

NuMicro[®] Family
Arm[®] Cortex[®]-M4-based Microcontroller

NuMaker-M463KG
User Manual

Evaluation Board for NuMicro[®] M460 Series

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1 OVERVIEW

The NuMaker-M463KG is an evaluation board for Nuvoton NuMicro M463KG, M463SG, M463LG and M463YG microcontrollers. The NuMaker-M463KG consists of two parts: an M463KG target board and an on-board Nu-Link2-Me debugger and programmer. The NuMaker-M463KG is designed for project evaluation, prototype development and validation with power consumption monitoring function.

The M463KG target board is based on NuMicro M463KGCAE. For the development flexibility, the M463KG target board provides the extension connectors, the Arduino UNO compatible headers and the capability of adopting multiple power supplies. Furthermore, the Nuvoton-designed ammeter connector can measure the power consumption instantly, which is essential for the prototype evaluation.

In addition, 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 could be shown on the built-in LEDs. Lastly, the Nu-Link2-Me could be detached from the evaluation board and become a stand-alone mass production programmer.

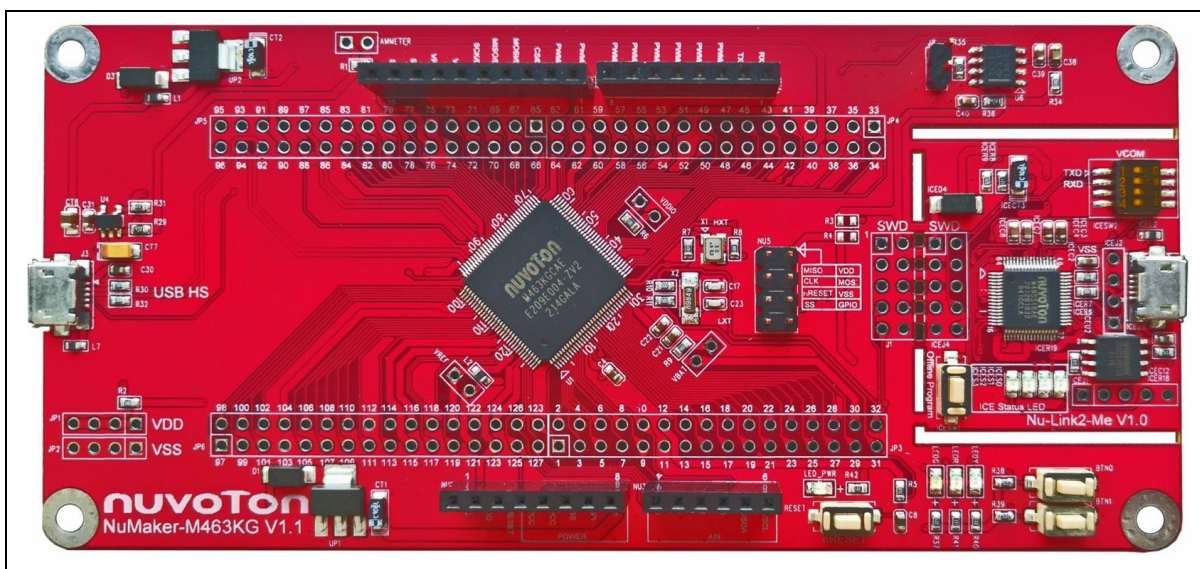


Figure 1-1 NuMaker-M463KG Evaluation Board

2 FEATURES

- NuMicro M463KGCAE used as main microcontroller with function compatible with:
 - M463SGCAE
 - M463LGCAE
 - M463YGCAE
- M463KGCAE full pins extension connectors
- Arduino UNO compatible extension connectors
- Ammeter connector for measuring the microcontroller's power consumption
- Flexible board power supply:
 - External V_{DD} power connector
 - Arduino UNO compatible extension connector V_{in}
 - HS-USB connector on M463KG target board
 - ICE USB connector on Nu-Link2-Me
- On-board Nu-Link2-Me debugger and programmer:
 - Debug through SWD interface
 - Online/offline programming
 - Virtual COM port function
- On-board component:
 - User LEDs and user buttons
 - HS-USB OTG connector
 - CAN FD transceiver

3 HARDWARE CONFIGURATION

3.1 Front View

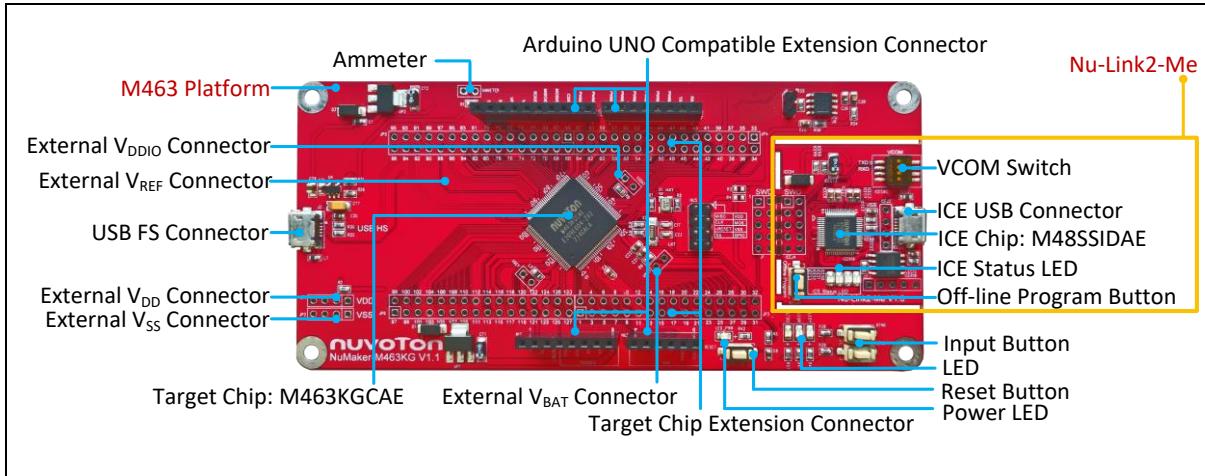


Figure 3-1 Front View of NuMaker-M463KG

Figure 3-1 shows the main components and connectors from the front side of NuMaker- M463KG. The following lists components and connectors from the front view:

- Target chip: M463KGCAE (U1)
- USB HS Connector (J3)
- CAN FD Transceiver (U6)
- Arduino UNO Compatible Extension Connectors (NU1, NU2, NU3, NU4 and NU5)
- M463KG Extension Connectors (JP3, JP4, JP5 and JP6)
- External V_{DD} Power Connector (JP1)
- External V_{SS} Power Connector (JP2)
- External V_{REF} Connector (VREF)
- External V_{DDIO} Connector (VDDIO)
- External V_{BAT} Connector (VBAT)
- Ammeter Connector (AMMETER)
- Reset Button (RESET)
- Power LED (LED_PWR), Red LED (LEDR), Green LED (LEDG) and Yellow LED (LEDY)
- 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-M463KG.

The following lists components and connectors from the rear view:

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

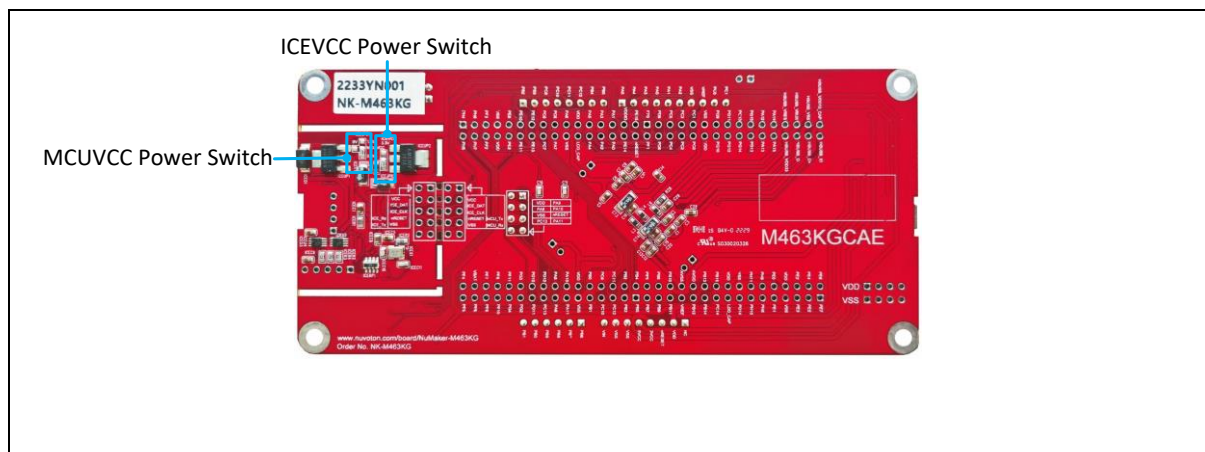


Figure 3-2 Rear View of NuMaker-M463KG

3.3 Extension Connectors

Table 3-1 presents the extension connectors.

Connector	Description
JP3, JP4, JP5 and JP6	Full pins extension connectors on the NuMaker-M463KG.
NU1, NU2, NU3, NU4 and NU5	Arduino UNO compatible pins on the NuMaker-M463KG.

Table 3-1 Extension Connectors

3.3.1 Pin Assignment for Extension Connectors

The NuMaker-M463KG provides the M463KGC AE onboard and extension connectors (JP3, JP4, JP5 and JP6). Figure 3-3 shows the M463KGC AE extension connectors.

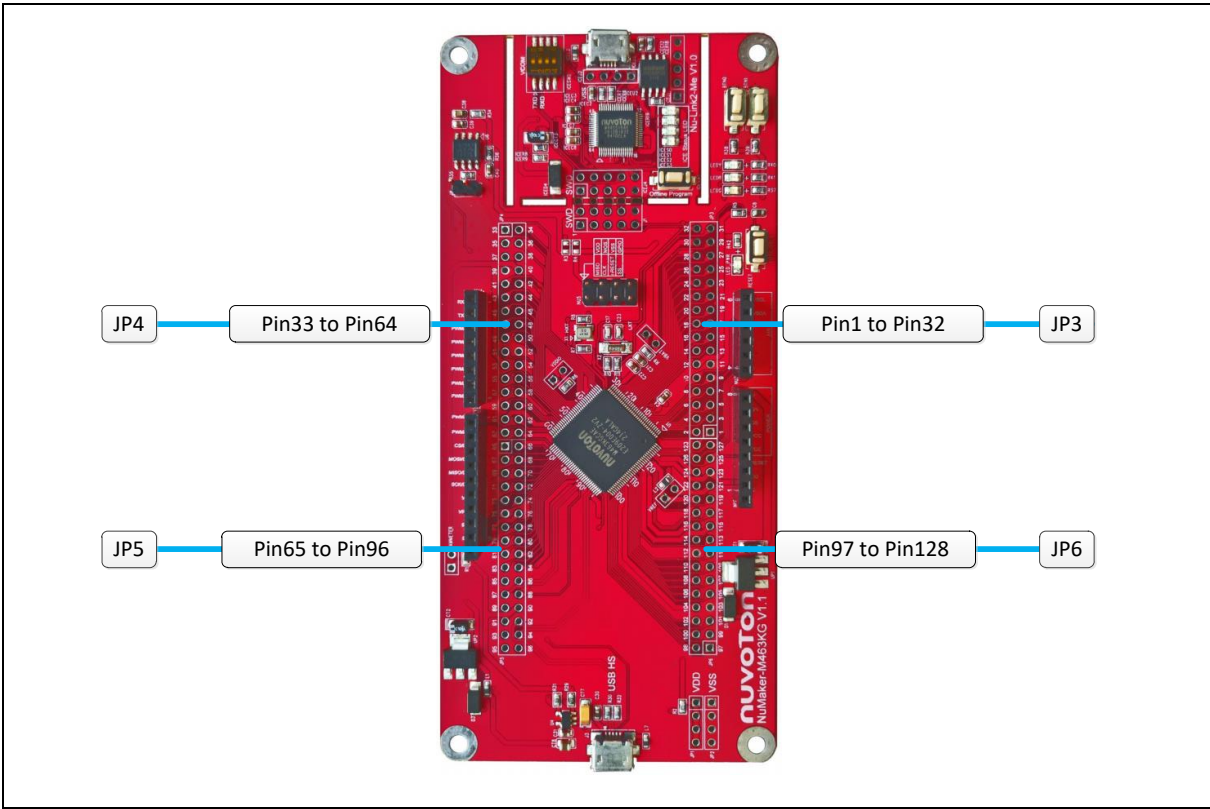


Figure 3-3 M463KGC AE Extension Connectors

Header		M463KGCAE	
		Pin No.	Function
JP3	JP3.1	1	PB.5 / EADC0_CH5 / ACMP1_N / EBI_ADR0 / SD0_DAT3 / SPI1_MISO / I2C0_SCL / UART5_TXD / SC0_CLK / EPWM0_CH0 / UART2_TXD / TM0 / INT0 / PSIO0_CH4 / KPI_COL6
	JP3.2	2	PB.4 / EADC0_CH4 / ACMP1_P1 / EBI_ADR1 / SD0_DAT2 / SPI1_MOSI / I2C0_SDA / UART5_RXD / SC0_DAT / EPWM0_CH1 / UART2_RXD / TM1 / INT1 / PSIO0_CH5 / KPI_COL7
	JP3.3	3	PB.3 / EADC0_CH3 / ACMP0_N / EBI_ADR2 / SD0_DAT1 / SPI1_CLK / UART1_TXD / UART5_nRTS / SC0_RST / EPWM0_CH2 / I2C1_SCL / TM2 / INT2 / PSIO0_CH6 / KPI_ROW0
	JP3.4	4	PB.2 / EADC0_CH2 / ACMP0_P1 / EBI_ADR3 / SD0_DAT0 / SPI1_SS / UART1_RXD / UART5_nCTS / SC0_PWR / EPWM0_CH3 / I2C1_SDA / TM3 / INT3 / PSIO0_CH7 / KPI_ROW1
	JP3.5	5	PC.12 / EBI_ADR4 / UART0_TXD / I2C0_SCL / UART6_TXD / SPI3_MISO / SC0_nCD / I2C4_SCL / ECAP1_IC2 / EPWM1_CH0 / ACMP0_O
	JP3.6	6	PC.11 / EBI_ADR5 / UART0_RXD / I2C0_SDA / UART6_RXD / SPI3_MOSI / I2C4_SDA / ECAP1_IC1 / EPWM1_CH1 / ACMP1_O
	JP3.7	7	PC.10 / EBI_ADR6 / UART6_nRTS / SPI3_CLK / UART3_TXD / CAN1_TXD / I2C4_SMBAL / ECAP1_IC0 / EPWM1_CH2
	JP3.8	8	PC.9 / EBI_ADR7 / UART6_nCTS / SPI3_SS / UART3_RXD / CAN1_RXD / I2C4_SMBSUS / EPWM1_CH3
	JP3.9	9	PB.1 / EADC0_CH1 / EBI_ADR8 / SD0_CLK / SPI3_I2SMCLK / UART2_TXD / I2C1_SCL / EPWM0_CH4 / EPWM1_CH4 / EPWM0_BRAKE0 / QSPI0_MISO1 / KPI_ROW2
	JP3.10	10	PB.0 / EADC0_CH0 / EBI_ADR9 / SD0_CMD / SPI2_I2SMCLK / USCIO_CTL0 / UART2_RXD / SPI0_I2SMCLK / I2C1_SDA / EPWM0_CH5 / EPWM1_CH5 / EPWM0_BRAKE1 / QSPI0_MOSI1 / KPI_ROW3
	JP3.11	11	VSS
	JP3.12	12	VDD
	JP3.13	13	PA.11 / ACMP0_P0 / EBI_nRD / SPI2_SS / USCIO_CLK / I2C2_SCL / UART6_TXD / BPWM0_CH0 / EPWM0_SYNC_OUT / TM0_EXT / KPI_ROW4
	JP3.14	14	PA.10 / ACMP1_P0 / EBI_nWR / SPI2_CLK / USCIO_DAT0 / I2C2_SDA / UART6_RXD / BPWM0_CH1 / EQEI1_INDEX / ECAP0_IC0 / TM1_EXT / KPI_ROW5
	JP3.15	15	PA.9 / EBI_MCLK / SPI2_MISO / USCIO_DAT1 / UART1_TXD / UART7_TXD / BPWM0_CH2 / EQEI1_A / ECAP0_IC1 / TM2_EXT
	JP3.16	16	PA.8 / EBI_ALE / SPI2_MOSI / USCIO_CTL1 / UART1_RXD / UART7_RXD / BPWM0_CH3 / EQEI1_B / ECAP0_IC2 / TM3_EXT / INT4
	JP3.17	17	PC.13 / EBI_ADR10 / SPI2_I2SMCLK / CAN1_TXD / USCIO_CTL0 / UART2_TXD / BPWM0_CH4 / CLK0 / EADC0_ST
	JP3.18	18	PD.12 / EBI_nCS0 / CAN1_RXD / UART2_RXD / BPWM0_CH5 / EQEI0_INDEX / CLK0 / EADC0_ST / INT5
	JP3.19	19	PD.11 / EBI_nCS1 / UART1_TXD / CAN0_TXD / EQEI0_A / INT6
	JP3.20	20	PD.10 / EBI_nCS2 / UART1_RXD / CAN0_RXD / EQEI0_B / INT7
	JP3.21	21	PG.2 / EBI_ADR11 / SPI2_SS / I2C0_SMBAL / I2C1_SCL / I2C3_SMBAL / TM0
	JP3.22	22	PG.3 / EBI_ADR12 / SPI2_CLK / I2C0_SMBSUS / I2C1_SDA / I2C3_SMBSUS / TM1
	JP3.23	23	PG.4 / EBI_ADR13 / SPI2_MISO / TM2
	JP3.24	24	PF.11 / EBI_ADR14 / SPI2_MOSI / UART5_TXD / TAMPER5 / TM3
	JP3.25	25	PF.10 / EBI_ADR15 / SC0_nCD / SPI0_I2SMCLK / UART5_RXD / TAMPER4
	JP3.26	26	PF.9 / EBI_ADR16 / SC0_PWR / SPI0_SS / UART5_nRTS / CAN1_TXD / TAMPER3
	JP3.27	27	PF.8 / EBI_ADR17 / SC0_RST / SPI0_CLK / UART5_nCTS / CAN1_RXD / TAMPER2
	JP3.28	28	PF.7 / EBI_ADR18 / SC0_DAT / SPI0_MISO / UART4_TXD / TAMPER1
	JP3.29	29	PF.6 / EBI_ADR19 / SC0_CLK / SPI0_MOSI / UART4_RXD / EBI_nCS0 / SPI3_I2SMCLK / TAMPER0 / TRACE_SWO
	JP3.30	30	VBAT
	JP3.31	31	PF.5 / UART2_RXD / EBI_AD1 / UART2_nCTS / EPWM0_CH0 / BPWM0_CH4 / EPWM0_SYNC_OUT / X32_IN / EADC0_ST / I2C4_SCL

