ARM® Cortex®-M

32-bit Microcontroller

NuMicro®Family
Nu-LB-NM18101Y
User Manual

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www.nuvoton.com

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1 OVERVIEW

Nu-LB-NM18101Y is the combination of (Nu-LVMDM-MOS_NM18101Y) and (NuTiny-EVB-NM18101Y). The board is also for NM18101Y developing. User can develop/emulate their project on it.

The Nuvoton Low Voltage Motor Development Module using MOSFET power stage (Nu-LVMDM-MOS-NM18101Y) (NL-NM18101Y) is used to accelerate product development by providing ready-to-run hardware and a comprehensive Motor Development Adapter (NuTiny-EVB-NM18101Y)(NT-NM18101Y).

NuTiny-EVB-NM18101Y(NT-NM18101Y) is the specific development tool for NuMicro® NM18101Y series. Users can use NuTiny-EVB-NM18101Y to develop and verify the application program easily.

NuTiny-EVB-NM18101Y includes two portions. One is NuTiny-EVB-NM18101Y and the other is Nu-Link-Me. NuTiny-EVB-NM18101Y is the evaluation board and Nu-Link-Me is its Debug Adaptor. Thus, users do not need other additional ICE or debug equipment.

The ARM® Cortex®-M0 core within NuMicro® NM18101Y 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, 1.5K-byte SPROM for security, and 4K-byte SRAM. Plentiful system level peripheral functions, such as I/O Port, Timer, UART, SPI, I^2C, PWM, ADC, Watchdog Timer, Analog Comparator and Brown-out Detector, have been incorporated into the NM18101Y series in order to reduce component count, board space and system cost. These useful functions make the NM18101Y series powerful for a wide range of motor driver applications

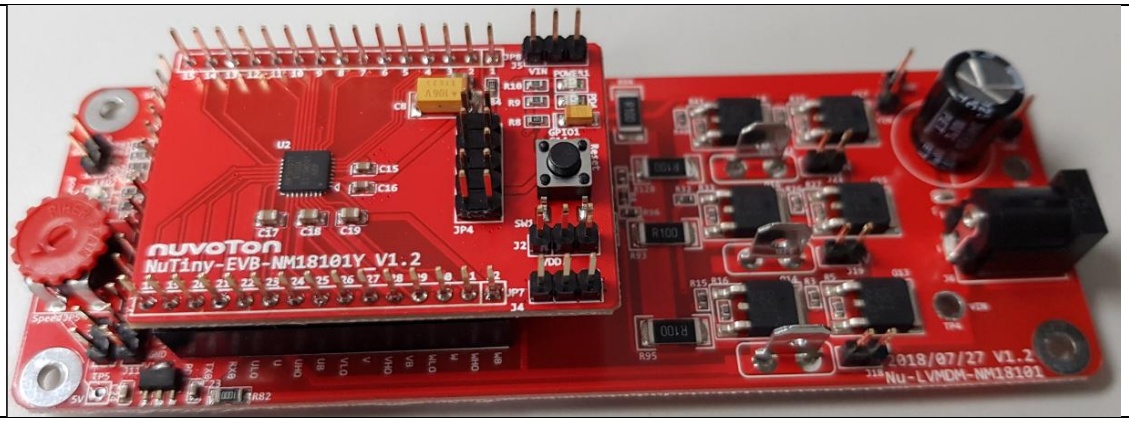


Figure 1-1 NuTiny-EVB-NM18101Y & Nu-LVMDM-MOS(NM18101Y) (PCB Board)

2 FEATURES

The key features of this board include the following:

- Motor Control interfaces
  - DC input 8V~48V.
  - Hall sensors interface for sensored motor control (J1)
  - 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 (PD4)
  - 50 KΩ VR (JP5)
  - SMD switch for configuration purposes (SW3)
- Communication Ports
  - UART communication via USB (J11)
- Power Supply Connectors
  - Auxiliary Power Tab Fast-On connectors (J4(Vin) and TP14(GND)) for the controller and power stage
  - Dedicated power connector (J6) for the controller and power stage
- Programming Connectors
  - Nu-Link connector for NuTiny-EVB-NM18101Y (JP4)

3 NUTINY-EVB-NM18101Y INTRODUCTION

NuTiny-EVB-NM18101Y uses the NM18101Y as the target microcontroller. Figure 3-1 is NuTiny-EVB-NM18101Y for NM18101Y series, the left portion is called NuTiny-EVB-NM18101Y and the right portion is Debug Adaptor called Nu-Link-Me.

NuTiny-EVB-NM18101Y 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 NM18101Y series features. The NuTiny-EVB-NM18101Y 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.

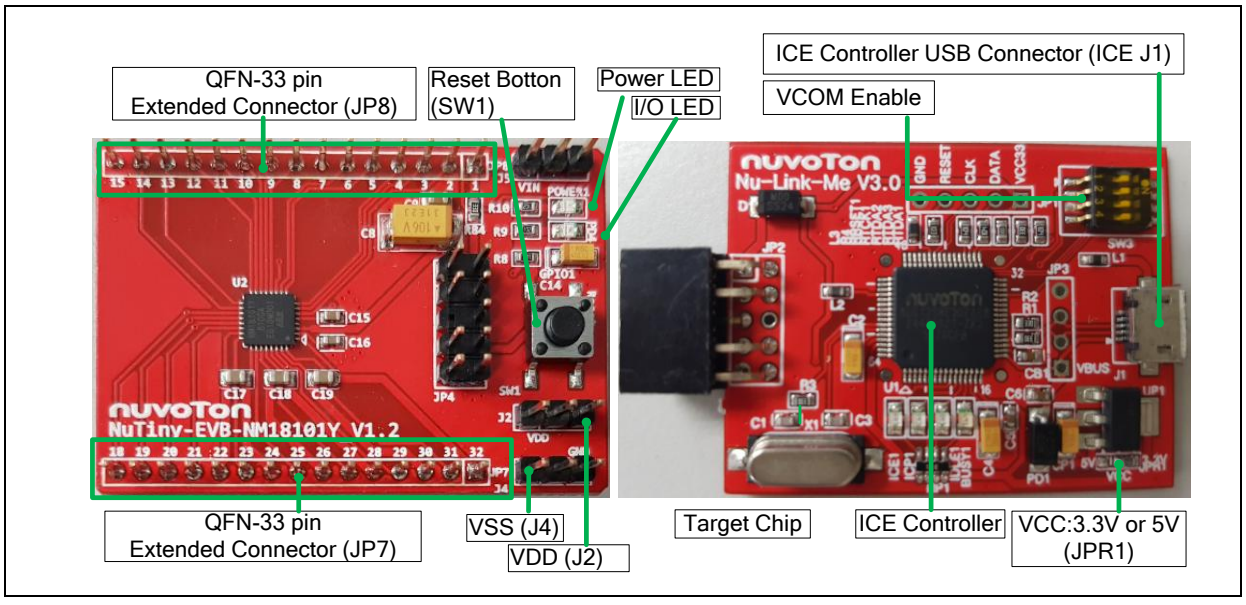


Figure 3-1 NuTiny-EVB-NM18101Y (PCB Board)

3.1 NuTiny-EVB-NM18101Y Pin Assignment for Extended Connector

NuTiny-EVB-NM18101Y use QFN33，provides extended connector for (**JP7** and **JP8**). Table 3-1 NuTiny -EVB-NM18101Y IO Extended Connector

- The extended connector the same with Nu-LVMDM-MOS-NM18101Y.

Pin No	Port	Pin Function (JP8)	Pin No	Port	Pin Function (JP7)
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-NM18101Y IO Extended Connector

3.2 NuTiny-EVB-NM18101Y Connector Description

3.2.1 Power Connector

- +15V: from Nu-LVMDM-MOS-NM18101Y (J24: Pin 11), or only use NuTiny-NM18101Y, from TP1 connect power supplier.
- +5V: from Nu-LVMDM-MOS-NM18101Y (J23: Pin 1), or connect to NM18101Y LDO5V. (NuTiny-NM18101Y J8 can switch +5V power sourse for VDD)

3.2.2 Debug Connector

- JP4: Connector in target board (NuTiny-EVB-NM18101Y) 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-NM18101Y)

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

- J2, J3: Show all chip pins in NuTiny-EVB-NM18101Y

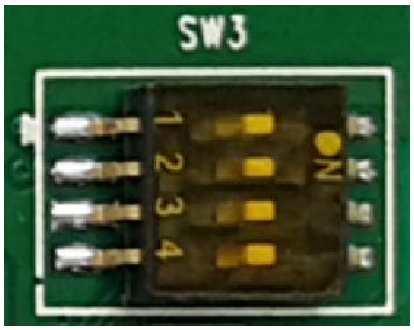
3.2.5 Reset Button

- SW4: Reset button in NuTiny-EVB-NM18101Y

3.2.6 VCOM Enable

SW3: VCOM function enable for NuTiny-EVB-NM18101Y. Switch SW3 on before power on to enable VCOM function. SW3 connects pin 13(PD2/RXD) and pin 17(PC0/TXD) in NuTiny-EVB-NM18101Y 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-MOS-NM18101Y INTRODUCTION

Low-voltage motor drive module (Nu-LVMDM-MOS-NM18101Y) provides users with motor-related applications. It is recommended to use DC8V~DC48V. 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

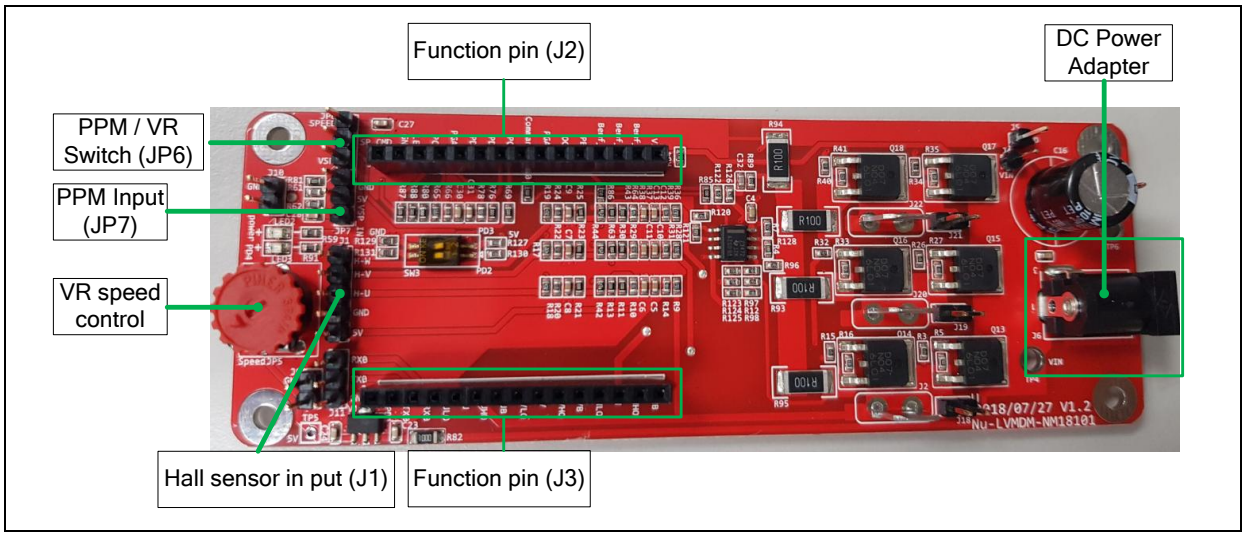


Figure 4-1 Nu-LVMDM-MOS(NM18101Y) (PCB Board)

4.1 Nu-LVMDM-MOS(NM18101Y) Pin Assignment for Extended Connector

Nu-LVMDM-(NM18101Y)， provides extended connector for (**J23** 及 **J24**)。

Pin No	Port	Pin Function (J23)	Pin No	Port	Pin Function (J24)
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-(NM18101Y) extended connector

4.2 Nu-LVMDM-MOS(NM18101Y) connect Description

4.2.1 Power connect

- J6: connector DC power (DC 110V~310V)
- DC power connect to Vin(J4,TP4) and GND(J5,TP6,TP14)
- LDO5V can use VIN conversion to 5V for Hall sensor

4.2.2 IO connect

- J16 and J17: Nu-LVMDM-MOS(NM18101Y) Extended Connector

4.2.3 IO Switch

- SW3: support PD2 and PD3 use pull high 10K or short to GND

4.2.4 Hall connect

- J1: connect to Motor Hall sensor line

4.2.5 VR and VPS input speed command

- JP6: use Jumper to Switch (VR or VPS) input speed command

4.2.6 USRT Connecter

- J11: UART connect

5 NU-LVMDM-MOS(NM18101Y) APPLICATION CIRCUIT

5.1 Hall Sensor Description

If want use “Hall sensor”, the function switching resistor R21, R23, R25 need use 0Ω connect to Bemf signal line Bemf_(U,V,W), and R155,R158,R42,R156,R159,R44,R157,R160,R43 need remove, If want use “Bemf detection”, R21, R23, R25 need remove, and R155,R158,R156,R159, R157,R160, need use 0R, Follow the configuration to avoid conflicts.

