NuMicro® Family

Arm® Cortex®-M4-based Microcontroller

NuMaker-HMI-M487

User Manual

Evaluation Board for NuMicro® M480 Series

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

www.nuvoton.com

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1 OVERVIEW

This user manual is aimed to give users a fast introduction to the NuMaker HMI M487 board (NK-BEDM487D). This board consists of a NuMaker-PFM-M487 (Ver 3.0) main board and a NuMaker M487 Advance (Ver 4.0) daughter board. This board provides user the development hardware board based on M487 MCU chip (M487JIDAE) to implement some dedicated applications, especially for the NuMaker HMI GUI display and HMI function on TFT LCD screen with touch input.

Figure 1-1 shows the NuMaker HMI M487 board that combined from a NuMaker-PFM-M487 main board (bottom) and NuMaker M487 Advance daughter board (top).

Figure 1-1 NuMaker HMI M487 Board

1.1 Target Chip M487JIDAE MCU Features

In the NuMaker-PFM-M487 main board, it uses the M487JIDAE microcontroller (MCU) as the target chip for users to develop their system applications. Some important features on M487JIDAE chip are listed as the followings. For more detailed information about the M487 series chip, please visit Nuvoton NuMicro Family ARM® Cortex® -M4 MCUs website to get the related information or to download the Data Sheet and TRM (Technical Reference Manual) documents.

https://www.nuvoton.com/hq/products/microcontrollers/arm-cortex-m4-mcus/m487-ethernet-series/?__locale=en

- M487JIDAE Chip Features:
  - 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
- EPWM and BPWM
- Quadrature Encoder Interface (QEI)
- WDT and WWDT
- RTC
- UART
- Smart Card (ISO-7816-3) Host Interface
- I^2C
- SPI
- SPIM (SPI Master)
- 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
- OPA

1.2 NuMaker HMI Demonstration

When user got this NuMaker HMI M487 board and plugged-in an USB cable to connect the ICEJ (USB Micro AB) on the Nu-Link-Me portion of NuMaker-PFM-M487 board to the USB Host port to supply the power to this board, user can see some NuMaker HMI demonstrations on the TFT LCD screen. The firmware of these NuMaker HMI demonstrations were programmed into the internal flash of M487JIDAE target chip by Nuvoton before this board is delivered to users. Figure 1-2 shows one of NuMaker HMI demonstrations that displayed on the TFT LCD screen. This TFT LCD module has a built-in resistor-type touch screen and the touch function for HMI also had been implemented in this same firmware. User can press the “Halt” icon on the bottom-right of the TFT LCD screen to halt this current demonstration program or press the “Next” icon to skip this current demonstration and jump to the next demonstration program.

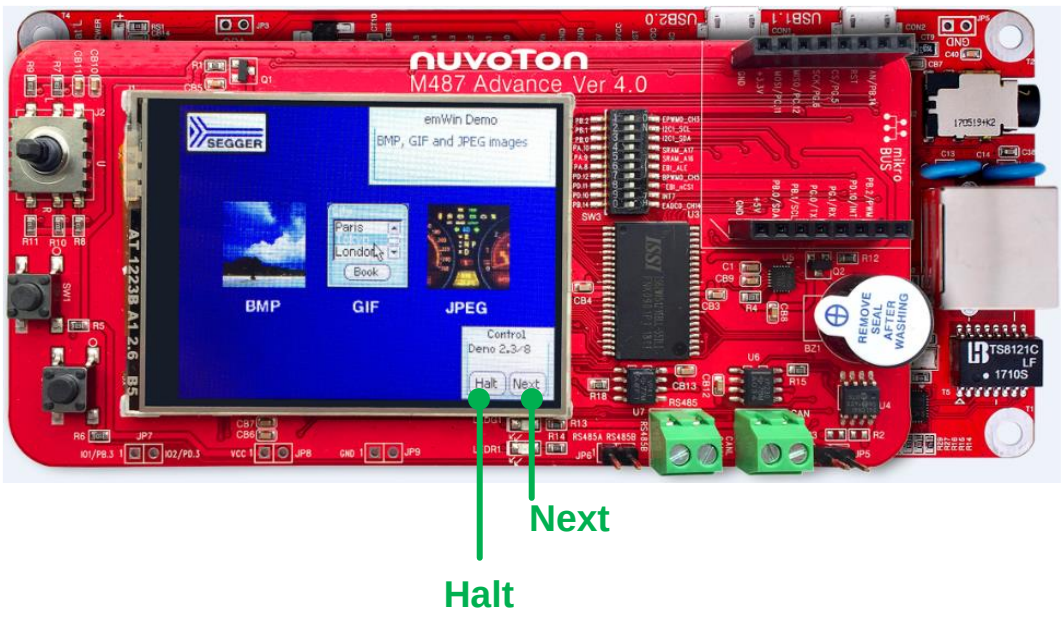

Figure 1-2 NuMaker HMI Demonstration

1.3 NuMaker HMI Resource

Nuvoton provided all the related resources of NuMaker HMI. Users can visit the page of NuMaker-HMI-M487 from Nuvoton NuMicro Family ARM® Cortex® -M4 MCUs website to get the software resource. Users can download the lastest DSP software in URL: https://www.nuvoton.com/products/gui-solution/gui-platform/numaker-hmi-m487/?group=Software&tab=2

After Decompressing the zip file in windows, users can find a Doc (Document) folder under the NuMaker-HMI-M487 folder, the files in that will guide users on how to start or use the NuMaker HMI API and tools in a project. There are provide some related execution files in a folder of "Tool", helping users to create the GUI that displays on the TFT LCD screen of the NuMaker HMI project.

2 NUMAKER-PFM-M487 BOARD

2.1 NuMaker-PFM-M487 Board Overview

The NuMaker-PFM-M487 is a development board based on an ARM® Cortex®-M4 microcontroller (MCU) – M480 series which has very rich peripherals.

This board is provided by Nuvoton and created specially to support the ARM® mbed™ IoT Device Platform, and let user easily to develop the IoT application program on this board. The NuMaker-PFM-M487 also provides user many useful and powerful learning materials for how to develop and verify the application programs through the peripherals and interfaces on MCU and this board.

Furthermore, this board also provides an Arduino UNO compatible interface for user to develop the specific function with any of Arduino modules or kits. Regarding to the Arduino, user can link directly to the Wikipedia website: en.wikipedia.org/wiki/Arduino to get more detailed introductions.

The NuMaker-PFM-M487 board consists of M487 Platform and Nu-Link-Me ICE Bridge. Figure 2-1 shows the NuMaker-PFM-M487 board.

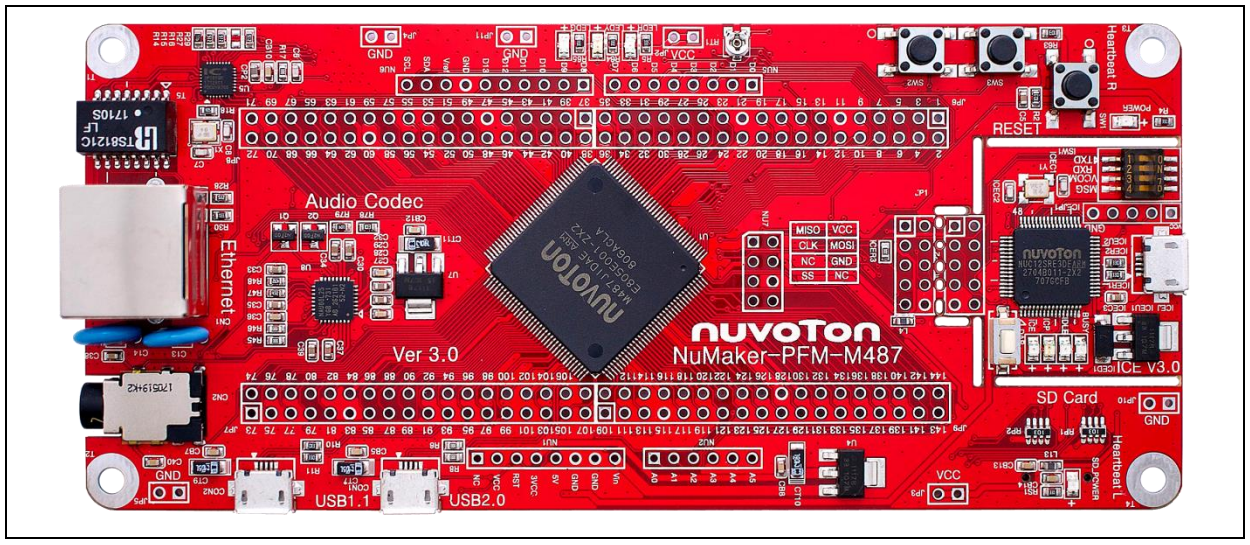

Figure 2-1 NuMaker-PFM-M487 Board

The right portion of this board is the M487 Platform that includes the target chip M487 MCU which embedded ARM® Cortex®-M4 core with DSP extensions and a Floating Point Unit (FPU) and the other related on-board application parts and connectors.

The left portion of this board is a 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.

For more information on the NuMaker-PFM-M487 board for the ARM® mbed™ Device Platform, please visit the ARM® mbed™ hardware board website:

https://developer.mbed.org/platforms/NUMAKER-PFM-M487/

2.2 NuMaker-PFM-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
- M487 extended interface connectors
- Audio codec (NAU88L25) with Microphone In and Headphone Out
- Ethernet for network application
- 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 for T-Flash
- Three push-buttons: one is for reset and the other two are for user-defined
- Four LEDs: one is for power indication and the other three are for user-defined

2.3 Front View

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

The following lists components and connectors from the front view:

- Target Chip: M487JIDAE (U1)
- Nu-Link-Me ICE Bridge: ICE Controller NUC12SRE3DE (ICEU2), USB connector (ICEJ) to PC Host
- Audio: Audio Codec NAU88L25 (U2), Headphone (CN2)
- Arduino UNO compatible interface connectors (NU1, NU2, NU5, NU6 and NU7)
- M487 extended interface connectors (JP6, JP7, JP8 and JP9)
- USB: USB 2.0 High-Speed OTG connector (CON1) and USB 1.1 OTG connector (CON2)
- Ethernet Transceivers: IP101GR (U5)
- Push-buttons (SW2 and SW3)
- LEDs (LEDR, LEDY and LEDG)

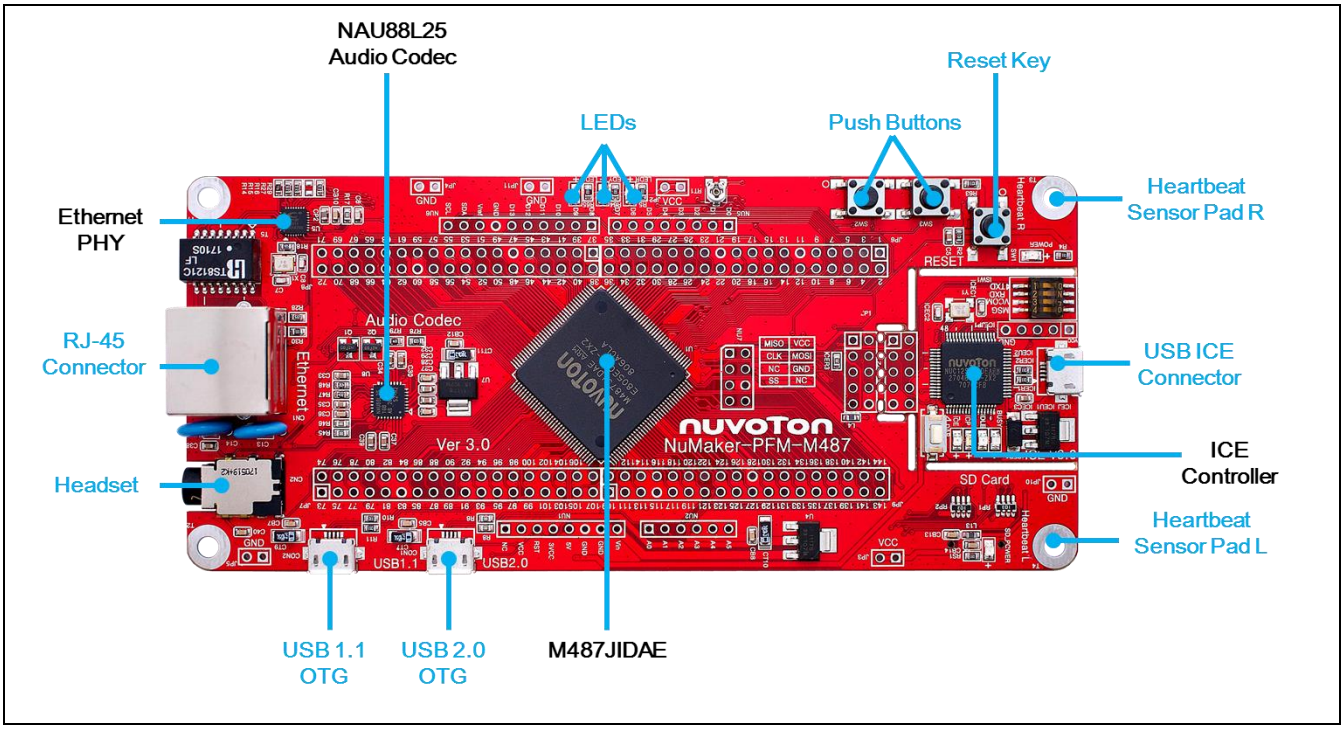

Figure 2-2 Front View of NuMaker-PFM-M487 Board

2.4 Rear View

Figure 2-3 shows the main components and connectors from the rear side of NuMaker-PFM-M487 board.

The following lists components and connectors from the rear view:

- MicroSD Card Slot: T-Flash slot (U9)
- SPI Flash: Winbond W25Q32JV (U6)

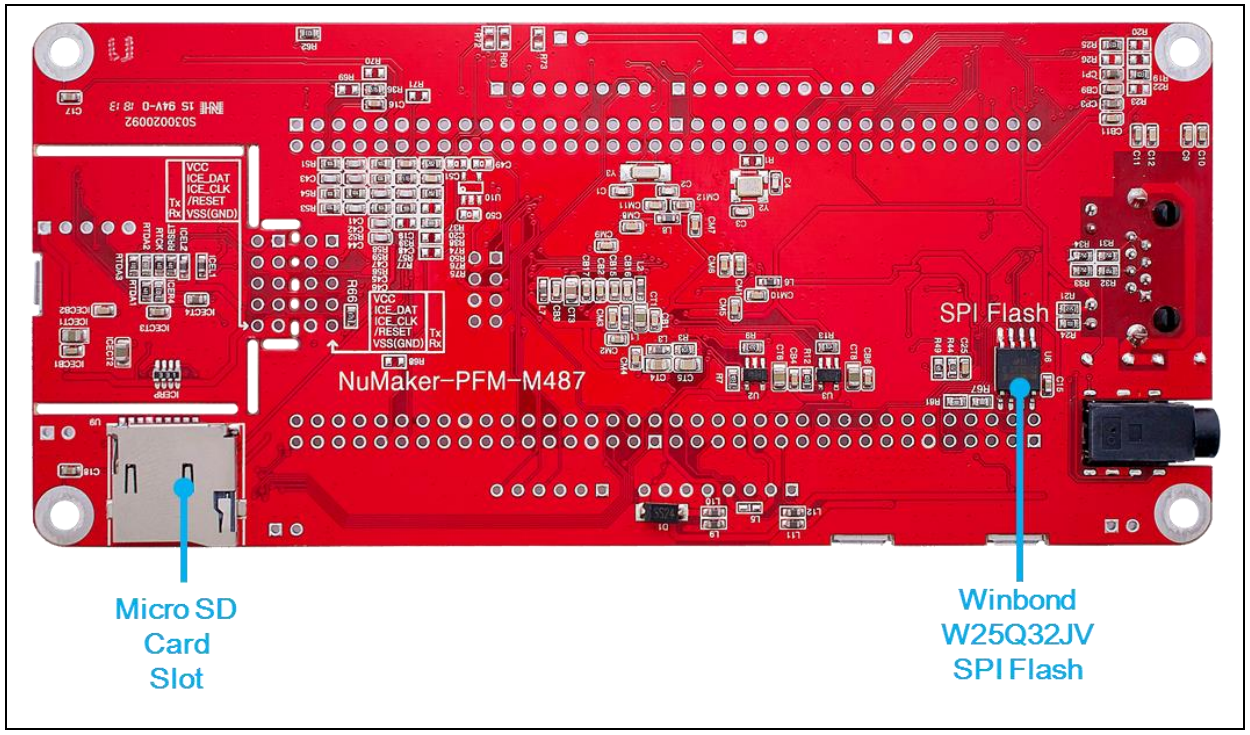

Figure 2-3 Rear View of NuMaker-PFM-M487 Board

2.5 Arduino UNO Compatible Interface

Figure 2-4 shows the Arduino UNO compatible interface.

