ARM® Cortex®-M

32-bit Microcontroller

NuMicro®Family
NK-NM18107Y
User Manual

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1 OVERVIEW

NK-NM18107 is the combination of (Nu-LVMDM) and (NuTiny-EVB-NM18107). The board is also for NM18107 developing. User can develop/emulate their project on it.

The Nuvoton Low Voltage Motor Development Module using MOSFET power stage (Nu-LVMDM-NM18107) (NK-NM18107) is used to accelerate product development by providing ready-to-run hardware and a comprehensive Motor Development Adapter (NuTiny-EVB-NM18107)(NT-NM18107).

NuTiny-EVB-NM18107(NT-NM18107) is the specific development tool for NuMicro® NM18107 series. Users can use NuTiny-EVB-NM18107 to develop and verify the application program easily.

NuTiny-EVB-NM18107 includes two portions. One is NuTiny-EVB-NM18107 and the other is Nu-Link-Me. NuTiny-EVB-NM18107 is the evaluation board and Nu-Link-Me is its Debug Adaptor. Thus, users do not need other additional ICE or debug equipment.

The NM18107 series 32-bit microcontroller(MCU) is embedded with ARM® Cortex™-M0 core and monolithic half-bridge gate driver for motor driver applications which require high performance, high integration, and low cost. The Cortex™-M0 is the ARM® embedded processor with 32-bit performance at a cost equivalent to the traditional 8-bit microcontroller.

The MCU of NM18107 series can run up to 48 MHz and offers 29.5K-bytes embedded program flash, size configurable Data Flash (shared with program flash), 2K-byte flash for the ISP, 1.5Kbyte SPROM for security, and 4K-byte SRAM. Plentiful system level peripheral functions, such as I/O Port, Timer, UART, SPI, I2C, PWM, ADC, Watchdog Timer, Analog Comparator and Brownout Detector, have been incorporated into the NM18107 series in order to reduce component count, board space and system cost. These useful functions make the NM18107 series powerful for a wide range of motor driver applications.

The power supply input of NM18107 is up to 35V. The UVLO circuits prevent malfunction when VCC is lower than the specified threshold voltage. It also build-in bootstrap diodes that can reduce output component. Additionally, the NM18107 series is equipped with ISP (In-System Programming) and ICP (In- Circuit Programming) functions, which allow the user to update the program memory without removing the chip from the actual end product.

NM18107 is the combination of MCU NM1120 and Gate Driver NCT3612.User may refer to the TRM of NM1120 and the datasheet of NCT3612 for the detailed specification. The NM1120 BSP is also for NM18107 software developing.

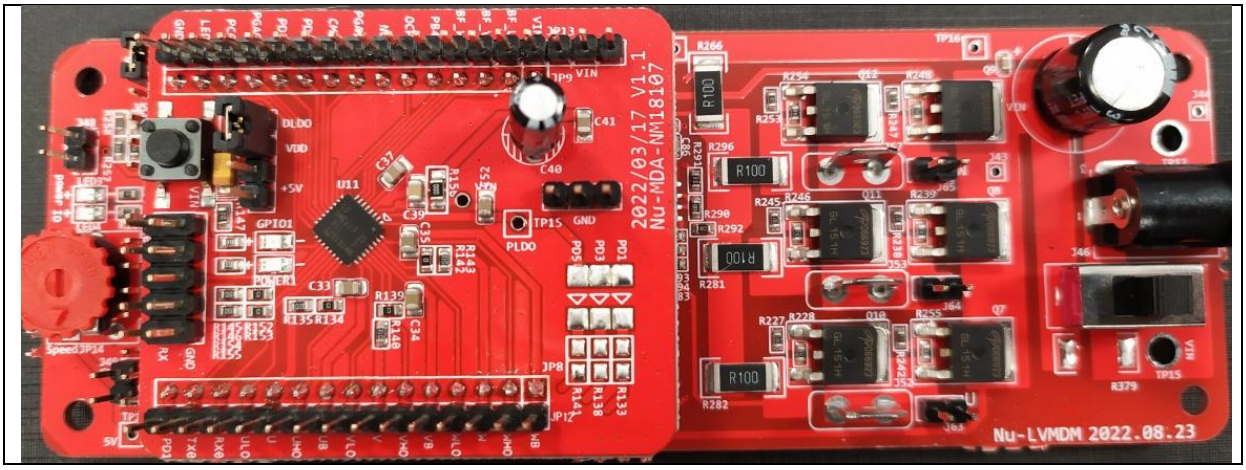


Figure 1-1 NuTiny-EVB-NM18107 & Nu-LVMDM (PCB Board)

2 FEATURES

The key features of this board include the following:

- Motor Control interfaces
  - DC input 15V~24V.
  - Hall sensors interface for sensored motor control (J41)
  - Phase voltage feedback for sensorless BLDC operation
  - DC bus voltage sense for over-voltage control
  - Over-current protection
  - Phase current sense resistor for one / two shunt vector control
- Motor Application function
  - Sine Wave / Square Wave choose
  - 1R or 2R Phase current detector
  - Hall & Bemf choose
- Input/Output Control Switches
  - One LED indicators for debugging purposes(LED3)
  - 50 KΩ VR (JP14)
  - SMD switch for configuration purposes (SW5)
- Communication Ports
  - UART communication via USB (J66)
- Power Supply Connectors
  - Auxiliary Power Tab Fast-On connectors (J43(Vin) and J44(GND)) for the controller and power stage
  - Dedicated power connector (J46) for the controller and power stage
- Programming Connectors
  - Nu-Link connector for NuTiny-EVB-NM18107 (JP19)

3 NUTINY-EVB-NM18107 INTRODUCTION

NuTiny-EVB-NM18107 uses the NM18107 as the target microcontroller. Figure 3-1 is NuTiny-EVB-NM18107 for NM18107 series, the left portion is called NuTiny-EVB-NM18107 and the right portion is Debug Adaptor called Nu-Link-Me.

NuTiny-EVB-NM18107 is similar to other development boards. Users can use it to develop and verify applications to emulate the real behavior. The on board chip covers NM18107 series features. The NuTiny-EVB-NM18107 can be a real system controller to design users' target systems, supports usb high speed interface, audio headphone out, audio line in and sdcad slot.

Nu-Link-Me is a Debug Adaptor. The Nu-Link-Me Debug Adaptor connects your PC's USB port to your target system (via Serial Wired Debug Port) and allows you to program and debug embedded programs on the target hardware. The Nu-Link-Me V3.0 also supports VCOM function, which gives users more flexibility when debug. To use Nu-Link-Me Debug adaptor with IAR or Keil, please refer to "Nuvoton NuMicro® IAR ICE driver user manual "or Nuvoton NuMicro® Keil ICE driver user manual" in detail. These two documents will be stored in the local hard disk when the user installs each driver. To use Nu-Link-Me 3.0 VCOM function, please refer to Chapter 8.

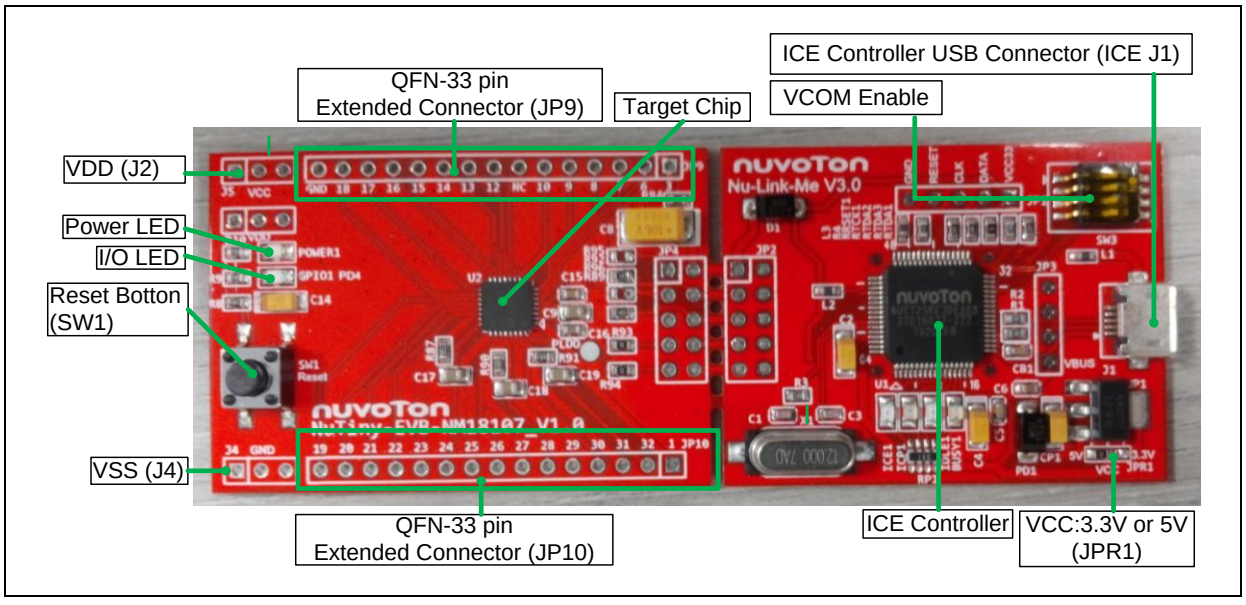


Figure 3-1 NuTiny-EVB-NM18107 (PCB Board)

3.1 NuTiny-EVB-NM18107 Pin Assignment for Extended Connector

NuTiny-EVB-NM18107 use QFN33， provides extended connector for (**JP17,JP20** and **JP18,JP21**). Table 3-1 NuTiny -EVB-NM18107 IO Extended Connector

- The extended connector the same with Nu-LVMDM-NM18107.

Pin No	Port	Pin Function	Pin No	Port	Pin Function
01		VIN	30		WB
02	PB.0	ADC0_CH0,ACMP0_P0,ECAP_P0	29		WHO
03	PB.1	ADC0_CH1,ACMP0_P1,ECAP_P1	28		W
04	PB.2	ADC0_CH2,BPWM_CH1,ACMP0_P2,ECAO_P2	27		WLO
05	PB.4	ADC1_CH0,ACMP0_N,TM1	26		VB
06	PC.1	ADC0_CH4,STADC,ACMP0_P3,ACMP1_P1,SPI0_MOSI,SPI1_MISO	25		VHO
07			24		V
08	PB.3	ACMP1_N,PGA_I,TM0	23		VLO
09	PC.2	ADC1_CH2,BRAKE,CCAP_P1,I2C1_SDA,SPI0_MISO,SPI1_MOSI,UART1_RXD	22		UB
10	PD.2	ICE_DAT,ADC1_CH1,CCAP_P0,I2C0_SDA,SPI0_MOSI,SPI1_MISO,UART0_RXD	21		UHO
11	PD.3	BPWM_CH1,UART1_TXD	20		U
12	PC.3	ACMP1_O,PGA_O,SPI0_CLK,SPI1_SS	19		ULO
13	PC.0	ADC0_CH3,BPWM_CH0,ACMP1_P0,I2C1_SCL,SPI0_SS,SPI1_CLK,UART1_TXD	18	PD.6	UART0_RXD
14	PD.4	BPWM_CH0,UART1_RXD	17	PD.5	UART0_TXD
15		VSS	16	PD.1	ICE_CLK,ACMP1_P2,I2C0_SCL,SPI0_CLK,SPI1_SS,UART_TXD

Table 3-1 NuTiny -EVB-NM18107 IO Extended Connector

3.2 NuTiny-EVB-NM18107 Connector Description

3.2.1 Power Connector

- +15V: from Nu-LVMDM-NM18107 (J24: Pin 11) connect power supplier.
- +5V: from Nu-LVMDM-NM18107 (J23: Pin 1), or connect to NM18107 LDO5V. (NuTiny-NM18107 J8 can switch +5V power sourse for VDD)

3.2.2 Debug Connector

- JP4: Connector in target board (NuTiny-EVB-NM18107) for connecting with Nuvoton ICE adaptor (Nu-Link-Me V3.0)
- JP2: Connector in ICE adaptor (Nu-Link-Me V3.0) for connecting with a target board (for example NuTiny-EVB-NM18107)

3.2.3 USB Connector

- J1: Mini USB Connector in Nu-Link-Me V3.0 connected to a PC USB port

3.2.4 Extended Connector

- J9, J10: Show all chip pins in NuTiny-EVB-NM18107

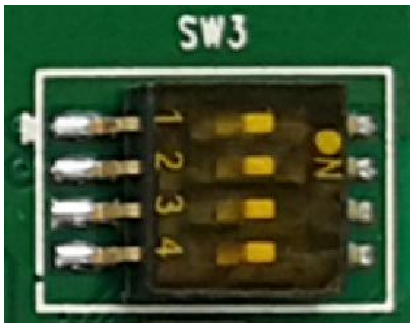
3.2.5 Reset Button

- SW4: Reset button in NuTiny-EVB-NM18107

3.2.6 VCOM Enable

SW3: VCOM function enable for NuTiny-EVB-NM18107. Switch SW3 on before power on to enable VCOM function. SW3 connects pin 13(PD2/RXD) and pin 17(PC0/TXD) in NuTiny-EVB-NM18107 with pin 22(PB.1/TXD) and pin 21(PB.0/RXD) in Nuvoton ICE adaptor (Nu-Link-Me V3.0). SW3 connects pin 29(VCOM) in Nuvoton ICE adaptor (Nu-Link-Me V3.0) to GND to enable VCOM function.

Switch Pin Number	Function Name	UART0 Mode	VCOM Mode
1	ICE_TX	Off	On
2	ICE_RX	Off	On
3	VCOM_EN	Off	On
4	X	X	X



X: Unused.