Header		M463KGCAE	
		Pin No.	Function
	JP3.32	32	PF.4 / UART2_TXD / EBI_AD0 / UART2_nRTS / EPWM0_CH1 / BPWM0_CH5 / X32_OUT / I2C4_SDA
JP4	JP4.1	33	PH.4 / EBI_ADR3 / SPI1_MISO / UART7_nRTS / UART6_TXD
	JP4.2	34	PH.5 / EBI_ADR2 / SPI1_MOSI / UART7_nCTS / UART6_RXD
	JP4.3	35	PH.6 / EBI_ADR1 / SPI1_CLK / UART7_TXD
	JP4.4	36	PH.7 / EBI_ADR0 / SPI1_SS / UART7_RXD
	JP4.5	37	PF.3 / EBI_nCS0 / UART0_TXD / I2C0_SCL / XT1_IN / BPWM1_CH0 / I2C4_SMBAL
	JP4.6	38	PF.2 / EBI_nCS1 / UART0_RXD / I2C0_SDA / QSPI0_CLK / XT1_OUT / BPWM1_CH1 / I2C4_SMBSUS
	JP4.7	39	VSS
	JP4.8	40	VDD
	JP4.9	41	PE.8 / EBI_ADR10 / SPI2_CLK / UART2_TXD / EPWM0_CH0 / EPWM0_BRAKE0 / ECAP0_IC0 / TRACE_DATA3
	JP4.10	42	PE.9 / EBI_ADR11 / SPI2_MISO / UART2_RXD / EPWM0_CH1 / EPWM0_BRAKE1 / ECAP0_IC1 / TRACE_DATA2
	JP4.11	43	PE.10 / EBI_ADR12 / SPI2_MOSI / UART3_TXD / EPWM0_CH2 / EPWM1_BRAKE0 / ECAP0_IC2 / TRACE_DATA1
	JP4.12	44	PE.11 / EBI_ADR13 / SPI2_SS / UART3_RXD / UART1_nCTS / EPWM0_CH3 / EPWM1_BRAKE1 / ECAP1_IC2 / TRACE_DATA0 / KPI_COL7
	JP4.13	45	PE.12 / EBI_ADR14 / SPI2_I2SMCLK / UART1_nRTS / EPWM0_CH4 / ECAP1_IC1 / TRACE_CLK / KPI_COL6
	JP4.14	46	PE.13 / EBI_ADR15 / I2C0_SCL / UART4_nRTS / UART1_TXD / EPWM0_CH5 / EPWM1_CH0 / BPWM1_CH5 / ECAP1_IC0 / TRACE_SWO / KPI_COL5
	JP4.15	47	PC.8 / EBI_ADR16 / I2C0_SDA / UART4_nCTS / UART1_RXD / EPWM1_CH1 / BPWM1_CH4 / KPI_COL4
	JP4.16	48	PC.7 / EBI_AD9 / SPI1_MISO / UART4_TXD / UART0_nCTS / I2C1_SMBAL / UART6_TXD / EPWM1_CH2 / BPWM1_CH0 / TM0 / INT3 / KPI_COL3
	JP4.17	49	PC.6 / EBI_AD8 / SPI1_MOSI / UART4_RXD / UART0_nRTS / I2C1_SMBSUS / UART6_RXD / EPWM1_CH3 / BPWM1_CH1 / TM1 / INT2 / KPI_COL2
	JP4.18	50	PA.7 / EBI_AD7 / SPI1_CLK / UART0_TXD / I2C1_SCL / QSPI1_MISO1 / EPWM1_CH4 / BPWM1_CH2 / ACMP0_WLAT / TM2 / INT1 / KPI_COL1
	JP4.19	51	PA.6 / EBI_AD6 / SPI1_SS / UART0_RXD / I2C1_SDA / QSPI1_MOSI1 / EPWM1_CH5 / BPWM1_CH3 / ACMP1_WLAT / TM3 / INT0 / KPI_COL0
	JP4.20	52	VSS
	JP4.21	53	VDD
	JP4.22	54	LDO_CAP
	JP4.23	55	PA.5 / QSPI0_MISO1 / SPI1_I2SMCLK / UART0_nCTS / UART5_TXD / I2C0_SCL / CAN0_TXD / UART0_TXD / BPWM0_CH5 / EPWM0_CH0 / EQEI0_INDEX
	JP4.24	56	PA.4 / QSPI0_MOSI1 / SPI0_I2SMCLK / SC0_nCD / UART0_nRTS / UART5_RXD / I2C0_SDA / CAN0_RXD / UART0_RXD / BPWM0_CH4 / EPWM0_CH1 / EQEI0_A
	JP4.25	57	PA.3 / QSPI0_SS / SPI0_SS / SC0_PWR / UART4_TXD / UART1_TXD / I2C1_SCL / I2C0_SMBAL / BPWM0_CH3 / EPWM0_CH2 / EQEI0_B / EPWM1_BRAKE1 / PSIO0_CH4
	JP4.26	58	PA.2 / QSPI0_CLK / SPI0_CLK / SC0_RST / UART4_RXD / UART1_RXD / I2C1_SDA / I2C0_SMBSUS / BPWM0_CH2 / EPWM0_CH3 / PSIO0_CH5
	JP4.27	59	PA.1 / QSPI0_MISO0 / SPI0_MISO / SC0_DAT / UART0_TXD / UART1_nCTS / I2C2_SCL / BPWM0_CH1 / EPWM0_CH4 / PSIO0_CH6
	JP4.28	60	PA.0 / QSPI0_MOSI0 / SPI0_MOSI / SC0_CLK / UART0_RXD / UART1_nRTS / I2C2_SDA / BPWM0_CH0 / EPWM0_CH5 / PSIO0_CH7
	JP4.29	61	VDDIO
	JP4.30	62	PE.14 / EBI_AD8 / UART2_TXD / CAN0_TXD / UART6_TXD / PSIO0_CH0
	JP4.31	63	PE.15 / EBI_AD9 / UART2_RXD / CAN0_RXD / UART6_RXD / PSIO0_CH1

Header		M463KGCAE	
		Pin No.	Function
	JP4.32	64	nRESET
JP5	JP5.1	65	PF.0 / UART1_TXD / I2C1_SCL / UART0_TXD / UART2_TXD / I2C0_SCL / EPWM1_CH4 / BPWM1_CH0 / ACMP0_O / ICE_DAT / EADC0_ST / QSPI1_MISO0
	JP5.2	66	PF.1 / UART1_RXD / I2C1_SDA / UART0_RXD / UART2_RXD / I2C0_SDA / EPWM1_CH5 / BPWM1_CH1 / ACMP1_O / ICE_CLK / QSPI1_MOSI0
	JP5.3	67	PD.9 / EBI_AD7 / I2C2_SCL / UART2_nCTS / UART7_TXD / PSIO0_CH2
	JP5.4	68	PD.8 / EBI_AD6 / I2C2_SDA / UART2_nRTS / UART7_RXD / PSIO0_CH3
	JP5.5	69	PC.5 / EBI_AD5 / QSPI0_MISO1 / UART2_TXD / I2C1_SCL / CAN0_TXD / UART4_TXD / EPWM1_CH0 / QSPI1_SS / I2C3_SMBAL / PSIO0_CH0 / KPI_ROW0
	JP5.6	70	PC.4 / EBI_AD4 / QSPI0_MOSI1 / SPI1_I2SMCLK / UART2_RXD / I2C1_SDA / CAN0_RXD / UART4_RXD / EPWM1_CH1 / QSPI1_CLK / I2C3_SMBSUS / PSIO0_CH1 / KPI_ROW1
	JP5.7	71	PC.3 / EBI_AD3 / QSPI0_SS / SPI1_MISO / UART2_nRTS / I2C0_SMBAL / CAN1_TXD / UART3_TXD / EPWM1_CH2 / QSPI1_MISO0 / I2C3_SCL / PSIO0_CH2 / KPI_ROW2
	JP5.8	72	PC.2 / EBI_AD2 / QSPI0_CLK / SPI1_MOSI / UART2_nCTS / I2C0_SMBSUS / CAN1_RXD / UART3_RXD / EPWM1_CH3 / QSPI1_MOSI0 / I2C3_SDA / PSIO0_CH3 / KPI_ROW3
	JP5.9	73	PC.1 / EBI_AD1 / QSPI0_MISO0 / SPI1_CLK / UART2_TXD / I2C0_SCL / EPWM1_CH4 / ACMP0_O / EADC0_ST / QSPI1_SS / KPI_ROW4
	JP5.10	74	PC.0 / EBI_AD0 / QSPI0_MOSI0 / SPI1_SS / UART2_RXD / I2C0_SDA / EPWM1_CH5 / ACMP1_O / QSPI1_CLK / KPI_ROW5
	JP5.11	75	VSS
	JP5.12	76	VDD
	JP5.13	77	PG.9 / EBI_AD0 / QSPI1_MISO1 / I2C4_SCL / BPWM0_CH5
	JP5.14	78	PG.10 / EBI_AD1 / QSPI1_MOSI1 / I2C4_SDA / BPWM0_CH4
	JP5.15	79	PG.11 / EBI_AD2 / QSPI1_SS / UART7_TXD / I2C4_SMBAL / BPWM0_CH3
	JP5.16	80	PG.12 / EBI_AD3 / QSPI1_CLK / UART7_RXD / I2C4_SMBSUS / BPWM0_CH2
	JP5.17	81	PG.13 / EBI_AD4 / QSPI1_MISO0 / UART6_TXD / BPWM0_CH1
	JP5.18	82	PG.14 / EBI_AD5 / QSPI1_MOSI0 / UART6_RXD / BPWM0_CH0
	JP5.19	83	PG.15 / CLK0 / EADC0_ST / QSPI1_MISO1
	JP5.20	84	PD.13 / EBI_AD10 / SD0_nCD / SPI0_I2SMCLK / SPI1_I2SMCLK / QSPI1_MOSI0 / UART6_RXD / BPWM0_CH0 / CLK0 / EADC0_ST / QSPI1_MOSI1
	JP5.21	85	PA.12 / UART4_TXD / I2C1_SCL / SPI2_SS / CAN0_TXD / SPI0_SS / QSPI1_MISO0 / BPWM1_CH2 / EQEI1_INDEX / PSIO0_CH4
	JP5.22	86	PA.13 / UART4_RXD / I2C1_SDA / SPI2_CLK / CAN0_RXD / SPI0_CLK / QSPI1_MOSI0 / BPWM1_CH3 / EQEI1_A / PSIO0_CH5
	JP5.23	87	PA.14 / UART0_TXD / EBI_AD5 / SPI2_MISO / I2C2_SCL / SPI0_MISO / BPWM1_CH4 / EQEI1_B / I2C0_SCL / PSIO0_CH6
	JP5.24	88	PA.15 / UART0_RXD / SPI2_MOSI / I2C2_SDA / SPI0_MOSI / BPWM1_CH5 / EPWM0_SYNC_IN / I2C0_SDA / PSIO0_CH7
	JP5.25	89	HSUSB_VRES
	JP5.26	90	HSUSB_VDD33
	JP5.27	91	HSUSB_VBUS
	JP5.28	92	HSUSB_D-
	JP5.29	93	HSUSB_VSS
	JP5.30	94	HSUSB_D+
	JP5.31	95	HSUSB_VDD12_CAP
	JP5.32	96	HSUSB_ID

Header		M463KGCAE	
		Pin No.	Function
JP6	JP6.1	97	PE.7 / SD0_CMD / UART5_TXD / CAN1_TXD / EQEI1_INDEX / EPWM0_CH0 / BPWM0_CH5 / PSIO0_CH0
	JP6.2	98	PE.6 / SD0_CLK / SPI3_I2SMCLK / SC0_nCD / USCIO_CTL0 / UART5_RXD / CAN1_RXD / EQEI1_A / EPWM0_CH1 / BPWM0_CH4 / PSIO0_CH1
	JP6.3	99	PE.5 / EBI_nRD / SD0_DAT3 / SPI3_SS / SC0_PWR / USCIO_CTL1 / UART6_TXD / UART7_nRTS / EQEI1_B / EPWM0_CH2 / BPWM0_CH3 / PSIO0_CH2
	JP6.4	100	PE.4 / EBI_nWR / SD0_DAT2 / SPI3_CLK / SC0_RST / USCIO_DAT1 / UART6_RXD / UART7_nCTS / EQEI0_INDEX / EPWM0_CH3 / BPWM0_CH2 / PSIO0_CH3
	JP6.5	101	PE.3 / EBI_MCLK / SD0_DAT1 / SPI3_MISO / SC0_DAT / USCIO_DAT0 / UART6_nRTS / UART7_TXD / EQEI0_A / EPWM0_CH4 / BPWM0_CH1
	JP6.6	102	PE.2 / EBI_ALE / SD0_DAT0 / SPI3_MOSI / SC0_CLK / USCIO_CLK / UART6_nCTS / UART7_RXD / EQEI0_B / EPWM0_CH5 / BPWM0_CH0
	JP6.7	103	VSS
	JP6.8	104	VDD
	JP6.9	105	PE.1 / EBI_AD10 / QSPI0_MISO0 / SPI1_MISO / UART3_TXD / I2C1_SCL / UART4_nCTS
	JP6.10	106	PE.0 / EBI_AD11 / QSPI0_MOSI0 / SPI1_MOSI / UART3_RXD / I2C1_SDA / UART4_nRTS
	JP6.11	107	PH.8 / EBI_AD12 / QSPI0_CLK / SPI1_CLK / UART3_nRTS / I2C1_SMBAL / I2C2_SCL / UART1_TXD
	JP6.12	108	PH.9 / EBI_AD13 / QSPI0_SS / SPI1_SS / UART3_nCTS / I2C1_SMBSUS / I2C2_SDA / UART1_RXD
	JP6.13	109	PH.10 / EBI_AD14 / QSPI0_MISO1 / SPI1_I2SMCLK / UART4_TXD / UART0_TXD
	JP6.14	110	PH.11 / EBI_AD15 / QSPI0_MOSI1 / UART4_RXD / UART0_RXD / EPWM0_CH5
	JP6.15	111	PD.14 / EBI_nCS0 / SPI3_I2SMCLK / SPI0_I2SMCLK / EPWM0_CH4
	JP6.16	112	VSS
	JP6.17	113	LDO_CAP
	JP6.18	114	VDD
	JP6.19	115	PC.14 / EBI_AD11 / SPI0_I2SMCLK / USCIO_CTL0 / QSPI0_CLK / TRACE_SWO / EPWM0_SYNC_IN / TM1
	JP6.20	116	PB.15 / EADC0_CH15 / EBI_AD12 / SPI0_SS / USCIO_CTL1 / UART0_nCTS / UART3_TXD / I2C2_SMBAL / EPWM0_BRAKE1 / EPWM1_CH0 / TM0_EXT / PSIO0_CH0 / KPI_COL0
	JP6.21	117	PB.14 / EADC0_CH14 / EBI_AD13 / SPI0_CLK / USCIO_DAT1 / UART0_nRTS / UART3_RXD / I2C2_SMBSUS / EPWM1_CH1 / TM1_EXT / CLK0 / PSIO0_CH1 / KPI_COL1
	JP6.22	118	PB.13 / EADC0_CH13 / ACMP0_P3 / ACMP1_P3 / EBI_AD14 / SPI0_MISO / USCIO_DAT0 / UART0_TXD / UART3_nRTS / I2C2_SCL / EPWM1_CH2 / TM2_EXT / PSIO0_CH2 / KPI_COL2
	JP6.23	119	PB.12 / EADC0_CH12 / ACMP0_P2 / ACMP1_P2 / EBI_AD15 / SPI0_MOSI / USCIO_CLK / UART0_RXD / UART3_nCTS / I2C2_SDA / SD0_nCD / EPWM1_CH3 / TM3_EXT / PSIO0_CH3 / KPI_COL3
	JP6.24	120	AVDD
	JP6.25	121	VREF
	JP6.26	122	AVSS
	JP6.27	123	PB.11 / EADC0_CH11 / EBI_ADR16 / UART0_nCTS / UART4_TXD / I2C1_SCL / CAN0_TXD / SPI0_I2SMCLK / BPWM1_CH0 / SPI3_CLK / HSUSB_VBUS_ST
	JP6.28	124	PB.10 / EADC0_CH10 / EBI_ADR17 / UART0_nRTS / UART4_RXD / I2C1_SDA / CAN0_RXD / BPWM1_CH1 / SPI3_SS / HSUSB_VBUS_EN
	JP6.29	125	PB.9 / EADC0_CH9 / EBI_ADR18 / UART0_TXD / UART1_nCTS / I2C1_SMBAL / UART7_TXD / I2C0_SCL / BPWM1_CH2 / SPI3_MISO / INT7
	JP6.30	126	PB.8 / EADC0_CH8 / EBI_ADR19 / UART0_RXD / UART1_nRTS / I2C1_SMBSUS / UART7_RXD / I2C0_SDA / BPWM1_CH3 / SPI3_MOSI / INT6
	JP6.31	127	PB.7 / EADC0_CH7 / EBI_nWRL / CAN1_TXD / UART1_TXD / EBI_nCS0 / BPWM1_CH4 / EPWM1_BRAKE0 / EPWM1_CH4 / INT5 / ACMP0_O / KPI_COL4 / SPI1_CLK

Header		M463KGCAE	
		Pin No.	Function
	JP6.32	128	PB.6 / EADC0_CH6 / EBI_nWRH / CAN1_RXD / UART1_RXD / EBI_nCS1 / BPWM1_CH5 / EPWM1_BRAKE1 / EPWM1_CH5 / INT4 / ACMP1_O / KPI_COL5 / SPI1_SS