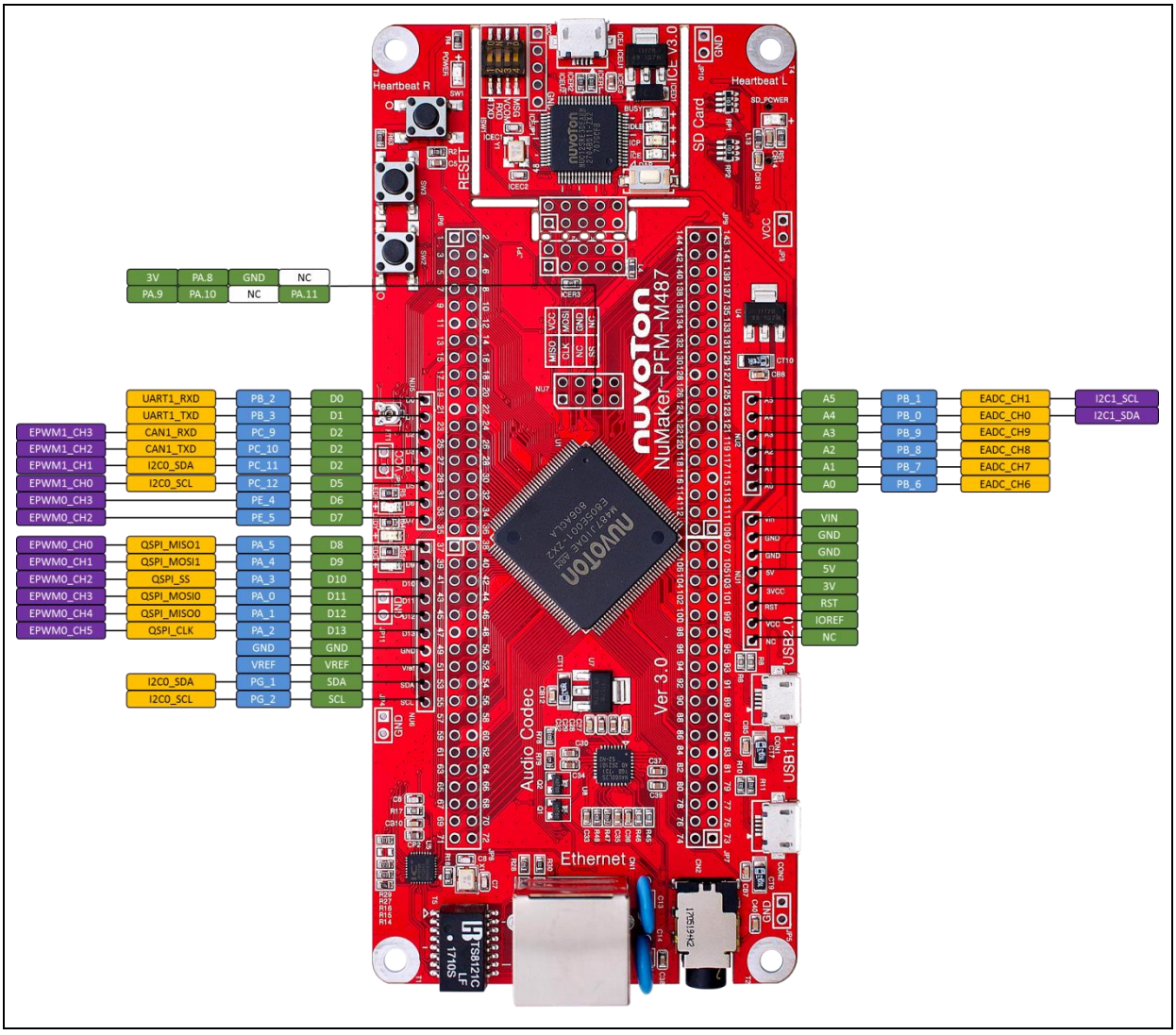

Figure 2-4 Arduino UNO Compatible Interface

Table 2-1 Arduino UNO Interface Mapping with M487JIDAE GPIO

Header		NuMaker-PFM-M487		Header		NuMaker-PFM-M487	
		Compatible to Arduino UNO	GPIO Pin of M487			Compatible to Arduino UNO	GPIO Pin of M487
NU1	NU1.1	NC	-	NU6	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
NU2	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	NU5	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-PFM-M487		Header		NuMaker-PFM-M487	
		Compatible to Arduino UNO	GPIO Pin of M487			Compatible to Arduino UNO	GPIO Pin of M487
NU7	NU7.1	VCC	-	NU7	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	-

2.6 Pin Assignment for Extended Connectors

The NuMaker-PFM-M487 provides the M487JIDAE target chip onboard and extended connectors (JP6, JP7, JP8 and JP9) for LQFP144-pin. The Figure 2-5 shows the M487JIDAE extended connectors that are one-to-one mapped to the target chip.

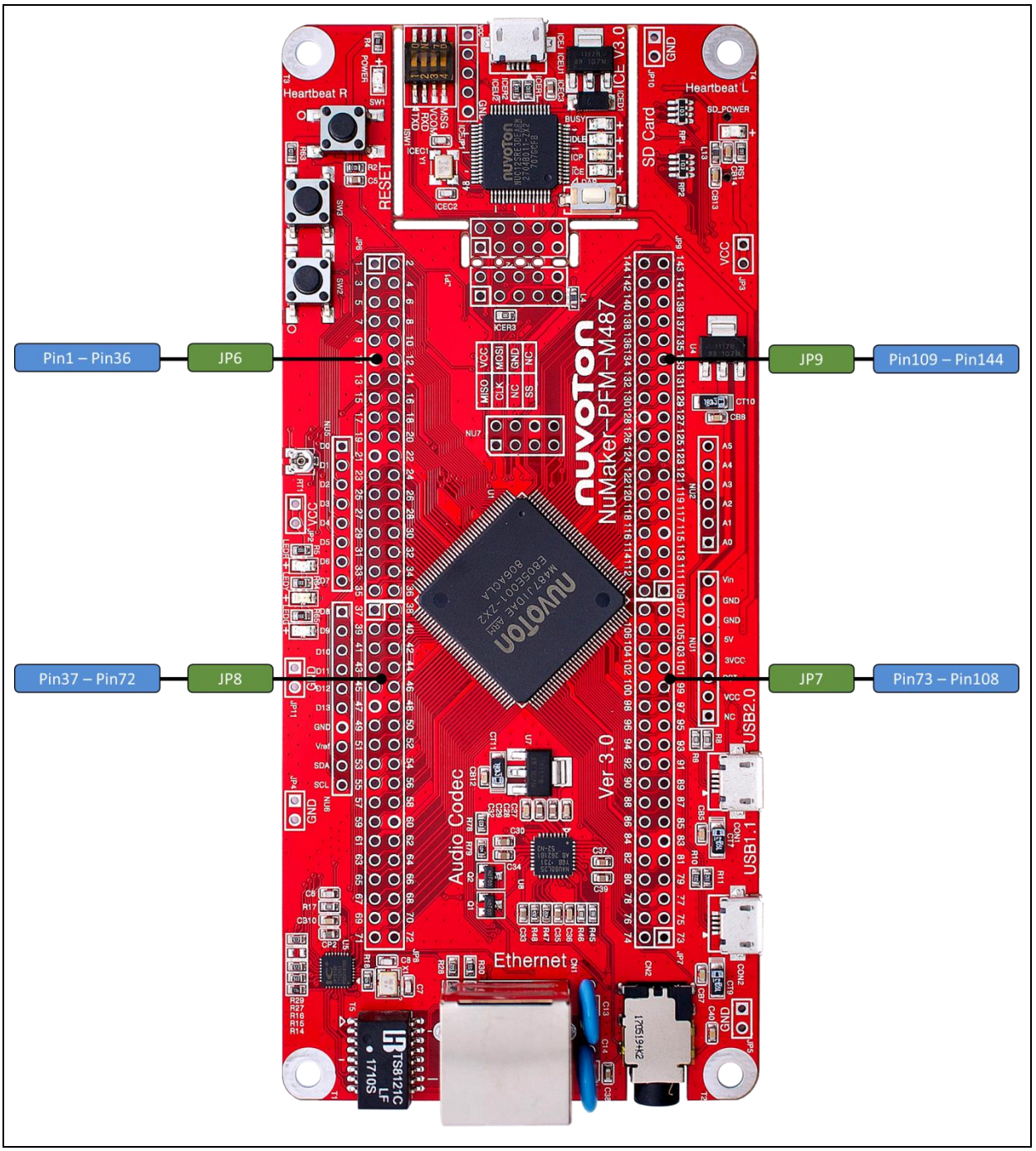

Figure 2-5 M487JIDAE Extended Connectors

Table 2-2 Extended Connector JP6 Interface with M487JIDAE GPIO

Header		M487JIDAE		Header		M487JIDAE	
		Pin No.	Function			Pin No	Function
JP6	JP6.1	1	SD0_DAT3	JP6	JP6.2	2	SD0_DAT2
	JP6.3	3	PB.3		JP6.4	4	OPA0_O
	JP6.5	5	PC.12		JP6.6	6	PC.11
	JP6.7	7	PC.10		JP6.8	8	PC.9
	JP6.9	9	OPA0_N		JP6.10	10	OPA0_P
	JP6.11	11	GND		JP6.12	12	3VCC
	JP6.13	13	PA.11		JP6.14	14	OPA1_O
	JP6.15	15	OPA1_N		JP6.16	16	OPA1_P
	JP6.17	17	JKDET		JP6.18	18	OPA2_O
	JP6.19	19	OPA2_N		JP6.20	20	OPA2_P
	JP6.21	21	GND		JP6.22	22	3VCC
	JP6.23	23	PG.0		JP6.24	24	PG.1
	JP6.25	25	PG.2		JP6.26	26	PG.3
	JP6.27	27	PG.4		JP6.28	28	SW3
	JP6.29	29	I2S0_BCLK		JP6.30	30	I2S0_MCLK
	JP6.31	31	I2S0_DI		JP6.32	32	I2S0_DO
	JP6.33	33	I2S0_LRCK		JP6.34	34	3VCC
	JP6.35	35	XT32_IN		JP6.36	36	XT32_OUT

Table 2-3 Extended Connector JP8 Interface with M487JIDAE GPIO

Header		M487JIDAE		Header		M487JIDAE	
		Pin No.	Function			Pin No	Function
JP8	JP8.1	37	LED_R	JP8	JP8.2	38	LED_Y
	JP8.3	39	LED_G		JP8.4	40	PH.3
	JP8.5	41	PH.4		JP8.6	42	PH.5
	JP8.7	43	PH.6		JP8.8	44	PH.7
	JP8.9	45	XT1_IN		JP8.10	46	XT1_OUT
	JP8.11	47	GND		JP8.12	48	3VCC
	JP8.13	49	EMAC_MDC		JP8.14	50	EMAC_MDIO
	JP8.15	51	EMAC_TXD0		JP8.16	52	EMAC_TXD1
	JP8.17	53	EMAC_TXEN		JP8.18	54	JKEN#
	JP8.19	55	EMAC_REFCLK		JP8.20	56	EMAC_RXD0
	JP8.21	57	EMCAC_RXD1		JP8.22	58	EMAC_RXDV
	JP8.23	59	EMAC_RXERR		JP8.24	60	GND
	JP8.25	61	3VCC		JP8.26	62	LDO_CAP
	JP8.27	63	PA.5		JP8.28	64	PA.4
	JP8.29	65	PA.3		JP8.30	66	PA.2
	JP8.31	67	PA.1		JP8.32	68	PA.0
	JP8.33	69	VDDIO		JP8.34	70	PE.14
	JP8.35	71	PE.15		JP8.36	72	nRESET

Table 2-4 Extended Connector JP7 Interface with M487JIDAE GPIO

Header		M487JIDAE		Header		M487JIDAE	
		Pin No.	Function			Pin No	Function
JP7	JP7.1	73	ICEDAT	JP7	JP7.2	74	ICECLK
	JP7.3	75	PD.9		JP7.4	76	PD.8
	JP7.5	77	SPIM_D2		JP7.6	78	SPIM_D3
	JP7.7	79	SPIM_SS		JP7.8	80	SPIM_CLK
	JP7.9	81	SPIM_MISO		JP7.10	82	SPIM_MOSI
	JP7.11	83	GND		JP7.12	84	3VCC
	JP7.13	85	PG.9		JP7.14	86	PG.10
	JP7.15	87	PG.11		JP7.16	88	PG.12
	JP7.17	89	PG.13		JP7.18	90	PG.14
	JP7.19	91	SW2		JP7.20	92	PD.3
	JP7.21	93	PD.2		JP7.22	94	I2C2_SCL
	JP7.23	95	I2C2_SDA		JP7.24	96	SD0_nCD
	JP7.25	97	USB_VBUS		JP7.26	98	USB_D-
	JP7.27	99	USB_D+		JP7.28	100	USB_ID
	JP7.29	101	HSUSB_VRES		JP7.30	102	HSUSB_VDD33
	JP7.31	103	HSUSB_VBUS		JP7.32	104	HSUSB_D-
	JP7.33	105	HSUSB_VSS		JP7.34	106	HSUSB_D+
	JP7.35	107	HSUSB_VDD12_CAP		JP7.36	108	HSUSB_ID

Table 2-5 Extended Connector JP9 Interface with M487JIDAE GPIO

Header		M487JIDAE		Header		M487JIDAE	
		Pin No.	Pin Name			Pin No	Pin Name
JP9	JP9.1	109	SD0_CMD	JP9	JP9.2	110	SD0_CLK
	JP9.3	111	PE.5		JP9.4	112	PE.4
	JP9.5	113	SD0_DAT1		JP9.6	114	SD0_DAT0
	JP9.7	115	GND		JP9.8	116	3VCC
	JP9.9	117	PE.1		JP9.10	118	PE.0
	JP9.11	119	PH.8		JP9.12	120	PH.9
	JP9.13	121	PH.10		JP9.14	122	PH.11
	JP9.15	123	PD.14		JP9.16	124	PG.5
	JP9.17	125	PG.6		JP9.18	126	PG.7
	JP9.19	127	PG.8		JP9.20	128	GND
	JP9.21	129	LDO_CAP		JP9.22	130	3VCC
	JP9.23	131	USB_VBUS_ST		JP9.24	132	USB_VBUS_EN
	JP9.25	133	EADC0_CH14		JP9.26	134	TXD
	JP9.27	135	RXD		JP9.28	136	AVDD
	JP9.29	137	VREF		JP9.30	138	ADAVSS
	JP9.31	139	HSUSB_VBUS_ST		JP9.32	140	HSUSB_VBUS_EN
	JP9.33	141	PB.9		JP9.34	142	PB.8
	JP9.35	143	PB.7		JP9.36	144	PB.6

2.7 System Configuration

2.7.1 5V Power Source

- **ICEJ:** USB connector in Nu-Link-Me to program code and supplies 5V power from PC Host.
- **CON1:** USB 2.0 High-Speed OTG connector on NuMaker-PFM-M487 board to supply 5V power from PC Host when this USB is a device that be decided by the ID pin of OTG cable and this ID pin is low.
- **CON2:** USB 1.1 OTG connector on NuMaker-PFM-M487 board to supply 5V power from PC Host when this USB is a device that be decided by the ID pin of OTG cable and this ID pin is low.
- **NU1 pin5:** VDD5V voltage connector on NuMaker-PFM-M487 board to supply 5V power from external power source.

Table 2-6 5V Power Hardware Settings

Power Source	Connector	Comment
ICE_USB_VBUS	ICEJ	ICEJ supplies the 5V power from PC Host. **Note**: L9 should be shorted 0ohm
HSUSB_VBUS	CON1	CON1 supplies the 5V power from PC Host. **Note**: L11 should be shorted 0ohm.
USB_VBUS	CON2	CON2 supplies the 5V power from PC Host. **Note**: L12 should be shorted 0ohm.
External 5V Source	NU1 pin5	NU1 pin5 supplies the 5V power from external power source. **Note**: L10 should be shorted 0ohm.

2.7.2 3.3V Power Source

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

Table 2-7 3V Power Hardware Settings

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:** L4 should be shorted 0ohm
U4	HSUSB_VBUS	U4 convert HSUSB_VBUS to 3.3V and supplies it to M487 platform board. **Note:** L5 should be shorted 0ohm.
U4	USB_VBUS	U4 convert USB_VBUS to 3.3V and supplies it to M487 platform board. **Note:** L5 should be shorted 0ohm.

2.7.3 USB Connectors

- **ICEJ:** USB connector (ICE) in Nu-Link-Me that connects to a PC's USB Host port to program code and supply power.
- **CON1:** USB 2.0 High-Speed connector (OTG) on NuMaker-PFM-M487 board for USB OTG application use.
- **CON2:** USB 1.1 connector (OTG) on NuMaker-PFM-M487 board for USB OTG application use.

2.7.4 Ethernet Connectors

- **CN1:** Ethernet connector (RJ-45) on NuMaker-PFM-M487 board for application use.

2.7.5 Arduino UNO Compatible Interface Connectors

- **NU1, NU2, NU5, NU6 and NU7:** Arduino UNO compatible pins on the NuMaker-PFM-M487 board.

2.7.6 Extended Connectors

- **JP6, JP7, JP8 and JP9:** Extended connectors interface pins on the NuMaker-PFM-M487 board.

2.7.7 Phone Jack

- **CN2:** Phone jack connector on NuMaker-PFM-M487 for audio application use.

2.7.8 MicroSD Card Slot

- **U9:** MicroSD card slot for application use.

2.7.9 Push-Buttons

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

2.7.10 LEDs

- **POWER:** The power LED indicates that the NuMaker-PFM-M487 board is powered.
- **I/O1, I/O2 and I/O3:** Only for application use.

2.7.11 Heartbeat Sensor Pads

- **Heartbeat L:** The heartbeat sensor pad on the left hand.
- **Heartbeat R:** The heartbeat sensor pad on the right hand.

2.7.12 Power Connectors

- **JP2 and JP3:** 3VCC connectors on the NuMaker-PFM-M487 board.
- **JP4, JP5, JP10 and JP11:** GND connectors on the NuMaker-PFM-M487 board.

2.8 Audio

NuMaker-PFM-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-PFM-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. Table 2-8 shows the pin mapping between NUC88L25 and M487JIDAE.

Table 2-8 NAU88L25 Mapping with M487JIDAE

NuMaker-PFM-M487	NAU88L25	Comment
I2C2_SCL	SCLK	I²C clock output **Note**: The I²C address of NAU88L25 is 0x1A by default.
I2C2_SDA	SDIO	I²C data input/output **Note**: The I²C address of NAU88L25 is 0x1A by default.
I2S0_BCLK	BCLK	I²S bit clock output from NAU88L25
I2S0_MCLK	MCLK	I²S master clock output from M487
I2S0_DI	ADCOUT	I²S data input to NAU88L25
I2S0_DO	DACIN	I²S data output from M487
I2S0_LRCK	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 2-6 shows the phone jack diagram.

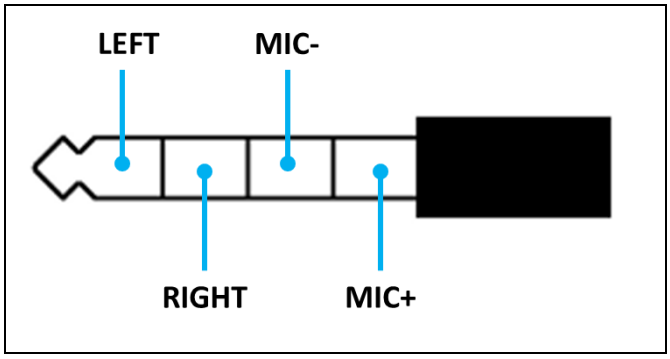

Figure 2-6 3.5mm Phone Jack Diagram

2.9 Heartbeat Sensor

NuMaker-PFM-M487 features an on-board heartbeat sensor that can detect the tiny electrical signal between human's right hand and left hand during each heartbeat. The tiny electrical signal passes through three stages of operational amplifiers which are built in M487JI8AE to amplify the differential electrical signal and filter the noise of environment. The Figure 2-7 shows the heartbeat sensor block diagram.

