop (PLL) multiplies frequency upto 72MHz.
- 32.768kHz RTC crystal
- Onboard Peripherals
  - 2x16 character LCD with background light
  - 4 No's LEDs(active Low)
  - 4 No's Push Button(Active Low)
  - 2 No's Potentiometer (POT) for Analog Input of 3.3V
  - EEPROM (M95640) on SPI bus
  - Buzzer
  - Reset button
  - On Board CAN interface
  - CAN Transceiver - MCP2551 -2 No's
  - UART- With Handshaking (by MAX232) - 1 No's
  - UART RS 485 - 1 No's
  - SWD - Supports In-Circuit Serial Programming for flash and debugging.
  - Dimensions: 130 x 130 mm
  - Two-layer PCB (FR-4 material) for better noise immunity.

HARDWARE

Power Supply

The STM32f Board can be powered by a USB type B port. Power Supply Circuit is given below. The Board works on 3.3V DC, if the boards supply increases above 3.3V, STM32 IC will be damaged. The Power supply section uses steps down regulator its covert 5V to 3.3V.



Clock Source

STM32f development Board has two clock sources

- 32 KHz Crystal as the RTC clock source
- 16 MHz Crystal as the MCU clock source

CPU

The core part of The STM32f dev board is STM32f405RGTx IC by STM.

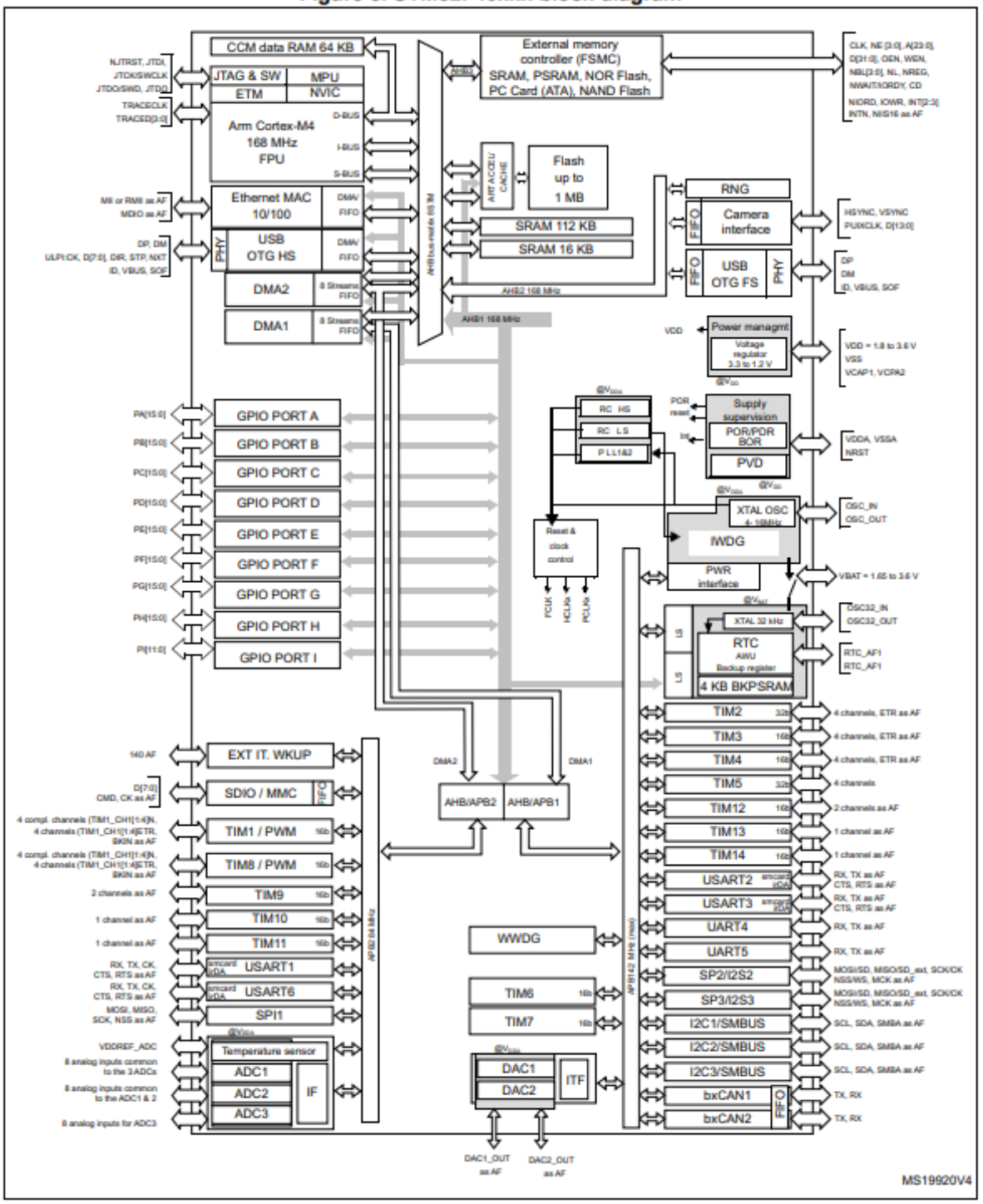
The STM32f405RBT6 IC employs a powerful 32-bit architecture, ideal for applications that rely on high-speed, repetitive computations, as well as control.

