ARM® Cortex®-M

32-bit Microcontroller

NuMicro® Family
NH-NM1817 and
NT-NM1817
User Manual

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www.nuvoton.com

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1 OVERVIEW

The Nuvoton High Voltage Motor Development Module using MOSFET power stage (Nu-HVMDM-MOS-NM1817) (NH-NM1817) is used to accelerate product development by providing ready-to-run hardware and a comprehensive Motor Development Adapter (NuTiny-EVB-NM1817)(NT-NM1817).

NuTiny-EVB-NM1817(NT-NM1817) is the specific development tool for NuMicro® NM1817 series. Users can use NuTiny-EVB-NM1817 to develop and verify the application program easily.

NuTiny-EVB-NM1817 includes two portions. One is NuTiny-EVB-NM1817 and the other is Nu-Link-Me. NuTiny-EVB-NM1817 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® NM1817 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, I2C, PWM, ADC, Watchdog Timer, Analog Comparator and Brown-out Detector, have been incorporated into the NM1817 series in order to reduce component count, board space and system cost. These useful functions make the NM1817 series powerful for a wide range of motor driver applications.

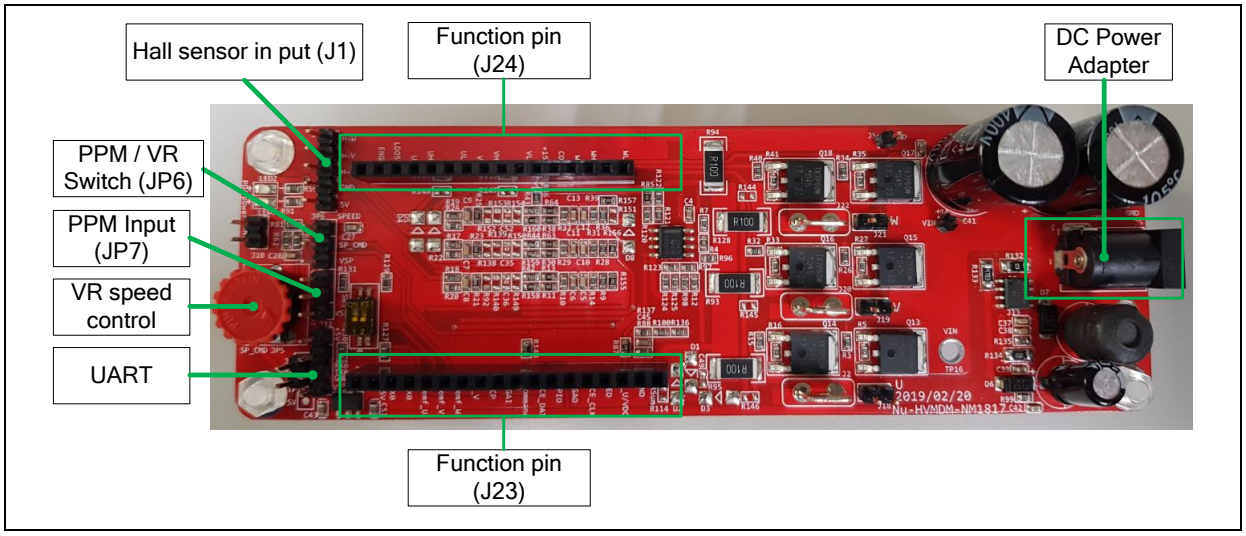


Figure 1-1 Nu-HVMDM-MOS(NM1817) (PCB Board)

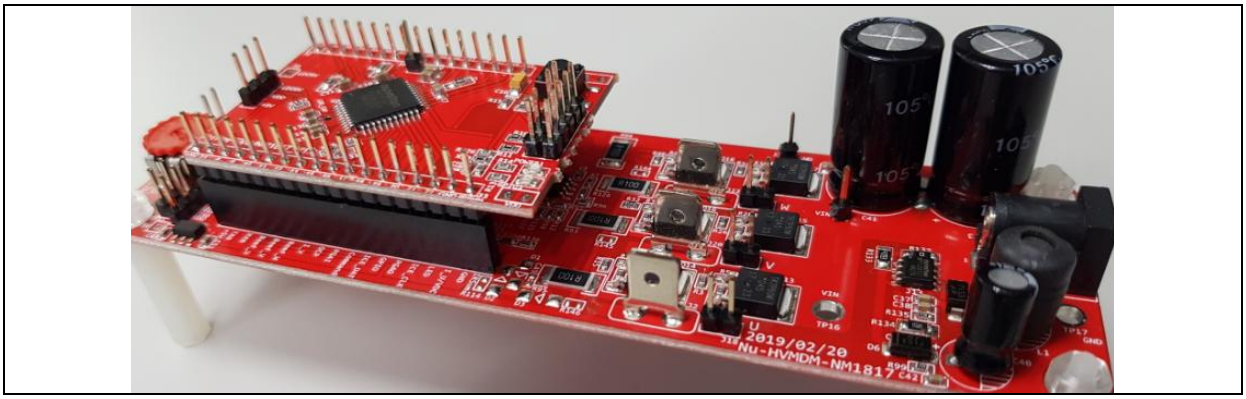


Figure 1-2 NuTiny-EVB-NM1817 connect to Nu-HVMDM-MOS(NM1817) (PCB Board)

1.1 Features

The key features of this board include the following:

- Motor Control interfaces
  - One or two phase inverter bridge with apower rating of DC 310V.
  - 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-NM1817 (JP4)

2 NUTINY-EVB-NM1817 INTRODUCTION

NuTiny-EVB-NM1817 uses the NM1817 as the target microcontroller. Figure 2-1 is NuTiny-EVB-NM1817 for NM1817 series, the left portion is called NuTiny-EVB-NM1817 and the right portion is Debug Adaptor called Nu-Link-Me.

NuTiny-EVB-NM1817 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 NM1817 series features. The NuTiny-EVB-NM1817 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 5.

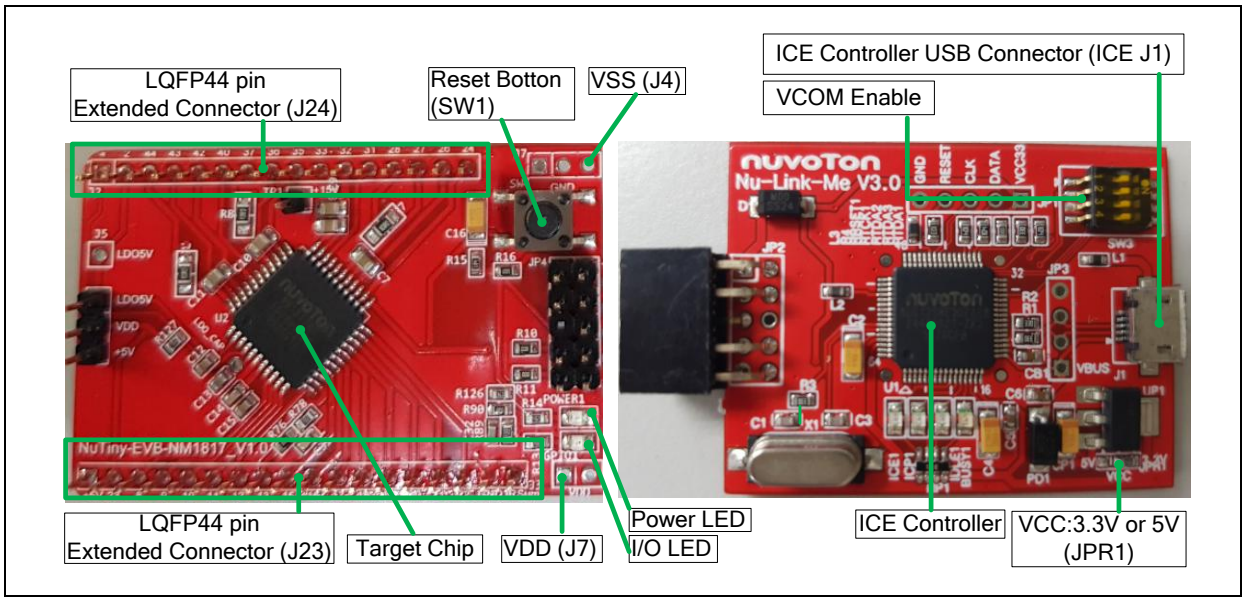


Figure 2-1 NuTiny-EVB-NM1817 (PCB Board)

