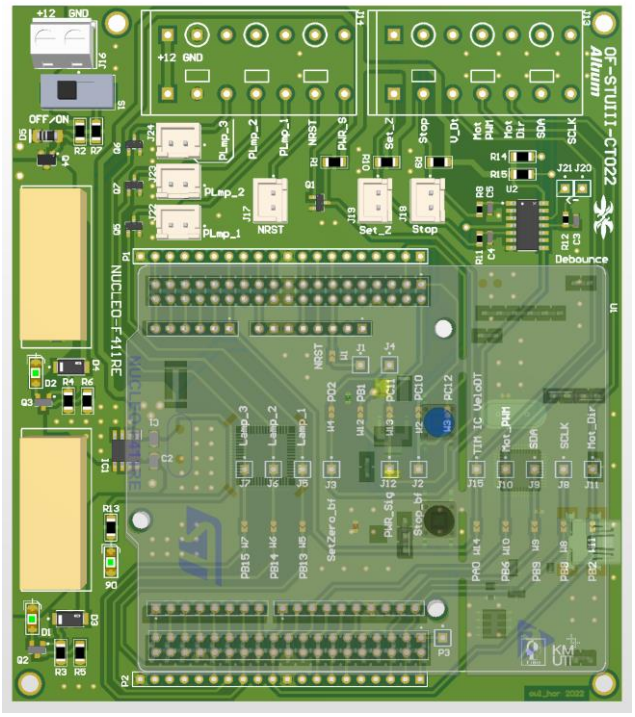
OF-STUIII-CT02X

Nucleo Socket board



This is socket mount circuit board for STM32 Nucleo-F411RE to interface with buttons, pilot lamps, motor drivers, end effectors in the cabinet box.

This circuit board is specifically designed for the cabinet box in "FRA262 Robotics Studio 3: Industrial topic".

Features

- Controller: STM32 Nucleo-F411RE
- I2C external pull up resistors (CT022 only)
- PMOS ON/OFF Switch
- 2 Fuse box with blowing detect
- Solder bridge & Cross jumper
- 3 channel debounce circuit
- 3 Pilot Lamp drivers
- Nucleo reset external button connection
- Spring Terminal

Contents

Hardware Diagram

FRA262 STUIII :HARDWARE Diagram
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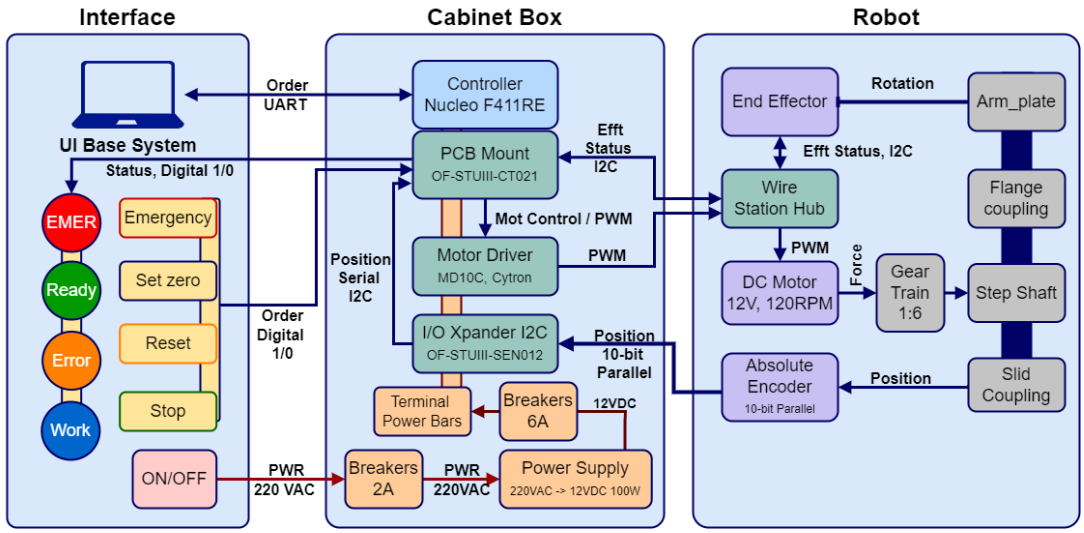


This diagram represents all the devices in the system. CT02X circuit acts like a connection hub between the microcontroller (STM32 Nucleo-F411RE) and the other circuits. In the cabinet box, there're motor drivers [MD10C], and an I/O expander circuit [OF-STUIII-SEN021]. At the robot, the microcontroller must be able to control the motor (PWM via driver), end effector (I2C), and Absolute encoder (I2C via SEN021).

