1T 8051

8-bit Microcontroller

NuMaker-ML56SD
User Manual
NuMicro® 8051 Series

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1 OVERVIEW

The NuMaker-ML56SD is a development board for Nuvoton NuMicro® ML56 series microcontrollers. The ML56 series is the first of NuMicro® 8051 series integrated with touch key and LCD controller functions. The touch key controller passes the IEC 61000-4-6 10 Vrms test with high touch sensitivity and high-noise immunity. The LCD controller can drive up to 10 cm x 10 cm panel. And an embedded programmable internal charge pump circuit that can provides stable V_{LCD} regardless of the voltage change of V_{DD} to maintain the excellent display quality of LCD panel. The NuMaker-ML56SD platform consists of three parts: an ML56 evaluation board, an on-board Nu-Link2-Me debugger and programmer, and a HTN-LCD panel module. The NuMaker-ML56SD is designed for project evaluation, prototype development and validation with power consumption monitoring function.

The ML56 evaluation board is based on the NuMicro® ML56SD1AE MCU. For the development flexibility, the ML56 platform provides the extension connectors of ML56SD1AE, the Arduino UNO compatible headers and able to adopt multiple power supply. Furthermore, the Nuvoton designed ammeter connector can measure the power consumption instantly, which is essential for the prototype evaluation. Additionally, the capacitive touch key sensing function on TK0 is an example for the touch key hardware design rules, firmware library functions, and related the PC developing tool. In addition to the capacitive touch key sensing function, the NuMaker-ML56SD provides 8 x 28 COM/SEG LCD display function. With the HTN-LCD panel, user can implement LCD display function of ML56SD1AE easily. In addition to the ML56 platform, there is an attached on-board debugger and programmer “Nu-Link2-Me”. The Nu-Link2-Me supports on-chip debugging, online and offline ICP programming via SWD interface. The Nu-Link2-Me supports virtual COM (VCOM) port for printing debug messages on PC. Besides, the programming status can be shown on the built-in LEDs. Lastly, the Nu-Link2-Me can be detached from the development board and become a stand-alone mass production programmer.

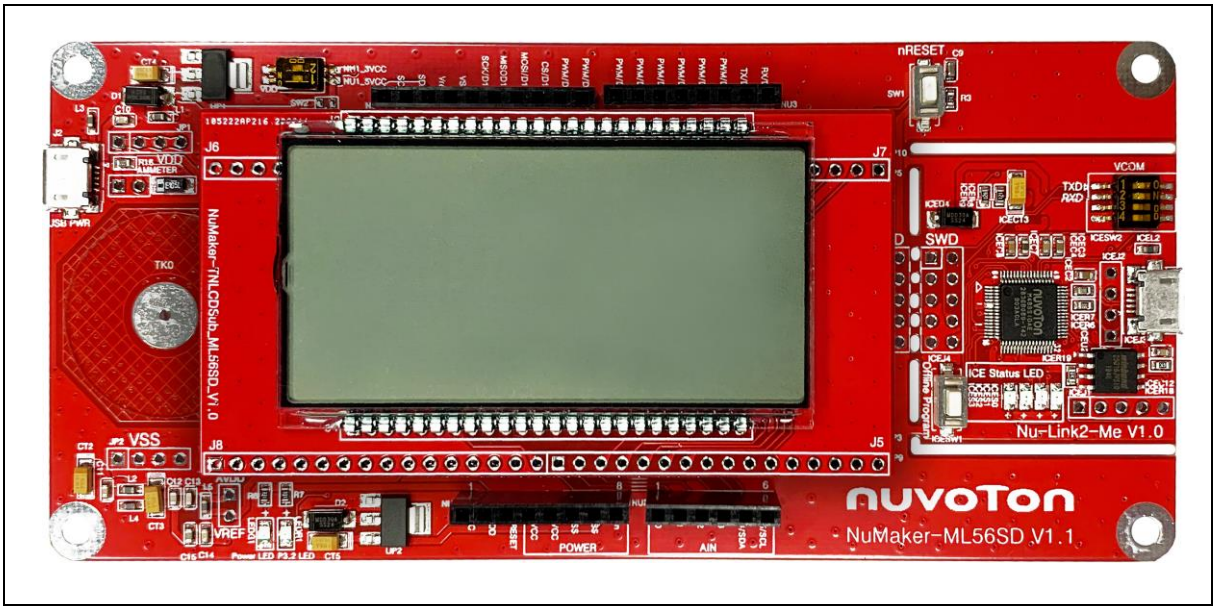

Figure 1-1 NuMaker-ML56SD Development Board

2 FEATURES

- NuMicro® ML56SD1AE microcontroller with function compatible with:
  - ML56LD1AE
  - ML56MD1AE
  - ML56LC1AE
  - ML56TC1AE
- ML56SD1AE full pin extension connectors
  - HTN-LCD panel module board can be plugged into extension connectors
- Arduino UNO compatible extension connectors
- Ammeter connector for measuring the microcontroller's power consumption
- Flexible board power source:
  - External V_{DD} power connector
  - Arduino UNO compatible extension connector Vin
  - USB FS connector on ML56 evaluation board
  - ICE USB connector on Nu-Link2-Me
- Supports one touch key on board
  - Equipped with 1 touch key + reference pad + shielding electrode
  - Touch development tool can set the hardware and software parameters automatically
- Supports 8 x 25 COM/SEG HTN-LCD panel on NuMaker-TNLCDSub_ML56SD
  - 1/4 bias, 1/8 duty, 8 x 25 COM/SEG
- On-board Nu-Link2-Me debugger and programmer:
  - Debug through SWD interface
  - On-line/off-line programming
  - Virtual COM port function

3 HARDWARE CONFIGURATION

3.1 Front View

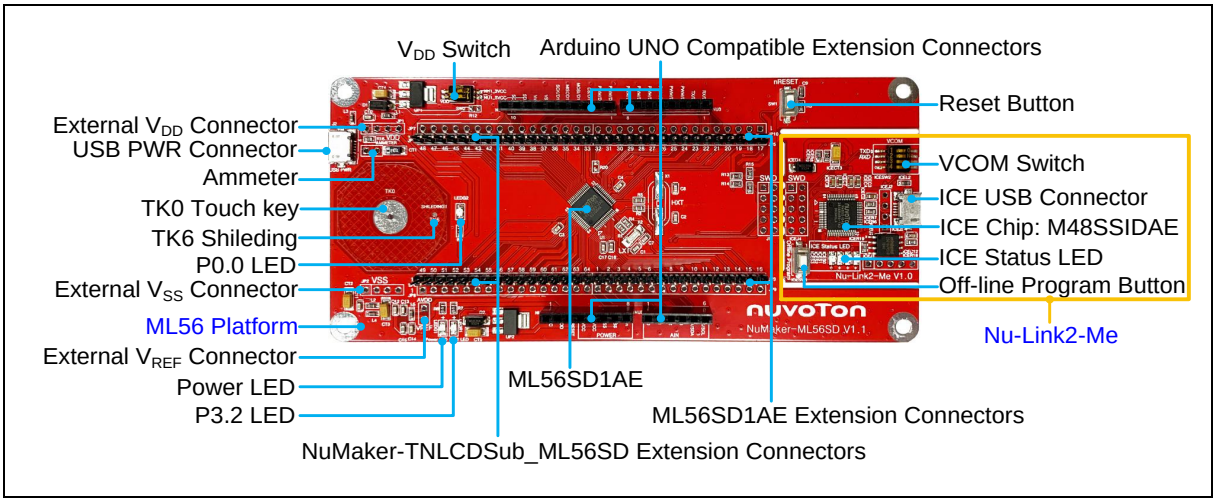

Figure 3-1 Front View of NuMaker-ML56SD

Figure 3-1 shows the main components and connectors from the front side of NuMaker-ML56SD. The following lists components and connectors from the front view:

- Target chip: ML56SD1AE (U1)
- USB PWR Connector (J2)
- Arduino UNO Compatible Extension Connectors (NU1, NU2, NU3, NU4)
- ML56 Extension Connectors (JP3, JP4, JP5, JP6 , JP7 , JP8 , JP9 and JP10)
- NuMaker-TNLCDSub_ML56 Extension Connectors (JP3, JP4, JP5 and JP6)
- External V_{DD} Power Connector (JP1)
- External V_{SS} Power Connector (JP2)
- External V_{REF} Connector (VREF)
- V_{DD} Switch (SW2)
- Ammeter Connector (AMMETER)
- Reset Button (SW1)
- Power LED, P3.2 LED and P0.0 LED (LEDG1, LEDR1 and LEDG2)
- Nu-Link2-Me
  - VCOM Switch
  - ICE Chip: M48SSIDAE (ICEU2)
  - ICE USB Connector (ICEJ3)
  - ICE Status LED (ICES0, ICES1, ICES2, ICES3)
  - Off-line Program Button (ICESW1)

3.2 Rear View

Figure 3-2 shows the main components and connectors from the rear side of NuMaker-ML56SD.

The following lists components and connectors from the rear view:

- Nu-Link2-Me
  - MCUVCC Power Switch (ICEJPR1)
  - ICEVCC Power Switch (ICEJPR2)

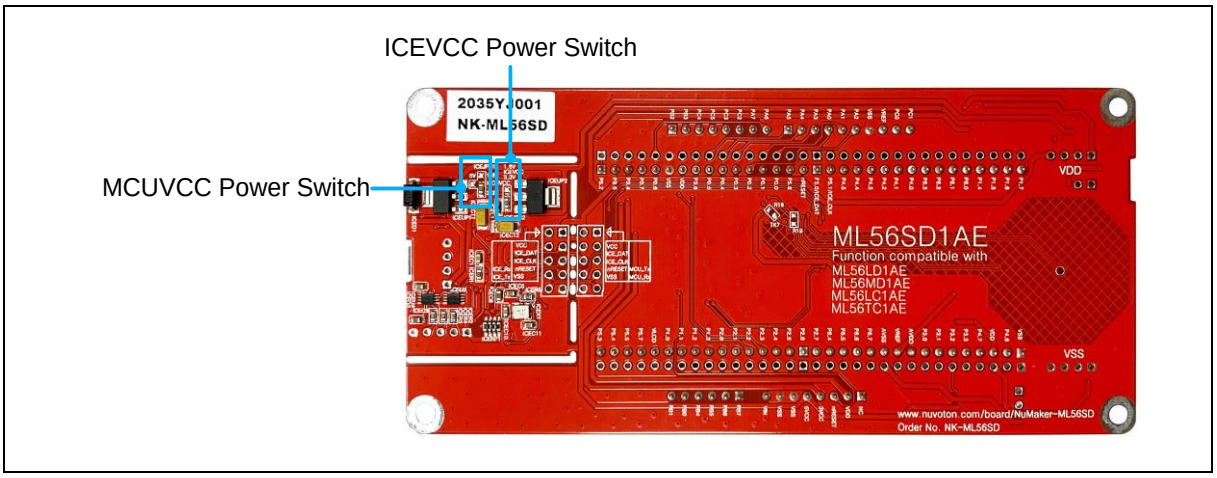

Figure 3-2 Rear View of NuMaker-ML56SD

3.3 Extension Connectors

Table 3-1 presents the extension connectors.

Connector	Description
JP3, JP4, JP5 , JP6 , JP7 , JP8 , JP9 and JP10	Full pins extension connectors on the NuMaker-ML56SD.
JP3, JP4, JP5 and JP6	NuMaker-TNLCDSub_ML56SD extension connectors on the NuMaker-ML56SD.
NU1, NU2, NU3 and NU4	Arduino UNO compatible pins on the NuMaker-ML56SD.

Table 3-1 Extension Connectors

3.3.1 Pin Assignment for Extension Connectors

The NuMaker-ML56SD provides the ML56SD1AE onboard and extension connectors (JP3, JP4, JP5 and JP6). The Figure 3-3 shows the ML56SD1AE extension connectors.