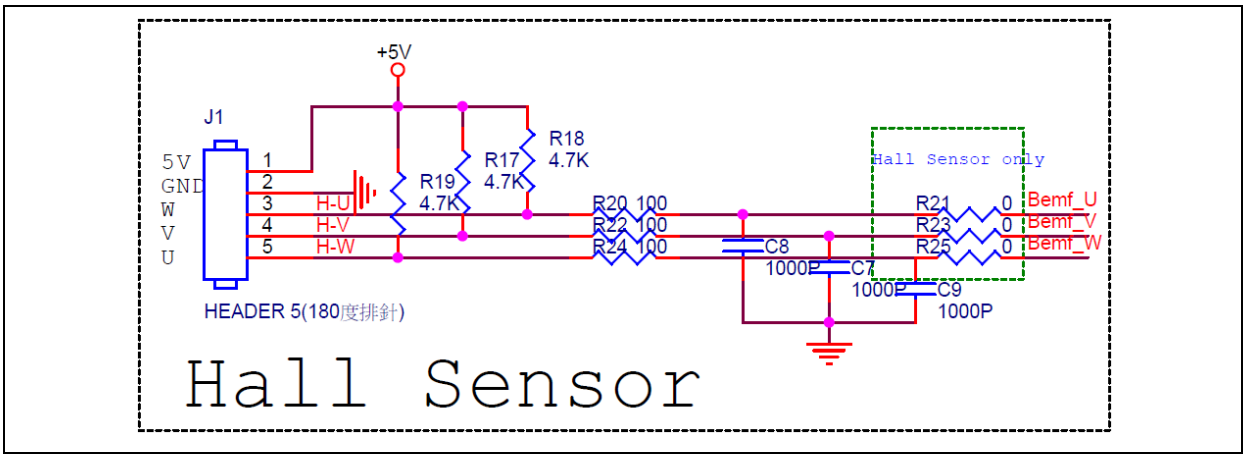


Figure 5-1 Hall sensor circuit

5.2 Input command switching from VR and PPM

JP6 can switch the speed command sourse, VR(JP5) use 50K variable resistor adjusts 0~5V as an input command or PPM (JP7) as an external command PWM signal as a speed command.

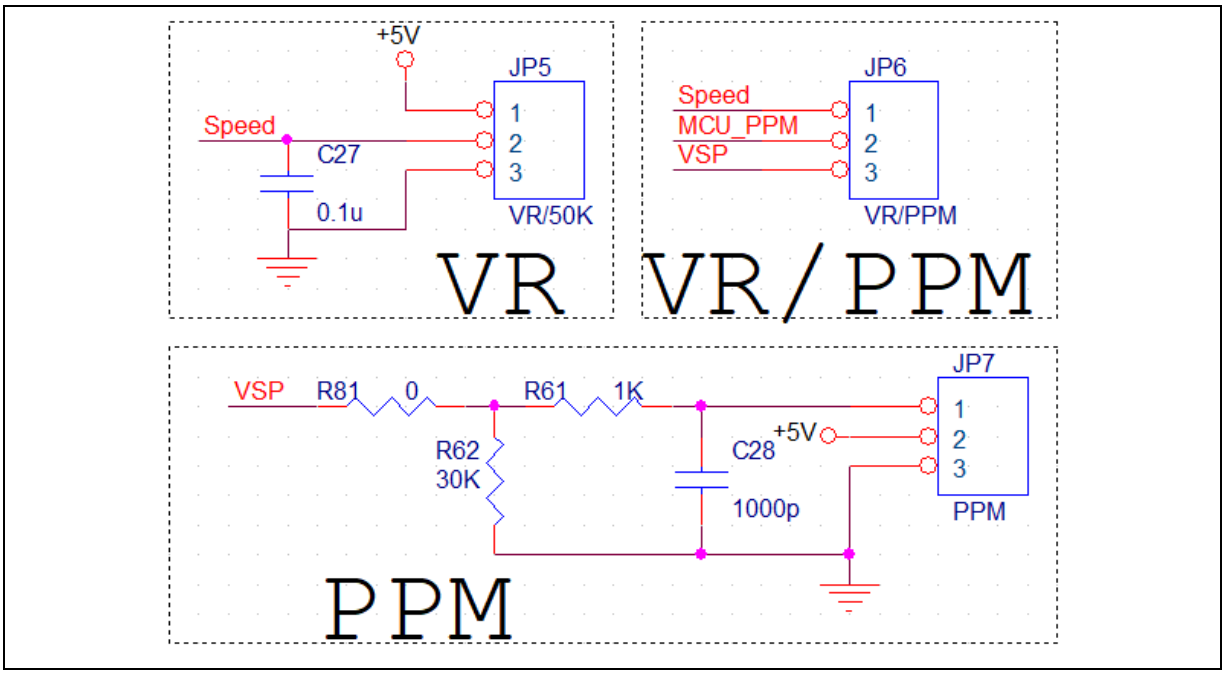


Figure 5-2 choose speed commeand

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 "R77" need to use at least 91K ohms.

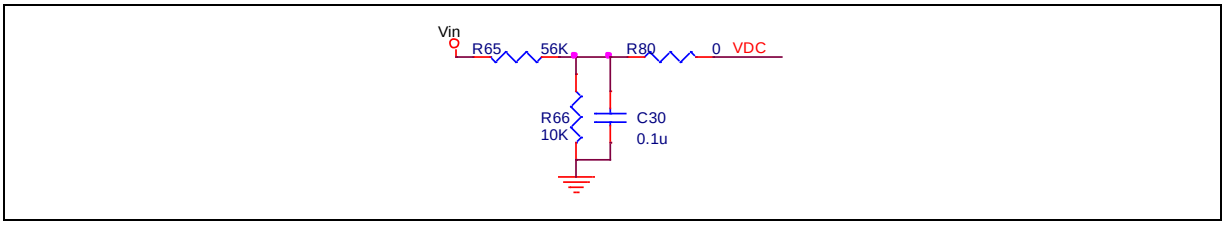


Figure 5-3 Choose DC bus detection voltage divider resistor

Vin (V)	R56(K)	R66(K)
48	150	10
24	330	10

5.4 Select phase voltage feedback mode

Nu-LVMDM-MOS(NM18101Y) provide a variety of phase voltage detection methods, user can replace or remove resistors to change phase voltage feedback mode. please refer Table 5-1

	R9	R10	R11	R13	R14	C5	C6
Mode1: Sine wave Bemf detection	V	X	X	V	V	V	X
Mode2: Square wave Bemf detection	V	V	V	X	V	V	V
Mode3: Hall sensor	X	X	X	X	X	X	X

Table 5-1 Select phase voltage feedback mode

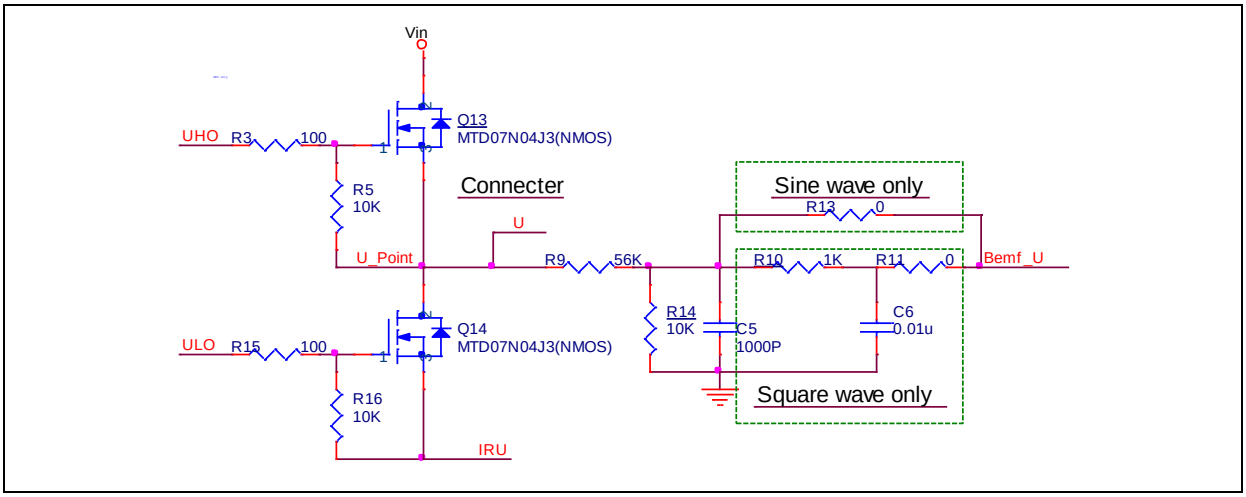


Figure 5-4 Select phase voltage feedback mode risister

Please pay attention to the DC input voltage of the application before use, so as to adjust the voltage divider of phase voltage detection to avoid higher voltage into the MCU.

Vin (V)	R1(K)	R2(K)
110	270	10
220	510	10
310	750	10
R1= R9,R28,R36		
R2= R14,R31,R39		

5.5 Select phase voltage feedback mode risister

Nu-LVMDM-MOS-NM18101Y Provide a variety of phase voltage detection methods, can be replaced or removed as needed, Figure 5-2。

U相電壓偵測方式選擇				V相電壓偵測方式選擇				W相電壓偵測方式選擇			
元件名稱	Bemf_U	Hall_U	Bemf_O	元件名稱	Bemf_V	Hall_V	Bemf_O	元件名稱	Bemf_W	Hall_W	Bemf_O
R9	V		V	R28	V		V	R36	V		V
R13	V			R63	V			R64	V		
R14	V		V	R31	V		V	R39	V		V
R10			V	R29			V	R37			V
R11			V	R30			V	R38			V
R42			V	R44			V	R43			V
C5	V		V	C10	V		V	C12	V		V
C6			V	C11			V	C13			V
R21		V		R23		V		R25		V	

Table 5-2 Select phase voltage feedback mode risister

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

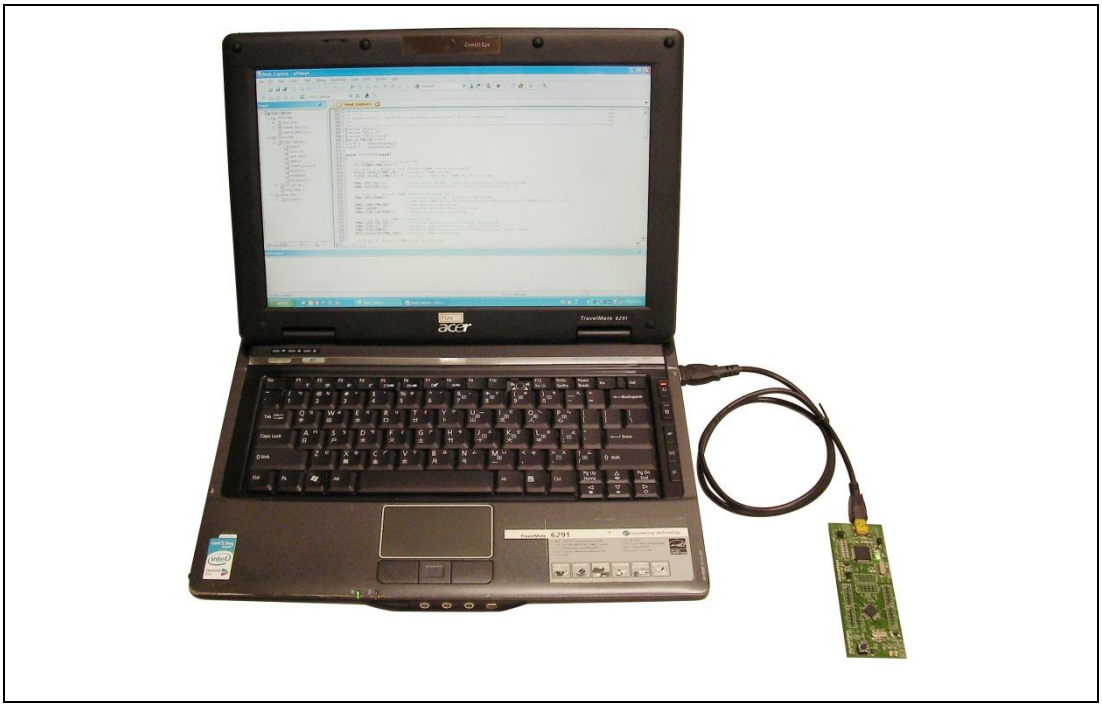


Figure 6-1 Nu-MDA-NM1120 Hardware Setup

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.