- **Heartbeat R/L Sensor Pads**
  The heartbeat sensor pads are used to detect the tiny electrical signal between human's right hand and left hand during each heartbeat.

- **OPA0 (Differential Amplifier and Filter)**
  OPA0 is used to amplify the differential electrical signal between right and left sensor pads and filter the DC bias then passes it to OPA1.

- **OPA1 (Bypass Filter and Input Buffer)**
  OPA1 is a bypass filter which is used to suppress 60Hz noise and pass the signal without the noise to OPA2.

- **OPA2 (Amplifier)**
  OPA2 is used to amplify the signal comes from OPA1 then passes it to the ADC channel of M487JI8AE to convert the analog signal to the digital signal.

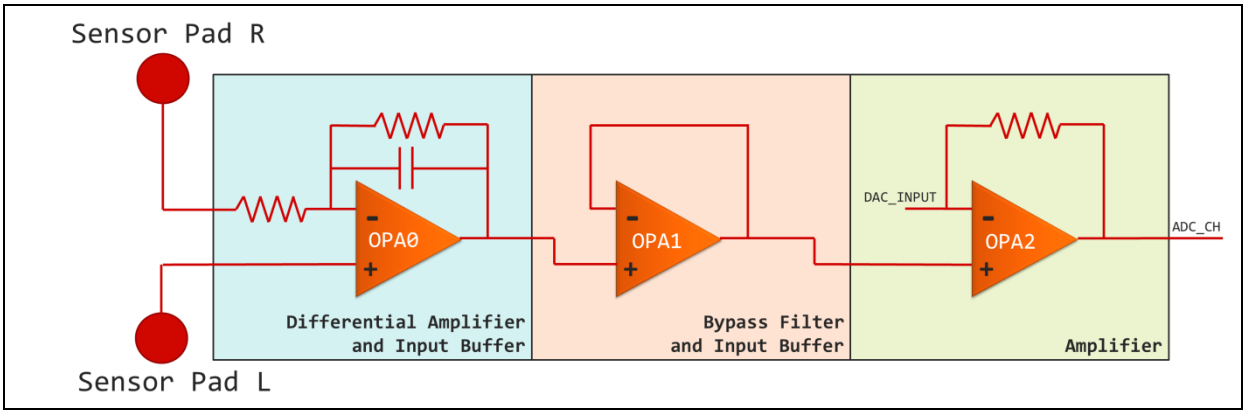

Figure 2-7 Heartbeat Sensor Block Diagram

These pins of heartbeat sensor share with the other pin-functions on NuMaker-PFM-M487 board. The Table 2-9 describes the pin usage on these pins of heartbeat sensor.

Table 2-9 Pin Usage of Heartbeat Sensor

M487JIDAE	Heartbeat Sensor	Alternative Function	Comment
PB.2	OPA0_O	D0	Short R69 to use the heartbeat function, otherwise it will be D0 of UNO Interface.
PB.1	OPA0_N	A5	Short R70 to use the heartbeat function, otherwise it will be A5 of UNO Interface.
PB.0	OPA0_P	A4	Short R71 to use the heartbeat function, otherwise it will be A4 of UNO Interface.
PA.10	OPA1_O	ICSP_CLK	Short R72 to use the heartbeat function, otherwise it will be CLK of UNO ICSP Interface.
PA.9	OPA1_N	ICSP_MISO	Short R73 to use the heartbeat function, otherwise it will be MISO of UNO Interface.
PA.8	OPA1_P	ICSP_MOSI	Short R74 to use the heartbeat function, otherwise it will be MOSI of UNO Interface.
PD.12	OPA2_O	-	Short R75 to use the heartbeat function, otherwise it will be PD.12 of M487JIDAE.
PD.11	OPA2_N	-	Short R76 to use the heartbeat function, otherwise it will be PD.11 of M487JIDAE.
PD.10	OPA2_P	-	Short R77 to use the heartbeat function, otherwise it will be PD.10 of M487JIDAE.
PB.12	DAC0_OUT	ICE_RXD	Short R68 to use the heartbeat function, otherwise it will be ICE_RXD of M487JIDAE.
PB.14	EADC0_CH14	-	Short R60 to use the heartbeat function, otherwise it will be PB.14 of M487JIDAE.

2.10 Nu-Link-Me

NuMaker-PFM-M487 features a Nu-Link-Me ICE debugger and programmer, it provide user to program M487JI8AE and debug their application via SWD interface, or it can emulate a USB pen driver when connect to the PC, user can update their firmware by pulling bin file to the pen driver. Nu-link-Me can also emulate a virtual COM port, user can log or print debug message via it. Refer Table 2-10 to enable or disable the optional function of Nu-Link-Me.

Table 2-10 Optional Function of Nu-Link-Me

ISW1		
Pin	**Nu-Link-Me**	**Comment**
1	TXD	**On**: Connect PB.13 (UART0_TXD) of M487JI8AE to Nu-Link-Me. **Off**: Disconnect PB.13 (UART0_TXD) of M487JI8AE to Nu-Link-Me.
2	RXD	**On**: Connect PB.12 (UART0_RXD) of M487JI8AE to Nu-Link-Me. **Off**: Disconnect PB.12 (UART0_RXD) of M487JI8AE 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 debugger and program via SWD interface. **Off**: Mass storage mode, user can update firmware by pulling bin file to pen driver.

2.11 PCB Placement

Figure 2-8 and Figure 2-9 show the front and rear placement of NuMaker-PFM-M487 board.

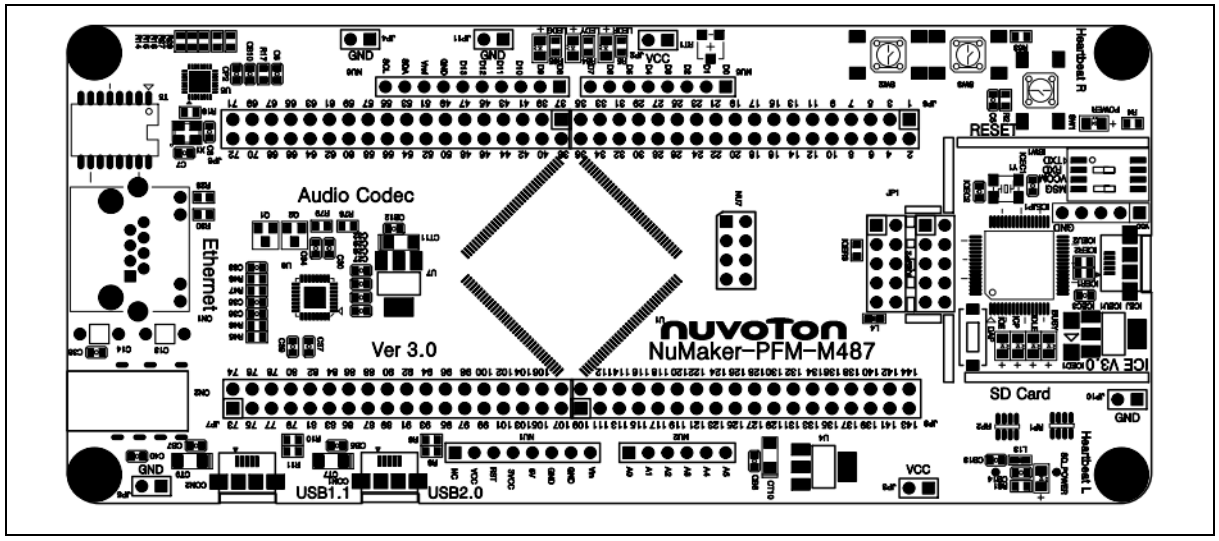

Figure 2-8 Front Placement

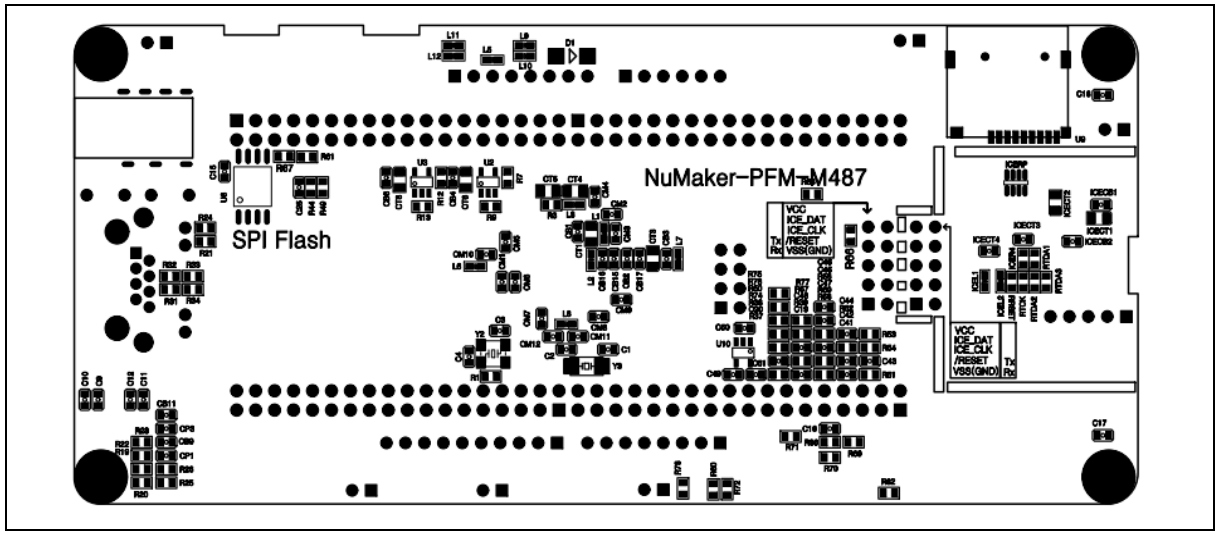

Figure 2-9 Rear Placement

2.12 NuMaker-PFM-M487 Schematics

2.12.1 Nu-Link-Me

Figure 2-10 shows the Nu-Link-Me circuit, which is a USB-to-SWD bridge used to program code to the target chip.

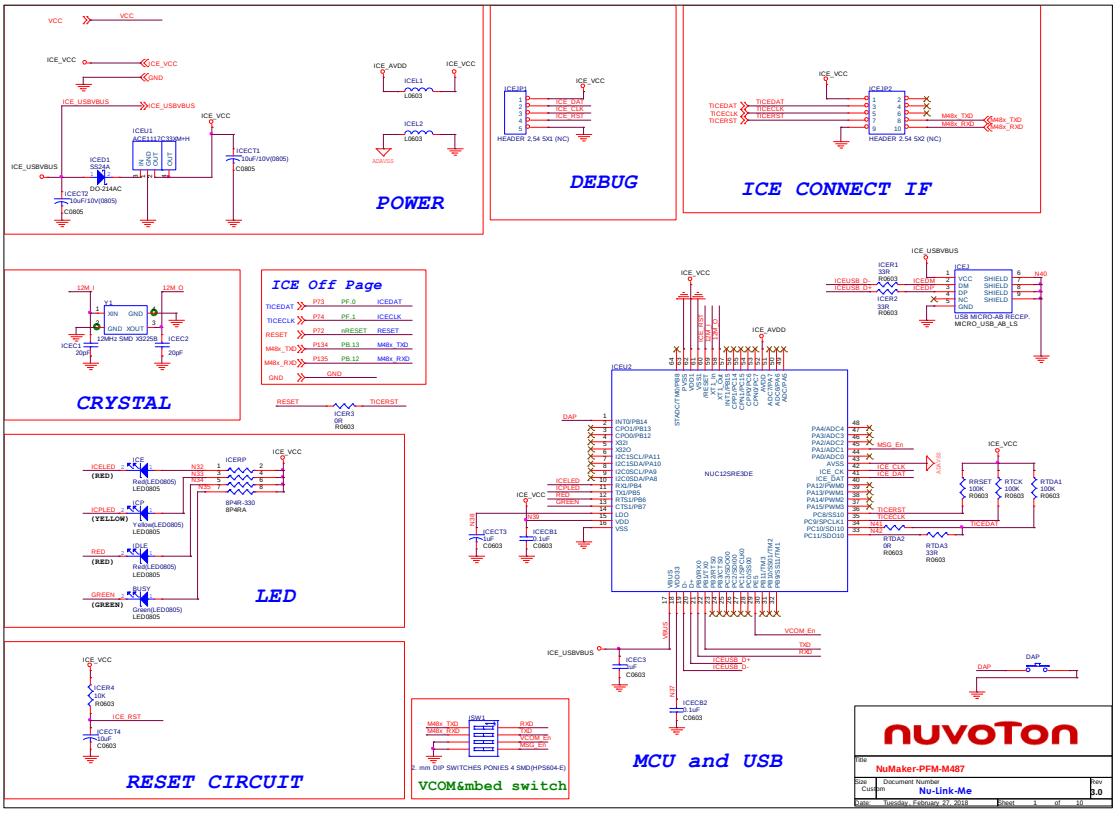

Figure 2-10 Nu-Link-Me Circuit

2.12.2 M487JIDAE Chip

Figure 2-11 shows the pin assignment of the M487JI8AE.

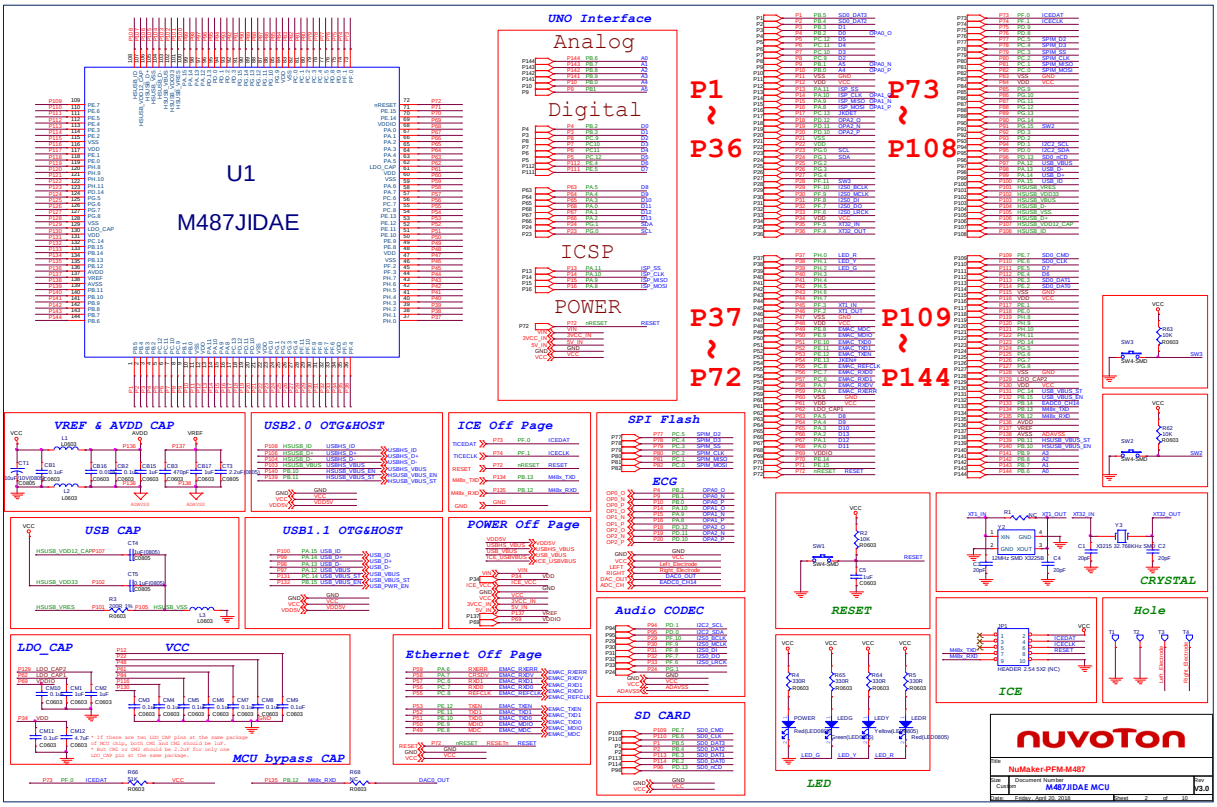

Figure 2-11 M487JI8AE Chip Pin Assignment

2.12.3 Power Supply

Figure 2-12 shows power configurations of NuMaker-PFM-M487 board.

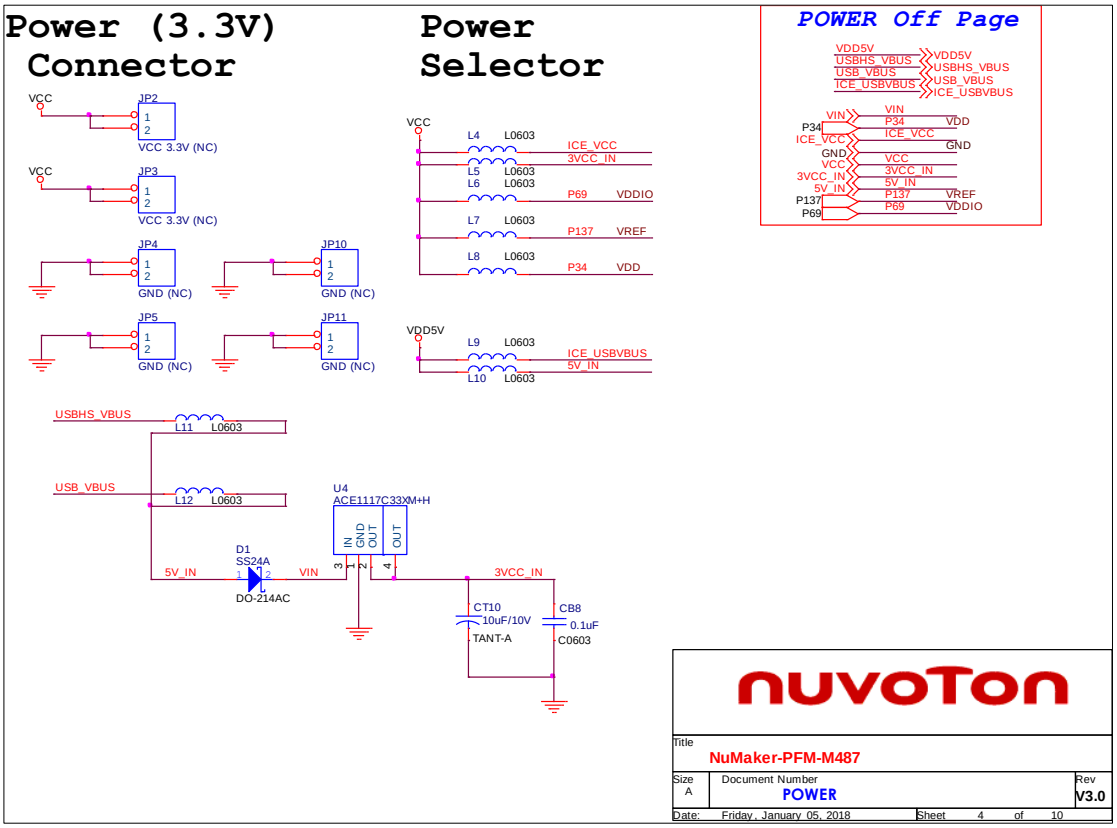

Figure 2-12 Power Circuit and Configurations

2.12.4 Arduino UNO Compatible Interface

Figure 2-13 shows the Arduino UNO compatible interface of NU1, NU2, NU5, NU6 and NU7 connectors.