Table 3-2 M463KGCAE Full-pin Extension Connectors and GPIO Function List

3.3.2 Arduino UNO Compatible Extension Connectors

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

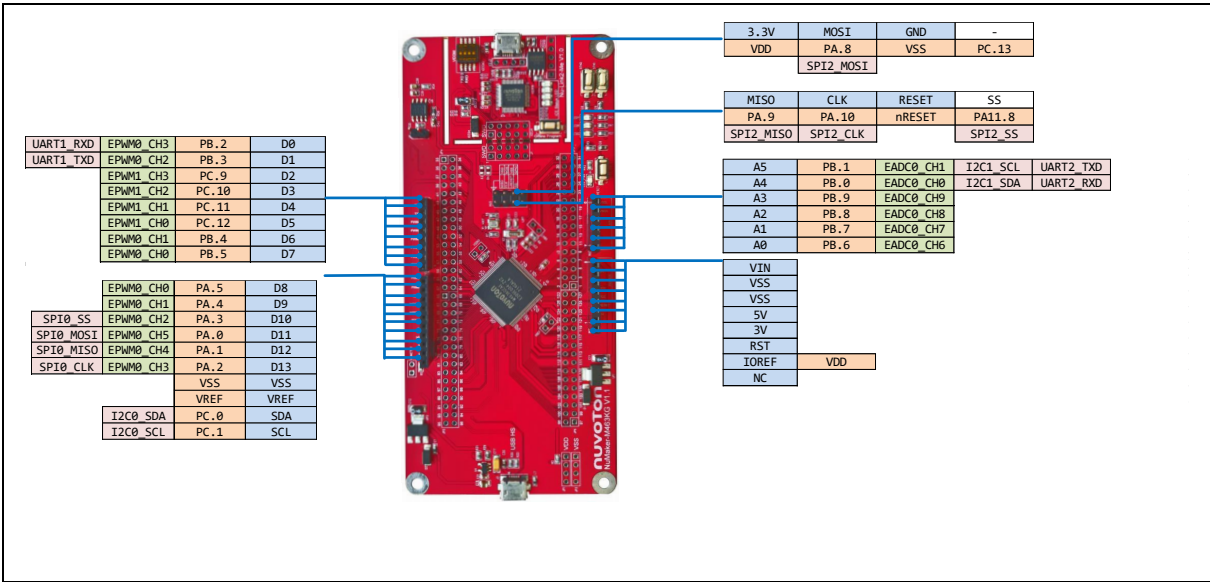


Figure 3-4 Arduino UNO Compatible Extension Connectors

Header		NuMaker-M463KG		Header		NuMaker-M463KG	
		Compatible to Arduino UNO	GPIO Pin of M463			Compatible to Arduino UNO	GPIO Pin of M463
NU3	NU3.1	D0	PB.2	NU2	NU2.6	A5	PB.6
	NU3.2	D1	PB.3		NU2.5	A4	PB.7
	NU3.3	D2	PC.9		NU2.4	A3	PB.8
	NU3.4	D3	PC.10		NU2.3	A2	PB.9
	NU3.5	D4	PC.11		NU2.2	A1	PB.7
	NU3.6	D5	PC.12		NU2.1	A0	PB.6
	NU3.7	D6	PB.4	NU1	NU1.8	VIN	-
	NU3.8	D7	PB.5		NU1.7	VSS	
NU4	NU4.1	D8	PA.5		NU1.6	VSS	
	NU4.2	D9	PA.4		NU1.5	5V	
	NU4.3	D10	PA.3		NU1.4	3V	nRESET
	NU4.4	D11	PA.0		NU1.3	RST	
	NU4.5	D12	PA.1		NU1.2	IOREF	V _{REF}
	NU4.6	D13	PA.2		NU1.1	NC	-
	NU4.7	VSS	V _{SS}				
	NU4.8	VREF	V _{REF}				
	NU4.9	SDA	PC.0				
	NU4.10	SCL	PC.1				

Table 3-3 Arduino UNO Extension Connectors and M463KGCAE Mapping GPIO List

3.4 Power Supply Configuration

The NuMaker-M463KG is able to adopt multiple power supplies. External power sources include NU1 Vin (7 V to 12 V), V_{DD} (depending on the target chip operating voltage), and PC through USB connector. By using switches and voltage regulator, multiple power domains can be created on the NuMaker-M463KG.

3.4.1 VIN Power Source

Table 3-4 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 UP1 converts the NU1 pin8 input voltage to 5 V and supplies it to NU1_5VCC.

Table 3-4 Vin Power Source

3.4.2 5 V Power Sources

Table 3-5 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 M463KG target board and Nu-Link2-Me.
J3	HSUSB_VBUS	USB connector on NuMaker-M463KG supplies 5 V power from PC to M463KG target board 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.

Table 3-5 5 V Power Sources

3.4.3 3.3 V Power Sources

Table 3-6 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 M463KG target board or ICE chip.
UP2	HSUSB_VBUS	UP2 converts USB_VBUS to 3.3 V and supplies 3.3 V to M463KG target board.
UP2	NU1_5VCC	UP2 converts NU1_5VCC to 3.3 V and supplies 3.3 V to M463KG target board.

Table 3-6 3.3 V Power Sources

3.4.4 Power Connectors

Table 3-7 presents the power connectors.

Connector	Description
JP1	V _{DD} connector on the NuMaker-M463KG. Note: M463 operating voltage range is from 1.8 V to 3.6 V.
JP2	V _{SS} connector on the NuMaker-M463KG.

Table 3-7 Power Connectors

3.4.5 USB Connectors

Table 3-8 presents the USB connectors.

Connector	Description
ICEJ3	ICE USB connector on Nu-Link2-Me for power supply, debugging and programming from PC.
J3	USB HS connector on NuMaker-M463KG for power supply.

Table 3-8 USB Connectors

3.4.6 Power Switches

Table 3-9 presents the power switches.

Switch	Description
ICEJPR1	Configures the target chip operating voltage at 1.8 V / 3.3 V / 5 V. Note: M463 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.

Table 3-9 Power Switches

3.4.7 Power Supply Models

3.4.7.1 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.

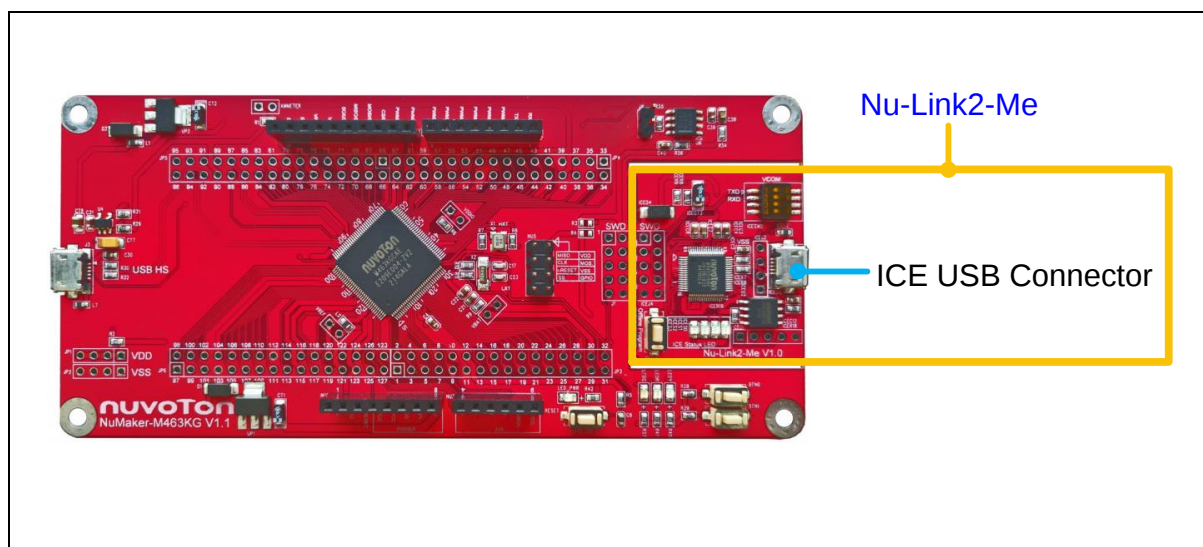


Figure 3-5 External Power Supply Sources on Nu-Link2-Me

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

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

Table 3-10 presents all power models when supplying 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	J3	Vin	JP1
1	1.8 V	Connect to PC	1.8 V	1.8 V	1.8 V	-	-	1.8 V output
2	3.3 V	Connect to PC	3.3 V (default)	3.3 V (default)	3.3 V	-	-	3.3 V output
3	5 V	Connect to PC	5 V	3.3 V (default)	3.3 V	-	-	5 V output
Note: 1. 0 Ω should be soldered between ICEJPR1's MCVCC 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. -: Unused.								

Table 3-10 Supply External Power through Nu-Link2-Me

3.4.7.2 External Power Supply through M463KG Target Board to Target Chip

The external power supply sources on M463KG target board are shown in Figure 3-6.

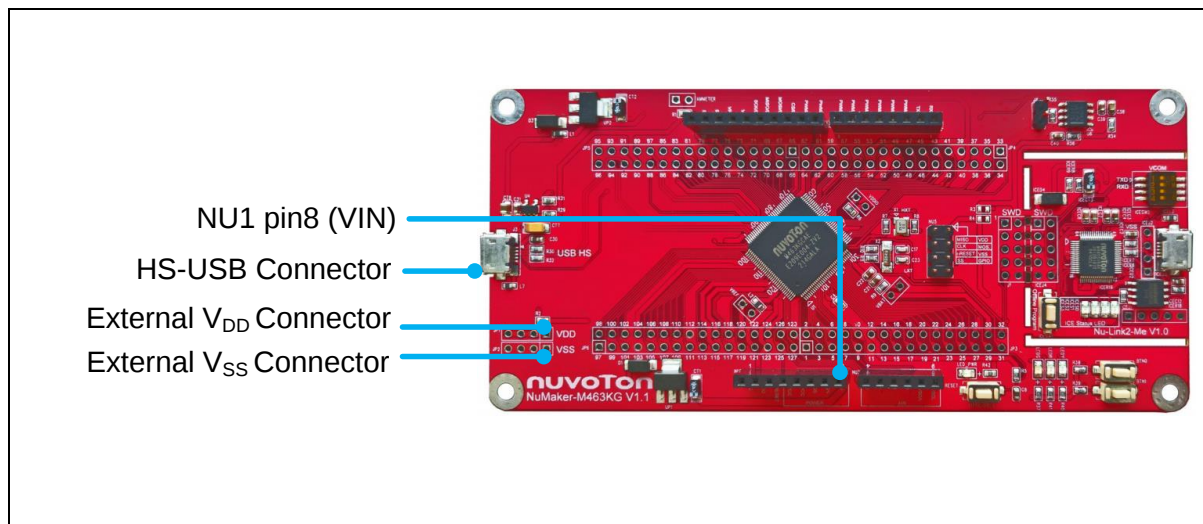


Figure 3-6 External Power Supply Sources on M463KG Target Board

To use Vin or J3 as external power supply source, please follow the steps below:

1. Remove the resistor on ICEJPR1 (MCUVCC).
2. Solder the resistor on ICEJPR2 (ICEVCC) depending on the ICE chip operating voltage.
3. Connect the external power supply to Vin or J3.

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

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

To use Vin or J3 as external power supply source with Nu-Link2-Me detached from NuMaker-M463KG, please follow the steps below:

1. Detach the Nu-Link2-Me from NuMaker-M463KG.
2. Connect the external power supply to Vin or J3.

To use JP1 as external power supply source with Nu-Link2-Me detached from NuMaker-M463KG, please follow the steps below:

1. Detach the Nu-Link2-Me from NuMaker-M463KG.
2. Connect the external power supply to JP1.

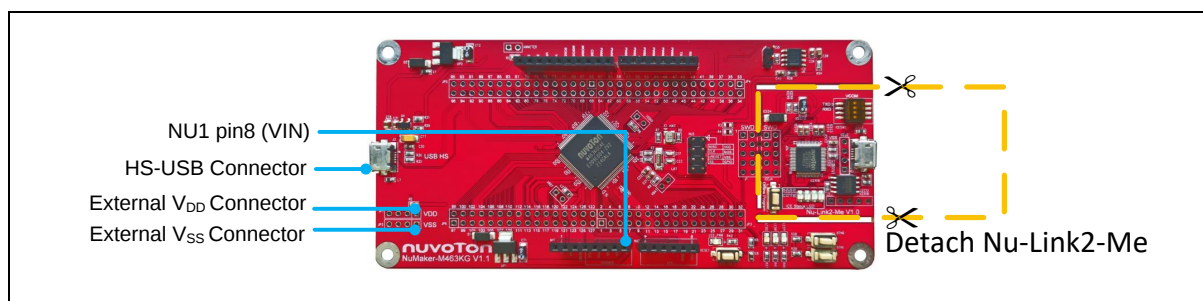


Figure 3-7 Detach the Nu-Link2-Me from NuMaker-M463KG

Table 3-11 presents all power models when supplies external power through M463KG target board. The M463KG target board external power sources are highlighted in yellow.

Model	Target Chip Voltage	Vin ^[1]	J3 ^[1]	ICEJ3	JP1 ^[2]	ICEJPR1 (MCUVCC) Selection ^[3]	ICEJPR2 (ICEVCC) Selection ^[4]	ICE Chip Voltage ^[5]
4	3.3 V	7 V ~ 12 V Input	-	-	3.3 V output	Remove resistor	3.3 V	3.3 V
5	3.3 V	-	Connect to PC	-	3.3 V output	Remove resistor	3.3 V	3.3 V
6	1.8 V ~ 3.6 V	-	-	Connect to PC	DC Input 1.8 V ~ 3.6 V	Remove resistor	1.8 V / 3.3 V	1.8 V / 3.3 V
7	1.8 V ~ 3.6 V	-	-	Nu-Link2-Me removed	DC Input 1.8 V ~ 3.6 V	-	-	-

Note:

1. The Vin input voltage will be converted by voltage regulator UP2 to 5 V. Supplying external power to Vin or J3 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 MCVCC 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. -: Unused

Table 3-11 Supply External Power for M463KG Target Board

3.5 External Reference Voltage Connector

Table 3-13 presents the external reference voltage connector.

Connector	Description
VREF	Connector for user to connect to the external reference voltage pin of the target chip. User needs to remove the L2 ferrite bead.

Table 3-12 External Reference Voltage Connector

3.6 Ammeter Connector

Table 3-13 presents the ammeter connector.

Connector	Description
AMMETER	Connector for user to measure the target chip power consumption easily. User needs to remove the R1 resistor.

Table 3-13 Ammeter Connector

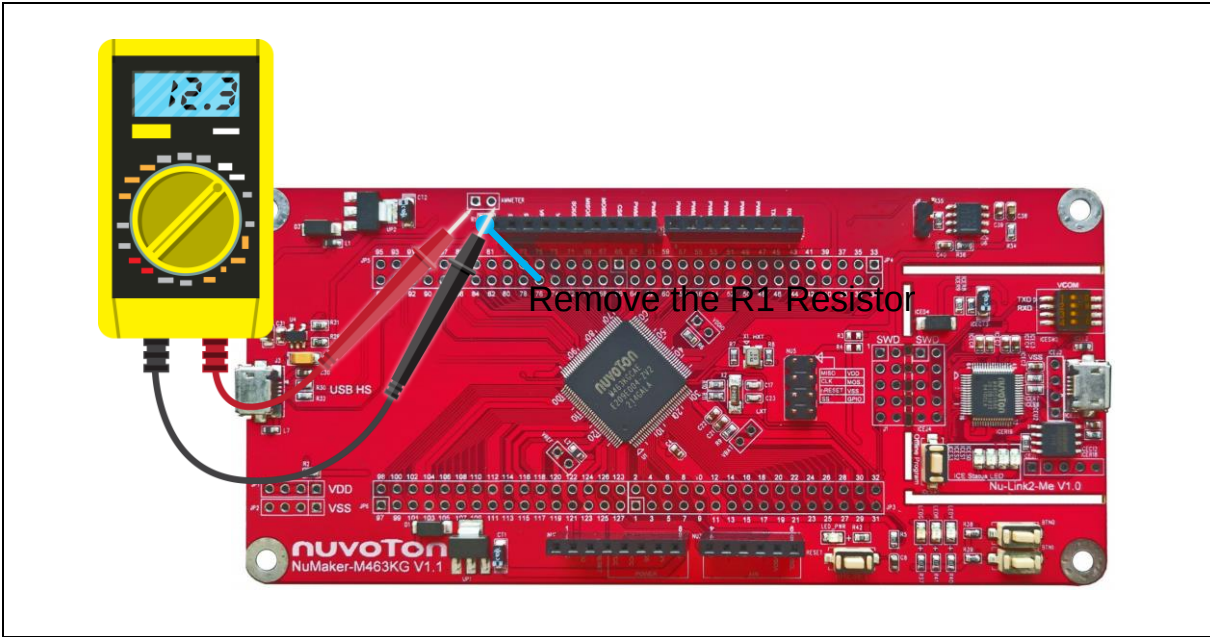


Figure 3-8 Wiring between Ammeter Connector and Ammeter

3.7 Push Buttons

Table 3-14 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.
BTN0/BTN1	User buttons for application usage.

Table 3-14 Push Buttons

3.8 LEDs

Table 3-15 presents the LEDs.

Component	Description
Power LED	The power LED indicates that the NuMaker-M463KG is powered.
LEDR/LEDG/LEDY	User LEDs for application usage.
ICES0, ICES1, ICES2 and ICES3	Nu-Link2-Me status LED.

Table 3-15 LEDs

3.9 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 could be shown on the built-in LEDs. Lastly, the Nu-Link2-Me could be detached from the evaluation board and become a stand-alone mass production programmer. For more information about Nu-Link2-Me, please refer to *Nu-Link2-Pro Debugger and Programmer User Manual*.

3.9.1 VCOM Switches

Table 3-16 presents how to set the VCOM function by ICESW2.

ICESW2		
Pin	Function	Description
1	TXD	On: Connect target chip PB.13 (UART0_TXD) to Nu-Link2-Me. Off: Disconnect target chip PB.13 (UART0_TXD) to Nu-Link2-Me.
2	RXD	On: Connect target chip PB.12 (UART0_RXD) to Nu-Link2-Me. Off: Disconnect target chip PB.12 (UART0_RXD) to Nu-Link2-Me.
Note: Pin 3 and 4 is unused.		

Table 3-16 VCOM Function of Nu-Link2-Me

3.9.2 Status LEDs

Table 3-15 presents the status LEDs patterns for different operation on Nu-Link2-Me.

Operation Status	Status LED			
	ICES0	ICES1	ICES2	ICES3
Boot	Flash x 3	Flash x 3	Flash x 3	Flash x 3
Idle	On	-	-	-
One Nu-Link2-Me is selected to connect	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	-	-
Note: "Online" means Nu-Link2-Me is connected to ICP Programming Tool, IDE or NuTool.				