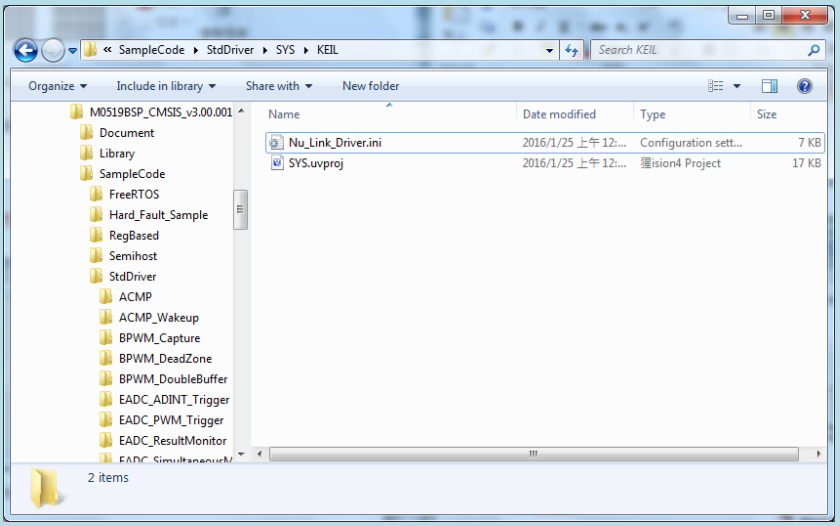
Directory	C:\ Nuvoton\BSP Library\NM1120BSP\SampleCode \StdDriver\SYS\KEIL
Project File	

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

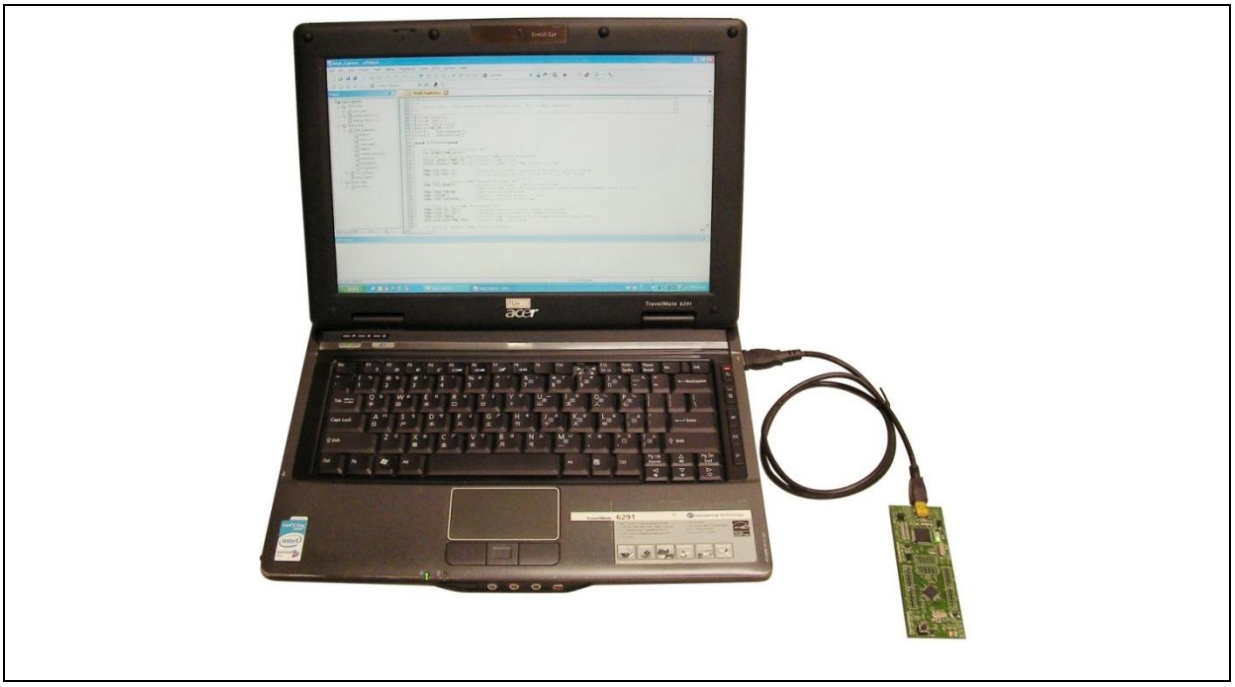


Figure 7-1 Nu-MDA-NM1120 Hardware Setup

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.

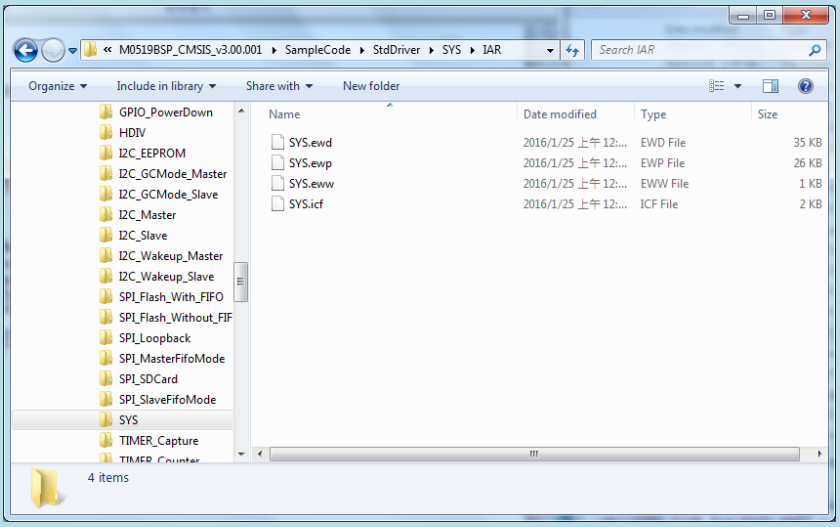
Directory	C:\ Nuvoton\BSP Library\NM1120BSP\SampleCode \StdDriver\SYS\IAR
Project File	

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.

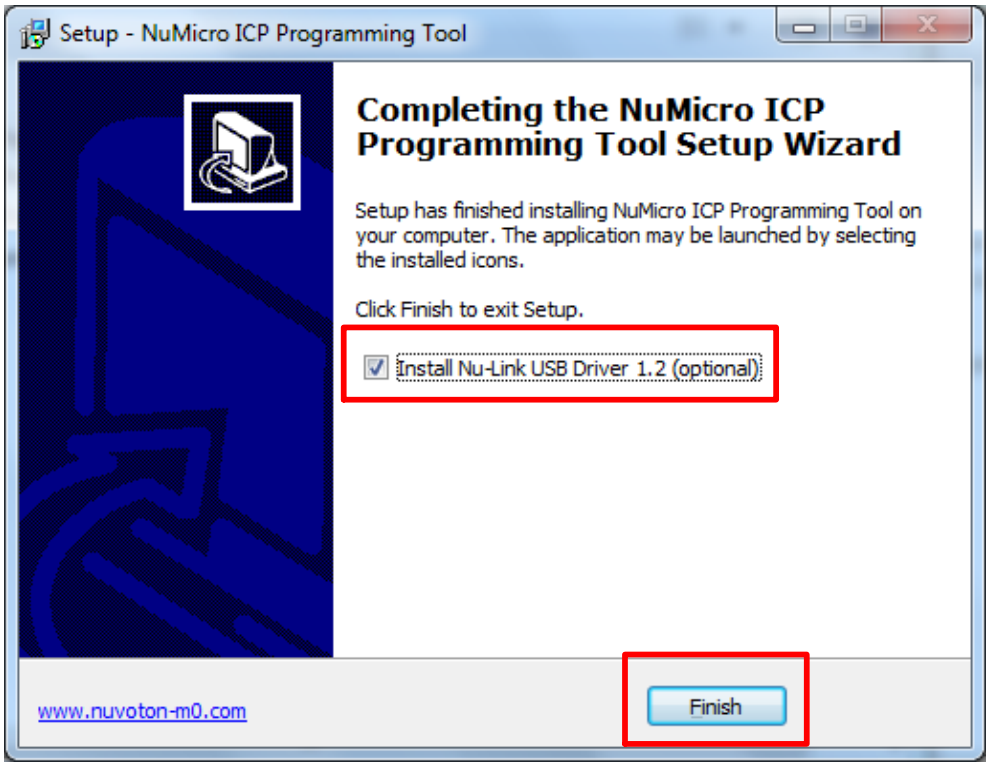


Figure 8-1 Optional Step after ICP Programming Tool Installation

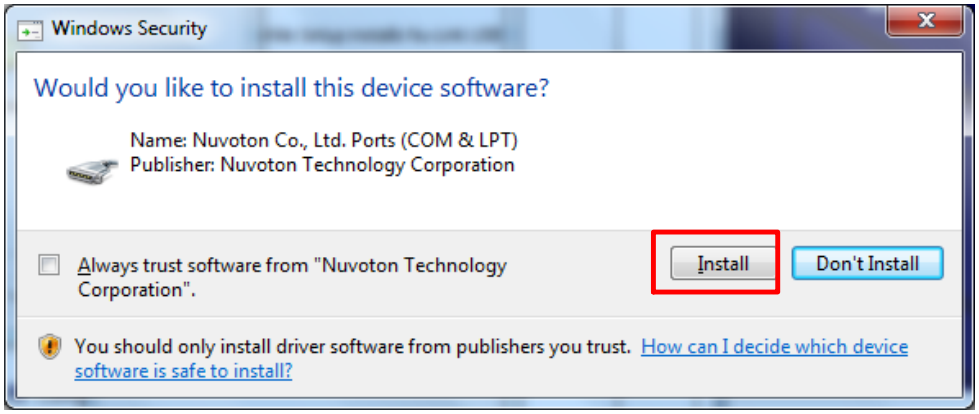


Figure 8-2 Install Nuvoton COM&LPT Driver

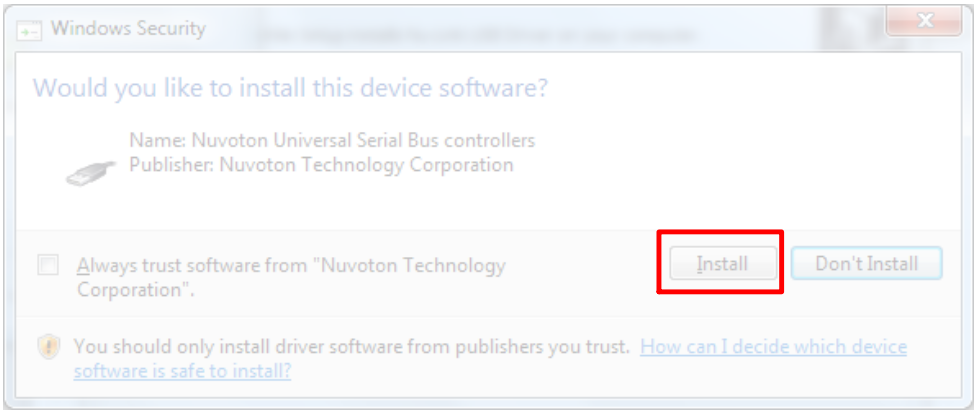


Figure 8-3 Install Nuvoton Universal Serial Bus Controllers

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.