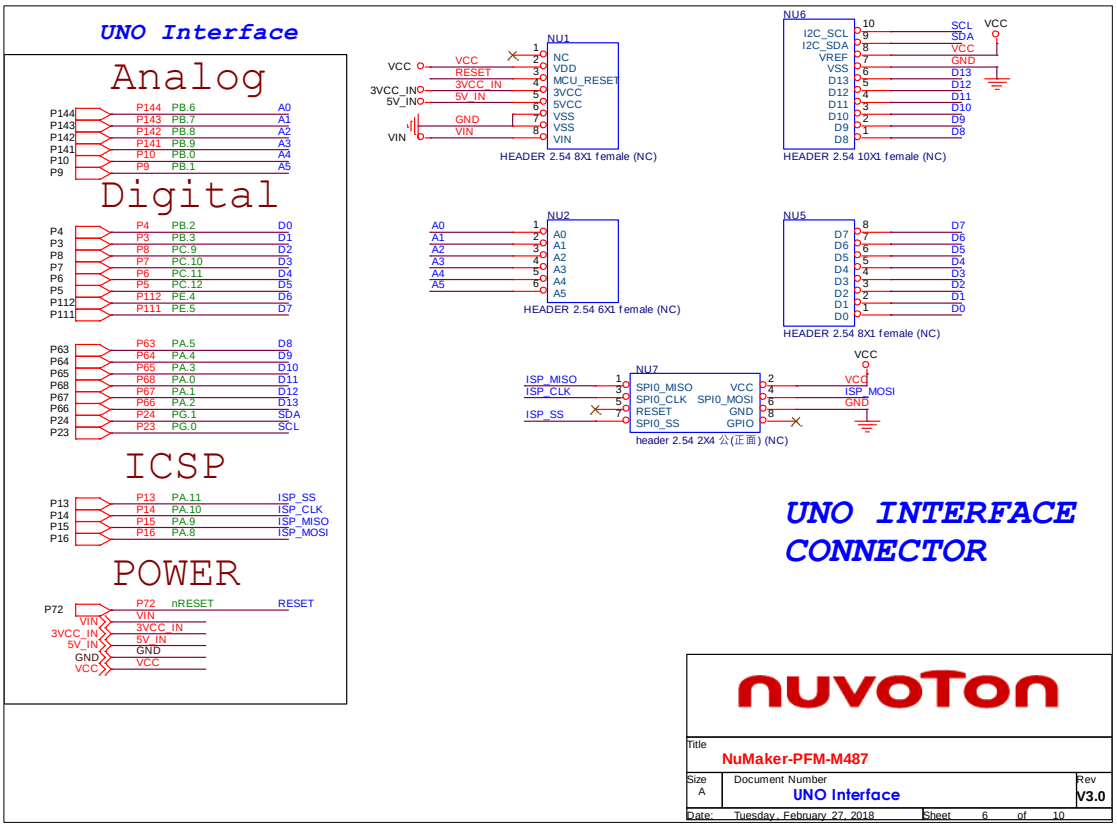

Figure 2-13 Arduino UNO Compatible Interface

2.12.5 Reset

Figure 2-14 shows the reset circuit for the M487JI8AE.

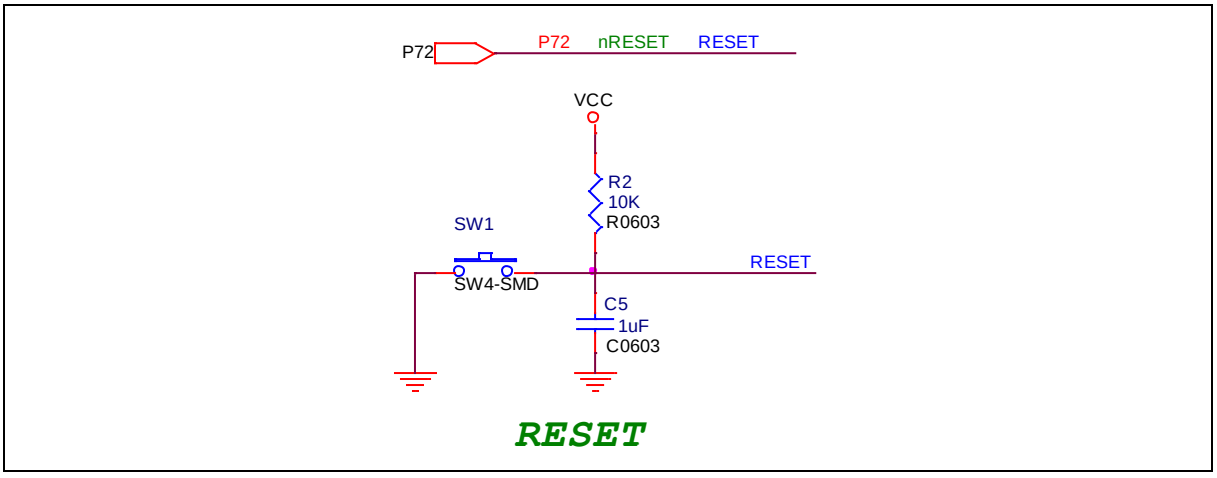

Figure 2-14 Reset Circuit

2.12.6 Crystal

Figure 2-15 shows two external crystal circuit for the M487JI8AE.

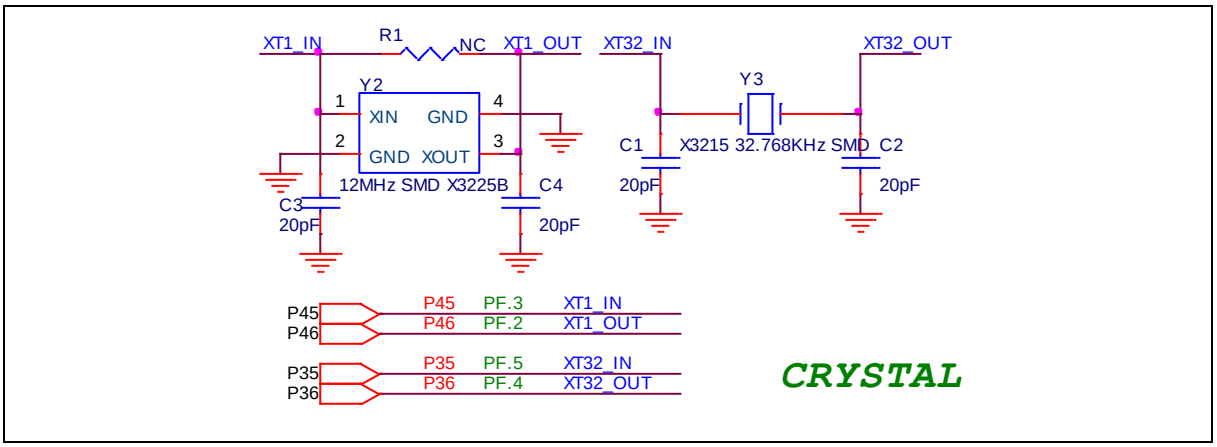

Figure 2-15 External Crystal Circuit

2.12.7 LEDs

Figure 2-16 shows the power LED and three IO LEDs that be controlled by PH.0, PH.1 and PH.2 pins of the M487JI8AE.

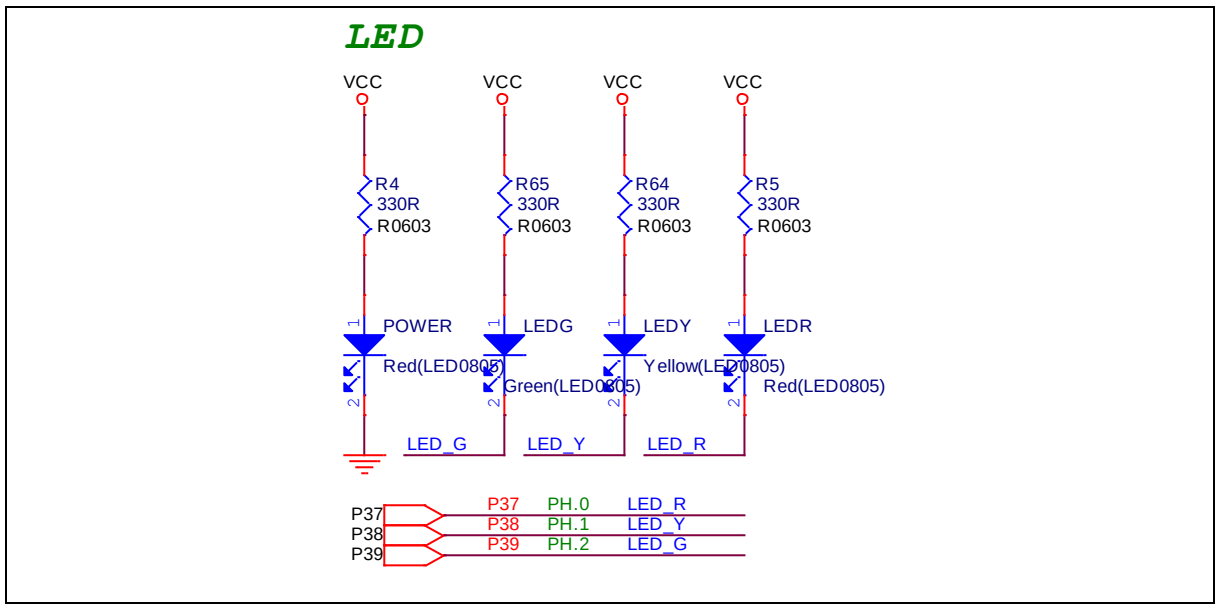

Figure 2-16 Power LED and IO LED Circuit

2.12.8 Push-Buttons

Figure 2-17 shows the push-buttons circuit on the NuMaker-PFM-M487 board.

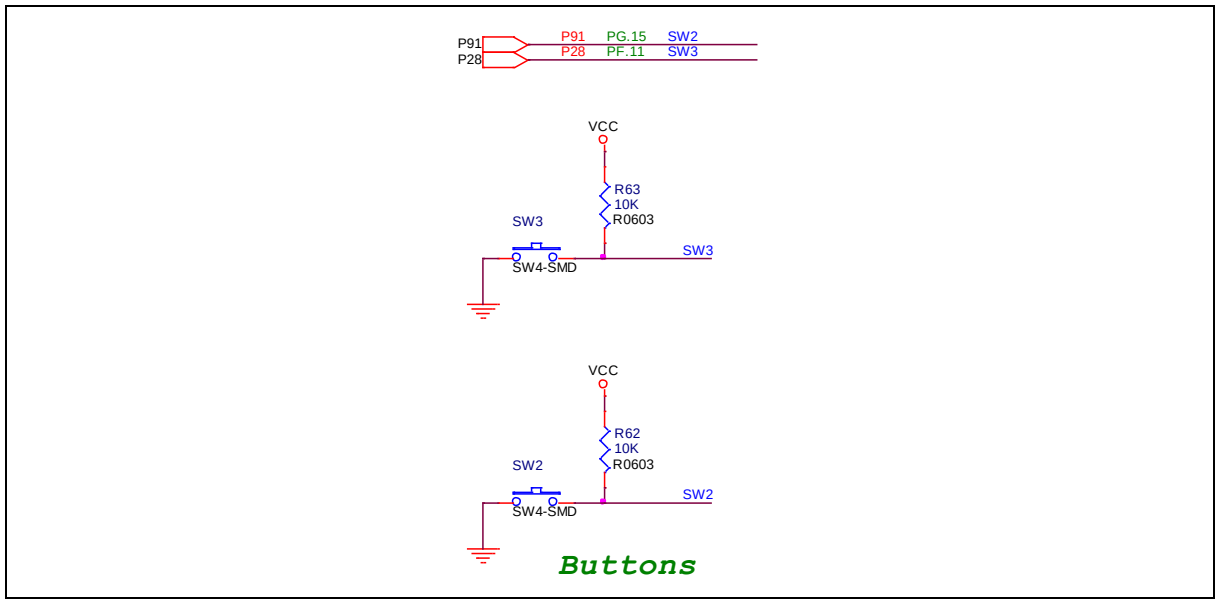

Figure 2-17 Push-Buttons Circuit

2.12.9 MicroSD Card

Figure 2-18 shows the MicroSD Card circuit on the NuMaker-PFM-M487 board.

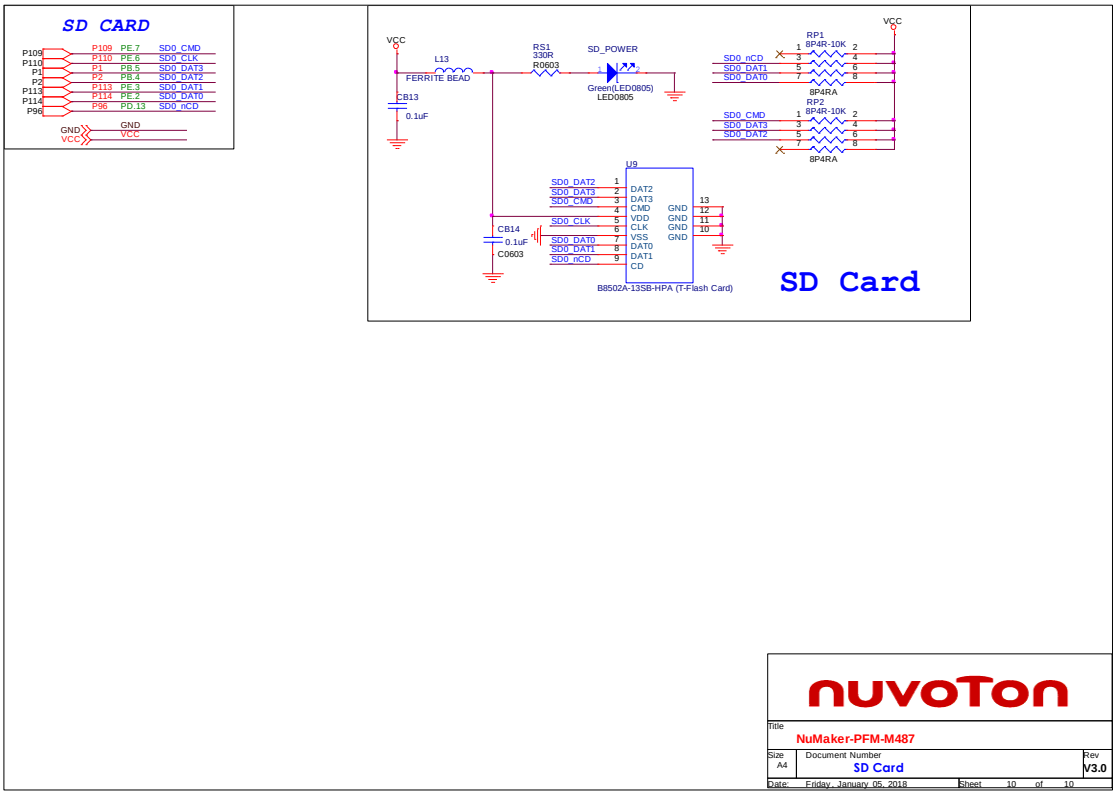

Figure 2-18 MicroSD Card Circuit

2.12.10 USB 2.0 HS OTG and USB 1.1 FS OTG

Figure 2-19 shows the USB 2.0 HS OTG and USB 1.1 FS OTG circuit on the NuMaker-PFM-M487 board.

