ARM® Cortex®-M

32-bit Microcontroller

NuMaker-IoT-M487
User Manual
NuMicro® M480 Series

For additional information or questions, please contact: Nuvoton Technology Corporation.

www.nuvoton.com

Table of Contents

List of Figures

List of Tables

1 OVERVIEW

This user manual is aimed to give users an introduction the specification, features, and uses of NuMaker-IoT-M487 board to develop network as well as Internet of Thing (IoT) applications.

1.1 Introduction to NuMaker-IoT-M487 Board

The NuMaker-IoT-M487 is a development board using Nuvoton M487JIDAE MCU which includes Arm® Cortex®-M4 core and rich peripherals. It also has motion sensor and Wi-Fi connectivity on board as well as plenty of reference materials to let user to quickly develop IoT device applications.

Furthermore, the board provides several interface and connectors for expansion. There are Arduino Uno compatible interface, mikroBUS™ interface, NuMaker Brick I^2C connector, and specific I/O connector to simulate, for example, image sensor interface. Not only can various Arduino or mikroBUS™ daughter boards be used directly, it is convenient for users to connect other required components.

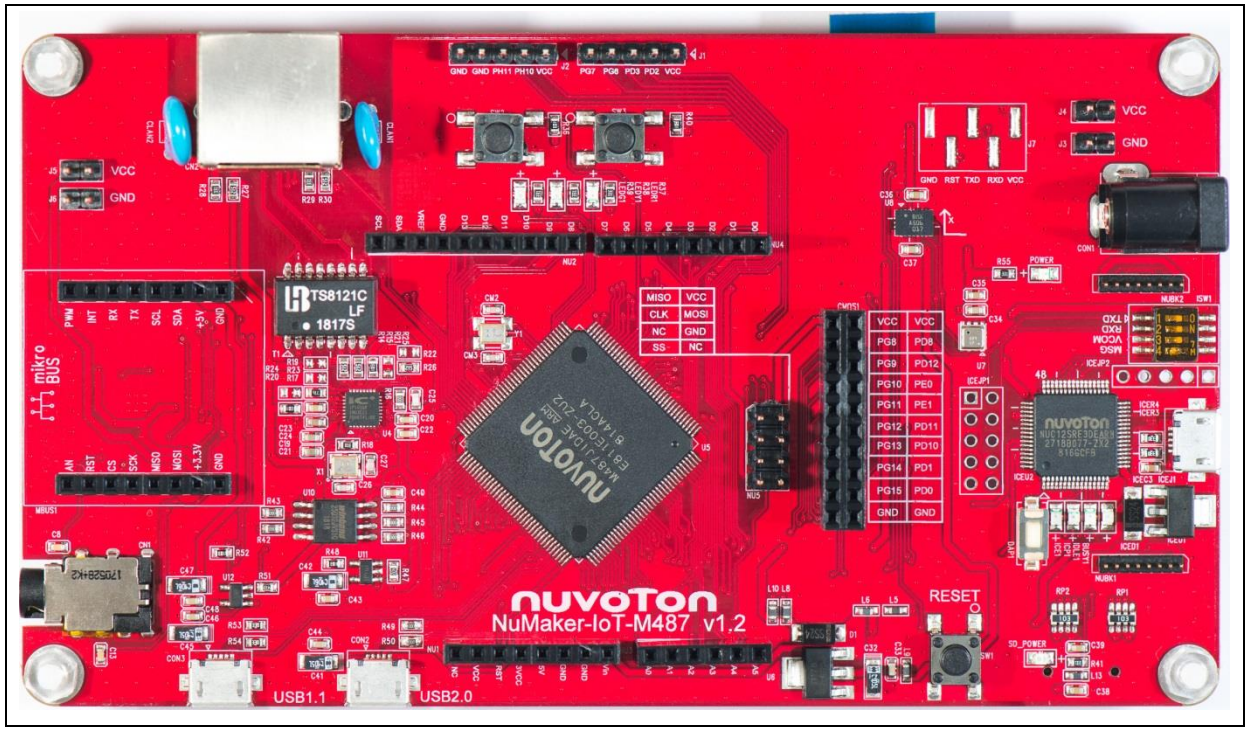

Figure 1-1 NuMaker-IoT-M487 Board

The middle of board is the target chip M487 MCU which embedded Arm® Cortex®-M4 core with DSP extension and a Floating Point Unit (FPU) and the other related parts and connectors.

The right side of this board is the Nu-Link-ME ICE Bridge based on the SWD (Serial Wire Debug) interface connected with the target chip, allowing user to program the application code to the flash of target chip through the USB port from PC host.

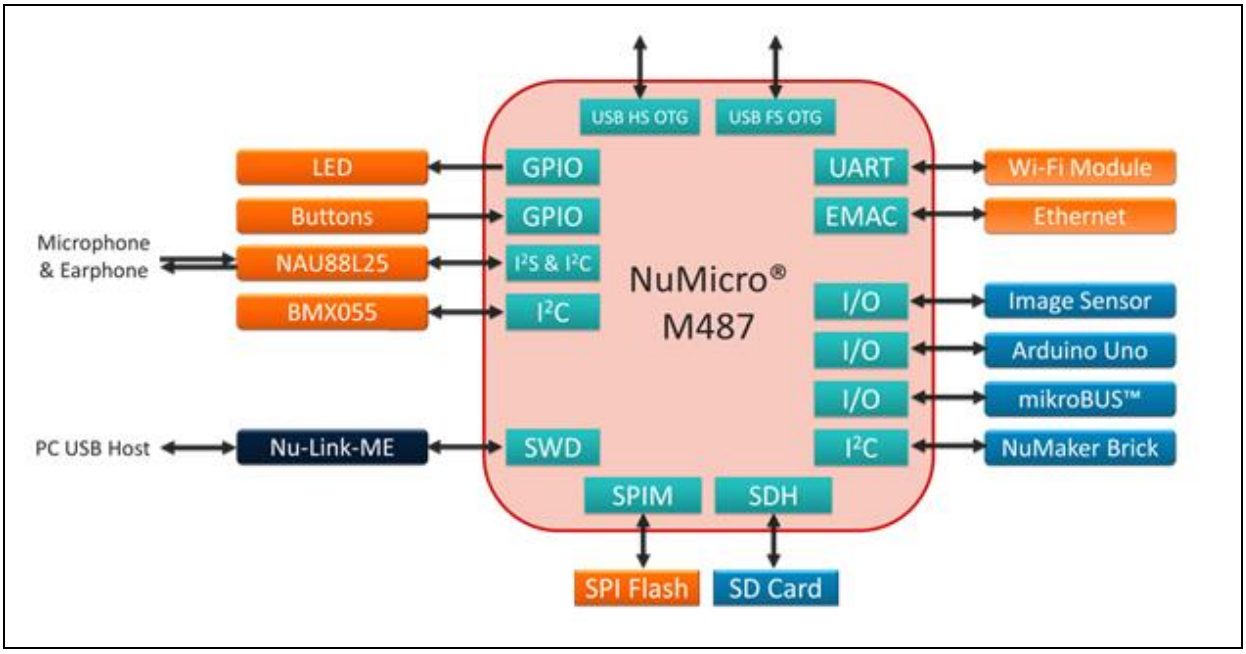

Figure 1-2 NuMaker-IoT-M487 Feature Block

1.2 M487 Series MCU Features

- M487JIDAE in LQFP144 package
- Arm® Cortex®-M4 core running up to 192 MHz with DSP extensions and FPU (Floating Point Unit)
- Built-in LDO for wide operating voltage ranged from 1.8 V to 3.6 V
- 512 Kbytes Flash
- 160 Kbytes SRAM
- External Bus Interface (EBI)
- GPIO
- Peripheral DMA (PDMA)
- Timer
- PWM and BPWM
- Quadrature Encoder Interface (QEI)
- WDT and WWDT
- RTC
- UART
- Smart Card (ISO-7816-3) Host Interface
- I^2C

- SPI
- SPIM
- I^2S
- Universal Serial Control Interface (USCI)
- USB 2.0 High-Speed OTG / Host / Device
- USB 1.1 Full-Speed OTG / Host / Device
- CAN 2.0
- Ethernet MAC
- SD Host
- Cryptographic Accelerator
- CRC
- ADC
- DAC
- Comparator

1.3 NuMaker-IoT-M487 Board Features

- On board Nu-Link-Me ICE Bridge (Mass storage as USB Disk drive) for drag and drop programming
- Arduino UNO compatible interface
- mikroBUS™ interface
- Simulated CMOS Sensor connector
- Nuvoton NuMaker-Brick Interface connectors
- Audio codec (NAU88L25) with Microphone In and Headphone Out
- Ethernet for network application
- Wi-Fi module for network application
- BOSCH 9-Axis Sensor (BMX055)
- USB 2.0 High-Speed OTG / Host / Device
- USB 1.1 Full-Speed OTG / Host / Device
- External SPI Flash which can be regarded as ROM module
- MicroSD Card slot
- Three push-buttons. One is reset and the other two are user defined
- Four LEDs. One is power indication and the other three are user defined

1.4 Introduction to Arm® Mbed™

The Arm® Mbed™ platform provides the operating system, cloud services, tools, and developer ecosystem to make the creation and deployment of commercial, standards-based IoT solutions possible. Mbed™ OS as an open-source operating system, contains a core, security, and these key IoT networking and communication.

The Arm® Mbed™ platform allows IoT devices to collaborate and communicate with each other on the basis of transparency. Otherwise each of the devices will not be able to talk to each other or to the cloud. With abstractions API design, Mbed™ allows users to focus on application development, not underlying system complexity.

Arm® Mbed™ homepage: https://www.mbed.com/

Documents and Tutorials: https://os.mbed.com/docs/

Online C/C++ Development Tool: https://ide.mbed.com/compiler

For more information of NuMaker-IoT-M487 board for Arm® Mbed™ platform, please visit Mbed™ hardware board homepage: https://os.mbed.com/platforms/NUMAKER-IOT-M487/

2 NUMAKER-IOT-M487 BOARD OVERVIEW

2.1 View

Figure 2-1 shows the main components and connectors from the front side of NuMaker-IoT-M487 board.

