BRING-UP PLAN

EECE8010 – Embedded System Hardware Design

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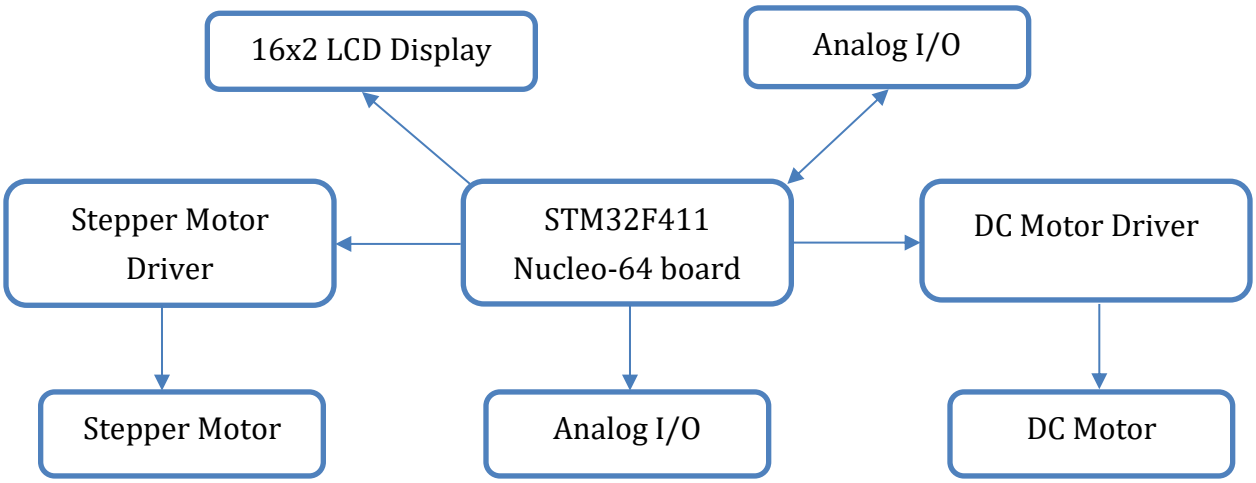
INTRODUCTION

The purpose of this document is to present a detailed description of testing plan for all components and on-board peripherals for the Embedded Microcontroller Board.

It will explain features of modules, steps for testing them along with expected results.

System Block Diagram



Phase Breakdown

The bring-up process is described as following steps:

- Visual Inspection: it is performed to ensure all components are correctly populated and with the right orientation as marked on the silkscreen. The components should be soldered as per the orientation without visual shorts exits. Besides, jumpers should be ensured to be in the right positions.
- Power Supply and Regulator Testing: this step is to check for any open/short circuit of power rails on the board. For each power source, validate voltage is within range, validate current is within range.
- Reset and Clock Circuit Testing: ensure all required clock sources are driven, and their oscillators and drivers meet the data sheet specifications for voltage, rise/fall time, and jitter. Besides, validating RESET net during power up is necessary.
- CPU Interface Testing: check that any micro-processor interfaces are working to expected specification, i.e inputs/outputs on the micro are working correctly.
- Software Loading: it is a must to test the connection between the micro-controller to I/O pins by loading test software (toggle function) onto the board. If any pin is damaged, it should be disconnected to the micro-controller.

- Peripheral Circuit Testing: when loading drivers to each peripheral module, check each pin of the module for expected signal level as well as its function.
- System Level Testing: Upload system level software to test the whole system.

VISUAL INSPECTION

It is necessary to check any damage on the PCB when receiving it. The damages could be visible scratches, short circuits or un-drilled vias/through holes on the PCBs.

Individual Component Inspection

Next step is to get bill of materials (BOM file) to verify the quantity of each component as well as its quality.

Description	Designator	Quantity	Check
Nucleo F411RET6 board		1	✓
Polarized Capacitor 85C 10uF ±20% 35V	C1, C3, C8	3	✓
Ceramic Capacitor .1uF 50v X7R 0805	C2, C4, C5, C6, C7, C9	6	✓
Ceramic Capacitor 220pF 50v X7R 0805	C10	1	✓
Ceramic Capacitor 33pF 50v COG 0805	C11, C12	2	×
Schottky Diode 40V 2A SMA	D1, D2	2	✓
Waveshare 0.95 inch OLED Module	DS1	1	✓
Resistor 4.99R OHM 1% 1/8W SMD 0805	R1, R2	2	✓
USB Mini Connector, SMD, RA	J1	1	✓
Terminal, 2-Pin	P1, P5	2	✓
6-Pin Position Header .100 VERT GOLD	P2, P3	2	✓
Header, 6-Pin Male	P4	1	✓
4-Pin Position Header .100 VERT GOLD	P6	1	✓
38 Position Header Connector 0.100in 19x2H Through Hole Gold	P7, P8	2	✓
CH340G USB to serial chip	U1	1	✓
L293DD IC Motor Driver PAR 20-SOIC	U2	1	✓
TB6608FNG IC Motor Driver Bipolar 2.7-5.5V 20SSOP	U3	1	✓
Crystal 12 MHz 18pF SMD	Y1	1	✓

Table 1. Bill of Materials

When the test of the extension board and components is confirmed, it is time for soldering.