2.1 NuTiny -EVB-NM1817 Jumper Description

2.1.1 Power Connector

- TP1: VCC connector in NuTiny-EVB-NM1817
- J7: VSS connector in NuTiny-EVB-NM1817

2.1.2 Debug Connector

- JP4: Connector in target board (NuTiny-EVB-NM1817) 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-NM1817)

2.1.3 USB Connector

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

2.1.4 Extended Connector

- J2, J3: Show all chip pins in NuTiny-EVB-NM1817

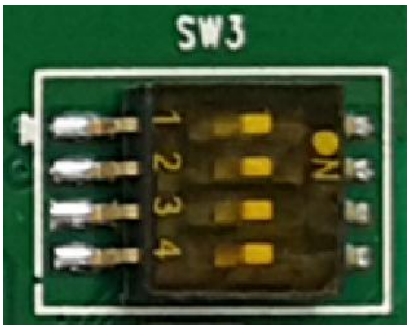
2.1.5 Reset Button

- SW4: Reset button in NuTiny-EVB-NM1817

2.1.6 VCOM Enable

- **SW3**: VCOM function enable for NuTiny-EVB-NM1817. Switch SW3 on before power on to enable VCOM function. SW3 connects pin 13(PD2/RXD) and pin 17(PC0/TXD) in NuTiny-EVB-NM1817 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.

2.2 Nu-HVMDM-MOS(NM1817) Jumper Description

2.2.1 Power Setting

- Mode1: Connect Vin(J4 or TP16) & Conncet GND(TP14 or TP17) for DC 110V~310V.
- Mode2: Connect adpter(J6) for output voltage is greater than DC 35V.

2.2.2 Extended Connecter

- J2 and J3: Show all function pins in Nu-HVMDM-MOS(NM1817)

2.2.3 GPIO Switch

- SW3: GPIO Switch button in Nu-HVMDM-MOS(NM1817)

2.2.4 Hall Connector

- J1: Hall connect in Nu-HVMDM-MOS(NM1817)

2.2.5 VR and PPM swhith Connecter

- JP6: VR and PPM Connect to input Command to MCU in Nu-HVMDM-MOS(NM1817)

2.2.6 USRT Connecter

- J11: UART connect in Nu-HVMDM-MOS(NM1817)

2.3 NuTiny -EVB-NM1817 Pin Assignment for Extended Connector

NuTiny-EVB-NM1817 provides NM1817ZC1AE on board and the extended connector for (**J2** and **J3**) for LQFP44-pin. Table 2-1 is the pin assignment for NM1817.

Pin No	Port	Pin Function (J3)	Pin No	Port	Pin Function (J2)
01		+5V	01	PC4	ECAP_P3
02	PD.5	UART0_TXD	02		LDO5V
03	PD.6	UART0_RXD	03		UB
04	PB.0	ADC0_CH0,ACMP0_P0,ECAP_P0	04		UHO
05	PB.1	ADC0_CH1,ACMP0_P1,ECAP_P1	05		U
06	PB.2	ADC0_CH2,BPWM_CH1,ACMP0_P2,ECAO_P2	06		ULO
07	PB.4	ADC1_CH0,ACMP0_N,TM1	07		VB
08	PC.1	ADC0_CH4,STADC,ACMP0_P3,ACMP1_P1,SPI0_MOSI,SPI1_MISO	08		VHO
09	PB.3	ACMP1_N,PGA_I,TM0	09		V
10	PC.2	ADC1_CH2,BRAKE,CCAP_P1,I2C1_SDA,SPI0_MISO,SPI1_MOSI,UART1_RXD	10		VLO
11	PD.2	ICE_DAT,ADC1_CH1,CCAP_P0,I2C0_SDA,SPI0_MOSI,SPI1_MISO,UART0_RXD	11		+15V
12	PD.3	BPWM_CH1,UART1_TXD	12		COM
13	PC.3	ACMP1_O,PGA_O,SPI0_CLK,SPI1_SS	13		WB
14	PD.1	ICE_CLK,ACMP1_P2,I2C0_SCL,SPI0_CLK,SPI1_SS,UART_TXD	14		WHO
15	PD.4	BPWM_CH0,UART1_RXD	15		W
16	PC.0	ADC0_CH3,BPWM_CH0,ACMP1_P0,I2C1_SCL,SPI0_SS,SPI1_CLK,UART1_TXD	16		WLO
17		VSS			
18		IRSum			

Table 2-1 Pin Assignment for NM1817 MCU

2.4 Nu-HVMDM-MOS(NM1817) Pin Assignment for Extended Connector

Nu-HVMDM-(NM1817) provides the extended connector for (**J2** and **J3**) for function-pin. Table 2-2 is the pin assignment for NM1817 driver board.

Pin No	Port	Pin Function (J3)	Pin No	Port	Pin Function (J2)
01		+5V	01	PC4	ENGD
02	PD.5	TX	02		LDO_5V_OUT
03	PD.6	RX	03		UB
04	PB.0	Bemf_U, Hall_U	04		UHO
05	PB.1	Bemf_V, Hall_V	05		U
06	PB.2	Bemf_W, Hall_W	06		ULO
07	PB.4	I_V, Bemf_O	07		VB
08	PC.1	OCP	08		VHO
09	PB.3	PGAI	09		V
10	PC.2	Speed_Command	10		VLO
11	PD.2	GPIO, ICE_DAT	11		+15V
12	PD.3	GPIO	12		COM
13	PC.3	PGAO	13		WB
14	PD.1	ICE_CLK	14		WHO
15	PD.4	LED	15		W
16	PC.0	I_U, VDC	16		WLO
17		VSS			
18		IRSum			

Table 2-2 Pin Assignment for NM1817 Driver Board

2.5 Choise Function Table

The Nu-HVMDM-MOS-NM1817 can be use resistance to choise function.Please follow Table 2-3.

Choise Function				Choise Function				Choise Function				Choise Function	
	Bemf_U	IPD_U	Hall_U		Bemf_V	IPD__V	Hall_V		Bemf_W	IPD_W	Hall_W		Bemf_O
R155	V			R156	V			R157	V			R42	V
R9	V			R28	V			R36	V			R43	V
R13	V			R63	V			R64	V			R44	V
R14	V			R31	V			R39	V				
R10				R29				R37					
R11				R30				R38					
R158	V			R159	V			R160	V				
R42				R44				R43					
C5	V			C10	V			C12	V				
C6				C11				C13					
R21			V	R23			V	R25			V		
R149		V		R150		V		R154		V			
R148		V		R147		V		R151		V			
R92		V		R138		V		R152		V			
R140		V		R139		V		R153		V			
C36		V		C35		V		C52		V			

Table 2-4 Pin Assignment for NM1817 Driver Board

2.6 Choise “bemf” measure voltage divider resistor

Vin (V)	R1(K)	R2(K)
100~130	270	10
140~180	360	10
190~220	510	10
230~260	560	10
270~310	750	10
R1= R9,R28,R36		
R2= R14,R31,R39		

2.7 Choise “Vin” measure voltage divider resistor

Vin (V)	R3(K)	R4(K)	R5(K)
110~150	150	150	10
240~310	330	330	10

3 HOW TO START NUTINY-EVB-NM1817 ON THE KEIL MVISION® IDE

3.1 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

3.2 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.

3.3 Hardware Setup

The hardware setup is shown as Figure 3-1.



Figure 3-1 NuTiny-EVB-NM1817 Hardware Setup

3.4 Example Program

This example demonstrates the ease of downloading and debugging an application on a NuTiny-EVB-NM1817 board. It can be found on Figure 3-2 list directory and downloaded from Nuvoton NuMicro® website.