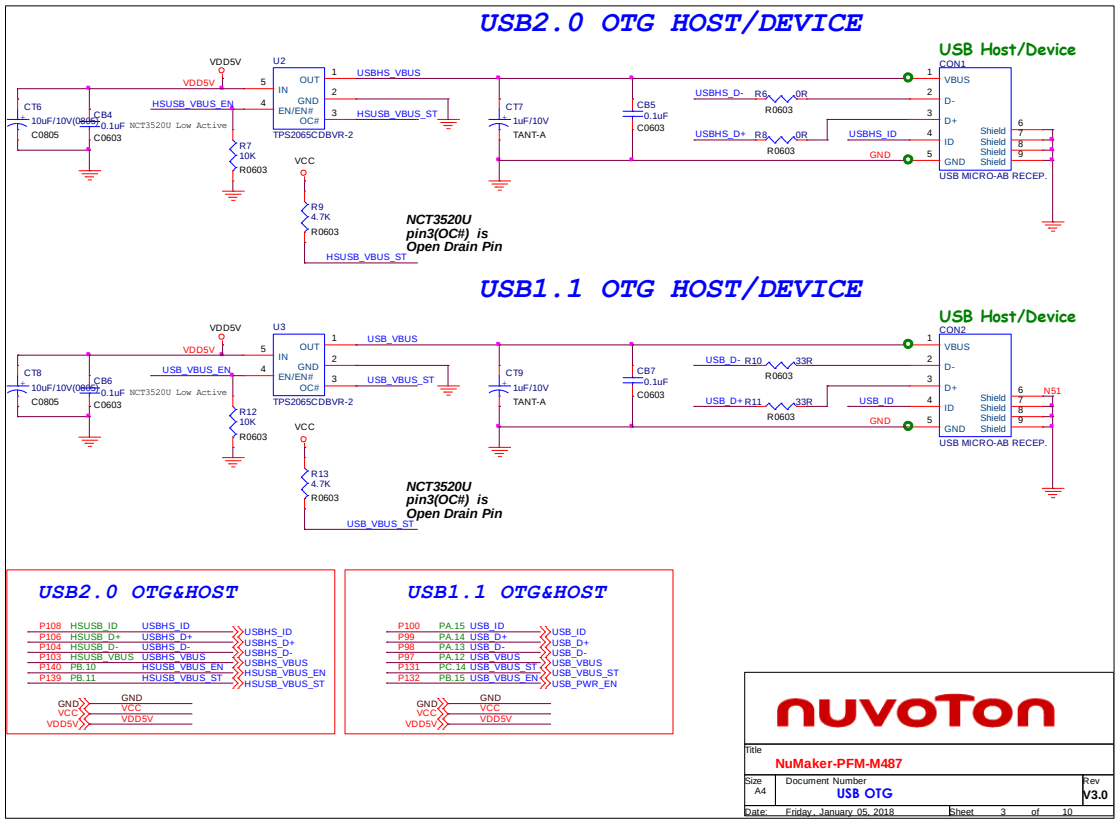

Figure 2-19 USB HS OTG and FS OTG Circuit

2.12.11 Ethernet

Figure 2-20 shows the Ethernet interface for networking application on the NuMaker-PFM-M487 board.

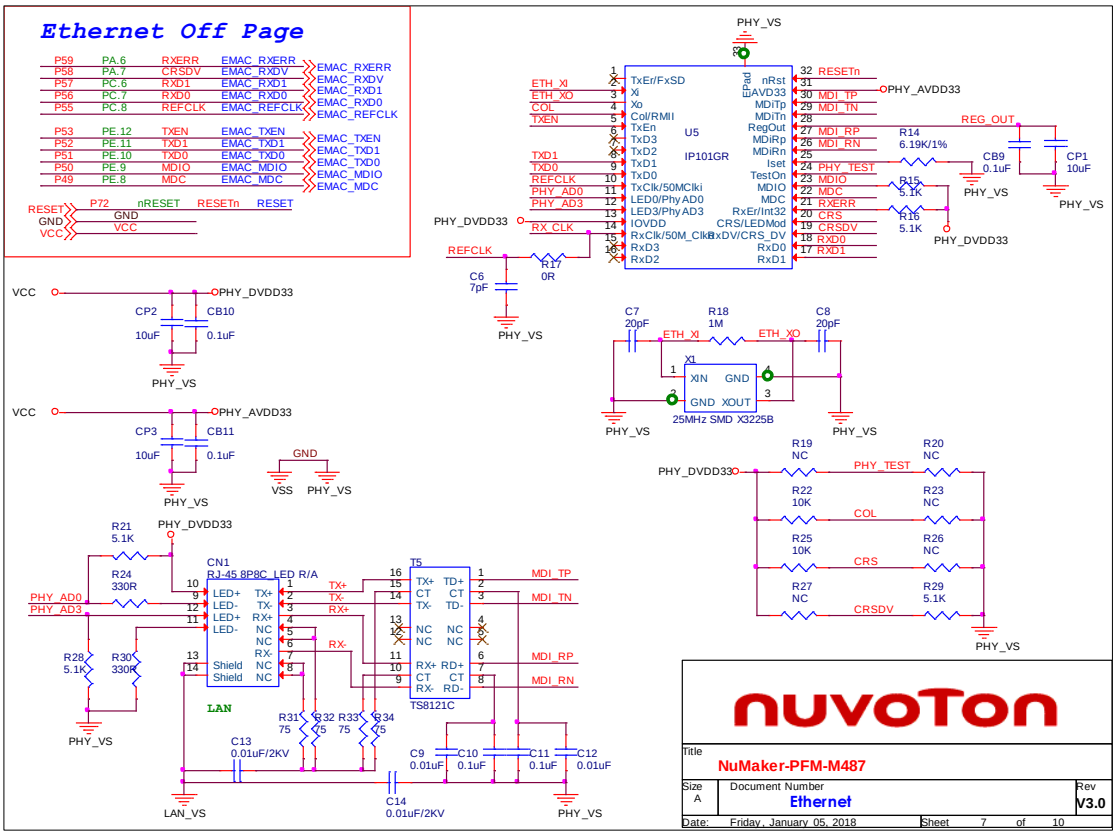

Figure 2-20 Ethernet Circuit

2.12.1224-bit Stereo Audio Codec

Figure 2-21 shows the audio codec application circuit based on NAU88L25 to simplify implementation of complete audio system solutions.

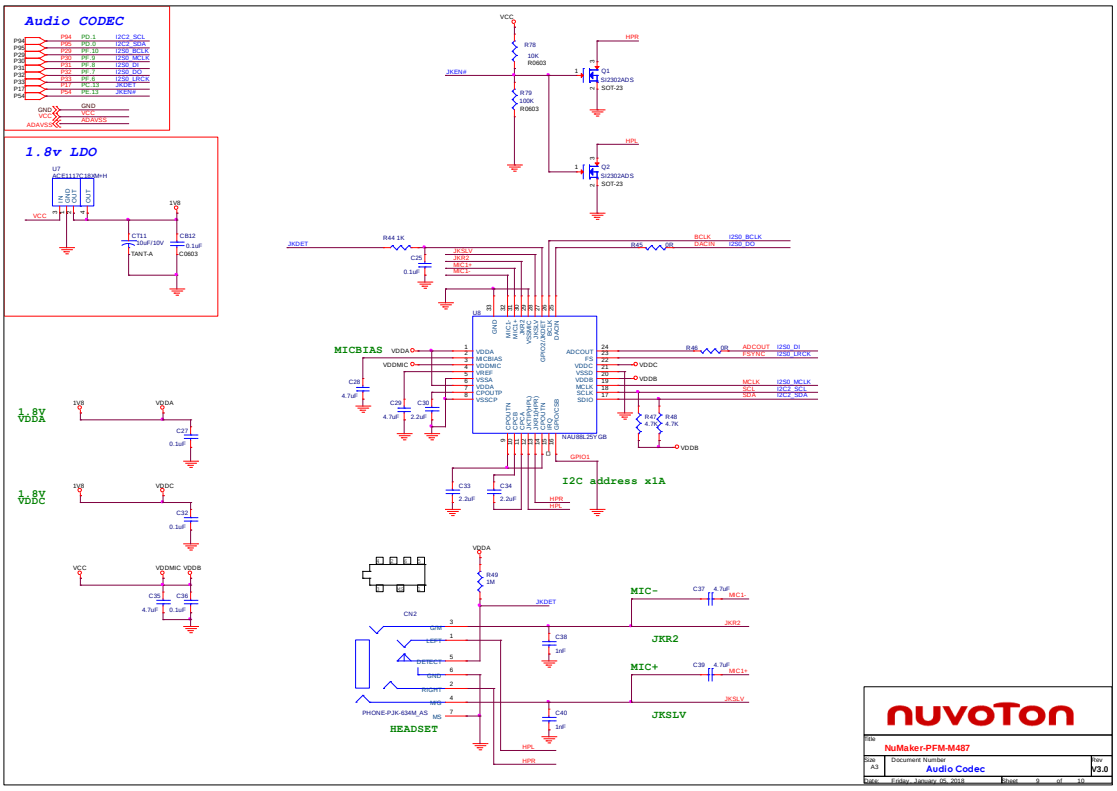

Figure 2-21 Audio Codec Circuit

2.12.13 Heartbeat Sensor and SPI Flash

Figure 2-22 shows the heartbeat sensor application circuit and the SPI flash circuit on the NuMaker-PFM-M487 board.

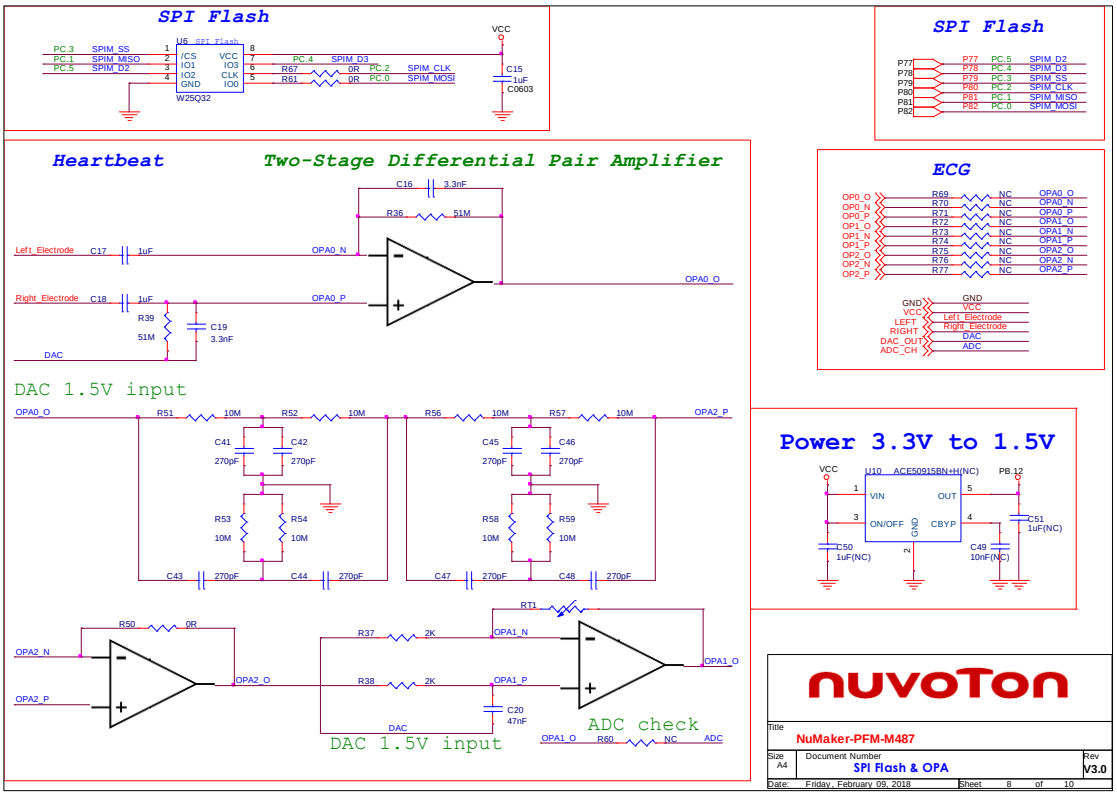

Figure 2-22 Heartbeat Sensor and SPI Flash Circuit

3 NUMAKER M487 ADVANCE BOARD

3.1 NuMaker M487 Advance Board Overview

This NuMaker M487 Advance (Ver 4.0) is a daughter board and it can't work independently by itself. It needs to be combined with the NuMaker-PFM-M487 (Ver 3.0) development board to implement some dedicated applications, for example the HMI GUI display and HMI function on TFT LCD screen with touch input, 1MB SRAM, MPU6500, I2C EEPROM, Mikro Bus, RS485 and CAN bus, etc., based on the target chip M487JIDAE microcontroller on the NuMaker-PFM-M487 main board.

Figure 3-1 shows the NuMaker M487 Advance (Ver 4.0) board.

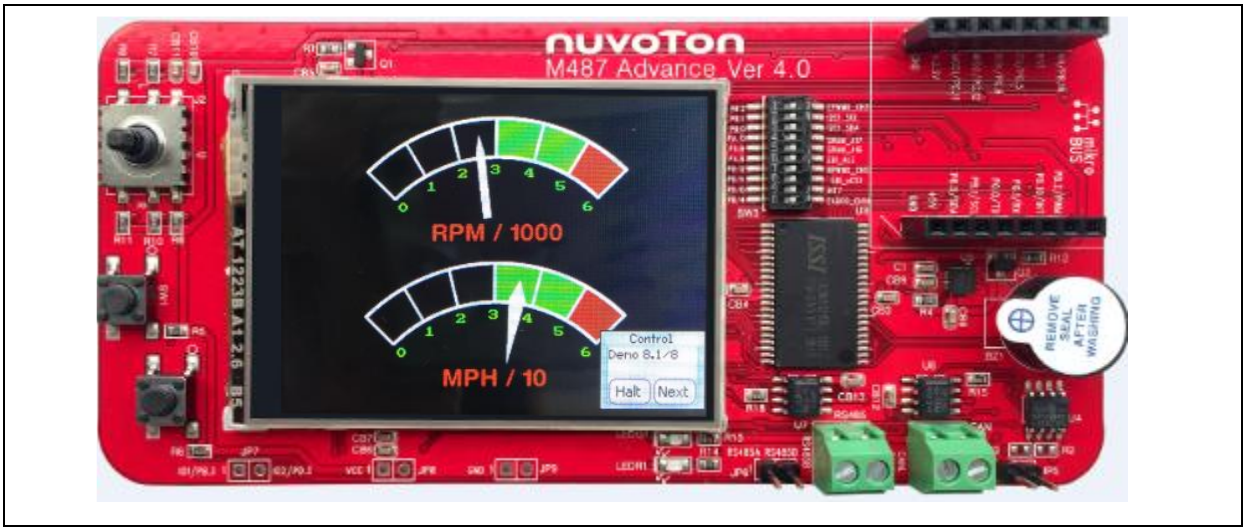

Figure 3-1 NuMaker M487 Advance Board

3.2 NuMaker M487 Advance Board Features

- QVGA (320x240 pixels) TFT LCD
- 1MB SRAM
- I²C EEPROM (24LC64)
- MEMS device (MPU6500)
- CAN Transceiver (SN65HVD230) and connector
- RS485 Transceiver (SN65HVD11DR) and connector
- Joystick
- Mikro Bus
- Buzzer
- LED
- Push-buttons

3.3 Front View

Figure 3-2 shows the main components and connectors from the front side of NuMaker M487 Advance board.

The following lists components and connectors from the front view:

- QVGA TFT LCM with Touch: LCDT24963701 (J1, driver ILI9341)
- SRAM: IS62WV51216B (U3, 1M bytes)
- I²C EEPROM: 24LC64 (U4)
- Motion Tracking Device: MPU6500 (U5)
- CAN Transceiver: SN65HVD230 (U6)
- RS485 Transceiver: SN65HVD11DR (U7)
- Joystick (J2)
- Mikro Bus (J3 and J4)
- Buzzer (BZ1)
- LEDs (LEDG1 and LEDR1)
- Push-buttons (SW1 and SW2)
- Multi-function Switches (SW3)

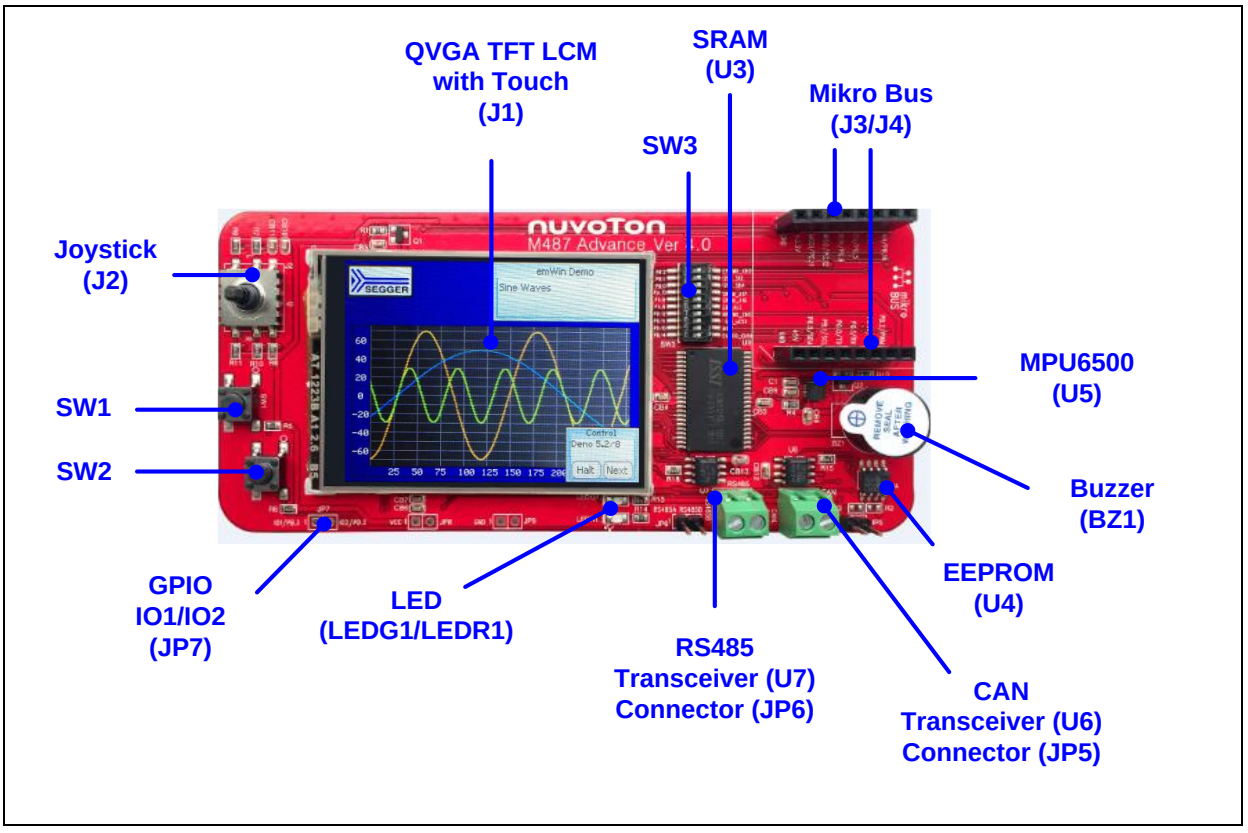

Figure 3-2 Front View of NuMaker M487 Advance Board

3.4 Rear View

Figure 3-3 shows the main components and connectors from the rear side of NuMaker M487 Advance board.