4 NU-LVMDM INTRODUCTION

Low-voltage motor drive module (Nu-LVMDM) provides users with motor-related applications. It is recommended to use DC8V~DC24V. This module includes DC8V~D48V conversion 5V circuit. Current detection supports single resistance sampling. The two-phase current sampling uses an external OP amplification signal, and the phase voltage sampling supports the detection of a sine wave, a square wave, and a Hall sensor. The external control commands are available with VR variable resistors and VSP external PWM input signals. Communication interface provides UART interface.

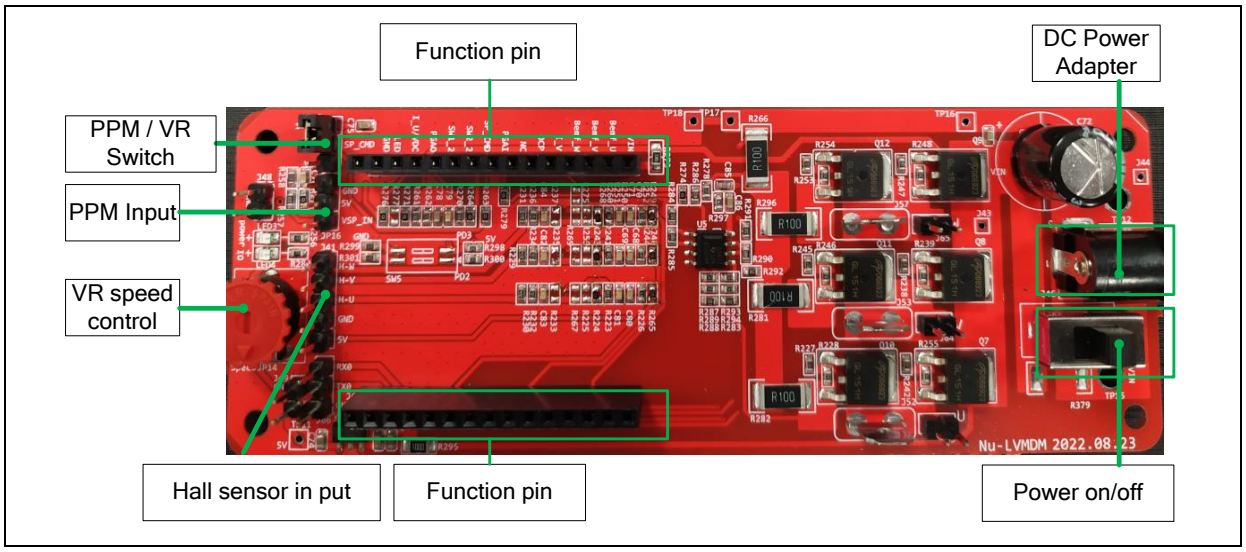


Figure 4-1 Nu-LVMDM (PCB Board)

4.1 Nu-LVMDM Pin Assignment for Extended Connector

Nu-LVMDM， provides extended connector for (**J58** 及 **J62**) 。

Pin No	Port	Pin Function (J58)	Pin No	Port	Pin Function (J62)
01		VIN	30		WB
02	PB.0	Bemf_U	29		WHO
03	PB.1	Bemf_V	28		W
04	PB.2	Bemf_W	27		WLO
05	PB.4	PB.4	26		VB
06	PC.1	PC.1,OCP	25		VHO
07	NC	NC	24		V
08	PB.3	PB.3,PGAI	23		VLO
09	PC.2	PC2,Speed_Command	22		UB
10	PD.2	PD2	21		UHO
11	PD.3	PD3	20		U
12	PC.3	PC3,PGAO	19		ULO
13	PC.0	PC0	18	PD.6	UART0_RXD
14	PD.4	PD4,LED	17	PD.5	UART0_TXD
15		GND	16	PD.1	PD1

Figure 4-2 Nu-LVMDM extended connector

4.2 NK-NM18107 connect Description

4.2.1 Power connect

- J46: connector DC power (DC 24V)
- DC power connect to Vin(J43,TP15) and GND(J44,TP12)
- LDO5V can use VIN conversion to 5V for Hall sensor

4.2.2 IO connect

- J58 and J62: Nu-LVMDM-(NM18107) Extended Connector

4.2.3 IO Switch

- SW5: support SW1 and SW2 use pull high 10K or short to GND
- NM18107Y connect to PD2 and PD3

4.2.4 Hall connect

- J41: connect to Motor Hall sensor line

4.2.5 VR and VPS input speed command

- JP15: use Jumper to Switch (VR or VPS) input speed command

4.2.6 USRT Connecter

- J66: UART connect

5 NULVMDM APPLICATION CIRCUIT

5.1 Select phase voltage feedback mode risister

Nu-LVMDM Provide a variety of phase voltage detection methods, can be replaced or removed as needed, Table 5-1 Select phase voltage feedback mode risister。

U Phase voltage detection mode selection				V Phase voltage detection mode selection				W Phase voltage detection mode selection			
Component name	Bemf_U	Hall_U	Bemf_O	Component name	Bemf_V	Hall_V	Bemf_O	Component name	Bemf_W	Hall_W	Bemf_O
R265	56K		56K	R240	56K		V	R249	56K		56K
R225	0R			R259	0R			R260	0R		
R226	10K		10K	R244	10K		10K	R252	10K		10K
R223	1K		1K	R241	1K		1K	R250	1K		1K
R224	0R		0R	R243	0R		0R	R251	0R		0R
R267			9.1K	R269			9.1K	R268			9.1K
C80	1000P		1000P	C68	1000P		1000P	C70	1000P		1000P
C81	0.01u		0.01u	C69	0.01u		0.01u	C71	0.01u		0.01u
R233		0R		R235		0R		R237		0R	

Table 5-1 Select phase voltage feedback mode risister

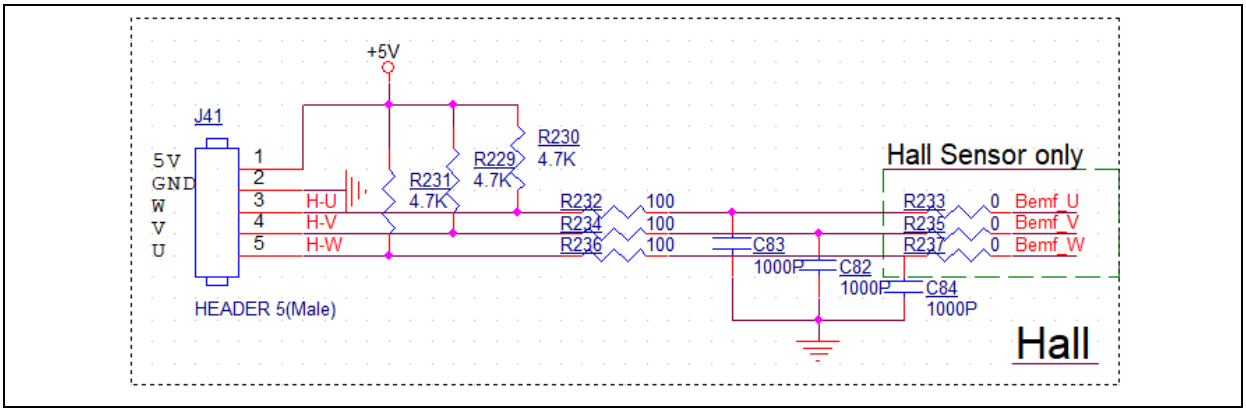


Figure 5-1 Hall sensor circuit

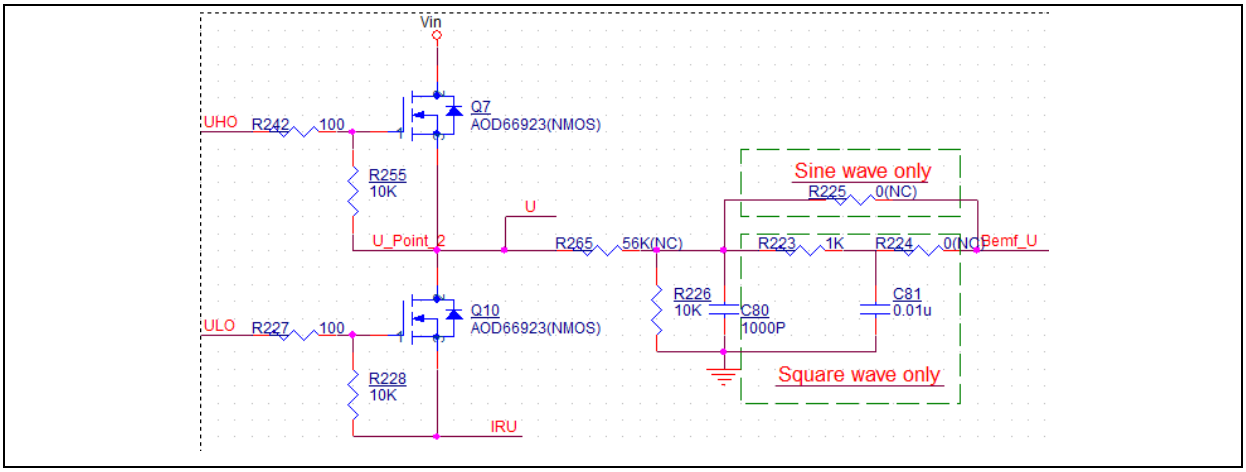


Figure 5-2 Select phase voltage feedback mode risister

5.2 Input command switching from VR and PPM

JP15 can switch the speed command sourse, VR(JP14) use 50K variable resistor adjusts 0~5V as an input command or PPM (JP16) as an external command PWM signal as a speed command.

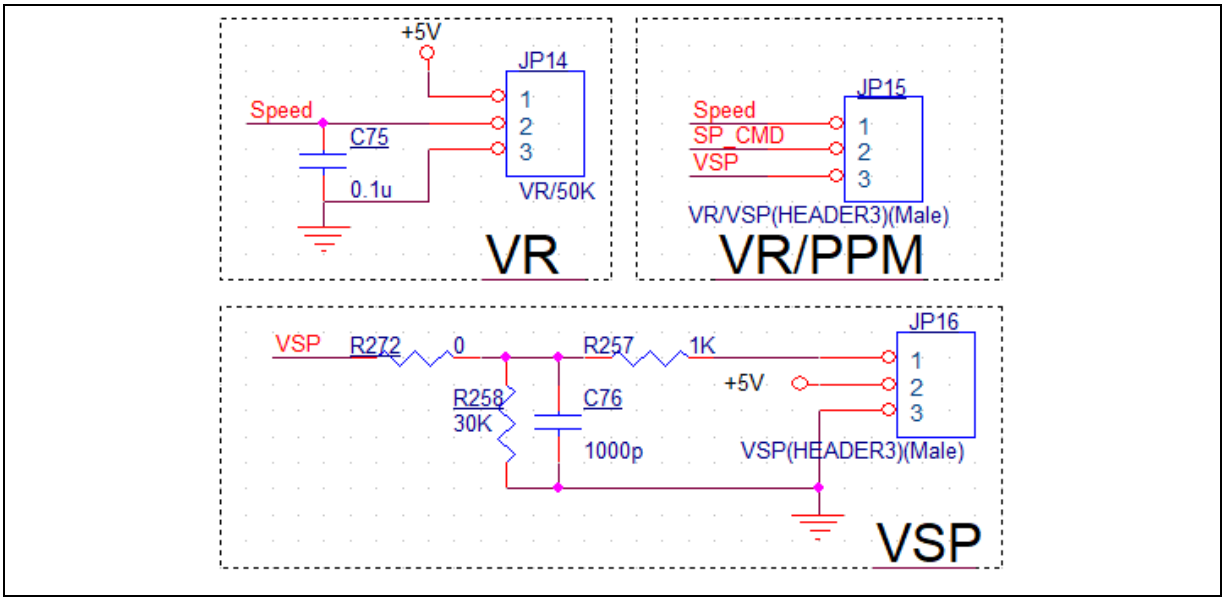


Figure 5-3 choose speed commeand

5.3 Choose DC bus detection voltage divider resistor

When changing the input voltage source, Please calculate that the divided DCV cannot exceed the limit of MUC IO. Example: VIN 24V divided voltage to 3.63V, if VIN up to 48V and not modify divider resistor, then the voltage is 7.27V and has exceeded the IO usage range of the MCU. Therefore, if you choose 48V input voltage "R261" need to use at least 91K ohms.

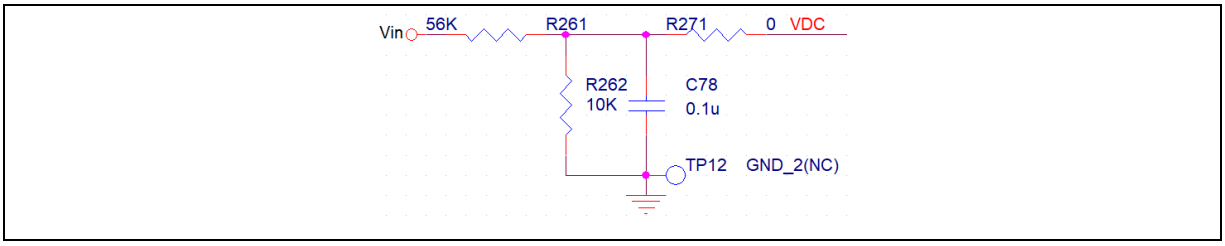


Figure 5-4 Choose DC bus detection voltage divider resistor

Vin (V)	R261(K)	R262(K)
48	120	10
24	56	10

6 HOW TO START NU-MDA-NM1120 ON THE KEIL MVISION® IDE

6.1 Keil uVision® IDE Software Download and Install

Please visit the Keil company website (http://www.keil.com) to download the Keil µVision® IDE and install the RVMDK

6.2 Nuvoton Nu-Link Driver Download and Install

Please visit the Nuvoton company NuMicro® website (http://www.nuvoton.com/NuMicro) to download "NuMicro® Keil µVision® IDE driver" file. When the Nu-Link driver has been well downloaded, please unzip the file and execute the "Nu-Link_Keil_Driver.exe" to install the driver.