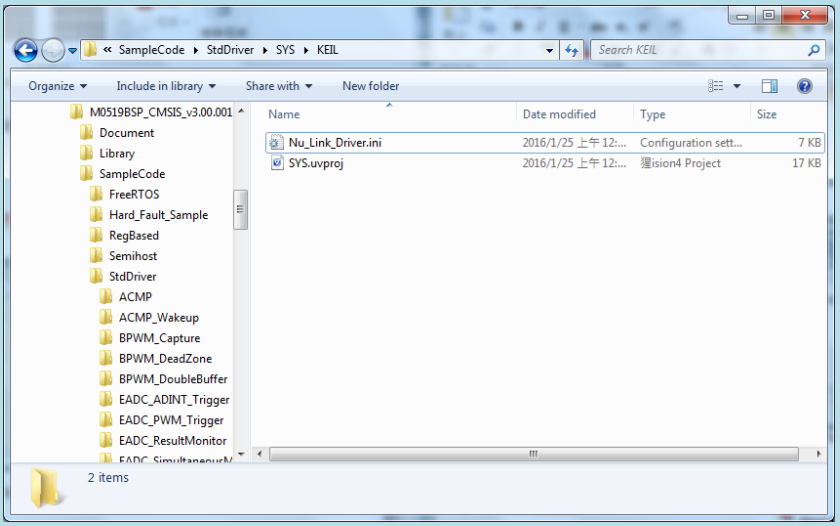
Directory	C:\ Nuvoton\BSP Library\NM1817BSP\SampleCode \StdDriver\SYS\KEIL
Project File	

Figure 3-2 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

4 HOW TO START NUTINY -EVB-NM1817 ON THE IAR EMBEDDED WORKBENCH

4.1 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.

4.2 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.

4.3 Hardware Setup

The hardware setup is shown as Figure 4-1.

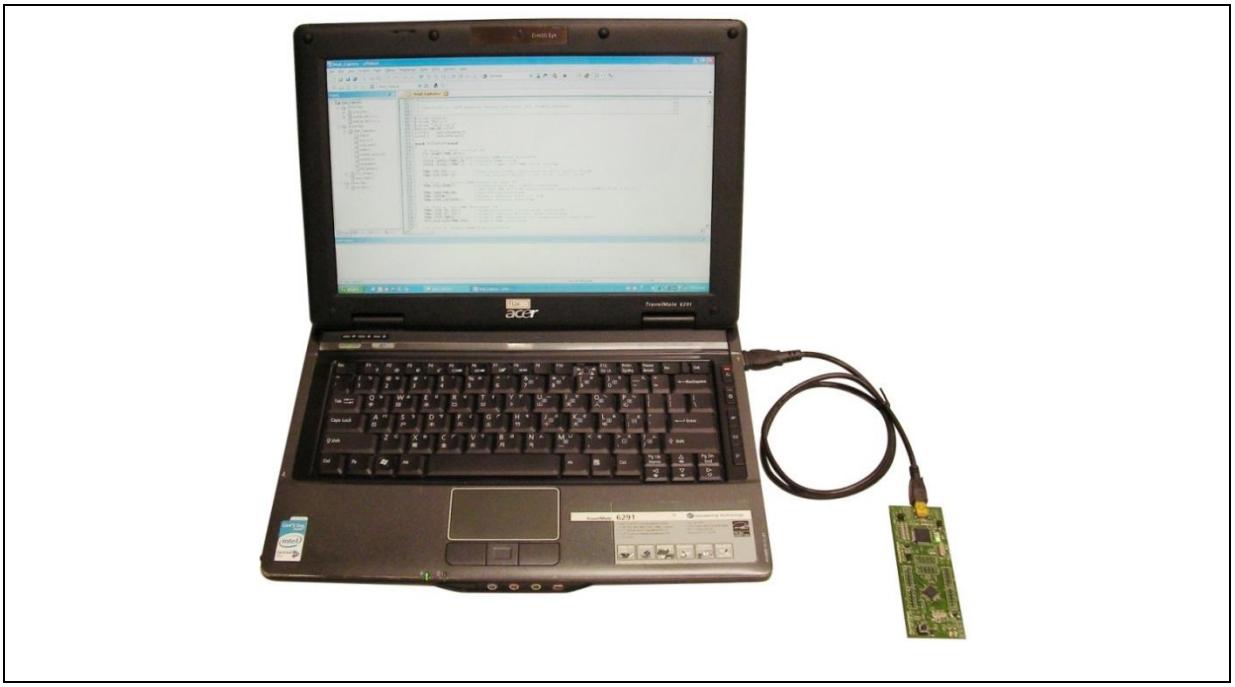


Figure 4-1 NuTiny-EVB-NM1817 Hardware Setup

4.4 Example Program

This example demonstrates the ease of downloading and debugging an application on a NuTiny-EVB-NM1817 board. It can be found on Figure 4-2 list directory and downloaded from Nuvoton NuMicro® website.

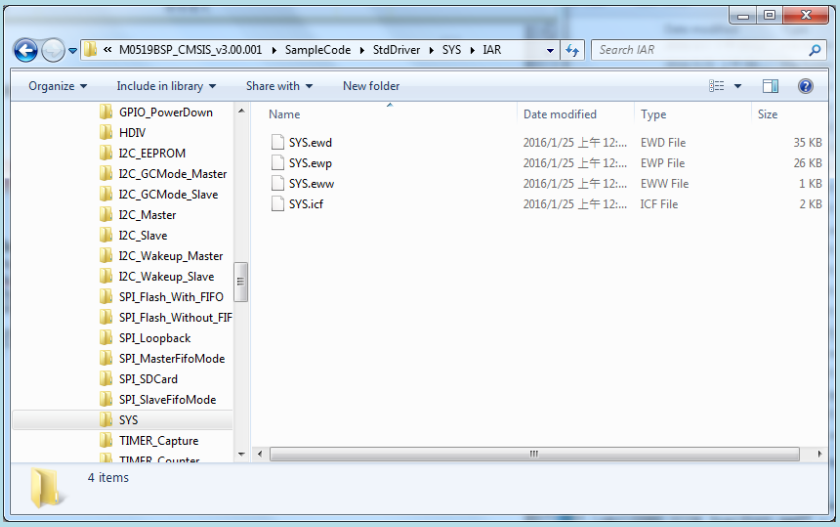
Directory	C:\ Nuvoton\BSP Library\NM1817BSP\SampleCode \StdDriver\SYS\IAR
Project File	

Figure 4-2 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

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

5.1 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.