Table 3-17 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 MDK Nuvoton edition M0/M23](#)
- [IAR EWARM](#)
- [NuEclipse GCC \(for Windows\)](#)
- [NuEclipse GCC \(for Linux\)](#)

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 MDK.
- Download and install [Nu-Link IAR Driver](#) when using IAR EWARM.
- Skip this step when using NuEclipse.

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.

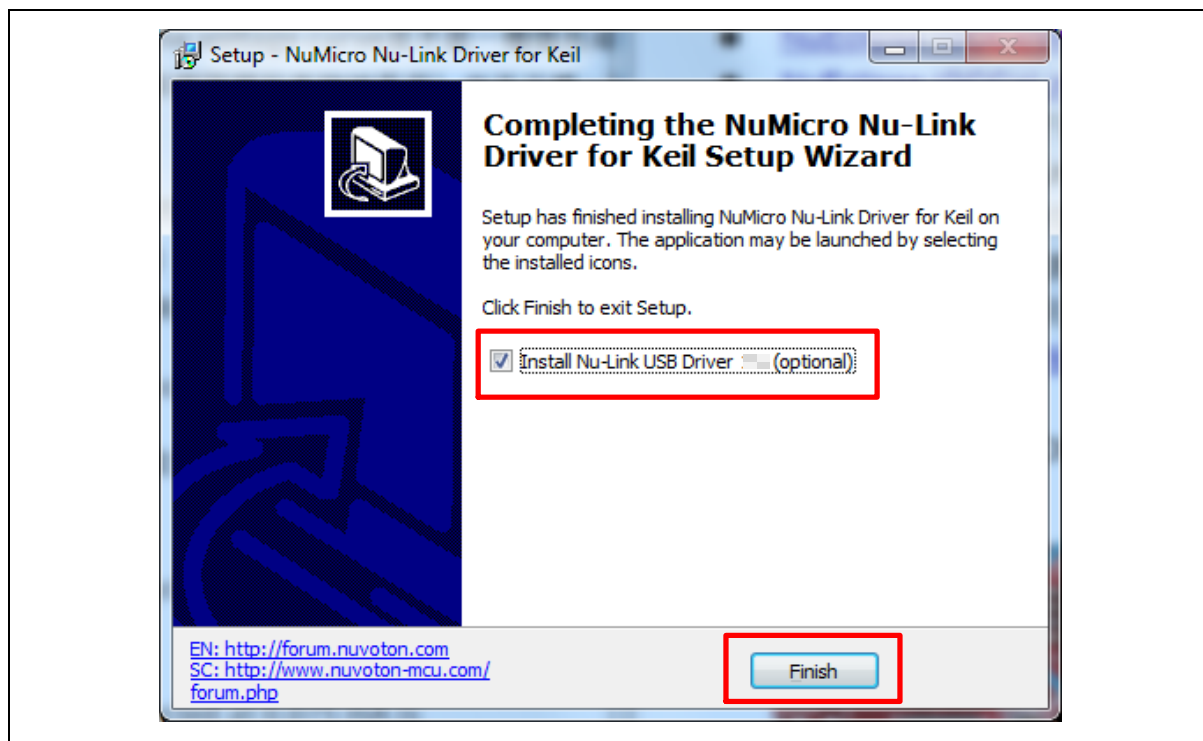


Figure 4-1 Nu-Link USB Driver Installation Setup

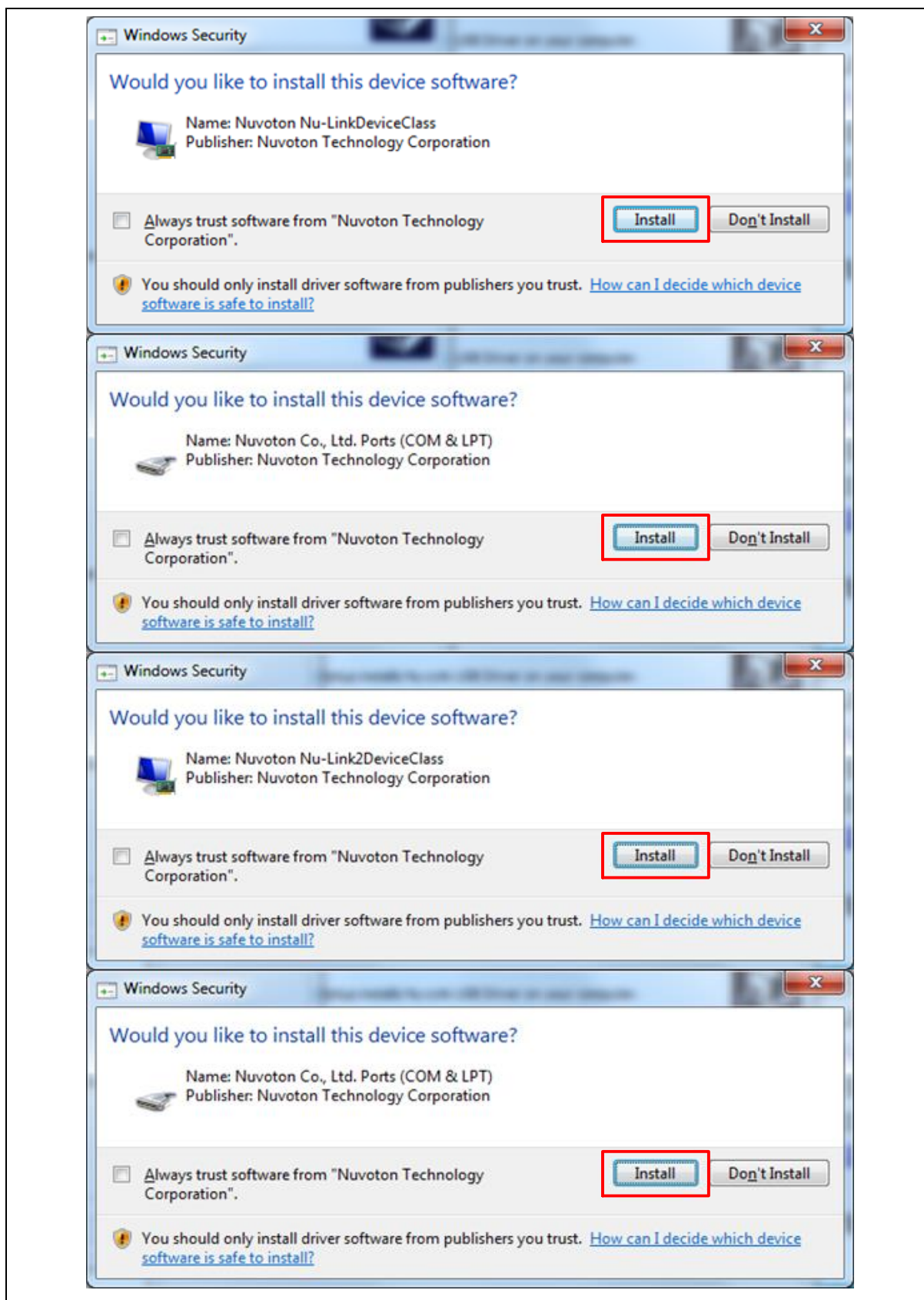


Figure 4-2 Nu-Link USB Driver Installation

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.

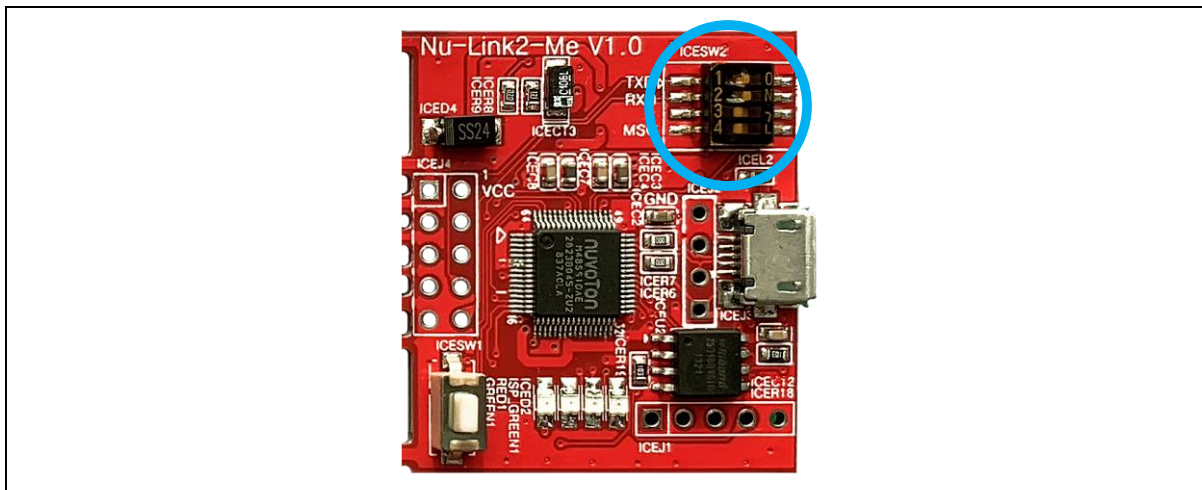


Figure 4-3 Open VCOM Function

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

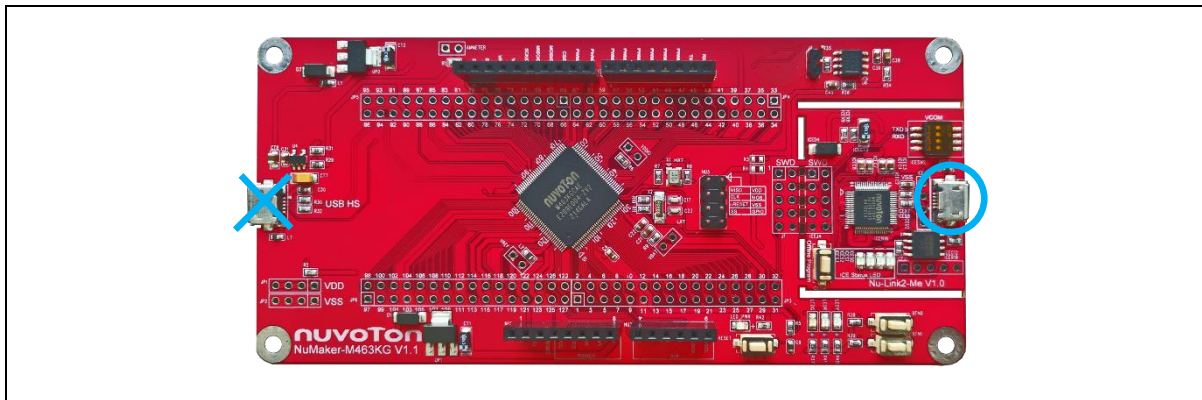


Figure 4-4 ICE USB Connector

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

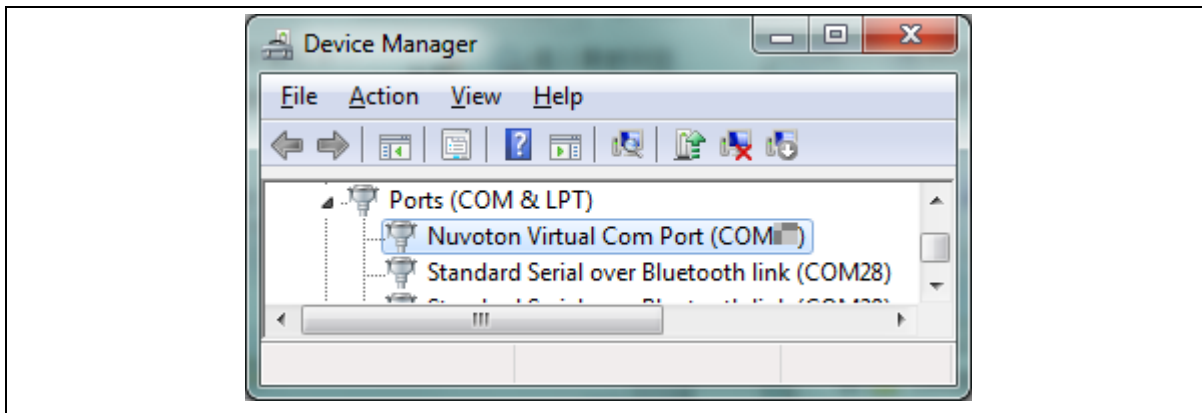


Figure 4-5 Device Manger

- 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.

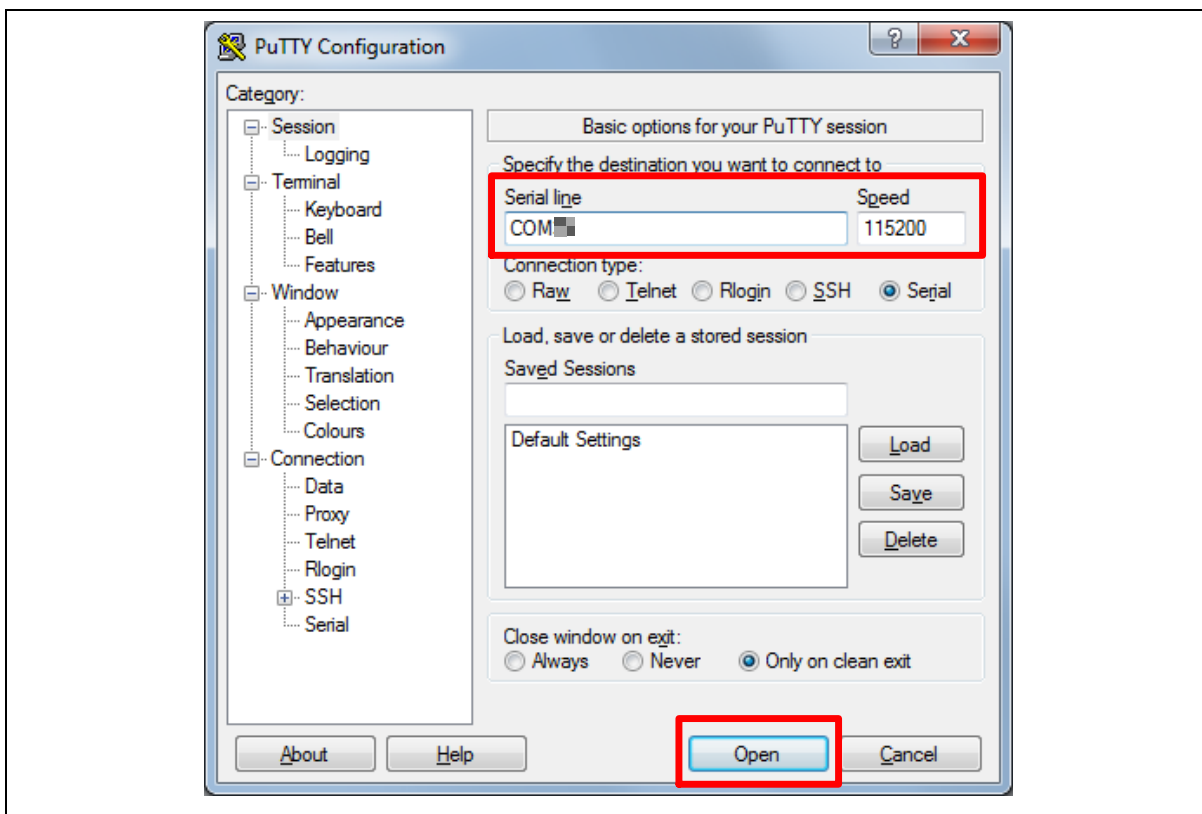


Figure 4-6 PuTTY Session Setting

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.

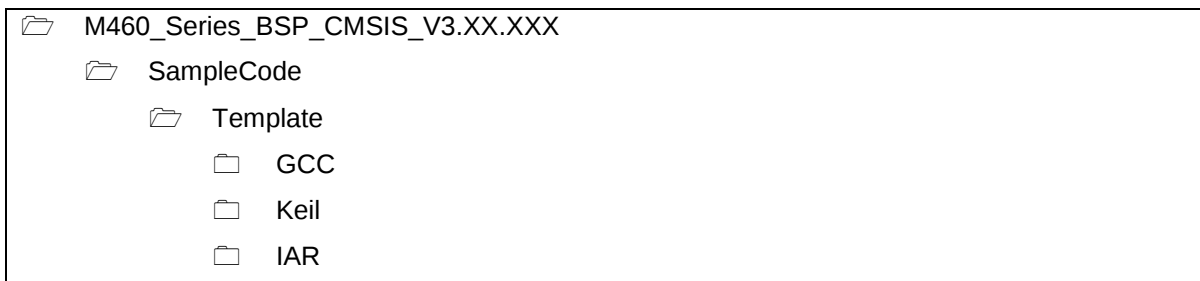


Figure 4-7 Template Project Folder Path

4.6 Execute the Project under Toolchains

Open and execute the project under the toolchain. The section 4.6.1, 4.6.2, and 4.6.3 describe the steps of executing project in Keil MDK, IAR EWARM and NuEclipse, respectively.