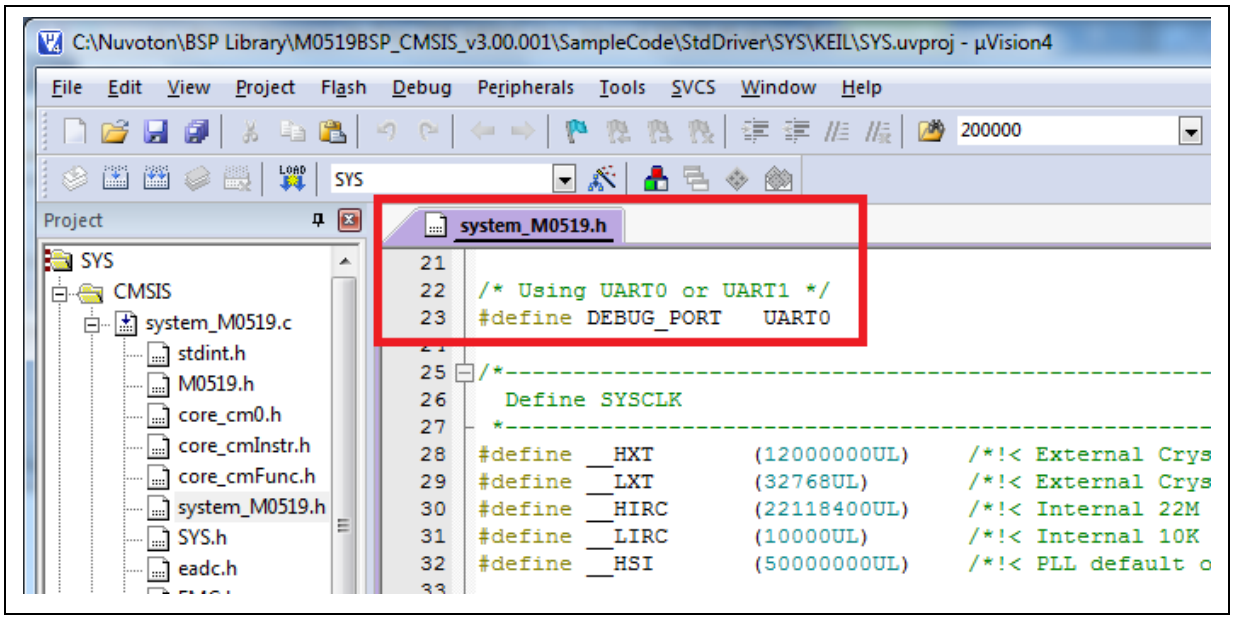
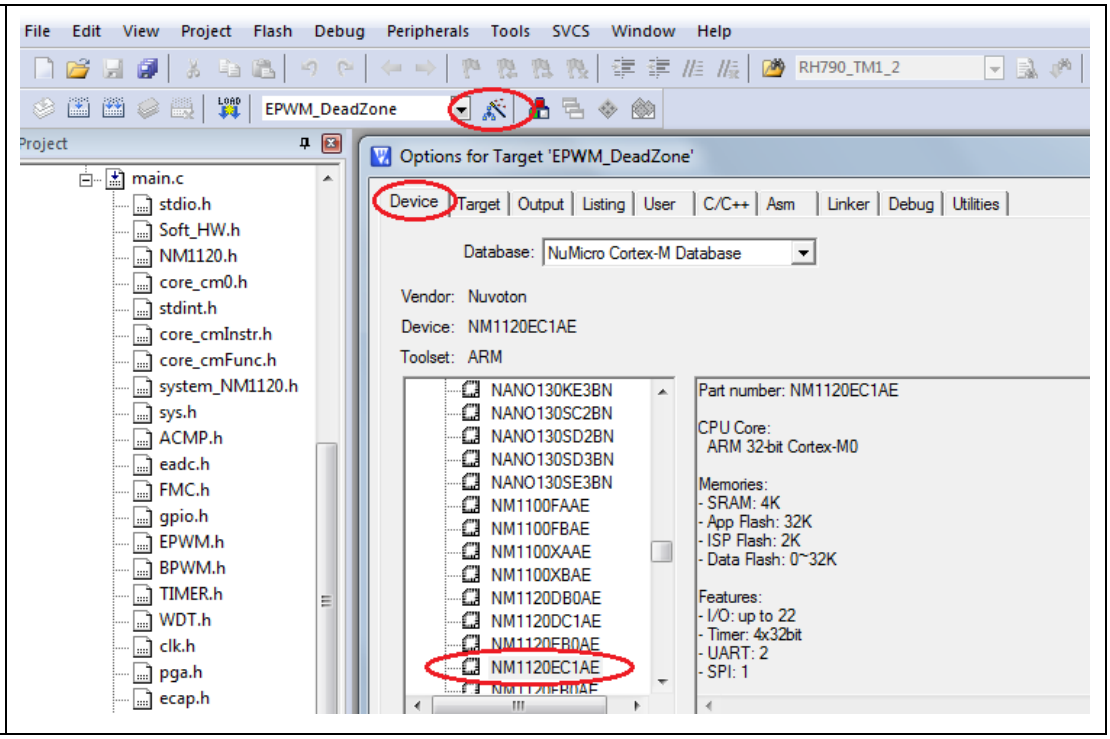
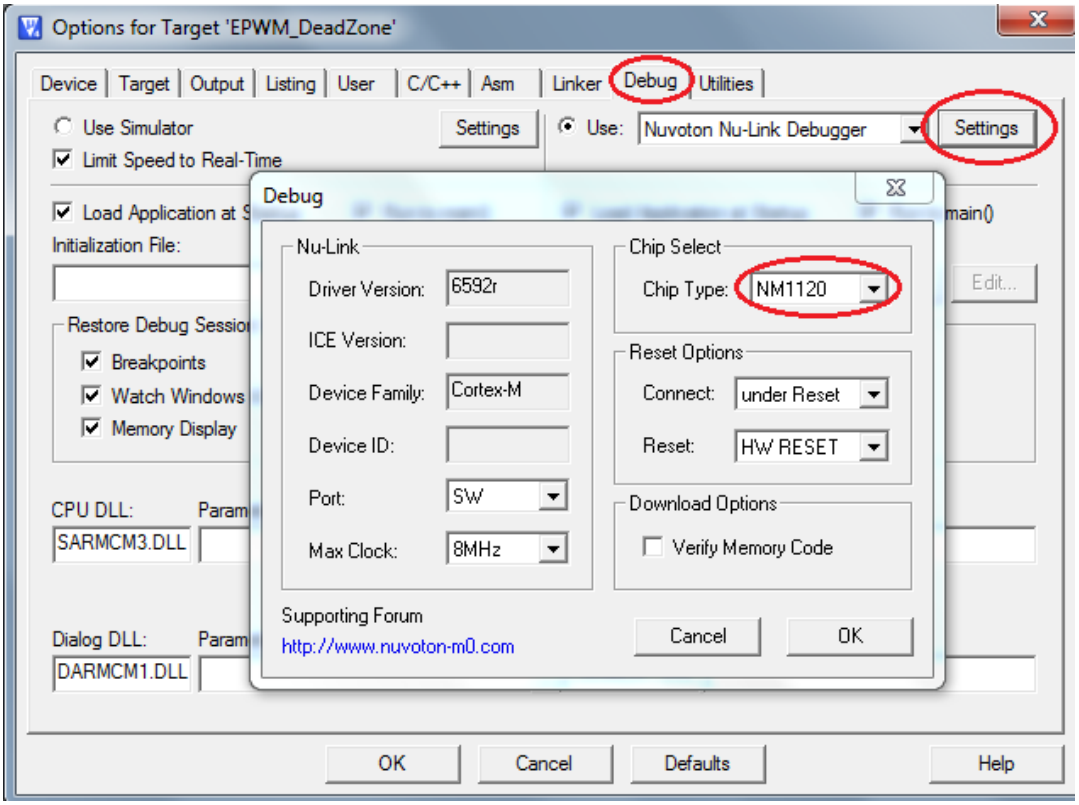
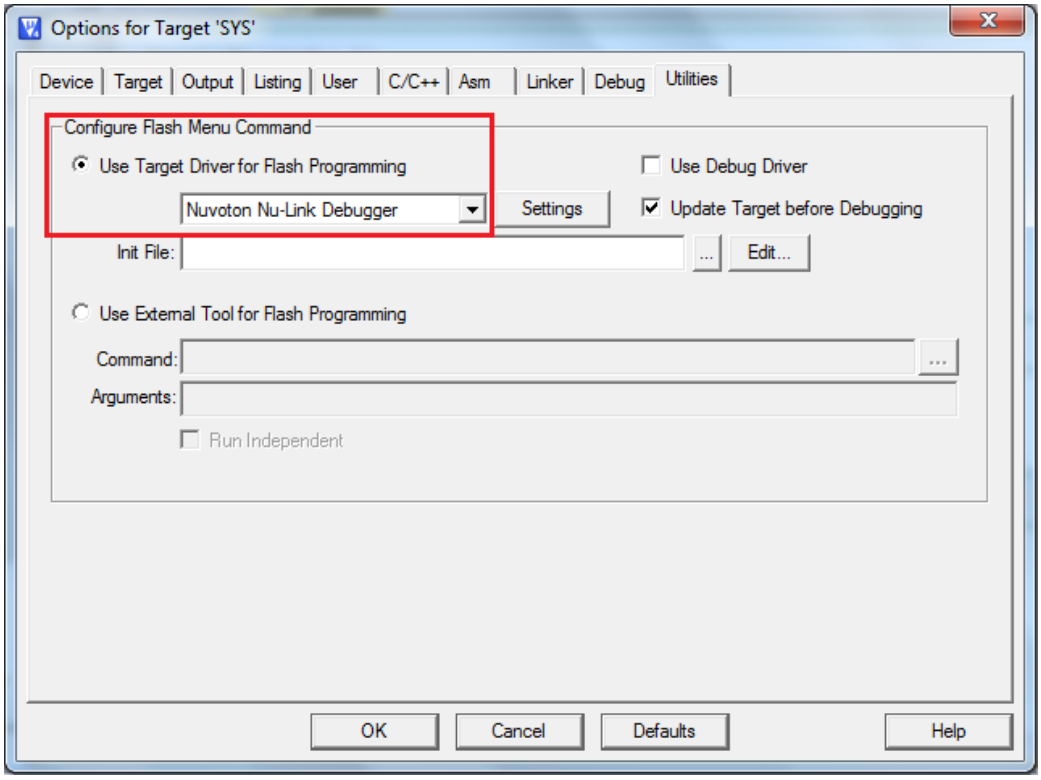


Figure 8-4 The Using UART on Keil µVision® IDE

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	
Step 3	

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.