About the user interface part, the microcontroller must be able to interface with the UI base system, get order input from several buttons and show the status on a pilot lamp.

Electrical Characteristics

	Min	Typ.	Max	Unit
VCC Supply Voltage Rating[1]	7	12	24	V
Current Rating[2]		2	3.5	A

[1] Consider from LDO regulator's maximum voltage. However, pilot lamp and end effector's voltage must be concerned.

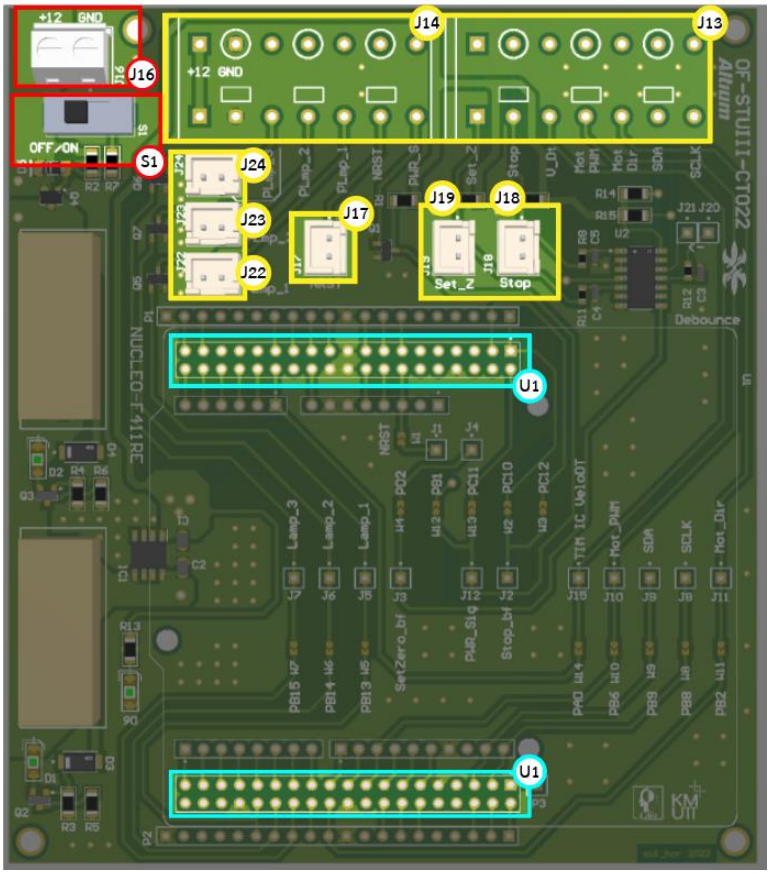
[2] Consider from current rating of PMOS at switch circuit.

Source code

The sample code using with CT02x circuit.

https://github.com/owlhor/FRA222MCCstm32/blob/main/FRA262STUIII/Core/Src/main.c

Circuit Pinout & Port Connection



Circuit Pinout

Components	Devices	Pin	Description
J16	Power Source	1 [+12]	VCC
		2 [GND]	GND
S1	OFF/ON Switch	-	PMOS OFF/ON Switch
U1	Nucleo-F411RE	-	Nucleo-F411RE
J[13..14]	Button, end effectors, drivers, I/O expander	[1..14]	Connect important signals Port connection
J17	External reset button	1 [NRST]	Nucleo reset pin
		2 [GND]	
J18	External Stop button	1 [Btn_Stop]	
		2 [GND]	
J19	External Set zero button	1 [Btn_SetZ]	
		2 [GND]	
J[22..24]	Pilot Lamp	1 [12V]	Pilot lamp's Power source
		2 [Fet]	NPN pilot lamp MOSFET driver

Port connection

Signal	Spring Terminal	Wafer	Nucleo port	Description
+12_ef	J14 - 1	-	-	End effector's power source
GND	J14 - 2	-	-	End effector's GND
PLamp_3	J14 – 3	J24 - 1	PB15	Pilot Lamp Drive # 3
PLamp_2	J14 – 4	J23 - 1	PB14	Pilot Lamp Drive # 2
PLamp_1	J14 – 5	J22 - 1	PB13	Pilot Lamp Drive # 1
Nucleo_Reset_btn	J14 – 6	J17 - 1	NRST	Nucleo reset
PWR_Sense	J14 - 7	-	PB1, PC11	Sense the emergency switch
BTN_SetZero	J13 - 1	J19 – 1	PD2	Set zero position order
BTN_Stop	J13 – 2	J18 - 1	PC10, PC12	Stop rotation order
VeloDetect	J13 – 3	-	PA0	Input capture velocity detect
Mot_PWM	J13 – 4	-	PB6	PWM for motor drive
Mot_dir	J13 – 5	-	PB2	MD10C direction config
SDA	J13 – 6	-	PB9	I2C
SCLK	J13 - 7	-	PB8	I2C