The following lists components and connectors from the front view:

- Target Chip: M487JIDAE (U5)
- Nu-Link-Me ICE Bridge: ICE Controller NUC12SRE3DE (ICEU2), USB connector (ICEJ1) to PC Host
- Arduino UNO compatible interface connectors (NU1, NU2, NU3, NU4 and NU5)
- mikroBUS™ interface connector (MBUS1)
- CMOS Sensor connector (COMS1)
- Nuvoton NuMaker Brick Interface connectors (NUBK1, NUBK2)
- Wi-Fi Module connector (J7)
- BMX055 9-Axis Sensor (U8)
- Winbond W25Q32 SPI Flash (U10)
- IC Plus IP10GR Ethernet Transceivers (U4)
- 5V DC Adapter connector (CON1)
- USB: USB 2.0 High-Speed OTG connector (CON2) and USB 1.1 OTG connector (CON3)
- Push-buttons (SW2, SW3)
- LEDs (LEDR, LEDY and LEDG)
- 3VCC connector (J4, J5) and GND connector (J3, J6)

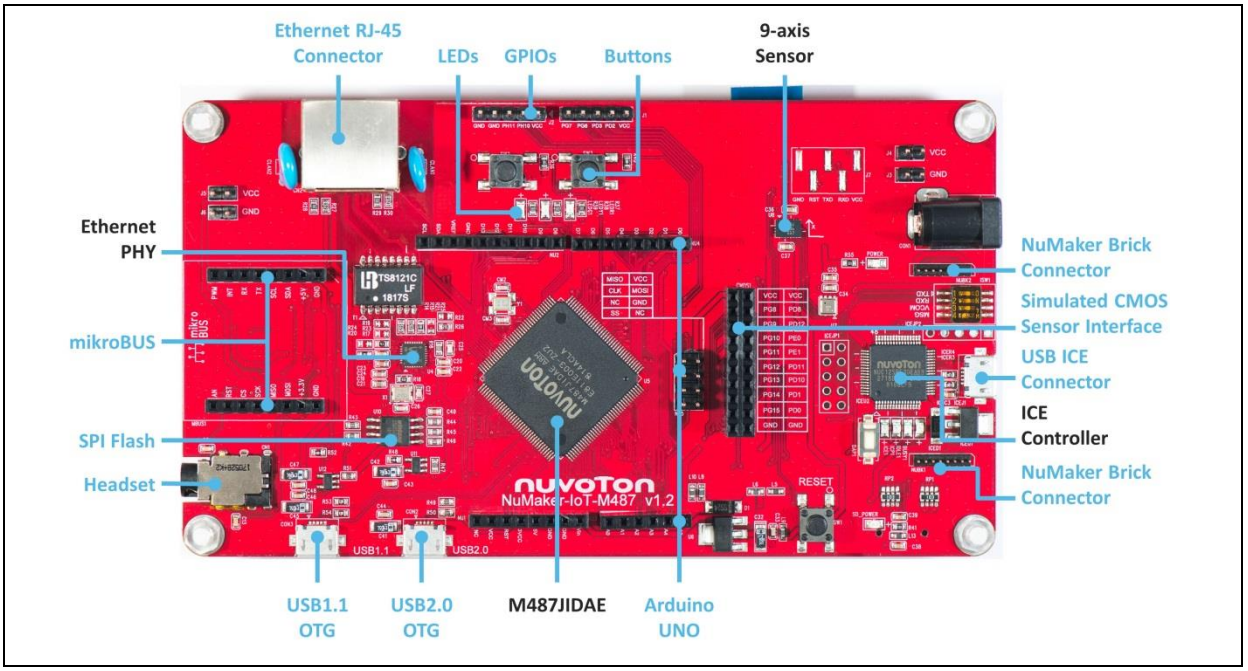

Figure 2-1 Front View of NuMaker-IoT-M487 Board

2.2 Rear View

Figure 2-2 shows the main components and connectors from the rear side of NuMaker-IoT-M487 board.

The following lists components and connectors from the rear view:

- MicroSD Card Slot (U9)
- Nuvoton NAU88L25 Audio Codec (U2)
- Wi-Fi Module Interface (WIFI1)

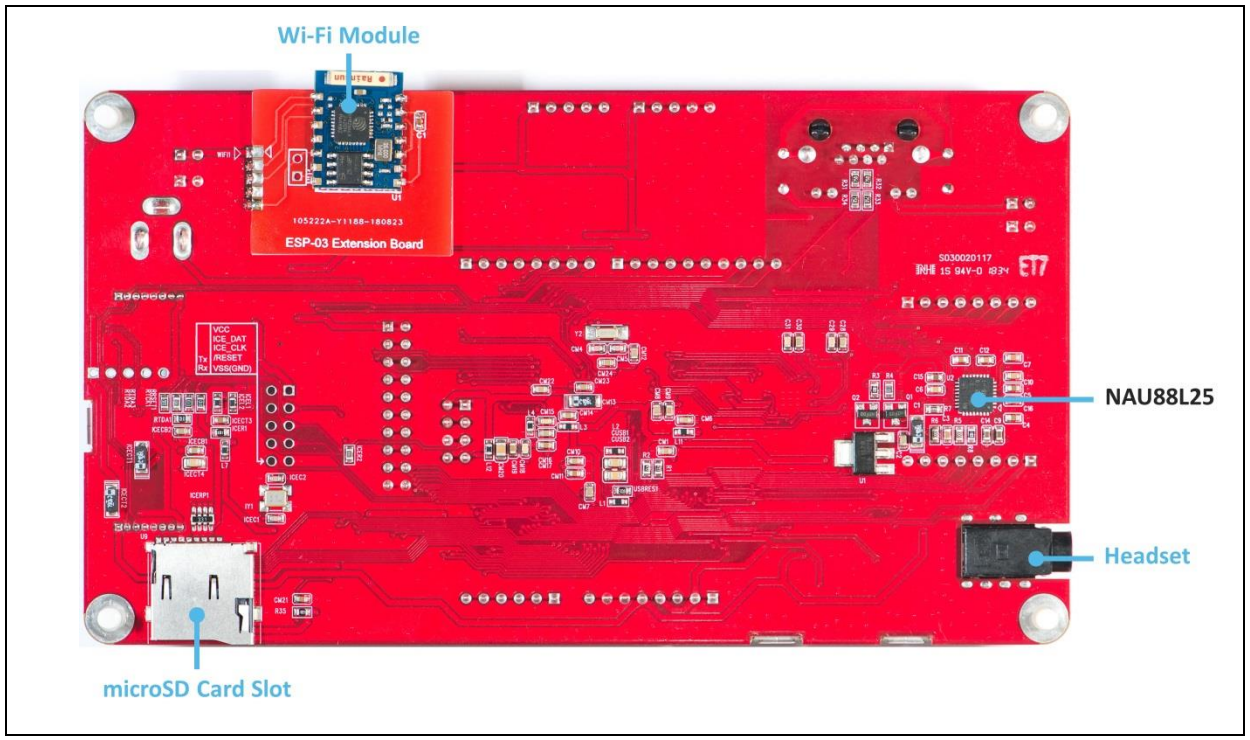

Figure 2-2 Rear View of NuMaker-IoT-M487 Board

2.3 Arduino UNO Compatible Interface

Figure 2-3 shows the Arduino UNO compatible interface.