Report if there is any issue

There is no ceramic capacitor 33pF. Instead, it is replaced by ceramic capacitor 55pF.

Solder Check

Solder joints should be checked carefully to make sure that they are clean and tidy, without any short circuit (solder bridge) or open circuit (bad barrel fill or tombstoning).

If found, log below.

Pins of the mini-USB connector are not soldered properly to the board, thus, it can not operate correctly.

Jumper Check

Check that all jumper wires are in the correct location.

Device	Description	Connector	Expected Status	Check
Nucleo-F411RE	ST-Link/Nucleo selector	CN2	Connected	✓
	USART to ST-link MCU selector	CN3	Disconnected	✓
	SWD connector	CN4	Connected	✓
		CN11	Connected	✓
		CN12	Connected	✓
	maximum current consumption of the board	JP1	Disconnected	✓
	Measuring STM32 microcontroller consumption	JP6	Connected	✓
	Power source selector	JP5	U5V	✓
Extension board				

POWER SUPPLIES AND REGULATORS

Before applying power, check each voltage power rail on the board to make sure it is not shorted to ground. Use an Ohmmeter to measure resistance of each rail to ground with the board powered off. Resistance can be quite low under normal circumstances, depending on what type and amount of circuitry is powered by that rail.

Current Monitoring

For this test, the current of the whole system should be checked. Using a power supply with the limited current (at about 500mA) is helpful to prevent any damage, then apply power to the power supply circuitry.

If available, watch the board come alive with a thermal imaging camera to detect known hot spots. If it is unavailable, touch all the major components lightly to feel for ones that are getting too hot. Also, feel the PCB for hot areas. Besides, monitor the current being drawn and ensure that it does not exceed design calculations.

Report if there is any issue

Voltage Verification

Connect the power supply into the Nucleo board and then measure the voltage of each power rail the output voltage level of each regulator. Oscilloscope could be helpful to see if the rail looks stable or is oscillating or really noisy.

Verify the following voltage level to ensure that it is within the specified accepted tolerance range.

Device	Description	Pin	Expected Voltage	Measured Voltage
Nucleo-F411RE	V_{CC} Power	CN7-12, 16	3.3V ± 10%	3.32V
	5V V_{CC} Power	CN7-18	5V ± 5%	5.02V
	Ground	CN7-8, 19 20, 22	0V ± 5%	0V
	Ground	CN10-9, 20	0V ± 5%	0V
	Analog V_{DD}	CN10-7	3.3V ± 5%	3.32V
	Analog Ground	CN10-32	0V ± 5%	0V
OLED Module	V_{CC} Power	1	3.3V ± 5%	3.32V
	Ground	2	0V ± 5%	0V
CH340G	Ground	1	0V ± 5%	0V
Analog I/O	Analog Ground	1	0V ± 5%	0V
	Analog V_{DD} Power	6	3.3V ± 5%	3.32V
L293DD	V_{SS} – Logic Supply Voltage	20	5V ± 5%	5.02V
	Ground	4, 5, 6, 7, 14, 15, 16,17	0V ± 5%	0V
TB6608FNG	V_{CC} – Logic Supply Voltage	1	3.3V ± 5%	3.32V
	Ground	15	0V ± 5%	0V

Power Pin Verification

Connect the external power supply into the PCB and verify the following voltage level:

Device	Description	Pin	Expected Voltage	Measured Voltage
Mini USB	5V Power output	1	5V ± 10%	4.95V
	Ground	5	0V ± 5%	0V
TB6608FNG	Power supply pin for output	6	5V ± 5%	4.8V
L293DD	Power supply pin for output	10	5V ± 5%	4.8V

RESET AND CLOCK CIRCUIT

Oscillator Frequency Check

Use an oscilloscope to measure the oscillator frequency and ensure that it is within accepted range.

Report if there is any issue

The oscillator circuit of CH340G will not work as it is powered by mini-USB connector.

