DEXTER BASE DOCUMENT

The purpose of this document is to familiarize yourself with the functionalities of DEXTER, a custom-built embedded processor built exclusively for your Build Club experiments

This document has three parts:

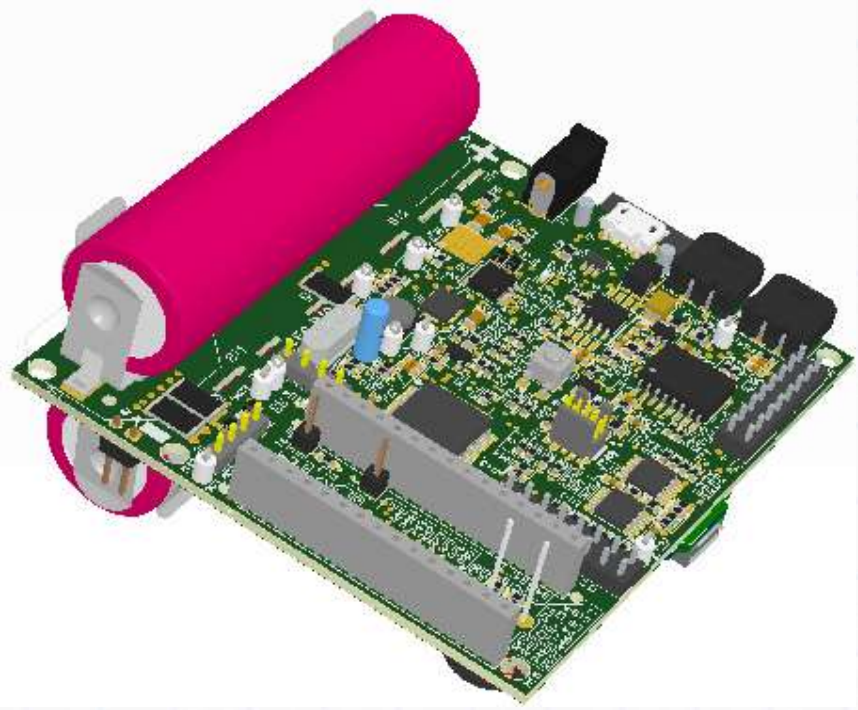
- Dexter Quick Reference Guide
- STM IDE Installation guide
- Dexter User Functions

(click the part you'd like to read)

DEXTER

an Embedded Controller Platform

Quick reference guide



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1. DEXTER: Product View

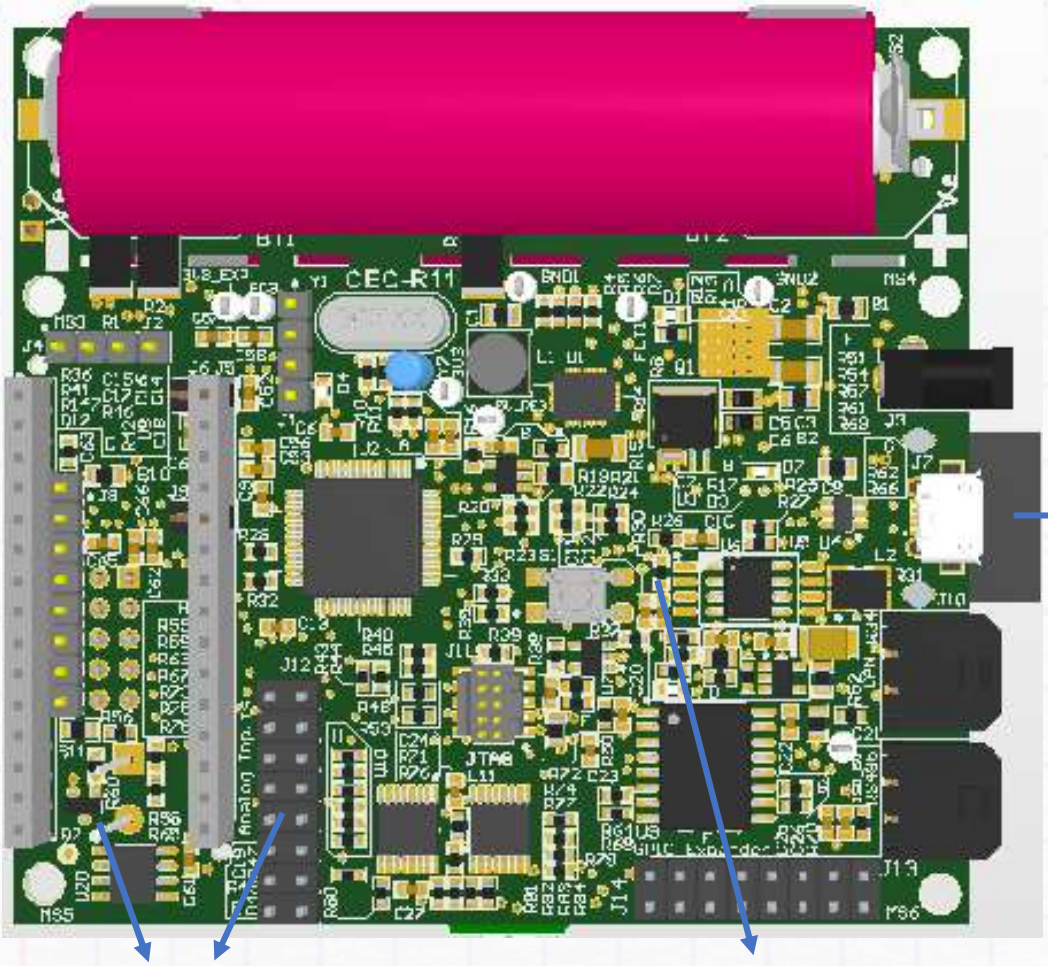


Figure 1: Top View

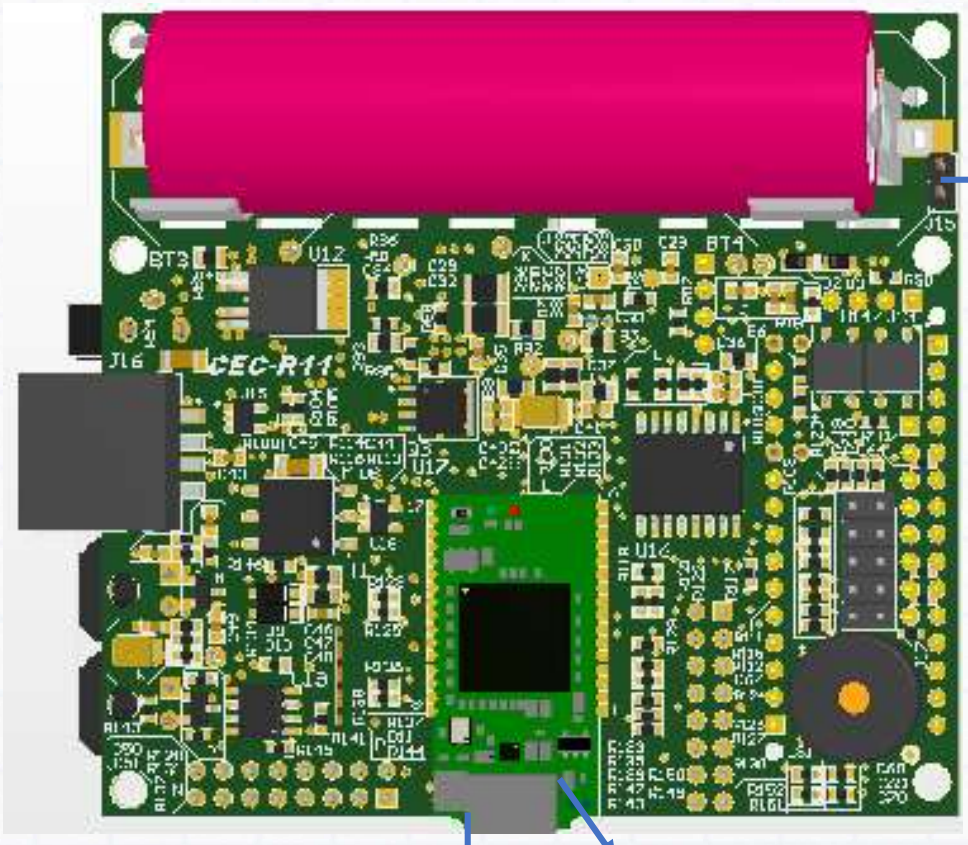


Figure 2: Bottom View

2. DEXTER : Hardware Architecture and Specification

	Specification
Micro Controller STM32L452RC	✓ ARM 32-bit Cortex -M4 CPU with FPU, DSP instructions ✓ Frequency up to 80 MHz, MPU, 100 DMIPS ✓ 256 KB single bank Flash, 160 KB SRAM ✓ Ultra-low-power with Flex Power Control
Interfaces / Ports	✓ CAN 2.0 B, upto1Mbps ✓ RS485, upto 220kbaud ✓ USB 2.0 device micro-AB port @12Mbps ✓ USB 2.0 ST-link micro-AB port for program/debug ✓ Expanded I/O: 8 digital o/p & 8 Analog i/p ports ✓ 1 opto-isolated i/p & 1 opto-isolated o/p ports ✓ JTAG/SWD Cortex port for program and debug ✓ Expansion port for plug-in hardware (Arduino Nano compatible) ✓ Alert notification through Buzzer and LED
Expansion Memory	✓ 256 Mb SPI flash memory, scalable up to 1Gb ✓ Optional Memory: FRAM or serial EEPROM
Powering options	✓ Rechargeable 2.6Ah @ 3.65V, 18650 NMC cell ✓ DC adapter port : 0.5A @ 7.5V or 9V DC input ✓ USB 2.0 device port to receive DC power, max 0.5A @ 5VDC