6.3 Hardware Setup

The hardware setup is shown as Figure 6-1

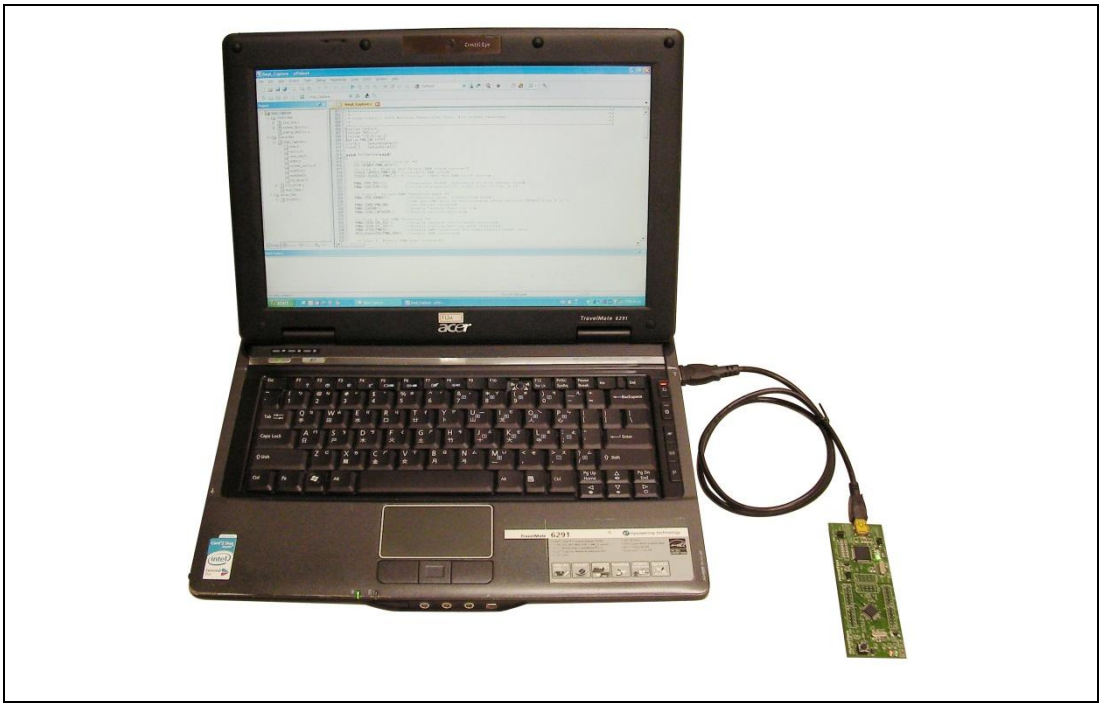


Figure 6-1 Nu-MDA-NM1120 Hardware Setup

6.4 Example Program

This example demonstrates the ease of downloading and debugging an application on a Nu-MDA-NM1120 board. It can be found on Figure 6-2 list directory and downloaded from Nuvoton NuMicro® website.

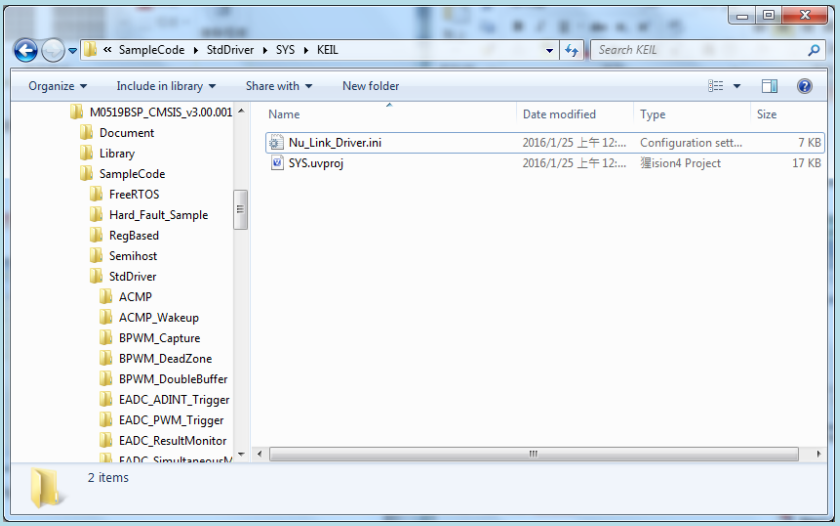
Directory	C:\ Nuvoton\BSP Library\NM1120BSP\SampleCode \StdDriver\SYS\KEIL
Project File	

Figure 6-2 Example Directory

This sample code will show some functions about system manager controller and clock controller.

- Start uVision®
- Project – Open
  Open the SYS.uvproj project file
- Project – Build
  Compile and link the SYS application
- Flash – Download
  Program the application code into on-chip Flash ROM
- Start debug mode
  When using the debugger commands, you may:
  - Review variables in the watch window
  - Single step through code
  - Reset the device
  - Run the application

7 HOW TO START NUTINY -SDK-NM1120 ON THE IAR EMBEDDED WORKBENCH

7.1 IAR Embedded Workbench Software Download and Install

Please connect to IAR company website (http://www.iar.com) to download the IAR Embedded Workbench and install the EWARM.

7.2 Nuvoton Nu-Link Driver Download and Install

Please visit the Nuvoton company NuMicro® website (http://www.nuvoton.com/NuMicro) to download the "NuMicro® IAR EWARM Driver" file. When the Nu-Link driver has been well downloaded, please unzip the file and execute the "Nu-Link_Keil_Driver.exe" to install the driver.

7.3 Hardware Setup

The hardware setup is shown as Figure 7-1

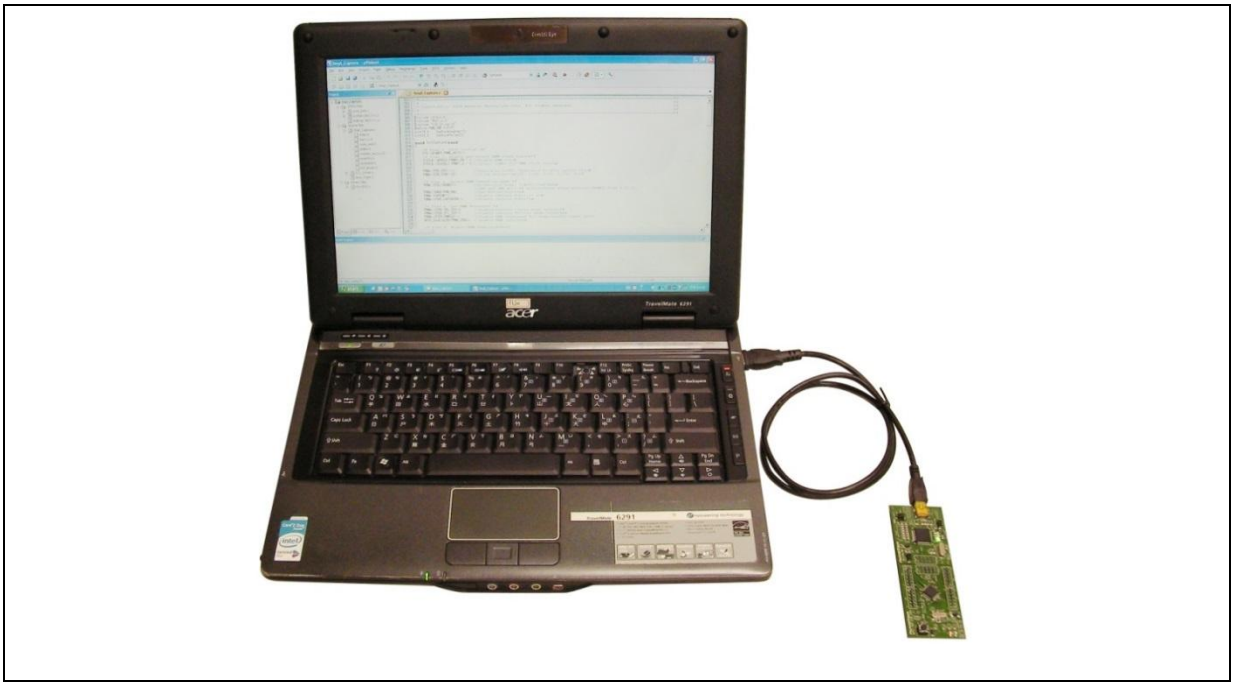


Figure 7-1 Nu-MDA-NM1120 Hardware Setup

7.4 Example Program

This example demonstrates the ease of downloading and debugging an application on a Nu-MDA-NM1120 board. It can be found on Figure 7-2 list directory and downloaded from Nuvoton NuMicro® website.

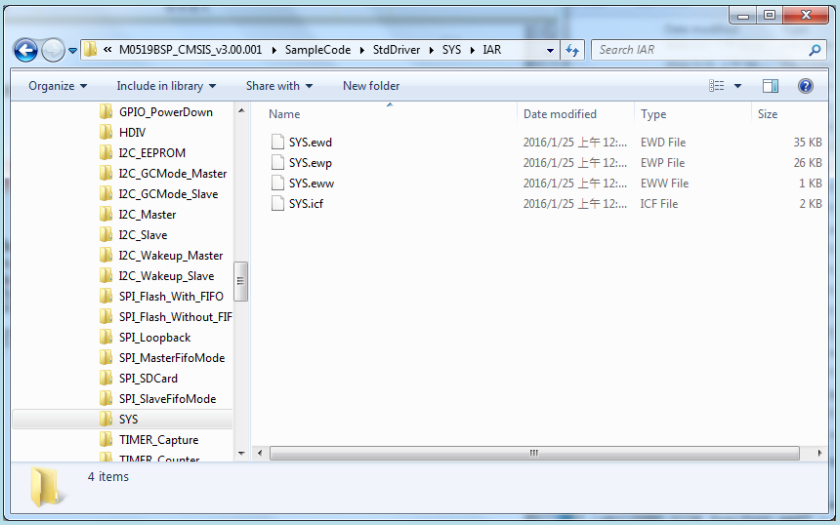
Directory	C:\ Nuvoton\BSP Library\NM1120BSP\SampleCode \StdDriver\SYS\IAR
Project File	

Figure 7-2 Example Directory

This sample code will show some functions about system manager controller and clock controller.

- Start IAR Embedded Workbench
- File-Open-Workspace
  Open the SYS.eww workspace file
- Project - Make
  Compile and link the SYS application
- Project – Download and Debug
  Program the application code into on-chip Flash ROM
  - Single step through code
  - Reset the device
  - Run the application

8 STARTING TO USE NU-LINK-ME 3.0 VCOM FUNCTION

8.1 Downloading and Installing VCOM Driver

Please connect to Nuvoton NuMicro® website (http://www.nuvoton.com/NuMicro) to download the "NuMicro® ICP Programming Tool" file. After the ICP Programming Tool driver is downloaded, please unzip the file and execute the "ICP Programming Tool.exe". Simply follow the installation and optional steps to install ICP Programming Tool and Nu-Link USB Driver, which included VCOM driver.