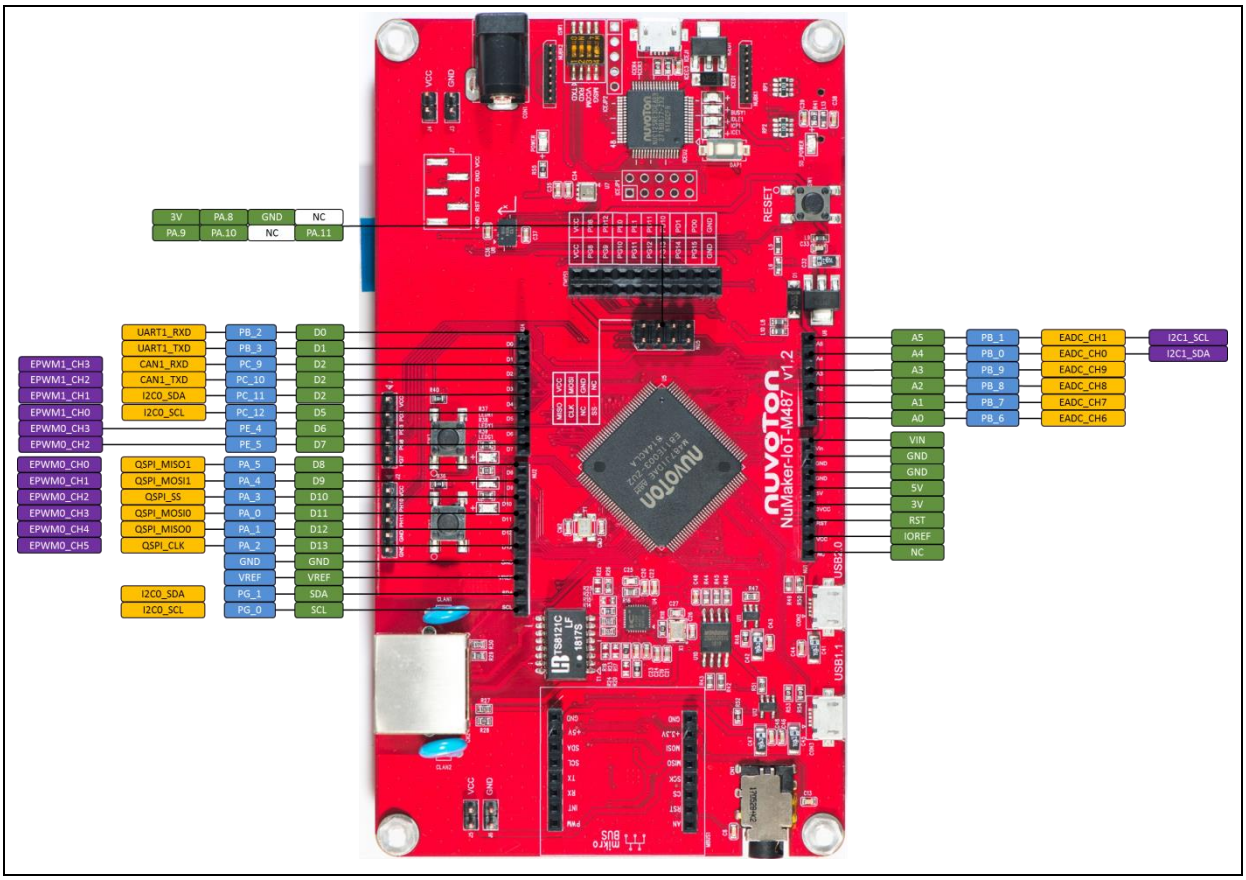

Figure 2-3 Arduino UNO Compatible Interface

Table 2-1 Arduino UNO Interface Mapping with M487JIDAE GPIO

Header		NuMaker-IoT-M487		Header		NuMaker- IoT -M487	
		Compatible to Arduino UNO	M487JIDAE			Compatible to Arduino UNO	M487JIDAE
NU1	NU1.1	NC	-	NU2	NU6.10	SCL	PG.0
	NU1.2	IOREF			NU6.9	SDA	PG.1
	NU1.3	RESET	RESET		NU6.8	VREF	-
	NU1.4	3VCC	-		NU6.7	GND	
	NU1.5	5VCC			NU6.6	D13	PA.2
	NU1.6	GND			NU6.5	D12	PA.1
	NU1.7	GND			NU6.4	D11	PA.0
	NU1.8	VIN			NU6.3	D10	PA.3
NU3	NU2.1	A0	PB.6		NU6.2	D9	PA.4
	NU2.2	A1	PB.7		NU6.1	D8	PA.5
	NU2.3	A2	PB.8	NU4	NU5.8	D7	PE.5
	NU2.4	A3	PB.9		NU5.7	D6	PE.4
	NU2.5	A4	PB.0		NU5.6	D5	PC.12
	NU2.6	A5	PB.1		NU5.5	D4	PC.11
					NU5.4	D3	PC.10
					NU5.3	D2	PC.9
					NU5.2	D1	PB.3
					NU5.1	D0	PB.2

Header		NuMaker-IoT-M487		Header		NuMaker-IoT-M487	
		Compatible to Arduino UNO	M487JIDAE			Compatible to Arduino UNO	M487JIDAE
NU5	NU7.1	VCC	-	NU5	NU7.2	MISO	PA.9
	NU7.3	CLK	PA.10		NU7.4	MOSI	PA.8
	NU7.5	NC	-		NU7.6	GND	-
	NU7.7	SS	PA.11		NU7.8	NC	-

2.4 System Configuration

2.4.1 5V Power Source

- **ICEJ1:** USB connector in Nu-Link-Me to program code and supplies 5V power from PC Host.
- **CON2:** USB 2.0 High-Speed OTG connector on NuMaker-IoT-M487 board to supply 5V power from PC Host.
- **CON3:** USB 1.1 OTG connector on NuMaker-IoT-M487 board to supply 5V power from PC Host .
- **CON1:** 5V power jack on NuMaker-IoT-M487 board to supply 5V power from 5V DC adapter.
- **NU1.8:** VDD5V pin on NuMaker-IoT-M487 board to supply 5V power from external power source.

Power Source	Connector	Comment
ICE_USBVBUS	ICEJ1	ICEJ1 supplies the 5V power from PC Host. **Note**: L5 should be shorted 0ohm
HSUSB_VBUS	CON2	CON2 supplies the 5V power from PC Host. **Note**: L6 and L8 should be shorted 0ohm.
USB_VBUS	CON3	CON3 supplies the 5V power from PC Host. **Note**: L6 and L10 should be shorted 0ohm.
External 5V Source	CON1	CON1 supplies the 5V power from 5V DC adapter
	NU1.8	NU1 pin8 supplies the 5V power from external power source.

2.4.2 3.3V Power Source

- **ICEU1:** The voltage regular converts the 5V source to 3.3V and supplies it to NuMaker-IoT-M487 board.
- **U4:** The voltage regular converts the 5V source to 3.3V and supplies it to NuMaker-IoT-M487 board.

Voltage Regular	5V Source	Comment
ICEU1	ICE_USB_VBUS	ICEU1 convert ICE_USB_VBUS to 3.3V and supplies it to M487 platform board. **Note:** L8 should be shorted 0ohm
U4	HSUSB_VBUS	U4 convert HSUSB_VBUS to 3.3V and supplies it to M487 platform board. **Note:** L9 should be shorted 0ohm.
	USB_VBUS	U4 convert USB_VBUS to 3.3V and supplies it to M487 platform board. **Note:** L9 should be shorted 0ohm.

	CON1	U4 convert 5V from DC adapter to 3.3V and supplies it to M487 platform board. **Note:** L9 should be shorted 0ohm.
	NU1.8	U4 convert 5V power from external power source to 3.3V and supplies it to M487 platform board. **Note:** L9 should be shorted 0ohm.

2.4.3 USB Connectors

- **ICEJ1:** USB connector (ICE) in Nu-Link-Me that connects to a PC's USB Host port to program code and supply power.
- **CON2:** USB 2.0 High-Speed connector (OTG) on NuMaker-IoT-M487 board for USB OTG application use.
- **CON3:** USB 1.1 connector (OTG) on NuMaker- IoT -M487 board for USB OTG application use.

2.4.4 Arduino UNO Compatible Interface Connectors

- **NU1, NU2, NU3, NU4 and NU5:** Arduino UNO compatible pins on the NuMaker- IoT -M487 board.

2.4.5 Push-Buttons

- **SW1:** Reset button to reset the target chip on NuMaker-IoT-M487 board.
- **SW2, SW3:** Only for application use.

2.4.6 LEDs

- **POWER:** The power LED indicates that the NuMaker-IoT-M487 board is powered.
- **LEDR, LEDY and LEDG:** Only for application use.

2.4.7 Power Connectors

- **J3, J5:** 3VCC connectors on the NuMaker-IoT-M487 board.
- **J4, J6:** GND connectors on the NuMaker-IoT-M487 board.

2.5 Nu-Link-Me

NuMaker-IoT-M487 features a Nu-Link-Me ICE debugger and programmer, it provide user to program M487 and debug their application via SWD interface, or it can emulate a USB mass storage drive when connect to the PC, user can update their firmware by pulling bin file to the drive. Nu-link-Me can also emulate a virtual COM port, user can use it to log or print debug message. Refer Table 2-2 to enable or disable optional function of Nu-Link-Me.

Table 2-2 Optional Function of Nu-Link-Me

ISW1		
Pin	**Nu-Link-Me**	**Comment**
1	TXD	**On**: Connect PB.13 (UART0_TXD) of M487 to Nu-Link-Me. **Off**: Disconnect PB.13 (UART0_TXD) of M487 to Nu-Link-Me.
2	RXD	**On**: Connect PB.12 (UART0_RXD) of M487 to Nu-Link-Me. **Off**: Disconnect PB.12 (UART0_RXD) of M487 to Nu-Link-Me.
3	VCOM	**On**: Enable Nu-Link-Me virtual COM port function. **Off**: Disable Nu-Link-Me virtual COM port function.
4	MSG	**On**: Normal ICE mode, user can debug and program via SWD interface. **Off**: Mass storage mode, user can update firmware by pulling bin file to drive.

2.6 Audio

NuMaker-IoT-M487 features a Nuvoton NAU88L25 audio codec which is an ultra-low power high performance audio codec designed for headphone or headset application. It includes one I²S/PCM interface, one high quality stereo DACs, one mono ADC, a Class G stereo headphone amplifier, and industry leading advanced headset features.

The NAU88L25 connects to the NuMaker-IoT-M487 via I²C bus (M487 is I²C master) for control, the I²C address of NUA88L25 is 0x1A by default, and via I²S bus (M487 is I²S slave) for audio digital data. The Table 2-3 shows the pin mapping between NUC88L25 and M487JIDAE.

Table 2-3 NAU88L25 Mapping with M487JIDAE

M487JIDAE	NAU88L25	Comment
I2C2_SCL (PD.1)	SCLK	I²C clock output **Note**: The I²C address of NAU88L25 is 0x1A by default.
I2C2_SDA (PD.0)	SDIO	I²C data input/output **Note**: The I²C address of NAU88L25 is 0x1A by default.
I2S0_BCLK (PF.11)	BCLK	I²S bit clock output from NAU88L25
I2S0_MCLK (PF.9)	MCLK	I²S master clock output from M487
I2S0_DI (PF.8)	ADCOUT	I²S data input to NAU88L25
I2S0_DO (PF.7)	DACIN	I²S data output from M487
I2S0_LRCK (PF.6)	FS	I²S left right channel clock output from NAU88L25
PC.13	JKDET	To detect phone jack insertion and ejection
PE.13	JKEN#	To control phone jack output

The 3.5mm phone jack CN2 is used to attach the headset with microphone, the Figure 2-4 shows the phone jack diagram.

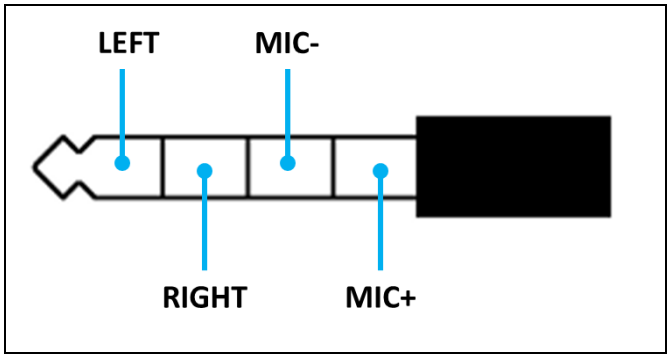

Figure 2-4 3.5mm Phone Jack Diagram

2.7 CMOS Sensor Interface

NuMaker-IoT-M487 features the COMS Sensor Interface which compatible with Himax Image HM01B0 CMOS Sensor module which is an ultra-low power image sensor contains 320 x 320 pixel resolution and have maximum frame rate up to 60FPS. The Table 2-4 shows the pin mapping between HM01B0 CMOS sensor module and M487JIDAE.

Table 2-4 HM01B0 CMOS Sensor Module Mapping with M487JIDAE

CMOS1	NuMaker-IoT-M487		CMOS1	NuMaker-IoT-M487	
	HM01B0	M487JIDAE		HM01B0	M487JIDAE
1	VCC	VCC	2	VCC	VCC
3	PCLK	PD.8	4	D0	PG.8
5	MCLK	PD.12	6	D1	PG.9
7	VSYNC	PE.0	8	D2	PG.10
9	HSYNC	PE.1	10	D3	PG.11
11	TRIG	PD.11	12	D4	PG.12
13	INT	PD.10	14	D5	PG.13
15	SCL	PD.1	16	D6	PG.14
17	SDA	PD.0	18	D7	PG.15
19	GND	GND	20	GND	GND

2.8 mikroBUS™ Interface

NuMaker-IoT-M487 features a MikroElektronika microBUS™ socket which have smallest number of pins but have maximum expandability. The MikroElektronika microBUS™ consists of communications pins included SPI, UART and I^2C, one PWM pin, one interrupt pin, one analog input pin, one reset pin and one chip select pin, and have 3.3V and 5V power pin. The Table 2-5 shows microBUS™ Mapping with M487JIDAE.