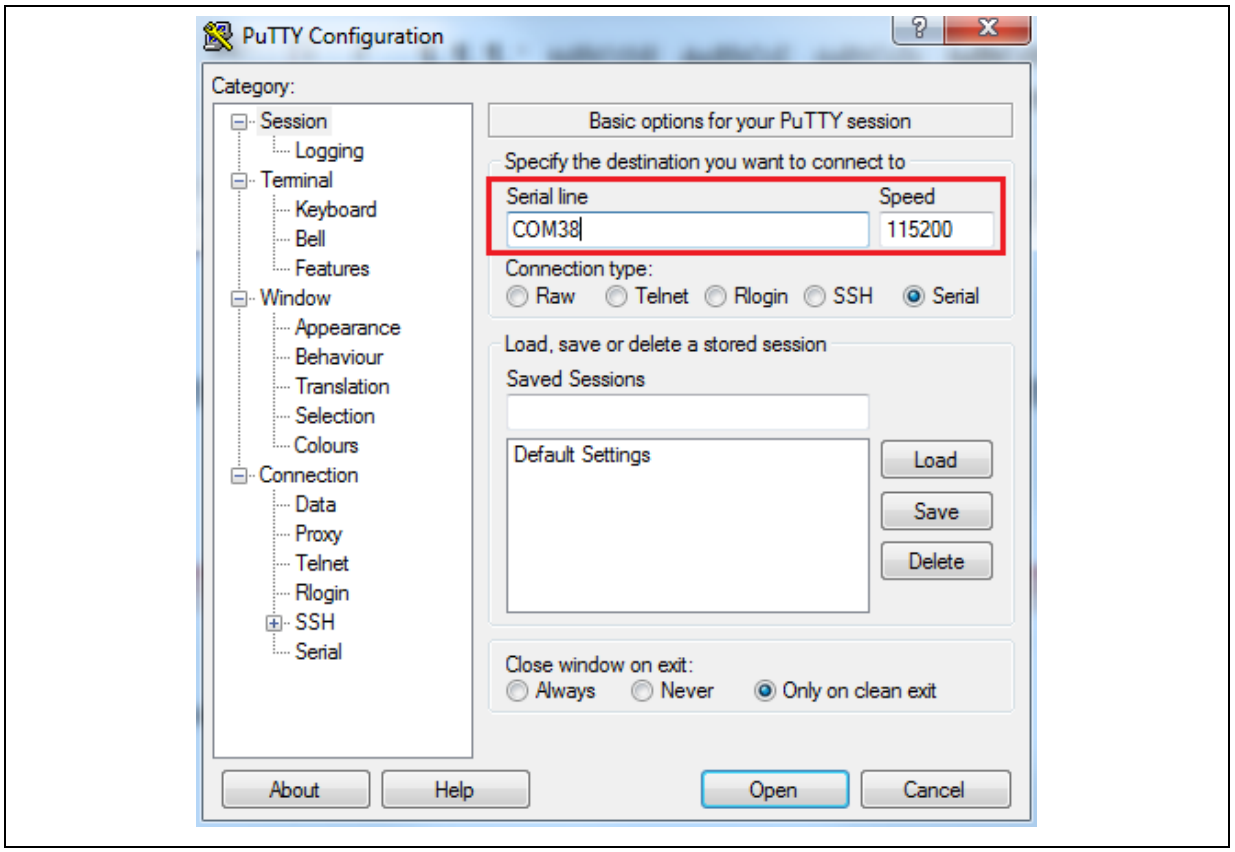


Figure 8-5 Set Baud Rate

8.3.5 Reset Chip

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

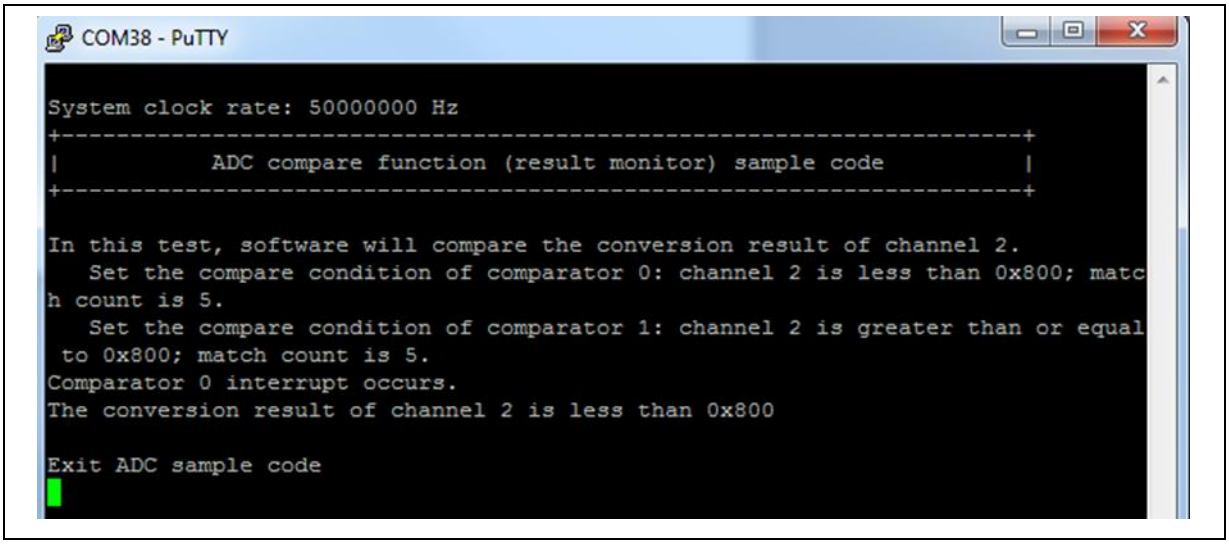


Figure 8-6 Serial Port Terminal Windows

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-NM18101Y Schematic

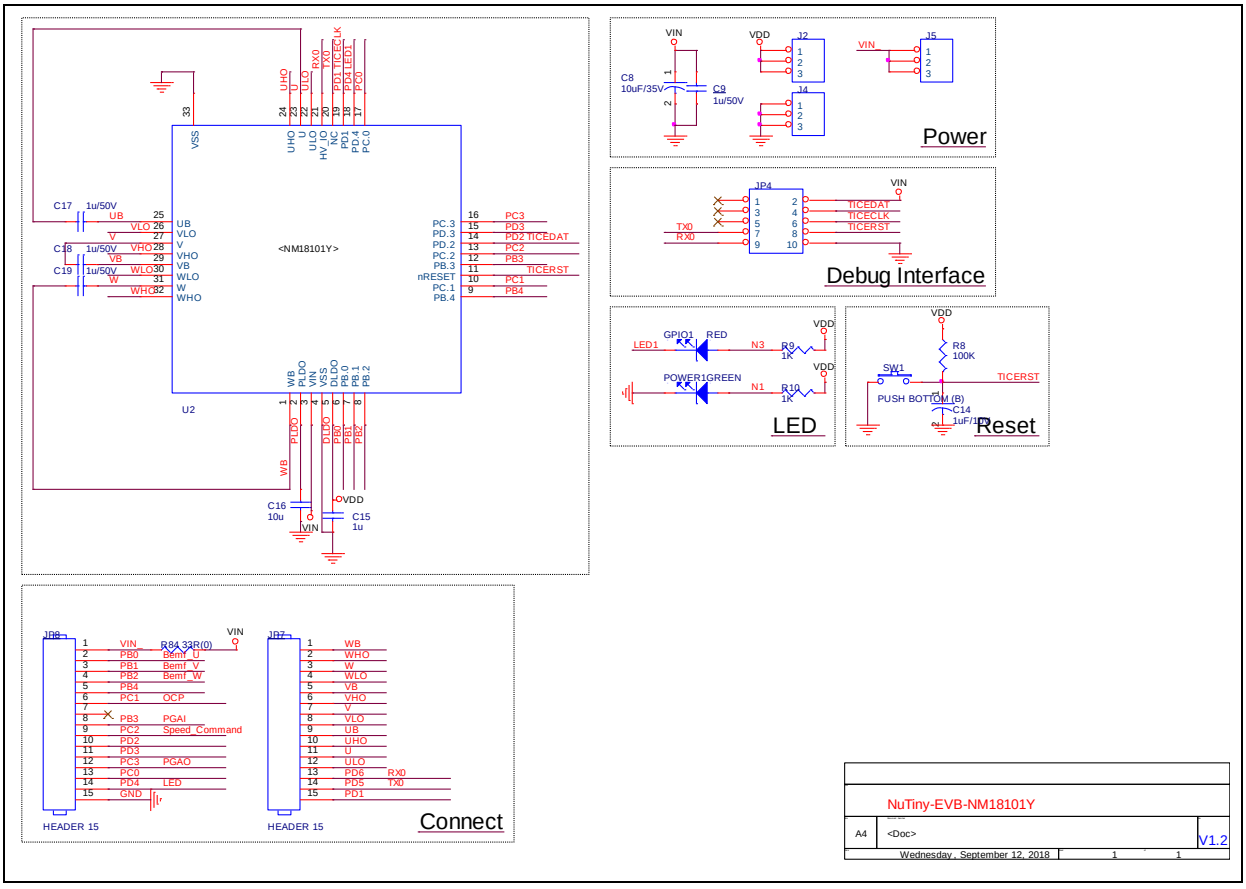


Figure 9-1 NuTiny-EVB-NM18101Y Schematic

9.2 Nu-Link-Me V3.0 Schematic

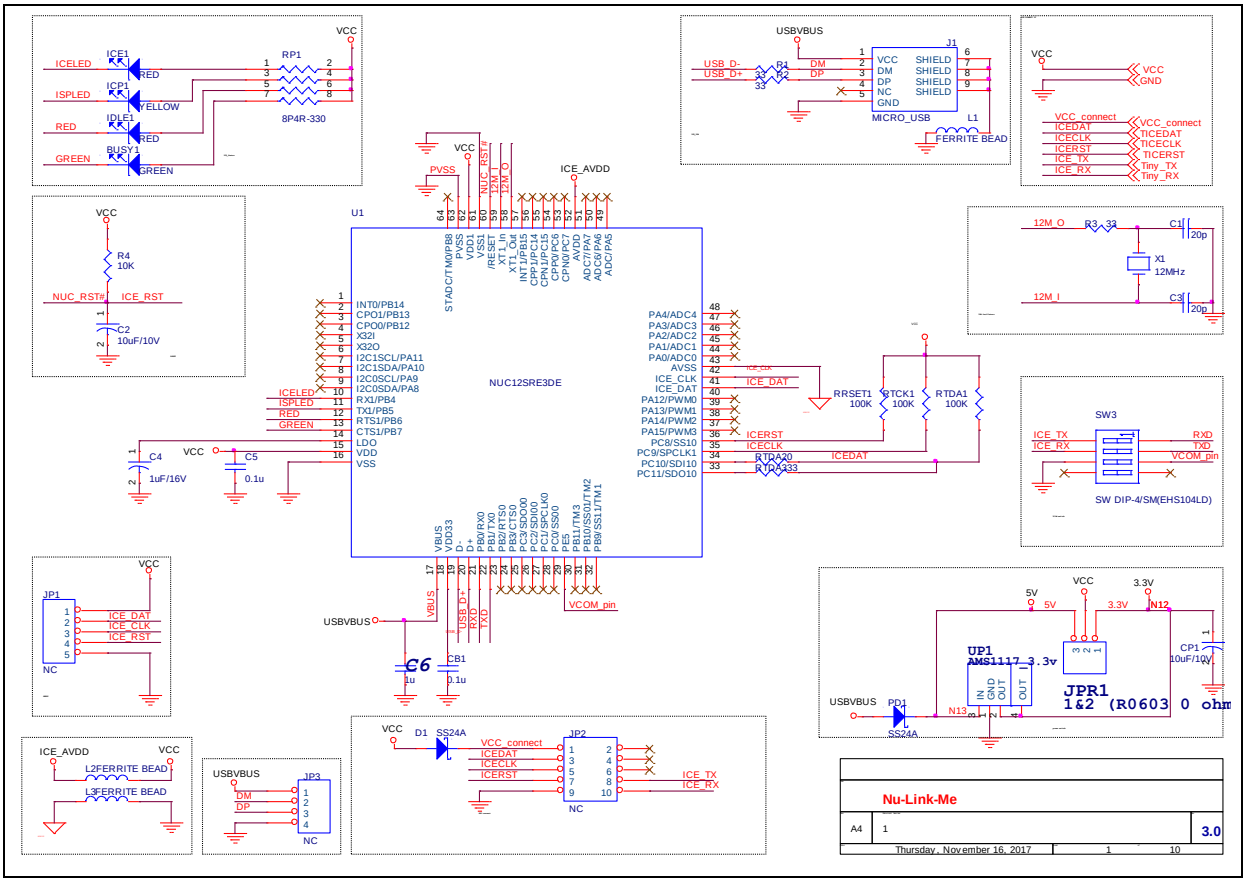


Figure 9-2 Nu-Link-Me V3.0 Schematic

9.3 Nu-LVMDM-MOS(NM18101Y) connect schematic

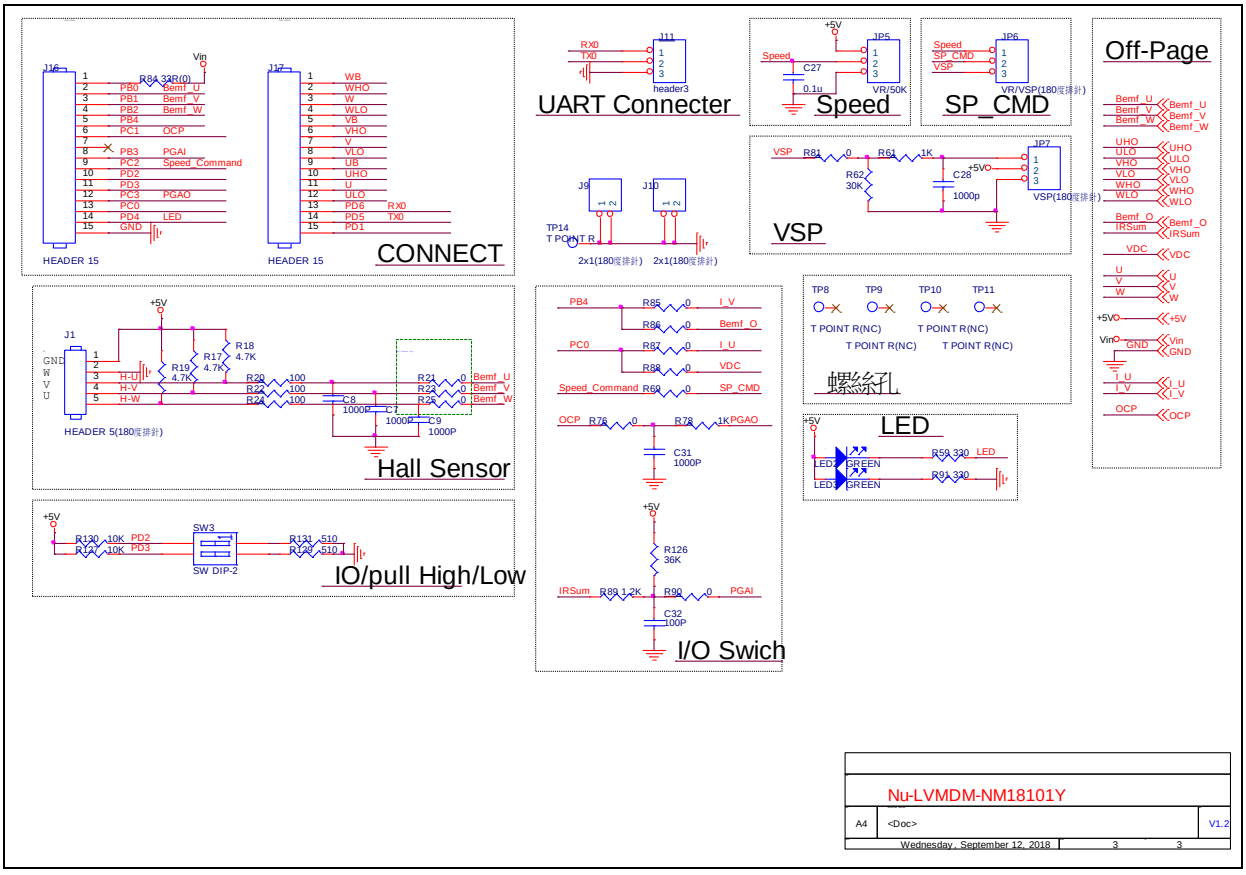


Figure 9-3 Nu-LVMDM-MOS(NM18101Y)connecet schematic