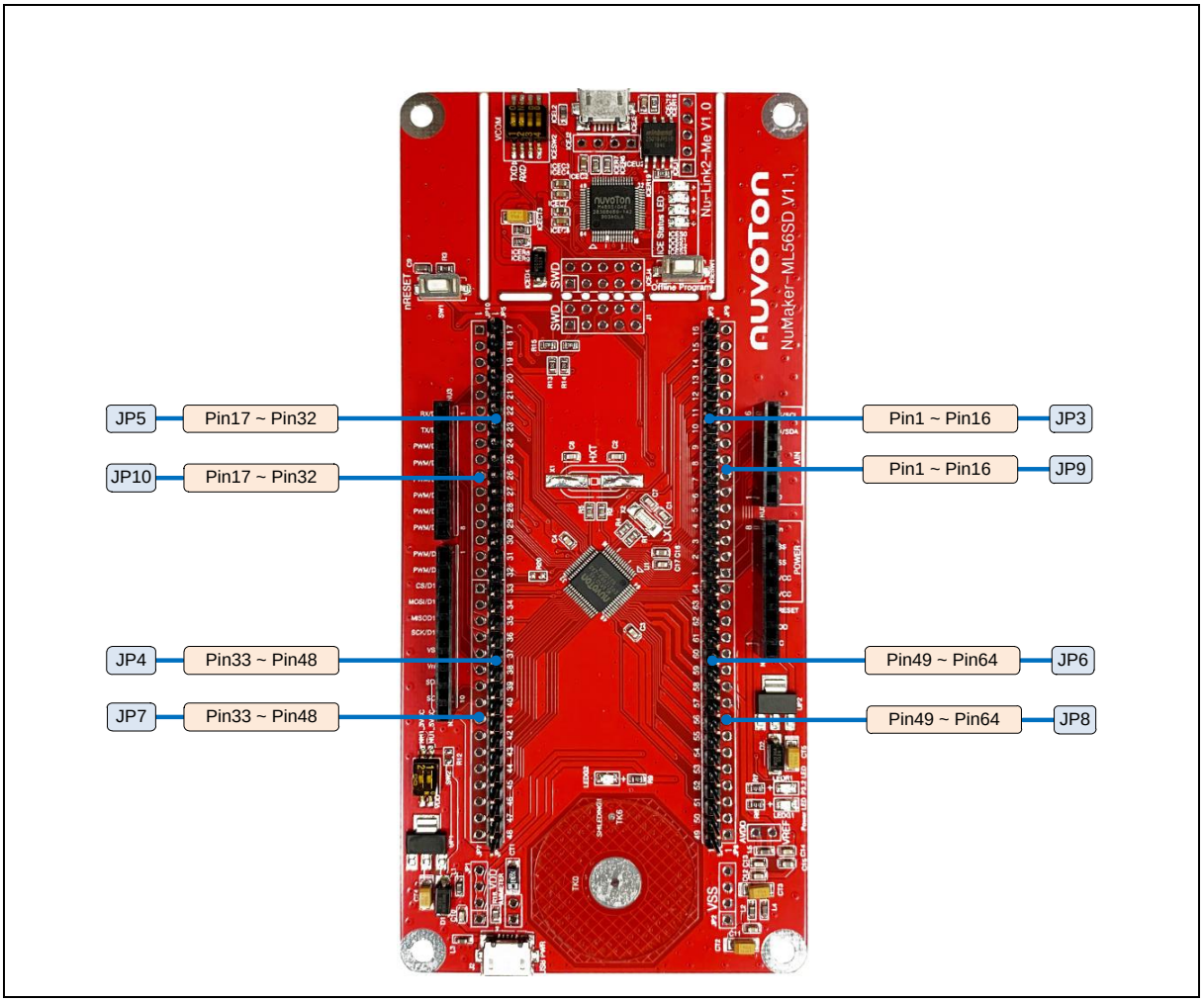

Figure 3-3 ML56SD1AE Extension Connectors

Header			ML56SD1AE	
			Pin No.	Function
JP3 JP9	JP3.1	JP9.1	1	P2.6 / LCD_SEG6 / UART1_RXD / PWM3_CH1 / ACMP1_O
	JP3.2	JP9.2	2	P2.5 / ADC_CH0 / ACMP0_P0 / ACMP1_P0 / I2C0_SCL / PWM0_CH0 / UART2_TXD / T0 / INT0
	JP3.3	JP9.3	3	P2.4 / ADC_CH1 / ACMP0_N0 / LCD_COM1 / I2C0_SDA / PWM0_CH1 / UART2_RXD / T1 / INT1
	JP3.4	JP9.4	4	P2.3 / ADC_CH2 / ACMP0_P1 / ACMP1_P1 / I2C1_SCL / LCD_COM2 / UART1_TXD / PWM0_CH2 / PWM0_BRAKE
	JP3.5	JP9.5	5	P2.2 / ADC_CH3 / ACMP1_N0 / I2C1_SDA / LCD_COM3 / UART1_RXD / PWM0_CH3
	JP3.6	JP9.6	6	2.1 / ADC_CH4 / ACMP0_P2 / ACMP1_P2 / LCD_SEG5 / UART2_TXD / I2C1_SCL / PWM0_CH4 / PWM3_CH0 / PWM0_BRAKE
	JP3.7	JP9.7	7	P2.0 / ADC_CH5 / ACMP0_N1 / LCD_SEG4 / UART2_RXD / I2C1_SDA / PWM0_CH5 / PWM3_CH1 / PWM0_BRAKE
	JP3.8	JP9.8	8	P1.3 / IC0
	JP3.9	JP9.9	9	P1.2 / LCD_DH2 / UART3_TXD / IC1
	JP3.10	JP9.10	10	P1.1 / LCD_DH1 / UART3_RXD / UART1_TXD / IC2
	JP3.11	JP9.11	11	P1.0 / UART1_RXD / IC0
	JP3.12	JP9.12	12	V_{LCD}
	JP3.13	JP9.13	13	P5.7 / PWM0_BRAKE / PWM0_CH4 / CLKO
	JP3.14	JP9.14	14	P5.5 / UART2_RXD / PWM0_CH0 / X32_IN / STADC
	JP3.15	JP9.15	15	P5.4 / UART2_TXD / PWM0_CH1 / X32_OUT
	JP3.16	JP9.16	16	P5.3 / UART0_TXD / I2C0_SCL / XT1_IN
JP5 JP10	JP5.1	JP10.1	17	P5.2 / UART0_RXD / I2C0_SDA / XT1_OUT
	JP5.2	JP10.2	18	P3.5 / LCD_SEG3 / PWM2_CH0 / T0
	JP5.3	JP10.3	19	P3.4 / LCD_SEG2 / PWM2_CH1 / T1
	JP5.4	JP10.4	20	P0.7 / LCD_SEG1 / UART0_TXD / I2C1_SCL / PWM3_CH0 / INT1
	JP5.5	JP10.5	21	P0.6 / LCD_SEG0 / UART0_RXD / I2C1_SDA / PWM3_CH1 / INT0
	JP5.6	JP10.6	22	V_{SS}
	JP5.7	JP10.7	23	V_{DD}
	JP5.8	JP10.8	24	P3.6 / TK7 / PWM0_CH5 / INT1
	JP5.9	JP10.9	25	P0.5 / UART0_TXD / I2C0_SCL / TK6 / PWM0_CH0
	JP5.10	JP10.10	26	P0.4 / UART0_RXD / I2C0_SDA / TK5 / PWM0_CH1
	JP5.11	JP10.11	27	P0.3 / SPI0_SS / SPI1_SS / UART1_TXD / I2C1_SCL / TK4 / STADC / PWM0_CH2 / CLKO
	JP5.12	JP10.12	28	P0.2 / SPI0_CLK / SPI1_CLK / UART1_RXD / I2C1_SDA / TK3 / PWM0_CH3
	JP5.13	JP10.13	29	P0.1 / SPI0_MISO / SPI1_MISO / UART2_RXD / UART0_TXD / TK2 / PWM0_CH4
	JP5.14	JP10.14	30	P0.0 / SPI0_MOSI / SPI1_MOSI / UART2_TXD / UART0_RXD / TK1 / PWM0_CH5

	JP5.15	JP10.15	31	P5.6 / PWM0_BRAKE / PWM0_CH1 / CLKO
	JP5.16	JP10.16	32	nRESET
JP4 JP7	JP4.1	JP7.1	33	P5.0 / UART1_TXD / I2C1_SCL / UART0_TXD / ICE_DAT
	JP4.2	JP7.2	34	P5.1 / UART1_RXD / I2C1_SDA / UART0_RXD / ICE_CLK
	JP4.3	JP7.3	35	P4.5 / LCD_SEG31 / LCD_COM4 / UART2_TXD / I2C1_SCL / PWM1_CH0
	JP4.4	JP7.4	36	P4.4 / LCD_SEG30 / LCD_COM5 / UART2_RXD / I2C1_SDA / TK12 / PWM1_CH1
	JP4.5	JP7.5	37	P4.3 / LCD_SEG29 / LCD_COM6 / TK13 / PWM2_CH0
	JP4.6	JP7.6	38	P4.2/ LCD_SEG28 / LCD_COM7 / TK14 / PWM2_CH1
	JP4.7	JP7.7	39	P4.1 / LCD_SEG27 / LCD_COM2 / UART2_TXD / I2C0_SCL / PWM3_CH0 / ACMP0_O
	JP4.8	JP7.8	40	P4.0 / LCD_SEG26 / LCD_COM3 / UART2_RXD / I2C0_SDA / PWM3_CH1 / ACMP1_O / INT1
	JP4.9	JP7.9	41	P6.3 / LCD_SEG25 / SPI0_SS / UART0_TXD / TK8
	JP4.10	JP7.10	42	P6.2 / LCD_SEG24 / UART3_TXD / SPI0_CLK / UART0_RXD / TK9
	JP4.11	JP7.11	43	P6.1 / LCD_SEG23 / UART3_RXD / SPI0_MISO / TK10
	JP4.12	JP7.12	44	P6.0 / LCD_SEG22 / SPI0_MOSI / TK11
	JP4.13	JP7.13	45	P1.4 / LCD_SEG21 / I2C1_SCL / LCD_COM4
	JP4.14	JP7.14	46	P1.5 / LCD_SEG20 / I2C1_SDA / LCD_COM5
	JP4.15	JP7.15	47	P1.6 / LCD_SEG19 / UART0_TXD / LCD_COM6
	JP4.16	JP7.16	48	P1.7 / LCD_SEG18 / UART0_RXD / LCD_COM7
JP6 JP8	JP6.1	JP8.1	49	V_{SS}
	JP6.2	JP8.2	50	P4.6 / LCD_SEG17 / PWM0_CH0 / T0 / CLKO / INT0
	JP6.3	JP8.3	51	V_{DD}
	JP6.4	JP8.4	52	P4.7 / LCD_SEG16 / LCD_COM0 / T1
	JP6.5	JP8.5	53	P3.3 / LCD_SEG15 / SPI1_SS / LCD_COM1 / PWM1_CH0 / IC0 / PWM0_BRAKE
	JP6.6	JP8.6	54	P3.2 / ADC_CH7 / ACMP1_N1 / LCD_SEG14 / SPI1_CLK / UART3_RXD / PWM1_CH1 / IC1 / CLKO
	JP6.7	JP8.7	55	P3.1 / ADC_CH6 / ACMP0_P3 / ACMP1_P3 / LCD_SEG13 / SPI1_MISO / UART3_TXD / UART0_TXD / PWM2_CH0 / IC2
	JP6.8	JP8.8	56	P3.0 / ADC_CH10 / LCD_SEG12 / SPI1_MOSI / UART0_RXD / PWM2_CH1 / IC0
	JP6.9	JP8.9	57	AV_{DD}
	JP6.10	JP8.10	58	V_{REF}
	JP6.11	JP8.11	59	AV_{SS}
	JP6.12	JP8.12	60	P6.7 / ADC_CH11 / LCD_SEG11 / I2C1_SCL
	JP6.13	JP8.13	61	P6.6 / ADC_CH12 / LCD_SEG10 / LCD_V1 / I2C1_SDA
	JP6.14	JP8.14	62	P6.5 / ADC_CH13 / LCD_SEG9 / LCD_V2 / UART0_TXD
	JP6.15	JP8.15	63	P6.4 / ADC_CH14 / LCD_SEG8 / LCD_V3 / UART0_RXD

	JP6.16	JP8.16	64	P2.7 / ADC_CH15 / LCD_SEG7 / UART1_TXD / PWM3_CH0 / ACMP0_O

Table 3-2 ML56SD1AE Full-pin Extension Connectors and GPIO Function List

3.3.2 NuMaker-TNLCDSub_ML56SD Compatible Extension Connectors

Table 3-3 shows the NuMaker-TNLCDSub_ML56SD compatible extension connectors.

Header		ML56SD1AE		Header	NuMaker-TNLCDSub_ML56SD
		Pin No.	Function		Function
JP3	JP3.1	1	LCD_SEG6	J3.11	SEG11
	JP3.2	2	LCD_COM0	J3.20	COM4
	JP3.3	3	LCD_COM1	J3.19	COM3
	JP3.4	4	LCD_COM2	J3.18	COM2
	JP3.5	5	LCD_COM3	J3.17	COM1
	JP3.6	6	LCD_SEG5	J4.6	SEG30
	JP3.7	7	LCD_SEG4	J4.5	SEG29
	JP3.8	8	-	-	-
	JP3.9	9	-	-	-
	JP3.10	10	-	-	-
	JP3.11	11	-	-	-
	JP3.12	12	-	-	-
	JP3.13	13	-	-	-
	JP3.14	14	-	-	-
	JP3.15	15	-	-	-
	JP3.16	16	-	-	-
JP5	JP5.1	17	-	-	-
	JP5.2	18	LCD_SEG3	J4.4	SEG28
	JP5.3	19	LCD_SEG2	J4.3	SEG27
	JP5.4	20	LCD_SEG1	J4.2	SEG26
	JP5.5	21	LCD_SEG0	J4.1	SEG25
	JP5.6	22	-	-	-
	JP5.7	23	-	-	-
	JP5.8	24	-	-	-
	JP5.9	25	-	-	-
	JP5.10	26	-	-	-
	JP5.11	27	-	-	-

	JP5.12	28	-	-	-
	JP5.13	29	-	-	-
	JP5.14	30	-	-	-
	JP5.15	31	-	-	-
	JP5.16	32	-	-	-
JP4	JP4.1	33	-	-	-
	JP4.2	34	-	-	-
	JP4.3	35	LCD_COM4	J3.24	COM8
	JP4.4	36	LCD_COM5	J3.23	COM7
	JP4.5	37	LCD_COM6	J3.22	COM6
	JP4.6	38	LCD_COM7	J3.21	COM5
	JP4.7	39	-	-	-
	JP4.8	40	LCD_SEG26	J4.24	SEG48
	JP4.9	41	LCD_SEG25	J4.23	SEG47
	JP4.10	42	LCD_SEG24	J4.22	SEG46
	JP4.11	43	LCD_SEG23	J4.21	SEG45
	JP4.12	44	LCD_SEG22	J4.20	SEG44
	JP4.13	45	LCD_SEG21	J4.19	SEG43
	JP4.14	46	LCD_SEG20	J4.18	SEG42
	JP4.15	47	LCD_SEG19	J4.17	SEG41
	JP4.16	48	LCD_SEG18	J4.16	SEG40
JP6	JP6.1	49	-	-	-
	JP6.2	50	LCD_SEG17	J4.15	SEG39
	JP6.3	51	-	-	-
	JP6.4	52	LCD_SEG16	J4.14	SEG38
	JP6.5	53	LCD_SEG15	J4.13	SEG37
	JP6.6	54	LCD_SEG14	J4.12	SEG36
	JP6.7	55	-	-	-
	JP6.8	56	-	-	-
	JP6.9	57	-	-	-
	JP6.10	58	-	-	-
	JP6.11	59	-	-	-

	JP6.12	60	LCD_SEG11	J4.11	SEG35
	JP6.13	61	LCD_SEG10	J4.10	SEG34
	JP6.14	62	LCD_SEG9	J4.9	SEG33
	JP6.15	63	LCD_SEG8	J4.8	SEG32
	JP6.16	64	LCD_SEG7	J4.7	SEG31

Table 3-3 NuMaker-TNLCDSub_ML56SD Compatible Extension Connectors

3.3.3 Arduino UNO Compatible Extension Connectors

Figure 3-4 shows the Arduino UNO compatible extension connectors.