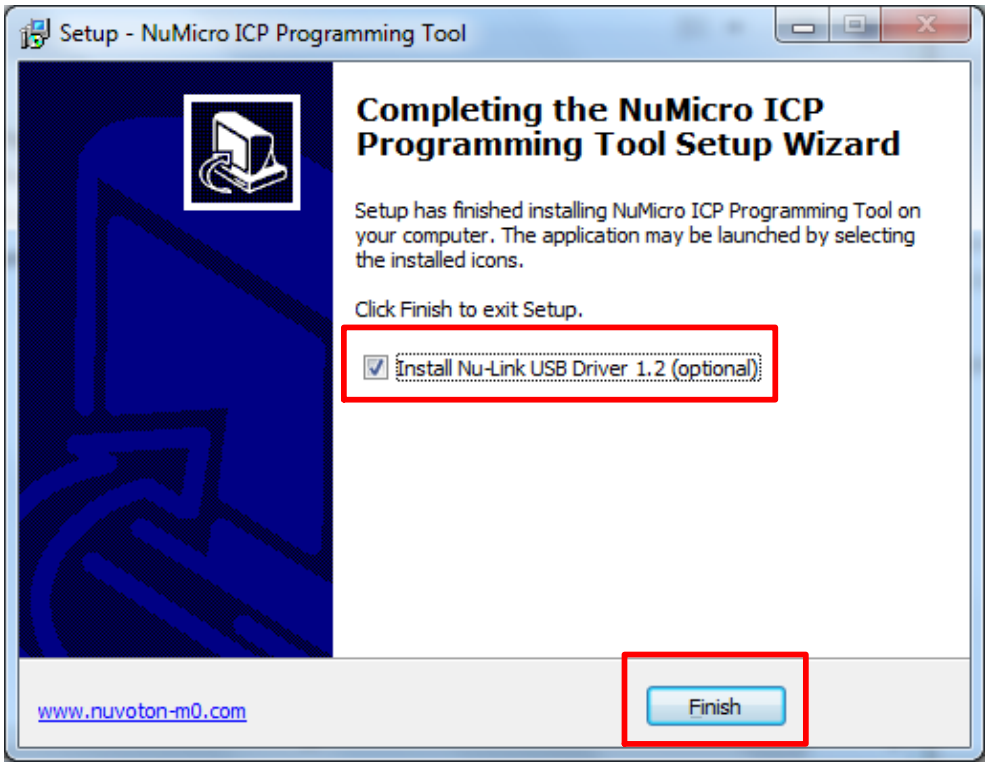


Figure 8-1 Optional Step after ICP Programming Tool Installation

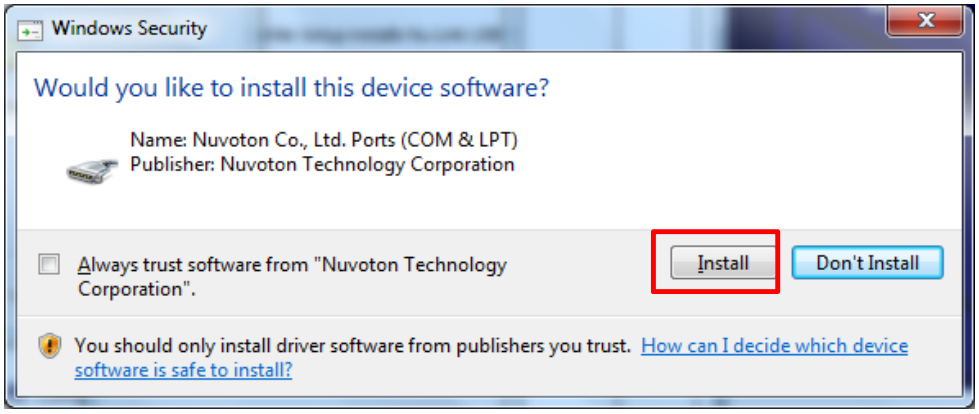


Figure 8-2 Install Nuvoton COM&LPT Driver

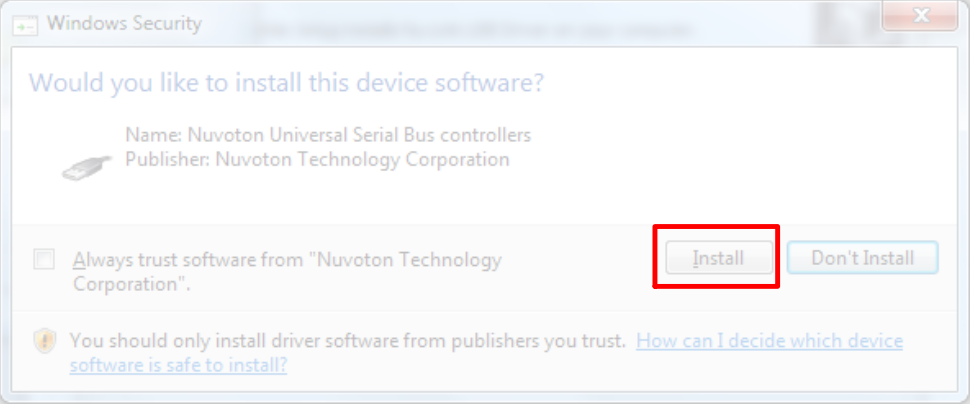


Figure 8-3 Install Nuvoton Universal Serial Bus Controllers

8.2 VCOM Mode Setting on Nu-MDA-NM1120

Before the Nu-MDA-NM1120 is connected to the PC, please enable SW3 VCOM function by switching on SW3. The Nu-MDA-NM1120 transmits through UART0 to VCOM to send out data. Switch SW3 off when using UART0 function without VCOM function.

8.3 Setup on the Development Tool

The example is demonstrated on the Keil µVision® IDE.

8.3.1 Check the Using UART on the Keil µVision® IDE

Please open the project and find system_NM1120.h to check the using UART in DEBUG_PORT, which has to be the same as the using UART in the Nu-MDA-NM1120.

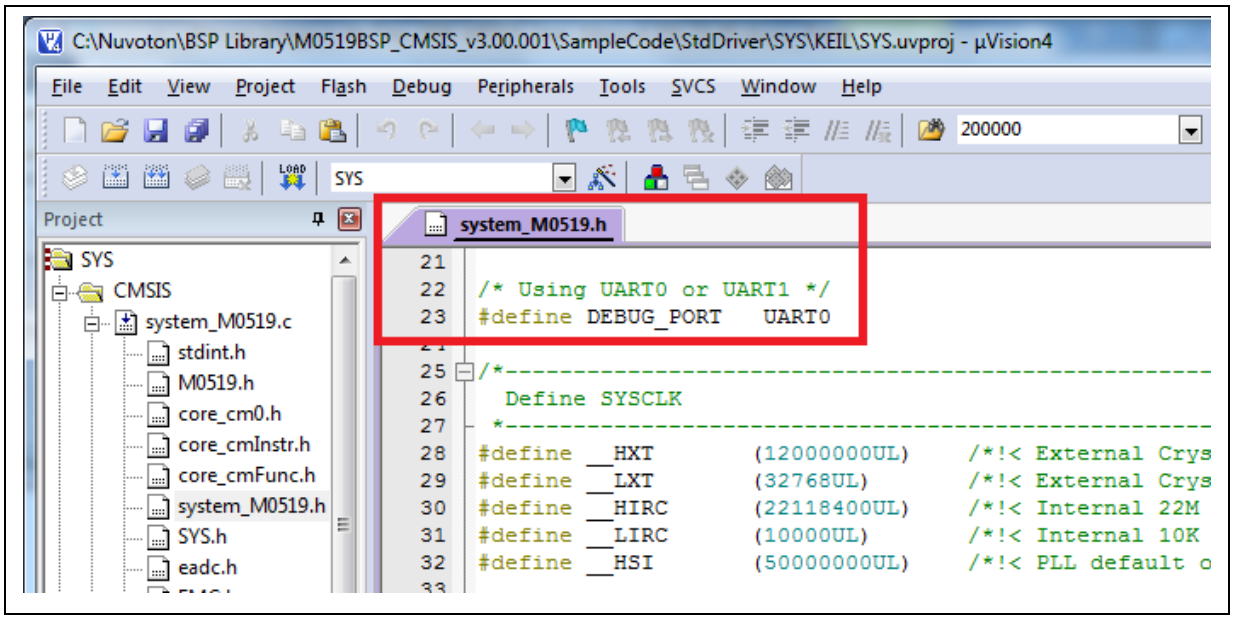
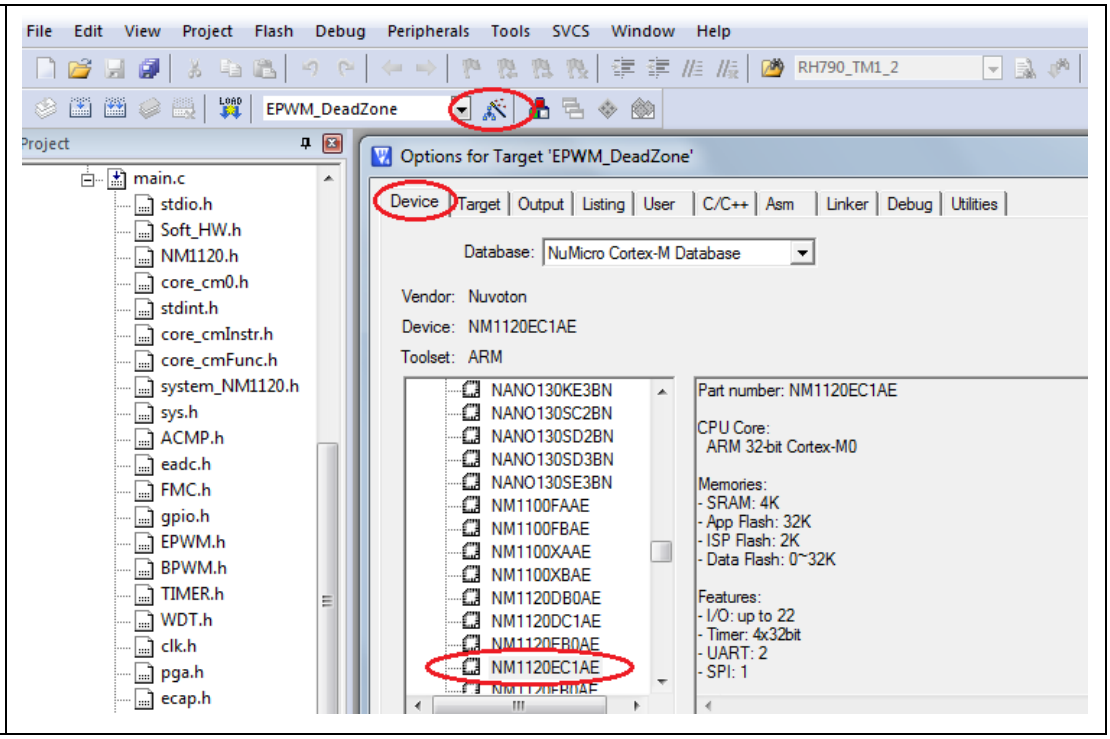
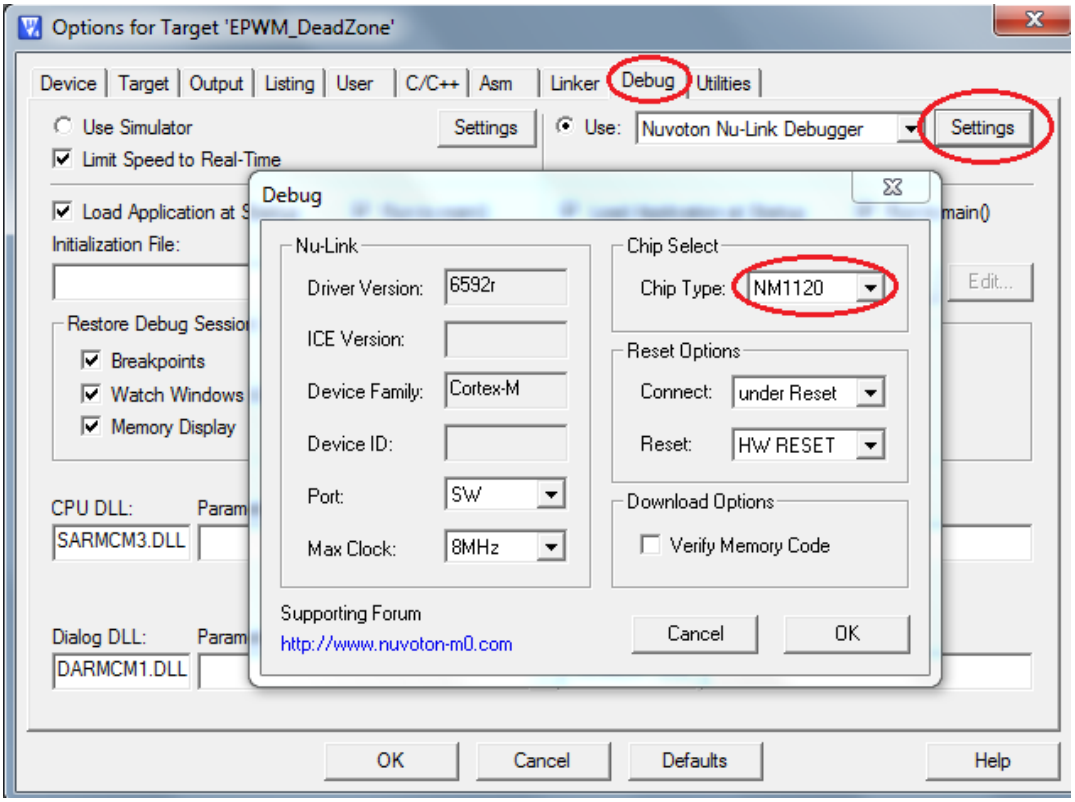
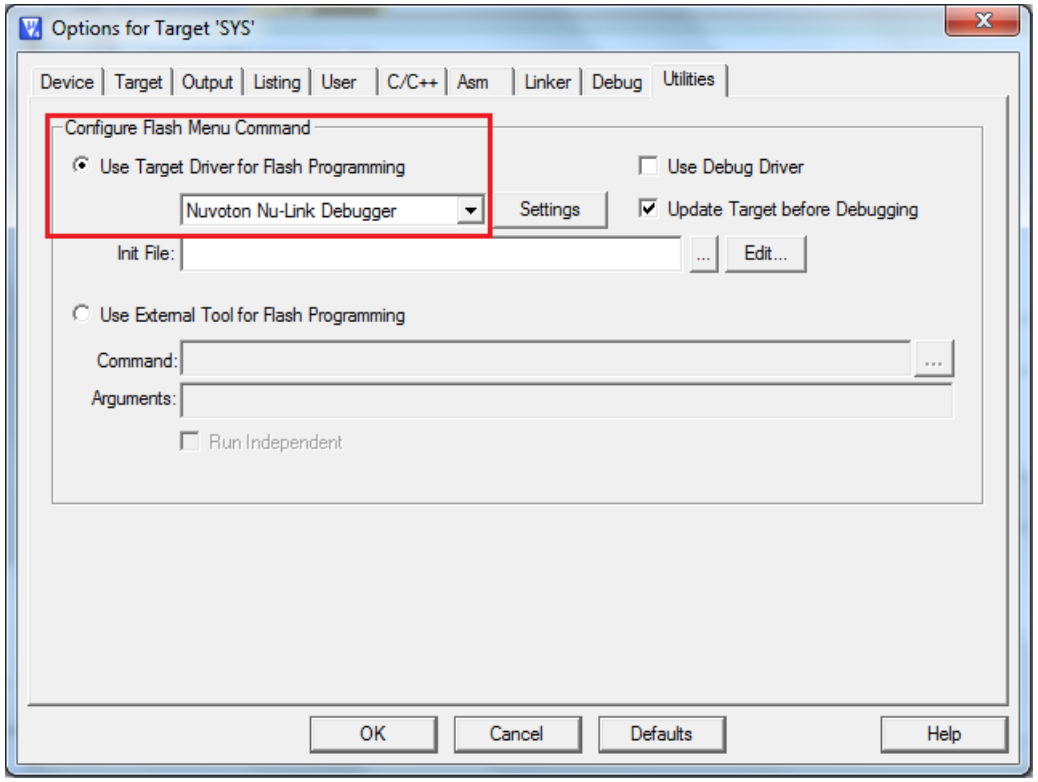


Figure 8-4 The Using UART on Keil µVision® IDE

8.3.2 Check the Target Device and Debug Setting

The target device has to be the same as the setting in Debug. Please click “Target Option” to open the Option windows, and find the setting in “Device”, “Debug”, and “Utilities” page. Please follow the steps below to check the setting.