The following are the features of CPU

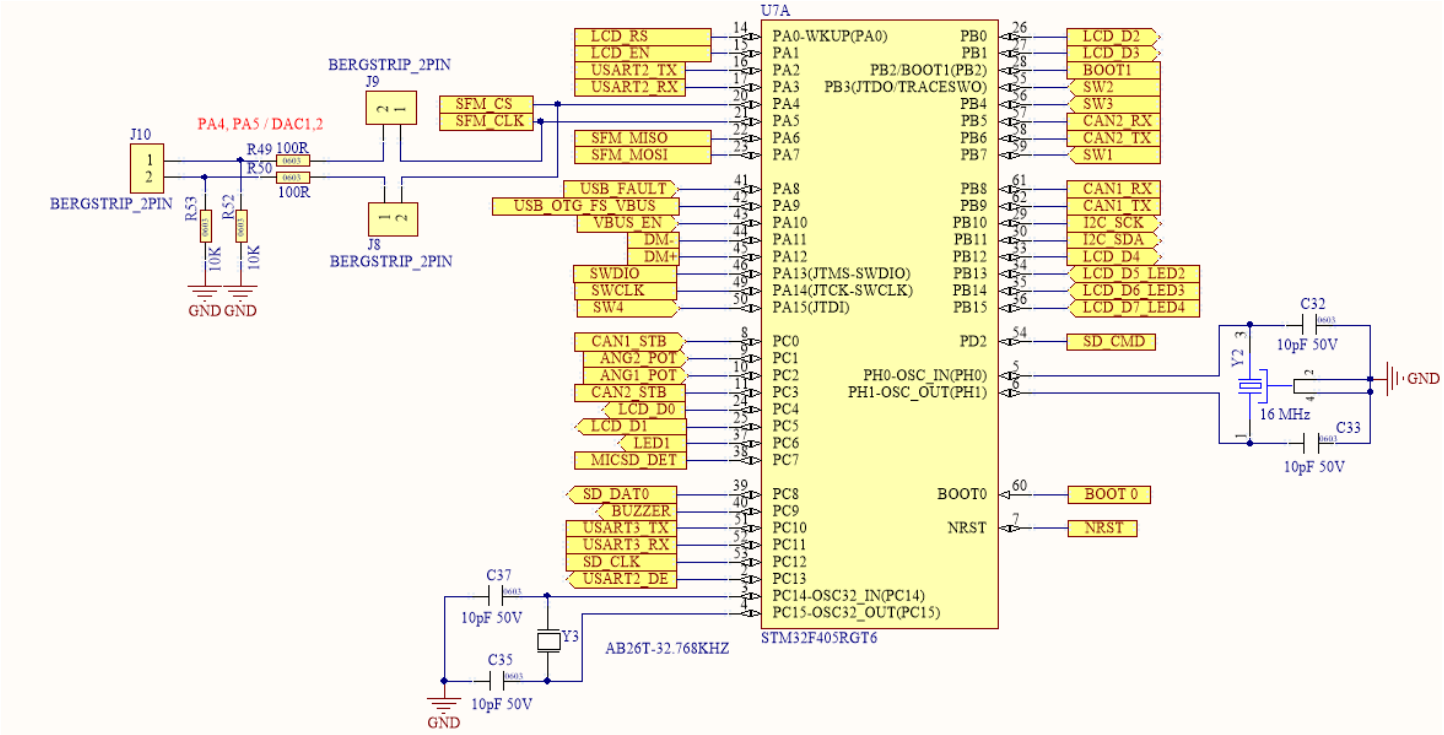
- Core: ARM® 32-bit Cortex®-M4 CPU – 168 MHz maximum frequency, 1.25 DMIPS/MHz (Dhrystone 2.1) performances at 0 wait state memory access – Single-cycle multiplication and hardware division
- Memories –1 Mbytes of Flash memory – 192+4 Kbytes of general-purpose SRAM
- Clock, reset and supply management – 1.8 to 3.6 V application supply and I/Os – POR, PDR, and programmable voltage detector (PVD), BOR – 4-to-26 MHz crystal oscillator – Internal 16 MHz factory-trimmed RC – Internal 32 kHz RC with calibration – 32 kHz oscillator for RTC with calibration
- Low power – Sleep, Stop and Standby modes – VBAT supply for RTC and backup registers
- 3 × 12-bit, 0.5µs A/D converters (24 channels) – Conversion range: 0 to 3.6 V – Sample and hold capability – Temperature sensor – up to 6 MSPS in interleaved mode
- 2 × 12-bit D/A converters • DMA: 16-channel DMA controller – Supported peripherals: timers, ADCs, DAC, I2Ss, SPIs, I2Cs and USARTs
- Debug mode – Serial wire debug (SWD) interfaces – Cortex®-M4 Embedded Trace Macrocell™
- Up to 140 I/Os, all mappable up to 84 MHz and almost all 138 are 5 V-tolerant
- CRC calculation unit, 96-bit unique ID
- Up to 17 timers with pinout remap capability – Up to twelve 16-bit timers, each with up to 4 IC/OC/PWM or pulse counter and quadrature (incremental) encoder input – 1 × 16-bit motor control PWM timer with dead-time generation and emergency stop – 2 × watchdog timers (Independent and Window) – SysTick timer: a 24-bit down counter – 2 × 16- bit basic timers to drive the DAC
- Up to 15 communication interfaces with pinout remap capability – Up to 3 × I2C interfaces (SMBus/PMBus) – Up to 4 USARTs and 2 UARTs(ISO 7816 interface, LIN, IrDA capability, modem control) – Up to 3 SPIs (42 Mbit/s), 2 with a multiplexed I2S interface that offers audio class accuracy via advanced PLL schemes – 2 × CAN interfaces (2.0B Active) SDIO interface – USB 2.0 full-speed device/host/OTG controller with on-chip PHY and ULPI – 10/100 Ethernet MAC with dedicated DMA supports IEEE1588v2 hardware support, MII/RMII available on all packages.
- 8 to 14 bit Parallel camera interface.