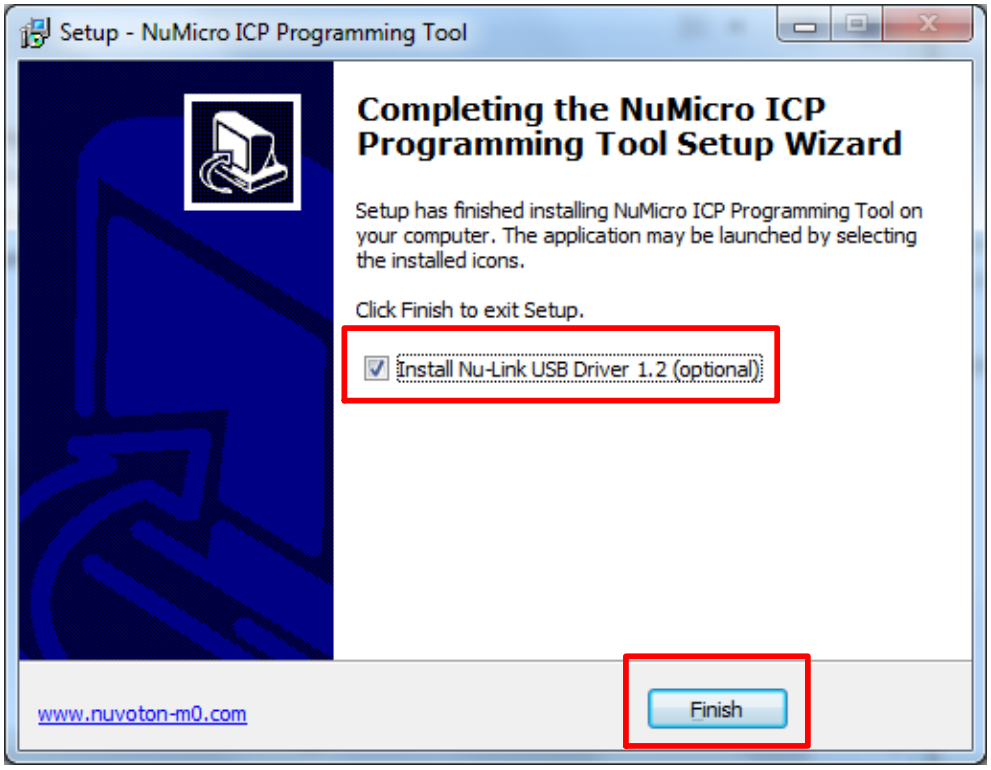


Figure 5-1 Optional Step after ICP Programming Tool Installation

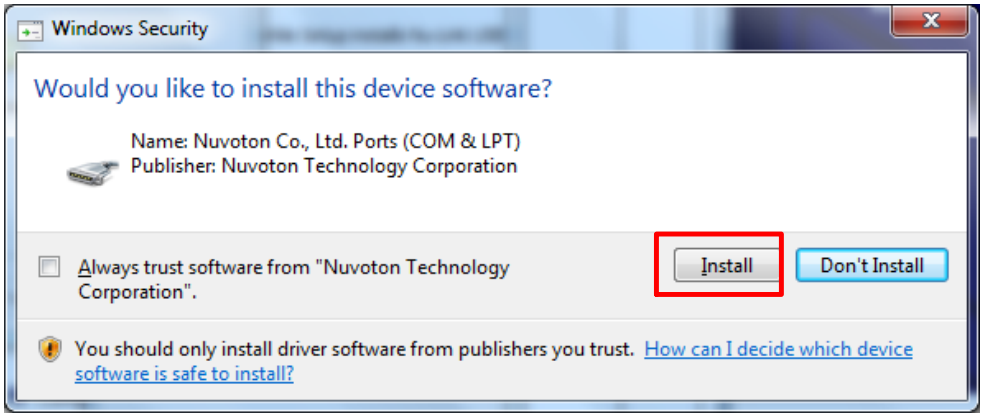


Figure 5-2 Install Nuvoton COM&LPT Driver

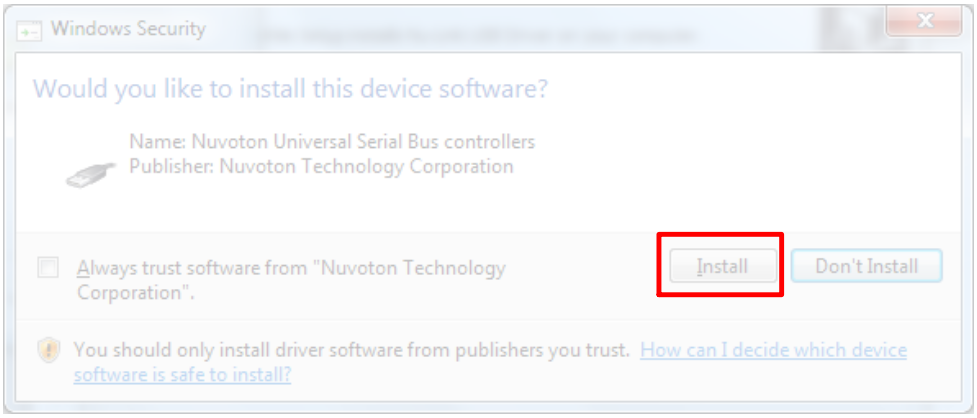


Figure 5-3 Install Nuvoton Universal Serial Bus Controllers

5.2 VCOM Mode Setting on NuTiny-EVB-NM1817

Before the NuTiny-EVB-NM1817 is connected to the PC, please enable SW3 VCOM function by switching on SW3. The NuTiny-EVB-NM1817 transmits through UART0 to VCOM to send out data. Switch SW3 off when using UART0 function without VCOM function.

5.3 Setup on the Development Tool

The example is demonstrated on the Keil µVision® IDE.

5.3.1 Check the Using UART on the Keil µVision® IDE

Please open the project and find system_NM1817.h to check the using UART in DEBUG_PORT, which has to be the same as the using UART in the NuTiny-EVB-NM1817.

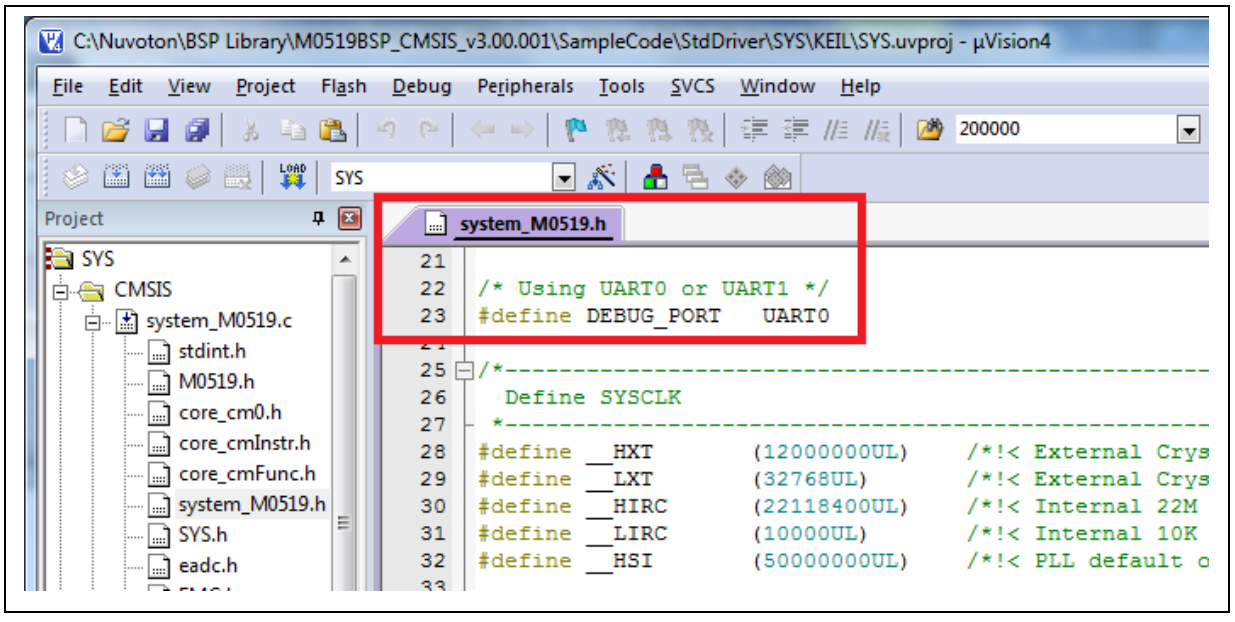
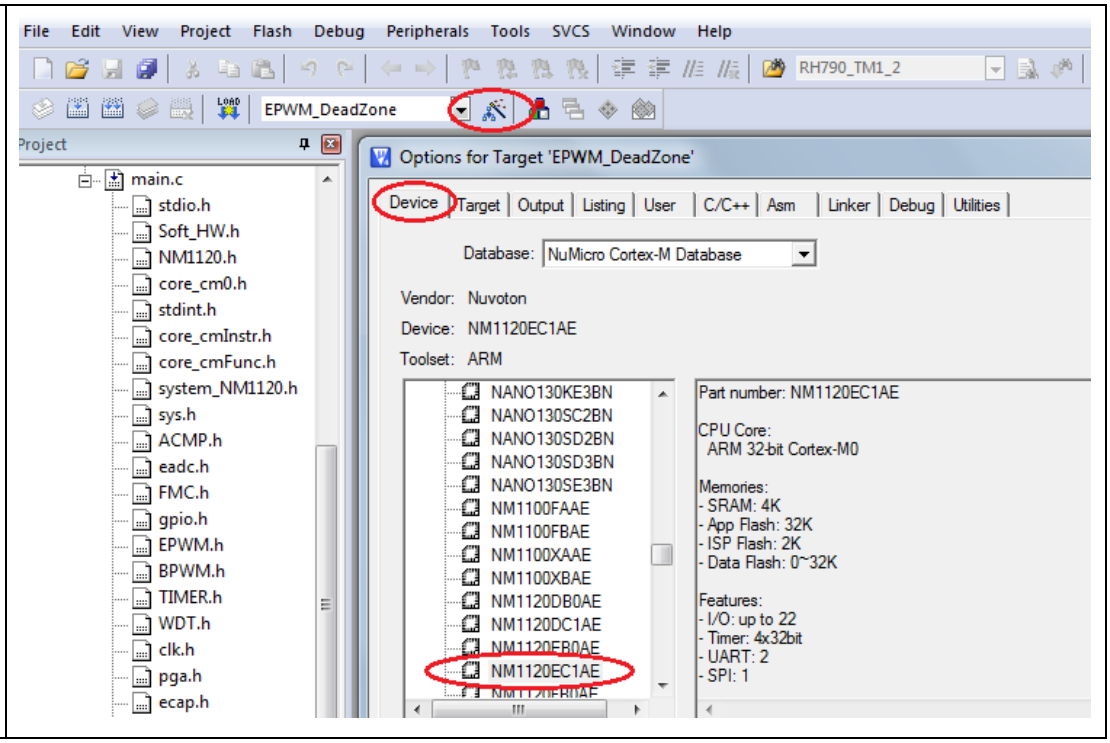