CPU TESTING

Since the board is an extension board of Nucleo-F411RE board, there is unnecessary to perform CPU testing. Thus, this phase is ignored.

SOFTWARE LOADING

I/O Testing

After loading test software onto the board, exercise each interface one at a time. The software should allow testing of each aspect within each interface individually.

Poll serial I/O to ensure integrity of ports. Software should allow writing to all I/O locations. By putting all output in HIGH/LOW, this will help test if any I/O pin is damaged, and for that reason, the Nucleo-board could be disconnected from the extension board.

Record the success of each test before moving on to the next.

Pin	Signal Description	Expected Voltage	Measured Voltage
CN7-17	USB to UART TLL Tx	3.3V/0V	3.32V/0V
CN19-33	USB to UART TLL Rx	3.3V/0V	3.32V/0V
CN10-23	DC Motor 1 Enable pin PWM	3.3V/0V	3.28V/0V
CN10-16	DC Motor 1 Direction pin 1	3.3V/0V	3.28V/0V
P8-30	DC Motor 1 Direction pin 2	3.3V/0V	3.28V/0V
P8-13	DC Motor 1 Encoder Channel A	3.3V/0V	3.28V/0V
P8-15	DC Motor 1 Encoder Channel B	3.3V/0V	3.28V/0V
P8-21	DC Motor 2 Enable pin PWM	3.3V/0V	3.32V/0V
P8-28	DC Motor 2 Direction pin 1	3.3V/0V	3.32V/0V
P8-26	DC Motor 2 Direction pin 2	3.3V/0V	3.32V/0V
P8-17	DC Motor 2 Encoder Channel A	3.3V/0V	3.32V/0V
P7-21	DC Motor 2 Encoder Channel B	3.3V/0V	3.32V/0V
P8-1	Stepper Motor Enable pin	3.3V/0V	3.32V/0V
P8-2	Stepper Motor Reset pin	3.3V/0V	3.32V/0V
P8-4	Stepper Motor Direction pin	3.3V/0V	3.32V/0V
P7-30	Stepper Motor Step pin	3.3V/0V	3.32V/0V
P7-38	Analog Input pin 1	3.3V/0V	3.29V/0V
P7-36	Analog Input pin 2	3.3V/0V	3.29V/0V
P7-35	Analog Input pin 3	3.3V/0V	3.29V/0V
P7-32	Analog Output pin	3.3V/0V	3.29V/0V
P7-37	OLED Display Data In	3.3V/0V	3.28V/0V
P8-19	OLED Display Clocks	3.3V/0V	3.28V/0V
P8-22	OLED Display Chip Select	3.3V/0V	3.28V/0V
P8-24	OLED Display Data/Command Control	3.3V/0V	3.28V/0V
P7-34	OLED Display Reset	3.3V/0V	3.28V/0V

RAM / Memory Testing

Since the board is an extension board of Nucleo-F411RE board, there is unnecessary to perform CPU testing. Thus, this step is ignored.

PERIPHERAL CIRCUIT TESTING

This test is required the use of the test software/simplistic test code to verify that any external peripherals are controlled properly by the Nucleo-board. Each peripheral is individually tested.

USB to TTL UART

An external board was used to connect the Nucleo-board UART port to USB Port on the board.

The Nucleo-board will send a test message to the TTL converter then forwarded to the PuTTY through the mini-USB connector.

Report if there is any issue

This function is not tested as the mini-USB does not work properly

DC Motor and Feedback

- Check each pin for expected signal level.
- Check all voltage supply vias.

Each DC motor should continuously rotate with its speed changed, depending on the voltage on L293DD pin which is controlled by PWM module.

Report if there is any issue

This module works correctly.

OLED Display

- Check each pin for expected signal level.
- Check all voltage supply vias.

The OLED Display should display correctly contents put in by the Nucleo-board.

Report if there is any issue

This module works correctly.

Stepper Motors

- Check each pin for expected signal level.
- Check all voltage supply vias.

The stepper motor should continuously rotate with its constant speed.

Report if there is any issue

This module works correctly.

Analog I/O

- Check each pin for expected signal level.
- Check all voltage supply vias.

Report if there is any issue

These I/O correctly forward analog signal to the Nucleo-board.

SYSTEM LEVEL TESTING

The hardware is functionally tested; thus, this step is to implement the real logic that will be used.

Performance Testing

Test applicable peripherals for performance limits. Record results.

The test should be:

- Drive motors continuously.
- Read analog signal from analog I/O.
- Report these parameters to the OLED and forward them to the PuTTY through the mini-USB connector.

Report if there is any issue

Except for USB to TTL UART, other modules work as expected.