For more information about MikroElektronika microBUS™ standard, please visit the MikroElektronika microBUS™ website: https://www.mikroe.com/mikrobus .

Table 2-5 microBUS™ Mapping with M487JIDAE

MBUS1	NuMaker-IoT-M487		MBUS1	NuMaker-IoT-M487	
	Compatible to microBUS™	M487JIDAE		Compatible to microBUS™	M487JIDAE
1	AN	EADC0_CH14 (PB.14)	16	PWM	EPWM0_CH4 (PD.14)
2	RST	PD.9	15	INT	PG.4
3	CS	SPI1_SS (PH.7)	14	RX	UART2_RXD (PE.15)
4	SCLK	SPI1_CLK (PH.6)	13	TX	UART2_TXD (PE.14)
5	MISO	SPI1_MISO (PH.4)	12	SCL	I2C1_SCL (PG.2)
6	MOSI	SPI1_MOSI (PH.5)	11	SDA	I2C1_SDA (PG.3)
7	3VCC	-	10	5VCC	-
8	GND	-	9	GND	-

2.9 9-Axis Sensor

NuMaker-IoT-M487 features a BOSCH BMX055 9-axis sensor which have ultra-small footprint and integrates triaxial 12-bit acceleration sensor, a triaxial 16-bit gyroscope and a triaxial geomagnetic sensor. The BME680 connects to the NuMaker-IoT-M487 via I^2C bus. The Table 2-6 shows the pin mapping between BMX055 and M487JIDAE.

Table 2-6 BMX055 Mapping with M487JIDAE

M487JIDAE	BMX055	Comment
I2C2_SCL (PD.1)	SCL	I^2C clock output **Note**: The I^2C address of BME680's acceleration sensor is 0x18 by default. The I^2C address of BME680's gyroscope is 0x68 by default. The I^2C address of BME680's geomagnetic sensor is 0x10 by default.
I2C2_SDA (PD.0)	SDA	I^2C data input/output **Note**: The I^2C address of BME680's acceleration sensor is 0x18 by default. The I^2C address of BME680's gyroscope is 0x68 by default. The I^2C address of BME680's geomagnetic sensor is 0x10 by default.

2.10 PCB Placement

Figure 2-5 and Figure 2-6 show the front and rear placement of NuMaker-IoT-M487 board.