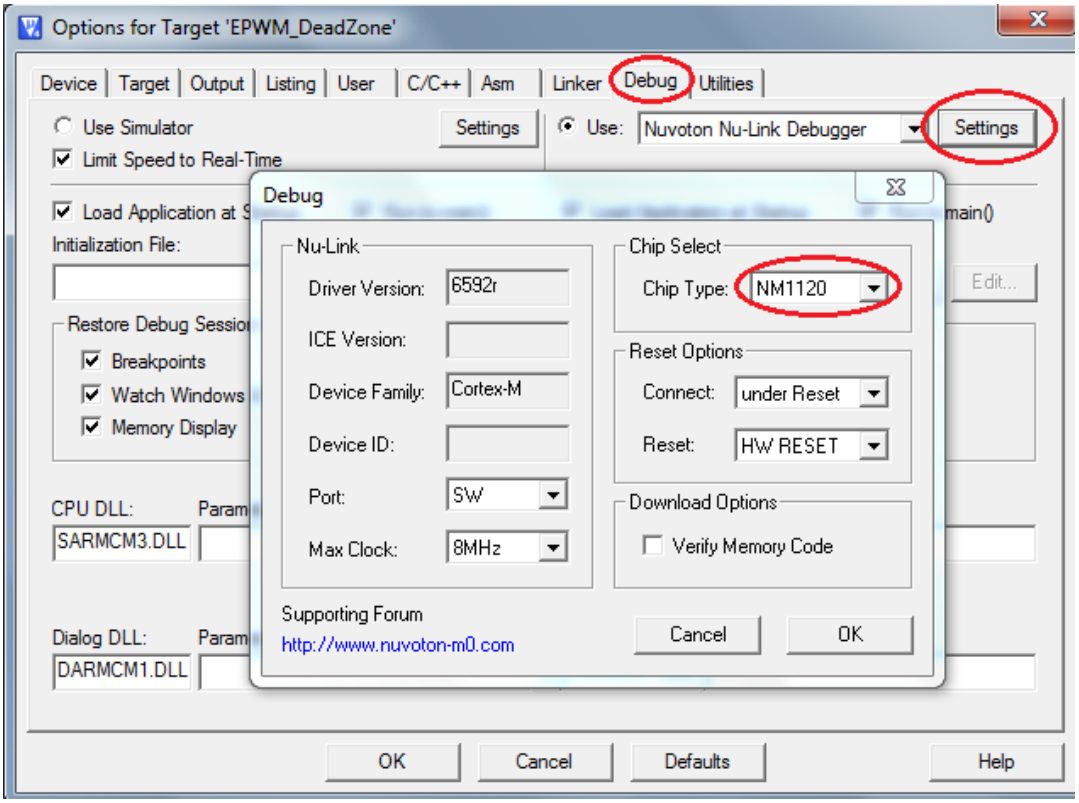
Figure 5-4 The Using UART on Keil µVision® IDE

5.3.2 Check the Target Device and Debug Setting

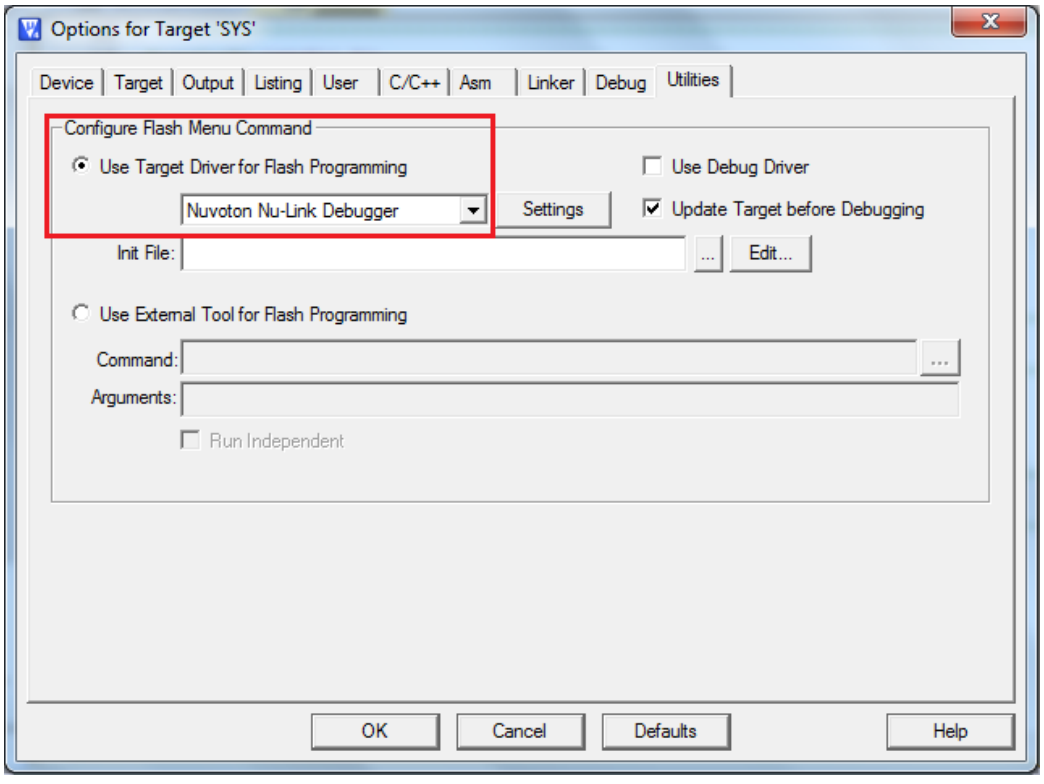
The target device has to be the same as the setting in Debug. Please click “Target Option” to open the Option windows, and find the setting in “Device”, “Debug”, and “Utilities” page. Please follow the steps below to check the setting.

Step 1	

Step 2


Options for Target 'EPWM_DeadZone'
Device
Target
Output
Listing
User
C/C++
Asm
Linker
Debug
Utilities
Use Simulator
Settings
Use:
Nuvoton Nu-Link Debugger
Settings
Limit Speed to Real-Time
Load Application at S
Initialization File:
Edit...
Restore Debug Sessio
Breakpoints
Watch Windows
Memory Display
CPU DLL:
Param
SARMCM3.DLL
Dialog DLL:
Param
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
Use Debug Driver
Nuvoton Nu-Link Debugger
Settings
Update Target before Debugging
Init File:
Edit...
Use External Tool for Flash Programming
Command:
Arguments:
Run Independent
OK
Cancel
Defaults
Help

5.3.3 Build and Download Code to NuTiny-EVB-NM1817

Please build the project and download code to NuTiny-EVB-NM1817.