Block Diagram for STM32f405:

Figure 5. STM32F40xxx block diagram



Schematic for CPU is given below:



LED Interface:

The STM32 Board has 4 LED's for indication. All 4 LED's are Active LOW LED's, making the PORT Zero (making it to ground) Turn's ON the LED. All PORTs on STM32f405RGTx as digital input pins are 5V tolerant and has 4 mA sink on all I/O pins.

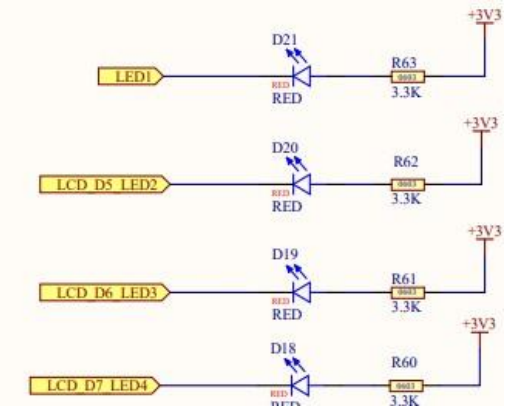
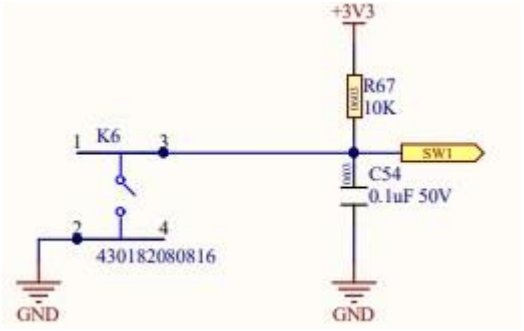


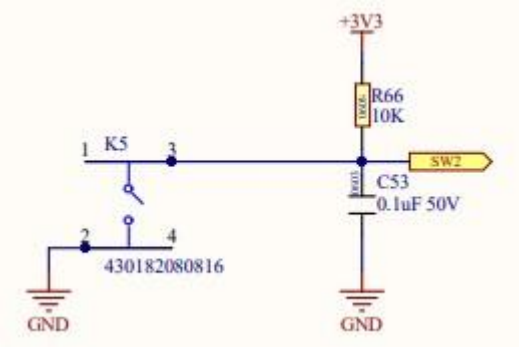
Table shows PIN Connection for LEDs

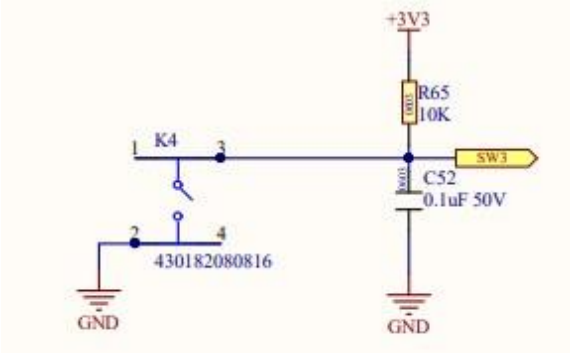
I/O	µC PIN	Remark
LED 1	PC6 [37]	Active low
LED 2	PB13 [34]	Active low
LED 3	PB14 [35]	Active low
LED 4	PB15 [36]	Active low

Push Button Interface:

All 4 Push buttons are pulled up to 3.3V, so the push buttons are active low buttons, i.e., on pressing the button it gives 0 V (zero) to the input. All PORTs on STM32f405RGTx as digital input pins are 5V tolerant and has 4 mA sink on all I/O pins.







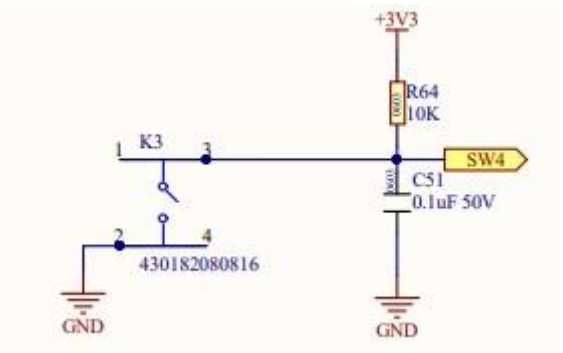


Table shows PIN connection for Push Button

I/O	µC PIN	Remark
SW1	PB7 [59]	Active low
SW2	PB3 [55]	Active low
SW3	PB4 [56]	Active low
SW4	PA15[50]	Active low

Buzzer

Buzzer connected to Pin 40 (PORT PC9) with a Jumper, the 5V buzzer is controlled using FET (2N7002) ,HIGH on Base of the transistor turns on buzzer. The buzzer can be Enabled or disabled using Jumper J2

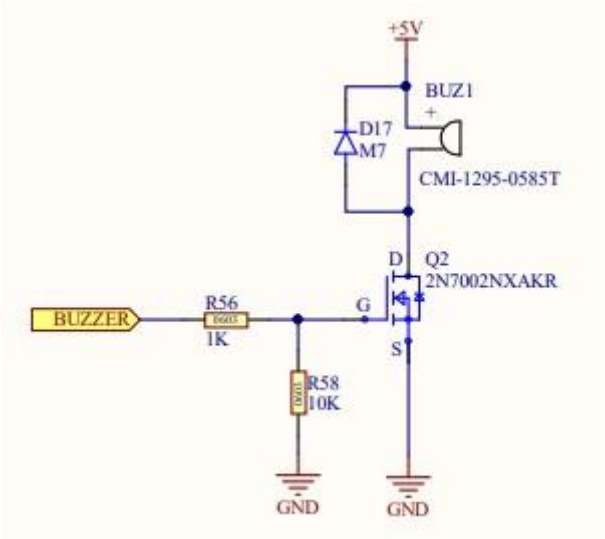


Table shows PIN connection for BUZZER

I/O	µC PIN	Remark
BUZZER	PC9 [40]	Active High

LCD-Liquid Crystal Display Interface:

The display is a standard 2x LCD which displays 4 lines of 20 characters. Each character is 40 Pixels, making it 1280 pixels overall. The display receives ASCII codes for each character at the data Inputs (D0–D7). The LCD module can be used in 8-bit mode. The module uses HD44780U (from Hitachi)as the controller IC. Pin LCD_LED can be used to turn the back light of LCD ON/OFF by making the pin HIGH/LOW respectively. A dedicated POT is given to adjust the contrast of the LCD. LCD can be programmed in 4bit mode.