Step 1	

Step 2	 Options for Target 'EPWM_DeadZone' Device Target Output Listing User C/C++ Asm Linker Debug Utilities Use Simulator Limit Speed to Real-Time Settings Use: Nuvoton Nu-Link Debugger Settings Load Application at S Initialization File: Restore Debug Sessio Breakpoints Watch Windows Memory Display CPU DLL: SARMCM3.DLL Dialog DLL: DARMCM1.DLL Debug Nu-Link Driver Version: 6592r ICE Version: Device Family: Cortex-M Device ID: Port: SW Max Clock: 8MHz Chip Select Chip Type: NM1120 Reset Options Connect: under Reset Reset: HW RESET Download Options Verify Memory Code Supporting Forum http://www.nuvoton-m0.com Cancel OK OK Cancel Defaults Help
Step 3	 Options for Target 'SYS' Device Target Output Listing User C/C++ Asm Linker Debug Utilities Configure Flash Menu Command Use Target Driver for Flash Programming Nuvoton Nu-Link Debugger Settings Use Debug Driver Update Target before Debugging Init File: Edit... Use External Tool for Flash Programming Command: Arguments: Run Independent OK Cancel Defaults Help

8.3.3 Build and Download Code to Nu-MDA-NM1120

Please build the project and download code to Nu-MDA-NM1120.

8.3.4 Open the Serial Port Terminal

User can use serial port terminal, PuTTY for example, to print out debug message.

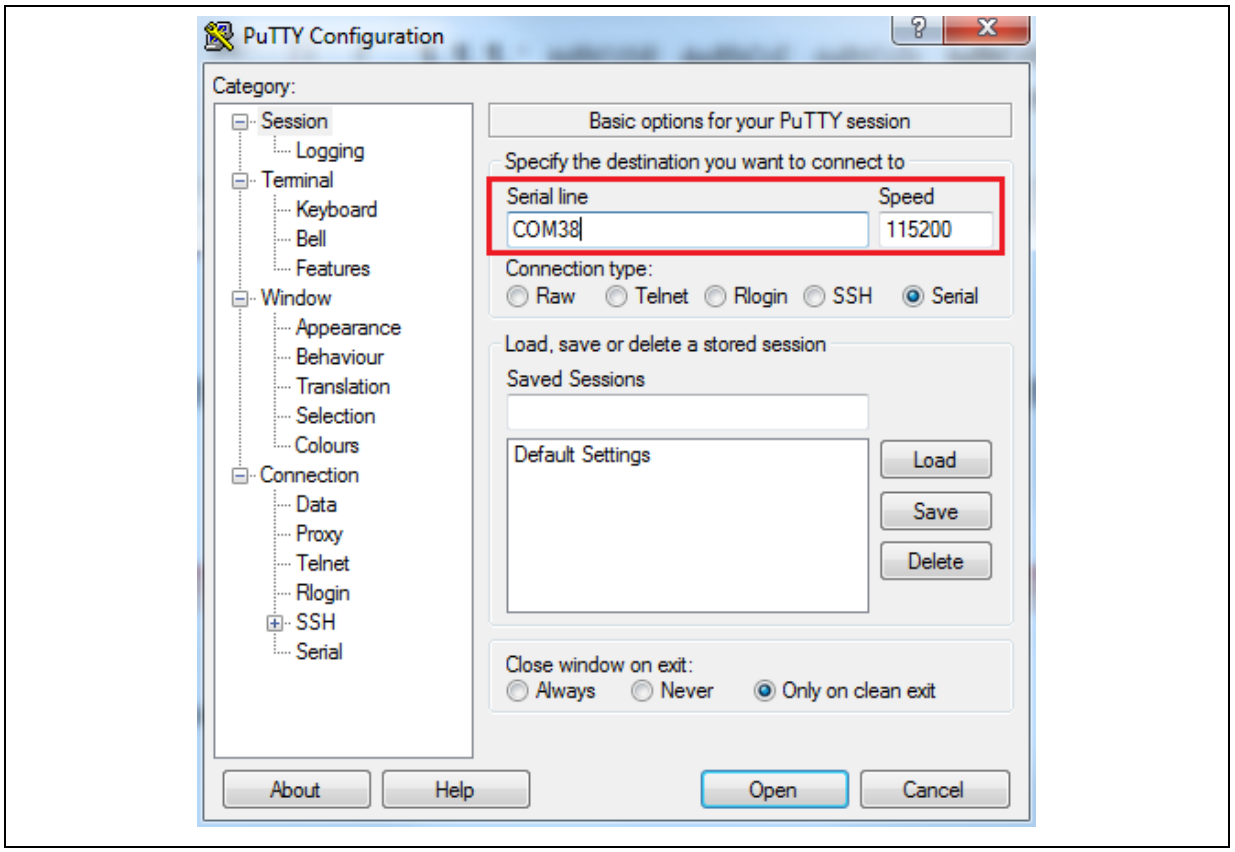


Figure 8-5 Set Baud Rate

8.3.5 Reset Chip

After pushing the reset button, the chip will reprogram application and print out debug message.

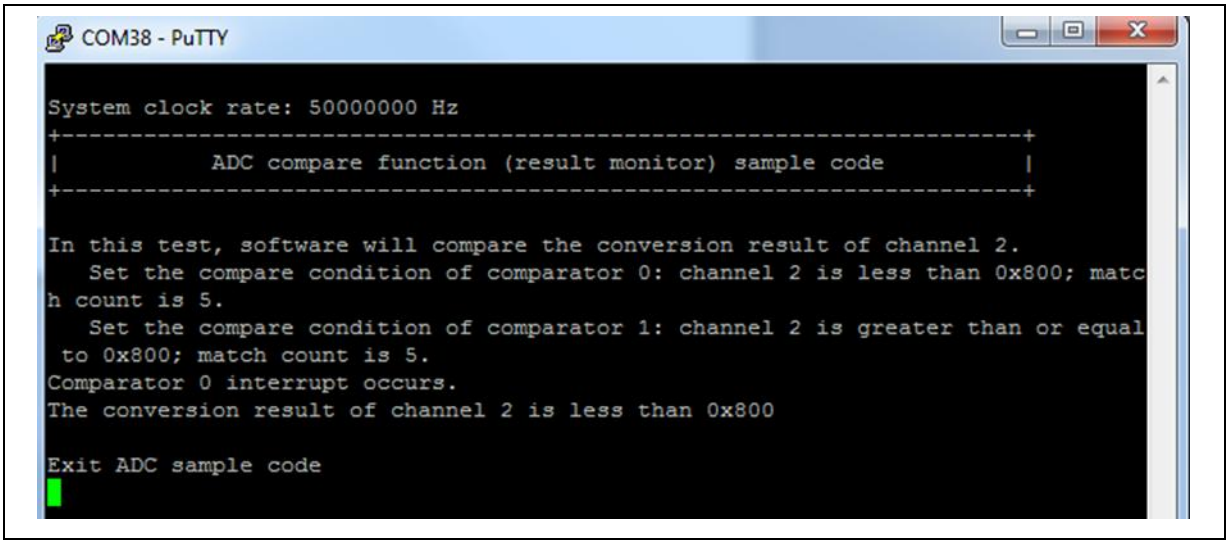


Figure 8-6 Serial Port Terminal Windows

Notice: Please switch SW3 on before the Nu-MDA-NM1120 connects to the PC. When the Nu-MDA-NM1120 connects to the PC with SW3 switch on, PC will detect VCOM as a USB device and the detection will only be processed once. VCOM will not function if switch on SW3 after the connection