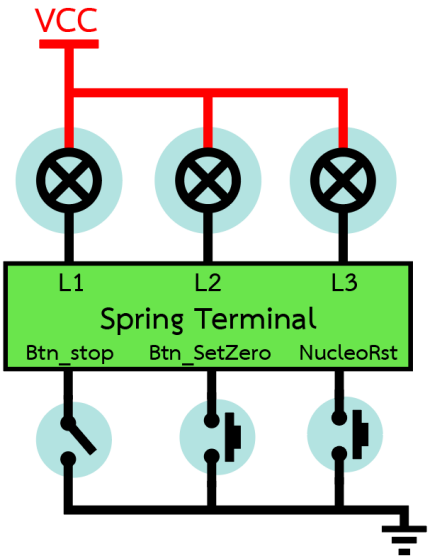
Connection concern for spring terminal

[Pilot Lamp]

- One of the pilot lamp's pins must be connected to the other **power source** (with the same GND reference) while another pin is connected to the spring terminal.

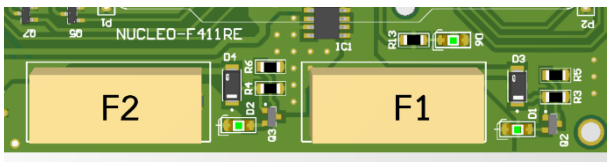
[Button: Nucleo Reset, Stop & Set Zero]

- One of the button's pins must be connected to the **GND** bar while another pin is connected to the spring terminal. The button must be normally open, **NO**.
- For the Stop button, the button's type is recommend to be **maintained**. While the others must be **momentary**.



Fuse box

There are 2 protection fuses in CT02x. **F1** will protect the microcontroller while **F2** will protect the end effector. There's also blowing detection. LED [**D1, D2**] will shine when any fuse blows.



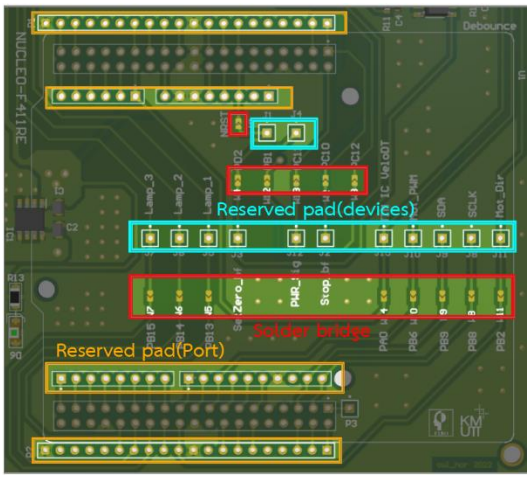
Fuses selection		Unit
Size	5 x 10	mm.
Current rating (F1)	1-2	A
Current rating (F2)	1	A

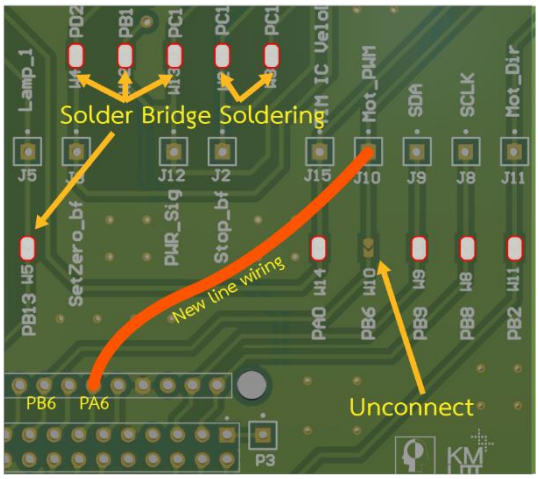
Solder bridge & Cross Jumper

In the soldering process, by default, **all of the solder bridges must be connected** to link every signal between the controller and the devices.

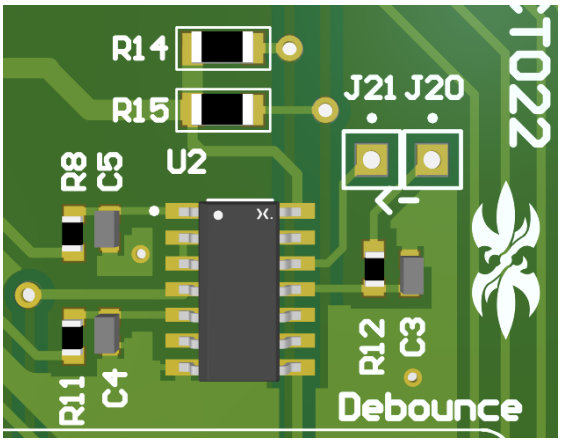
However, in case the connection needs to be changed from the default. Desolder that solder bridge and use a jumper to reconnect the device line to the required controller port.