5.3.4 Open the Serial Port Terminal

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

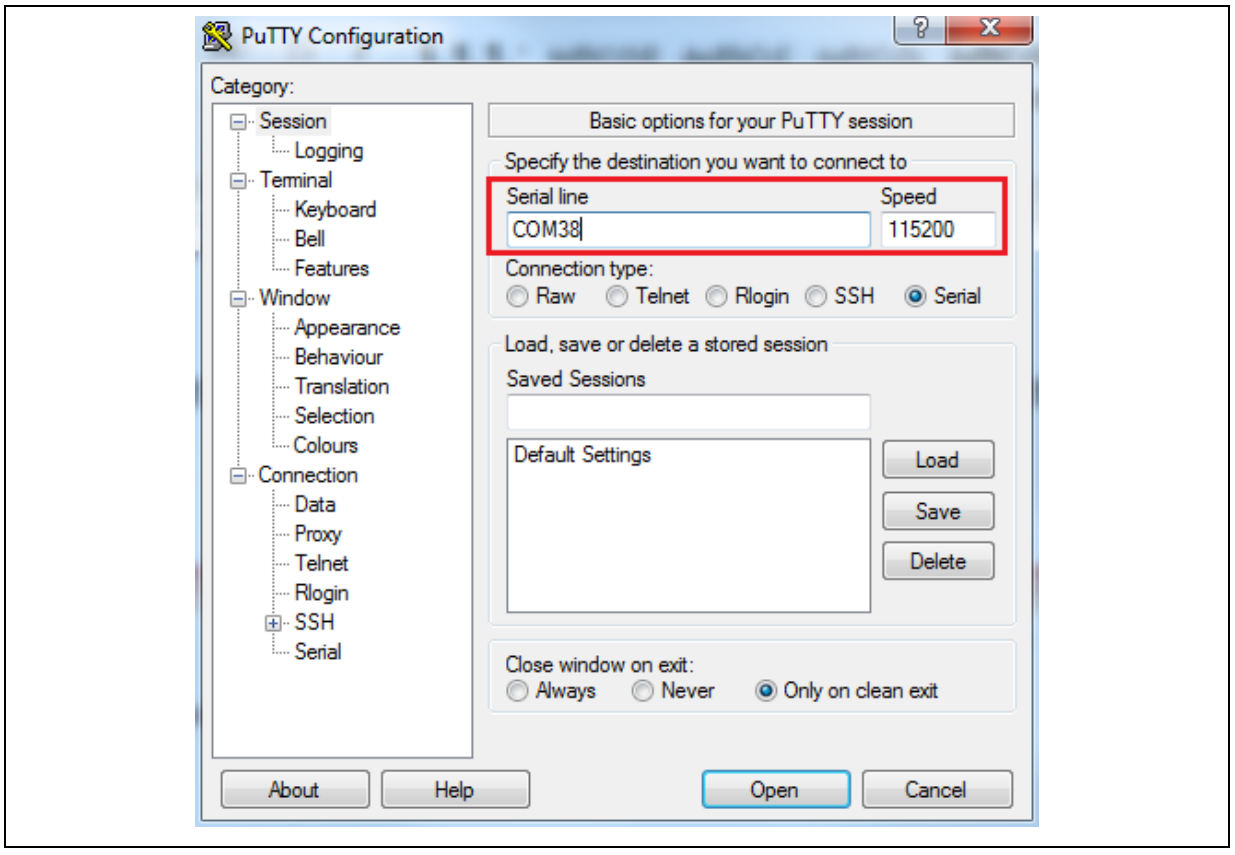


Figure 5-5 Set Baud Rate

5.3.5 Reset Chip

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

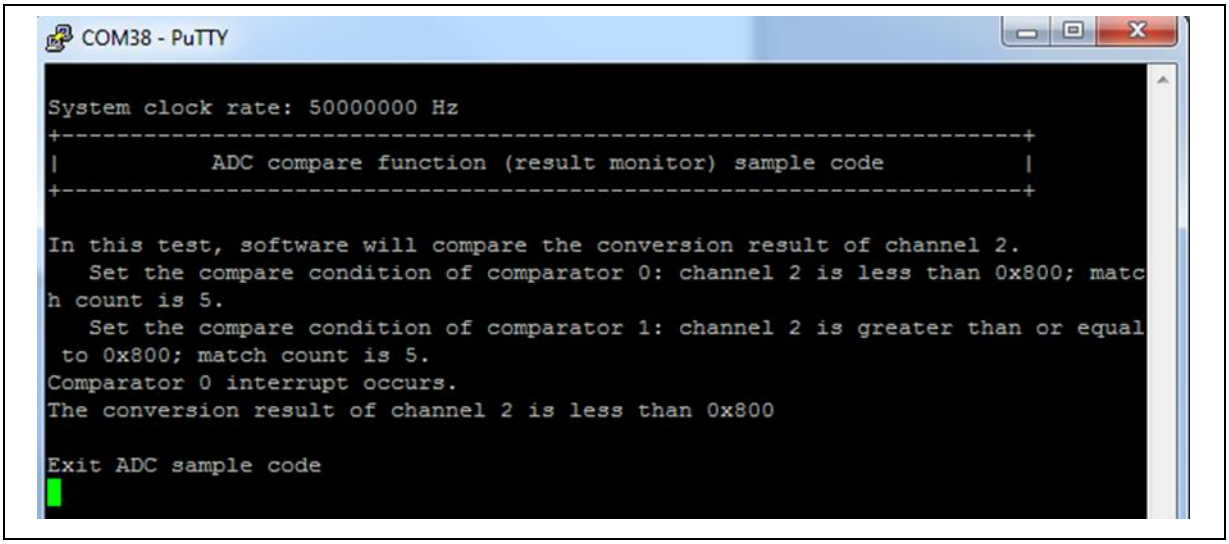
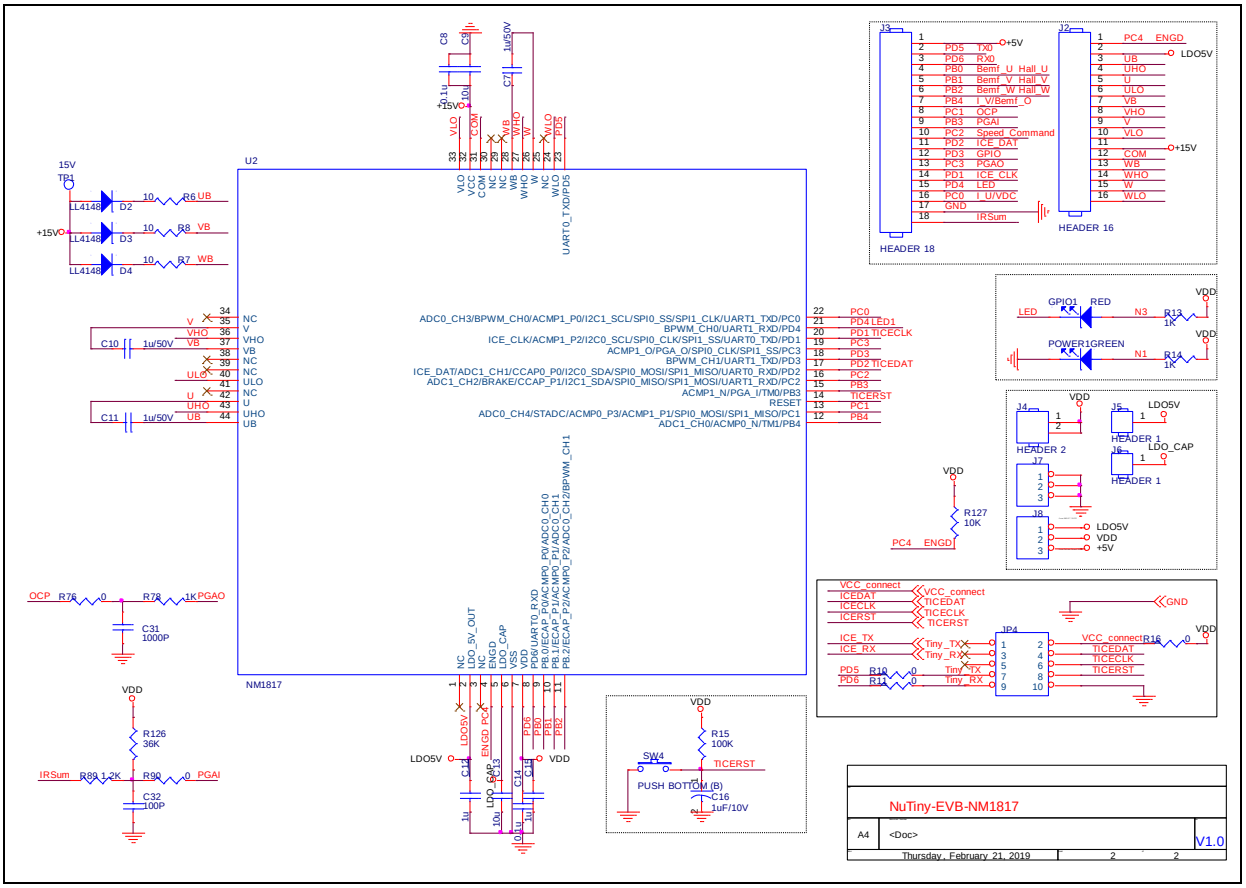