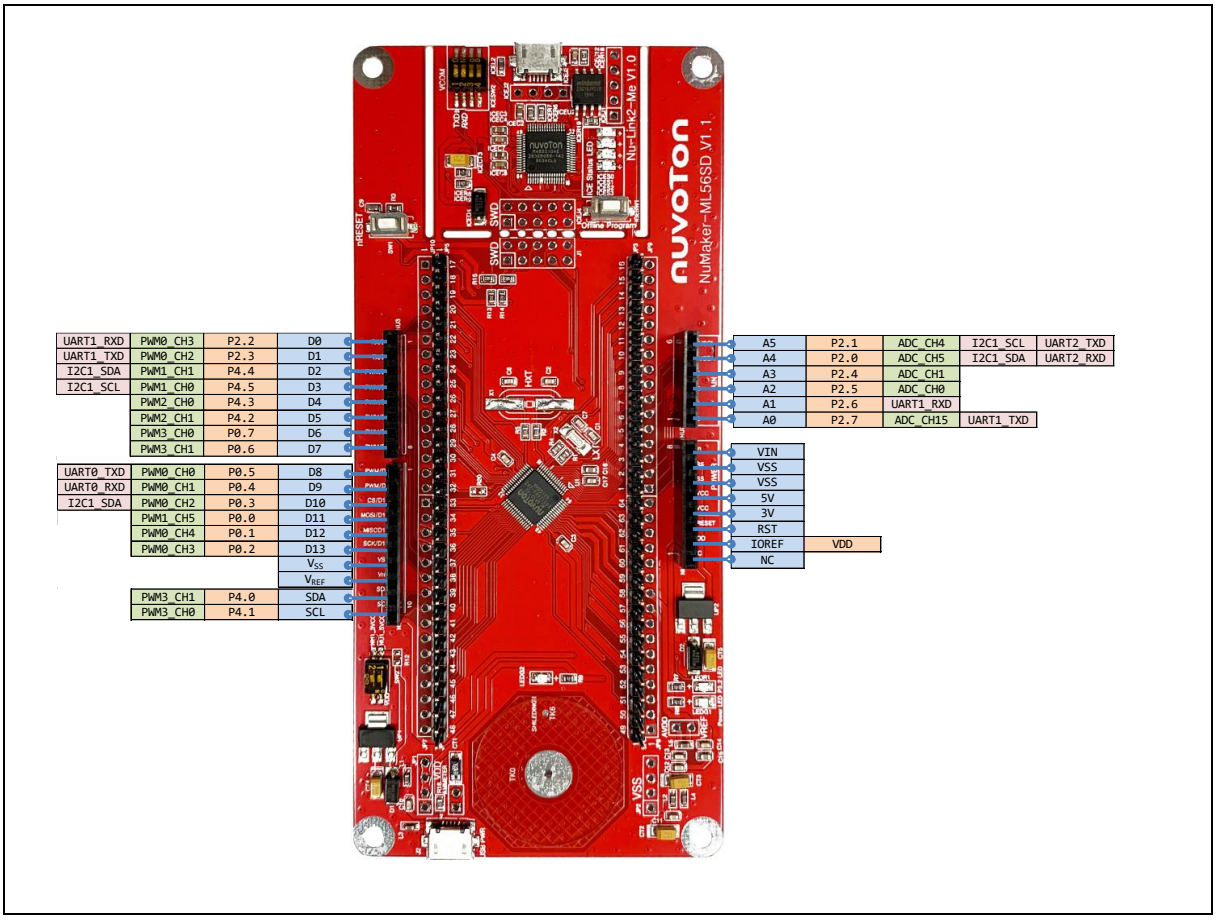

Figure 3-4 Arduino UNO Compatible Extension Connectors

Header		NuMaker-ML56SD		Header		NuMaker-ML56SD	
		Compatible to Arduino UNO	GPIO Pin of ML56			Compatible to Arduino UNO	GPIO Pin of ML56
NU3	NU3.1	D0	P2.2	**NU2**	NU2.6	A5	P2.1
	NU3.2	D1	P2.3		NU2.5	A4	P2.0
	NU3.3	D2	P4.4		NU2.4	A3	P2.4
	NU3.4	D3	P4.5		NU2.3	A2	P2.5
	NU3.5	D4	P4.3		NU2.2	A1	P2.6
	NU3.6	D5	P4.2		NU2.1	A0	P2.7
	NU3.7	D6	P0.7	**NU1**	NU1.8	VIN	-
	NU3.8	D7	P0.6		NU1.7	VSS	
NU4	NU4.1	D8	P0.5		NU1.6	VSS	
	NU4.2	D9	P0.4		NU1.5	5V	
	NU4.3	D10	P0.3		NU1.4	3V	
	NU4.4	D11	P0.0		NU1.3	RST	nRESET
	NU4.5	D12	P0.1		NU1.2	IOREF	V_{DD}
	NU4.6	D13	P0.2		NU1.1	NC	-
	NU4.7	VSS	V_{SS}				
	NU4.8	VREF	V_{REF}				
	NU4.9	SDA	P4.0				
	NU4.10	SCL	P4.1				

Table 3-4 Arduino UNO Extension Connectors and ML56SD1AE Mapping GPIO List

3.4 Power Supply Configuration

The NuMaker-ML56SD is able to adopt multiple power supply. External power sources include NU1 Vin (7 V to 12 V), V_{DD} (depending on target chip operating voltage), and PC through USB connector. By using switches and voltage regulator, multiple power domains can be created on the NuMaker-ML56SD.

3.4.1 VIN Power Source

Table 3-5 presents the Vin power source.

Connector	Net Name in Schematic	Description
NU1 pin8	NU1_VIN	Board external power source, with voltage range from 7 V to 12 V. The voltage regulator UP2 converts the NU1 pin8 input voltage to 5 V and supplies it to NU1_5VCC.

Table 3-5 Vin Power Source

3.4.2 5 V Power Sources

Table 3-6 presents the 5 V power sources.

Connector	Net Name in Schematic	Description
ICEJ3	USB_HS_VBUS	ICE USB connector supplies 5 V power from PC to ML56 platform and Nu-Link2-Me.
J2	USB_VBUS	USB connector on NuMaker-ML56SD supplies 5 V power from PC to ML56 platform and Nu-Link2-Me.
NU1 pin5	NU1_5VCC	ICEJ3, J2 or NU1 pin8 supplies 5 V power to NU1 pin5. NU1 pin5 supplies 5 V power to target chip or Arduino adapter board. **Note:** ML56 operating voltage range is from 1.8 V to 3.6 V. Do not switch SW2.1 (NU1 5VCC) to ON.

Table 3-6 5 V Power Sources

3.4.3 3.3 V Power Sources

Table 3-7 presents the 3.3 V power sources.

Voltage Regulator	5 V Source	Description
ICEUP1	USB_HS_VBUS	ICEUP1 converts USB_HS_VBUS to 3.3 V and supplies 3.3 V to ML56 platform or ICE chip.
UP1	USB_VBUS	UP1 converts USB_VBUS to 3.3 V and supplies 3.3 V to ML56 platform. **Note:** SW2.2 (NU1 3VCC) should be switched to ON.
UP1	NU1_5VCC	UP1 converts NU1_5VCC to 3.3 V and supplies 3.3 V to ML56 platform. **Note:** SW2.2 (NU1 3VCC) should be switched to ON.

Table 3-7 3.3 V Power Sources

3.4.4 1.8 V Power Sources

Table 3-8 presents the 1.8 V power source.

Voltage Regular	5V Source	Description
ICEUP2	USB_HS_VBUS	ICEUP2 converts USB_HS_VBUS to 1.8 V and supplies 1.8 V to ML56 platform or ICE chip.

Table 3-8 1.8 V Power Sources

3.4.5 Power Connectors

Table 3-9 presents the power connectors.

Connector	Description
JP1	V_{DD} connector on the NuMaker-ML56SD. **Note:** ML56SD1AE operating voltage range is from 1.8 V to 3.6 V.
JP2	V_{SS} connector on the NuMaker-ML56SD.

Table 3-9 Power Connectors

3.4.6 USB Connectors

Table 3-10 presents the USB connectors.

Connector	Description
ICEJ3	ICE USB connector on Nu-Link2-Me for power supply, debugging and programming from PC.
J2	USB FS connector on NuMaker-ML56SD for power supply.

Table 3-10 USB Connectors

3.4.7 Power Switches

Table 3-11 presents the power switches.

Switch	Description
ICEJPR1	Configures the target chip operating voltage at 1.8 V / 3.3 V / 5 V. **Note:** ML56SD1AE operating voltage range is from 1.8 V to 3.6 V. Do not switch ICEJPR1 (MCUVCC) to 5 V.
ICEJPR2	Configures the ICE chip operating voltage at 1.8 V / 3.3 V.
SW2	Configures the target chip operating voltage at 3.3 V / 5 V. **Note:** ML56SD1AE operating voltage range is from 1.8 V to 3.6 V. Do not switch SW2.1 (NU1 5VCC) to ON.

Table 3-11 Power Switches

3.4.8 Power Supply Models

3.4.8.1 External Power Supply through Nu-Link2-Me to Target Chip

The external power supply source on Nu-Link2-Me is shown in Figure 3-5.

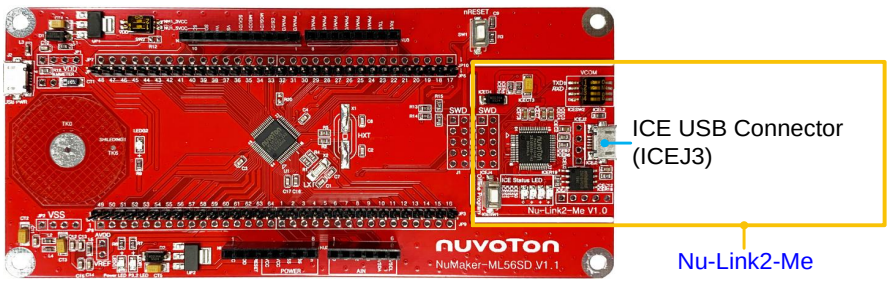

Figure 3-5 External Power Supply Sources on Nu-Link2-Me

To use ICEJ3 as external power supply source with Nu-Link2-Me, please follow the steps below:

1. Solder the resistor on ICEJPR1 (MCUVCC) depends on the target chip operating voltage.
2. Solder the resistor on ICEJPR2 (ICEVCC) depends on the ICE chip operating voltage.
3. Switch the SW2 to OFF.
4. Connect the external power supply to ICEJ3.

Table 3-12 presents all power models when supplies external power through Nu-Link2-Me. The Nu-Link2-Me external power sources are highlighted in yellow.

Model	Target Chip Voltage	ICEJ3	ICEJPR1 (MCUVCC) Selection [1]	ICEJPR2 (ICEVCC) Selection [2]	ICE Chip Voltage	SW2 Selection	J2	Vin	JP1
1	1.8 V	Connect to PC	1.8 V	1.8 V	1.8 V	Off	X	X	1.8 V output
2	3.3 V	Connect to PC	3.3 V (default)	3.3 V (default)	3.3 V	Off	X	X	3.3 V output
3	5 V	Connect to PC	5 V	3.3 V (default)	3.3 V	Off	X	X	5 V output
	Note: 1. 0 Ω should be soldered between ICEJPR1's MCUVCC and 1.8 V / 3.3 V / 5 V. 2. 0 Ω should be soldered between ICEJPR2's ICEVCC and 1.8 V / 3.3 V. 3. X: Unused.								

Table 3-12 Supply External Power through Nu-Link2-Me

3.4.8.2 External Power Supply through ML56 Platform to Target Chip

The external power supply sources on ML56 platform are shown in Figure 3-6.

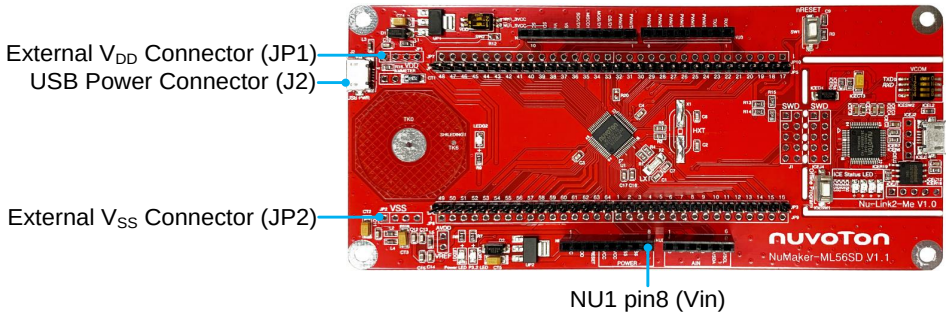

Figure 3-6 External Power Supply Sources on ML56 Platform

To use Vin or J2 as external power supply source, please follow the steps below:

1. Switch the SW2 depends on the target chip operating voltage.
2. Remove the resistor on ICEJPR1 (MCUVCC).
3. Solder the resistor on ICEJPR2 (ICEVCC) depends on the ICE chip operating voltage.
4. Connect the external power supply to Vin or J2.

To use JP1 as external power supply source, please follow the steps below:

1. Switch the SW2 to OFF.
2. Remove the resistor on ICEJPR1 (MCUVCC).
3. Solder the resistor on ICEJPR2 (ICEVCC) depends on the ICE chip operating voltage.
4. Connect ICEJ3 to PC.
5. Connect the external power supply to JP1.

To use Vin or J2 as external power supply source with Nu-Link2-Me detached from NuMaker-ML56SD, please follow the steps below:

1. Switch the SW2 depends on the target chip operating voltage.
2. Detach the Nu-Link2-Me from NuMaker-ML56SD.
3. Connect the external power supply to Vin or J2.

To use JP1 as external power supply source with Nu-Link2-Me detached from NuMaker-ML56SD, please follow the steps below:

1. Switch the SW2 to OFF.
2. Detach the Nu-Link2-Me from NuMaker-ML56SD.
3. Connect the external power supply to JP1.

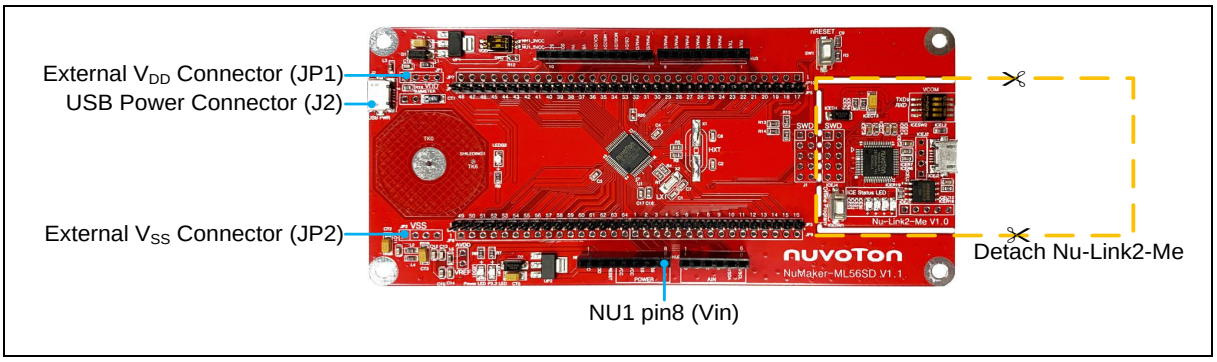

Figure 3-7 Detach the Nu-Link2-Me from NuMaker-ML56SD

Table 3-13 presents all power models when supplies external power through ML56 platform. The ML56 platform external power sources are highlighted in yellow.