9 REFERENCE SCHEMATIC

9.1 NuTiny-EVB-NM18107 Schematic

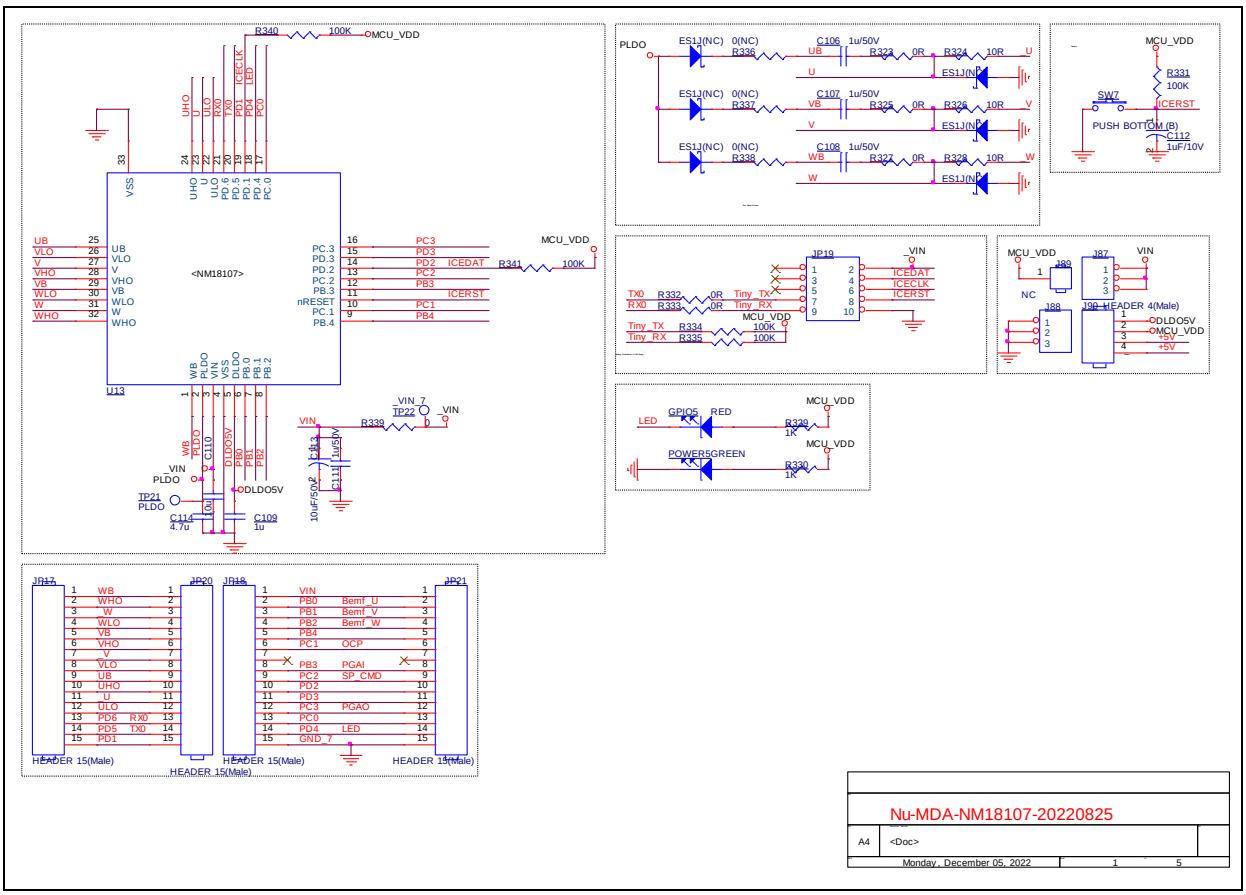


Figure 9-1 NuTiny-EVB-NM18107 Schematic

9.2 Nu-Link-Me V3.0 Schematic

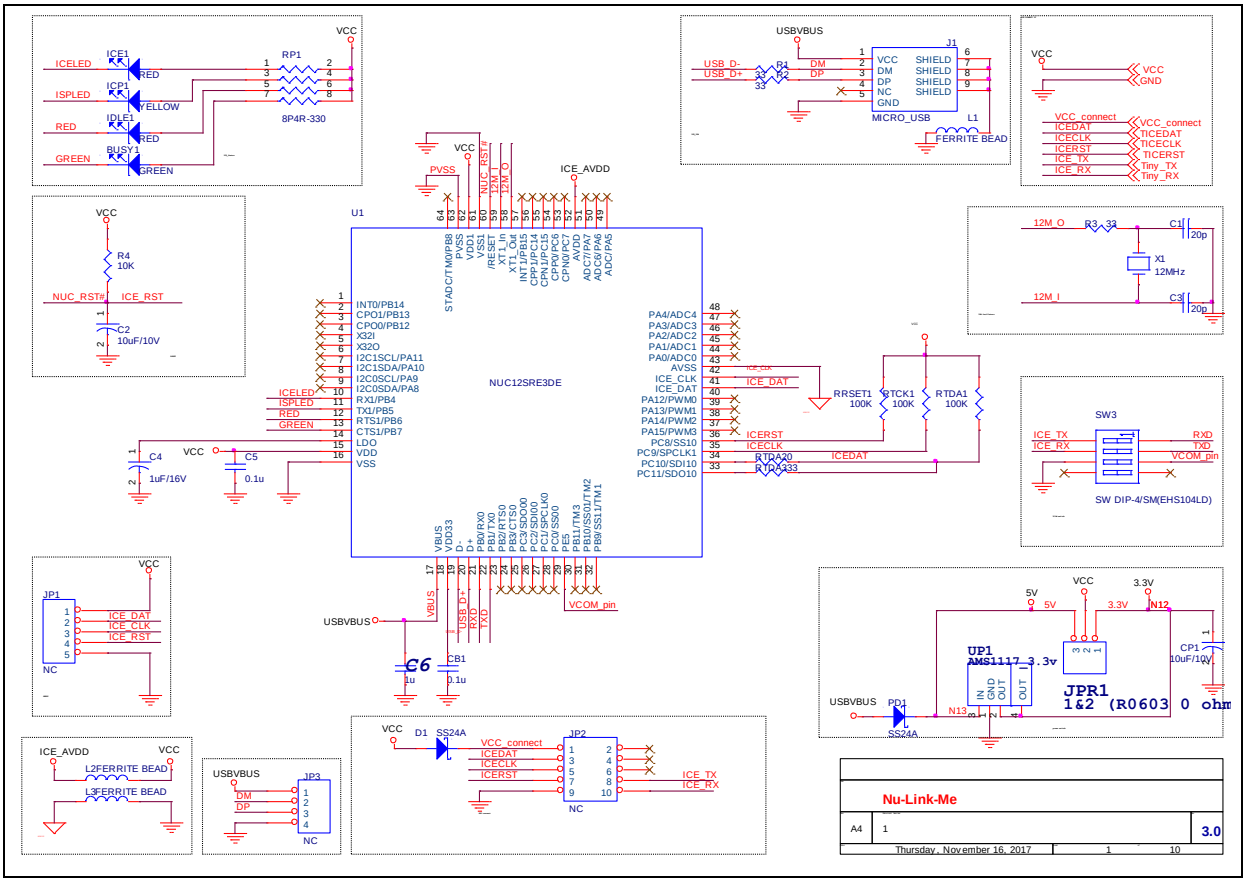


Figure 9-2 Nu-Link-Me V3.0 Schematic

9.3 Nu-MDA-NM18107Y Schematic

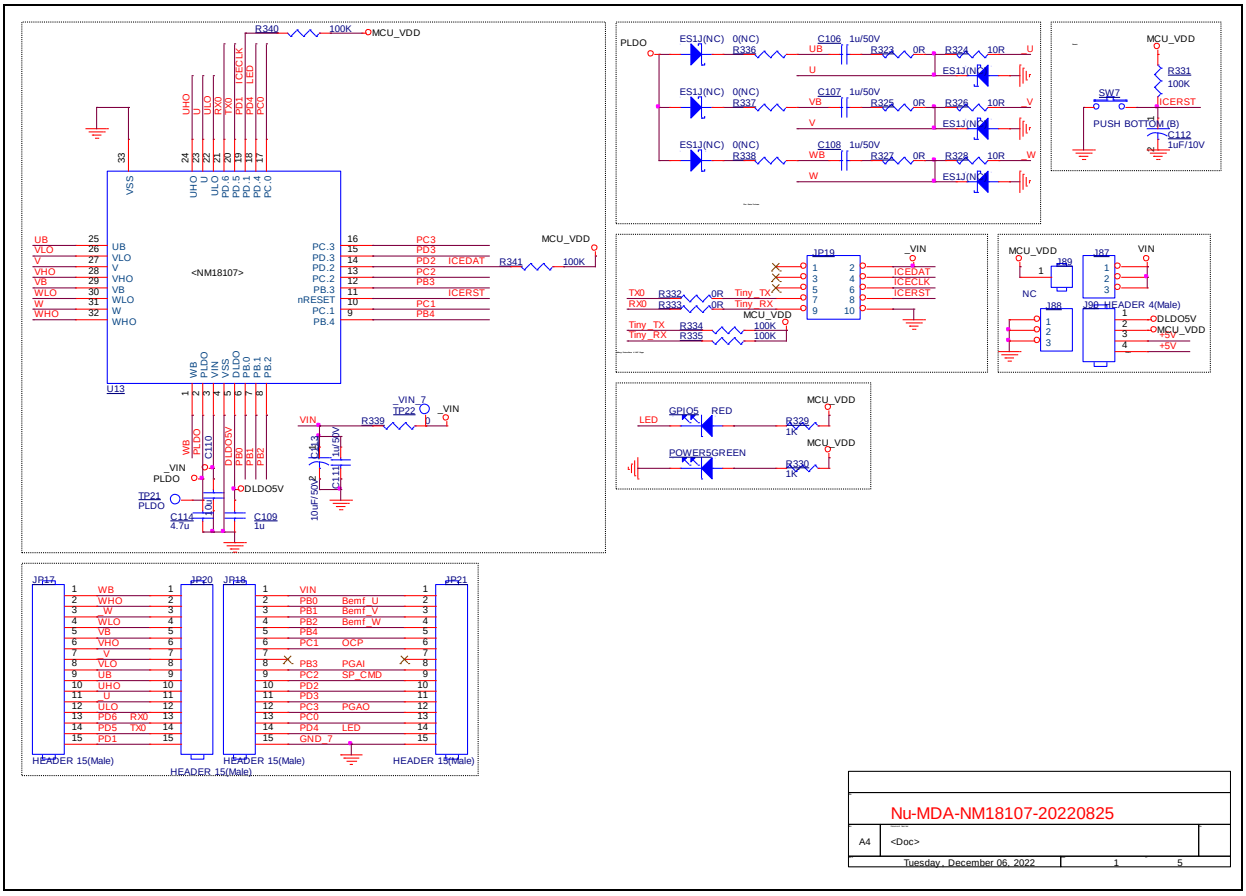


Figure 9-3 Nu-Link-Me V3.0 Schematic

9.4 Nu-LVMDM connect schematic

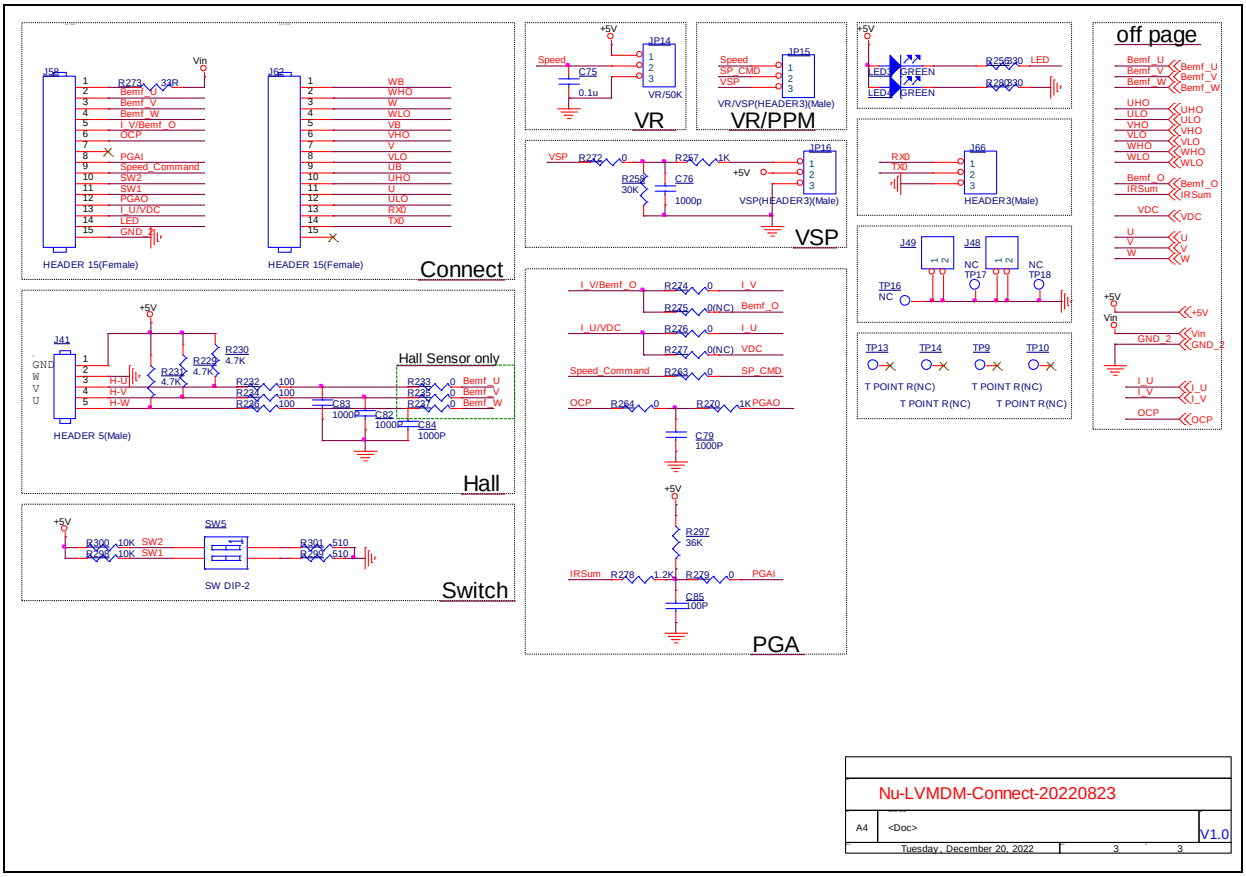


Figure 9-4 Nu-LVMDM connecet schematic

9.5 Nu-LVMDM MOS and Driver Schematic

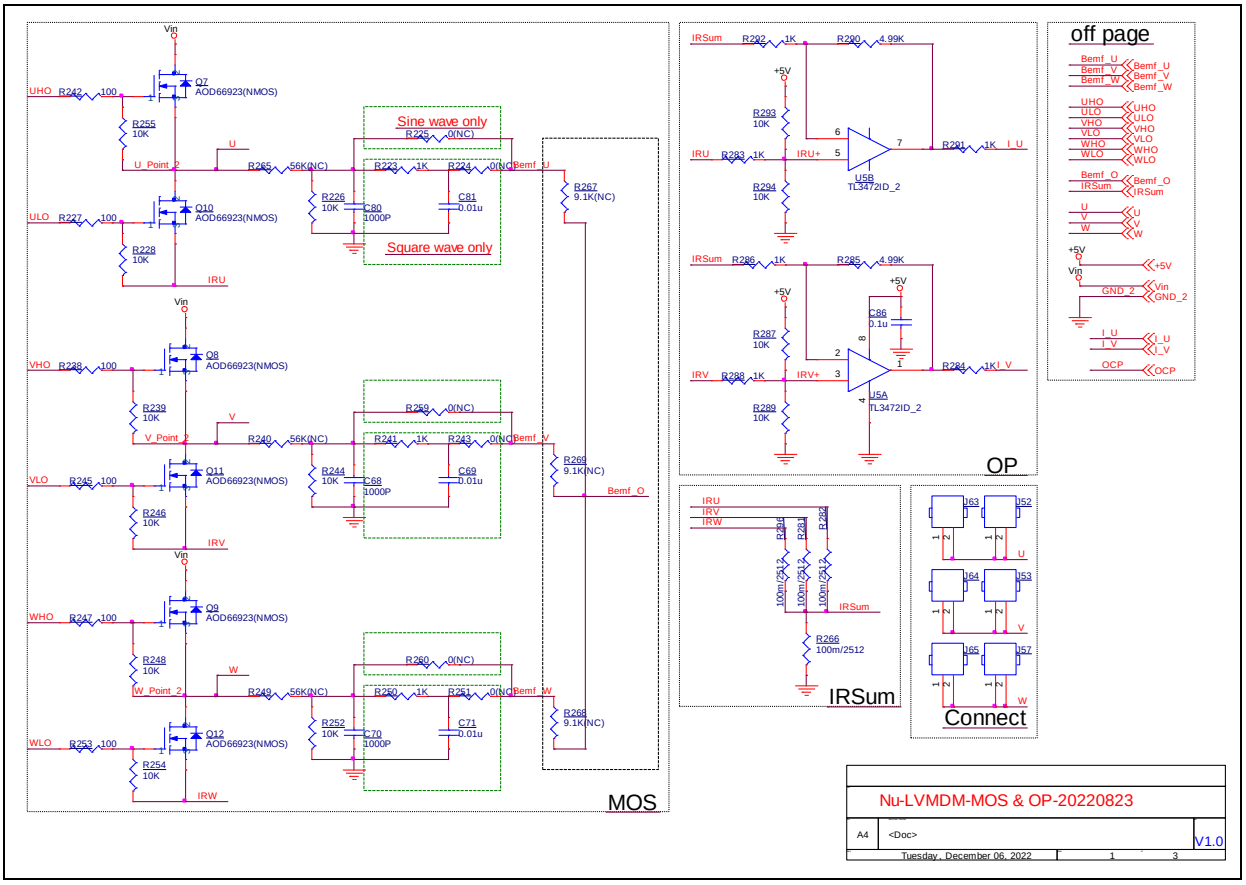


Figure 9-5 Nu-LVMDM MOS and Driver Schematic

9.6 Nu-LVMDM power schematic

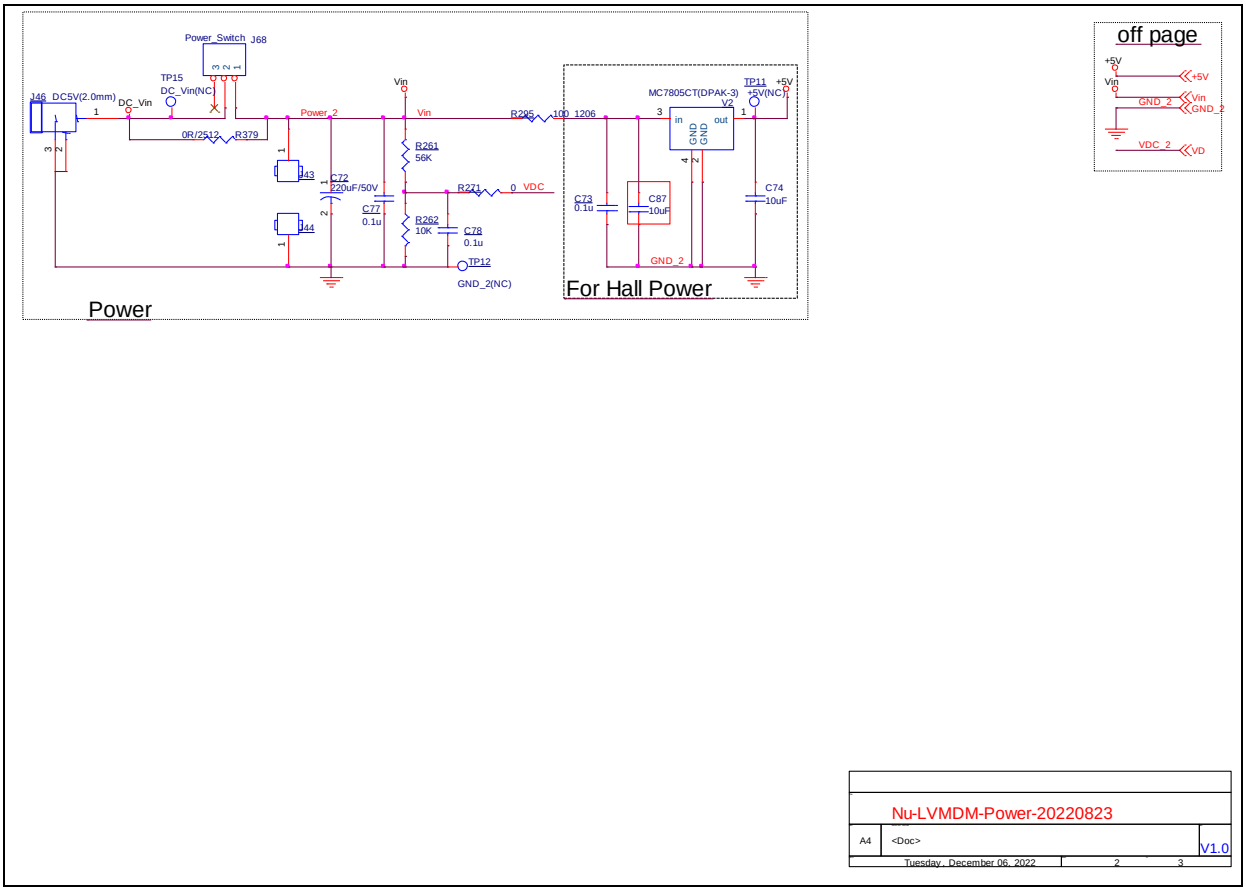


Figure 9-6 Nu-LVMDM power schematic

10 REFERENCE PCB PLACEMENT

10.1 NuTiny-EVB-NM18107 Placement

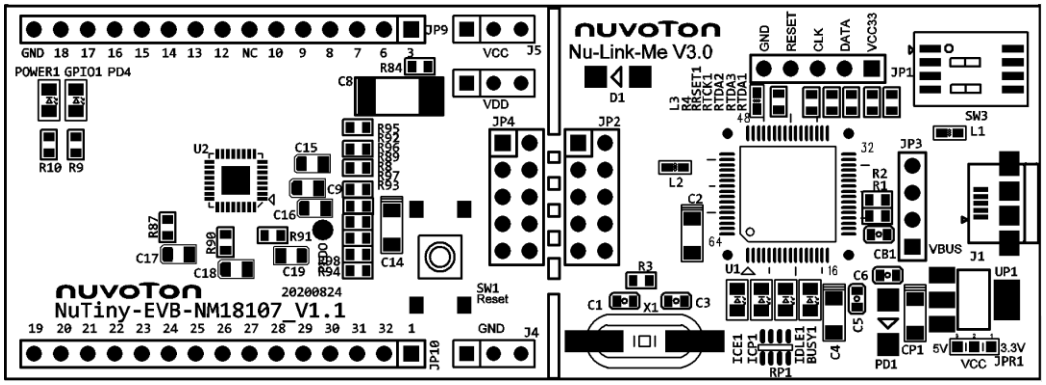


Figure 10-1 NuTiny-EVB-NM18107 Placement -TOP

10.2 NuTiny-EVB-NM18107 Placement

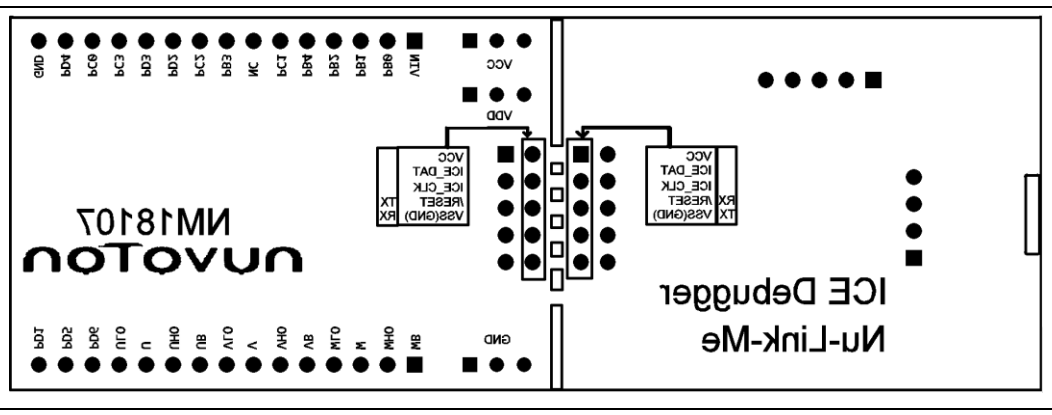


Figure 10-2 NuTiny-EVB-NM18107 Placement-Bottom

10.3 Nu-MDA-NM18107 Placement

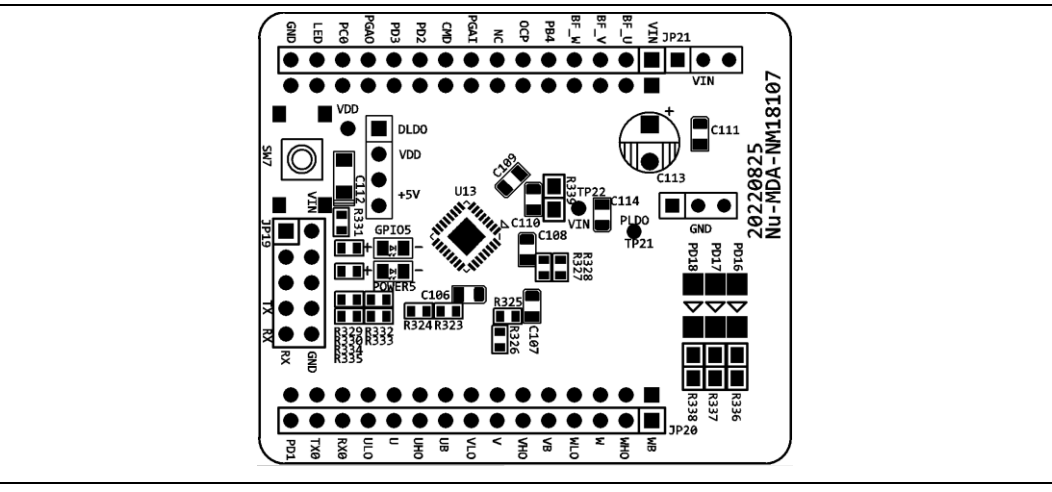