Figure 5-6 Serial Port Terminal Windows

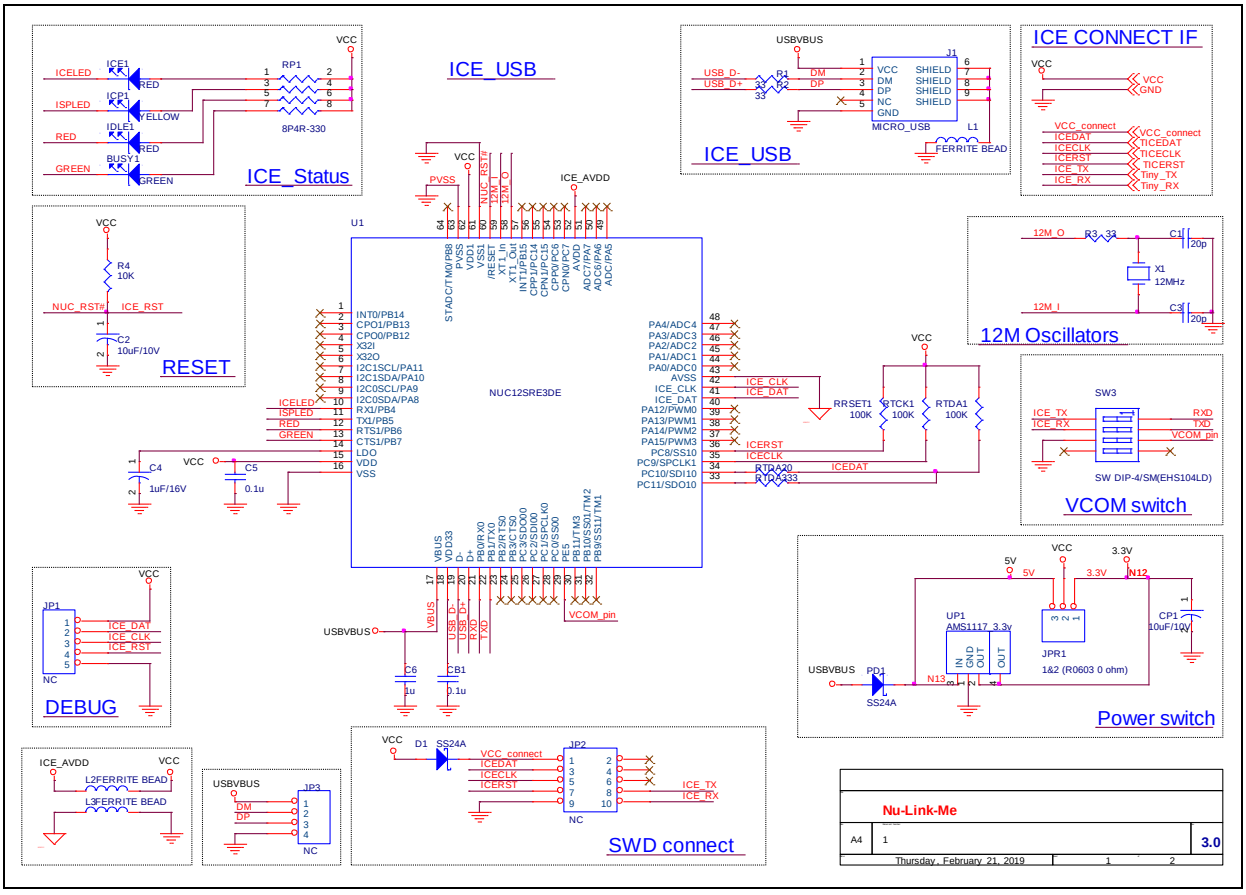
Notice: Please switch SW3 on before the NuTiny-EVB-NM1817 connects to the PC. When the NuTiny-EVB-NM1817 connects to the PC with SW3 switch on, PC will detect VCOM as a USB device and the detection will only be processed once. VCOM will not function if switch on SW3 after the connection.