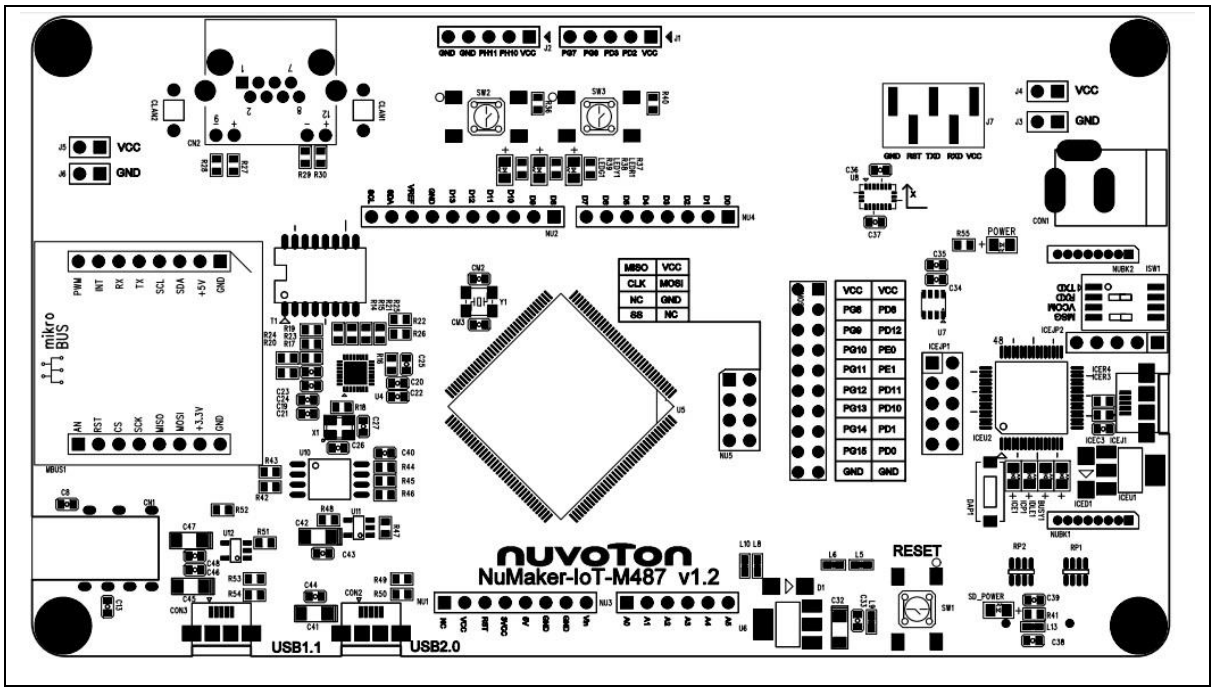

Figure 2-5 NuMaker-IoT-M487 Front Placement

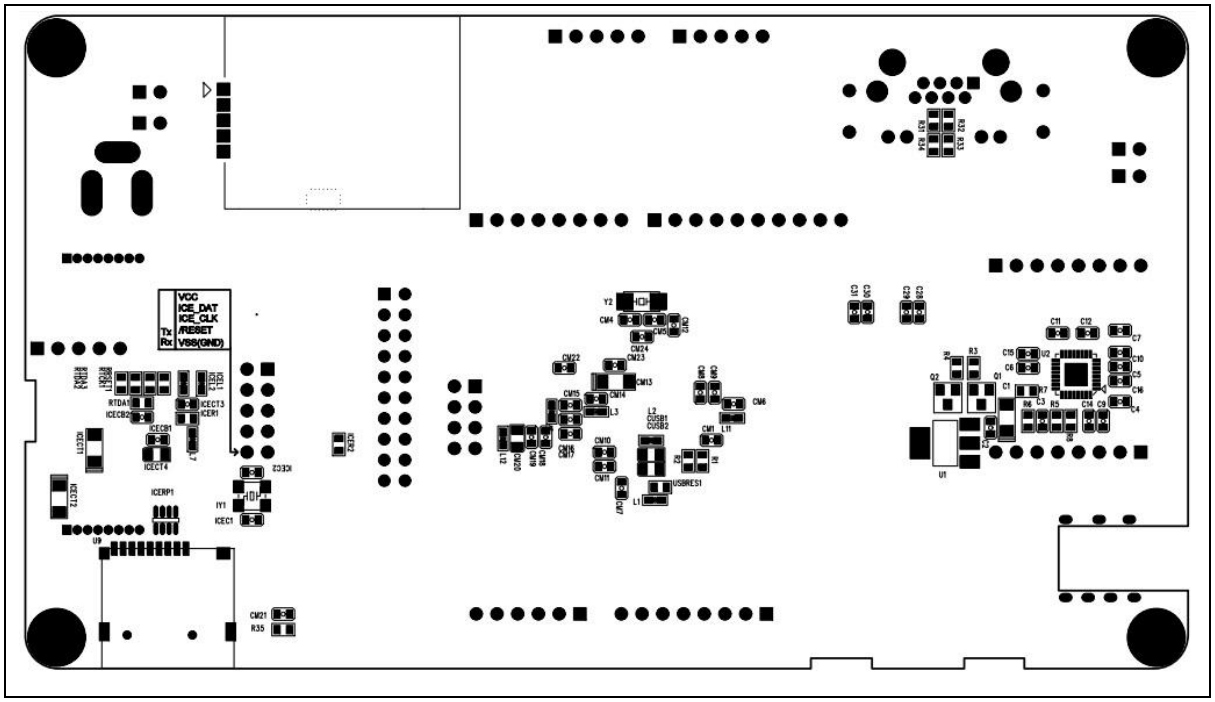

Figure 2-6 NuMaker-IoT-M487 Rear Placement

3 NUMAKER-IOT-M487 SCHEMATICS

3.1 Interconnection

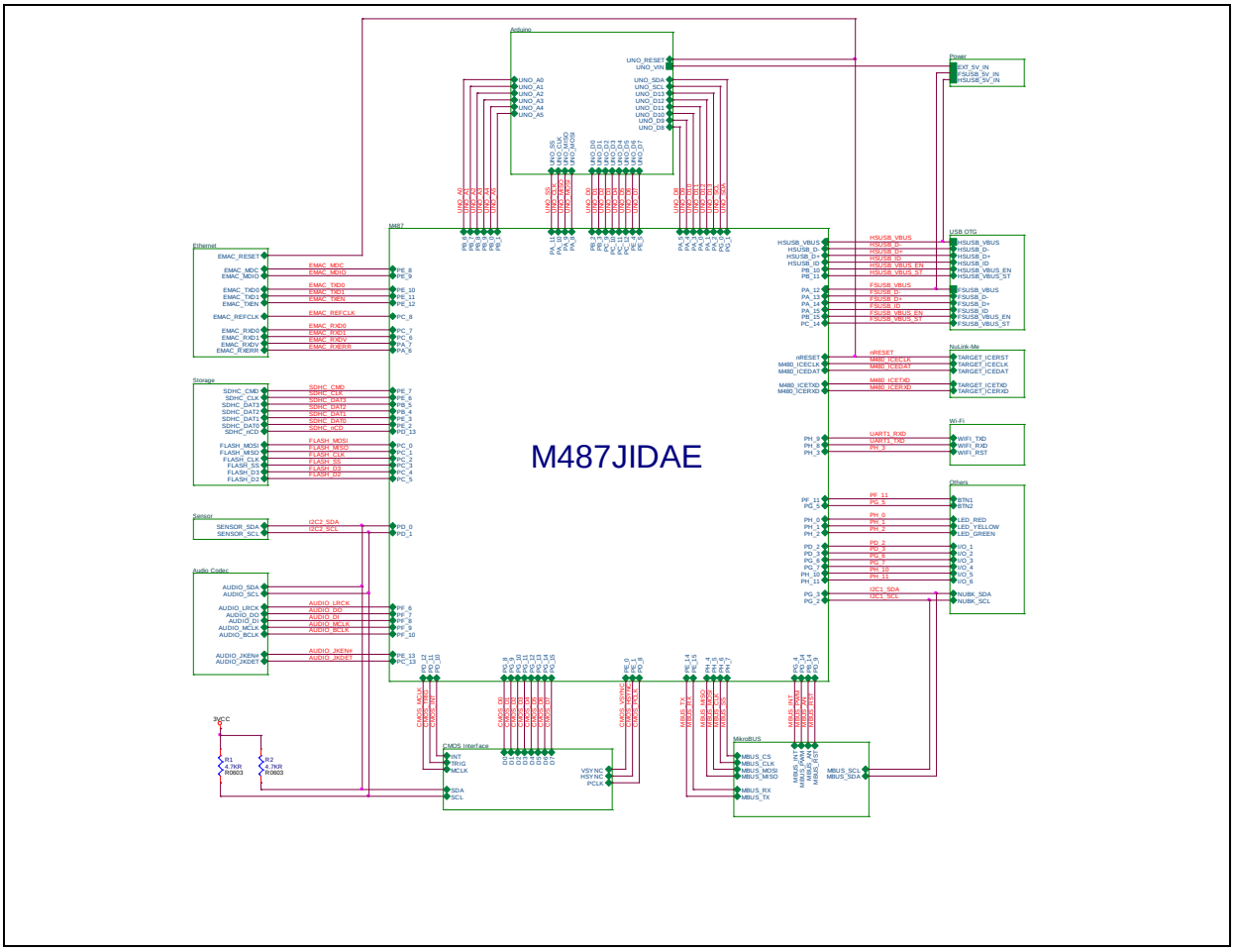

Figure 3-1 Interconnection of NuMaker-IoT-M487

3.2 Audio

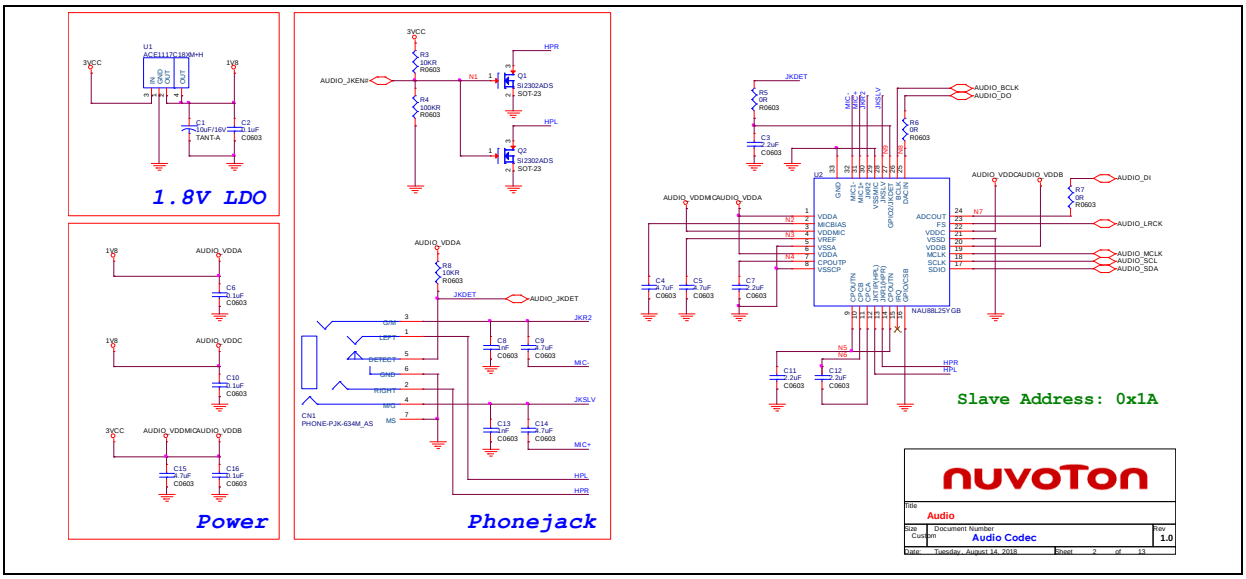

Figure 3-2 Audio Codec Circuit of NuMaker-IoT-M487

3.3 CMOS Sensor Interface

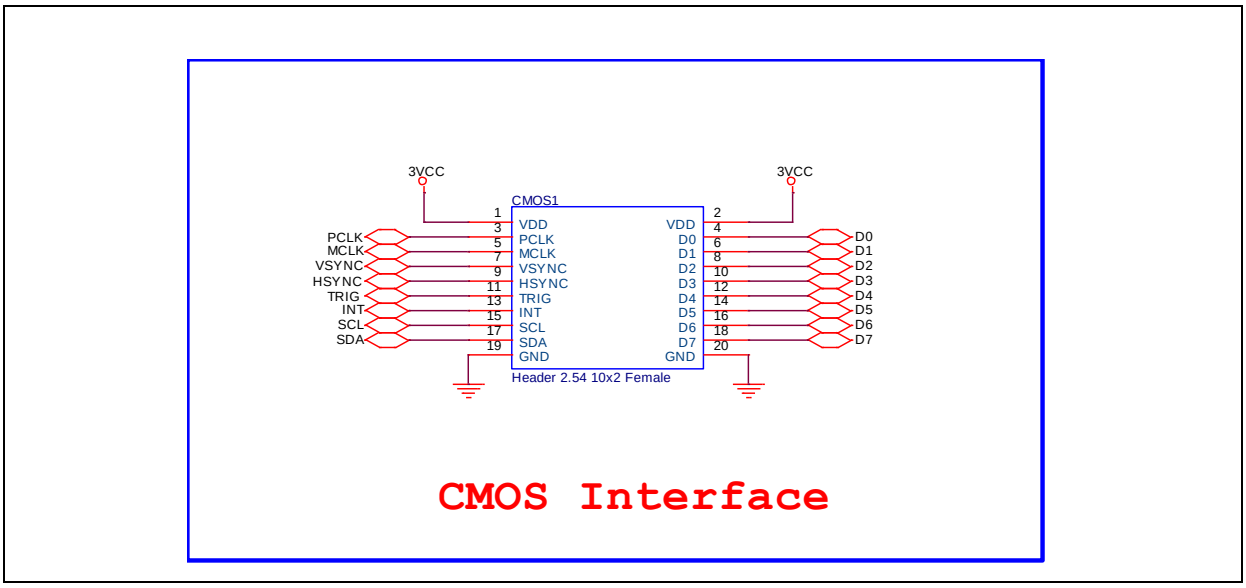