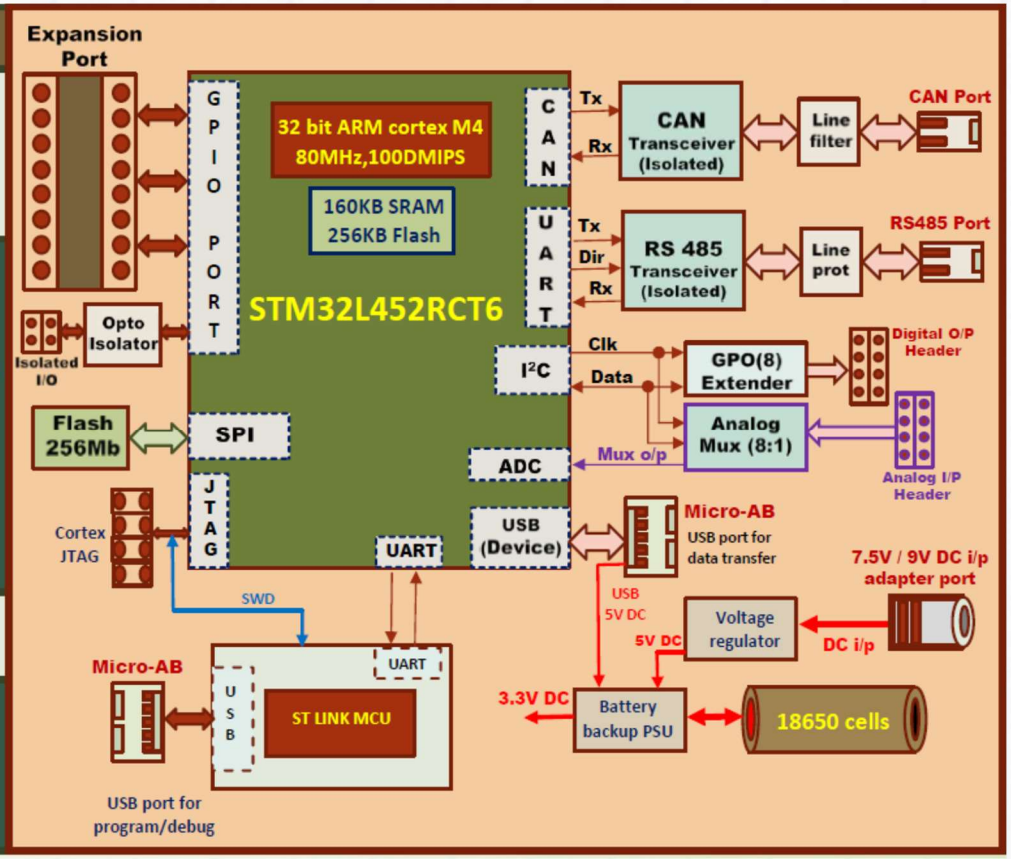


Figure 3: Block Diagram

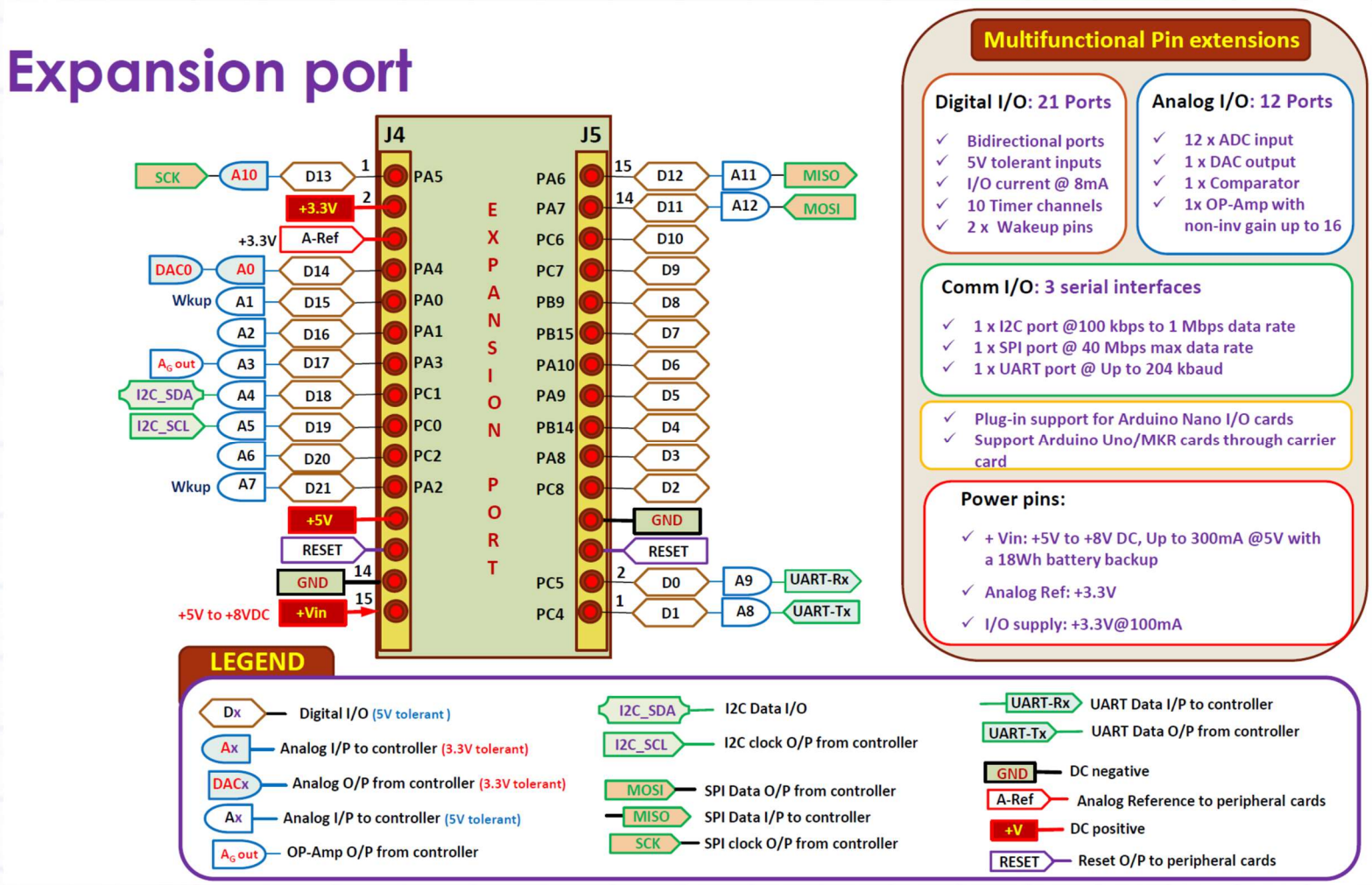


Figure 4: Expansion Port

3. DEXTER : Memory, Indicators and Ports

a) Memory

U16 : Flash Memory – SPI Interface

Pin #	Controller Pin mapping	Flash Memory Pin Name	Signal Name	Function
3	NRST	$\overline{\text{RESET}}$	FM_RST	Memory Reset
7	PA15	$\overline{\text{CS}}$	FM_CS	Chip Select
8	PC11	DO(IO1)	FM_MISO	Data I/P to Controller
9	PB5	$\overline{\text{WP(IO2)}}$	FM_WP	Write Protect
15	PC12	DI(IO0)	FM_MOSI	Data O/P from Controller
16	PC10	CLK	FM_SCK	Clock Input

U20 : FRAM Memory – I2C1 Interface

Pin #	Controller Pin mapping	FRAM Memory Pin Name	Signal Name	Function
5	PB7	SDA	uC_I2C1_SDA	Serial Data I/O
6	PB6	SCL	uC_I2C1_SCL	Serial Clock

b) LED status indicators

LED Reference	Controller Pin mapping	Function
D1	-	Glows to indicate Battery Charging
D4	PH0	Blinks to indicate Controller activity
D7	-	Glows to indicate USB Power switch Fault
D12	-	Glows to indicate 5V Power

c) Audio (Buzzer) indicator

Buzzer Reference	Controller Pin mapping	Function
LS1	PB3	Piezo electric buzzer (4KHz) with audible cadence

d) Ports

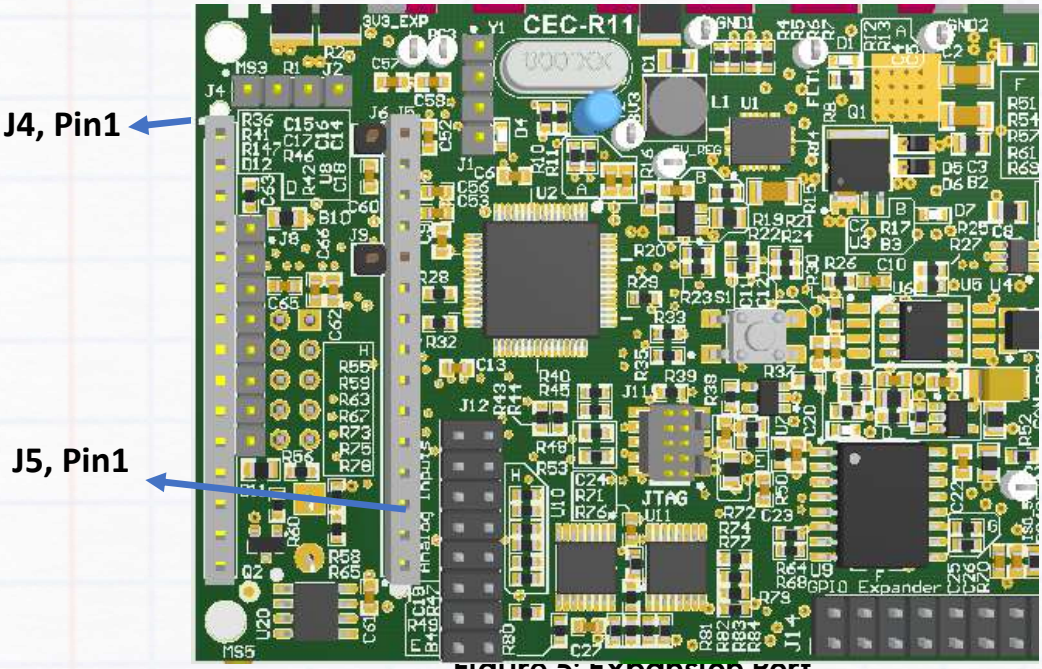


Figure 5: Expansion Port

J4 : Expansion Port connector Pinout

Table below summarizes the Pinout functions of Expansion Port shown in **Figure 4.**