9.4 Nu-LVMDM-MOS(NM18101Y) MOS and Driver Schematic

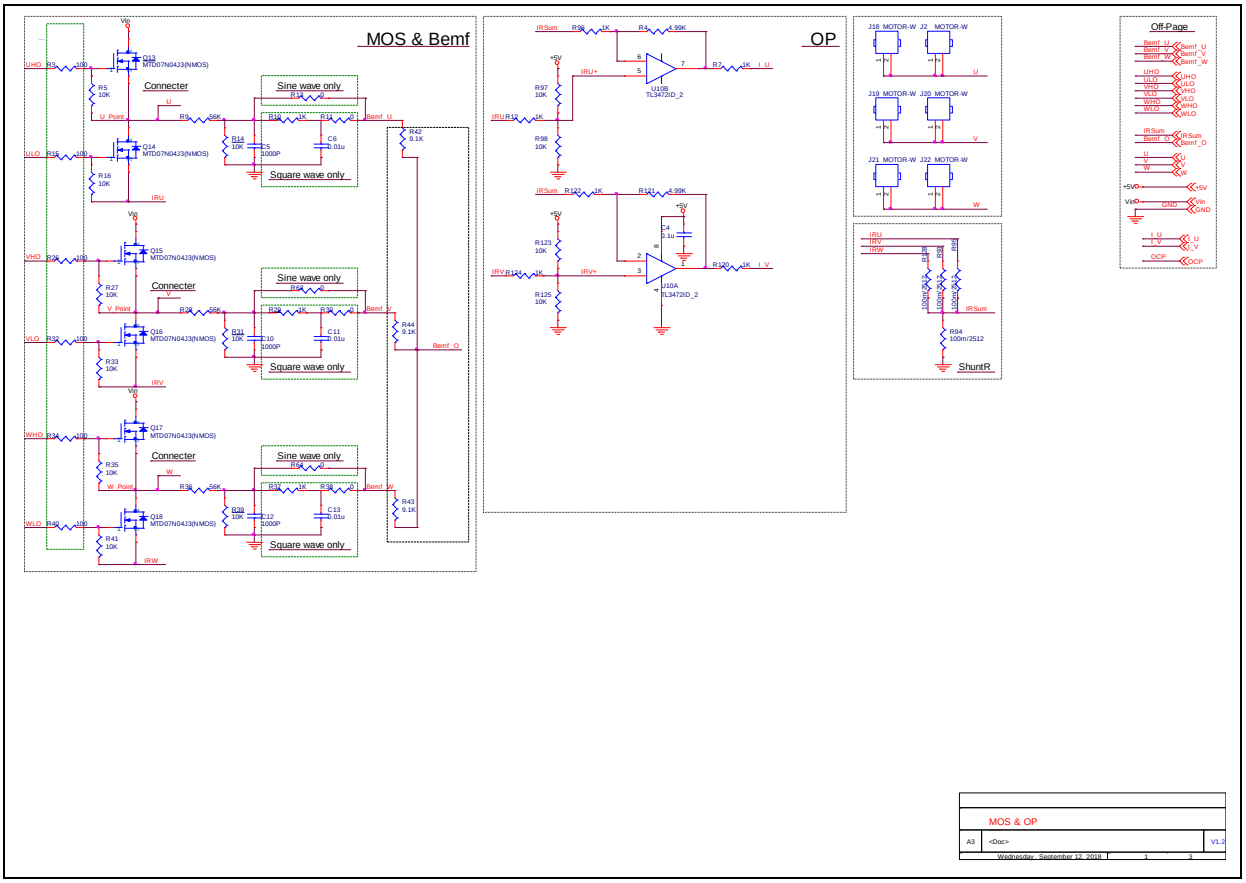


Figure 9-4 Nu-LVMDM-MOS(NM18101Y) MOS and Driver Schematic

9.5 Nu-LVMDM-MOS(NM18101Y) power schematic

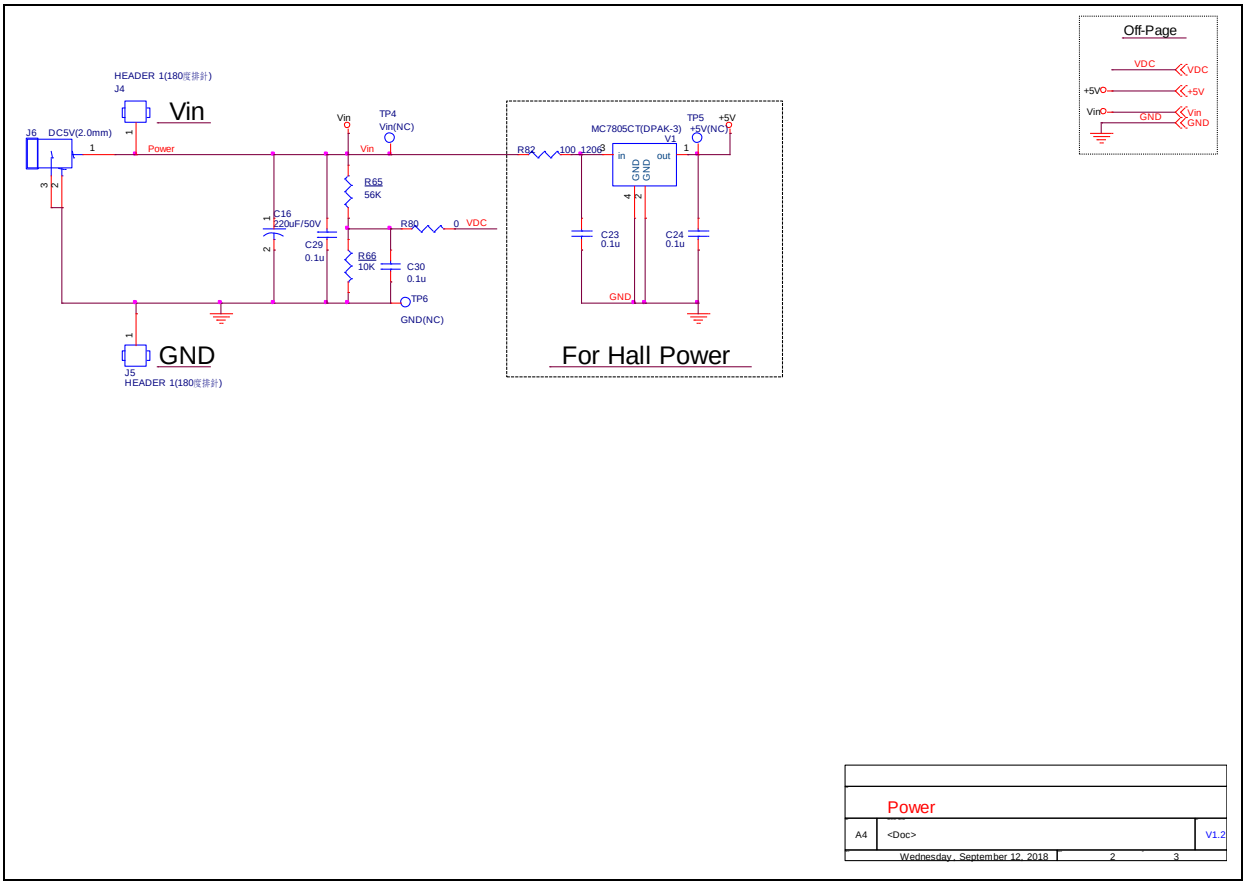


Figure 9-5 Nu-LVMDM-MOS(NM18101Y)power schematic

10 REFERENCE PCB PLACEMENT

10.1 NuTiny-EVB-NM18101Y Placement

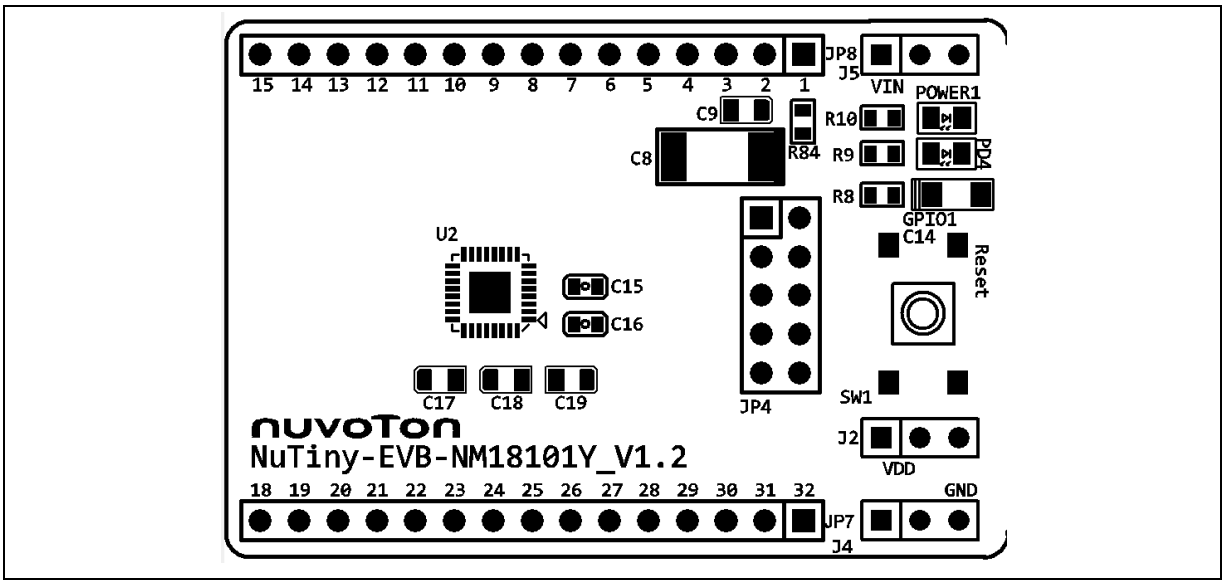


Figure 10-1 NuTiny-EVB-NM18101Y Placement -TOP

10.2 NuTiny-EVB-NM18101Y Placement

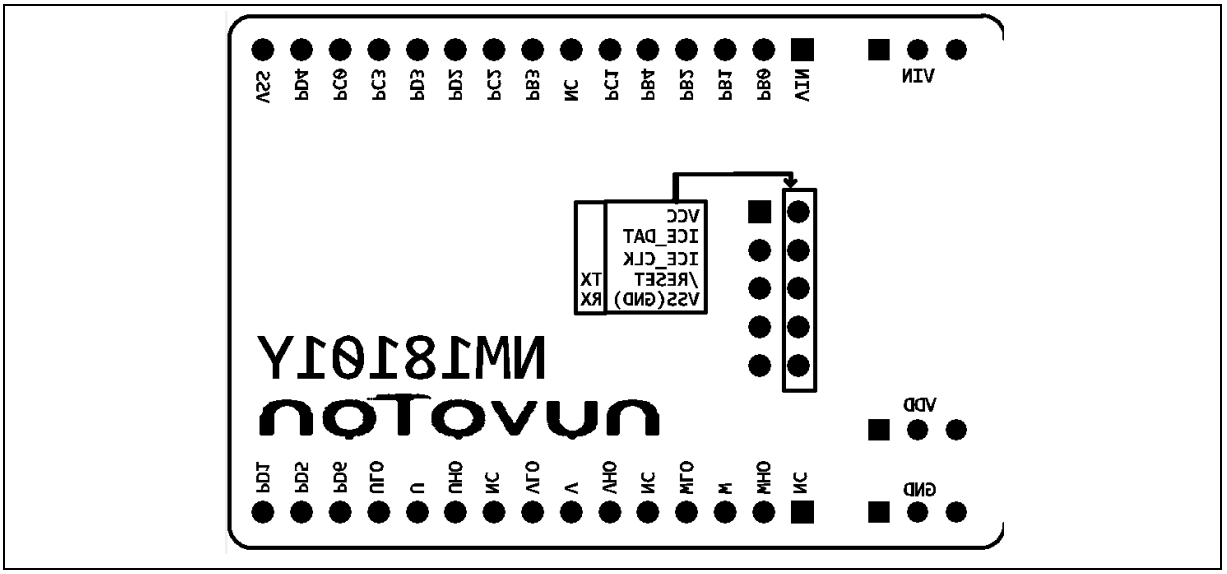


Figure 10-2 NuTiny-EVB-NM18101Y Placement-Bottom

10.3 Nu-LVMDM-MOS(NM18101Y) Placement