Figure 3-3 CMOS Sensor Interface of NuMaker-IoT-M487

3.4 Ethernet

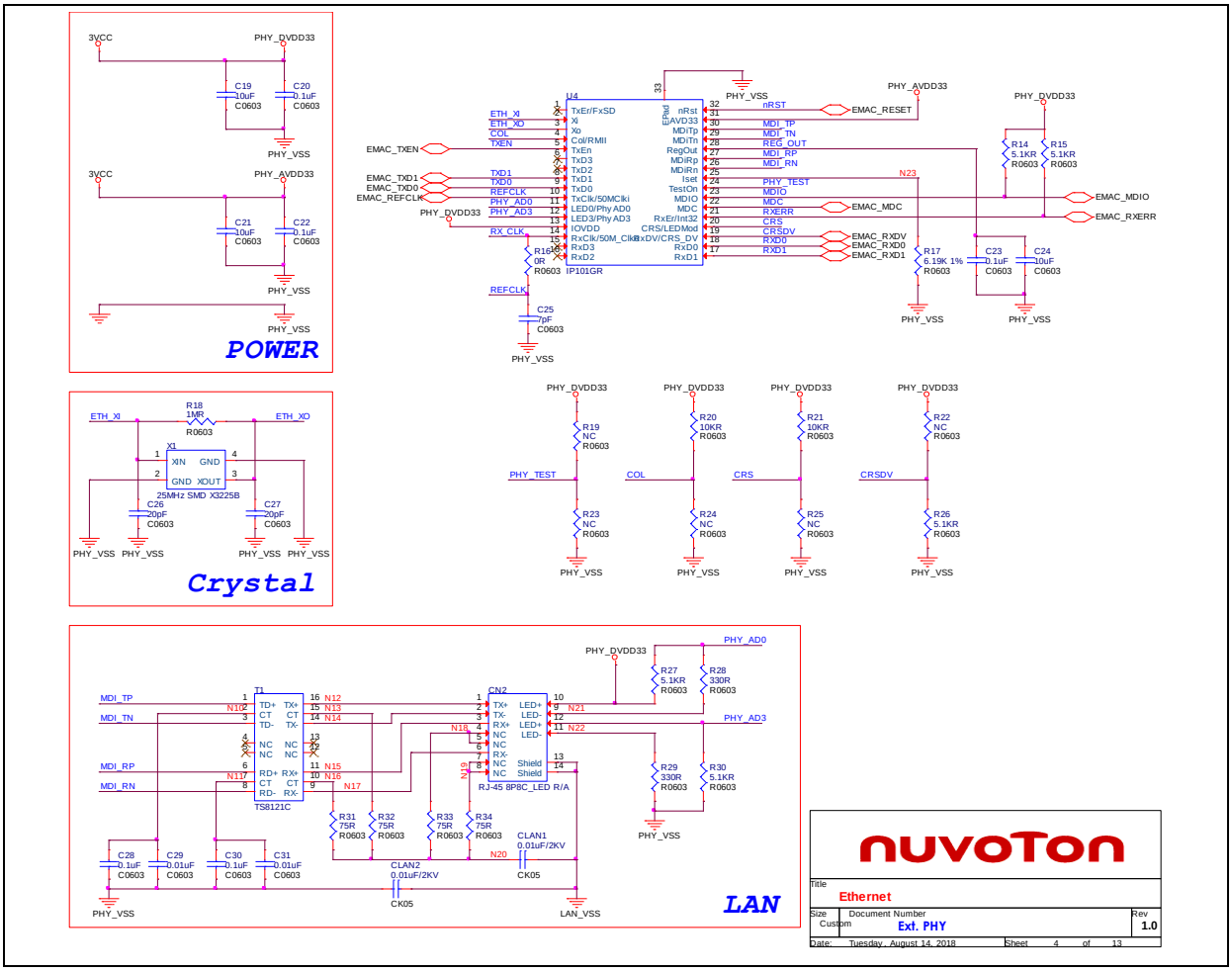

Figure 3-4 Ethernet Circuit of NuMaker-IoT-M487

3.5 Nu-Link-Me

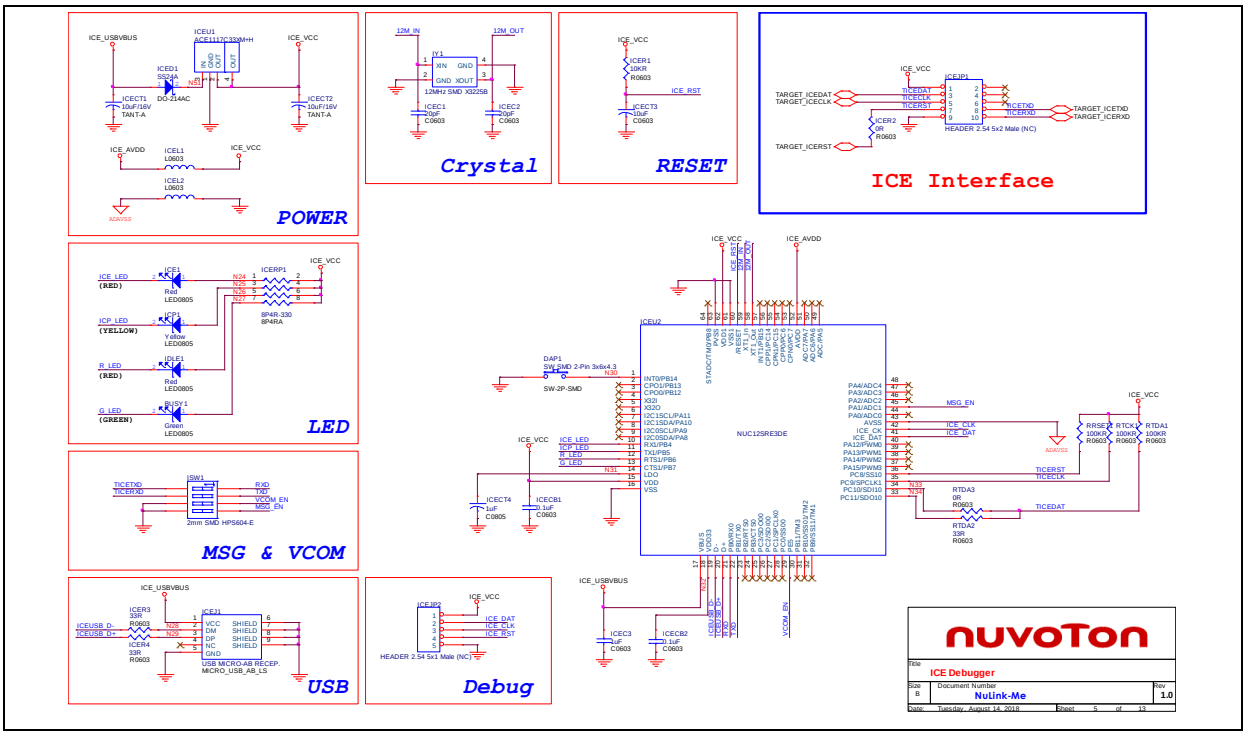

Figure 3-5 Nu-Link-Me Circuit of NuMaker-IoT-M487

3.6 M487JIDAE

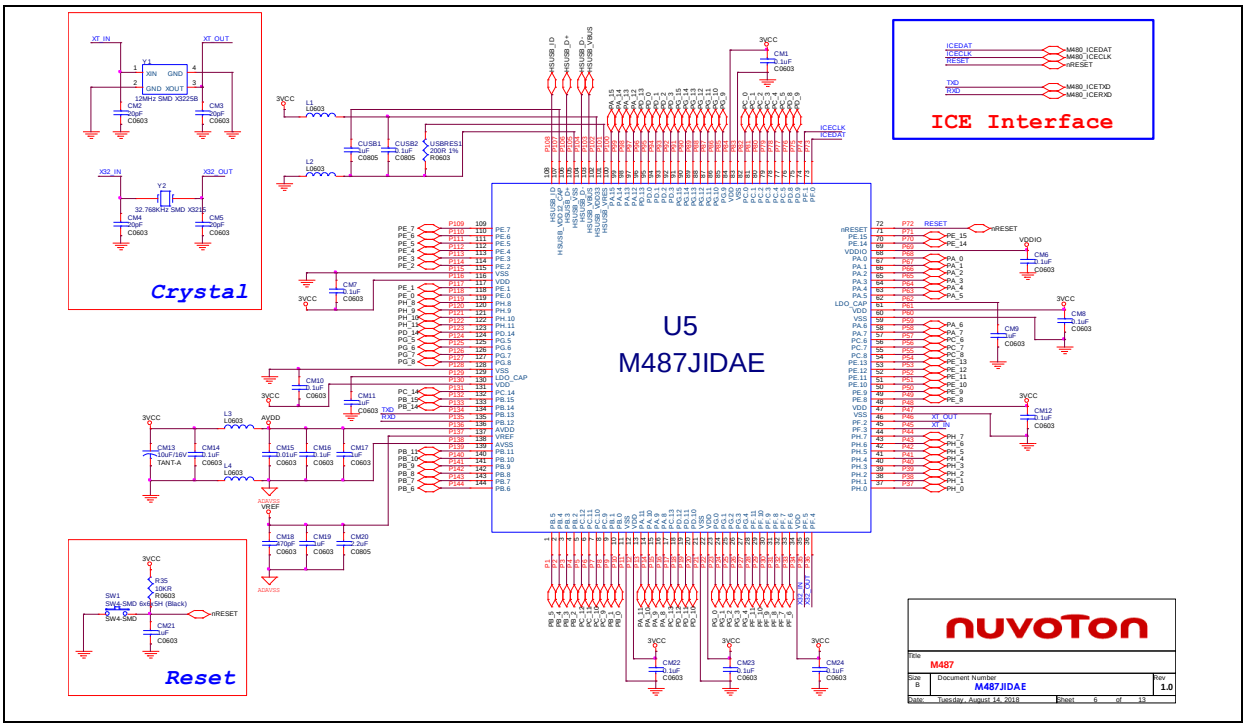

Figure 3-6 M487JIDAE Pin Assignment

3.7 mikroBUS™ Interface

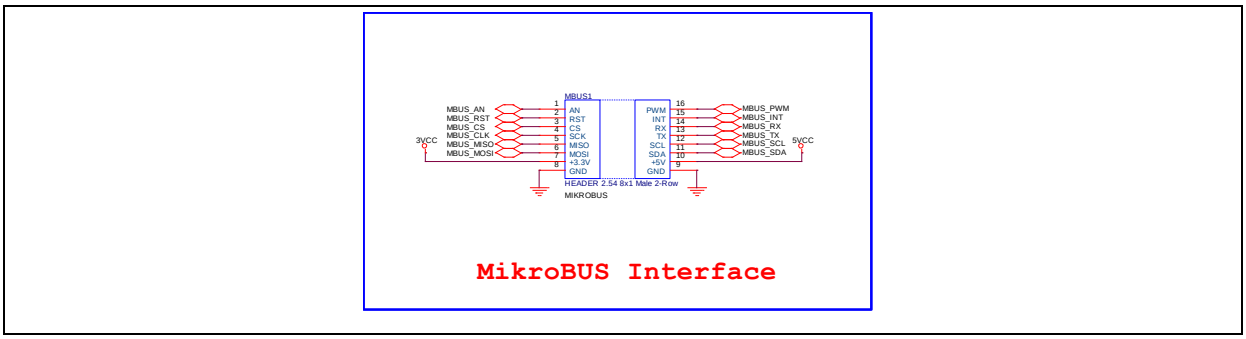

Figure 3-7 mikroBUS™ Interface of NuMaker-IoT-M487

3.8 Power

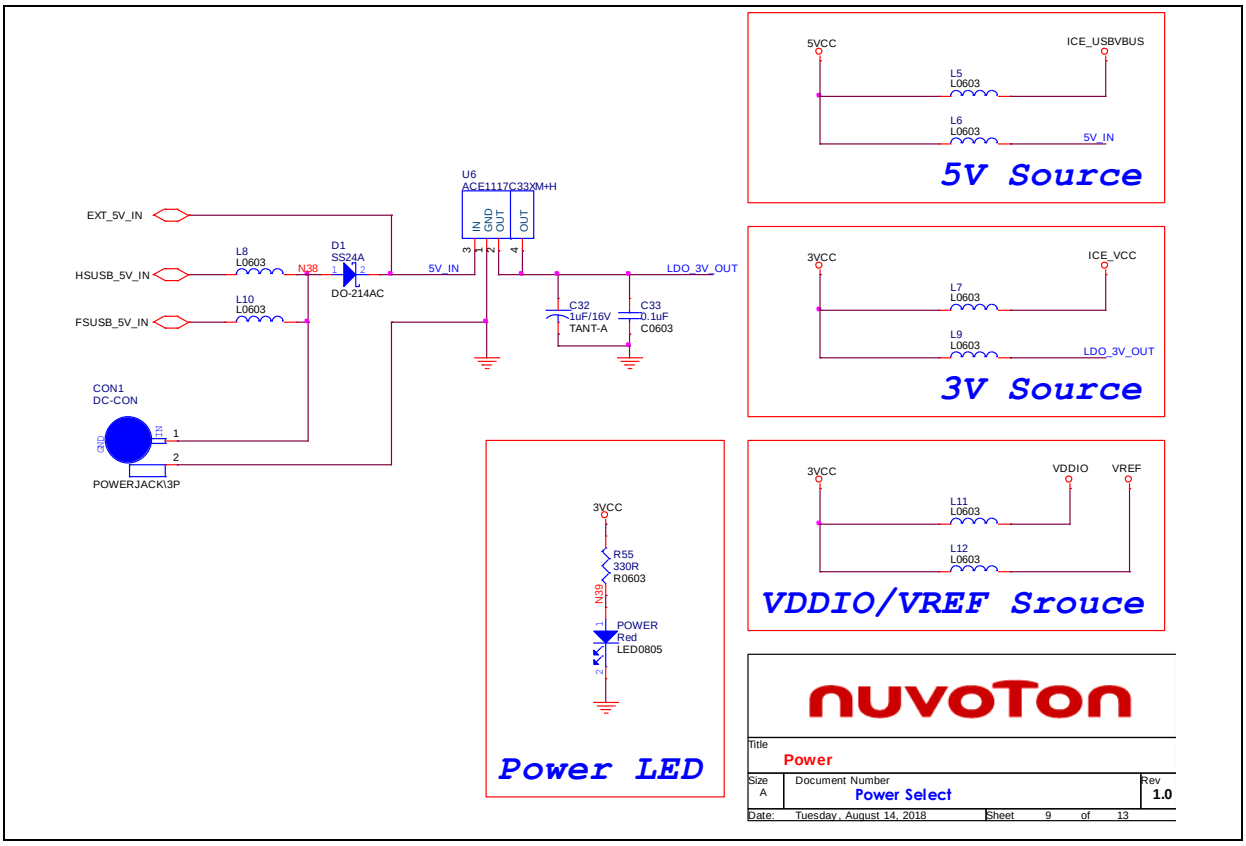