LCD schematic is given below

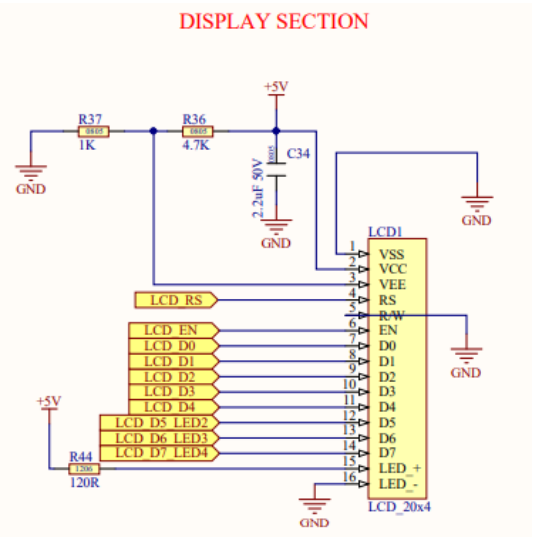
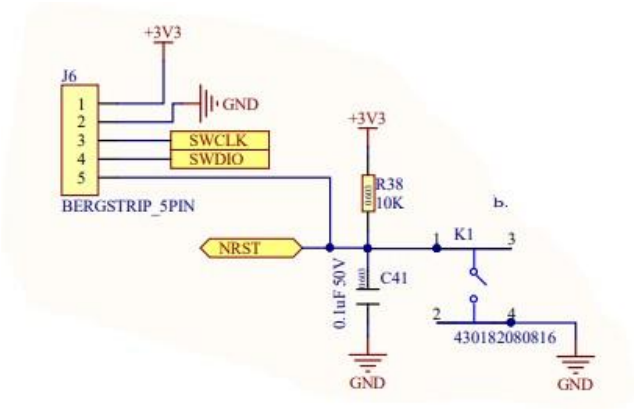


Table shows PIN connection for LCD

I/O	µC PIN	Remark
LCD_D0	PC4 [24]	
LCD_D1	PC5 [25]	
LCD_D2	PB0 [26]	
LCD_D3	PB1 [27]	
LCD_D4	PB12[33]	
LCD_D5	PB13 [34]	
LCD_D6	PB14 [35]	
LCD_D7	PB15 [36]	
LCD_LED -	GND	
LCD_RS	PA0 [14]	
LCD_RW	GND	
LCD_EN	PA1 [15]	

SWD Interface

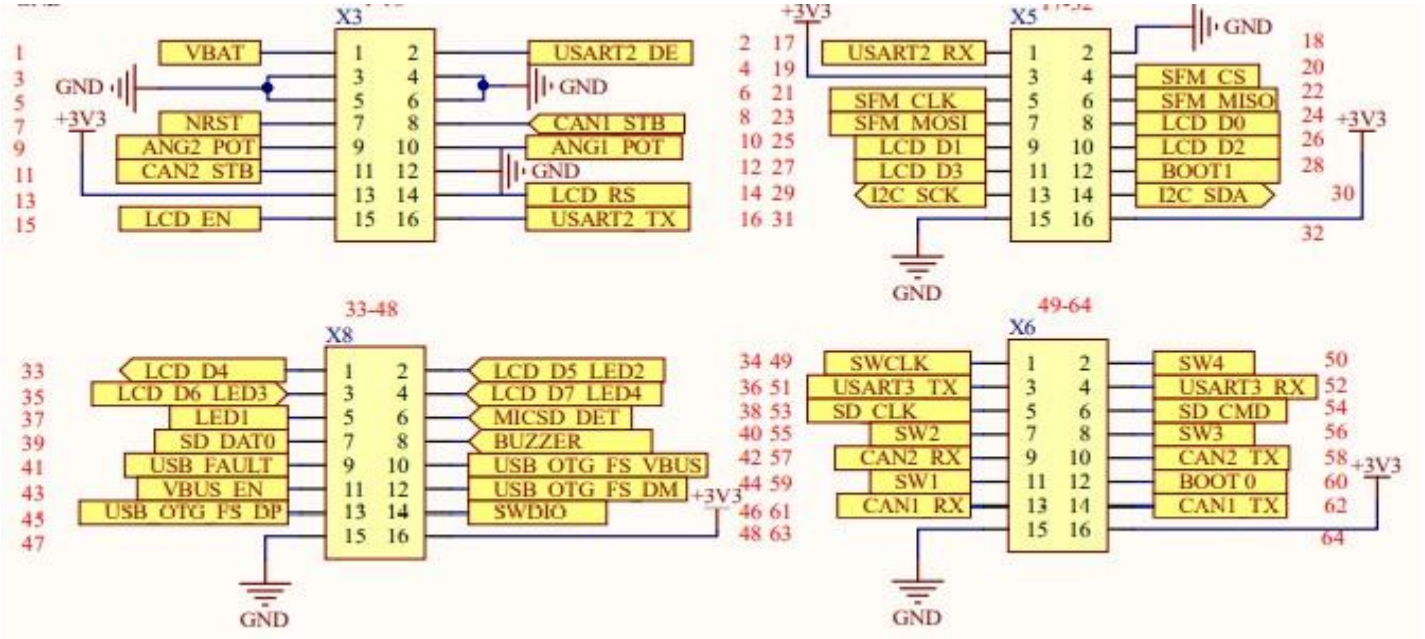
The STM32f Board has SWD interface. The Board can be programmed and debugged using SWD interface.