Figure 10-3 Nu-MDA-NM18107 Placement- TOP

10.4 Nu-LVMDM Placement

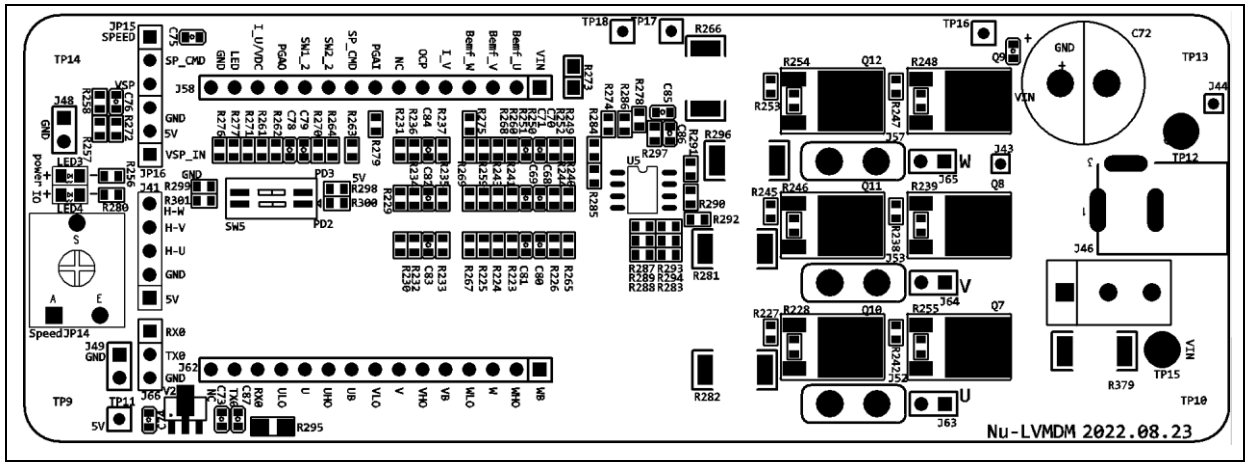


Figure 10-4 Nu-LVMDM Placement -TOP

10.5 Nu-LVMDM Placement

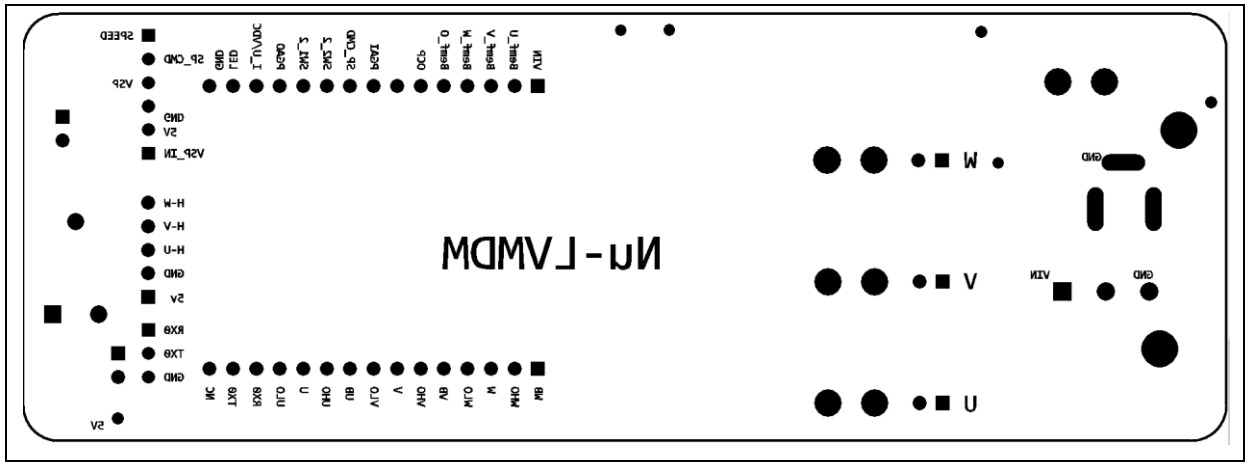


Figure 10-5 Nu-LVMDM Placement -Bottom

11 MOTOR LINE AND MOTOR HALL TEST

11.1 Step1: Application Circuit Measurement Points

Find 1K ohm~10k ohm resistor and connect to 3 phases of motor as right picture.

Use Nu-link to connect with demo board and USB to supply 5V for Hall.

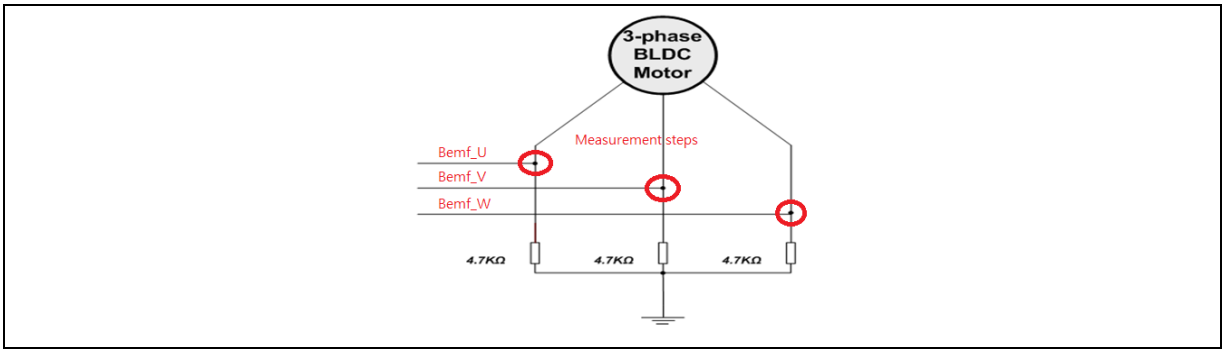


Figure 11-1 Motor connect to risister

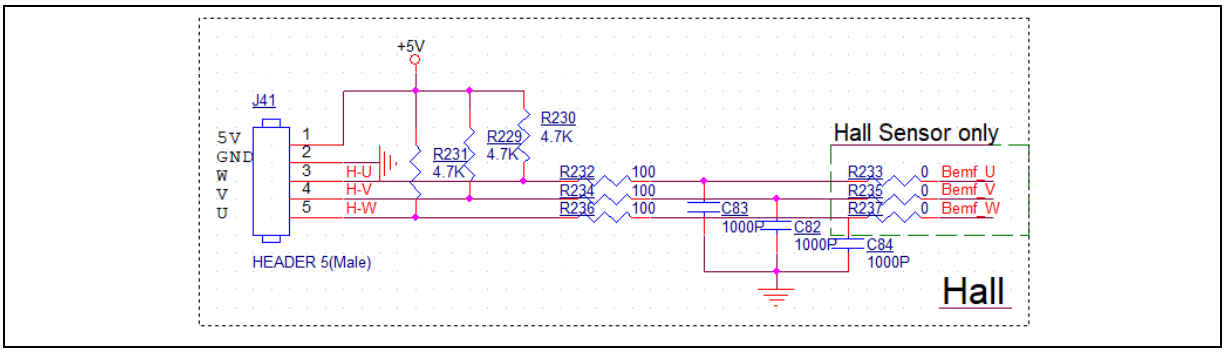


Figure 11-2 Hall Sensor Circuit

11.2 Step2: Physical circuit connection

The motor wires U, V, and W are each connected to 4.7K ohms. The three resistor ends are connected together and connected to the negative end of the carbon rod. One of the motor wires is the detection point, and the other carbon bar is used to measure the Hall_U signal line and the negative terminal. Connect to GND. DC Input 10~24V LDO will be converted to 5V for Hall sensor.