Figure 3-8 Power Circuit and Configurations

3.9 9-Axis Sensor

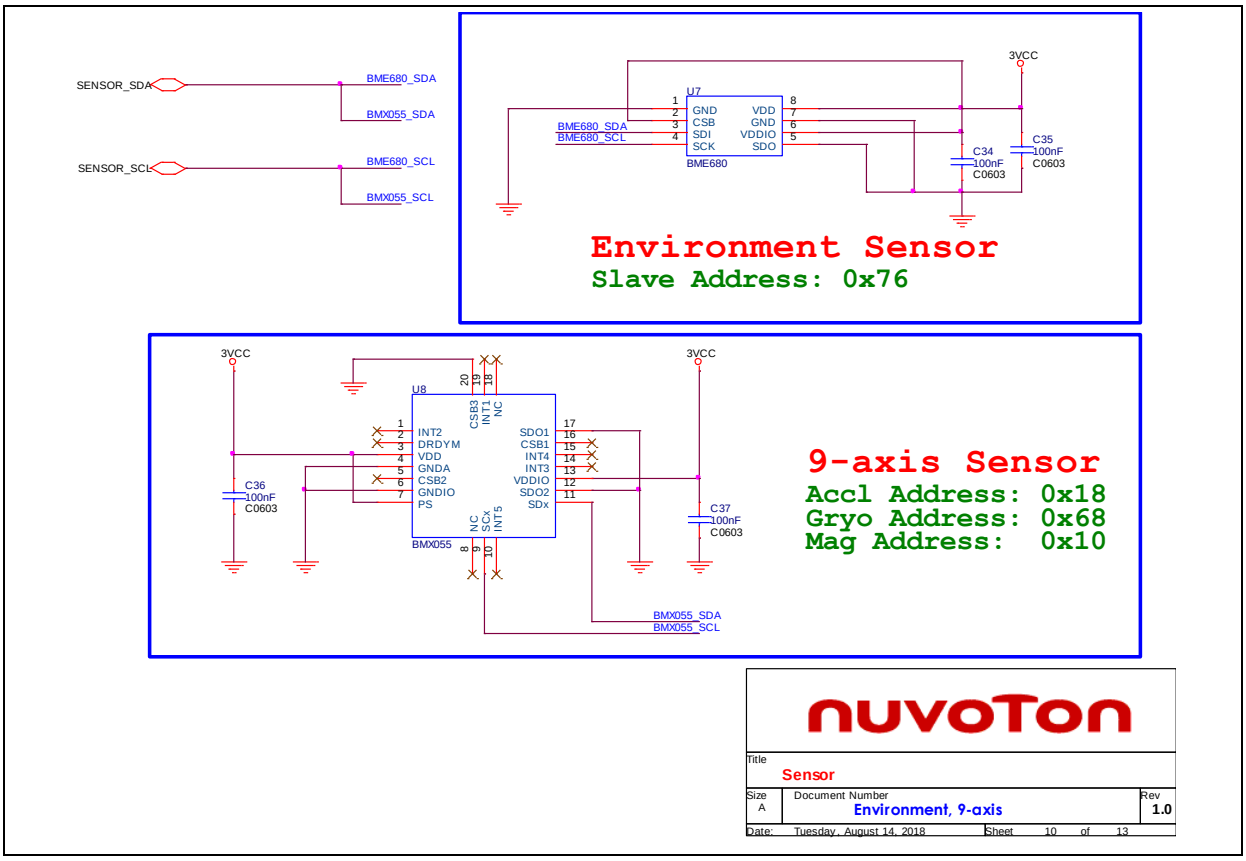

Figure 3-9 9-Axis Sensor Circuit of NuMaker-IoT-M487

3.10 SPI Flash and SD Card

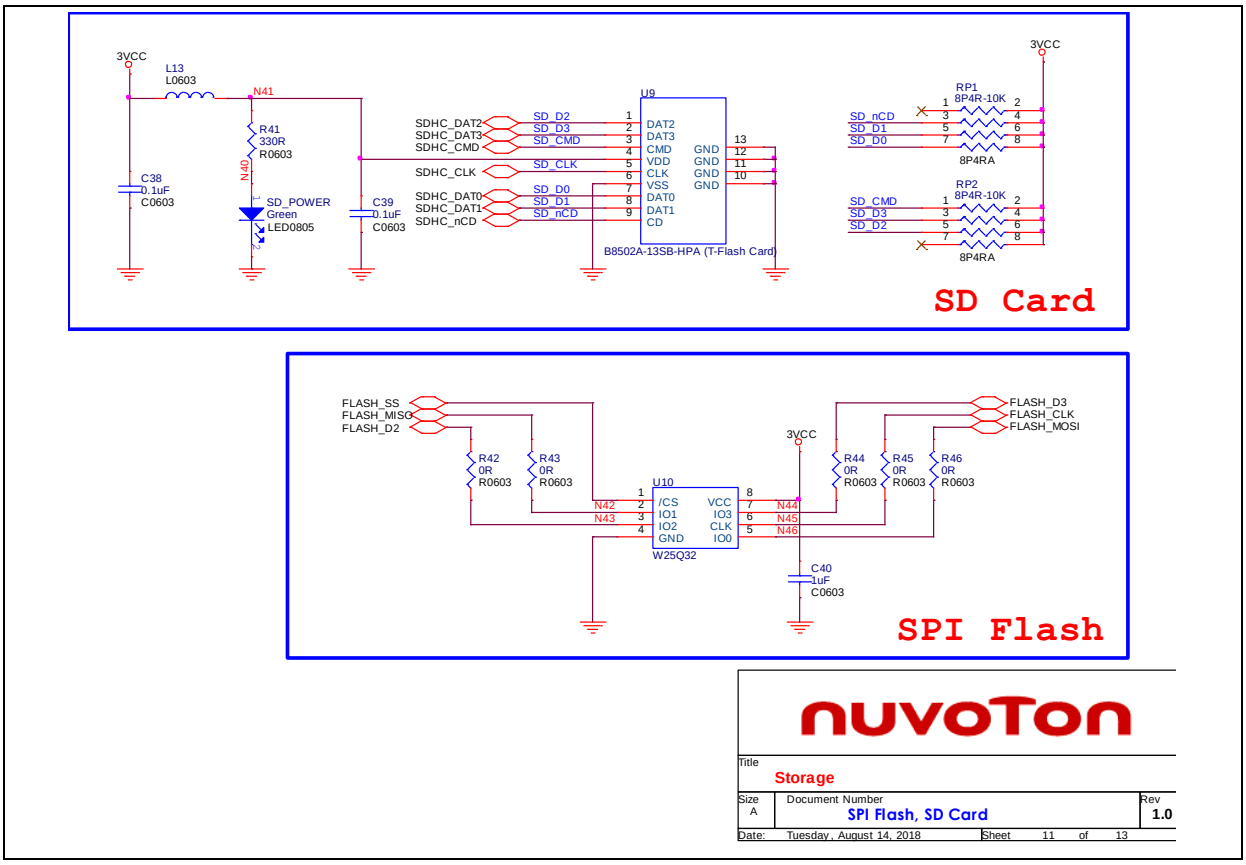

Figure 3-10 SPI Flash and SD Card Circuit of NuMaker-IoT-M487

3.11 Arduino UNO Compatible Interface

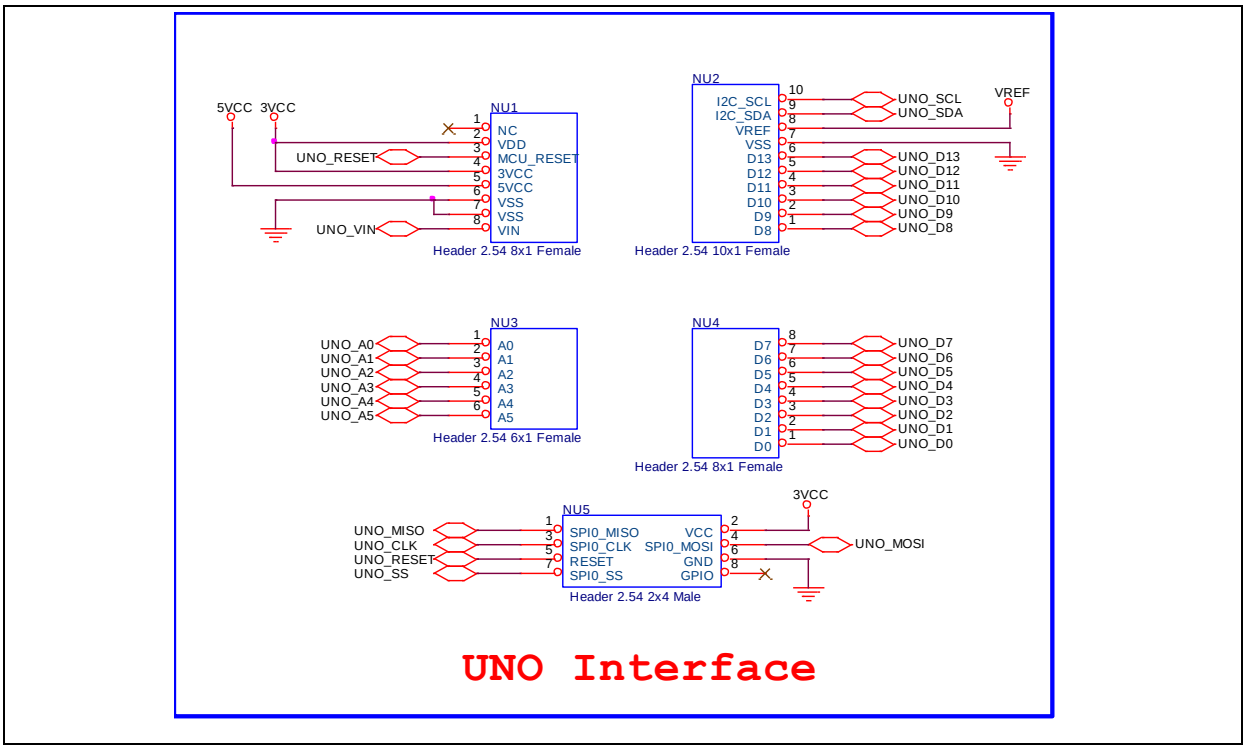

Figure 3-11 Arduino UNO Compatible Interface

3.12 High-Speed USB OTG and Full-Speed USB OTG

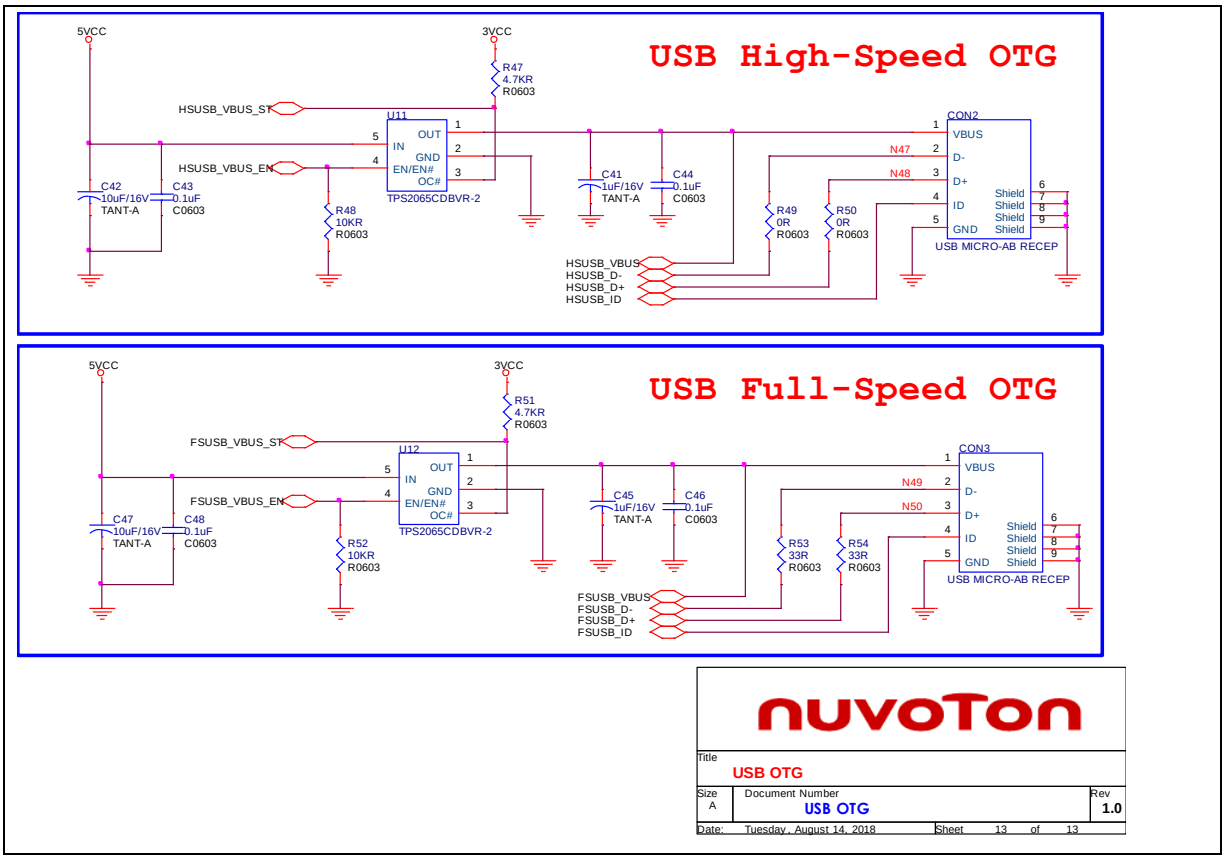