Pin #	Controller Pin mapping	Connector Pin Name	Controller Pin Multi-function features
1	PA5	D13/A10/SCK	D13: Digital I/O
			A10: Analog I/P(3.3V tolerant)
			SCK: SPI Clock O/P from Dexter; To interface Dexter using SPI interface
2	-	+3.3V	+3.3V DC Out from Dexter
3	-	A-Ref	To connect to Analog Reference of ADD-ON cards, +3.3V
4	PA4	D14/A0/DAC0	D14:Digital I/O
			A0: Analog I/P (3.3V tolerant)
			DAC0: DAC O/P
5	PA0	D15/A1/Wkup	D15: Digital I/O
			A1: Analog I/P (5V tolerant)
			Wkup: Wakeup signal I/P
6	PA1	D16/A2	D16: Digital I/O
			A2: Analog I/P (5V tolerant)
7	PA3	D17/A3/A_G out	D17: Digital I/O
			A3: Analog I/P (5V tolerant)
			A_G out: Op-Amp O/P from Dexter
8	PC1	D18/A4/ I2C_SDA	D18: Digital I/O
			A4: Analog I/P (5V tolerant)
			I2C_SDA: I2C Serial Data I/O
9	PC0	D19/A5/ **I2C_SCL**	D19: Digital I/O
			A5: Analog I/P (5V tolerant)
			I2C_SCL: I2C Serial Clock O/P from Dexter

Pin #	Controller Pin mapping	Connector Pin Name	Controller Pin Multi-function features
10	PC2	D20/A6	D20: Digital I/O
			A6: Analog I/P (5V tolerant)
11	PA2	D21/A7/Wkup	D21: Digital I/O
			A7: Analog I/P (5V tolerant)
			Wkup:Wakeup signal I/P
12	-	+5V	+5V O/P from Adapter board
13	NRST	RESET	RESET
14	-	GND	Ground
15	-	+VIN	Power I/P (+5V to +8V) to Adapter board

J5 : Expansion slot connector Pinout

Pin #	Controller Pin mapping	Pin Name	Controller Pin Multi-function features
1	PC4	D1/A8/UART-Tx	D1: Digital I/O
			A8: Analog I/P (5V tolerant)
			UART-Tx: UART Data O/P from Dexter
2	PC5	D0/A9/UART-Rx	D0: Digital I/O
			A9: Analog I/P (5V tolerant)
			UART-Rx: UART Data I/P to Dexter
3	NRST	RESET	RESET O/P to ADD-ON cards
4	-	GND	Ground
5	PC8	D2	D2: Digital I/O
6	PA8	D3	D3: Digital I/O
7	PB14	D4	D4: Digital I/O
8	PA9	D5	D5: Digital I/O
9	PA10	D6	D6: Digital I/O
10	PB15	D7	D7: Digital I/O
11	PB9	D8	D8: Digital I/O
12	PC7	D9	D9: Digital I/O
13	PC6	D10	D10: Digital I/O
14	PA7	D11/A12/MOSI	D11: Digital I/O
			A12: Analog I/P (5V tolerant)
			MOSI: SPI Data O/P from Dexter
15	PA6	D12/A11/MISO	D12: Digital I/O
			A11: Analog I/P (5V tolerant)
			MISO: SPI Data I/P to Dexter

J7 : USB Type AB connector Pinout

Pin #	Controller Pin mapping	Pin Name	Function
1	-	VBUS	VBUS (+5V)
2	-	USB_N	USB Differential Pair M
3	-	USB_P	USB Differential Pair P
4	PA10	OTG_FS_ID	USB ID
5	-	GND	Ground

J11: SWD / JTAG connector Pinout

Pin #	Controller Pin mapping	Pin Name	Function
1	-	3V3_VDD	+3.3V
2	PA13	SWDIO /TMS	SWD I/O ; Test Mode select
3	-	GND	Ground
4	PA14	SWCLK /JTCK	SW clock ; JTAG clock signal to target CPU
5	-	GND	Ground
6	PB3	TDO	JTAG data O/P from target CPU
7	-	NC	-
8	PA15	TDI	JTAG data I/P of target CPU
9	PB4	TRST	NC
10	NRST	SWD_RST	Reset

J15 : Shorting Link

Shorting Link to be inserted in J15 when using 2 cells in parallel

Cell Orientation		
Mode	**Orientation**	**J15**
2 Series	BT3 -ve, BT4 +ve	OPEN
2 Parallel	BT3 +ve, BT4 -ve	SHORT

4. DEXTER Power ON Procedure

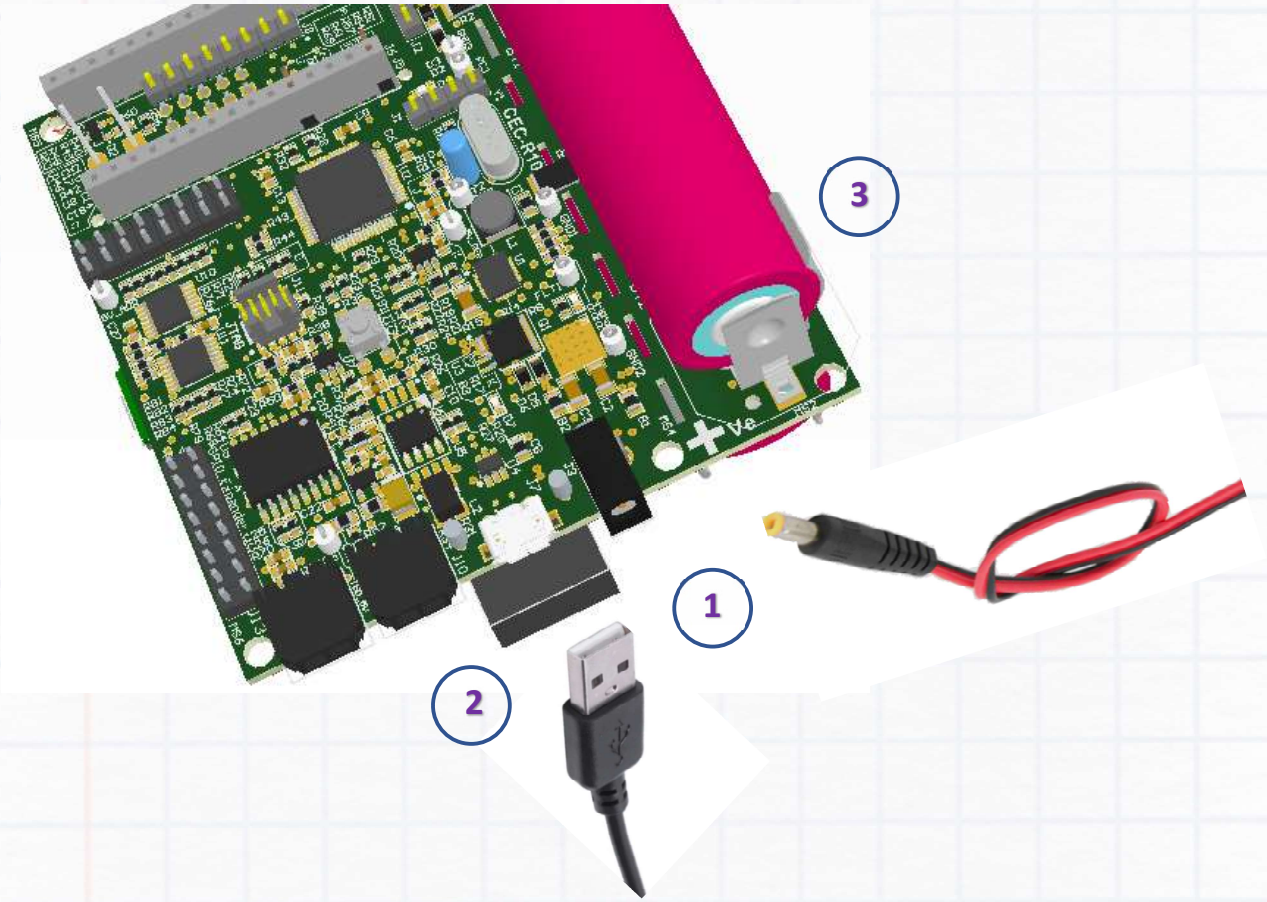


Figure 6: Powering options

DC Powering options

1. External 500mA @ 7.5V or 9V DC input from DC power adapter
2. USB 2.0 upto 500mA@5VDC
3. On-board 18650 rechargeable battery ; energy capacity of 9.5wh; on-board charger circuit

5. COTS Plugin options on Expansion slots

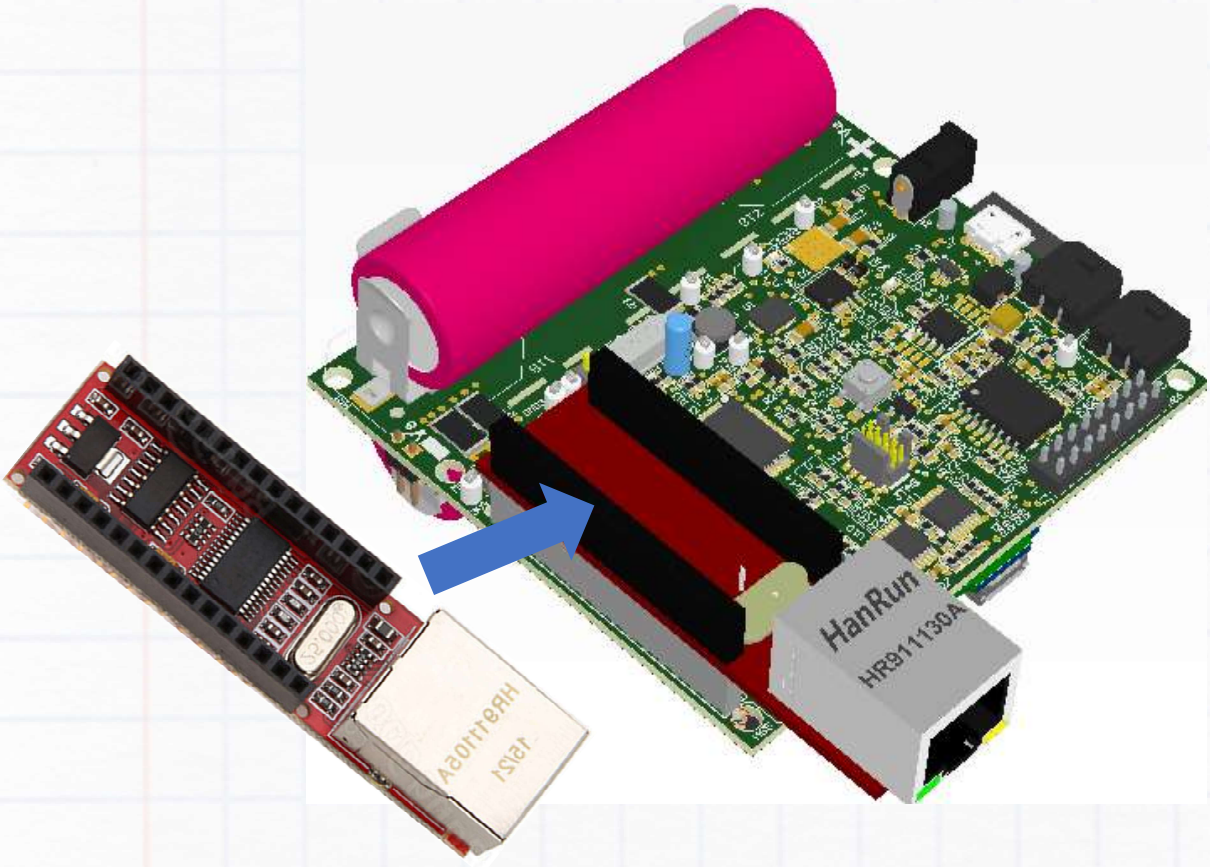


Figure 7: Plugging COTS boards

COTS (Commercially Off the shelf) Plug-in boards

Optional COTS boards on Expansion Slots	Applications
NANO IoT	IoT
NANO 33 BLE	Wi-Fi/BLE network connectivity.
NANO Ethernet Shield	Connect to Ethernet Network