For instance, If we need to change the *Mot_PWM* signal from **PB6** to **PA6**. Desolder W10 solder bridge and wire Mot_*PWM* from **J10** to **PA6** available pad to connect a new one.





Debounce circuit



In the circuit prototyping process, bouncing from the button has been found at an unacceptable rate (10++ bounce per press). Debounce circuit is integrated to filter united bounce.

There are 3 debounce filter channels. 2 are already connected to the "Stop" and "SetZero" buttons line. Another one is available for any button which needs to be debounced. Connect the bounced signal to **J20** as input and get the debounced from **J21**.

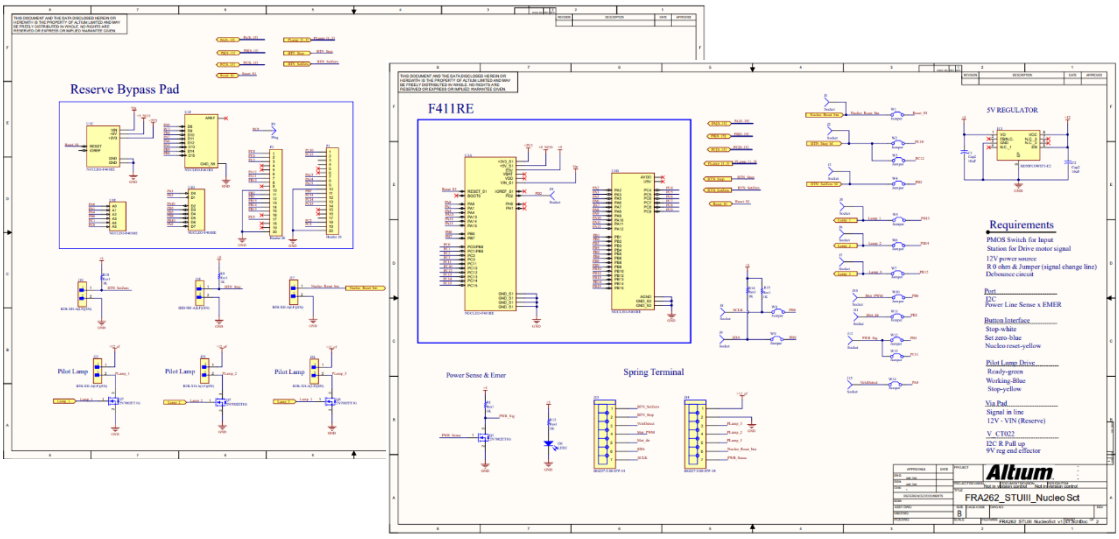
This timing diagram shows the bounce signal from the button (Orange) and the debounced signal (White) from the same button.

Schematics

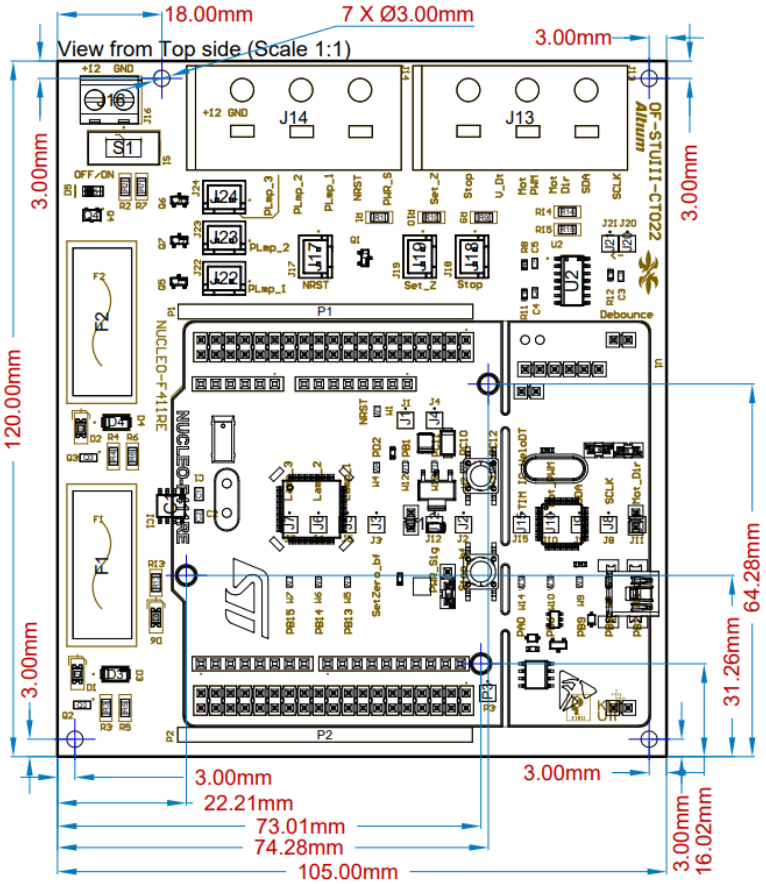
Full Version of Schematics can be downloaded from OF-Circuit, OWL's OFFICE