Board has SWDIO Data, SWCLK Clock pin and NRST reset pin for programming K1-RESET

Expansion Connector

STM32f development Board is not just a Monolithic design. All STM32f405RGTx pins are available on theconnector all of 64 pins in STM32f405RGTx are available for external connection. Connector X3, X5, X8, X6 having 16 pins each, making a total of 64 pins acts as a expansion connector



X3 connector	Pin Name	Port Name
1	VBAT	
2	USART2_DE	PC13
3	OSC32_IN(32.768Khz)	PC14
4	OSC32_OUT(32.768Khz)	PC15
5	OSC IN(16 Mhz)	PH0
6	OSC OUT(16 Mhz)	PH1
7	NRST	
8	CAN1 - STB	PC0

X3 connector	Pin Name	Port Name
9	ANG2_POT	PC1
10	ANG1_POT	PC2
11	CAN2_STB	PC3
12	GND	
13	3.3V	
14	LCD_RS	PA0
15	LCD_EN	PA1
16	USRT2_TX	PA2

X5 connector	Pin Name	Port Name
17	USRT2_RX	PA3
18	GND	
19	3.3V	
20	SFM_CS	PA4
21	SFM_CLK	PA5
22	SFM_MIS0	PA6
23	SFM_MOSI	PA7
24	LCD_D0	PC4

X5 connector	Pin Name	Port Name
25	LCD_D1	PC5
26	LCD_D2	PB0
27	LCD_D3	PB1
28	BOOT1	PB2
29	I2C_SCK	PB10
30	I2C_SDA	PB11
31	GND	
32	3.3V	

X8 connector	Pin Name	Port Name
33	LCD_D4	PB12
34	LCD D5 LED2	PB13
35	LCD D6 LED3	PB14

36	LCD D7 LED4	PB15
37	LED1	PC6
38	MICSD_DET	PC7
39	SD_DAT0	PC8
40	BUZZER	PC9

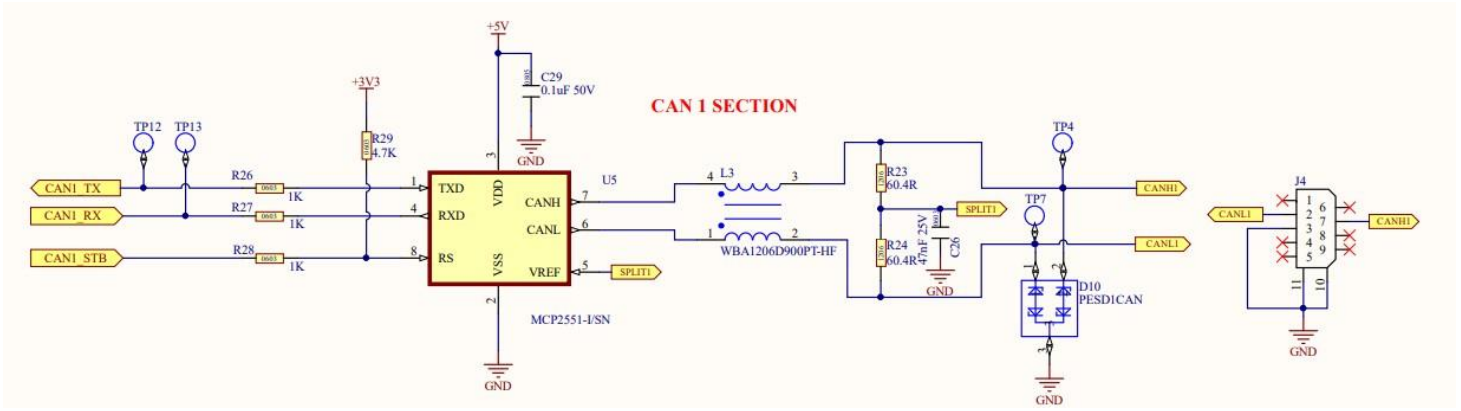
X8 connector	Pin Name	Port Name
41	USB_Fault	PA8
42	USB_OTG_FS_VBUS	PA9
43	VBUS_EN	PA10
44	DM-	PA11
45	DM+	PA12
46	SWDIO	PA13
47	GND	
48	3.3V	

X6 connector	Pin Name	Port Name
49	SWCLK	PA14
50	SW4	PA15
51	USART3_TX	PC10
52	USART3_RX	PC11
53	SD_CLK	PC12
54	SD_CMD	PD2
55	SW2	PB3
56	SW3	PB4

X6 connector	Pin Name	Port Name
57	CAN2_RX	PB5
58	CAN2_TX	PB6
59	SW1	PB7
60	BOOT0	
61	CAN1_RX	PB8
62	CAN1_TX	PB9
63	GND	
64	3.3V	

CAN Communication Module Interface

CAN (Controller Area Network) is a communication standard primarily intended for use in automotive industry. In this board there are two can peripheral. It enables the microcontroller to communicate to Vehicle devices without using a Host PC. Also, CAN communication widely using in Industrial automation. This module provides an interface between the microcontrollers to some peripheral device.