6. IO mapping of STM32L452RCT6 controller

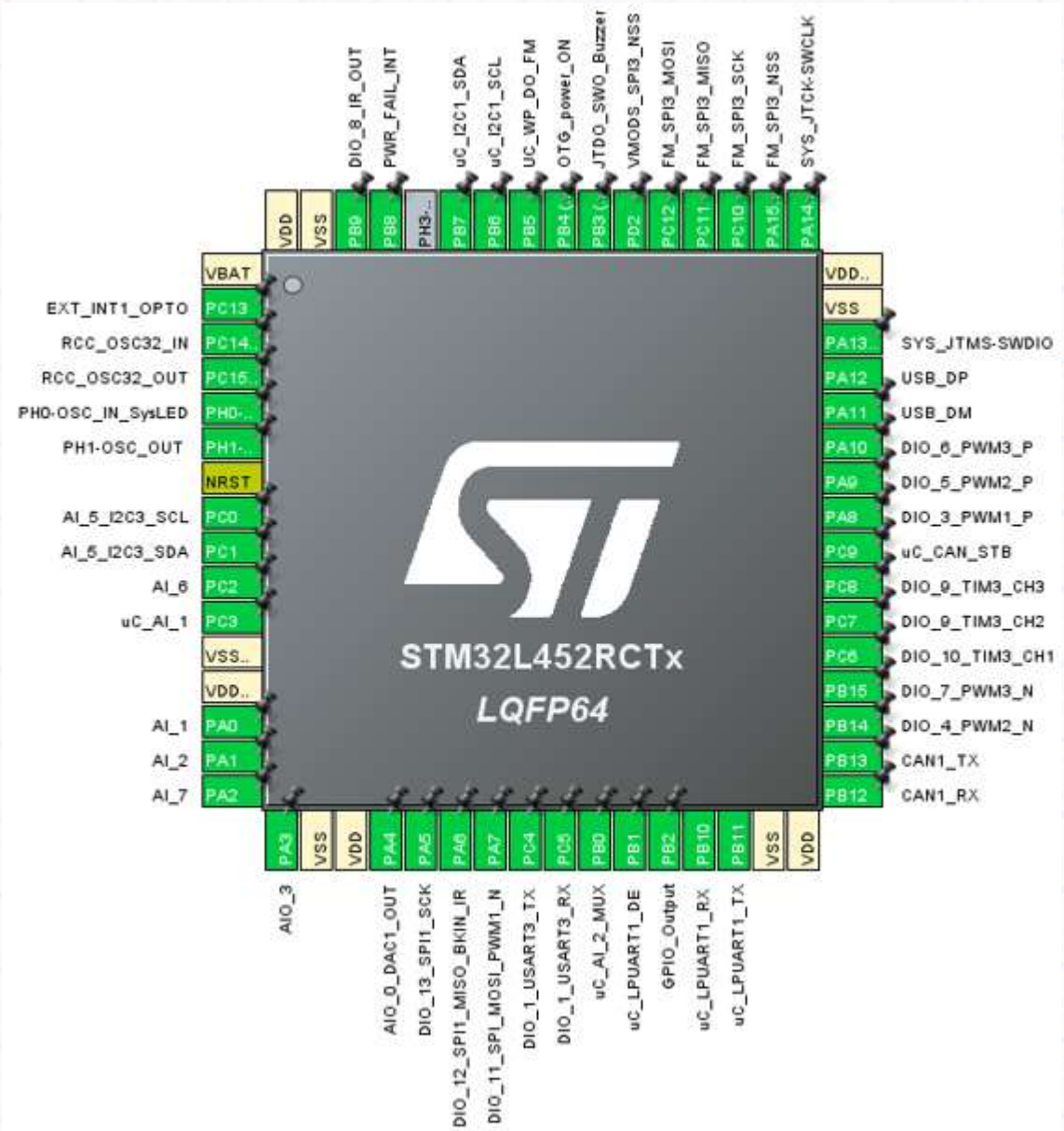


Figure 8: Pin mapping of DEXTER controller

7. DEXTER ADAPTER BOARD

Illustrations to expand Dexter efficacy using **"Adapter Board"** on expansion slots provided.

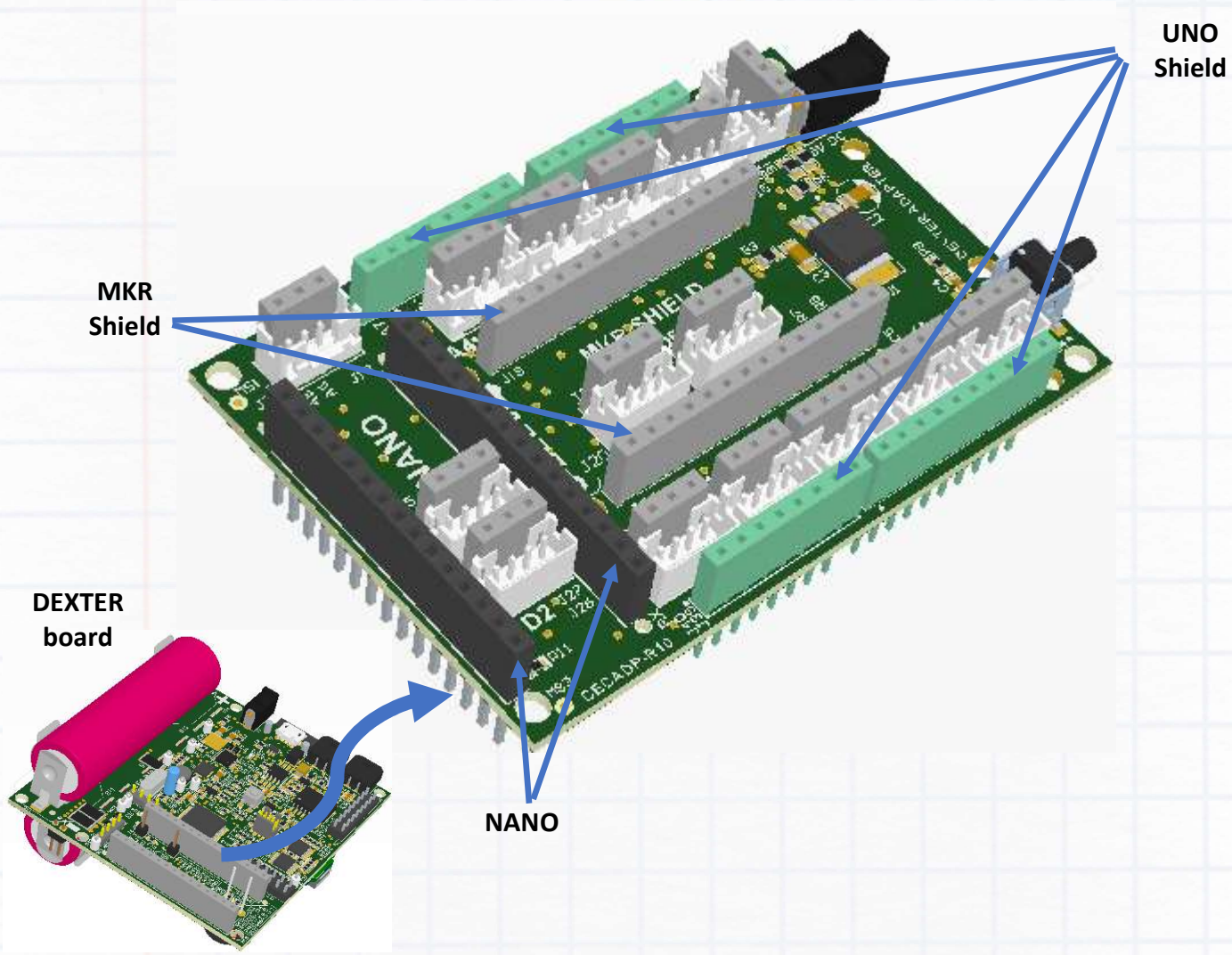


Figure 11: DEXTER Adapter board: attached on expansion slot of DEXTER

8. COTS plug-in Options on Expansion slots using Adapter/Carrier Board

a) Illustration 1 COTS Nano Ethernet shield plugged onto Adapter board that plugged to DEXTER