4.6.1 Keil MDK

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

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

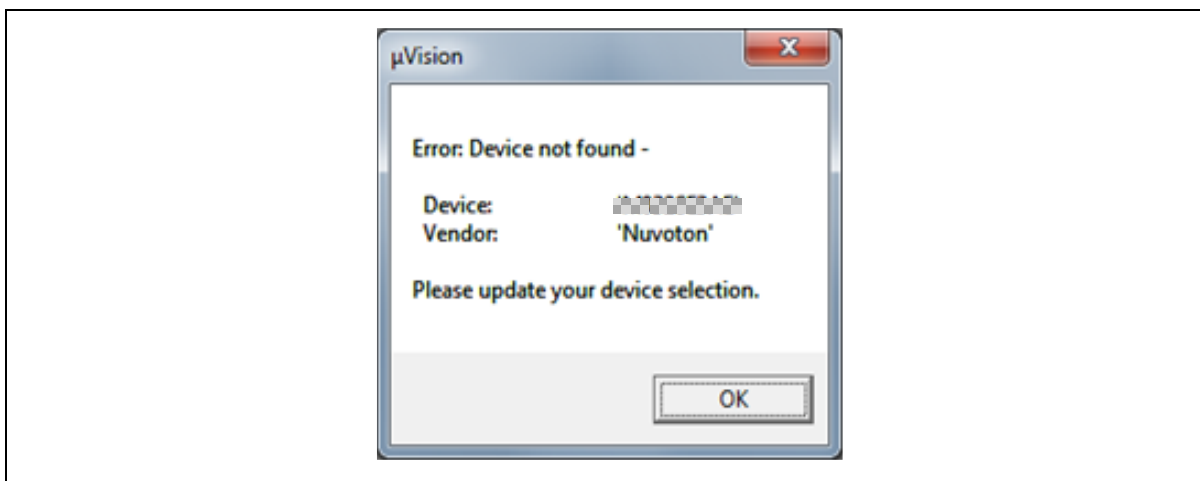


Figure 4-8 Warning Message of “Device not found”

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

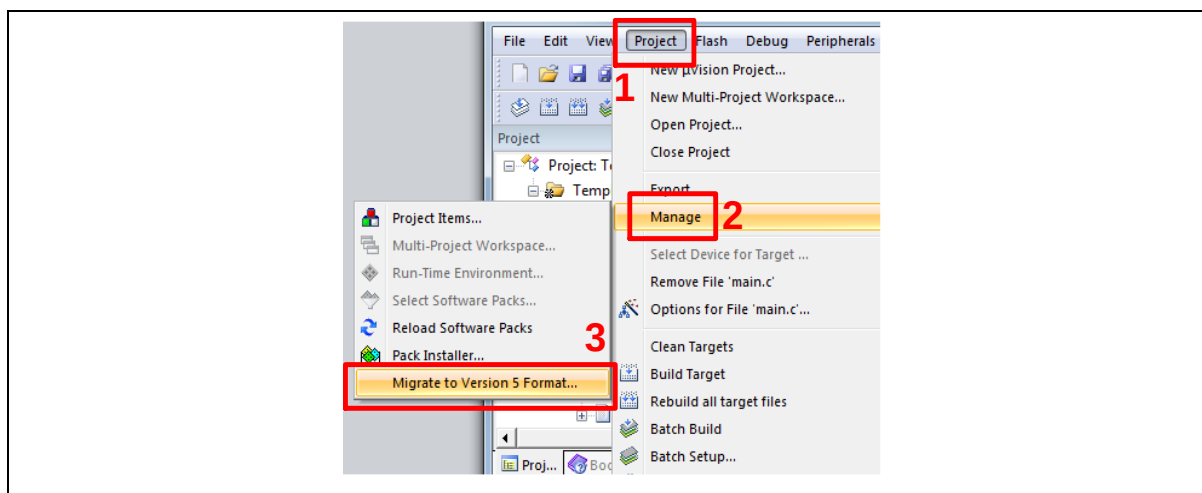


Figure 4-9 Project File Migrate to Version 5 Format

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

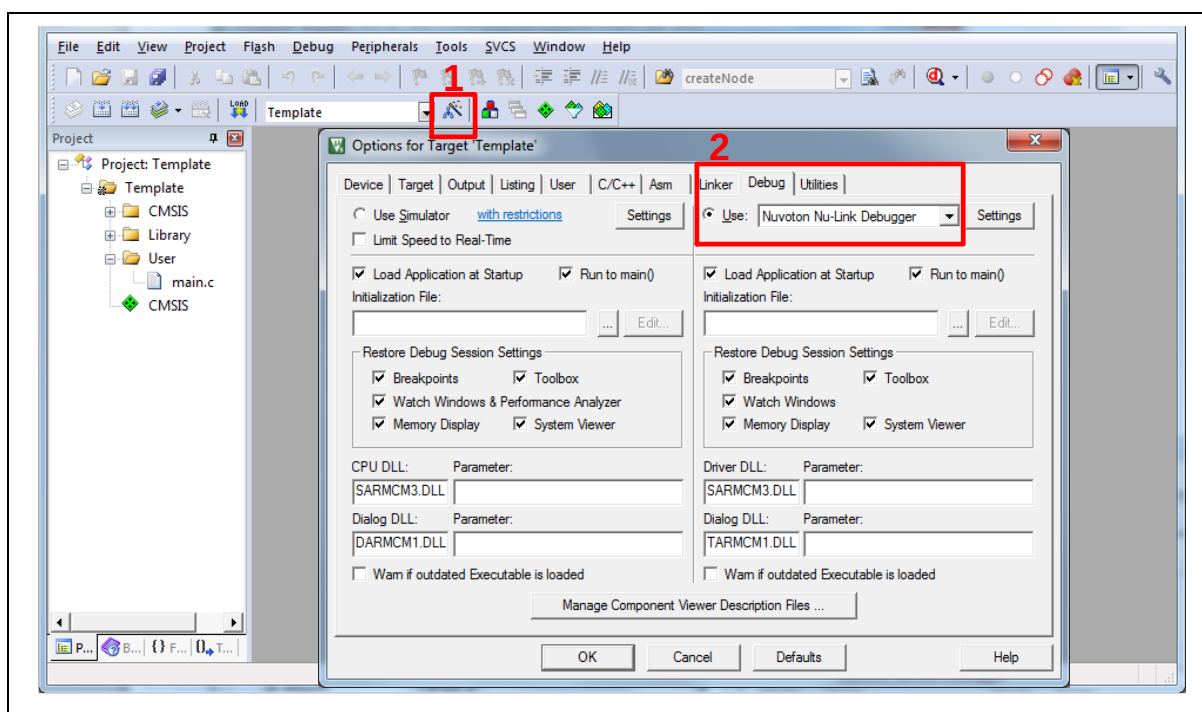


Figure 4-10 Debugger Setting in Options Window

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

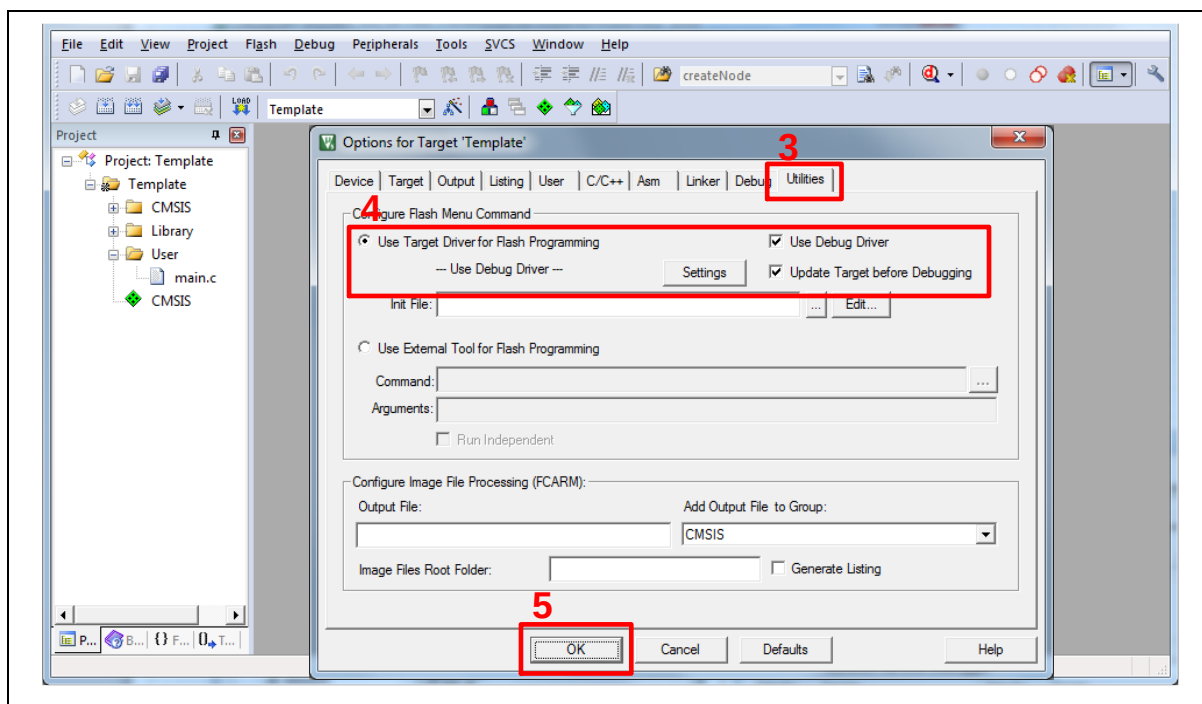


Figure 4-11 Programming Setting in Options Window

3. Rebuild all target files. After successfully compiling the project, download code to the Flash memory. Click **"Start/Stop Debug Section"** button to enter debug mode.

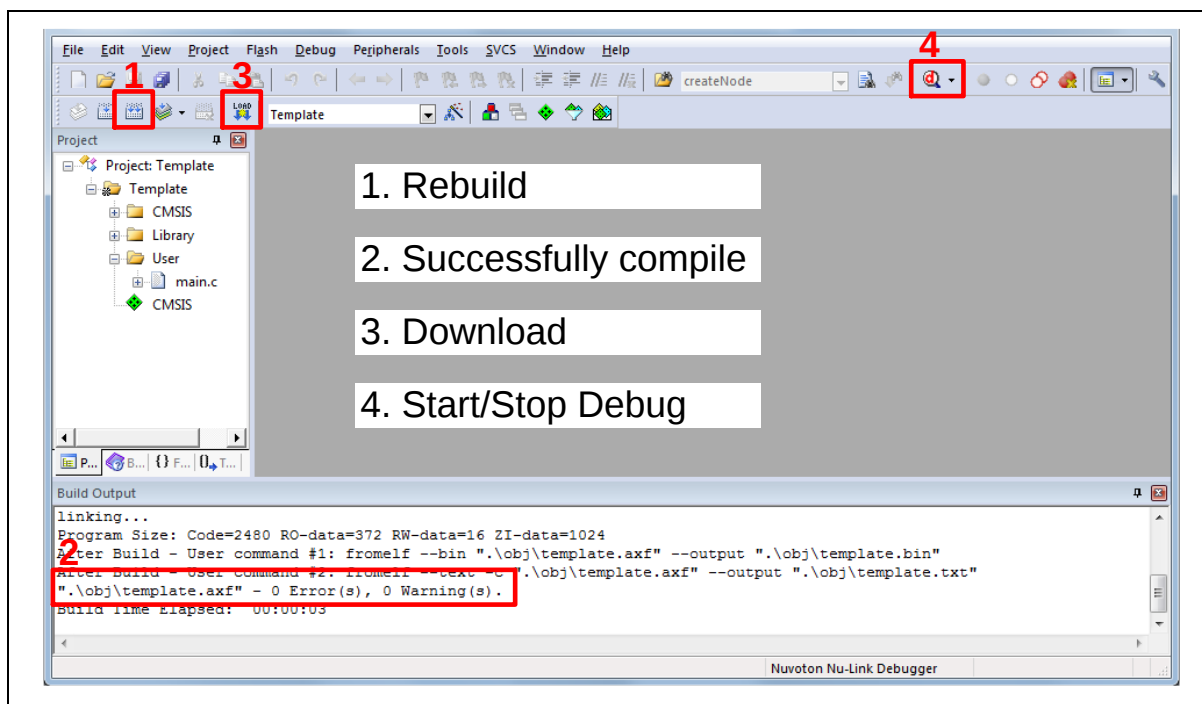


Figure 4-12 Compile and Download the Project

4. Figure 4-13 shows the debug mode under Keil MDK. 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.

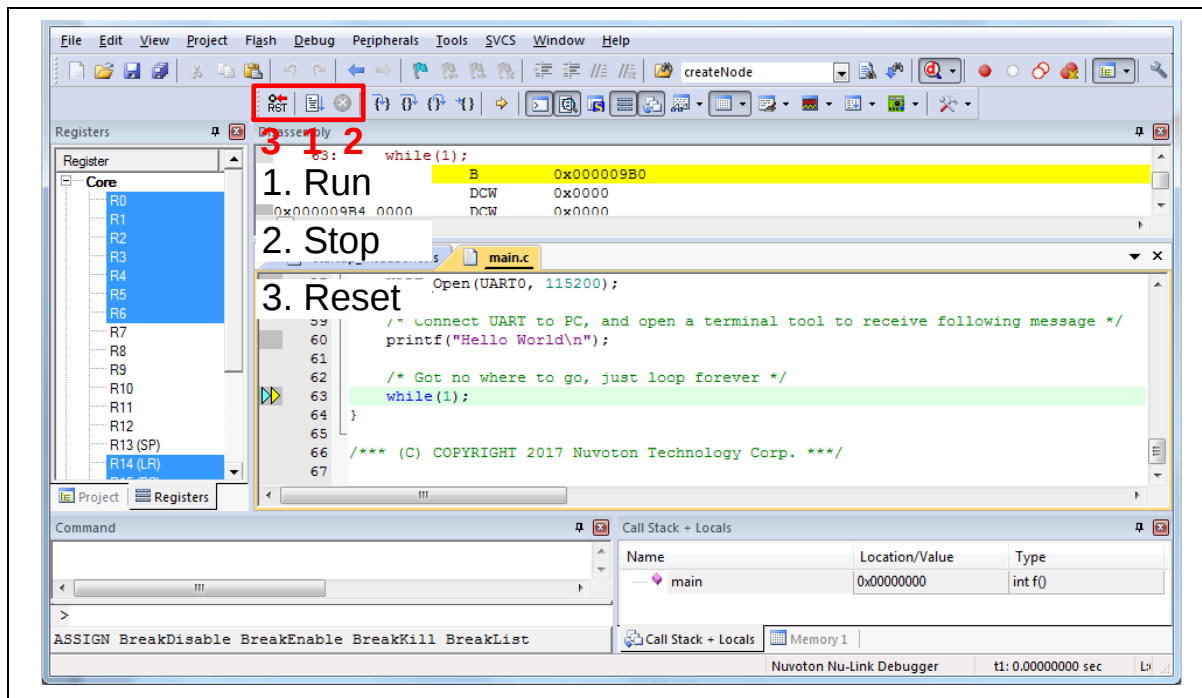


Figure 4-13 Keil MDK Debug Mode



Figure 4-14 Debug Message on Serial Port Terminal Windows

4.6.2 IAR EWARM

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

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

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

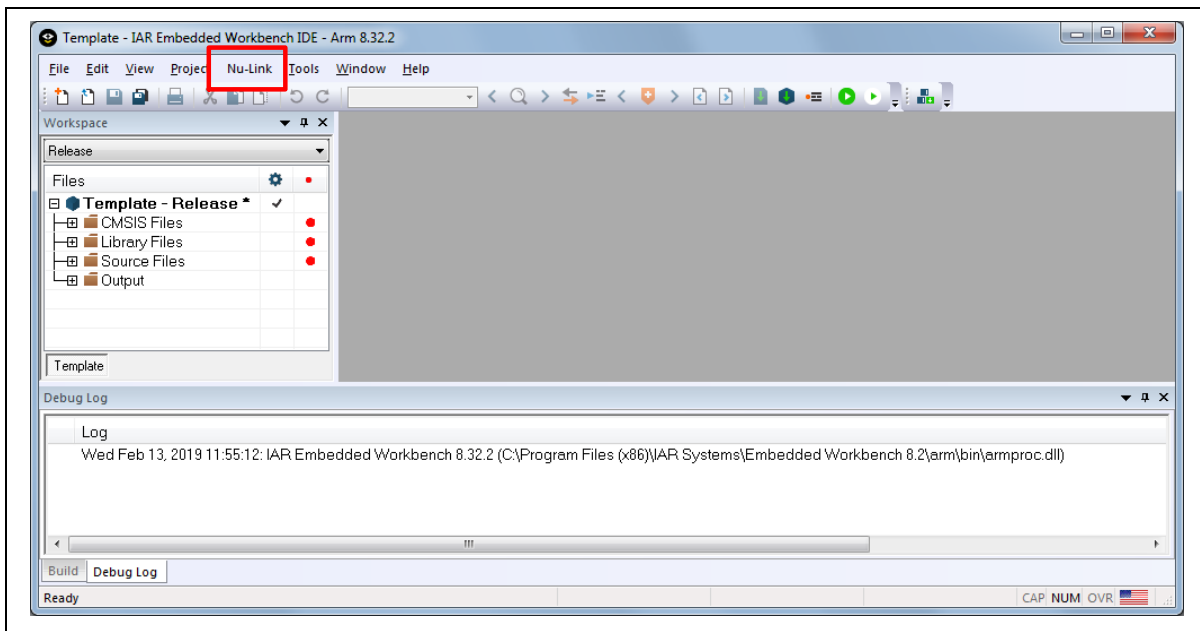


Figure 4-15 IAR EWARM Window

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

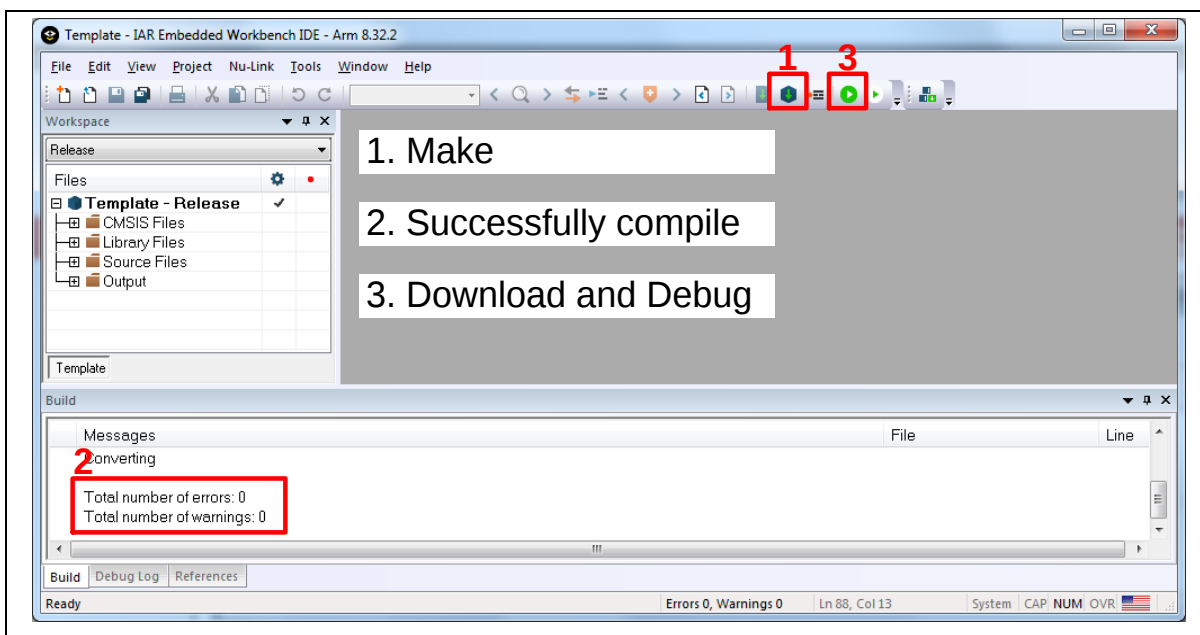


Figure 4-16 Compile and Download the Project

- Figure 4-17 shows the debug mode under IAR EWARN. 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.