I/O	µC PIN	Remark
CAN1_STB	PC0 [8]	
CAN1_TX	PB9[62]	
CAN1_RX	PB8 [61]	

Table gives PIN connection for CAN1 communication

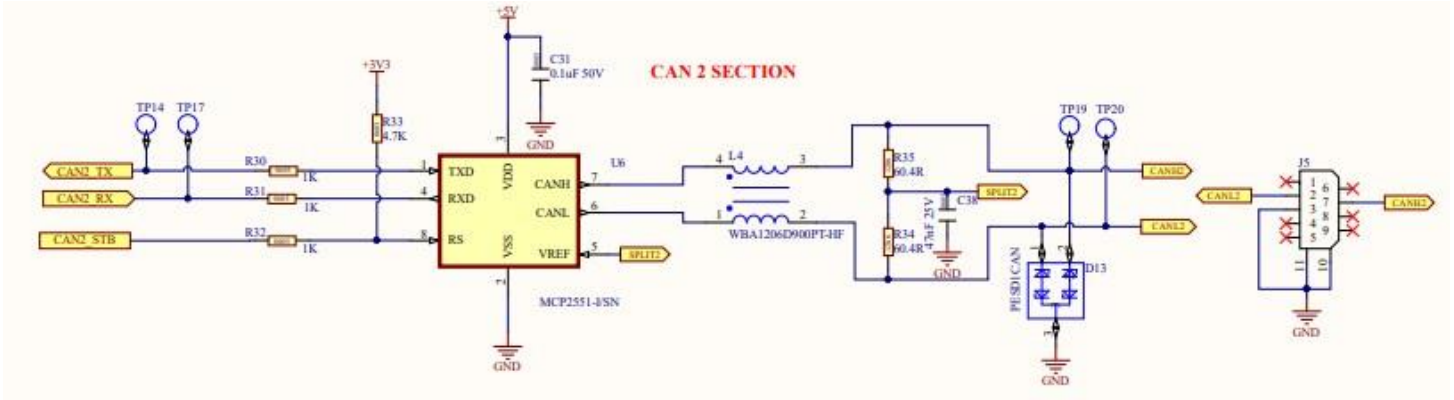


Table gives PIN connection for CAN2 communication

I/O	µC PIN	Remark
CAN2_STB	PC3 [11]	
CAN2_TX	PB6 [58]	
CAN2_RX	PB5[57]	

EXTERNAL EEPROM INTERFACE:

The STM32f development Board has an External EEPROM connected to them. This Prototype Board has M95640 EEPROM is a 64 Kbit serial electrically Erasable PROM. The memory is accessed via a simple Serial Peripheral Interface (SPI) compatible serial bus. The bus signals required are a clock input (SCK) plus separate data in (SI) anddata out (SO) lines. Access to the device is controlled through a Chip Select (CS) input with a maximum clock Frequency of 3MHz.

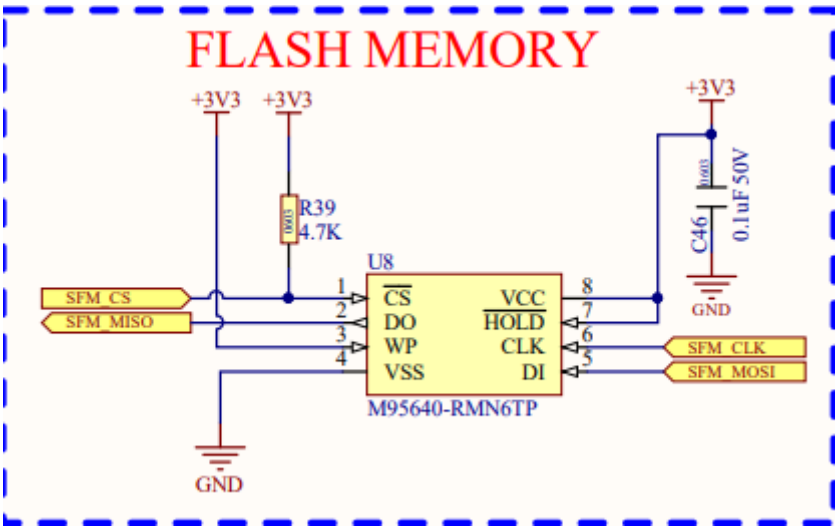


Table gives PIN connection for EXTERNAL EEPROM interface

I/O	µC PIN	Remark
SFM CLK	PA5[21]	
SFM MOSI	PA7[23]	
SFM MISO	PA6[22]	
SFM CS	PA4[20]	

UART COMMUNICATION INTERFACE:

The STM32f development Board has two UART modules. A universal asynchronous receiver/transmitter (UART) is a microchip that performs serial-to-parallel conversion of data received from peripheral devices and parallel- to- serial conversion of data coming from the CPU for transmission to peripheral devices. The UART chip has control capabilities and the ability to send an interrupt request to the processor that can be tailored in a way that minimizes the software management of the communication link between a computer and a peripheral device.