Model	Target Chip Voltage	Vin [1]	J2[1]	ICEJ3	SW2 Selection	JP1[2]	ICEJPR1 (MCUVCC) Selection [3]	ICEJPR2 (ICEVCC) Selection [4]	ICE Chip Voltage [5]
4	3.3 V	7 V ~ 12 V Input	X	X	NU1 3VCC	3.3 V output	Remove resistor	3.3 V	3.3 V
5	3.3 V	X	Connect to PC	X	NU1 3VCC	3.3 V output	Remove resistor	3.3 V	3.3 V
6	5 V	7 V ~ 12 V Input	X	X	NU1 5VCC	5 V output	Remove resistor	3.3 V	3.3 V
7	5 V	X	Connect to PC	X	NU1 5VCC	5 V output	Remove resistor	3.3 V	3.3 V
8	1.8 V ~ 3.6 V	X	X	Connect to PC	OFF	DC Input 1.8 V ~ 3.6 V	Remove resistor	1.8 V / 3.3 V	1.8 V / 3.3 V
9	1.8 V ~ 3.6 V	X	X	Nu-Link2-Me removed	OFF	DC Input 1.8 V ~ 3.6 V	X	X	X

Note:

1. The Vin input voltage will be converted by voltage regulator UP2 to 5 V. Supply external power to Vin or J2 can provide 5 V to NU1 pin5 (5V) and 3.3 V to NU1 pin4 (3VCC).
2. JP1 external power input only provides voltage to target chip.
3. 0 Ω should be removed from ICEJPR1's MCUVCC and 1.8 V / 3.3 V / 5 V.
4. 0 Ω should be soldered between ICEJPR2's ICEVCC and 1.8 V / 3.3 V.
5. The ICE chip voltage should be close to the target chip voltage.
6. X: Unused

Table 3-13 Supply External Power for ML56 Platform

3.5 External Reference Voltage Connector

Table 3-15 presents the external reference voltage connector.

Connector	Description
VREF1	Connector for user to connect to the external reference voltage pin of the target chip. User needs to remove the L5 ferrite bead.

Table 3-14 External Reference Voltage Connector

3.6 Ammeter Connector

Table 3-15 presents the ammeter connector.

Connector	Description
AMMETER	Connector for user to measure the target chip power consumption easily. User needs to remove the R16 resistor.

Table 3-15 Ammeter Connector

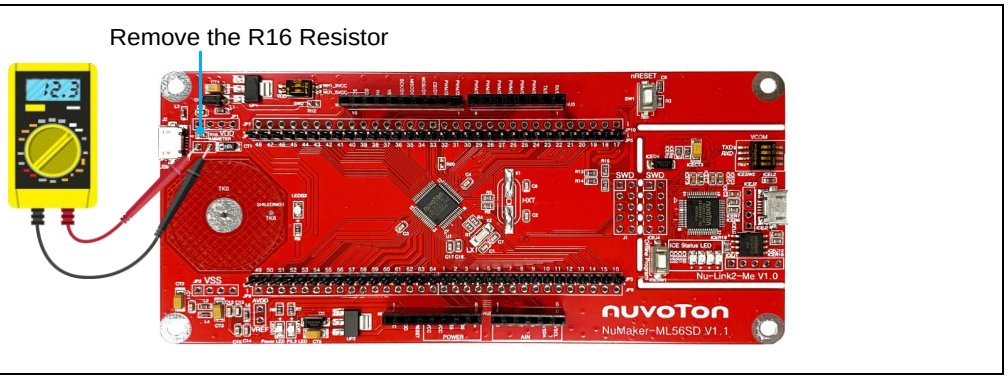

Figure 3-8 Wiring between Ammeter Connector and Ammeter

3.7 Push Buttons

Table 3-16 presents the push buttons.

Component	Description
ICESW1	Offline program button to start offline ICP programming the target chip.
SW1	Reset button to reset the target chip.

Table 3-16 Push-Buttons

3.8 LEDs

Table 3-17 presents the LEDs.

Component	Description
Power LED	The power LED indicates that the NuMaker-ML56SD is powered.
P3.2 LED	The LED is connected to the target chip P3.2.
P0.0 LED	The LED is connected to the target chip P0.0.
ICES0, ICES1, ICES2 and ICES3	Nu-Link2-Me status LED.

Table 3-17 LEDs

3.9 Touch Key

Table 3-18 presents the touch key.

Component	Description
TK0	Touch key.
TK6	Shielding electrode.
TK7	Reference pad.

Table 3-18 Touch Key

3.10 LCD

The LCD on the NuMaker-ML56SD with 8 x 40 COM/SEG. The LCD provides some information such as time, battery status, temperature, humidity and so on. The LCD is from TRICOMTEK part number RHE6616TP01. Figure 3-9 shows the LCD digit segment mapping table. Table 3-20 shows pin map for the LCD.

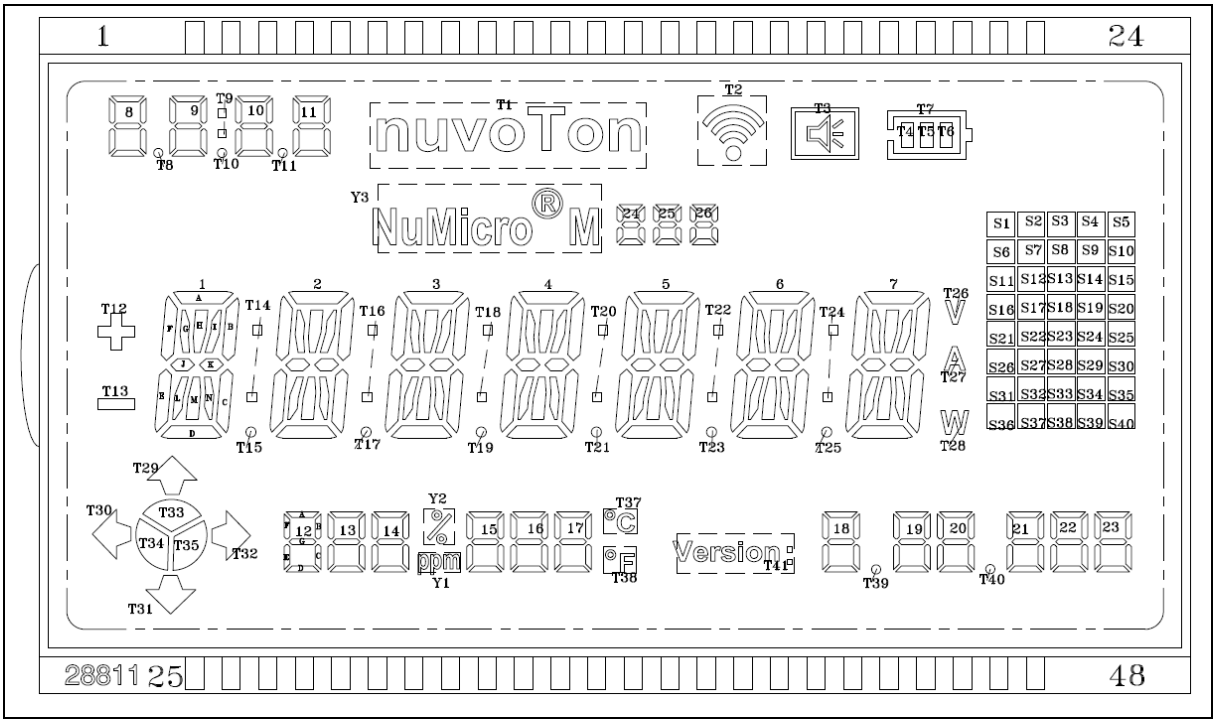

Figure 3-9 The LCD Digit Mapping Table

The assignment of COM pins and SEG pins for the LCD and NuMaker-ML56SD as shown in Table 3-3.

Table 3-19 presents LCD specifications.

Parameter	Specifications
Drive Condition	1/8 Duty, 1/4 Bias, 8 x 40 COM/SEG
View Direction	12 O'Clock
Operating Voltage	4.8 V
Dimension	100 ± 0.2 mm x 64 ± 0.2 mm
Connectors	PIN

Table 3-19 LCD Specifications

PIN	1	2	3	4	6	7	8	9	10	11	12
COM1	1B	1A	1G	1F	24C	25D	25C	26D	26C	T7	S1
COM2	1I	1H	1J	T12	24G	25E	25G	26E	26G	T6	S6
COM3	1K	1N	1M	1E	24B	25F	25B	26F	26B	T4	S11
COM4	1C	1D	1L	T13	T10	25A	T11	26A	Y3	T5	S16
COM5	T32	T29	8D	8C	9C	10D	10C	11D	11C	T1	S21
COM6	T35	T33	8E	8G	9G	10E	10G	11E	11G	T2	S26
COM7	T34	T30	8F	8B	9B	10F	10B	11F	11B	T3	S31
COM8	T31	-	8A	T8	T9	10A	10A	11A	-	-	S36
PIN	13	14	15	17	18	19	20	21	22	23	24
COM1	S2	S3	S4	COM1	-	-	-	-	-	-	-
COM2	S7	S8	S9	-	COM2	-	-	-	-	-	-
COM3	S12	S13	S14	-	-	COM3	-	-	-	-	-
COM4	S17	S18	S19	-	-	-	COM4	-	-	-	-
COM5	S22	S23	S24	-	-	-	-	COM5	-	-	-
COM6	S27	S28	S29	-	-	-	-	-	COM6	-	-
COM7	S32	S33	S34	-	-	-	-	-	-	COM7	-
COM8	S37	S38	S39	-	-	-	-	-	-	-	COM8
PIN	25	26	28	29	30	31	32	33	34	35	36
COM1	2F	2G	2B	3F	3G	3A	3B	4F	4G	4A	4B
COM2	T14	2J	2I	T16	3J	3H	3I	T18	4J	4H	4I
COM3	2E	2M	2K	3E	3M	3N	3K	4E	4M	4N	4K
COM4	T15	2L	2C	T17	3L	3D	3C	T19	4L	4D	4C
COM5	12A	-	-	14A	Y1	15A	Y2	16A	T37	17A	T38
COM6	12F	12B	13B	14F	14B	15F	15B	16F	16B	17F	17B
COM7	12E	12G	13G	14E	14G	15E	15G	16E	16G	17E	17G
COM8	12D	12C	13C	14D	14C	15D	15C	16D	16C	17D	17C
PIN	37	39	40	41	42	43	44	45	46	47	48
COM1	5F	5A	5B	6F	6G	6A	6B	7F	7G	7A	7B
COM2	T20	5H	5I	T22	6J	6H	6I	T24	7J	7H	7I
COM3	5E	5N	5K	6E	6M	6N	6K	7E	7M	7N	7K
COM4	T21	5D	5C	T23	6L	6D	6C	T25	7L	7D	7C
COM5	18A	19A	T41	20A	T40	21A	T28	22A	T27	23A	T26
COM6	18F	19F	19B	20F	20B	21F	21B	22F	22B	23F	23B

COM7	18E	19E	19G	20E	20G	21E	21G	22E	22G	23E	23G
COM8	18D	19D	19C	20D	20C	21D	21C	22D	22C	23D	23C

Table 3-20 LCD Pin Mapping Table

3.11 Nu-Link2-Me

The Nu-Link2-Me is an attached on-board debugger and programmer. The Nu-Link2-Me supports on-chip debugging, online and offline ICP programming through SWD interface. The Nu-Link2-Me also supports virtual COM port (VCOM) for printing debug messages on PC. Besides, the programming status can be shown on the built-in LEDs. Lastly, the Nu-Link2-Me can be detached from the development board and becoming a stand-alone mass production programmer. For more information about Nu-Link2-Me, please refer to Nu-Link2-Pro Debugger and Programmer User Manual.

3.11.1 VCOM Switches

Table 3-21 presents how to set the VCOM function by ICESW2.

ICESW2		
Pin	**Function**	**Description**
1	TXD	**On**: Connect target chip P3.1 (UART0_TXD) to Nu-Link2-Me. **Off**: Disconnect target chip P3.1 (UART0_TXD) to Nu-Link2-Me.
2	RXD	**On**: Connect target chip P3.0 (UART0_RXD) to Nu-Link2-Me. **Off**: Disconnect target chip P3.0 (UART0_RXD) to Nu-Link2-Me.
Note: Pin 3 and 4 is unused.		

Table 3-21 VCOM Function of Nu-Link2-Me

3.11.2 Status LEDs

Table 3-22 presents the status LEDs patterns for different operation on Nu-Link2-Me.

Operation Status	**Status LED**			
	ICES0	**ICES1**	**ICES2**	**ICES3**
Power on	Flash x 3	Flash x 3	Flash x 3	Flash x 3
Connected to IDE/NuTool	Flash x 3	Flash x 3	Flash x 3	On
ICE online (Not connected to a target chip)	On	-	Flash x 3	Flash x 3
ICE online (Connected to a target chip)	On	-	-	On
ICE online (Failed to connect to a target chip)	On	Any	Flash	On
During Offline Programming	-	On	-	Flash
Offline Programming Completed	On	-	-	-
Offline Programming Completed (Auto mode)	On	On	-	-
Offline Programming Failed	On	Flash	-	-

Table 3-22 Operation Status LED Patterns

4 QUICK START

4.1 Toolchains Supporting

Install the preferred toolchain. Please make sure at least one of the toolchains has been installed.

- KEIL C51
- IAR EW8051

4.2 Nuvoton Nu-Link Driver Installation

Download and install the latest Nuvoton Nu-Link Driver.

- Download and install Nu-Link_Keil_Driver when using Keil C51
- Download and install Nu-Link_IAR_Driver when using IAR EW8051

Please install the Nu-Link USB Driver as well at the end of the installation. The installation is presented in Figure 4-1 and Figure 4-2.