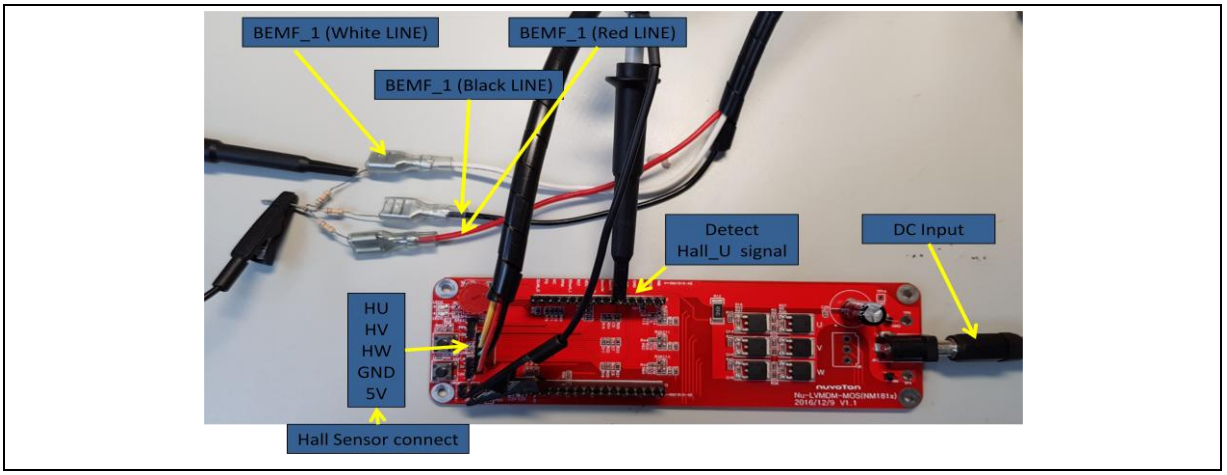


Figure 11-3 Actual connection test circuit

11.3 Step3: Find the signal of U phase

When measuring the Hall_U signal, select another motor line to measure. When the Hall sensor is powered, turn the motor to see the signal below. If the peak of Bemf is on the rising edge of the Hall signal, it means the pair is selected. If you choose another phase, it will not match the signal.

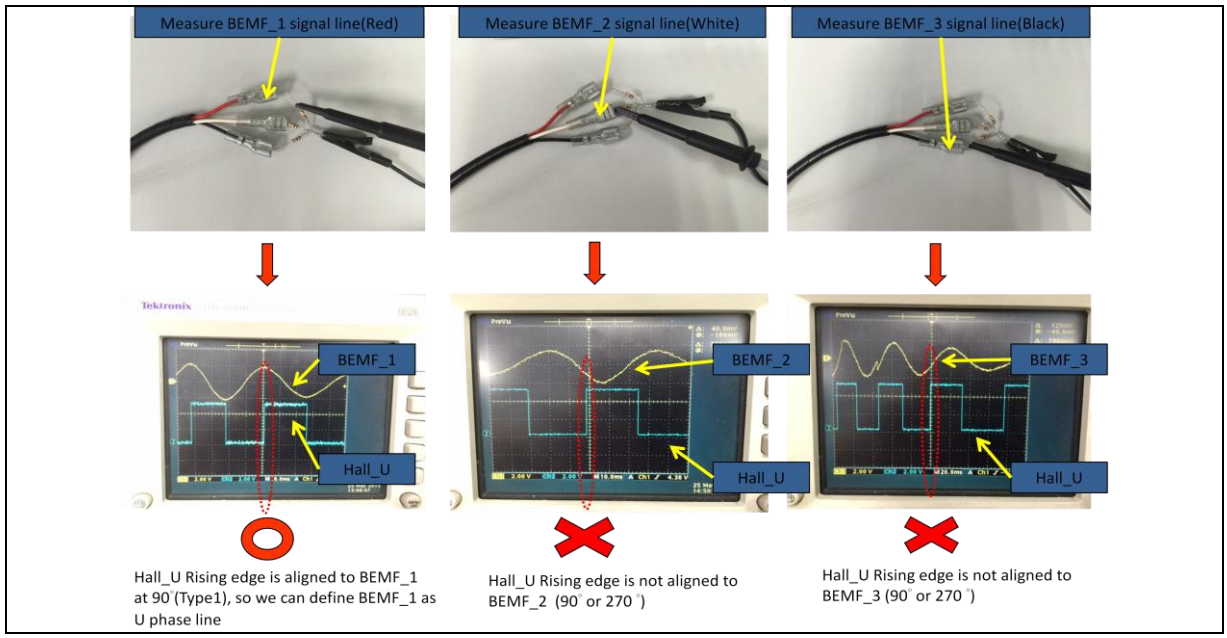


Figure 11-4 Measuring Hall_U and phase relationship

11.4 Step4: Find the signal of V & W phase

Measuring the other two Hall signals also finds the corresponding motor line in the manner of step 3.

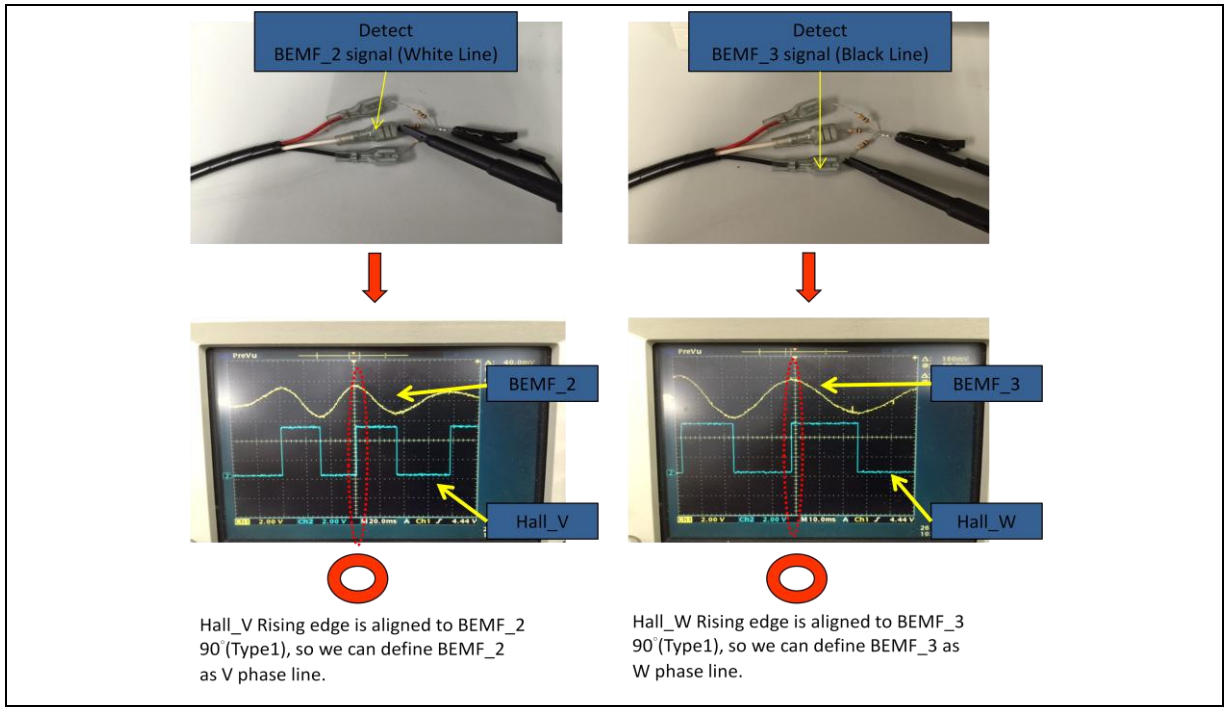


Figure 11-5 Measuring Hall_V, Hall_W and phase relationship

11.5 Step5: Check Hall Type

When the phase peak corresponds to the rising edge of Hall, the representation is Type 1. If the phase peak corresponds to the falling edge, it means Type 0。

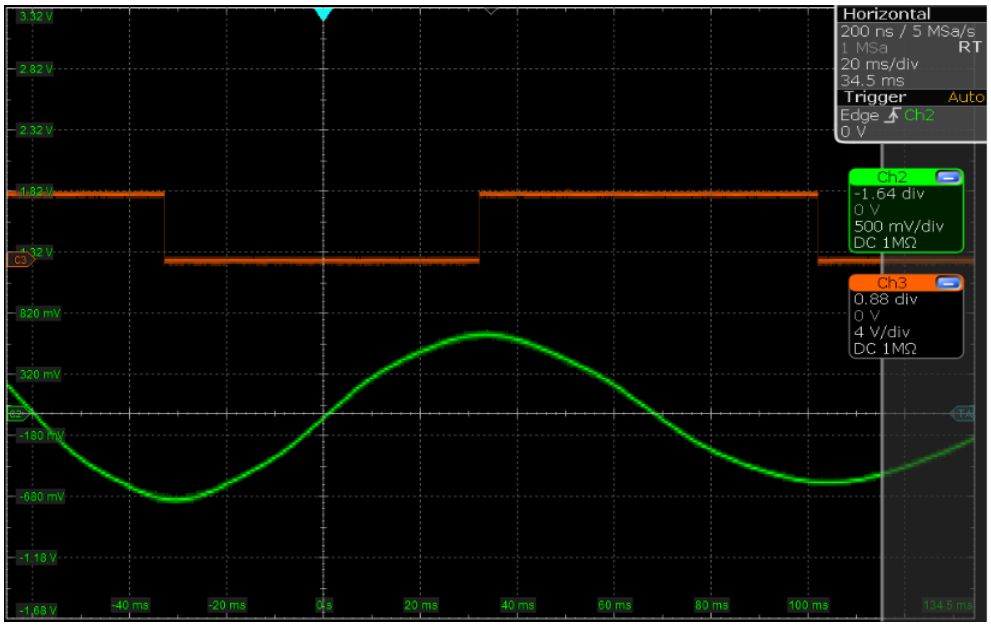


Figure 11-6 Type1 – Hall & BEMF

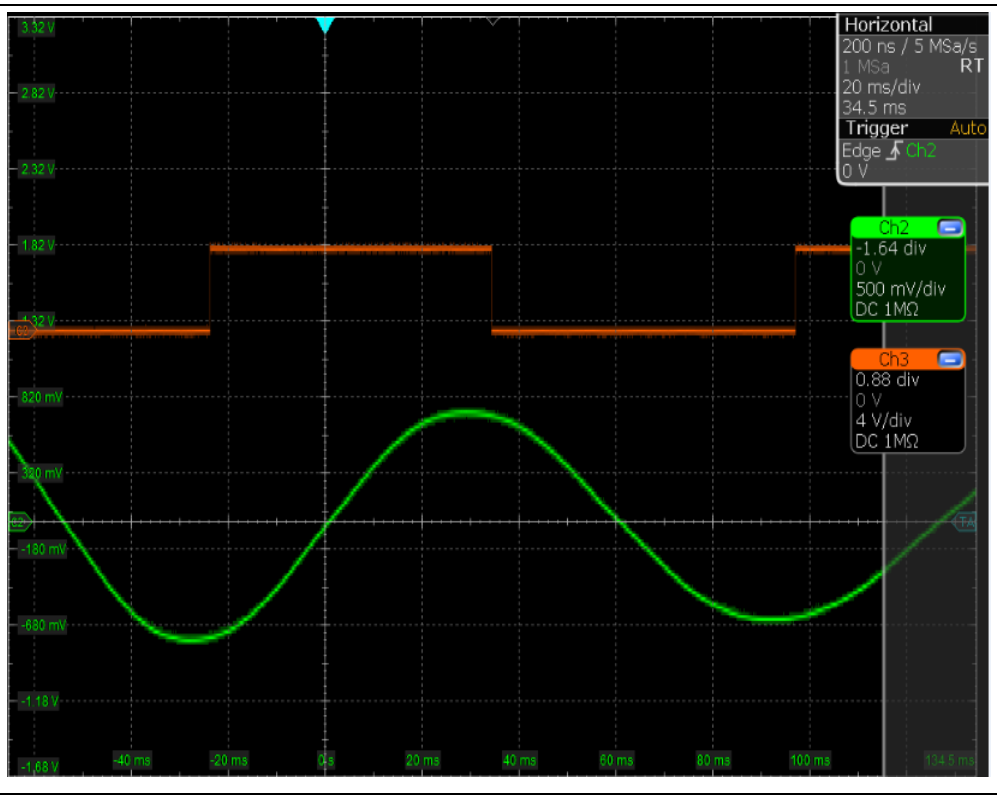


Figure 11-7 Type0 – Hall & BEMF

12 REVISION HISTORY

Date	Revision	Description
2019.05.08	1.00	1. Initially issued.
2022.06.02	1.01	2. Up date schematic & PCB picture
20221206	1.02	3. Up date schematic & PCB picture and Component name

Important Notice

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