The following lists connectors from the rear view:

- Header Connectors: JP1, JP2, JP3 and JP4 for the NuMaker-PFM-M487 board
- Octal D-type Transparent Latch Device: 74HC373 (U1 and U2)

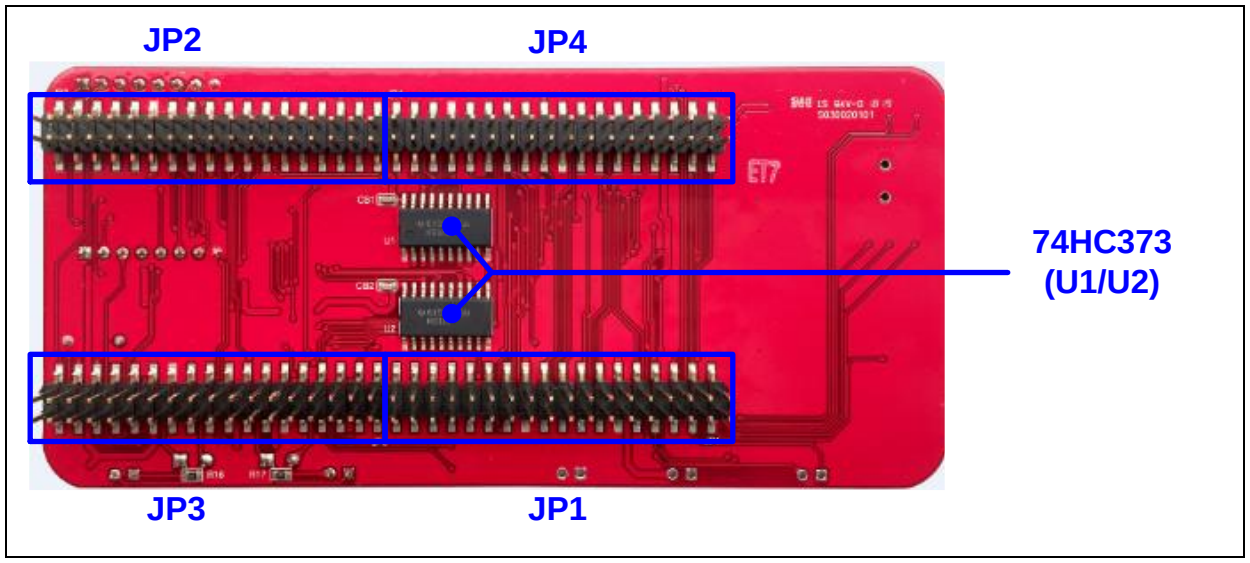

Figure 3-3 Rear View of NuMaker M487 Advance Board

3.5 The Connectors of NuMaker-PFM-M487 Board

The NuMaker-PFM-M487 board provides the M487JIDAE target chip onboard and extended connectors (JP6, JP7, JP8 and JP9) for LQFP144-pin. The Figure 3-4 shows the M487JIDAE extended connectors on the NuMaker-PFM-M487 board that should be connected to NuMaker M487 Advance board. The

Table 3-1 to

Table 3-4 shows the mapping tables on these connector headers of these two boards.

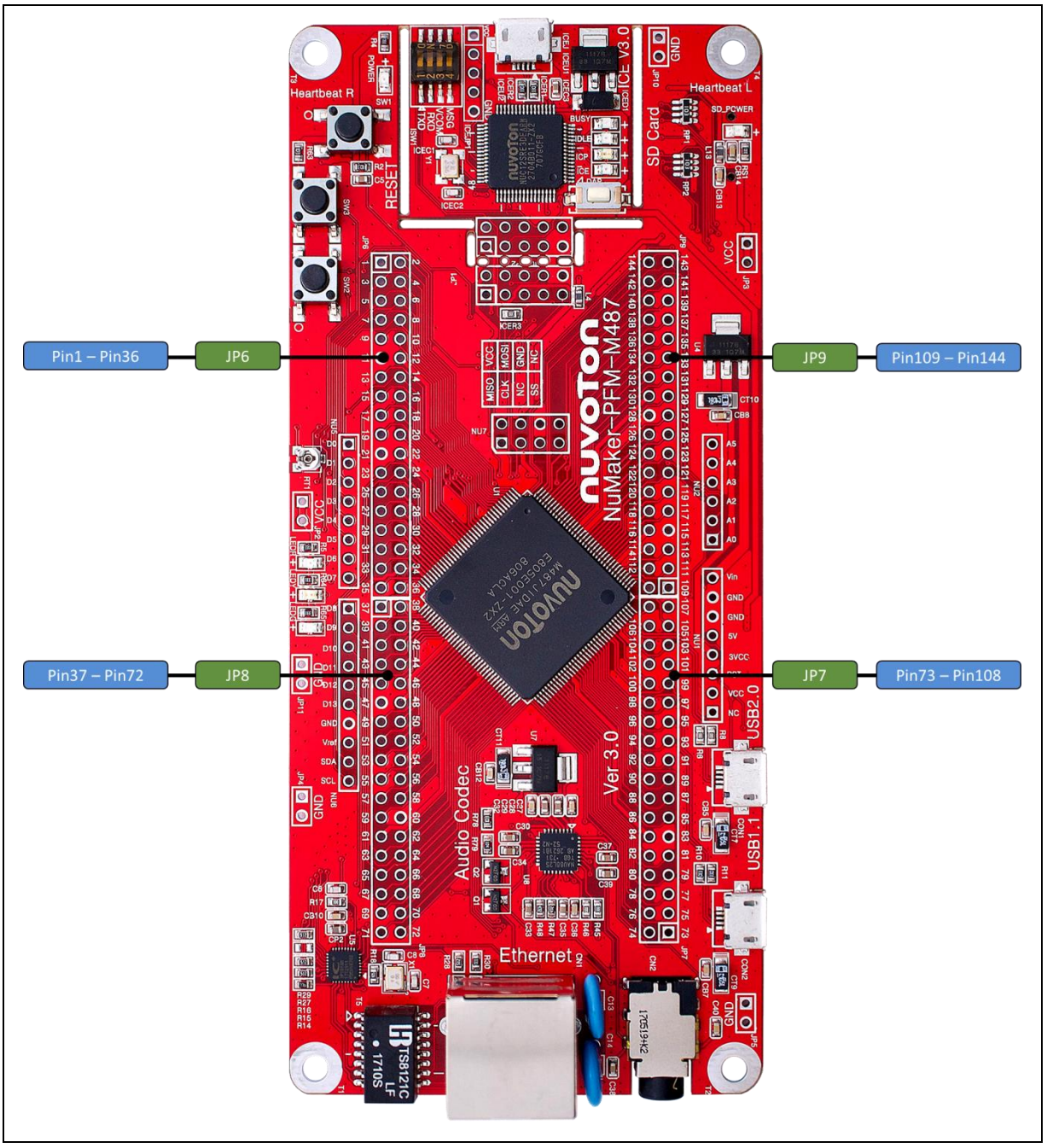

Figure 3-4 Connectors of NuMaker-PFM-M487

Table 3-1 Advance Board Connector JP1 Mapping to NuMaker-PFM-M487 Connector JP6

Header		M487 Chip	M487 PFM Board	Advance Board	Header		M487 Chip	M487 PFM Board	Advance Board
		GPIO	Function	Function			GPIO	Function	Function
JP1	JP1.1	PB.5	SD0_DAT3	-	JP1	JP1.2	PB.4	SD0_DAT2	-
	JP1.3	PB.3	-	IO1 (JP7)		JP1.4	PB.2	OPA0_O	EPWM0_CH3*1 (Mikro Bus)
	JP1.5	PC.12	-	SPI3_MISO (Mikro Bus)		JP1.6	PC.11	-	SPI3_MOSI (Mikro Bus)
	JP1.7	PC.10	-	Down (Joystick)		JP1.8	PC.9	-	Left (Joystick)
	JP1.9	PB.1	OPA0_N	I2C1_SCL*1 (Mikro Bus)		JP1.10	PB.0	OPA0_P	I2C1_SDA*1 (Mikro Bus)
	JP1.11	VSS	GND	GND		JP1.12	VDD	3VCC	3VCC
	JP1.13	PA.11	-	A18 (SRAM)		JP1.14	PA.10	OPA1_O	A17*1 (SRAM)
	JP1.15	PA.9	OPA1_N	A16*1 (SRAM)		JP1.16	PA.8	OPA1_P	EBI_ALE*1 (SRAM)
	JP1.17	PC.13	JKDET	-		JP1.18	PD.12	OPA2_O	BPWM0_CH5*1 (Buzzer)
	JP1.19	PD.11	OPA2_N	EBI_nCS1*1 (SRAM)		JP1.20	PD.10	OPA2_P	INT7*1 (Mikro Bus)
	JP1.21	VSS	GND	GND		JP1.22	VDD	3VCC	3VCC
	JP1.23	PG.0	-	UART1_TXD (Mikro Bus)		JP1.24	PG.1	-	UART1_RXD (Mikro Bus)
	JP1.25	PG.2	-	Up (Joystick)		JP1.26	PG.3	-	Center (Joystick)
	JP1.27	PG.4	-	Right (Joystick)		JP1.28	PF.11	SW3	-
	JP1.29	PF.10	I2S0_BCLK	-		JP1.30	PF.9	I2S0_MCLK	-
	JP1.31	PF.8	I2S0_DI	-		JP1.32	PF.7	I2S0_DO	-
	JP1.33	PF.6	I2S0_LRCK	-		JP1.34	VDD	3VCC	3VCC
	JP1.35	PF.5	XT32_IN	-		JP1.36	PF.4	XT32_OUT	-

Note 1: These pins share the same GPIO pins with those dedicated pin-functions on the NuMaker-PFM-M487 board. Please make sure these related resistors are open (these resistors are NC in default) on the NuMaker-PFM-M487 board and switch all “ON” for these pins on the SW3 of the NuMaker M487 Advance board to implement the application functions on this NuMaker M487 Advance board.

Table 3-2 Advance Board Connector JP3 Mapping to NuMaker-PFM-M487 Connector JP8

Header		M487 Chip	M487 PFM Board	Advance Board	Header		M487 Chip	M487 PFM Board	Advance Board
		GPIO	Function	Function			GPIO	Function	Function
JP3	JP3.1	PH.0	LEDR	UART5_TXD*2 (RS485)	JP3	JP3.2	PH.1	LEDY	UART5_RXD*2 (RS485)
	JP3.3	PH.2	LEDG	UART5_nRTS*2 (RS485)		JP3.4	PH.3	-	LCD_RS (LCD)
	JP3.5	PH.4	-	LCD_XL (LCD)		JP3.6	PH.5	-	LCD_YD (LCD)
	JP3.7	PH.6	-	LED2 (LEDR1)		JP3.8	PH.7	-	LED1 (LEDG1)
	JP3.9	PF.3	XT1_IN	-		JP3.10	PF.2	XT1_OUT	-
	JP3.11	VSS	GND	GND		JP3.12	VDD	3VCC	3VCC
	JP3.13	PE.8	EMAC_MDC	-		JP3.14	PE.9	EMAC_MDIO	-
	JP3.15	PE.10	EMAC_TXD0	-		JP3.16	PE.11	EMAC_TXD1	-
	JP3.17	PE.12	EMAC_TXEN	-		JP3.18	PE.13	#JKEN	-
	JP3.19	PC.8	EMAC_REFCLK	-		JP3.20	PC.7	EMAC_RXD0	-
	JP3.21	PC.6	EMCAC_RXD1	-		JP3.22	PA.7	EMAC_RXDV	-
	JP3.23	PA.6	EMAC_RXERR	-		JP3.24	VSS	GND	GND
	JP3.25	VDD	3VCC	3VCC		JP3.26	LDO	LDO_CAP	-
	JP3.27	PA.5	-	CAN0_TXD (CAN)		JP3.28	PA.4	-	CAN0_RXD (CAN)
	JP3.29	PA.3	-	C2 (CAN)		JP3.30	PA.2	-	C1 (CAN)
	JP3.31	PA.1	-	SW2 (Key button)		JP3.32	PA.0	-	SW1 (Key button)
	JP3.33	VDDIO	VDDIO	-		JP3.34	PE.14	-	EBI_AD8 (LCD/SRAM)
	JP3.35	PE.15	-	EBI_AD9 (LCD/SRAM)		JP3.36	nRESET	nRESET	RST (Mikro Bus)

Note 2: These LEDs (LEDR, LEDY and LEDG) of NuMaker-PFM-M487 board share the same pins (PH.0, PH.1 and PH.2) with these RS485 signals (UART5_TXD, UART5_RXD and UART5_nRTS) of NuMaker M487 Advance board. When RS485 function is running on NuMaker M487 Advance board, user can ignore the status of these LEDs on NuMaker-PFM-M487 board.

Table 3-3 Advance Board Connector JP2 Mapping to NuMaker-PFM-M487 Connector JP7

Header		M487 Chip	M487 PFM Board	Advance Board	Header		M487 Chip	M487 PFM Board	Advance Board
		GPIO	Function	Function			GPIO	Function	Function
JP2	JP2.1	PF.0	ICEDAT	-	JP2	JP2.2	PF.1	ICECLK	-
	JP2.3	PD.9	-	EBI_AD7 (LCD/SRAM)		JP2.4	PD.8	-	EBI_AD6 (LCD/SRAM)
	JP2.5	PC.5	SPIM_D2	-		JP2.6	PC.4	SPIM_D3	-
	JP2.7	PC.3	SPIM_SS	-		JP2.8	PC.2	SPIM_CLK	-
	JP2.9	PC.1	SPIM_MISO	-		JP2.10	PC.0	SPIM_MOSI	-
	JP2.11	VSS	GND	GND		JP2.12	VDD	3VCC	3VCC
	JP2.13	PG.9	-	EBI_AD0 (LCD/SRAM)		JP2.14	PG.10	-	EBI_AD1 (LCD/SRAM)
	JP2.15	PG.11	-	EBI_AD2 (LCD/SRAM)		JP2.16	PG.12	-	EBI_AD3 (LCD/SRAM)
	JP2.17	PG.13	-	EBI_AD4 (LCD/SRAM)		JP2.18	PG.14	-	EBI_AD5 (LCD/SRAM)
	JP2.19	PG.15	SW2	-		JP2.20	PD.3	-	IO2 (JP7)
	JP2.21	PD.2	-	INT (MPU6500)		JP2.22	PD.1	I2C2_SCL	I2C2_SCL (MPU6500/ EEPROM)
	JP2.23	PD.0	I2C2_SDA	I2C2_SDA (MPU6500/ EEPROM)		JP2.24	PD.12	SD0_nCD	
	JP2.25	PA.12	USB_VBUS	5V_IN (Mikro Bus)		JP2.26	PA.13	USB_D-	-
	JP2.27	PA.14	USB_D+	-		JP2.28	PA.15	USB_OTG_ID	-
	JP2.29	HSUSB_VRES	HSUSB_VRES	-		JP2.30	HSUSB_VDD33	HSUSB_VDD33	-
	JP2.31	HSUSB_VBUS	HSUSB_VBUS	5V_IN (Mikro Bus)		JP2.32	HSUSB_D-	HSUSB_D-	-
	JP2.33	HSUSB_VSS	HSUSB_VSS	-		JP2.34	HSUSB_D+	HSUSB_D+	-
	JP2.35	HSUSB_VDD12_CAP	HSUSB_VDD12_CAP	-		JP2.36	HSUSB_ID	HSUSB_ID	-

Table 3-4 Advance Board Connector JP4 Mapping to NuMaker-PFM-M487 Connector JP9

Header		M487 Chip	M487 PFM Board	Advance Board	Header		M487 Chip	M487 PFM Board	Advance Board
		GPIO	Function	Function			GPIO	Function	Function
JP4	JP4.1	PE.7	SD0_CMD	-	JP4	JP4.2	PE.6	SD0_CLK	-
	JP4.3	PE.5	-	EBI_nRD (LCD/SRAM)		JP4.4	PE.4	-	EBI_nWR (LCD/SRAM)
	JP4.5	PE.3	SD0_DAT1	-		JP4.6	PE.2	SD0_DAT0	-
	JP4.7	VSS	GND	GND		JP4.8	VDD	3VCC	3VCC
	JP4.9	PE.1	-	EBI_AD10 (LCD/SRAM)		JP4.10	PE.0	-	EBI_AD11 (LCD/SRAM)
	JP4.11	PH.8	-	EBI_AD12 (LCD/SRAM)		JP4.12	PH.9	-	EBI_AD13 (LCD/SRAM)
	JP4.13	PH.10	-	EBI_AD14 (LCD/SRAM)		JP4.14	PH.11	-	EBI_AD15 (LCD/SRAM)
	JP4.15	PD.14	-	EBI_nCS0 (LCD)		JP4.16	PG.5	-	SPI3_SS (Mikro Bus)
	JP4.17	PG.6	-	SPI3_CLK (Mikro Bus)		JP4.18	PG.7	-	EBI_nWRL (SRAM)
	JP4.19	PG.8	-	EBI_nWRH (SRAM)		JP4.20	VSS	GND	GND
	JP4.21	LDO	LDO_CAP	-		JP4.22	VDD	3VCC	3VCC
	JP4.23	PC.14	USB_VBUS_ST	-		JP4.24	PB.15	USB_VBUS_EN	-
	JP4.25	PB.14	EADC0_CH14	EADC0_CH14[*3] (Mikro Bus)		JP4.26	PB.13	UART0_TXD	-
	JP4.27	PB.12	UART0_RXD	-		JP4.28	AVDD	AVDD	AVDD
	JP4.29	VREF	VREF	-		JP4.30	AVSS	ADAVSS	AVSS
	JP4.31	PB.11	HSUSB_VBUS_ST	-		JP4.32	PB.10	HSUSB_VBUS_EN	-
	JP4.33	PB.9	-	LCD_XR (LCD)		JP4.34	PB.8	-	LCD_YU (LCD)
	JP4.35	PB.7	-	LCD_BL (LCD)		JP4.36	PB.6	-	LCD_RESET (LCD)

Note 3: This pin shares the same GPIO pin with the dedicated pin-function on the NuMaker-PFM-M487 board. Please make sure this related resistor is open (the resistor is NC in default) on the NuMaker-PFM-M487 board and switch “ON” for this pin on the SW3 of the NuMaker M487 Advance board to implement the application function on this NuMaker M487 Advance board.