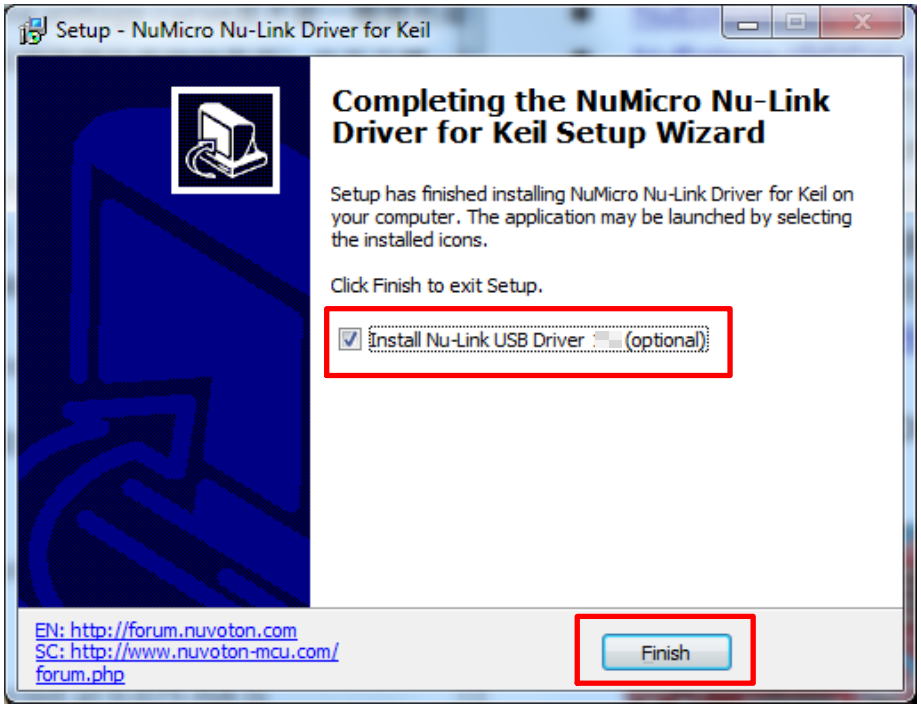

Figure 4-1 Nu-Link USB Driver Installation Setup

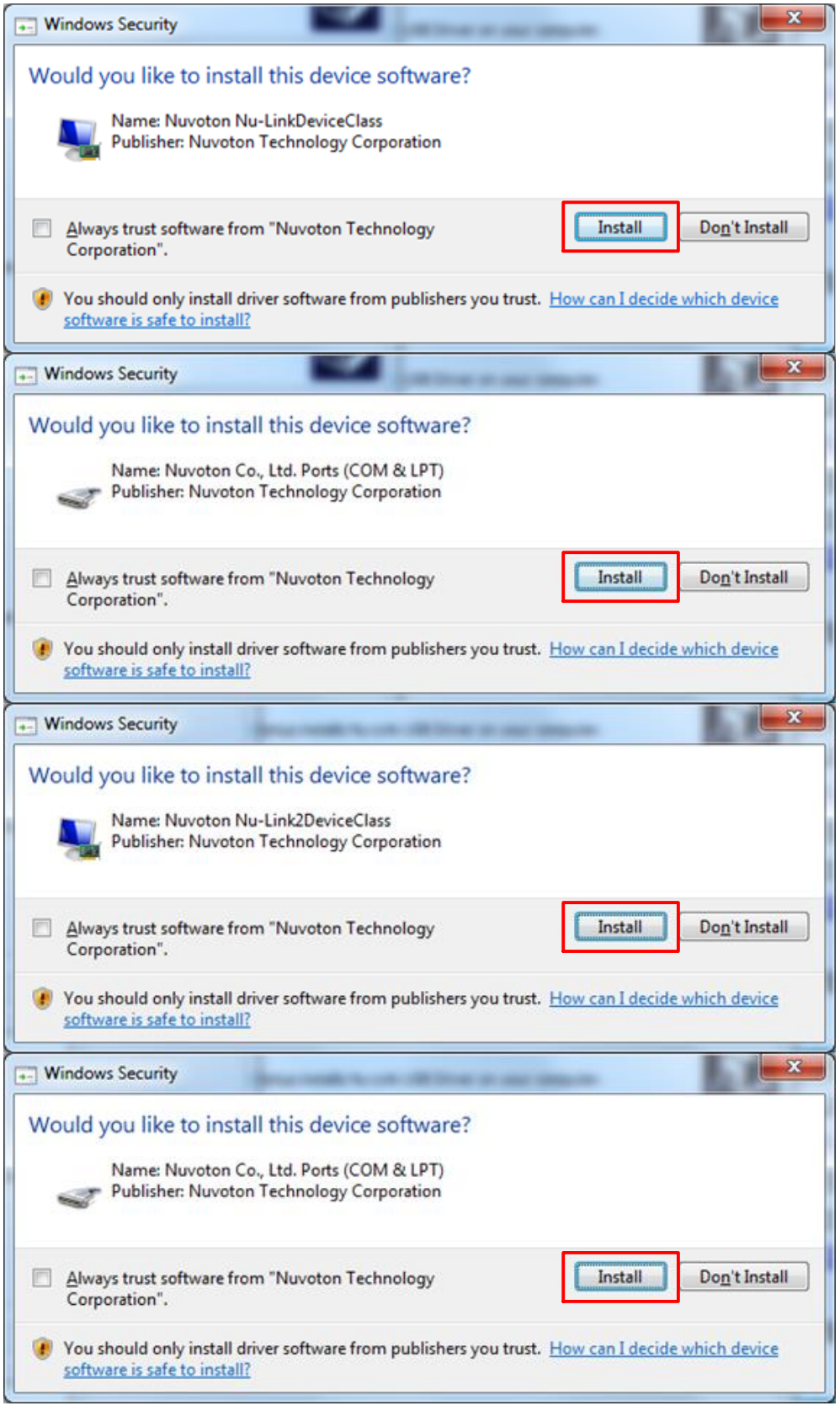

Figure 4-2 Nu-Link USB Driver Installation

4.3 BSP Firmware Download

Download and unzip the Board Support Package (BSP).

4.4 Hardware Setup

1. Open the virtual COM (VCOM) function by changing Nu-Link2-Me VCOM Switch No. 1 and 2 to ON.

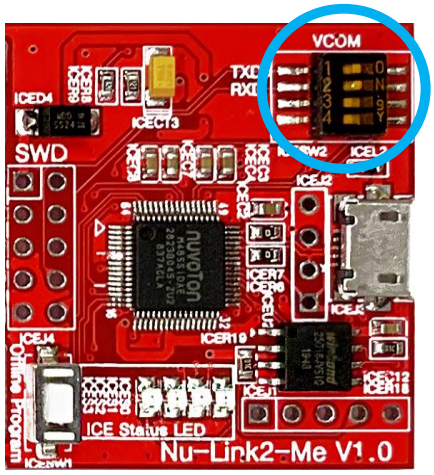

Figure 4-3 Open VCOM Function

2. Connect the ICE USB connector shown in Figure 4-4 to the PC USB port through USB cable.

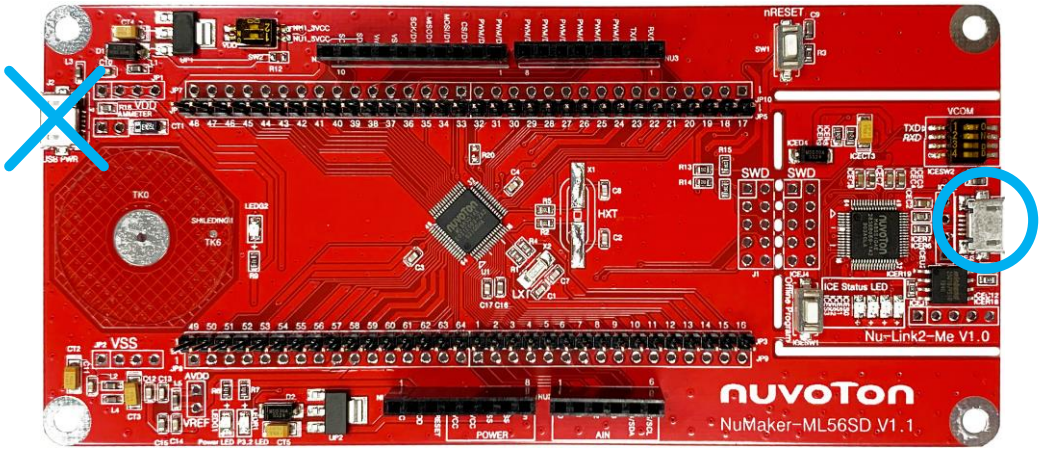

Figure 4-4 ICE USB Connector

3. Find the “Nuvoton Virtual COM Port” on the Device Manger as Figure 4-5.

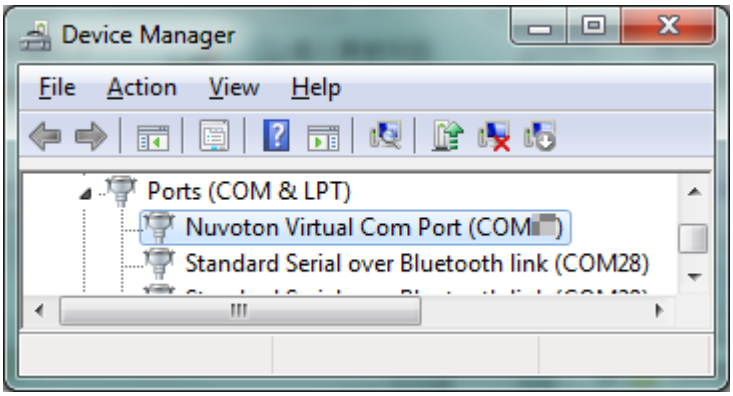

Figure 4-5 Device Manger

4. Open a serial port terminal, PuTTY for example, to print out debug message. Set the speed to 115200. Figure 4-6 presents the PuTTY session setting.

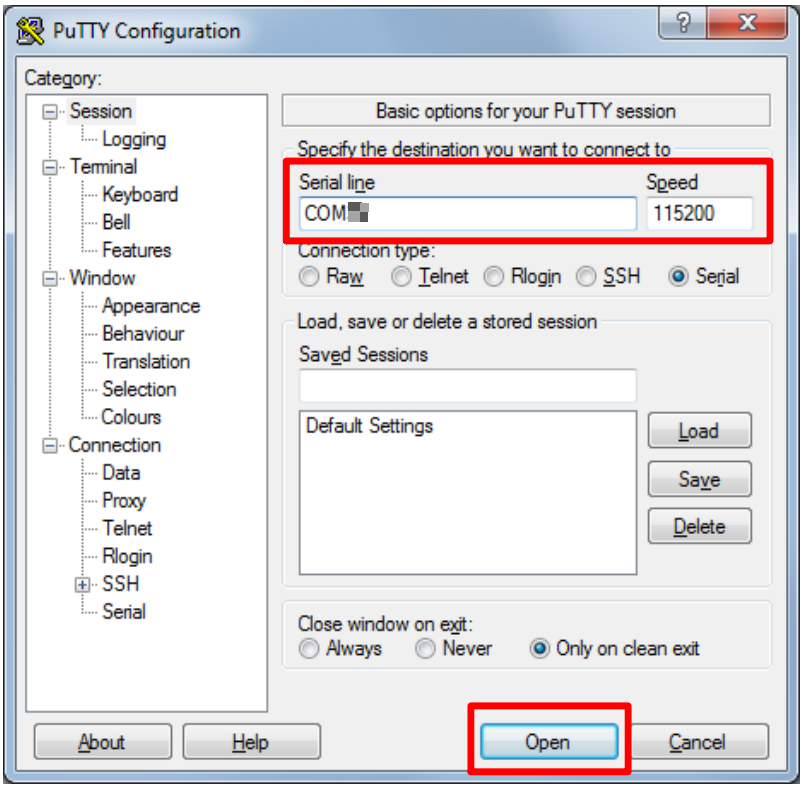

Figure 4-6 PuTTY Session Setting

4.5 Find the Example Project

Use the “Template” project as an example. The project can be found under the BSP folder as shown in Figure 4-7.

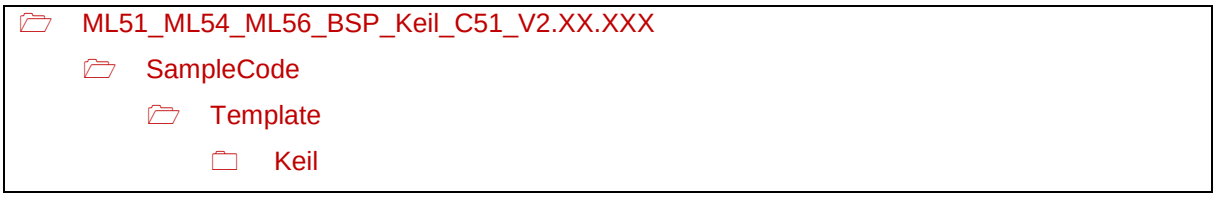

Figure 4-7 Template Project Folder Path

4.6 Execute the Project under Toolchains

Open and execute the project under the toolchain. Section 4.6.1 and 4.6.2 describe the steps of executing project in Keil C51 and IAR EW8051, respectively.

4.6.1 Keil C51

This section provides steps to beginners on how to run a project by using Keil C51.

1. Double click the “Template.uvproj” to open the project.

   Note: If Figure 4-8 warning message jumps out, please migrate to version 5 formats as shown in Figure 4-9. The “.uvproj” filename extension will change to “.uvprojx”.

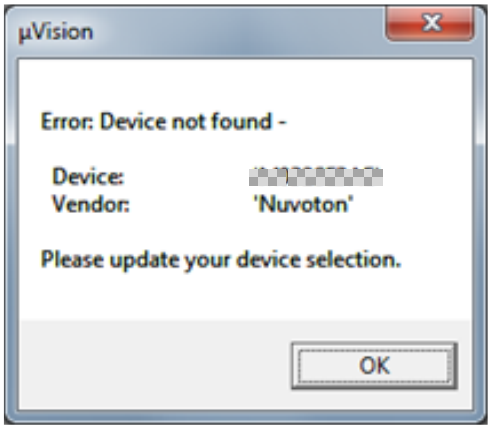

Figure 4-8 Warning Message of “Device not found”

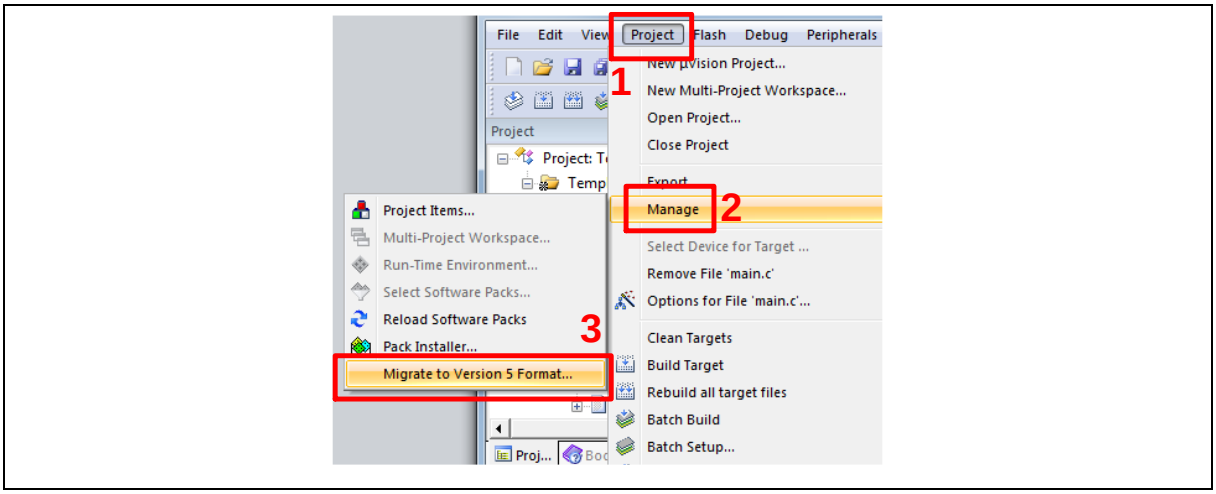

Figure 4-9 Project File Migrate to Version 5 Format

2. Make sure the debugger is “Nuvoton Nu-Link Debugger” as shown in Figure 4-10 and Figure 4-11.

   Note: If the dropdown menu in Figure 4-10 does not contain “Nuvoton Nu-Link Debugger” item, please rework section 4.2.