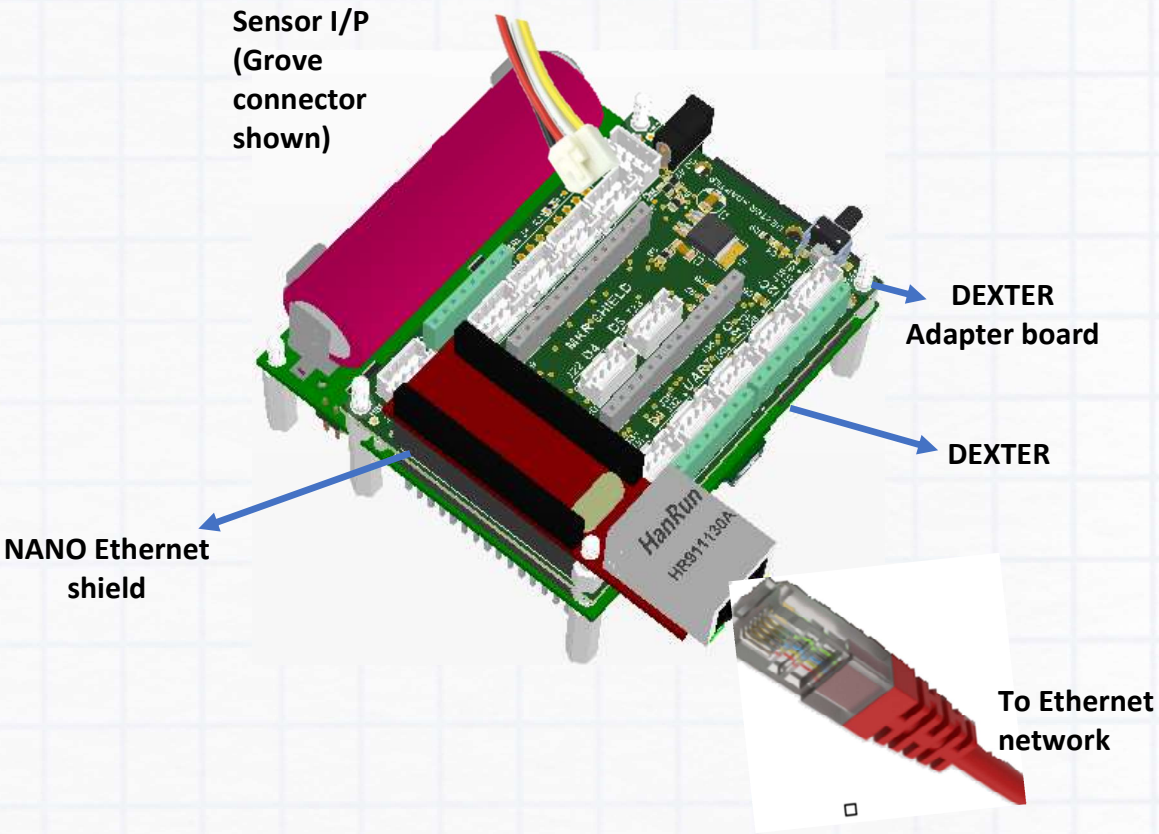


Figure 12: Illustration 1 *COTS Nano Ethernet shield plugged onto Adapter board that plugged to DEXTER*

b) Illustration 2 COTS Nano Ethernet shield and UNO motor shield plugged onto Adapter board that plugged to DEXTER

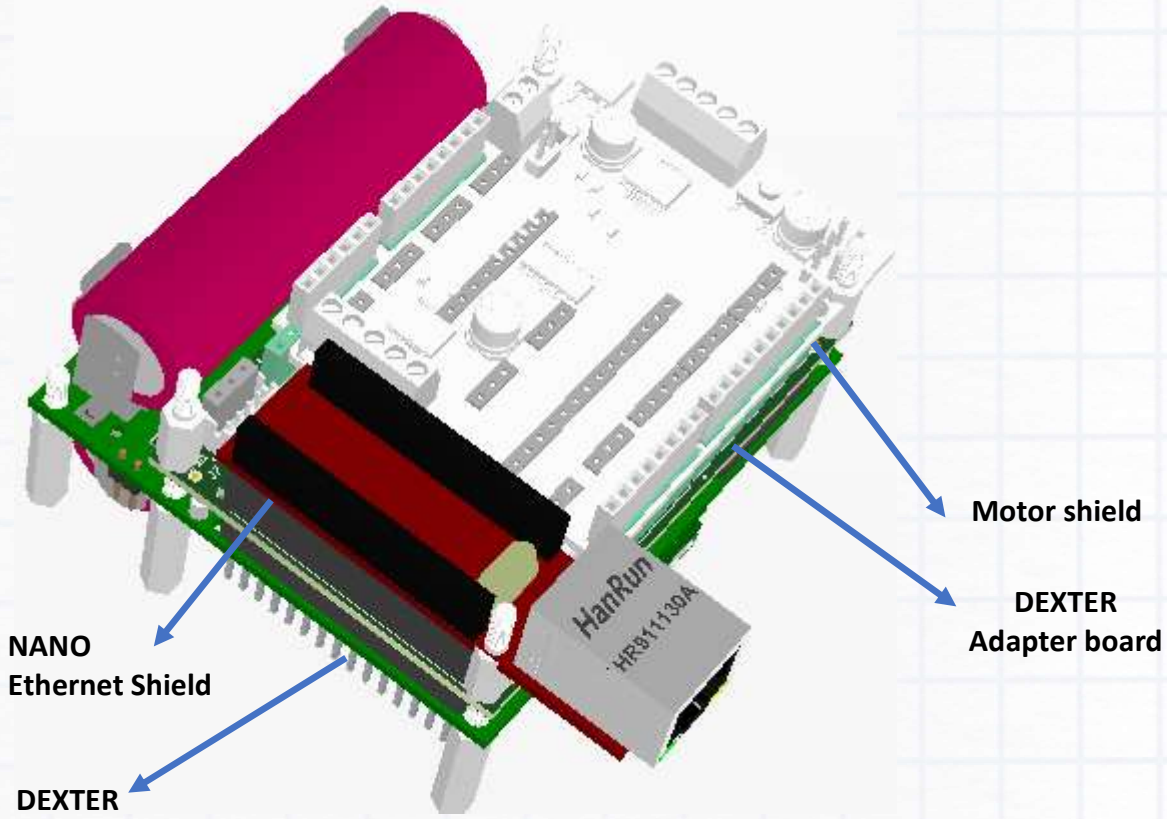
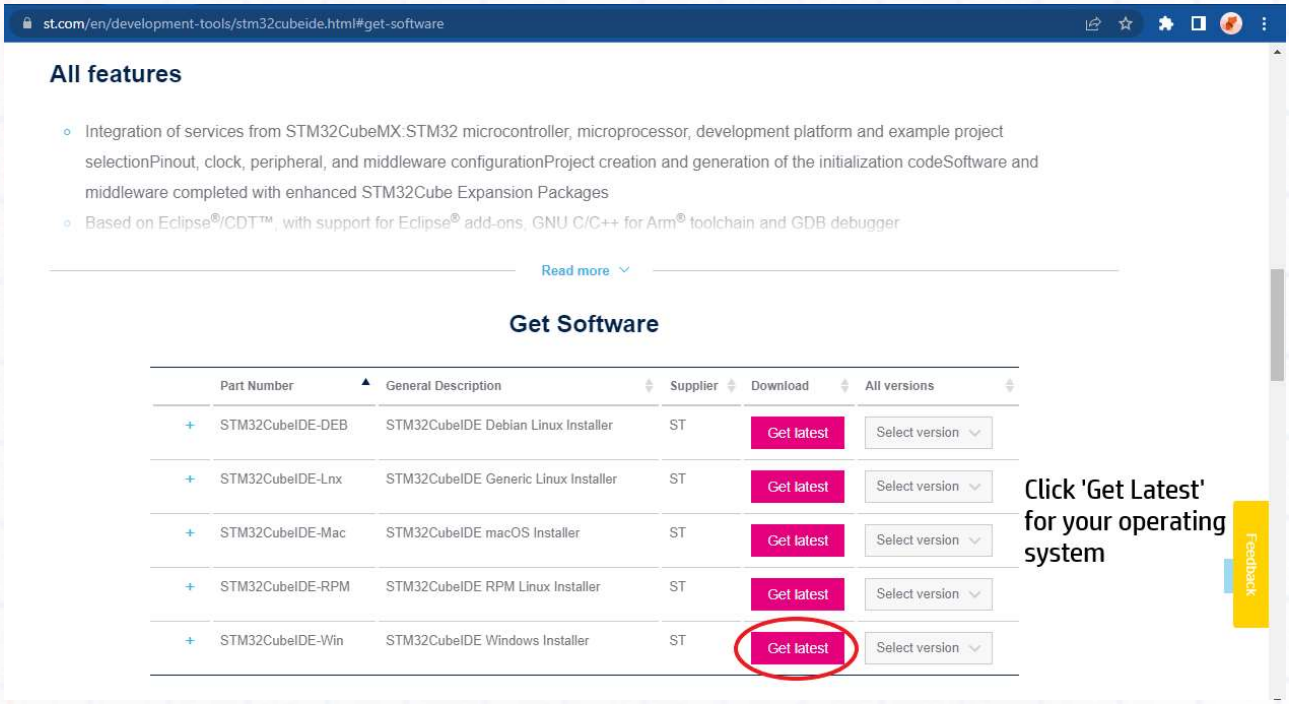


Figure 13: Illustration 2 *COTS UNO motor shield and Nano Ethernet shield plugged onto Adapter board that plugged to DEXTER*