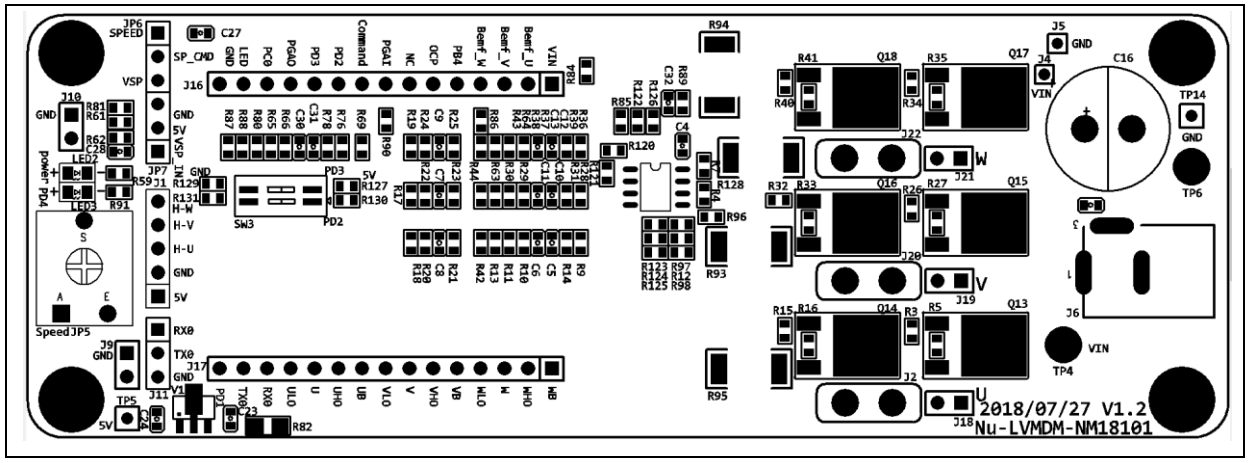


Figure 10-3 Nu-LVMDM-MOS(NM18101Y) Placement -TOP

10.4 Nu-LVMDM-MOS(NM18101Y) Placement

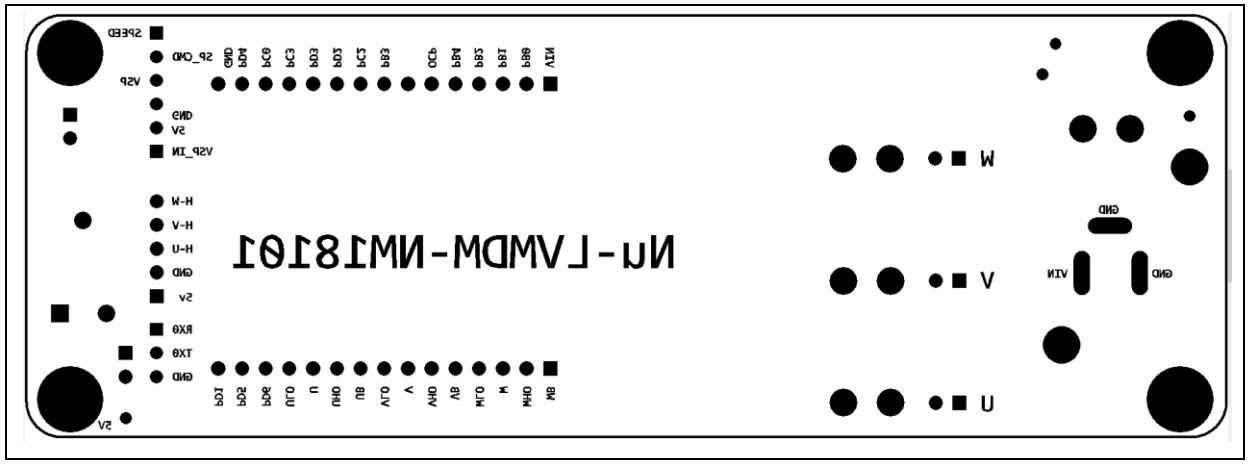


Figure 10-4 Nu-LVMDM-MOS(NM18101Y) Placement -Bottom

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.

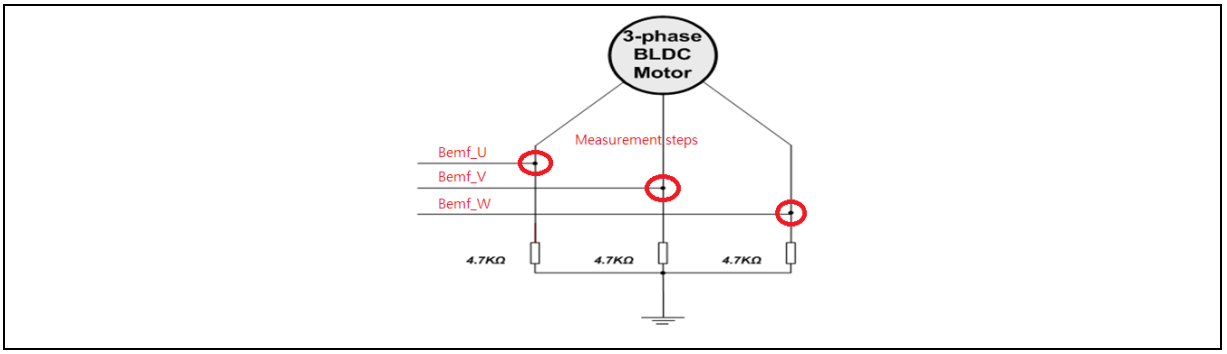


Figure 11-1 Motor connect to risister

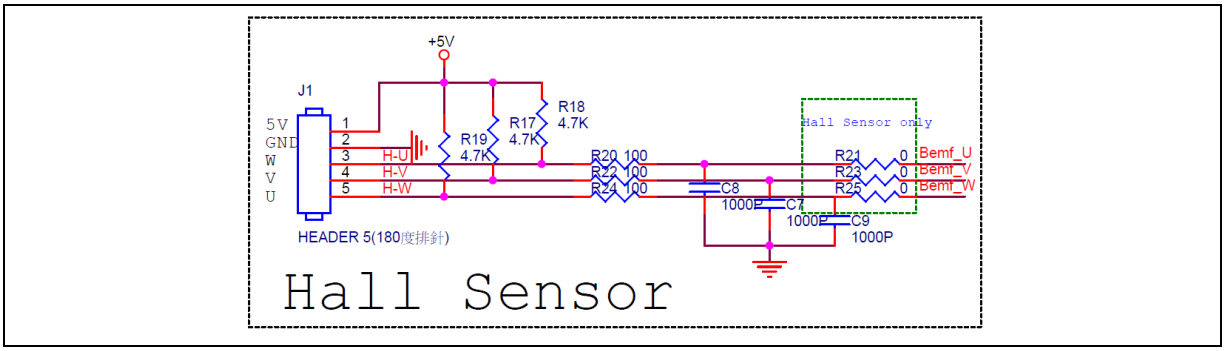


Figure 11-2 Hall Sensor Circuit

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.

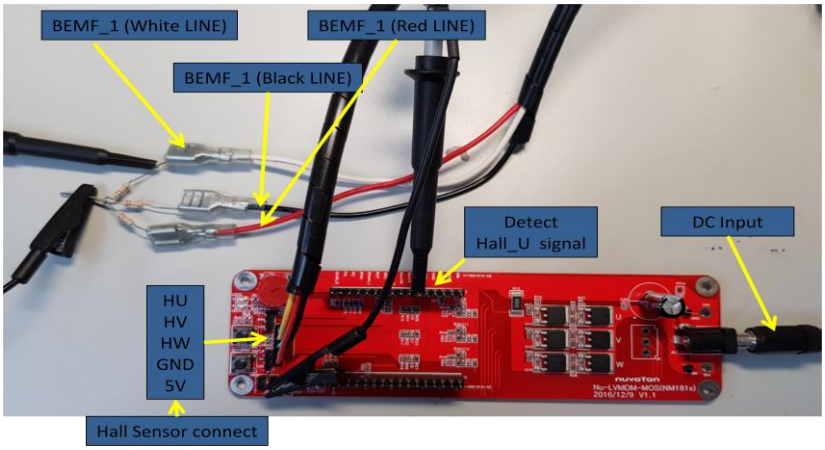


Figure 11-3 Actual connection test circuit

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.