https://sites.google.com/mail.kmutt.ac.th/owlhor/home/of-circuits

https://kmutt.me/ofcircuit.ct021sch



Dimensions



Bill of Materials

Designator	Description	Footprint	Value	Quantity
C1, C2	Capacitor	C0805	10uF	2
C3, C4, C5	Capacitor	1608[0603]	1uF	3
D1, D2, D6	Typical RED, GREEN, YELLOW, AMBER GaAs LED	TY-A1206PG1		3
D3, D4	DIODE SCHOTTKY 60V 3A PMDS	FP-PMDS-MFG		2
D5	Silicon MELF Zener Diode, 500 mW, 1.1 V, -65 to 175 degC, 2-Pin SMD (DO-213AA), Bulk	MCSM-DO-213AA-2_A_V		1
F1, F2	Fuse Box	BF-015		2
IC1	BD50FC0WEFJ-E2, Integrated Circuit	SOIC127P600X100-9N		1
J13, J14	PCB Spring Terminal Block 7 Poles,Pitch 5.08mm 300V/10A,Green Color DC10	DG237-5.08-07P-14		2
J16	Terminal Female Header, Pitch 5 mm, 1 x 2 Position, Height 10 mm, Tail Length 3.5 mm	TECO-282836-2_V		1
J17, J18, J19, J22, J23, J24	CONN HEADER VERT 2POS 2.5MM	FP-B2B-XH-A_LF_SN-MFG		6
P1, P2	Header, 20-Pin	HDR1X20		2
Q1, Q5, Q6, Q7	2N7002, MOSFET N-CH 60V 260MA SOT-23	FP-318-08-IPC_A		4
Q2, Q3	MMBT2907ALT1G General Purpose Transistor, PNP Silicon, 3-Pin SOT-23, Pb-Free, Tape and Reel	ONSC-SOT-23-3-318-08_V		2
Q4	SSM3J328R,LF, TOSHIBA Field-Effect Transistor Silicon P-Channel MOS Type (U-MOS VI), 20 V, -55 to 125 degC, 3-Pin SOTFL, RoHS, Tape and Reel	TOSH-SOT-23F_V		1
R1, R3, R4, R7, R9, R10, R13, R14, R15	Resistor	Res_1206_3mm	1K	9
R2	Resistor	Res_1206_3mm	10K	1
R5, R6	Resistor	Res_1206_3mm	5.1K	2
R8, R11, R12	Resistor	Res_0603_2mm	220	3
S1	SPDT Subminiature Toggle Switch, Right Angle Mounting, Vertical Actuation	SS-12F45		1
U1	STM32F401RE, mbed-Enabled Development Nucleo-64 STM32F4 ARMÂ® CortexÂ®-M4 MCU 32-Bit Embedded Evaluation Board	ST_NUCLEO-F401RE		1
U2	HEF40106BT,653, IC INVERT SCHMITT 6CH 6-INP 14SO	FP-SOT108-1-MFG		1

Disclaimer

This circuit board is a part of "FRA262 Robotics Studio 3: Industrial topic". Which is a 2nd-year university student project of the Institute of Field Robotics, King Mongkut's University of Technology Thonburi, Thailand. This circuit is designed by Altium Designer (Student License). Academic use purpose. Commercial use is prohibited.

This circuit board is a student project design. So, some usage problems might have occurred. Such as error concept design, transmission line length, ground plane, etc. Industrial standards are unclaimed in this model.

Using a power source which not in the range of recommended rating is a risk to get dangerous, breaking components, or underrating power.

Using different components, and parameters from specifying in this datasheet might cause altered voltage or unusable circuits. More Information about electrical characteristics for each IC is available on each own datasheet.

Information in this document supersedes and replaces information previously supplied in any prior versions of this document.

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