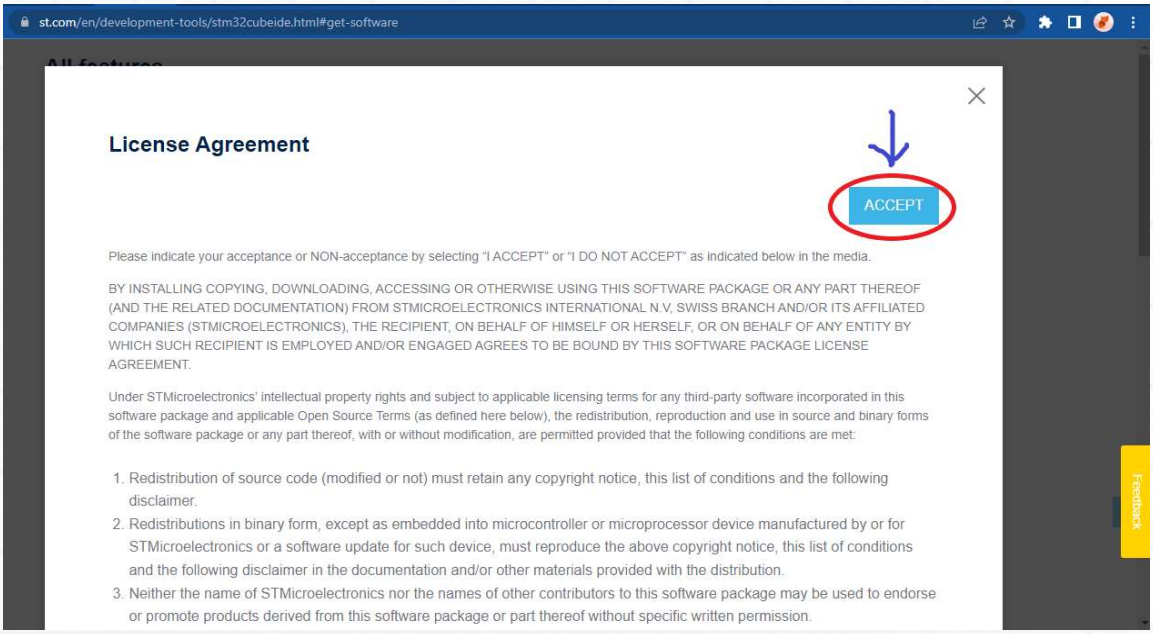
STM IDE Installation guide

STM IDE Installation guide

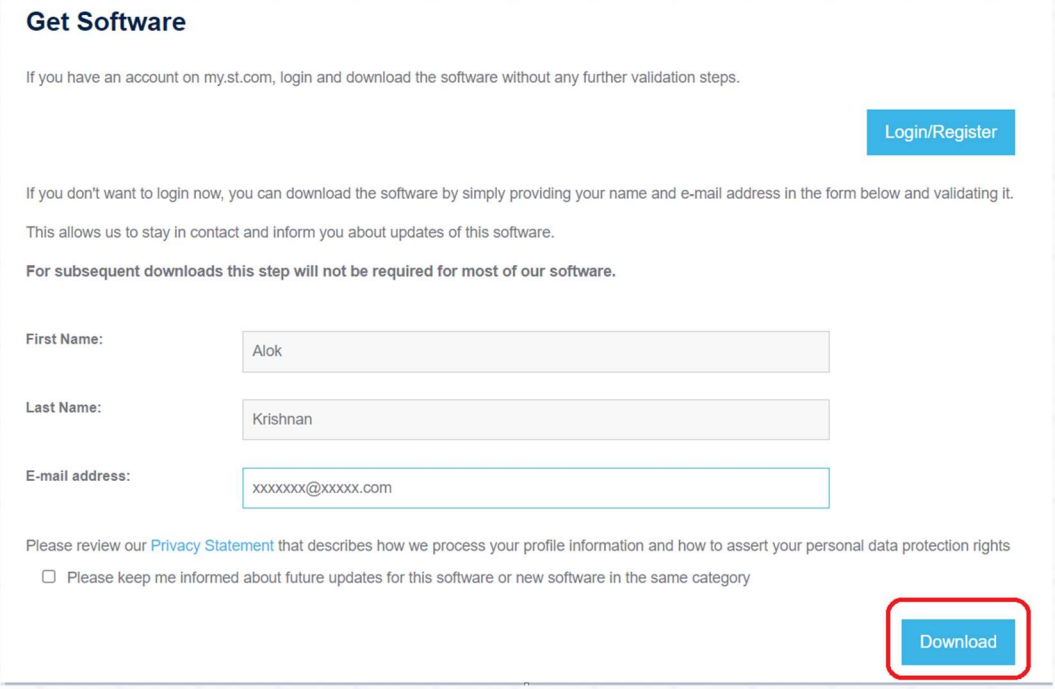
1) Go to https://www.st.com/en/development-tools/stm32cubeide.html#get-software
Locate the installer for your operating system and click '**Get Latest**'.



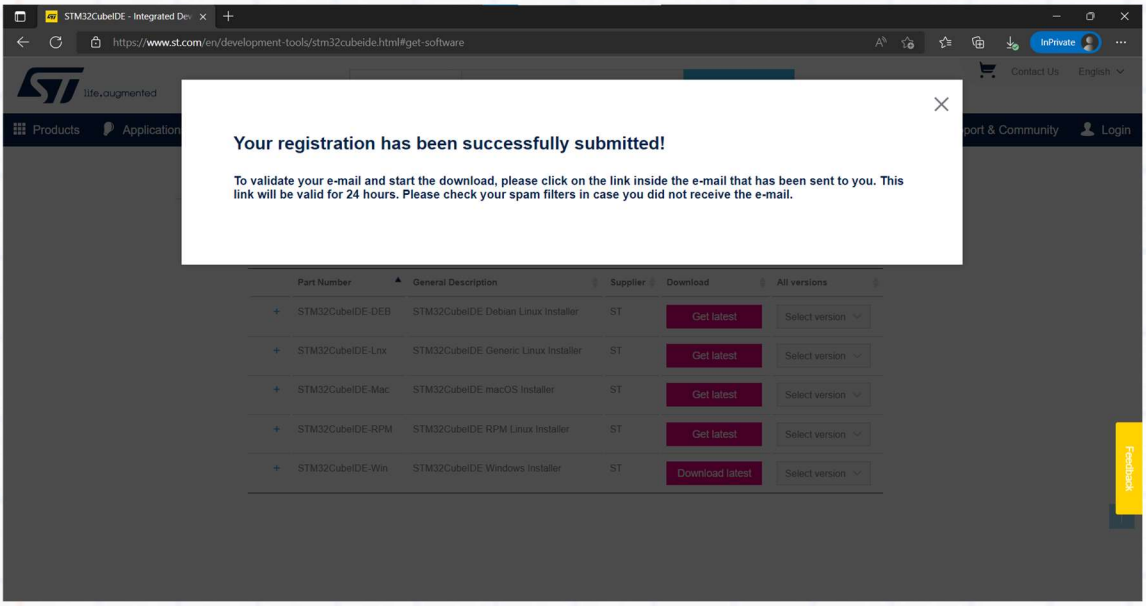
2) Now a pop up would appear to accept STM32's terms and agreements. Click '**Accept**'



3) Enter your details in the next window as shown. Next, hit '**Download**'.

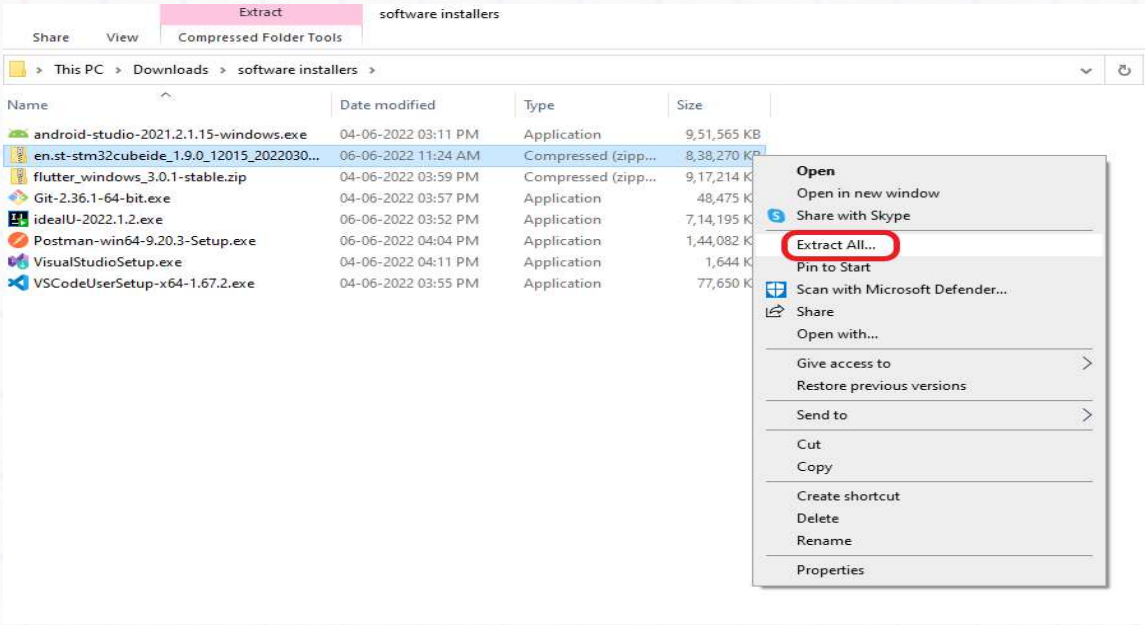


4) A confirmation pop up will be displayed conveying that an email with the Download link has been sent to the mail ID entered.

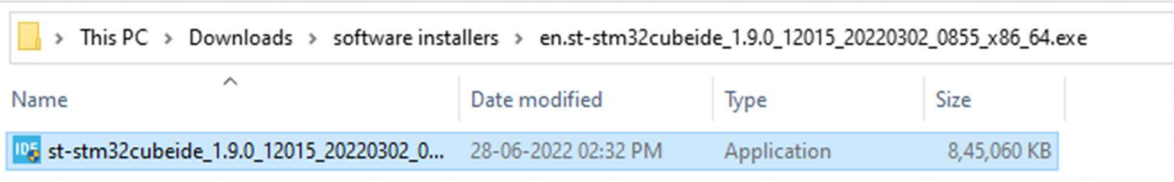


5) Go to your email and check for an email from STM32. Click on the '**Download Now**' button in the email.

6) A zip file will start downloading. Once the download is completed, right-click the ZIP file and select '**Extract All**'. The extracted folder will open when completed.

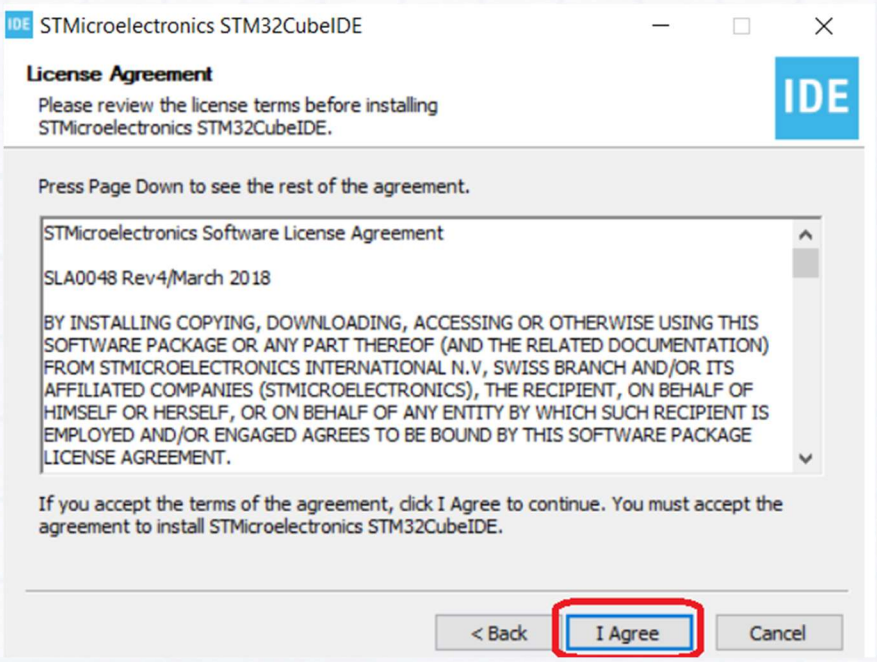


7) Inside the extracted folder, double-click the installer file.