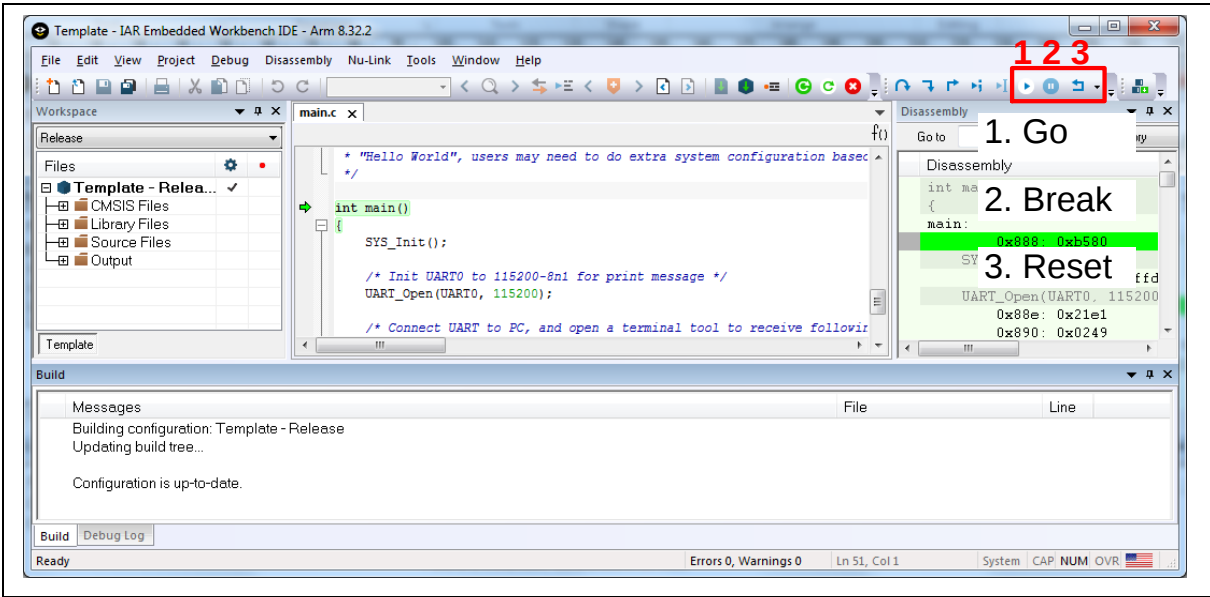


Figure 4-17 IAR EWARM Debug Mode

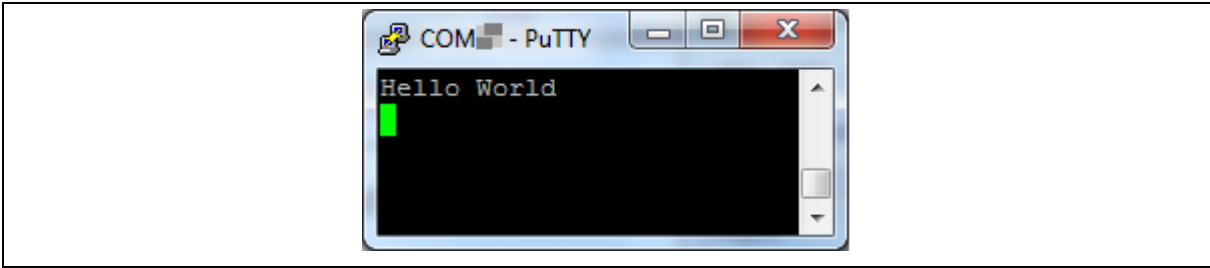


Figure 4-18 Debug Message on Serial Port Terminal Windows

4.6.3 NuEclipse

This section provides steps to beginners on how to run a project by using NuEclipse. Please make sure the filenames and project folder path contain neither invalid character nor space.

1. Double-click "NuEclipse.exe" to open the toolchain.
2. Import the "Template" project by following the steps presented in Figure 4-19 and Figure 4-20.

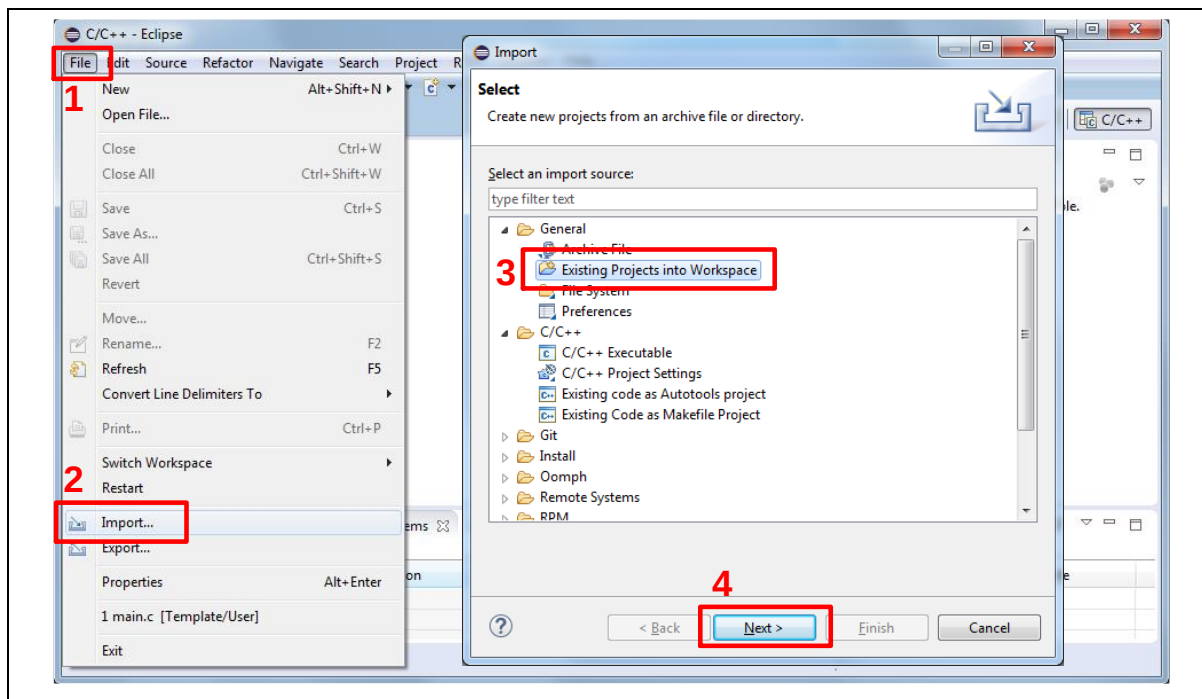


Figure 4-19 Import the Project in NuEclipse

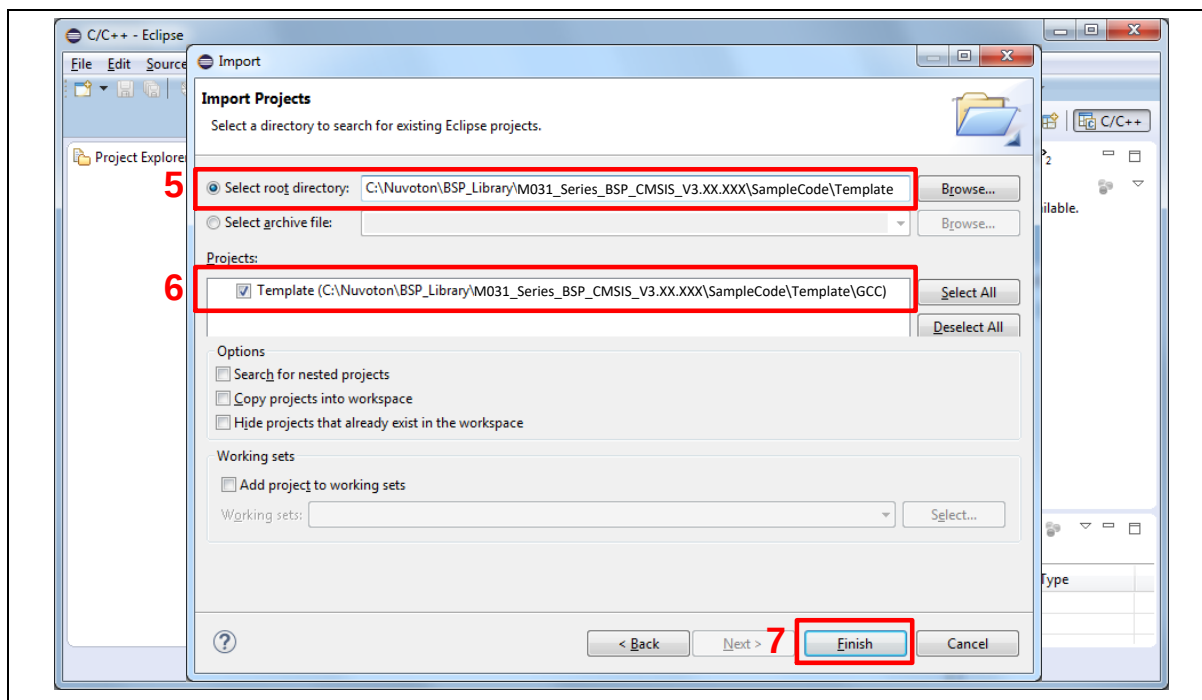


Figure 4-20 Import Projects Windows

- Click the “Template” project and find the project properties as shown in Figure 4-21. Make sure the settings are the same as settings in Figure 4-22.

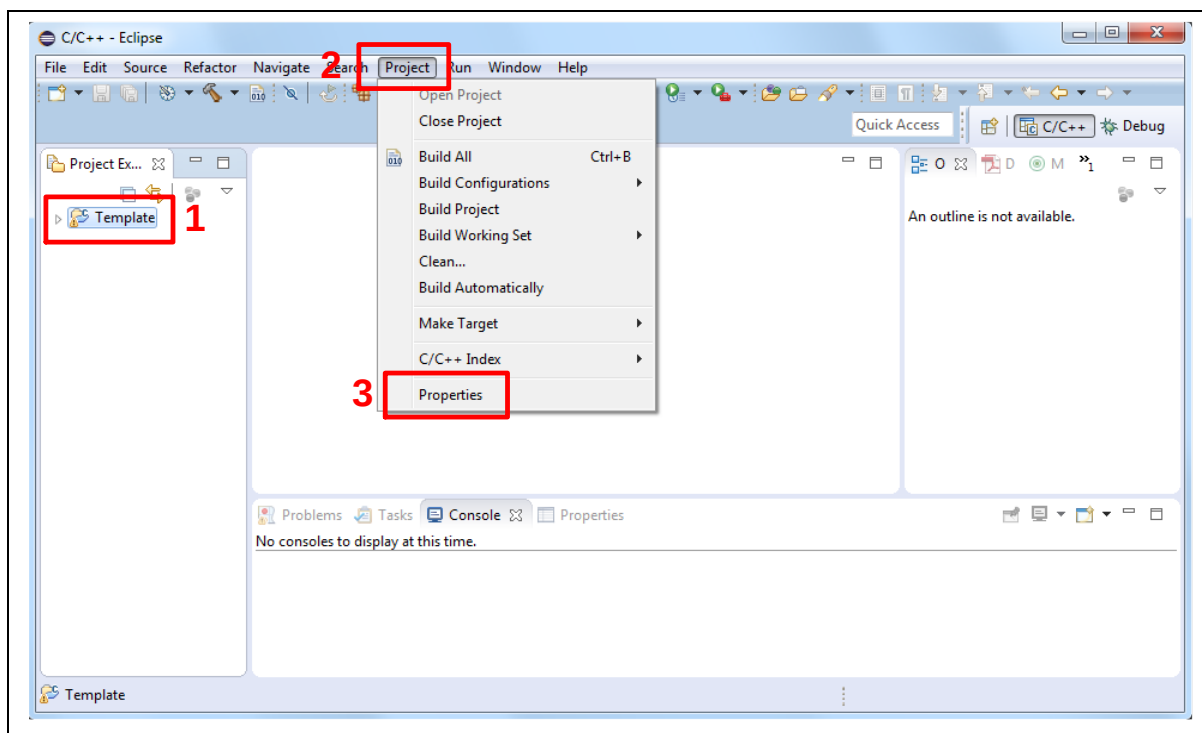


Figure 4-21 Open Project Properties Window

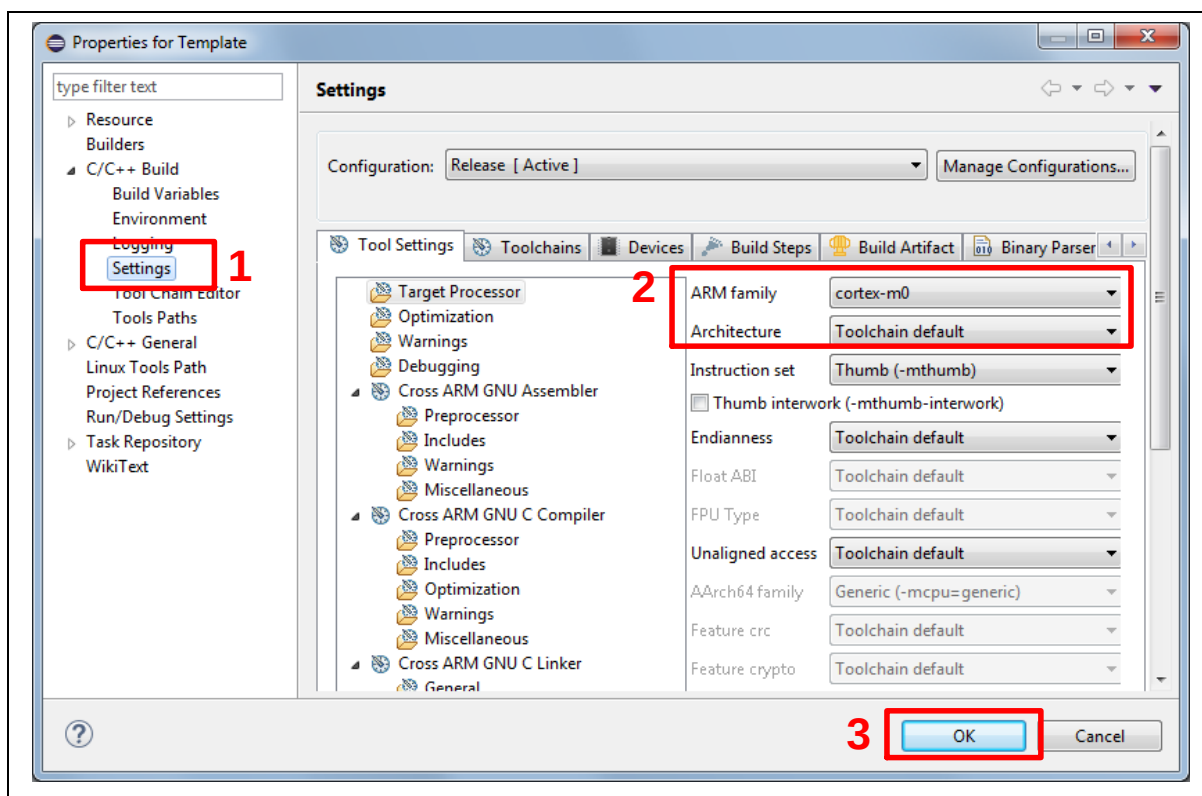


Figure 4-22 Project Properties Settings

4. Click the “Template” project and build the project.

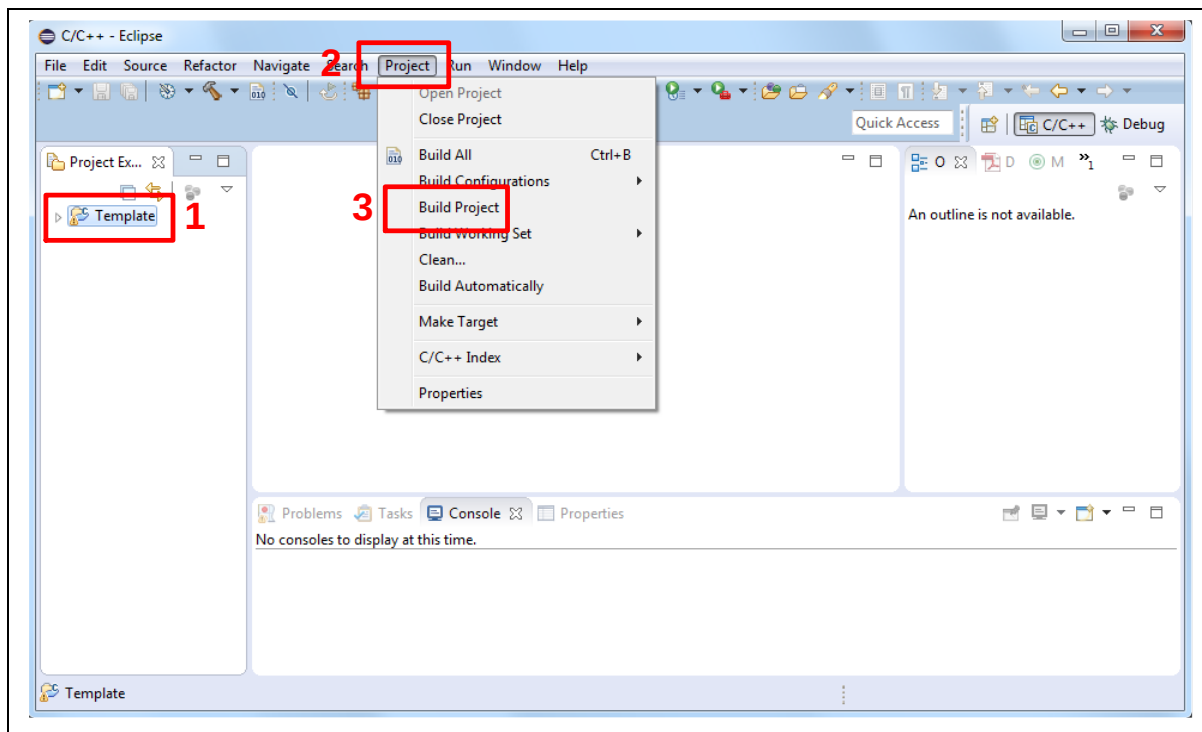


Figure 4-23 Build Project

5. After the project is built, click the “Template” project and set the “Debug Configuration” as shown in Figure 4-24. Follow the settings presented in Figure 4-25, Figure 4-26 and Figure 4-27 to enter debug mode.