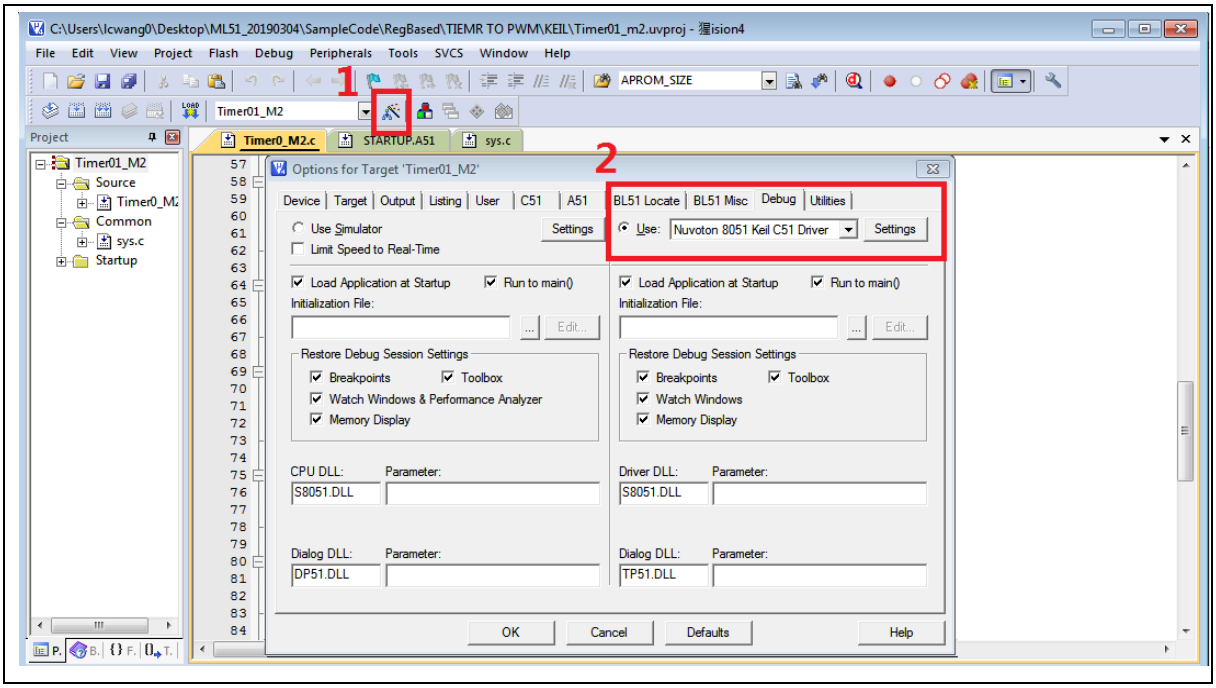

Figure 4-10 Debugger Setting in Options Window

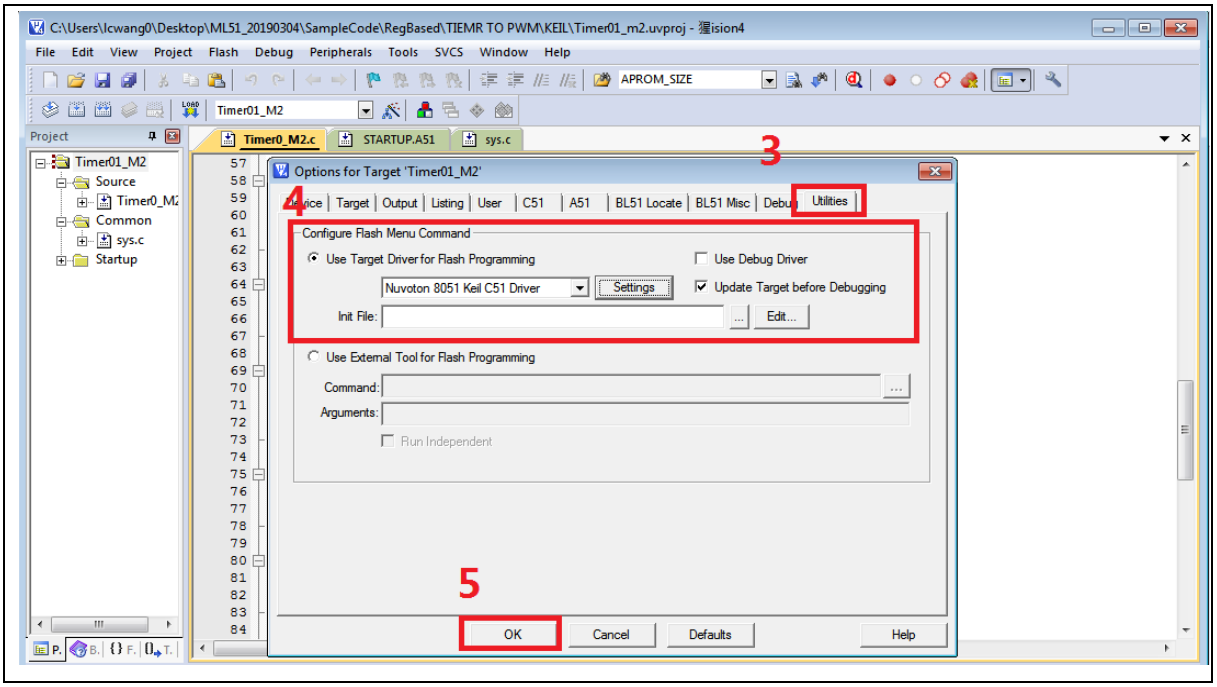

Figure 4-11 Programming Setting in Options Window

3. Rebuild all target files. After successfully compile the project, download code to the flash memory. Click “Start/Stop Debug Section” button can enter debug mode.

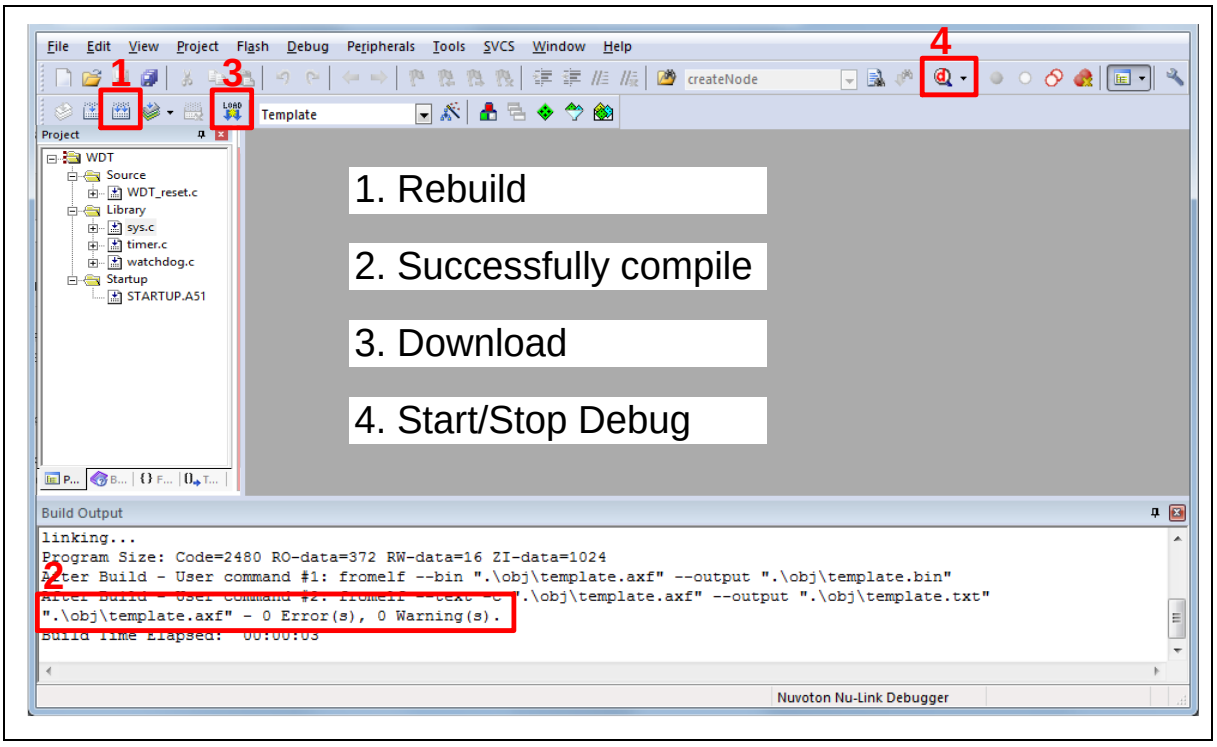

Figure 4-12 Compile and Download the Project

4. Figure 4-13 shows the debug mode under Keil C51. Click “Run” and the debug message will be

printed out as shown in Figure 4-14. User can debug the project under debug mode by checking source code, assembly language, peripherals' registers, and setting breakpoint, step run, value monitor, etc.

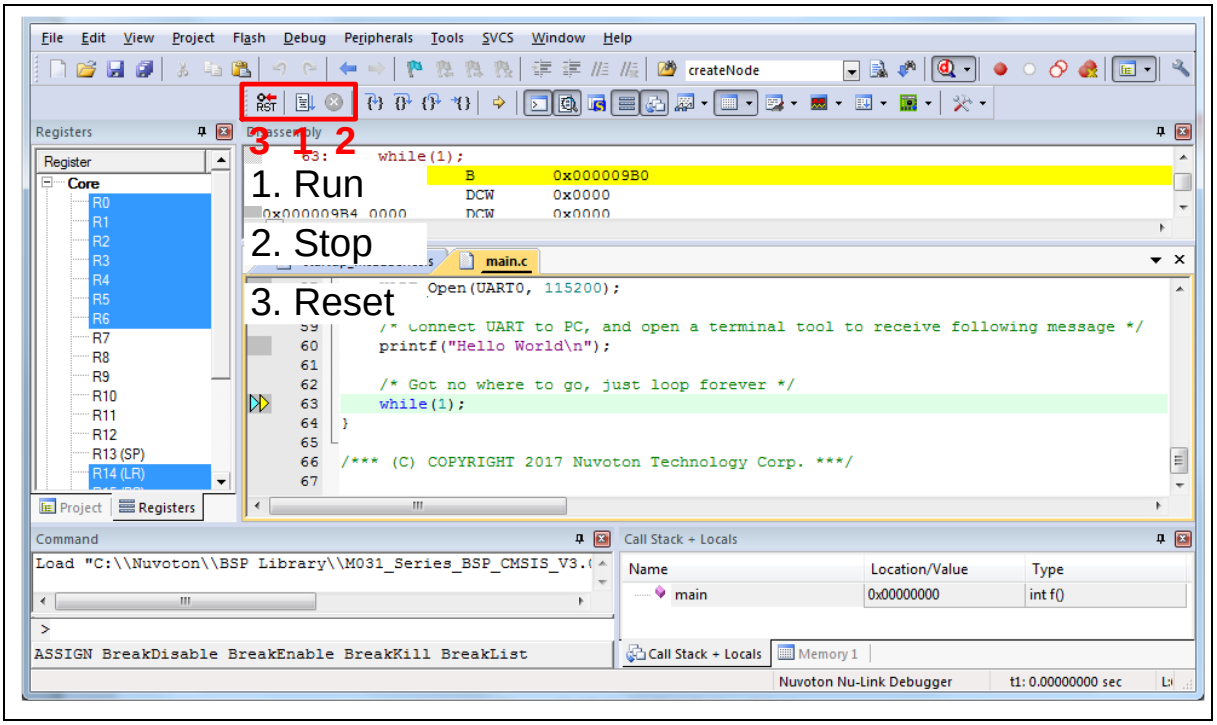

Figure 4-13 Keil C51 Debug Mode

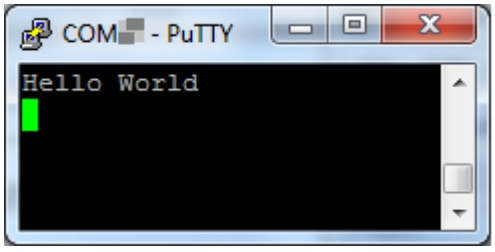

Figure 4-14 Debug Message on Serial Port Terminal Windows

4.6.2 IAR EW8051

This section provides steps to beginners on how to run a project by using IAR EW8051.

1. Double click the “Template.eww” to open the project.
2. Make sure the toolbar contain “Nu-Link” item as shown in Figure 4-15.

   Note: If the toolbar does not contain “Nu-Link” item, please rework section 4.2.

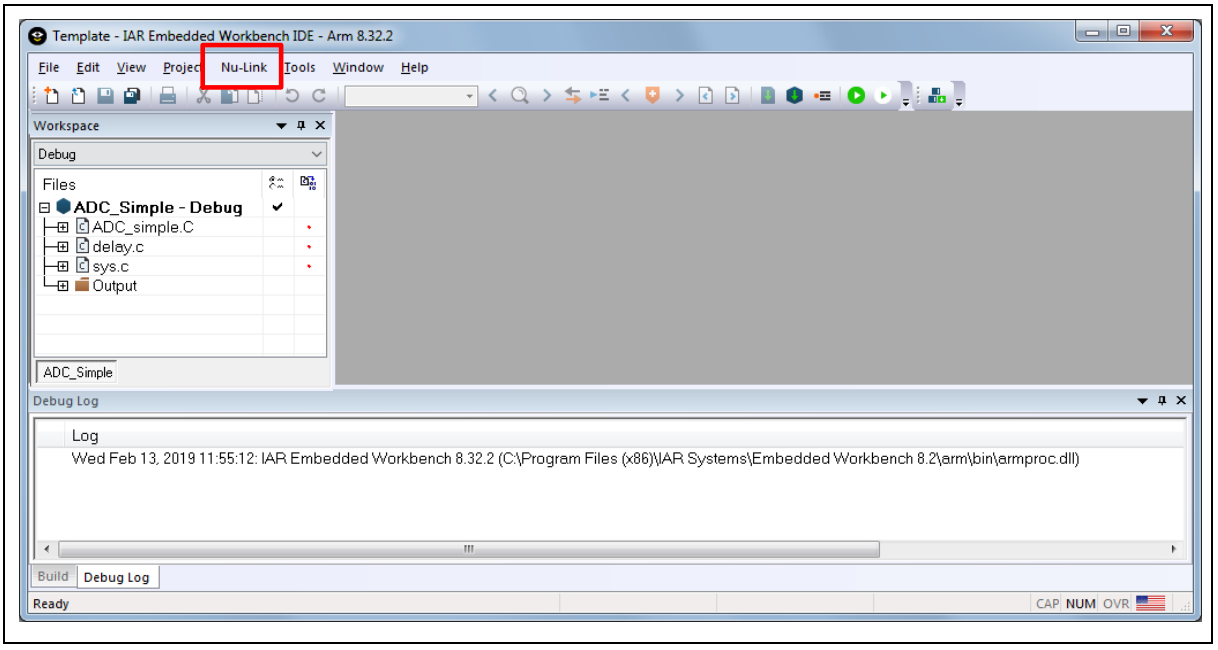

Figure 4-15 IAR EW8051 Window

3. Make target file as presented in Figure 4-16. After successfully compile the project, download code to the flash memory and enter debug mode.