UART RS232:

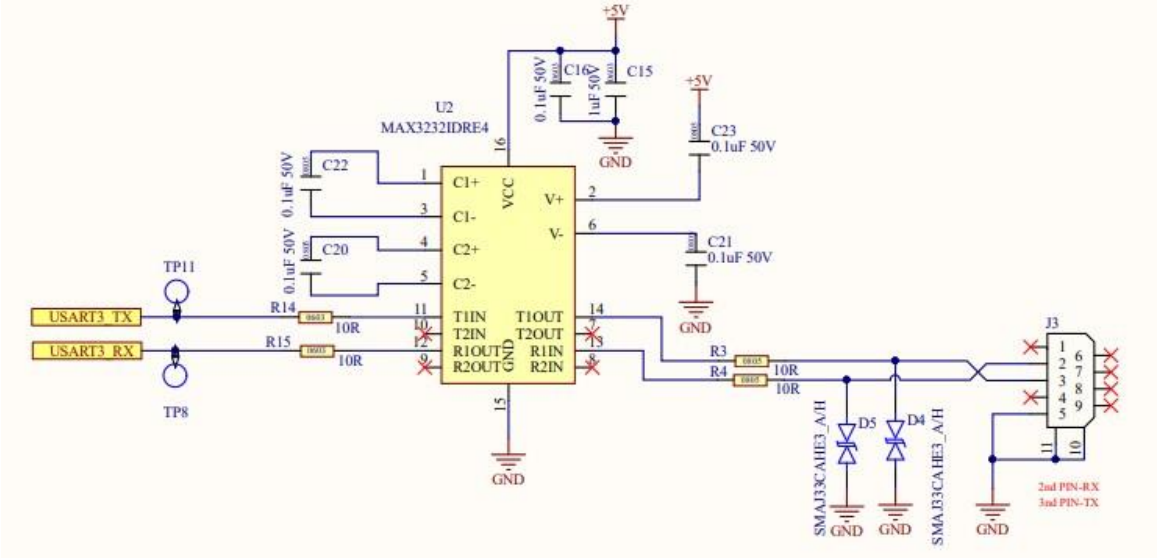
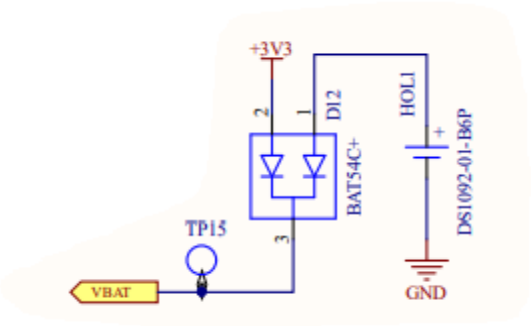


Table gives PIN connection for UART communication

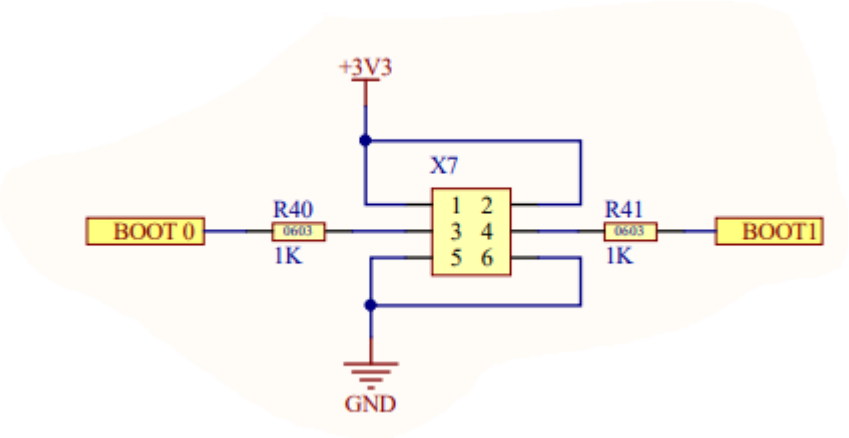
I/O	µC PIN	Remark
USART3_TX	PC10[51]	
USART3_RX	PC11[52]	

REAL TIME CLOCK (RTC):

The STM32f405 controller has an internal Real Time Clock. The clock/calendar provides seconds, minutes, hours, day, date, month, and year information. The end of the month date is automatically adjusted for months with fewer than 31 days, including corrections for leap year. The clock operates in either the 24-hour or 12-hour format with AM/PM indicator. Timekeeping operation continues while the part operates from the backup supply. Just battery connected is enough at the hardware side to code with RTC. The schematic is given below



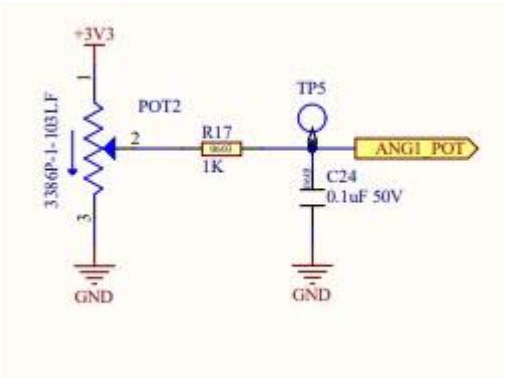
BOOT PIN:

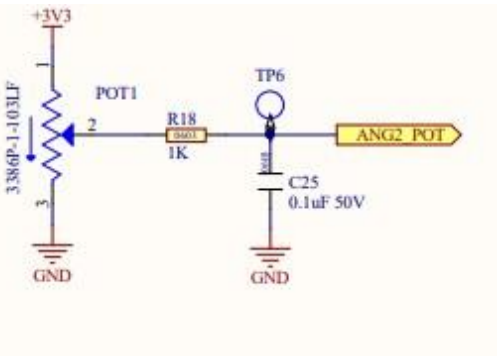


I/O	µC PIN	Remark
BOOT 0	BOOT 0 [60]	BOOT 0 should be connected to 0 by shorting pin 3 & 5 of X7 using jumper wire
BOOT 1	PB2 [28]	BOOT 1 should be connected to 0 by shorting pin 4 & 6 of X7 using jumper wire

Analog Interface:

Variable resistance POTs are connected to ADC pins for Analog Voltage measurement.