Figure 3-12 High-Speed USB OTG and Full-Speed USB OTG

3.13 Wi-Fi Module Interface

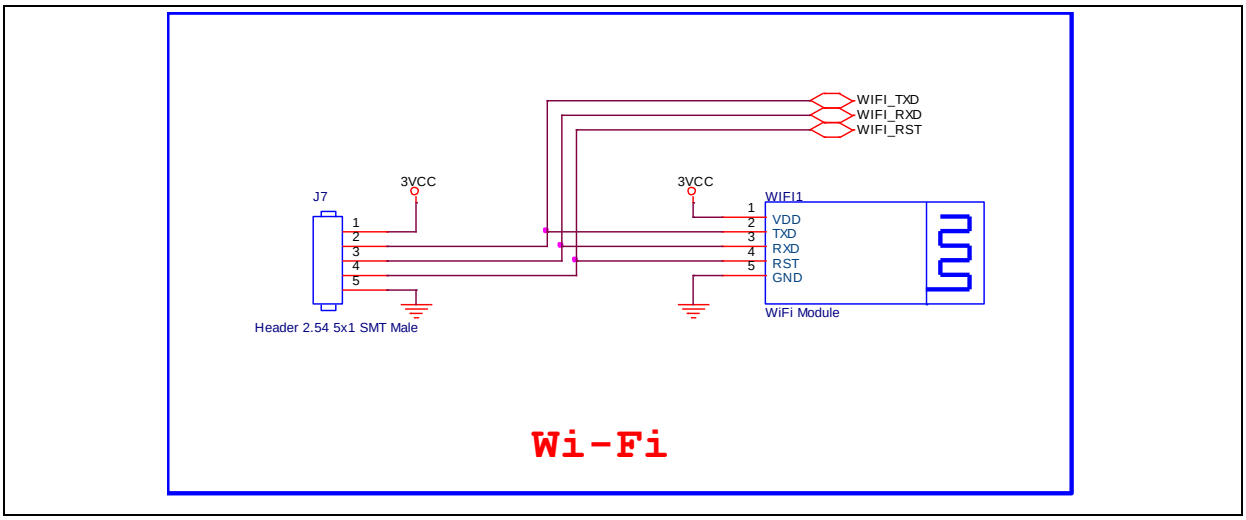

Figure 3-13 Wi-Fi Module Interface of NuMaker-IoT-M487

3.14 LEDs, Buttons, I/Os and NuMaker Brick Interface

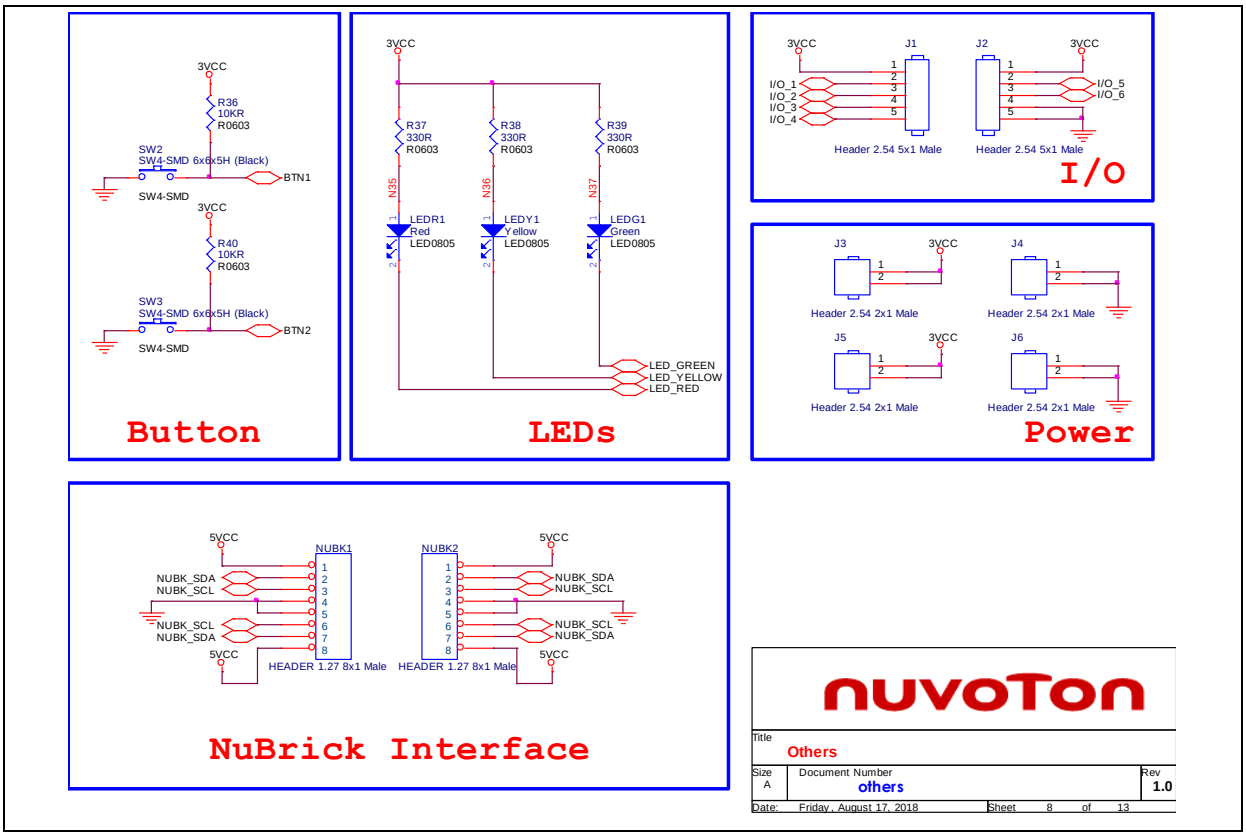

Figure 3-14 LEDs, Buttons, I/Os and NuMaker Brick Interface of NuMaker-IoT-M487

4 REVISION HISTORY

Date	Revision	Description
2018.12.05	1.01	1. Typo correction
2018.07.10	1.00	1. Initially issued.

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