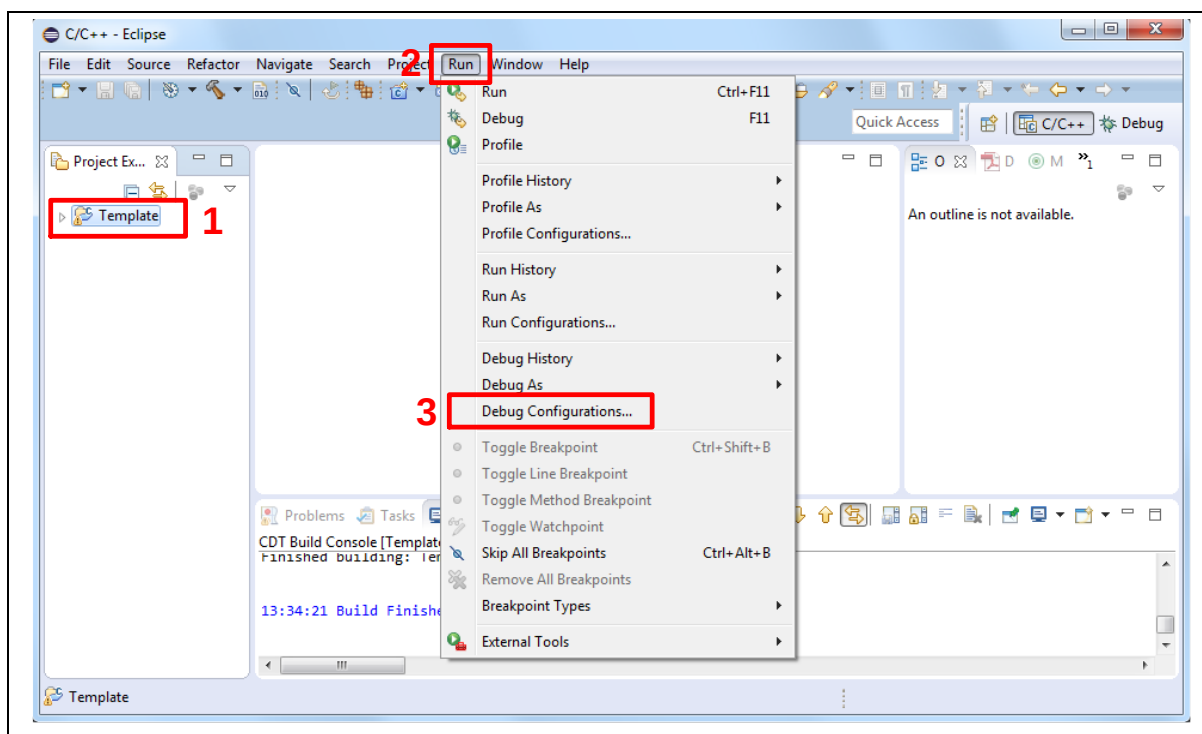
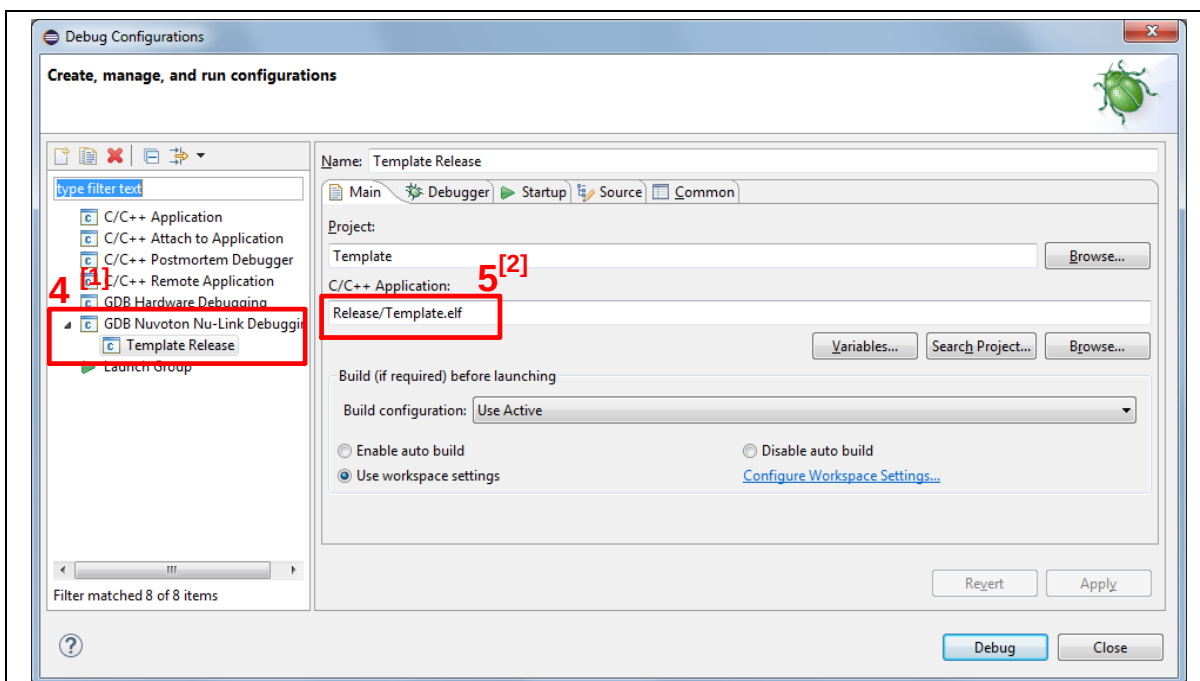


Figure 4-24 Open Debug Configuration



Note 1: Double-click the “GDB Nuvoton Nu-Link Debugging” to create the sub item.

Note 2: After the project is built, the “*.elf” file will be shown in “C/C++ Application” frame.

Figure 4-25 Main Tab Configuration

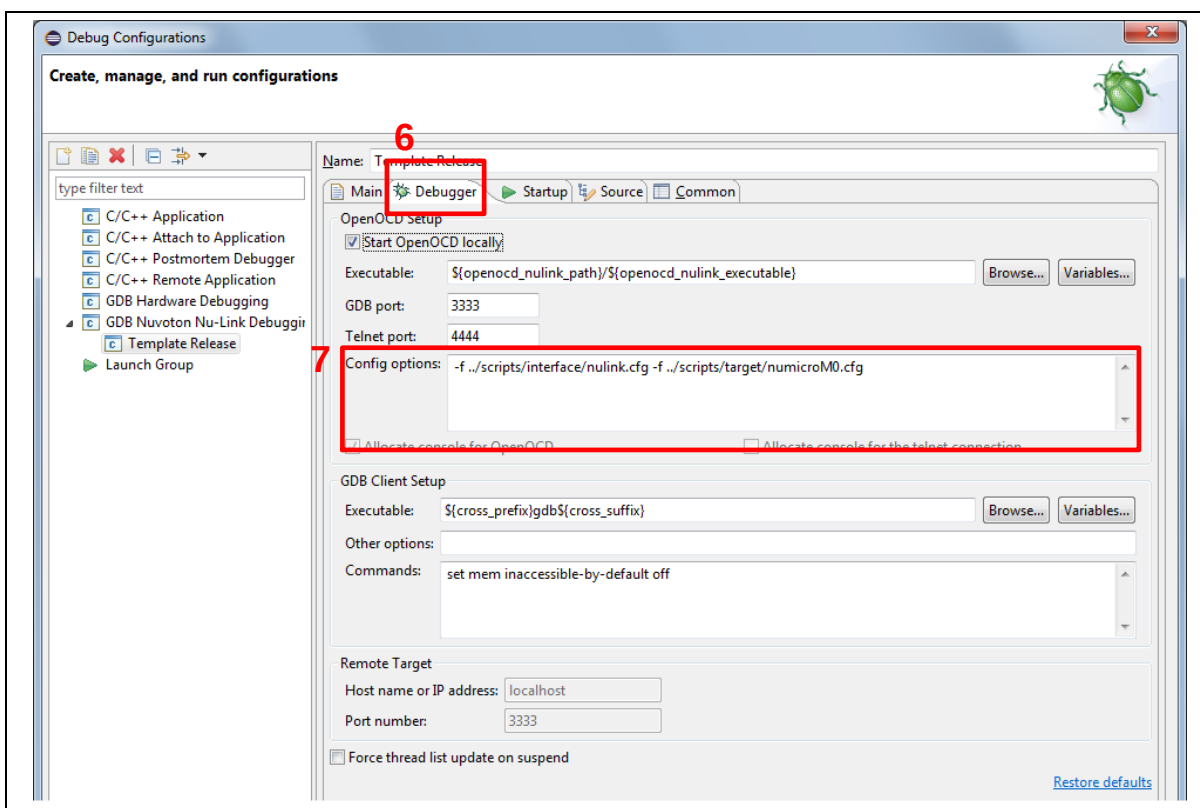


Figure 4-26 Debugger Tab Configuration

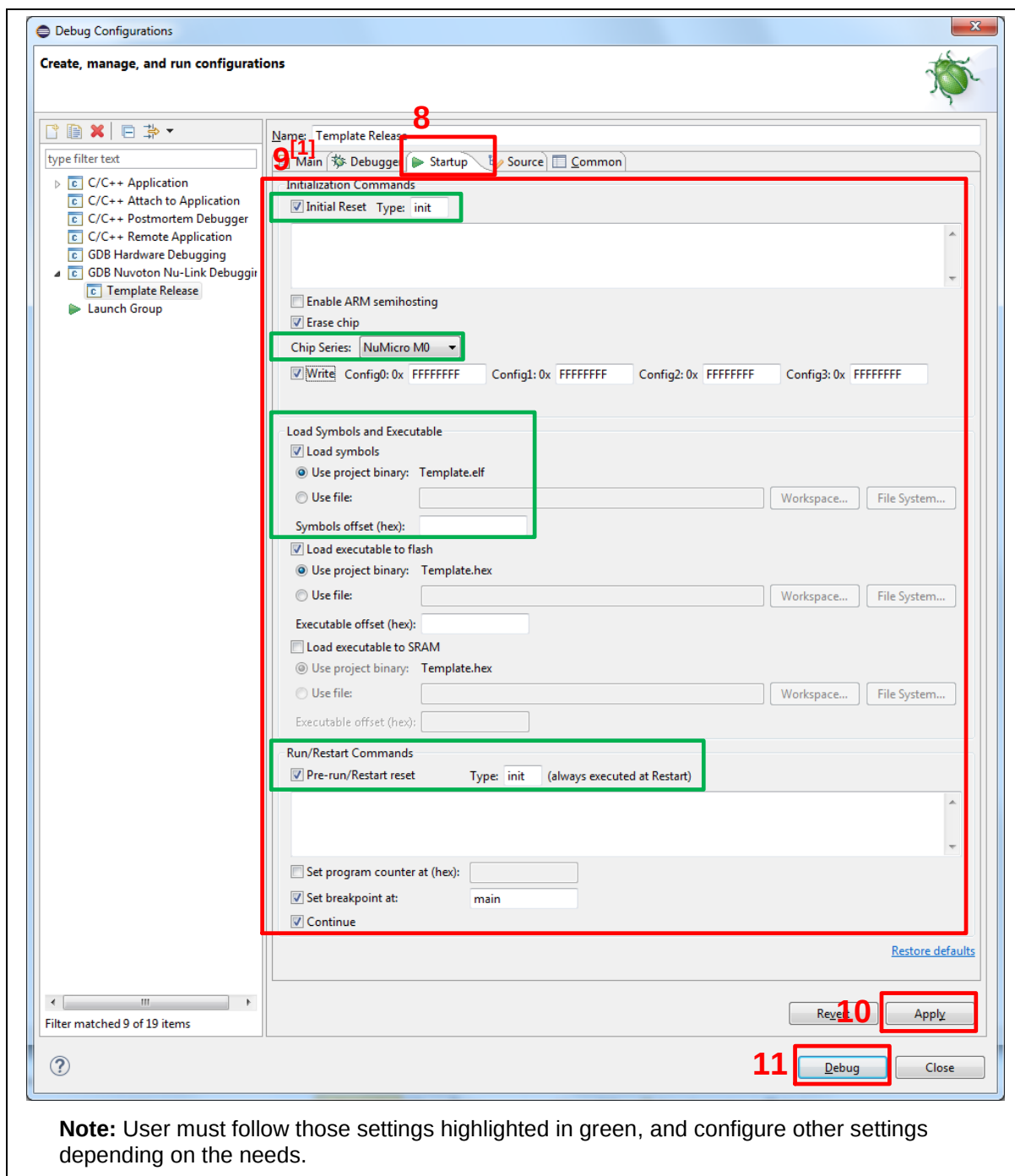


Figure 4-27 Startup Tab Configuration

6. Figure 4-28 shows the debug mode under NuEclipse. Click “**Resume**” and the debug message will be printed out as shown in Figure 4-29. User can debug the project under debug mode by checking source code, assembly language, peripherals’ registers, and setting breakpoint, step run, value monitor, etc. For more information about how to use NuEclipse, please refer to the *NuEclipse User Manual*.

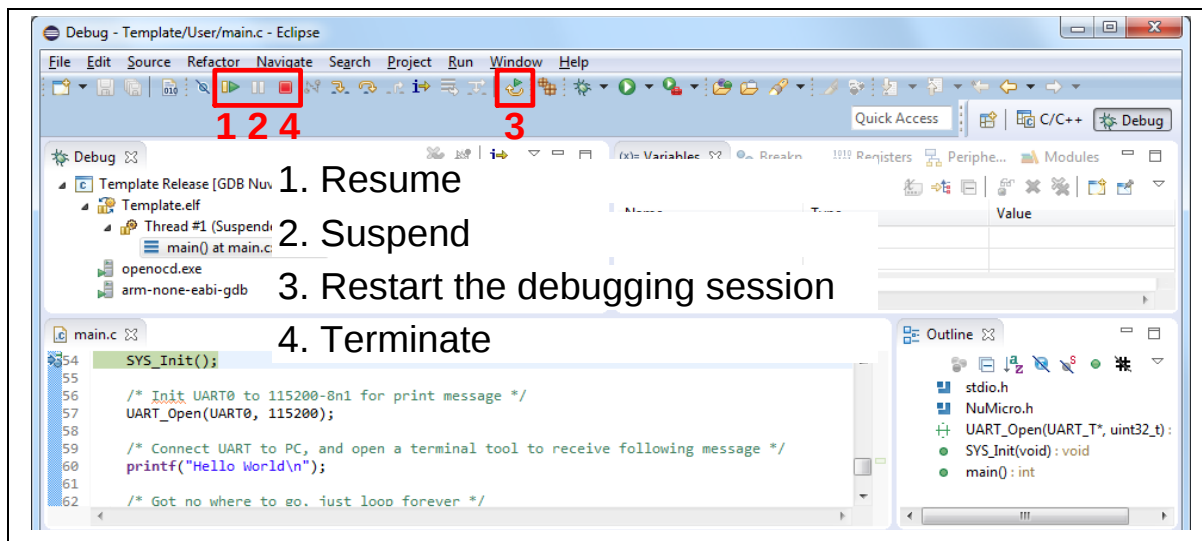


Figure 4-28 NuEclipse Debug Mode

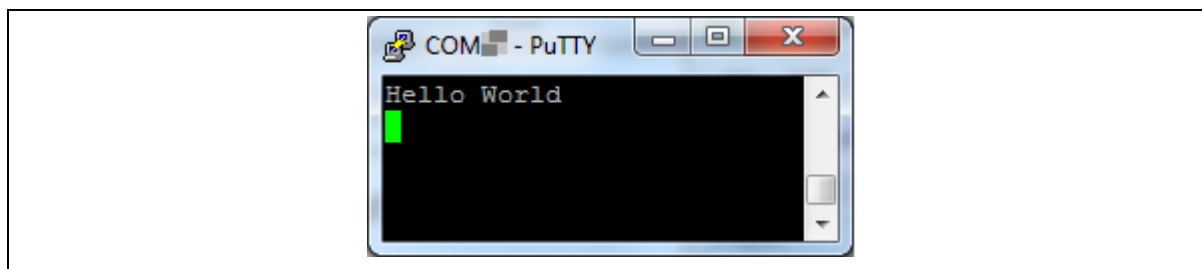


Figure 4-29 Debug Message on Serial Port Terminal Windows

5 NUMAKER-M463KG SCHEMATICS

5.1 Nu-Link2-Me

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

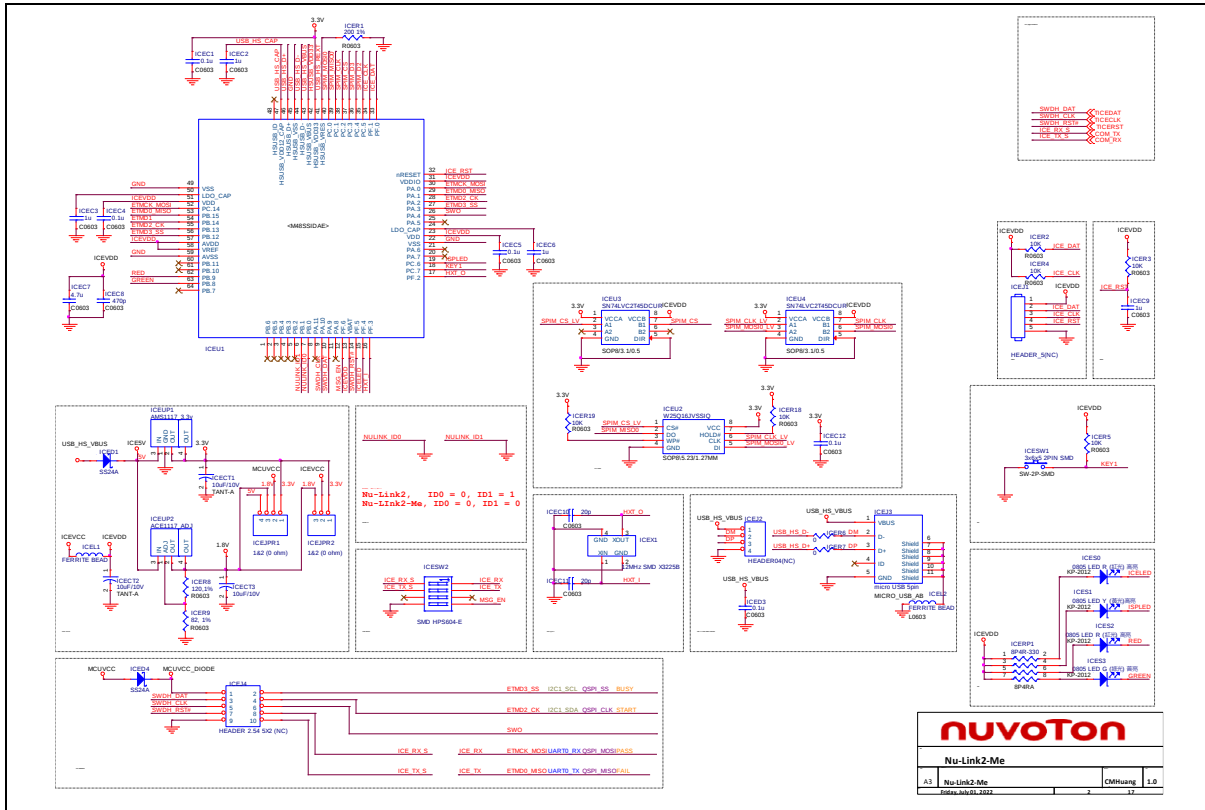


Figure 5-1 Nu-Link2-Me Circuit

5.2 M463KG Target Board

5.2.1 Power Source

Figure 5-2 shows the power source circuit.