Table 3-5 Function Options of SW3 on M487 Advance Board

SW3 Pin No.	M487 Chip	M487 PFM Board	Advance Board	Comment
1	PB.2	OPA0_O	EPWM0_CH3	1. Heartbeat function: To short R69 (the default is open) on NuMaker-PFM-M487 Ver. 3.0 main board and switch this switch to OFF (the default is ON). 2. Mikro Bus function: To keep R69 open and this switch ON.
2	PB.1	OPA0_N	I2C1_SCL	1. Heartbeat function: To short R70 (the default is open) on NuMaker-PFM-M487 Ver. 3.0 main board and switch this switch to OFF (the default is ON). 2. Mikro Bus function: To keep R70 open and this switch ON.
3	PB.0	OPA0_P	I2C1_SDA	1. Heartbeat function: To short R71 (the default is open) on NuMaker-PFM-M487 Ver. 3.0 main board and switch this switch to OFF (the default is ON). 2. Mikro Bus function: To keep R71 open and this switch ON.
4	PA.10	OPA1_O	A17 of SRAM	1. Heartbeat function: To short R72 (the default is open) on NuMaker-PFM-M487 Ver. 3.0 main board and switch this switch to OFF (the default is ON). 2. SRAM function: To keep R72 open and this switch ON.
5	PA.9	OPA1_N	A16 of SRAM	1. Heartbeat function: To short R73 (the default is open) on NuMaker-PFM-M487 Ver. 3.0 main board and switch this switch to OFF (the default is ON). 2. SRAM function: To keep R73 open and this switch ON.
6	PA.8	OPA1_P	EBI_ALE	1. Heartbeat function: To short R74 (the default is open) on NuMaker-PFM-M487 Ver. 3.0 main board and switch this switch to OFF (the default is ON). 2. SRAM function: To keep R74 open and this switch ON.
7	PD.12	OPA2_O	BPWM0_CH5	1. Heartbeat function: To short R75 (the default is open) on NuMaker-PFM-M487 Ver. 3.0 main board and switch this switch to OFF (the default is ON). 2. Buzzer function: To keep R75 open and this switch ON.
9	PD.11	OPA2_N	EBI_nCS1	1. Heartbeat function: To short R76 (the default is open) on NuMaker-PFM-M487 Ver. 3.0 main board and switch this switch to OFF (the default is ON). 2. SRAM function: To keep R76 open and this switch ON.
9	PD.10	OPA2_P	INT7	1. Heartbeat function: To short R77 (the default is open) on NuMaker-PFM-M487 Ver. 3.0 main board and switch this switch to OFF (the default is ON). 2. Mikro Bus function: To keep R77 open and this switch ON.
10	PB.14	EADC0_CH14	EADC0_CH14	1. Heartbeat function: To short R60 (the default is open) on NuMaker-PFM-M487 Ver. 3.0 main board and switch this switch to OFF (the default is ON). 2. Mikro Bus function: To keep R60 open and this switch ON.

3.6 PCB Placement

Figure 3-5 and Figure 3-6 show the front and rear placement of NuMaker M487 Advance board.

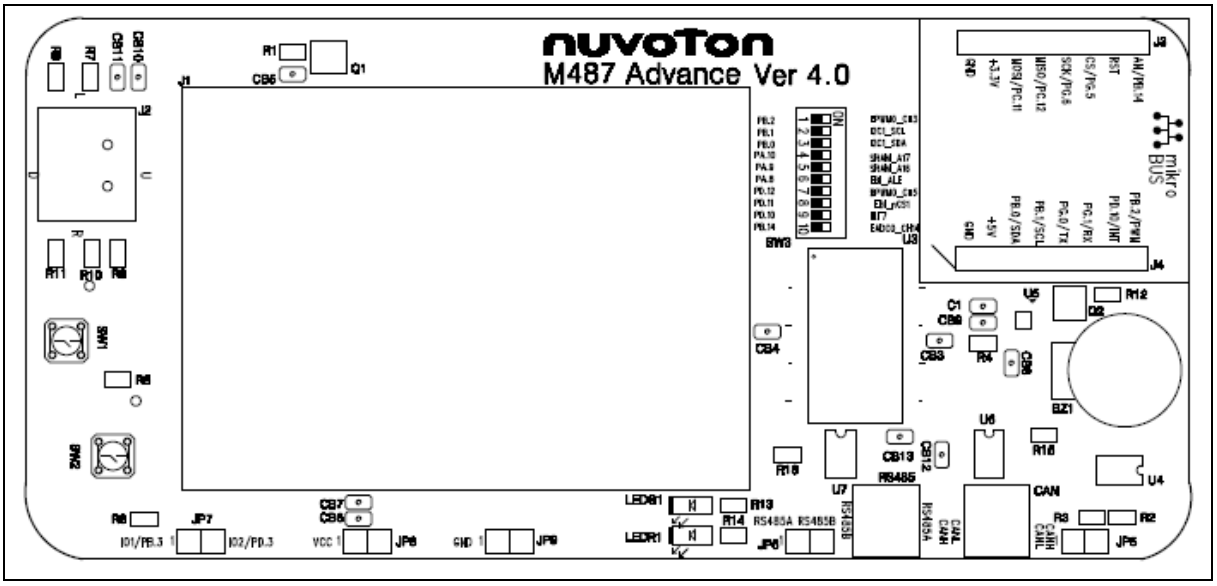

Figure 3-5 Front Placement

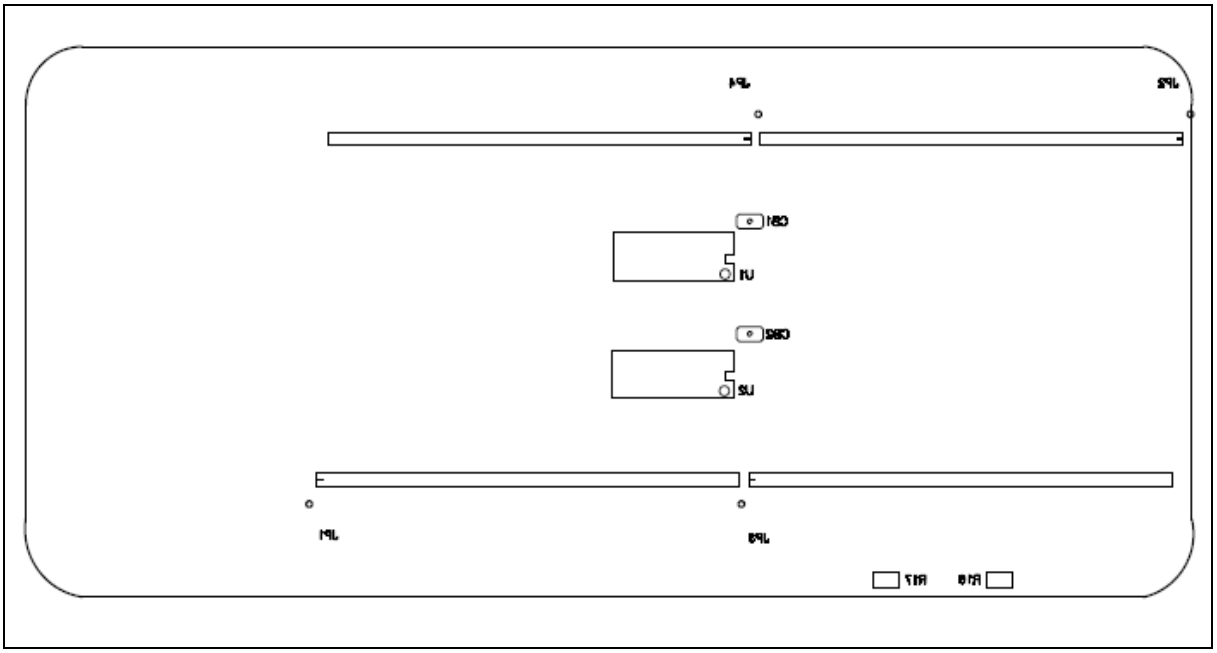

Figure 3-6 Rear Placement

3.7 NuMaker M487 Advance Schematics

3.7.1 Header Connectors

Figure 3-7 shows the all the header connecters JP1~JP4 that should be connected to the header connectors JP6~JP9 of NuMaker-PFM-M487 board. For the SW3 switches, there are ten pins share the same GPIO pins with those dedicated pin-functions on the NuMaker-PFM-M487 board. Please make sure these related resistors are open (these resistors are NC in default) on the NuMaker-PFM-M487 board (Ver 3.0) and switch all “ON” for these pins on this SW3 to implement the application functions on the NuMaker M487 Advance board.

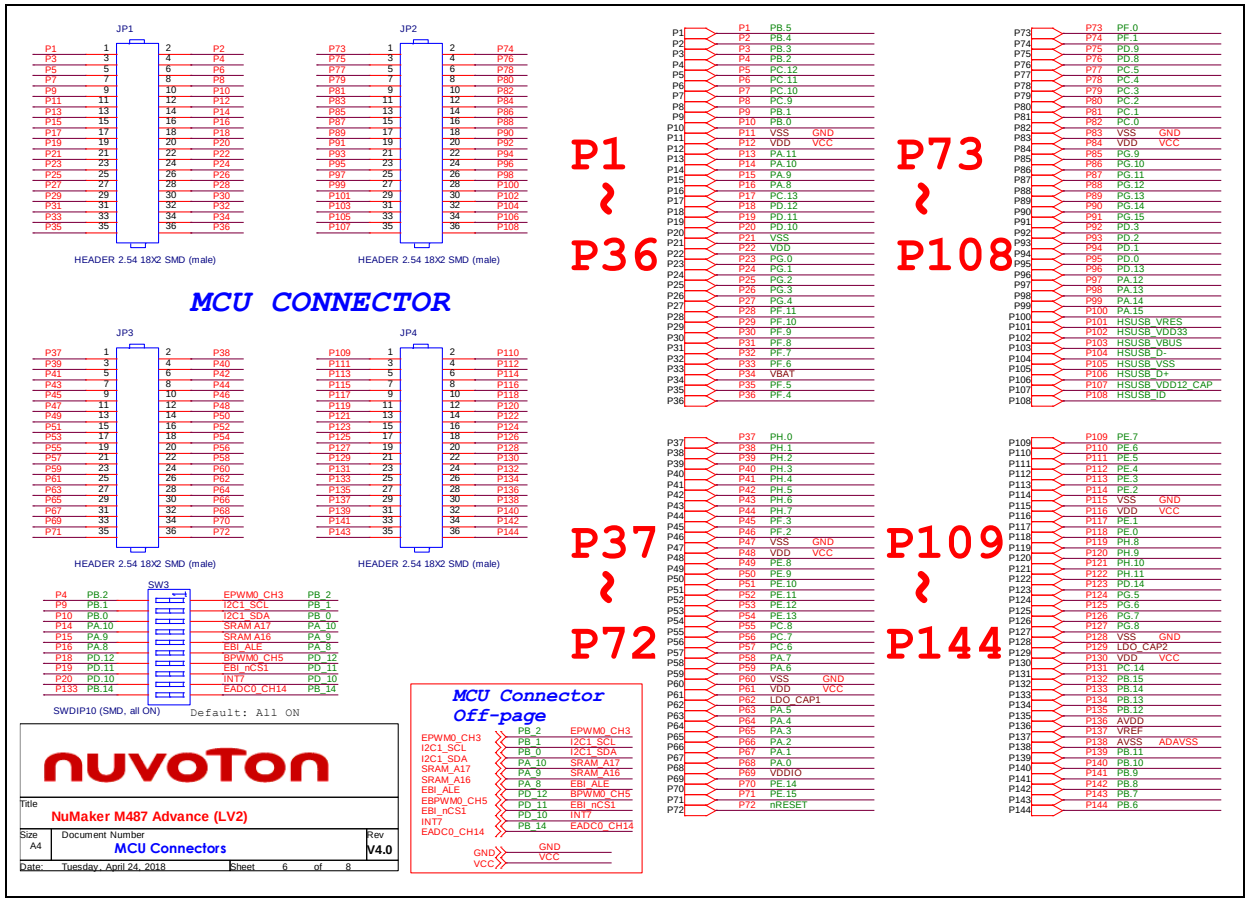

Figure 3-7 Header Connectors

3.7.2 QVGA TFT LCD Module with Touch

Figure 3-8 shows the QVGA TFT LCD module with touch circuit and the related EBI interface and GPIO control pins.

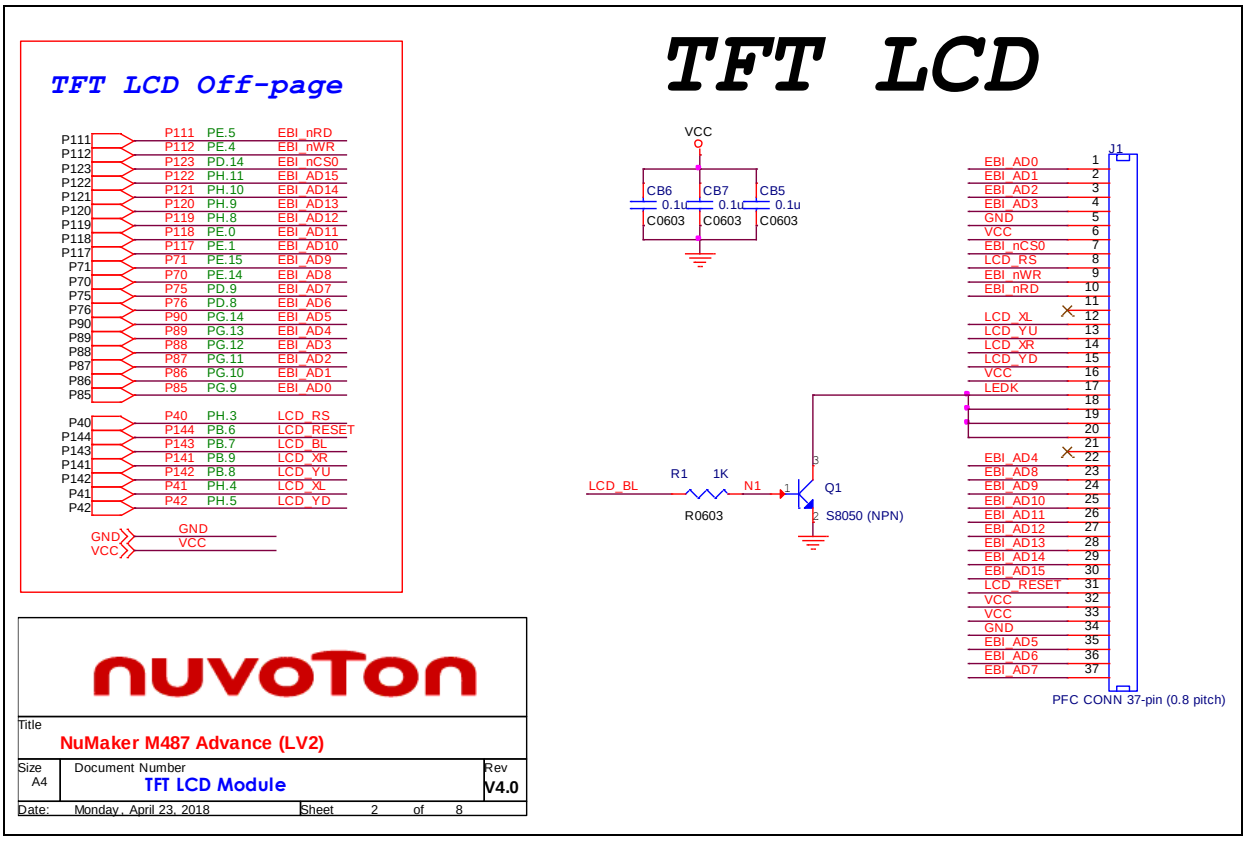

Figure 3-8 QVGA TFT LCD Module with Touch Circuit

3.7.3 SRAM (IS62WV51216B)

Figure 3-9 shows the SRAM (IS62WV51216B) circuit that can be accessed by M487 MCU through the EBI bus. But, the MSB address pins A16/A17/A18 to the SRAM are controlled by the GPIO (PA.9, PA.10 and PA.11) through the firmware controlled. These pins are not drove by the EBI bus directly.

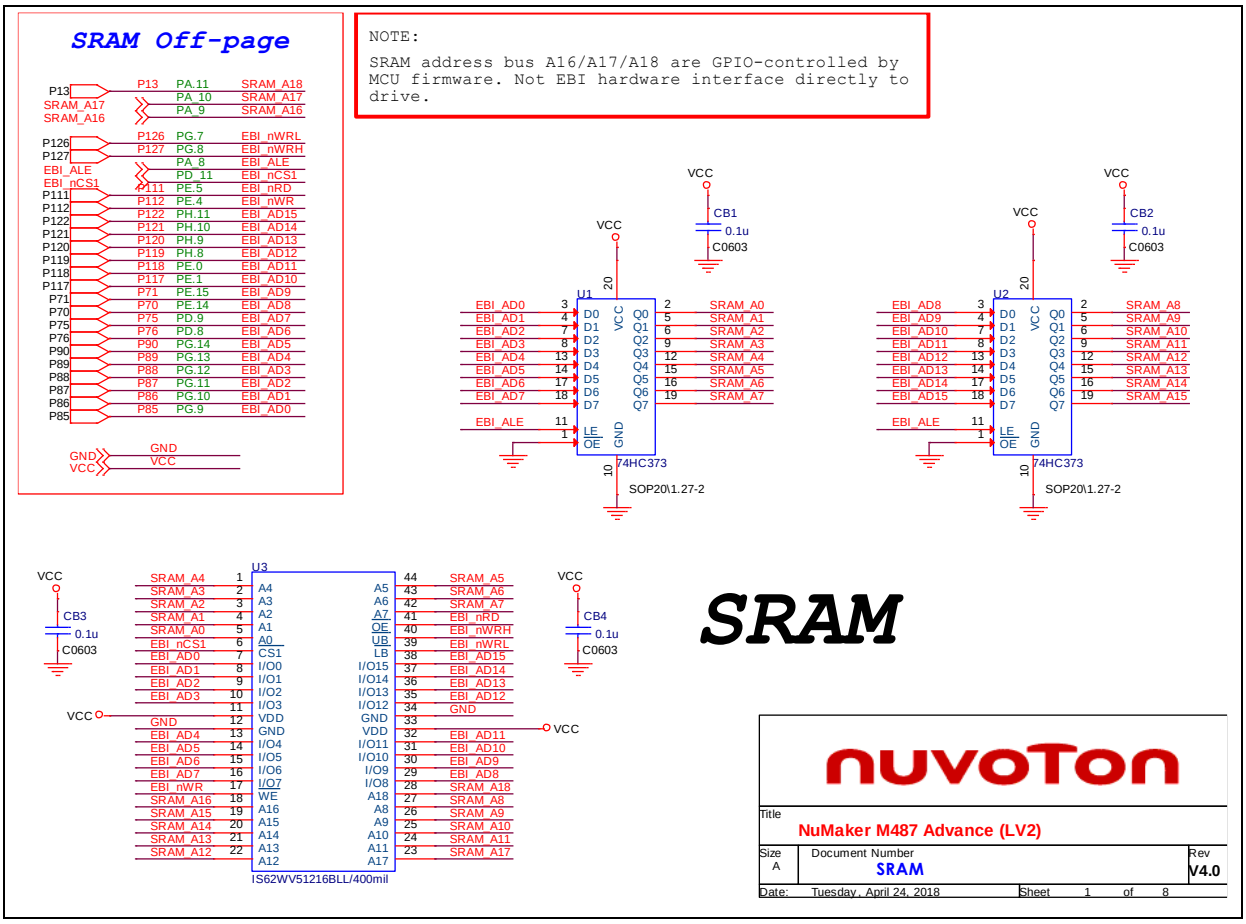

Figure 3-9 SRAM Circuit

3.7.4 I²C EEPROM (24LC64)

Figure 3-10 shows the I²C EEPROM (24LC64) circuit.