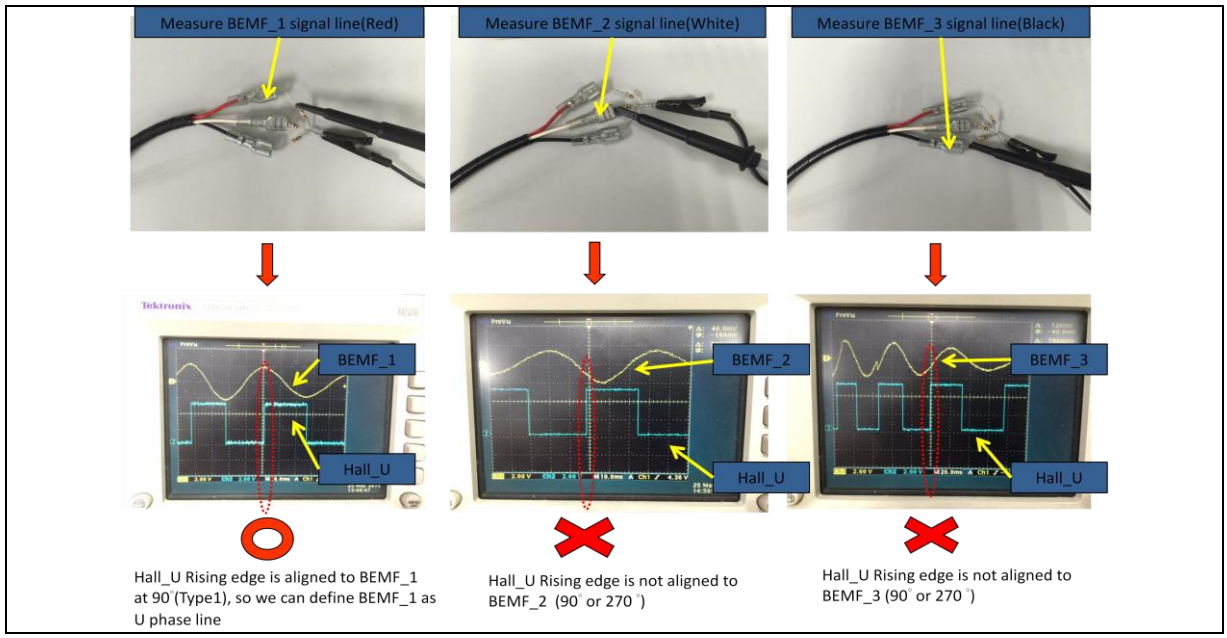


Figure 11-4 Measuring Hall_U and phase relationship

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.

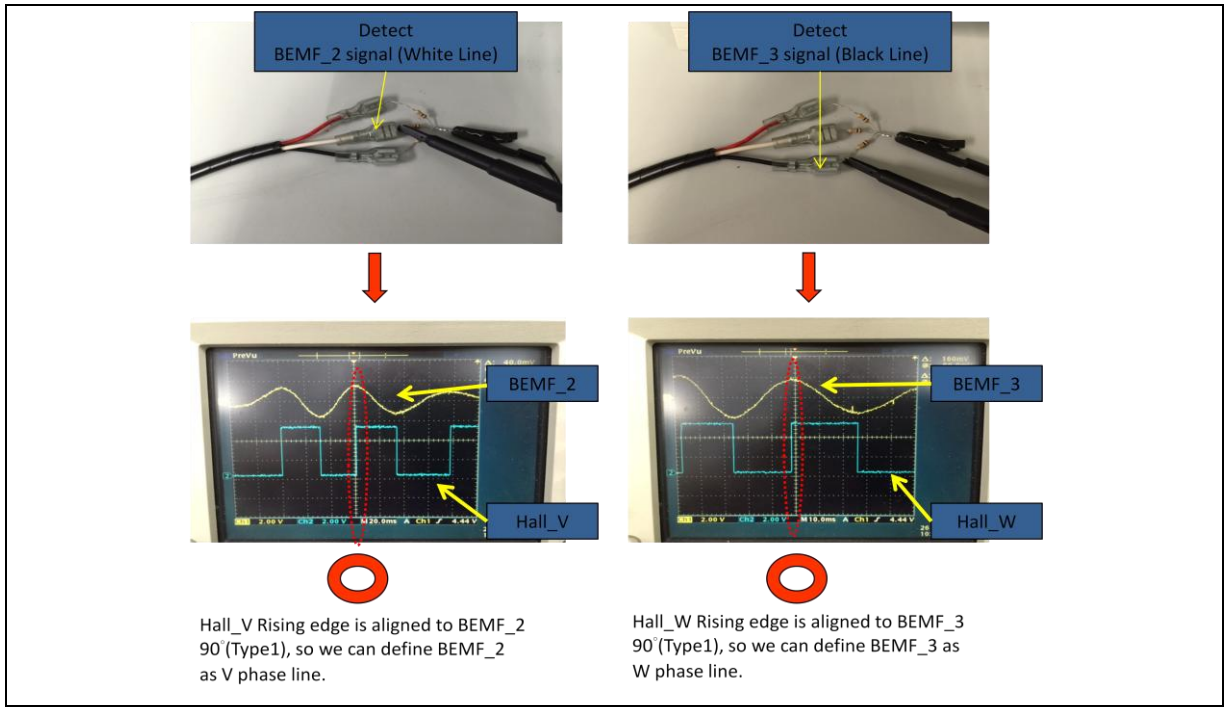


Figure 11-5 Measuring Hall_V, Hall_W and phase relationship

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。

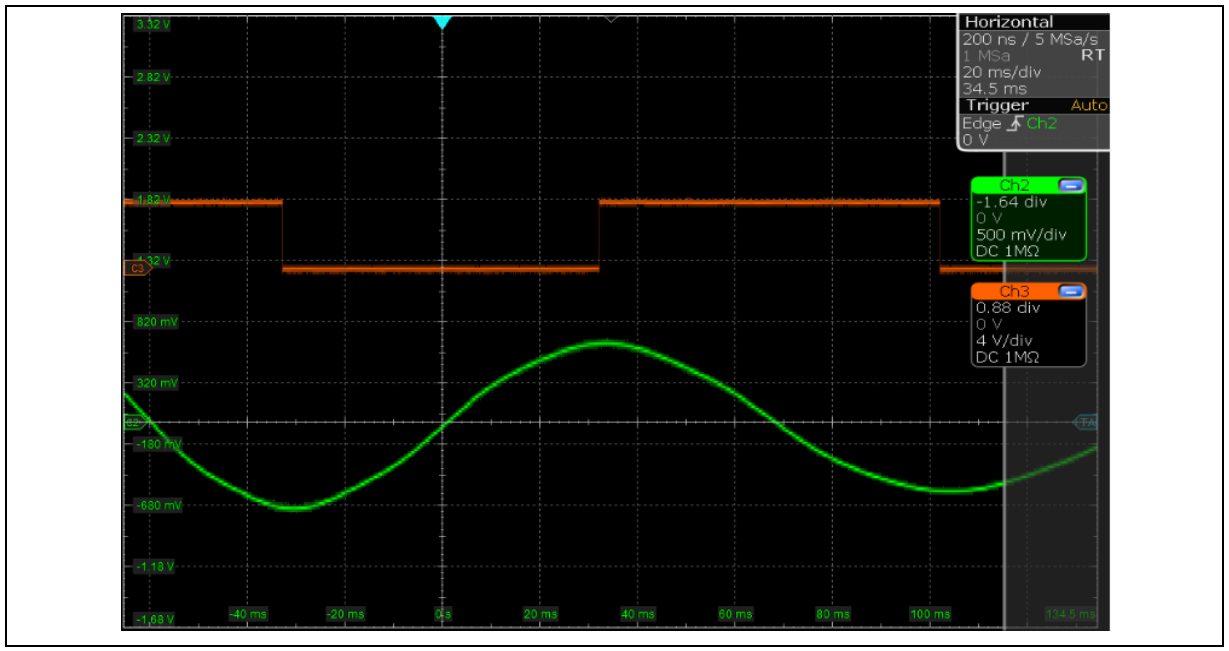


Figure 11-6 Type1 – Hall & BEMF

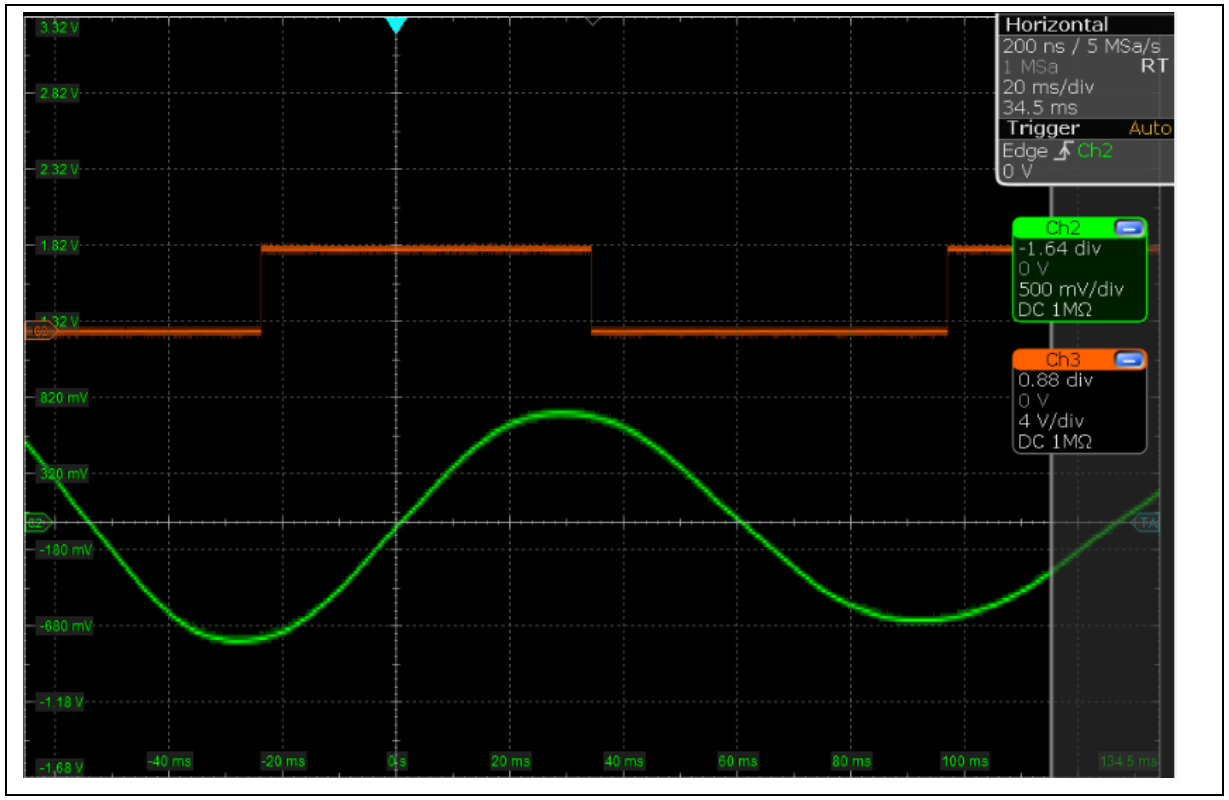


Figure 11-7 Type0 – Hall & BEMF

12 REVISION HISTORY

Date	Revision	Description
2019.05.08	1.00	1. Initially issued.

NU-LB-NM1817 USER MANUAL

Important Notice

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