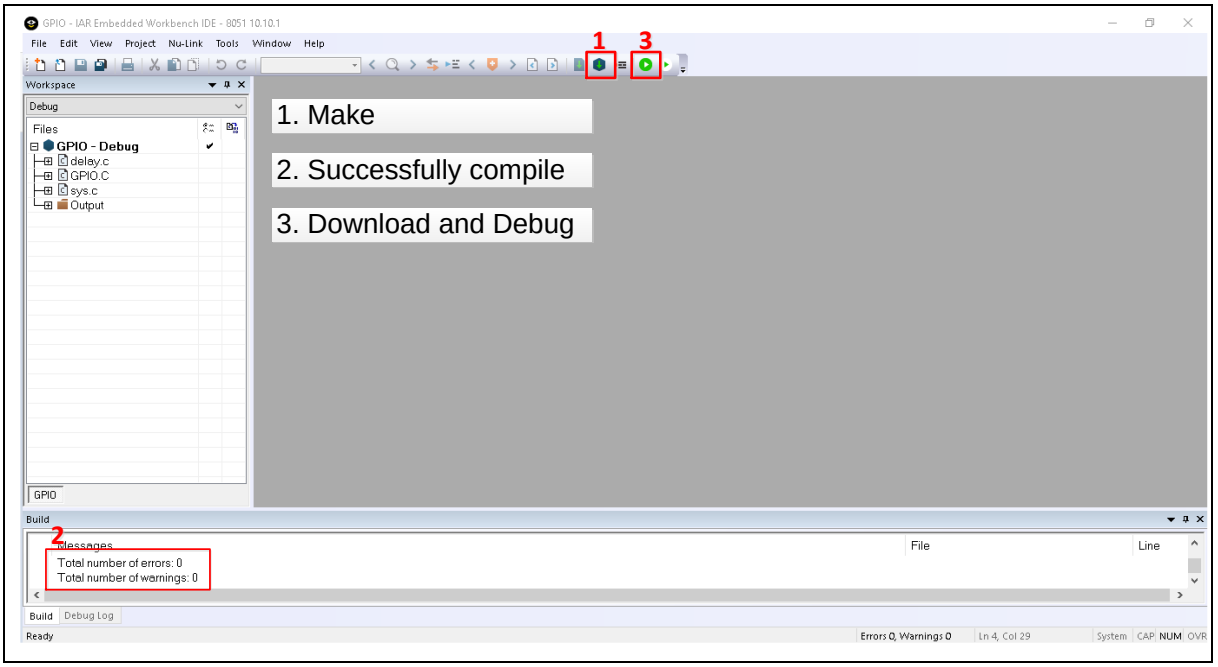

Figure 4-16 Compile and Download the Project

4. Figure 4-17 shows the debug mode under IAR EW8051. Click “Go” and the debug message will be printed out as shown in Figure 4-18. User can debug the project under debug mode by checking source code, assembly language, peripherals’ registers, and setting breakpoint, step run, value monitor, etc.

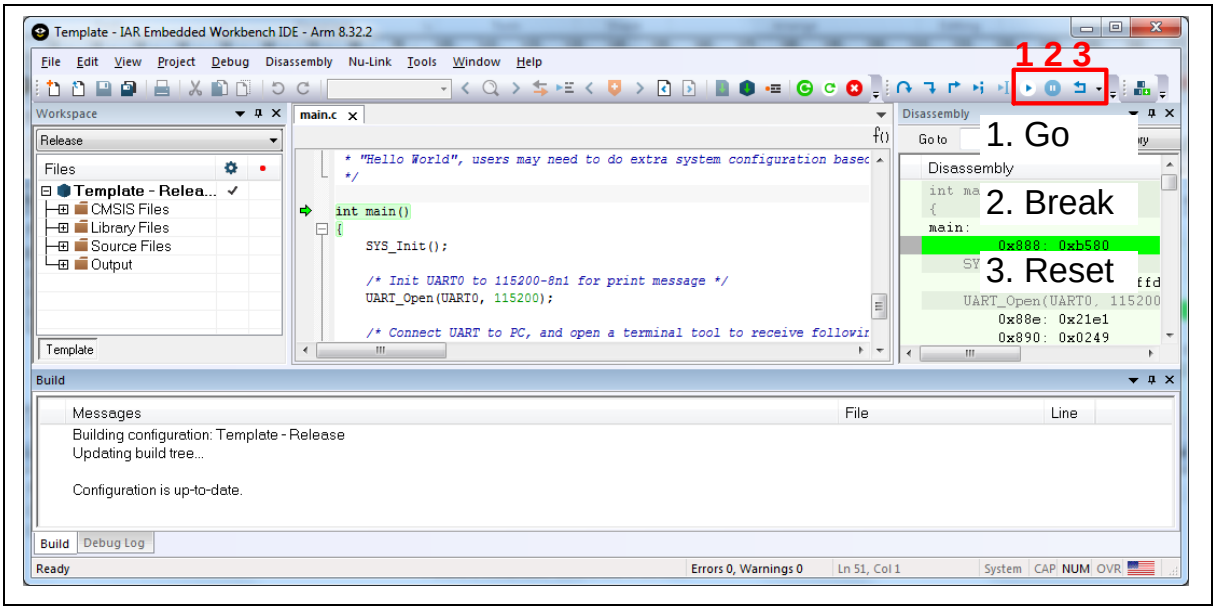

Figure 4-17 IAR EW8051 Debug Mode

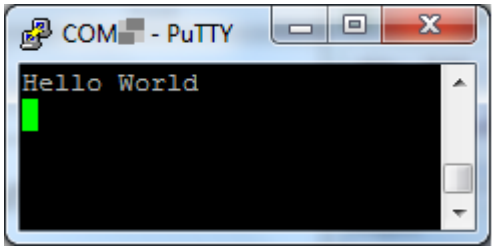

Figure 4-18 Debug Message on Serial Port Terminal Windows

5 NUMAKER-ML56SD SCHEMATICS

5.1 Nu-Link2-Me

Figure 5-1 shows the Nu-Link2-Me circuit.

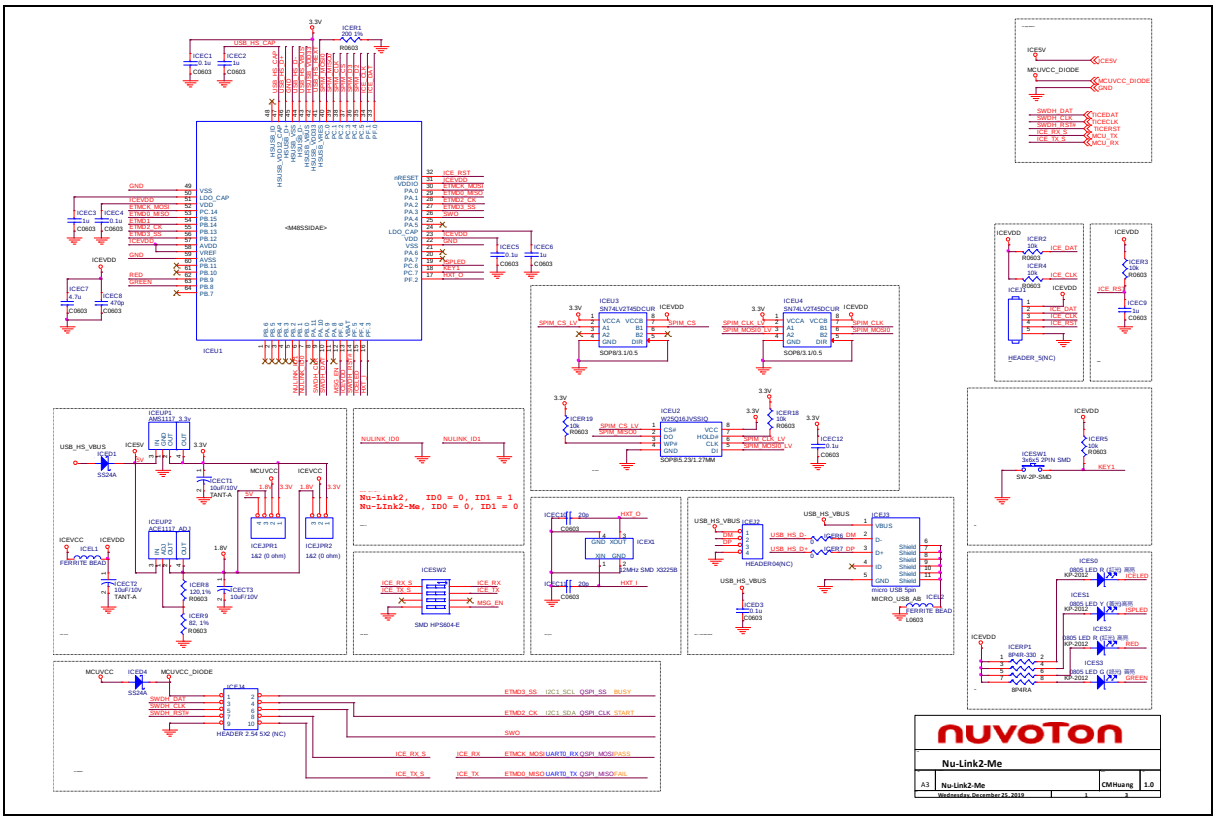

Figure 5-1 Nu-Link2-Me Circuit

5.2 ML56 platform

Figure 5-2 shows the ML56 platform circuit.

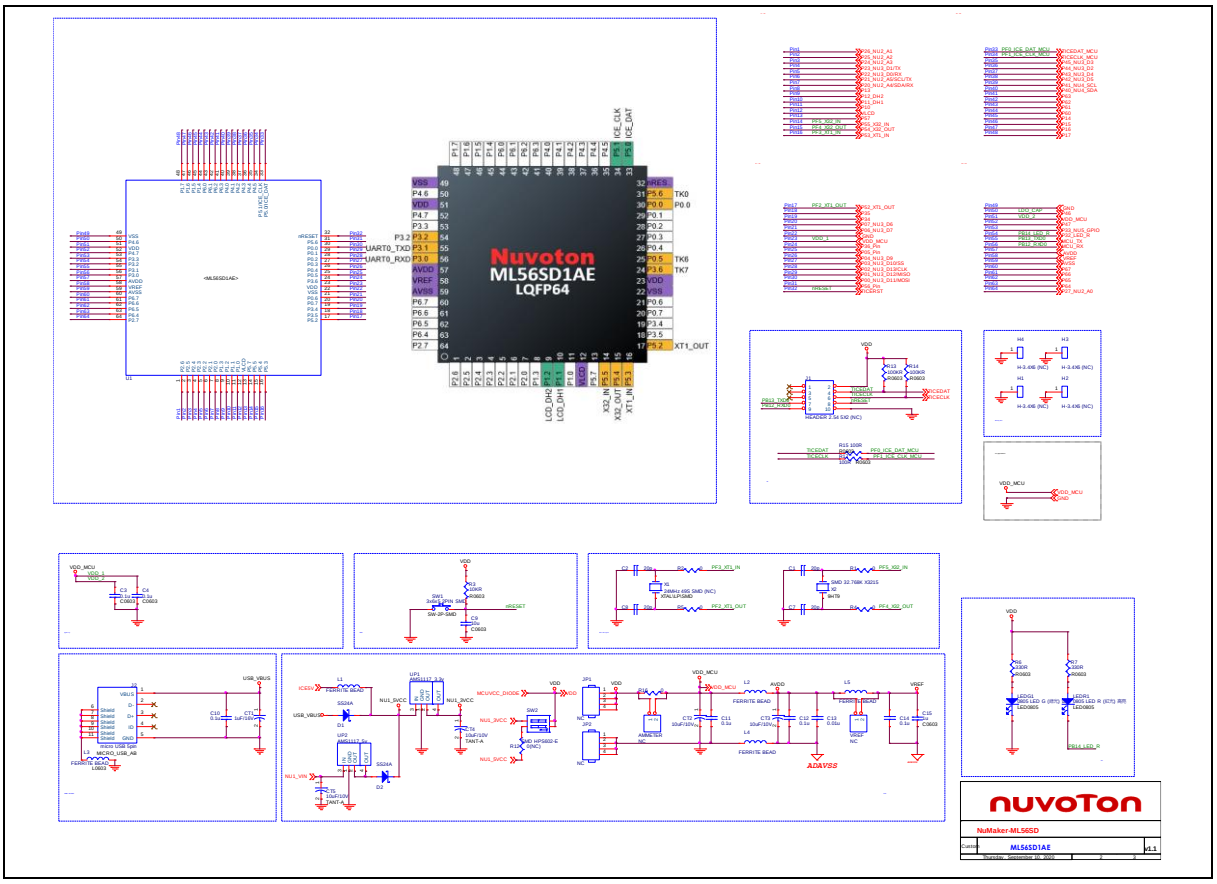

Figure 5-2 ML56 platform Circuit

5.3 Extension Connector

Figure 5-3 shows extension connectors of NuMaker-ML56SD.