I/O	µC PIN	Remark
ANG1 POT	PC2 [10]	ADC1 IN12
ANG2 POT	PC1 [9]	ADC1 IN11

Digital to Analog Interface:

DAC is available for converting digital data into analog voltage of range 0- 3.3V with precision of 12 bit.

I/O	µC Pin	Remark
DAC	PA4	OUT 1
DAC	PA5	OUT 2

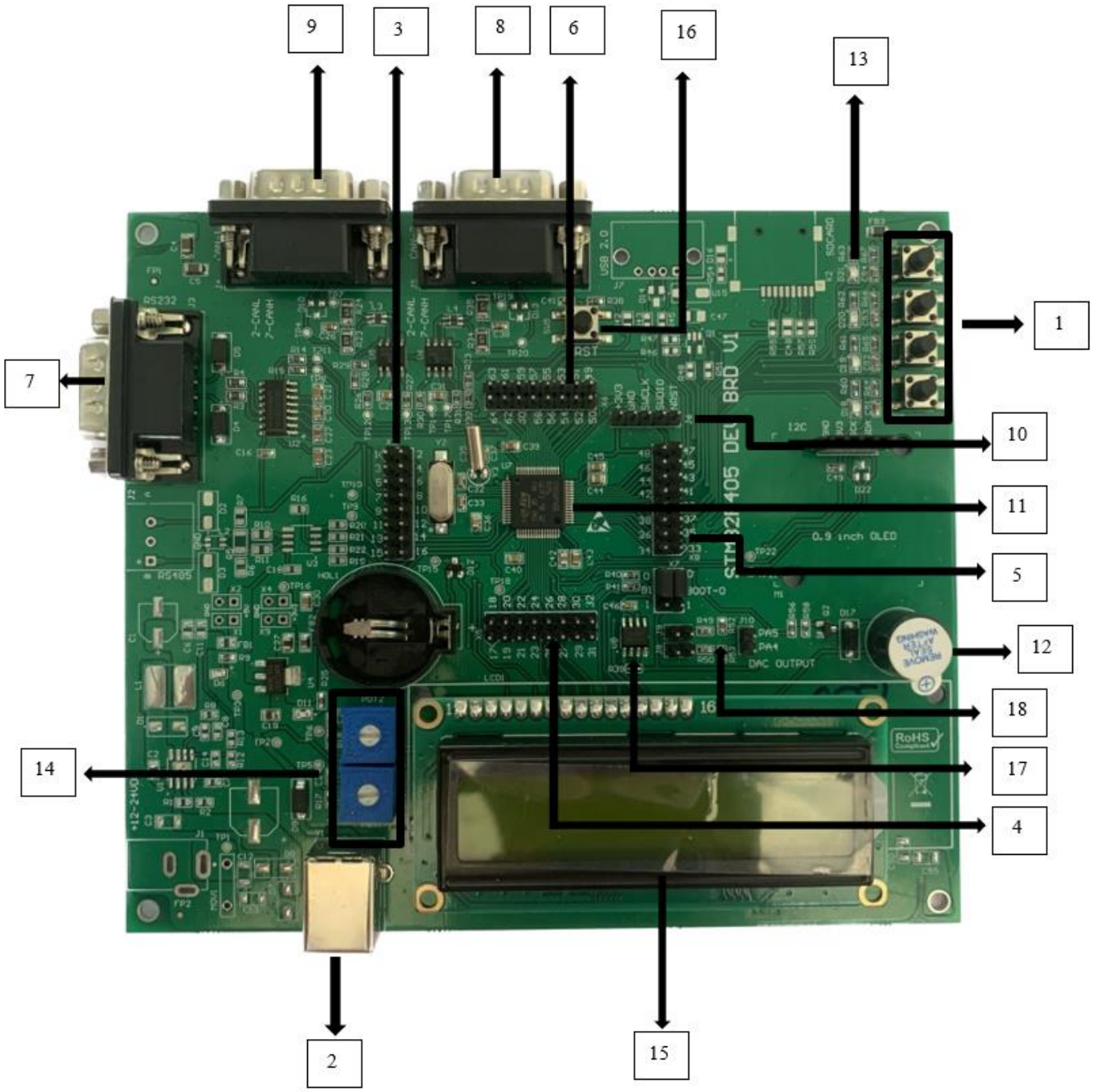
Running and Debugging Applications:

Steps to work on the STM32 board:

1. Launch STM32 cube ide.
2. Create a workspace.
3. Create a new STM32 Project.
4. Select the microcontroller as STM32f405RBT6
   - Give project name
   - Language selection C/C++ → select C
   - Target binary type → executable
   - Targeted project type → empty (if we don't want to use libraries)
5. Project window created has two important folders.
   - inc → this folder will contain all header files
   - src → this folder will have all dependent .c source files.
6. Right click project name and build.
   - To compile the empty project.
7. Observe the following warning build output window.
   - FPU is not initialized.

   right click on project name → properties →settings → tool settings→ →MCU settings→ in FPU →none→ in FPU ABI → software implementation
   - ➢ Apply in inner menu
   - ➢ Apply and close in outer menu
   - ➢ re-build the project
   - ➢ FPU warnings must be removed.

PERIPHERALS LIST – ON BOARD



PIN DESCRIPTION:

1. PUSH BUTTON SECTION
2. POWER SUPPLY – USB TYPE B(5V)
3. CONNECTOR 1

4. CONNECTOR 2
5. CONNECTOR 3
6. CONNECTOR 4
7. UART RS 232
8. CAN 2
9. CAN 1
10. PROGRAMMING CONNECTOR
11. MICRO CONTROLLER
12. BUZZER
13. LED SECTION
14. POT 1 AND 2 –ANALOG
15. LCD DISPLY 2X16
16. RESET PUSH BUTTON
17. EEPROM
18. DAC