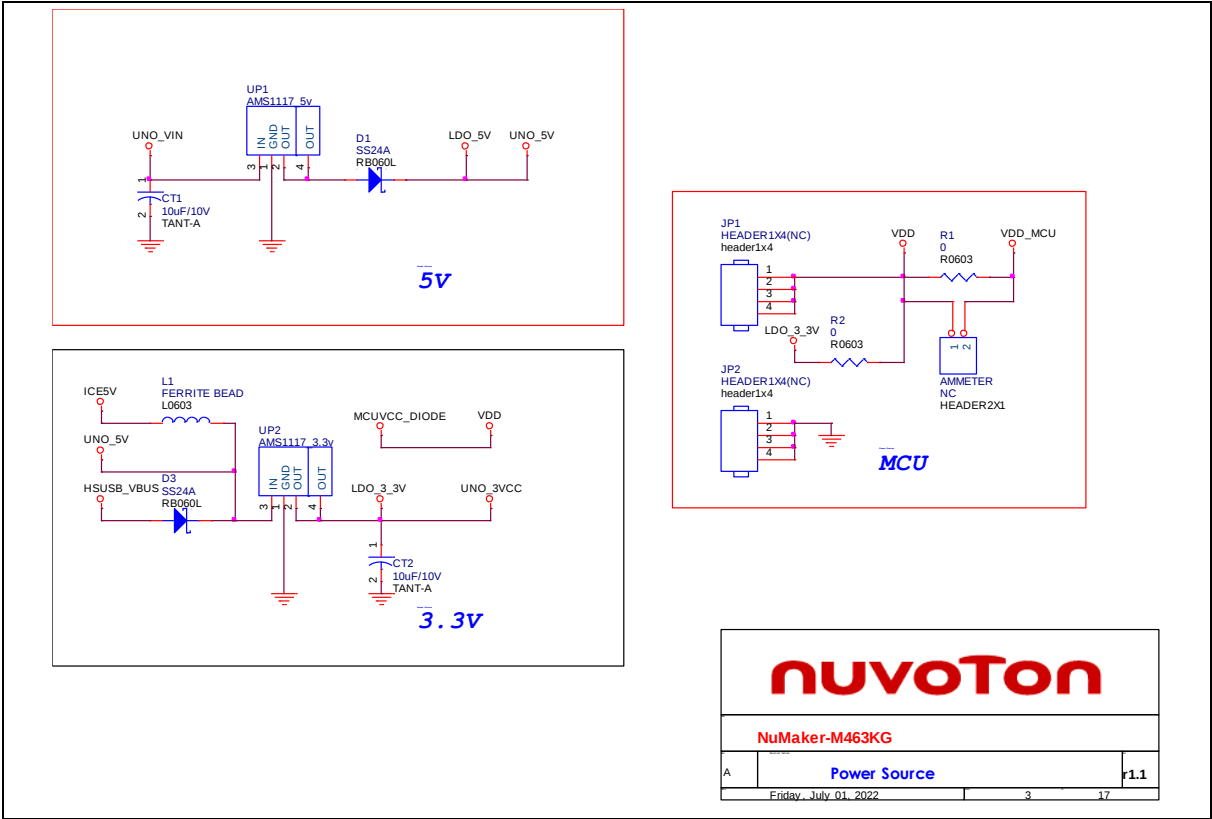


Figure 5-2 Power Source Circuit

5.2.2 M463KGCAE

Figure 5-3 shows the M463KGCAE circuit.

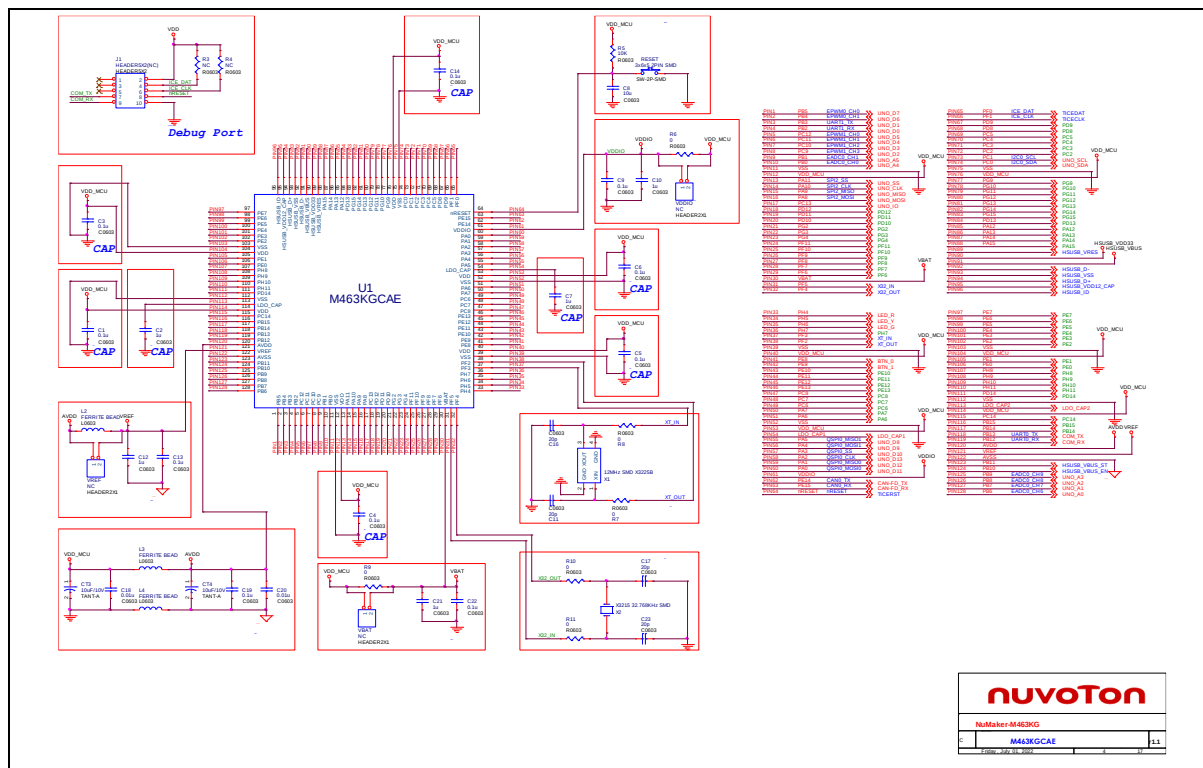


Figure 5-3 M463KGCAE Circuit

5.2.3 High-speed USB

Figure 5-4 shows the high-speed USB circuit.

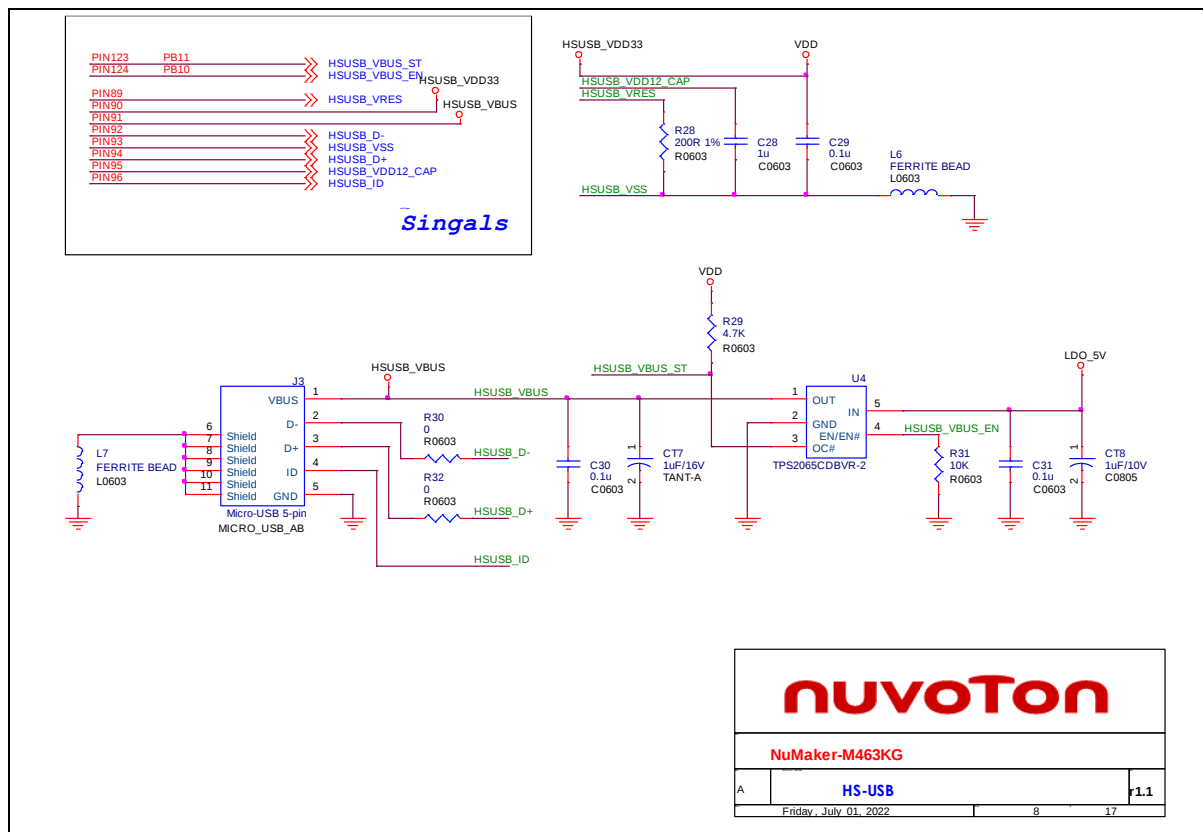


Figure 5-4 High-speed Circuit

5.2.5 Arduino UNO I/F

Figure 5-6 shows the Arduino UNO interface circuit.

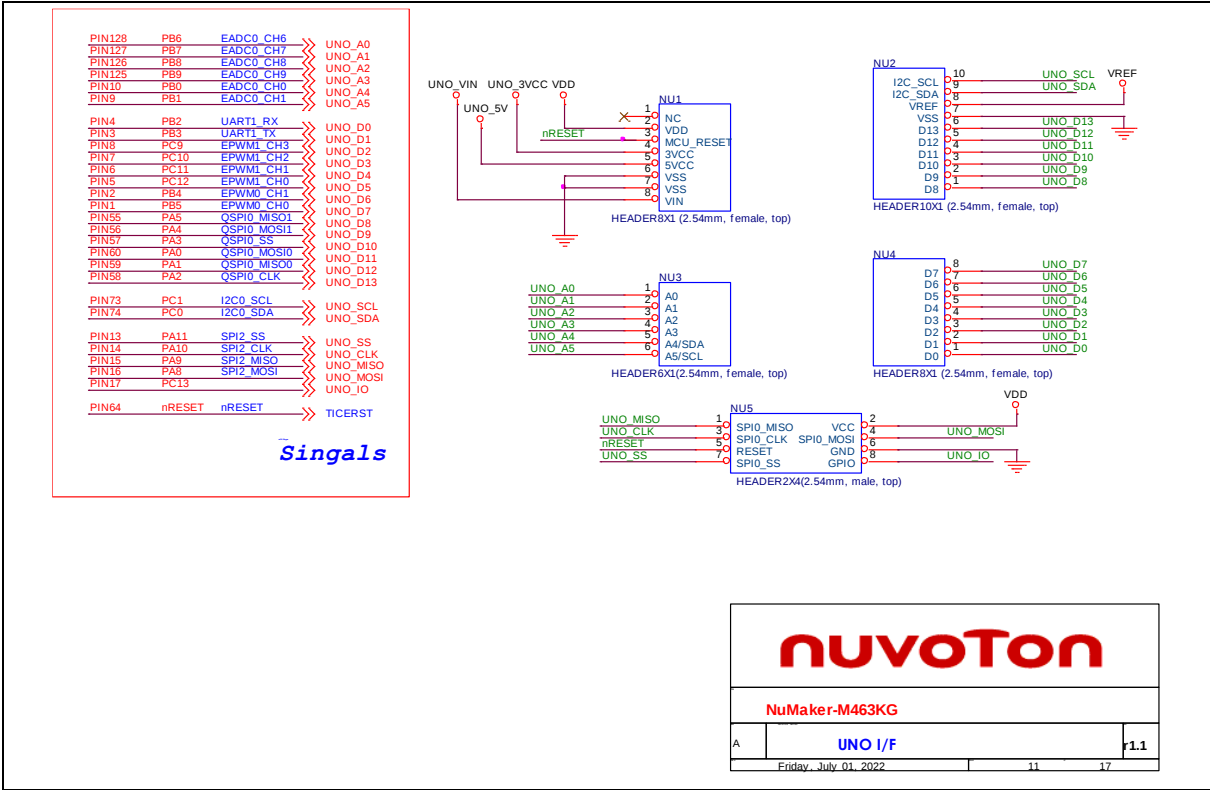


Figure 5-6 Arduino Uno I/F Circuit

5.2.6 CAN FD Transceiver

Figure 5-7 shows the CAN FD transceiver circuit.

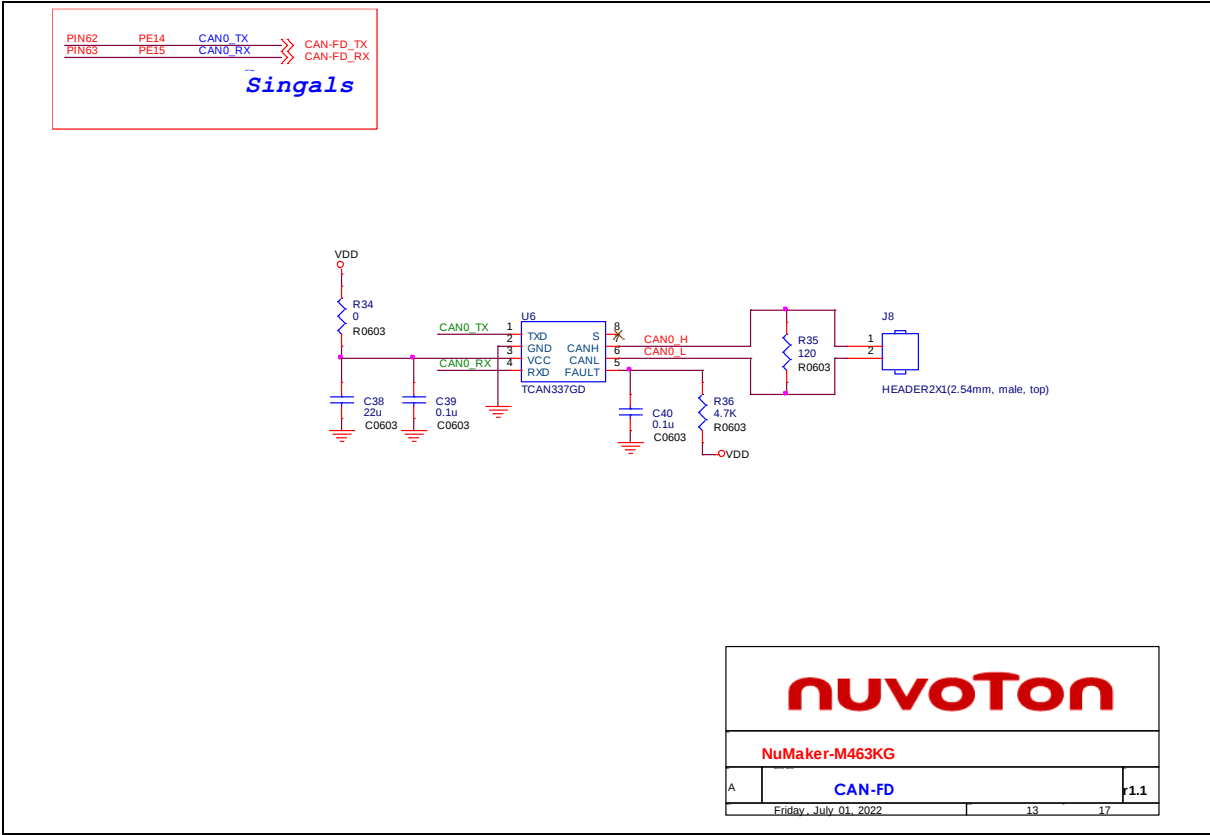


Figure 5-8 shows the LEDs and buttons circuit.



Figure 5-8 LEDs and Buttons Circuit

6 REVISION HISTORY

Date	Revision	Description
2022.07.20	1.00	Initial version.

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[LKS32MC037QM6Q8-K](#) [LKS32MC074DF8Q8-K](#) [LKS32MC034DF6Q8-k](#) [LKS32MC051C6T8-K](#) [LKS32MC081C8T8-K](#)
[LKS32MC083C8T8-K](#) [LKS32MC081C8T8-GK](#) [LKS32MC057M6S8-K](#) [LKS32MC037M6S8-K](#) [LKS32MC071C8T8-K](#) [LKS32MC057M6S8-GK](#) [LKS32MC054DF6Q8-K](#) [LKS32AT085C8Q9-K](#) [LKS32MC082K8Q8-K](#) [LKS32MC087M6S8-K](#)