8) Follow the below steps:

a)



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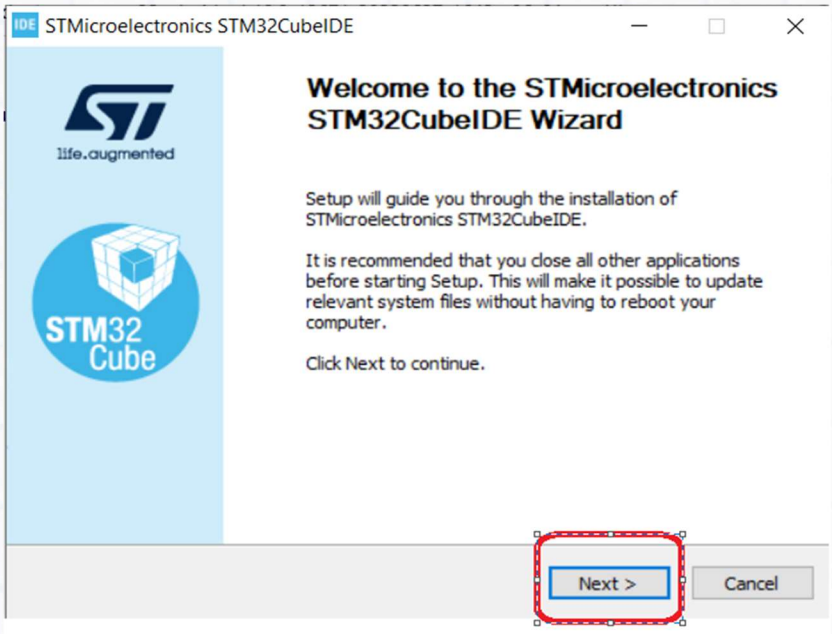
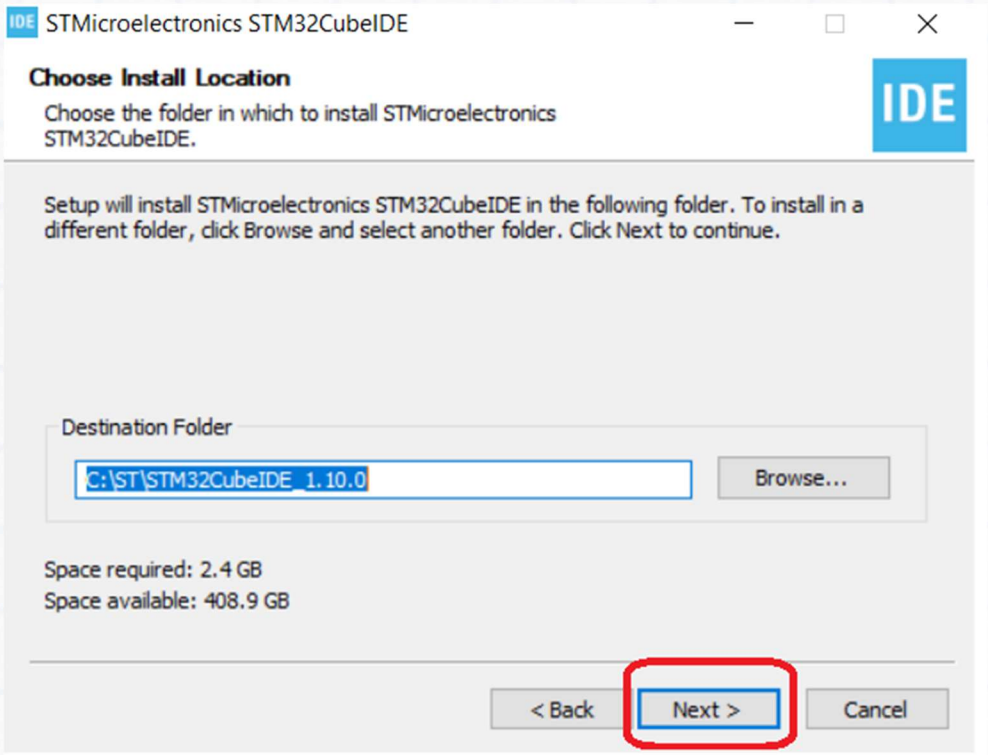
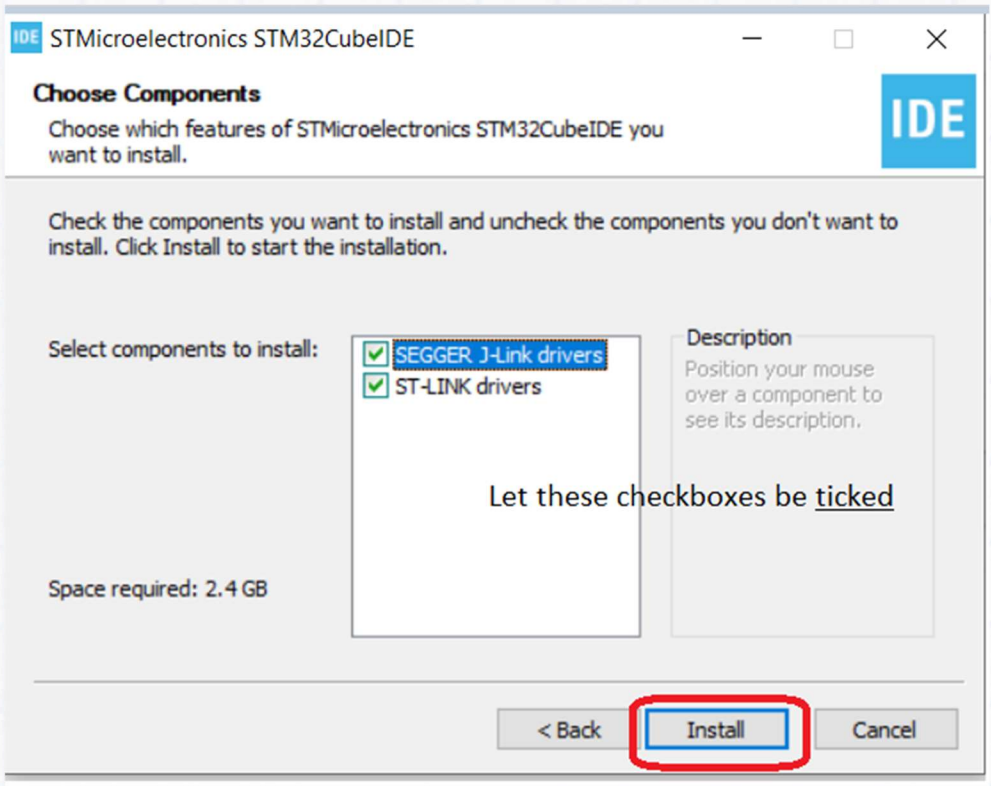
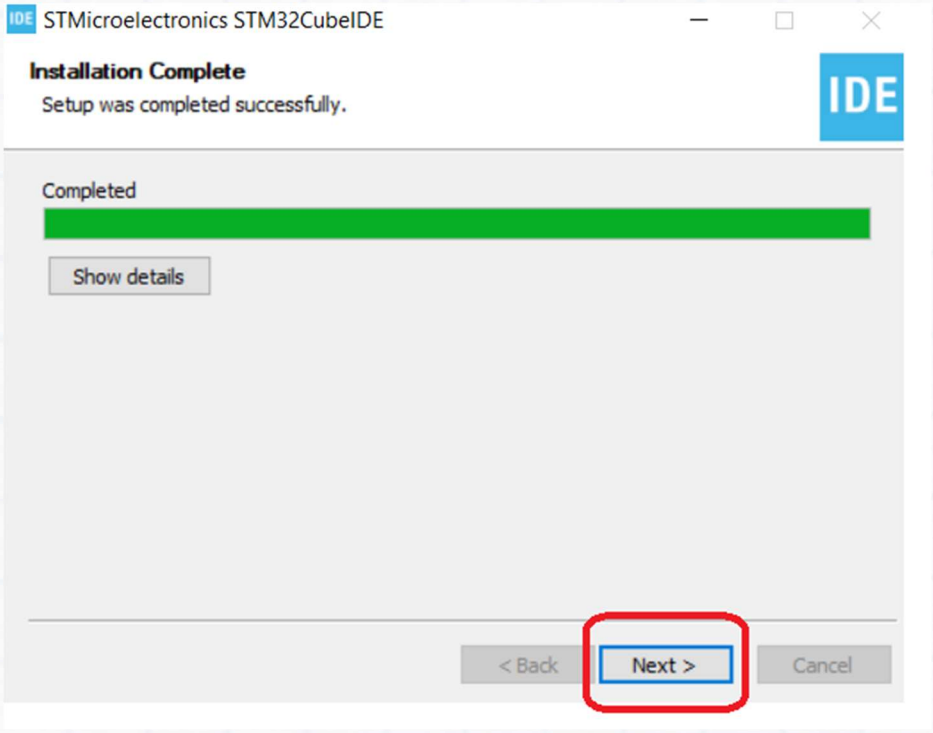



STMicroelectronics STM32CubeIDE
Choose Install Location
Choose the folder in which to install STMicroelectronics STM32CubeIDE.
IDE
Setup will install STMicroelectronics STM32CubeIDE in the following folder. To install in a different folder, click Browse and select another folder. Click Next to continue.
Destination Folder
C:\ST\STM32CubeIDE_1.10.0
Browse...
Space required: 2.4 GB
Space available: 408.9 GB
< Back
Next >
Cancel