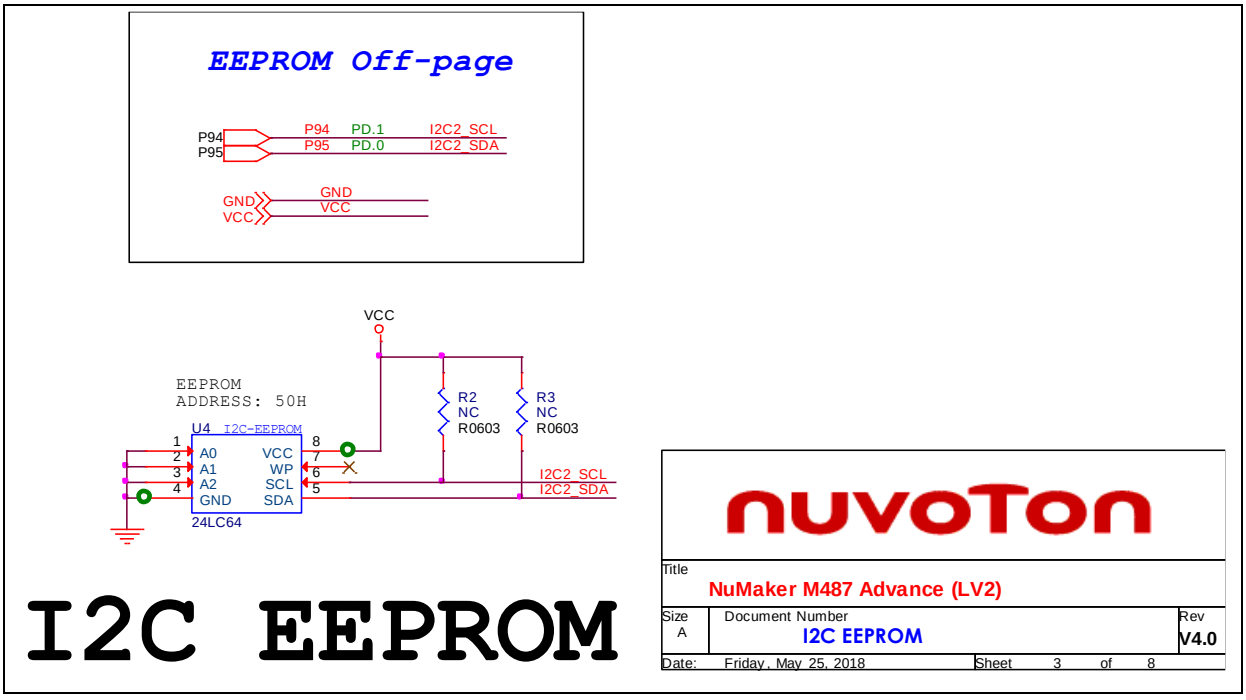

Figure 3-10 I²C EEPROM Circuit

3.7.5 I²C MEMS (MPU6500)

Figure 3-11 shows the I²C MEMS (MPU6500) circuit.

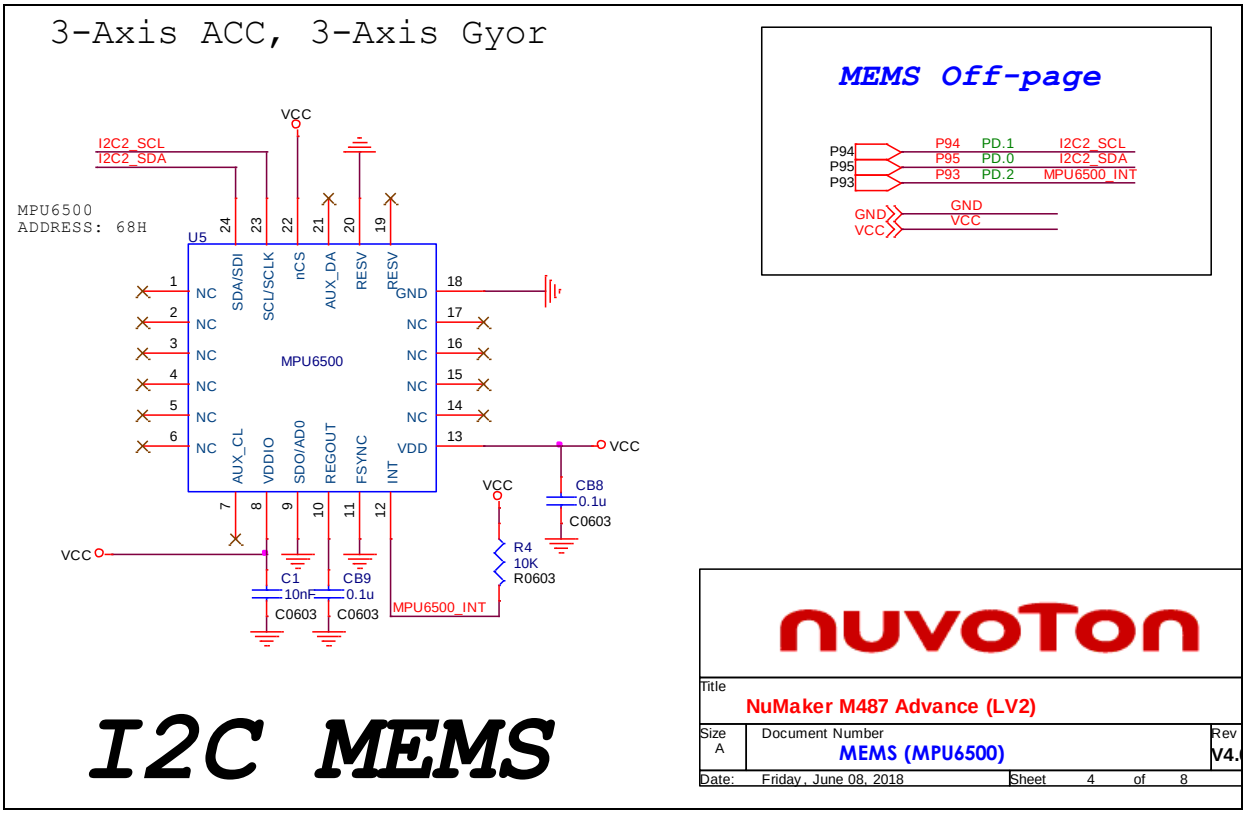

Figure 3-11 I²C MEMS Circuit

3.7.6 Joystick, Key Buttons, Buzzer, IO and LED

Figure 3-12 shows the joystick, key buttons, buzzer, IO and LED circuit.

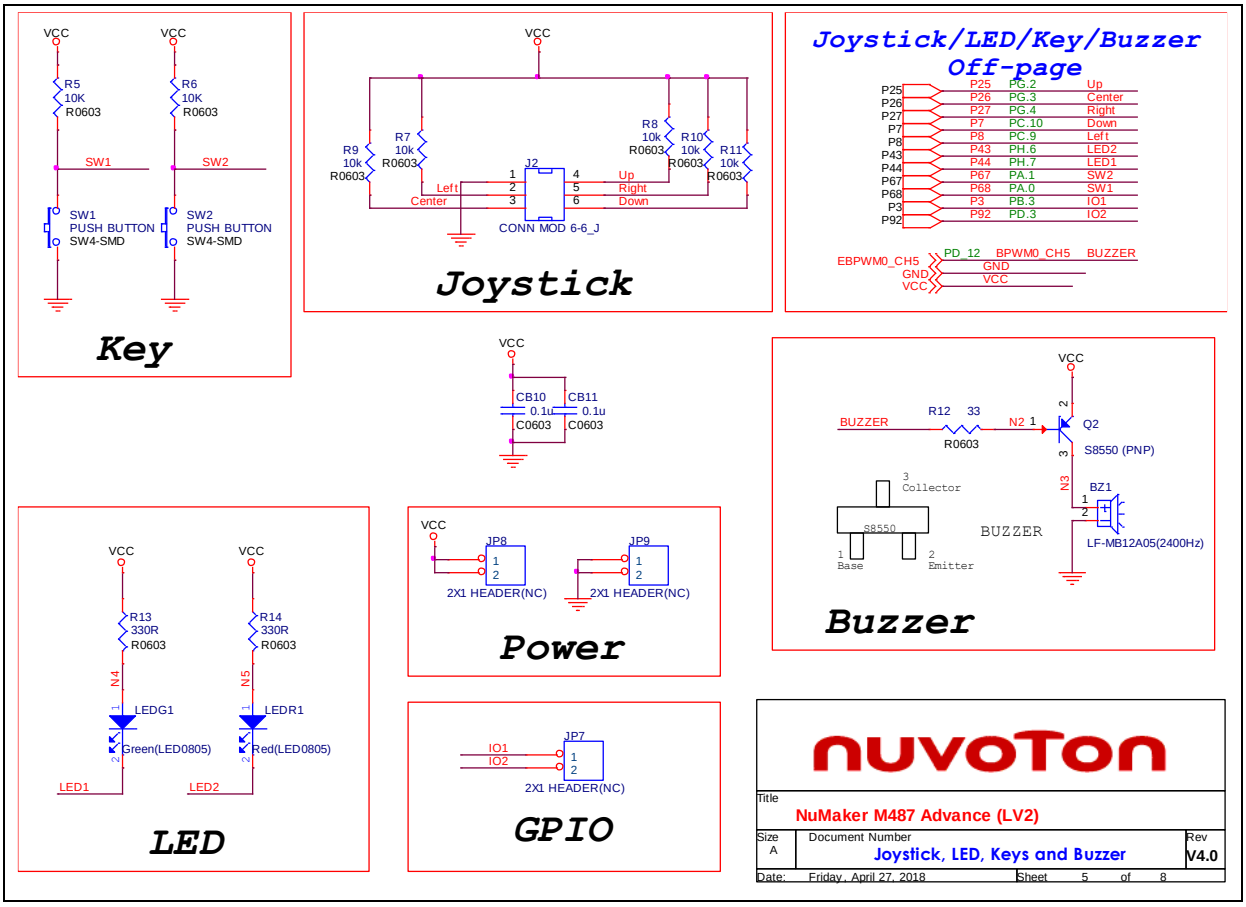

Figure 3-12 Joystick, Key Buttons, Buzzer, IO and LED Circuit

3.7.7 Mikro Bus

Figure 3-13 shows the Mikro Bus circuit.

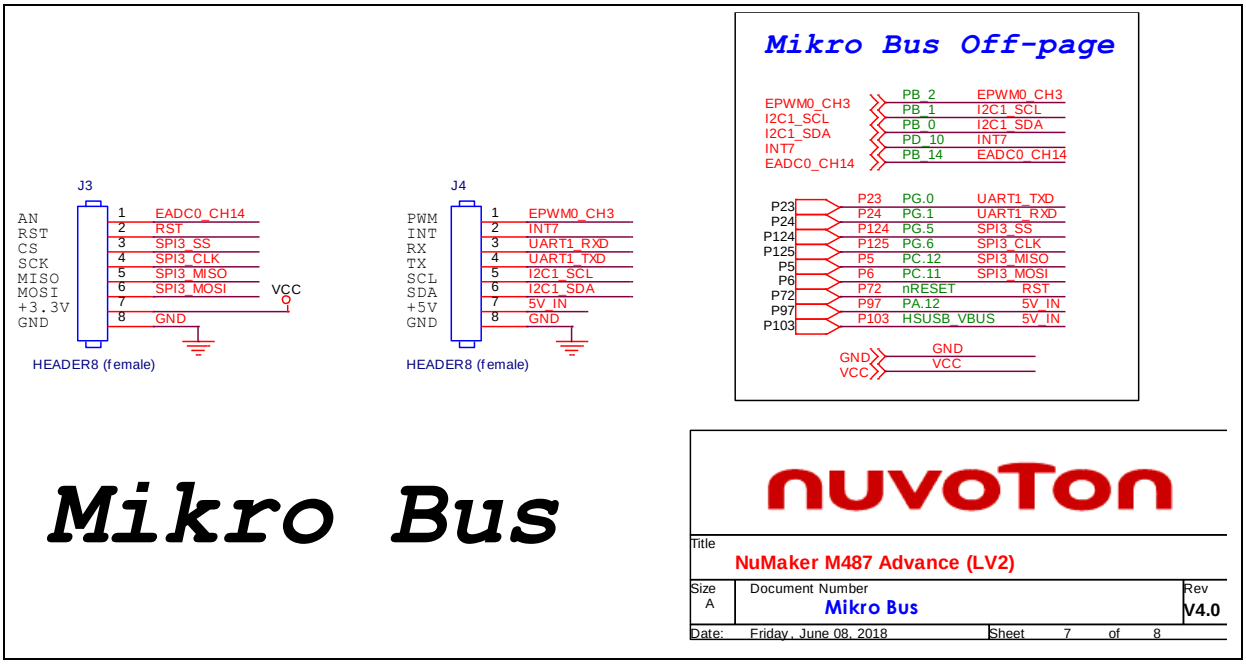

Figure 3-13 Mikro Bus Circuit

3.7.8 CAN and RS485

Figure 3-14 shows CAN and RS485 circuit.

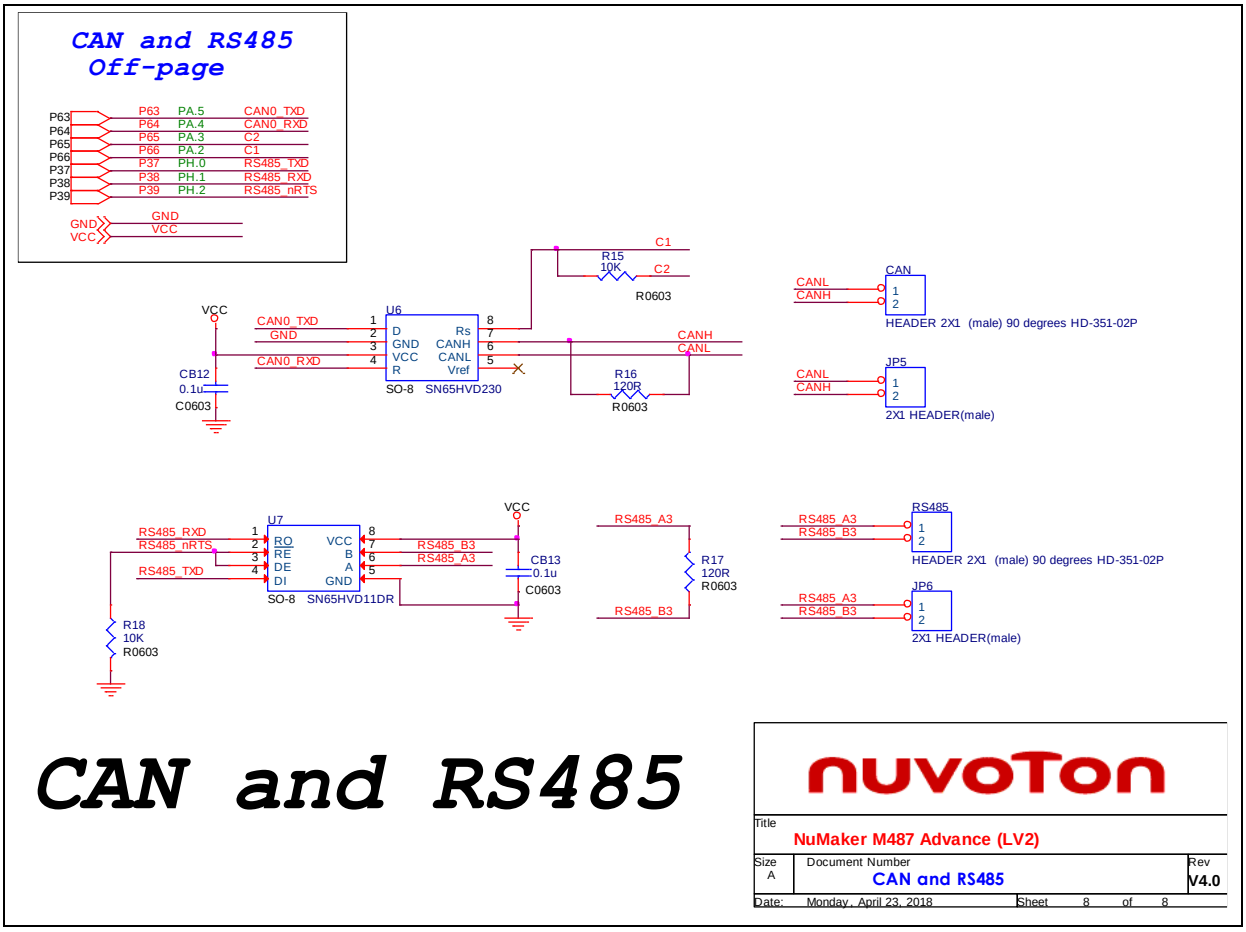

Figure 3-14 CAN and RS485 Circuit

4 REVISION HISTORY

Date	Revision	Description
2022.03.18	1.00	1. Initially issued.

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