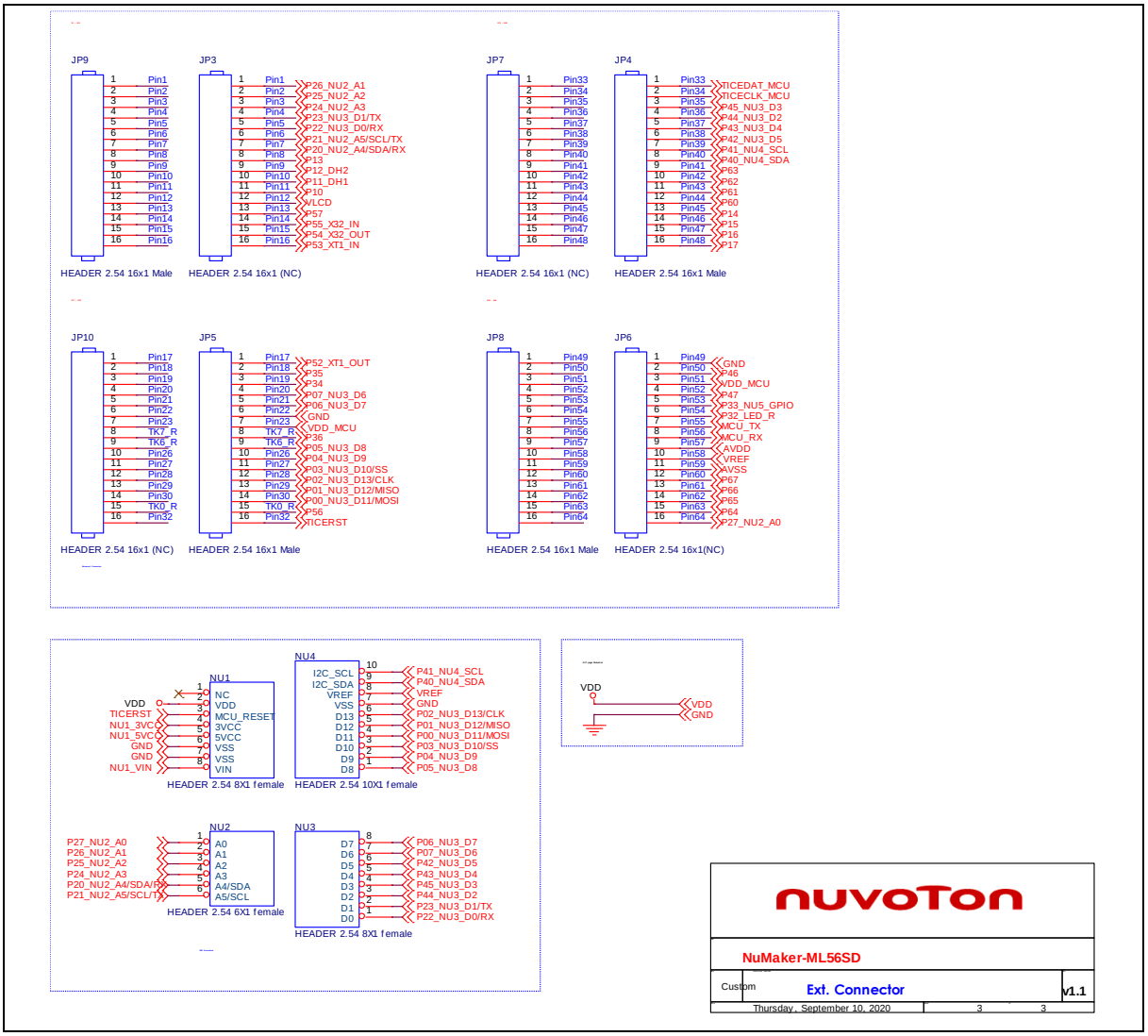

Figure 5-3 Extension Connectors Circuit

5.4 TK and LCD Cap

Figure 5-4 shows touch key and LCD cap of NuMaker-ML56SD.

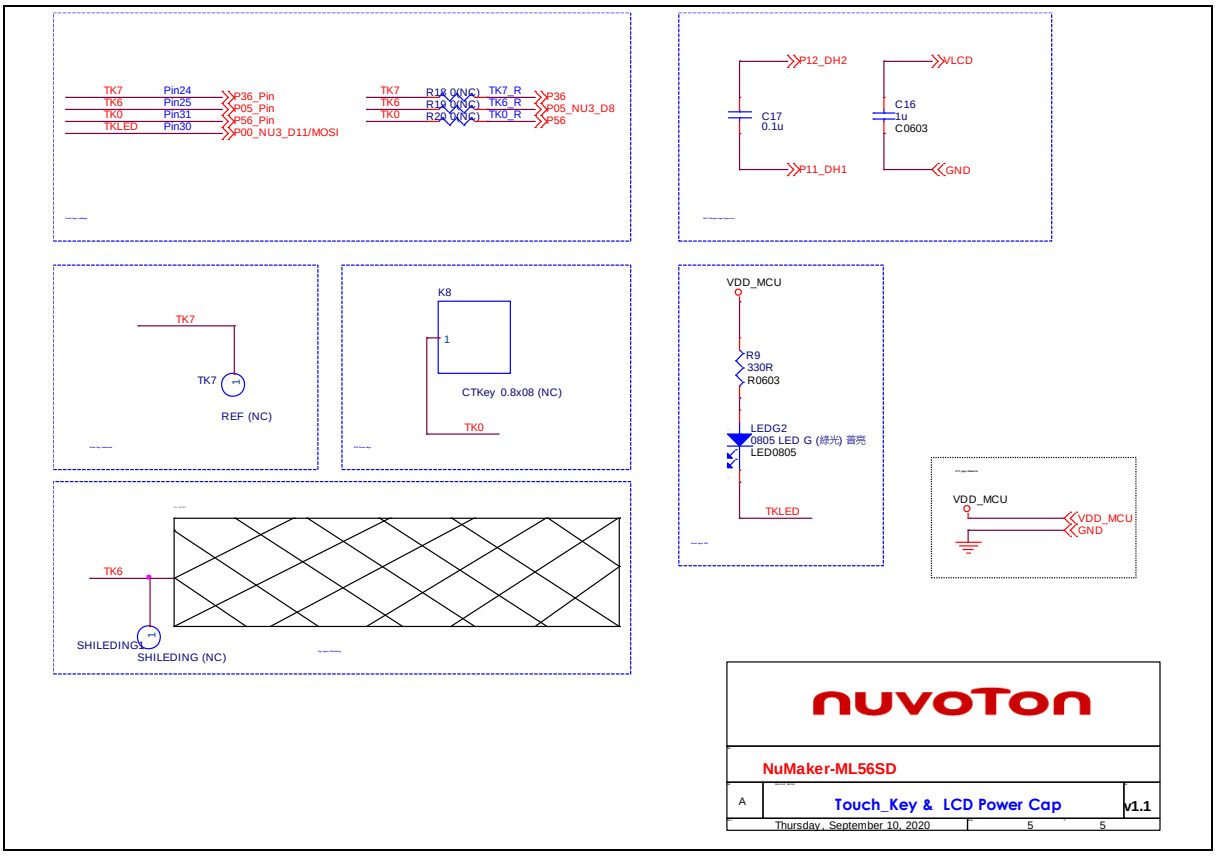

Figure 5-4 Touch Key and LCD Cap Circuit

5.5 PCB Placement

Figure 5-5 and Figure 5-6 show the front and rear placement of NuMaker-ML56SD.

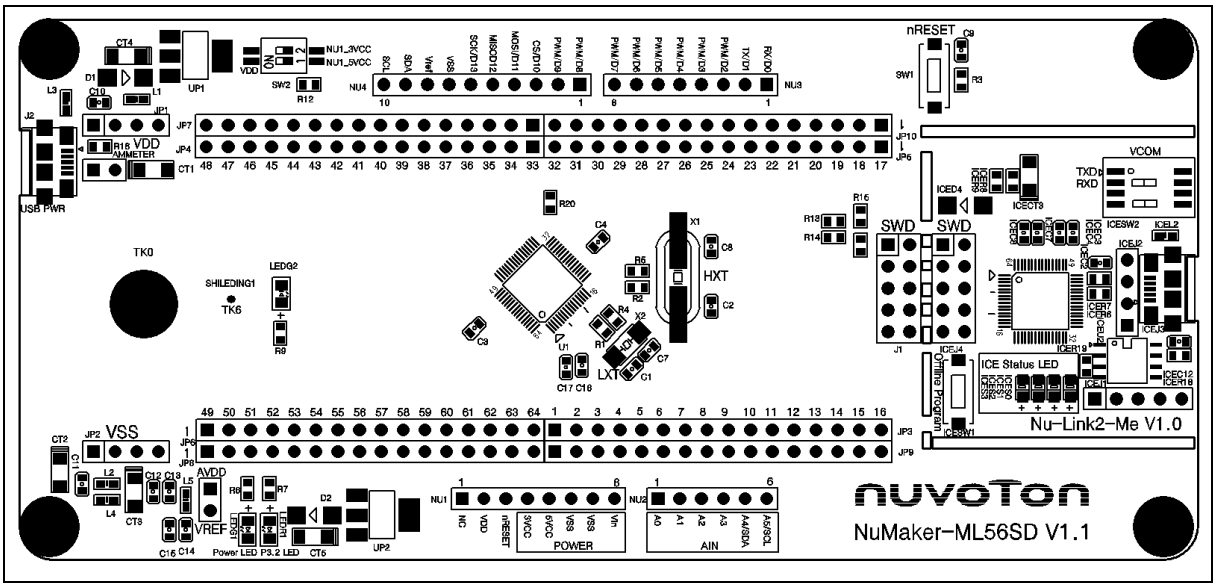

Figure 5-5 Front Placement

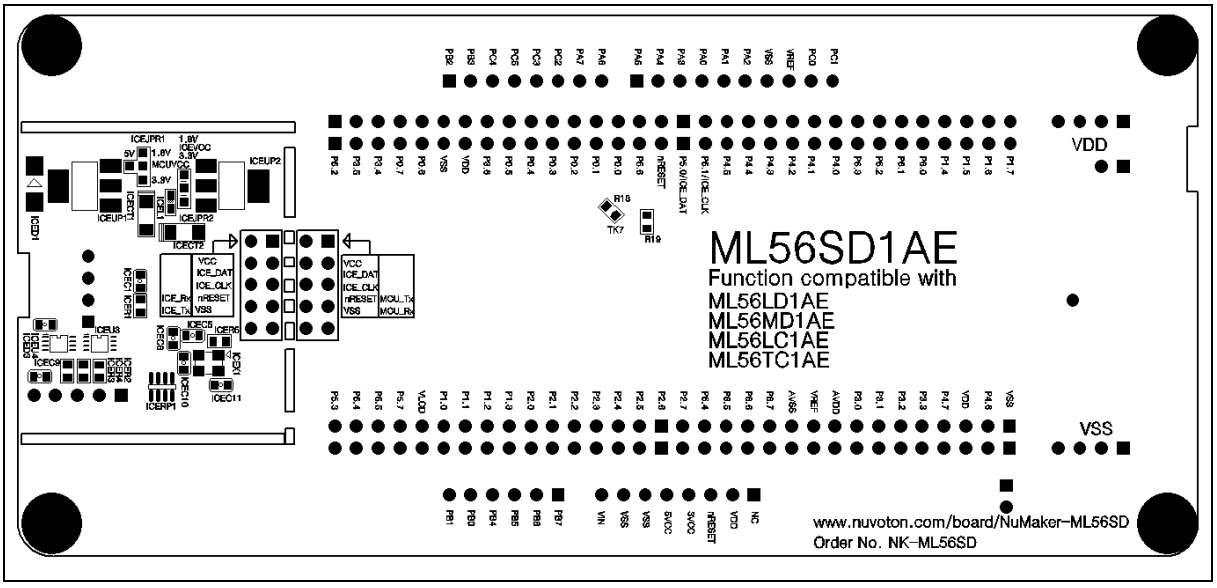

Figure 5-6 Rear Placement

6 NUMAKER-TNLCDSUB_ML56SD SCHEMATICS

6.1 LCD Connector

Figure 6-1 shows LCD connectors of TN CD daughter board.

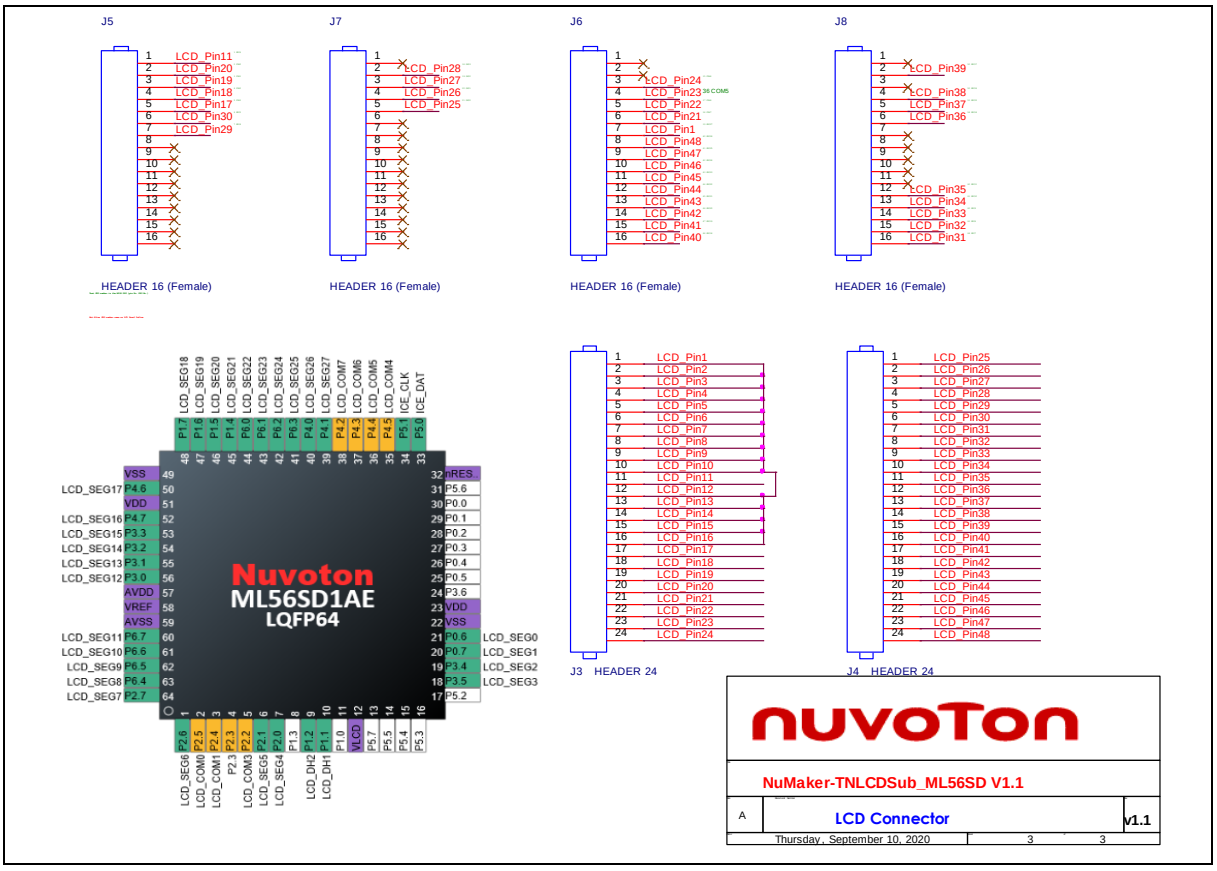

Figure 6-1 LCD Connectors of NuMaker-TNLCDSUB_ML56

7 REVISION HISTORY

Date	Revision	Description
2020.08.21	1.00	1. Initial version
2021.03.08	1.01	2. Modified the Figure 4-11, Figure 4-12 and 4-13.

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