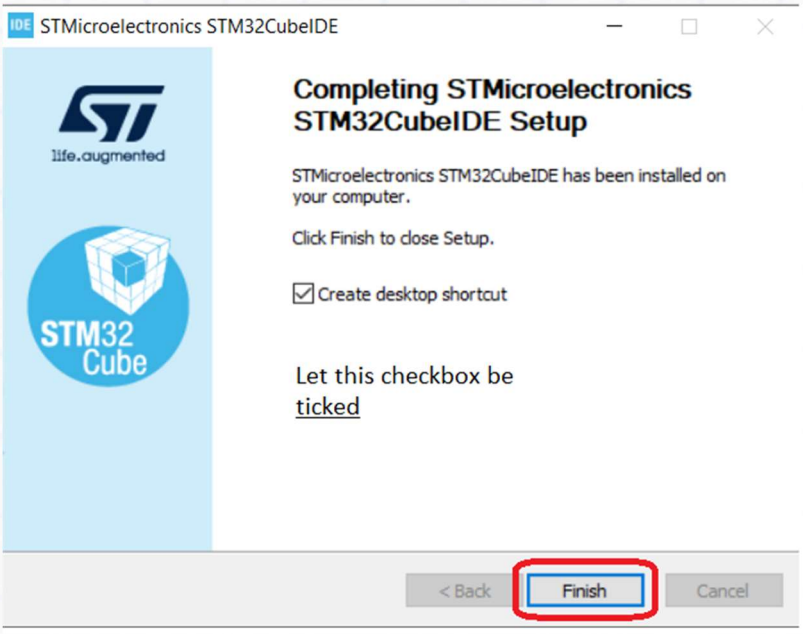
c)


STMicroelectronics STM32CubeIDE
Choose Components
Choose which features of STMicroelectronics STM32CubeIDE you want to install.
IDE
Check the components you want to install and uncheck the components you don't want to install. Click Install to start the installation.
Select components to install:
SEGGER J-Link drivers
ST-LINK drivers
Description
Position your mouse over a component to see its description.
Let these checkboxes be ticked
Space required: 2.4 GB
< Back
Install
Cancel

d)



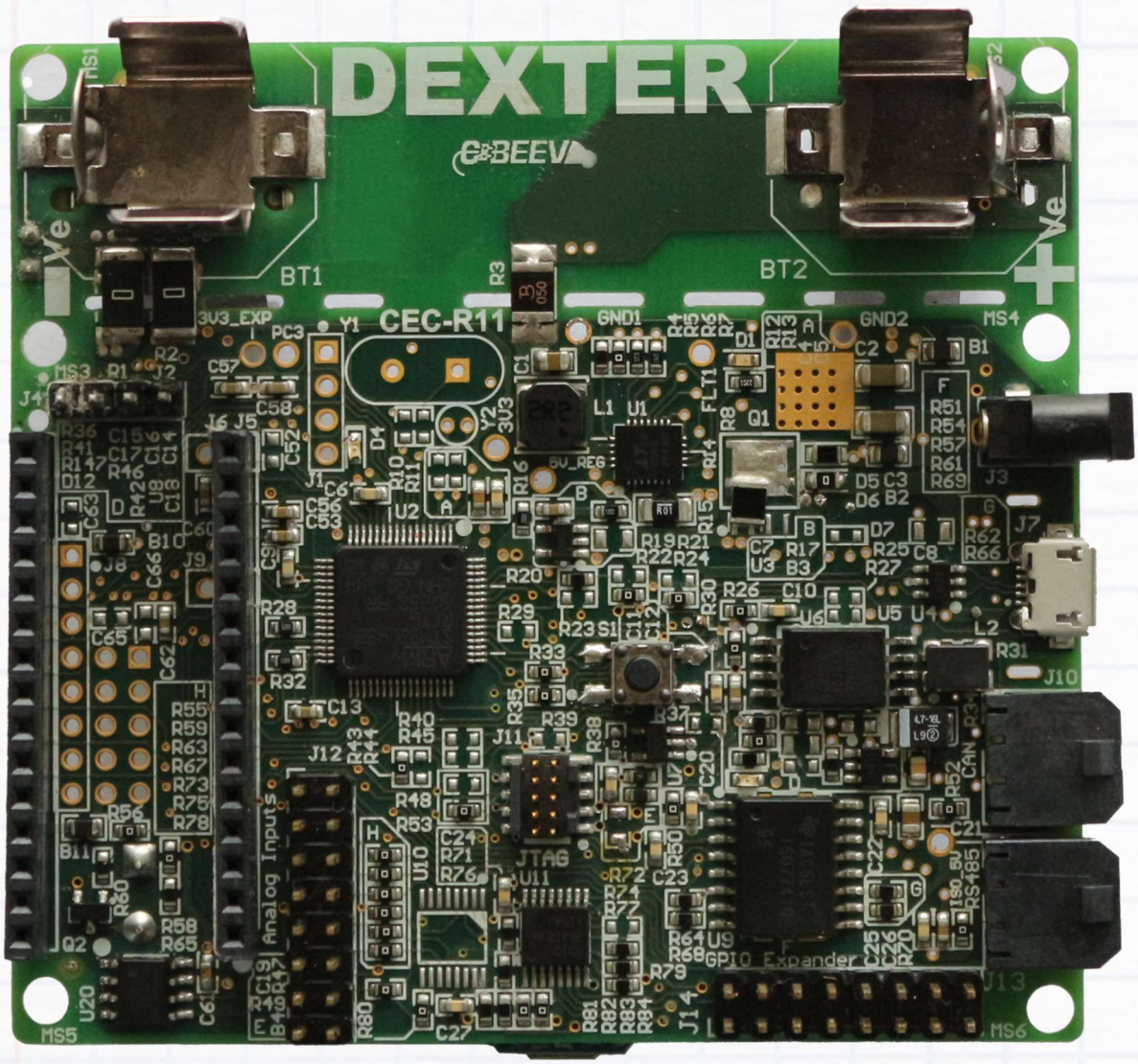
e) Great! You have successfully downloaded & installed the STM32 Cube IDE software!



Dexter User Functions

DEXTER – User Functions

Base Document v1.0



The **Dexter Board** is designed using the microcontroller **STM32L452RCT6** (LQFP64 package) from STMicroelectronics. It is a versatile microcontroller, which can be used in a variety of ways. For the early Build Club experiments, designed for Engineering and Science students, irrespective of disciplines, Dexter 'Wrapper' functions have been predefined. These wrapper functions use the **STM32 CUBE IDE** (Integrated Development Environment). The IDE comes with certain default settings. Although it is possible to change these default settings, for the initial Build Club experiments we recommend that only default settings be used.

The Wrapper functions are as follows:

1) GPIO - General Purpose Input / Output

To program GPIO pins. Can be used either for Digital signals or Analog signals. They can be thus used for driving LEDs, Motors or receive signals from sensors.

Type	Function call	Description
Digital IO	Digital_transmit (Pin, State);	To turn ON/OFF Digital Output pins
	Digital_transmit_pwm (Pin, Duty cycle);	To transmit to an output using PWM
	Digital_receive (Pin);	To receive Digital Input pins
Analog IO	Analog_transmit (Pin, State);	To turn ON/OFF Analog Output pins
	Analog_receive (Pin);	To receive Analog Input pins

2) Control Flow :

These are general functions that allow for managing the program's flow control and inserting time delays in it.

Type	Function call	Description
Delay Timer	Delay_ms (Time);	To insert a time delay (in milliseconds) into the program flow
Setup	Dexter_setup()	For writing one-time setup/initialisation code
Loop	Dexter_loop()	Any code written inside this function will be executed in an infinite loop

Communication Interfaces

UART - Universal Asynchronous Receiver / Transmitter

Bidirectional serial ports used in Build Club experiments in an Asynchronous (data bytes transmitted between start and stop bits without a clock signal) as well as Half Duplex (can either only Transmit or only Receive at a given time) mode.

The Baud Rate of the channel is configurable.

Channel	Function call	Description
UART1	Uart1_init (baud rate)	To initialize UART1 with Baud Rate
	Uart1_receive ()	To receive data via UART1 using PB6 (TX), PB7 (RX)
	Uart1_receive_IT ()	To receive data via UART1 using PB6 (TX), PB7 (RX) through Interrupt mechanism
	Uart1_transmit ()	To transmit data via UART1 using PB6 (TX), PB7 (RX)
UART2	Uart2_init (baud rate)	To initialize UART2 with Baud rate
	Uart2_receive ()	To receive data via UART2 using PA2 (TX), PA3 (RX)
	Uart2_receive_IT ()	To receive data via UART2 using PA2 (TX), PA3 (RX) through Interrupt mechanism
	Uart2_transmit()	To transmit data via UART2 using PA2 (TX), PA3 (RX)
UART3	Uart3_init (baud rate)	To initialize UART3 with Baud rate
	Uart3_receive()	To receive data via UART3 using PC4 (TX), PC5 (RX)
	Uart3_receive_IT ()	To receive data via UART3 using PC4 (TX), PC5 (RX) through Interrupt mechanism
	Uart3_transmit()	To transmit data via UART3 using PC4 (TX), PC5 (RX)

I2C - Inter Integrated Circuit

A Synchronous (data is sent at every tick of the serial clock SCL being transmitted by the controller) serial communication protocol that uses a Half Duplex link.

Channel	Function Call	Description
I2C1 (Master)	I2C_receive()	To receive data via I2C using PB8 (SCL), PB9 (SDA)
	I2C_transmit()	To transmit data via I2C using PB8 (SCL), PB9 (SDA)

SPI - Serial Peripheral Interface

A Synchronous (data is sent at every tick of the serial clock SCL being transmitted by the controller) serial communication protocol that uses a Half Duplex link.

Channel	Function call	Description
SPI1 (Full Duplex Master)	SPI1_transmit()	To transmit data via SPI1 using PA1 (SCK), PA11 (MISO), PA12 (MOSI).
	SPI1_receive()	To receive data via SPI1 using PA1 (SCK), PA11 (MISO), PA12 (MOSI).
	SPI1_transmit_receive()	To receive and transmit data via SPI1 using PA1 (SCK), PA11 (MISO), PA12 (MOSI).
SPI2 (Full Duplex Slave)	SPI2_transmit()	To transmit data via SPI2 using PB10 (SCK), PC2 (MISO), PC3 (MOSI).
	SPI2_receive()	To receive data via SPI2 using PB10 (SCK), PC2 (MISO), PC3 (MOSI).
	SPI2_transmit_receive()	To receive and transmit data via SPI2 using PB10 (SCK), PC2 (MISO), PC3 (MOSI).
SPI3 (Full Duplex Master)	SPI3_transmit()	To transmit data via SPI3 using PC10 (SCK), PC11 (MISO), PC12 (MOSI).
	SPI3_receive()	To receive data via SPI3 using PC10 (SCK), PC11 (MISO), PC12 (MOSI).
	SPI3_transmit_receive()	To receive and transmit data via SPI3 using PC10 (SCK), PC11 (MISO), PC12 (MOSI).

THE END.

Contact :

buildclub@respark.iitm.ac.in