6 NUTINY-EVB-NM1817 SCHEMATIC

6.1 NM1817 MCU Circuit Schematic

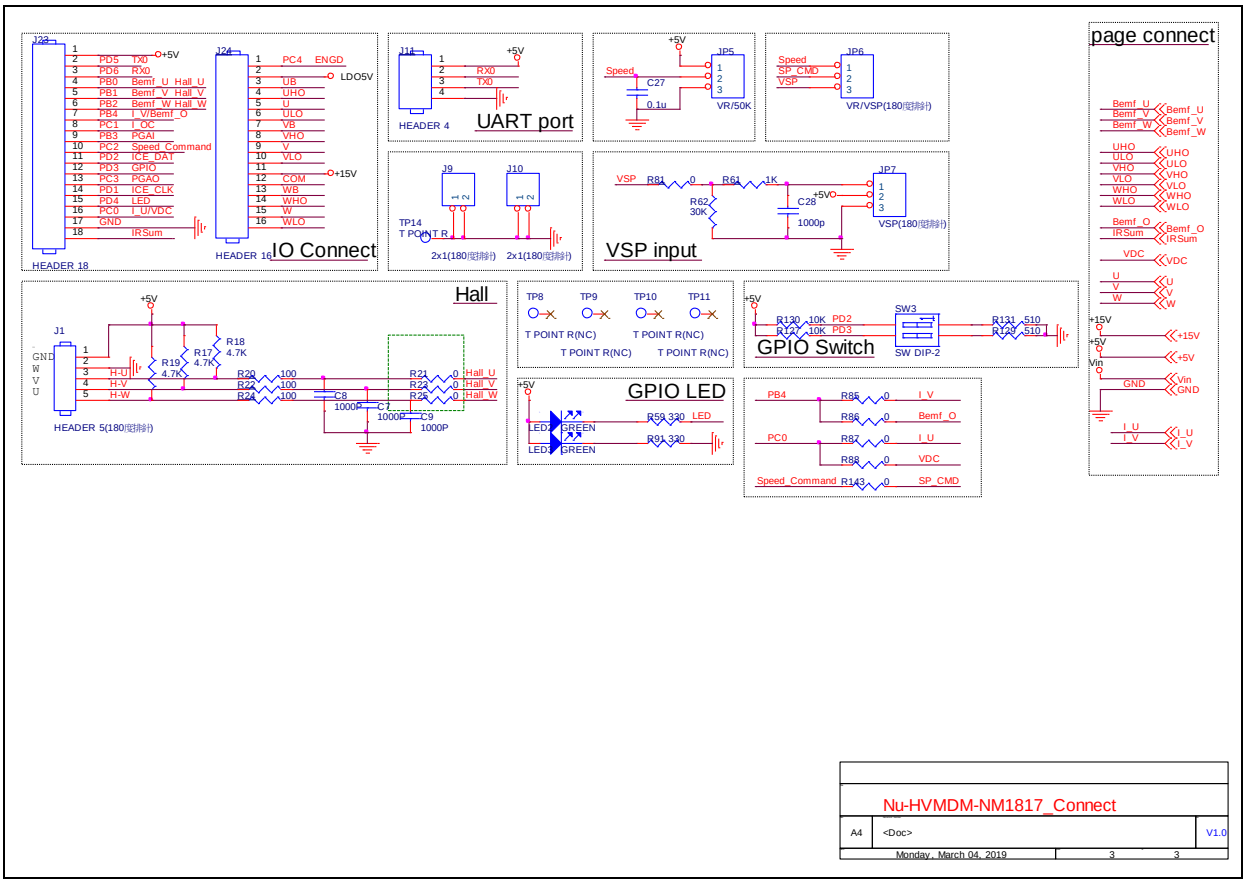


6.2 Nu-Link-Me V3.0 Schematic



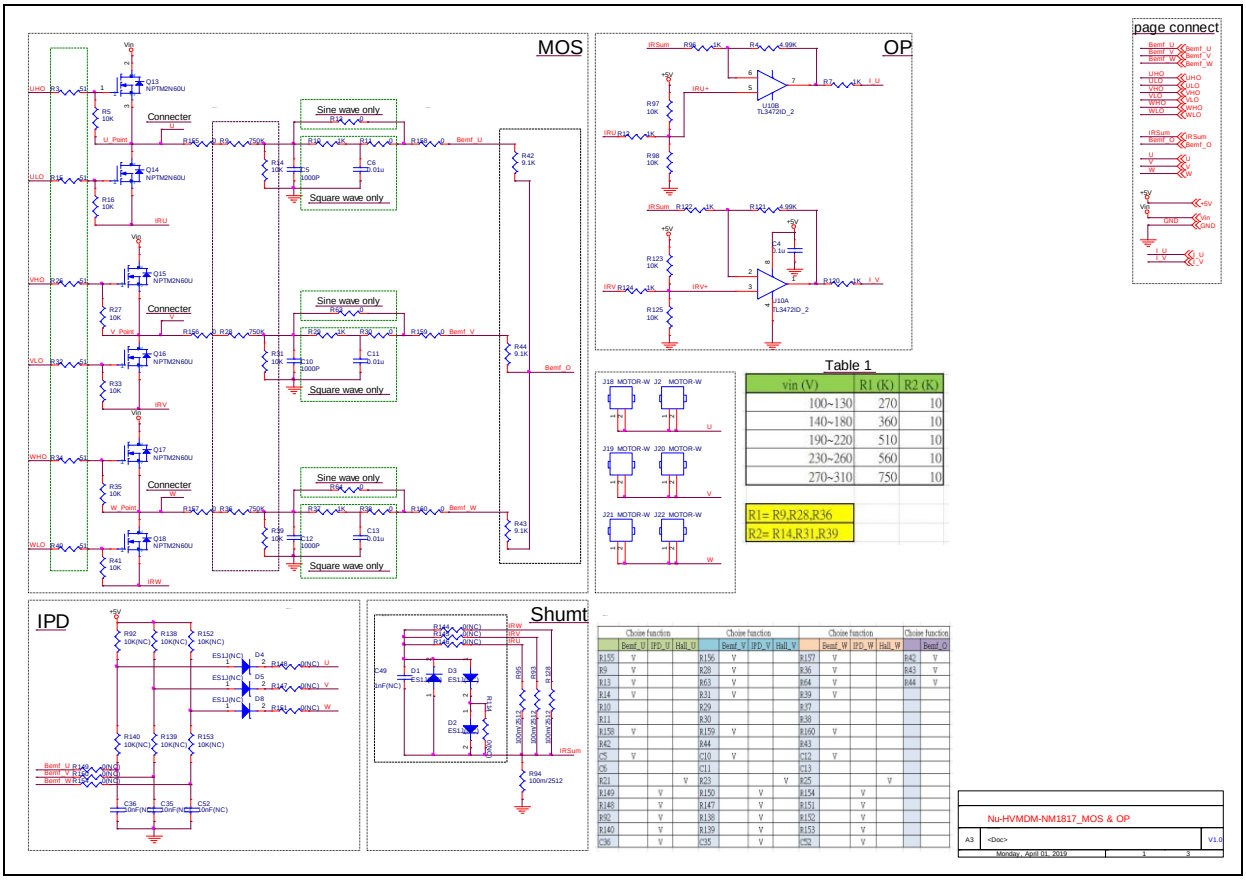
7 NU-HVMDM-MOS(NM1817) SCHEMATIC

7.1 Connect Schematic

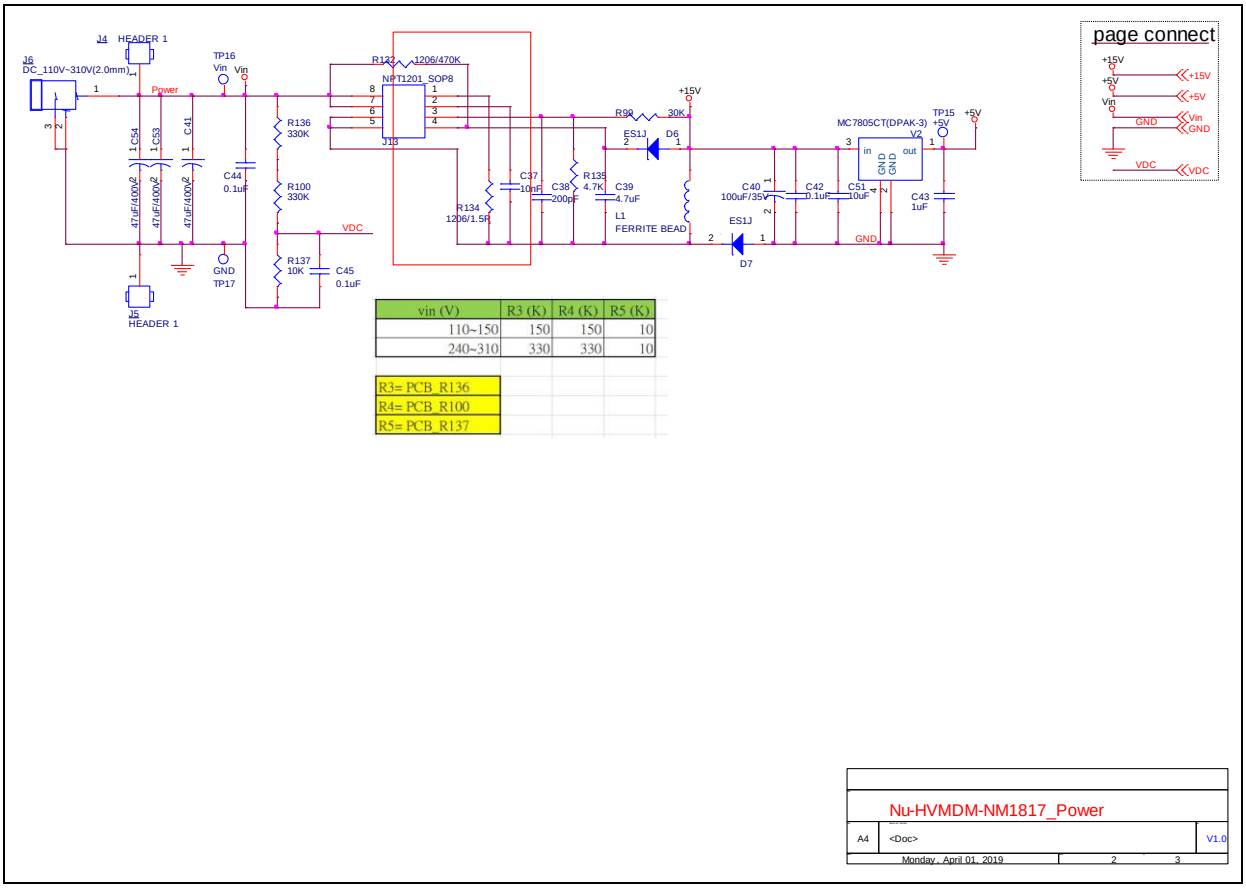


NUTINY-EVB-NM1817 AND DRIVER CONTRAL BOARD USER MANUAL

7.2 MOS and Driver Schematic



7.3 Power Schematic



7.4 NuTiny-EVB-NM1817 PCB Placemen

Users can refer to Figure 7-1 for the NuTiny-EVB-NM1817 PCB placements.

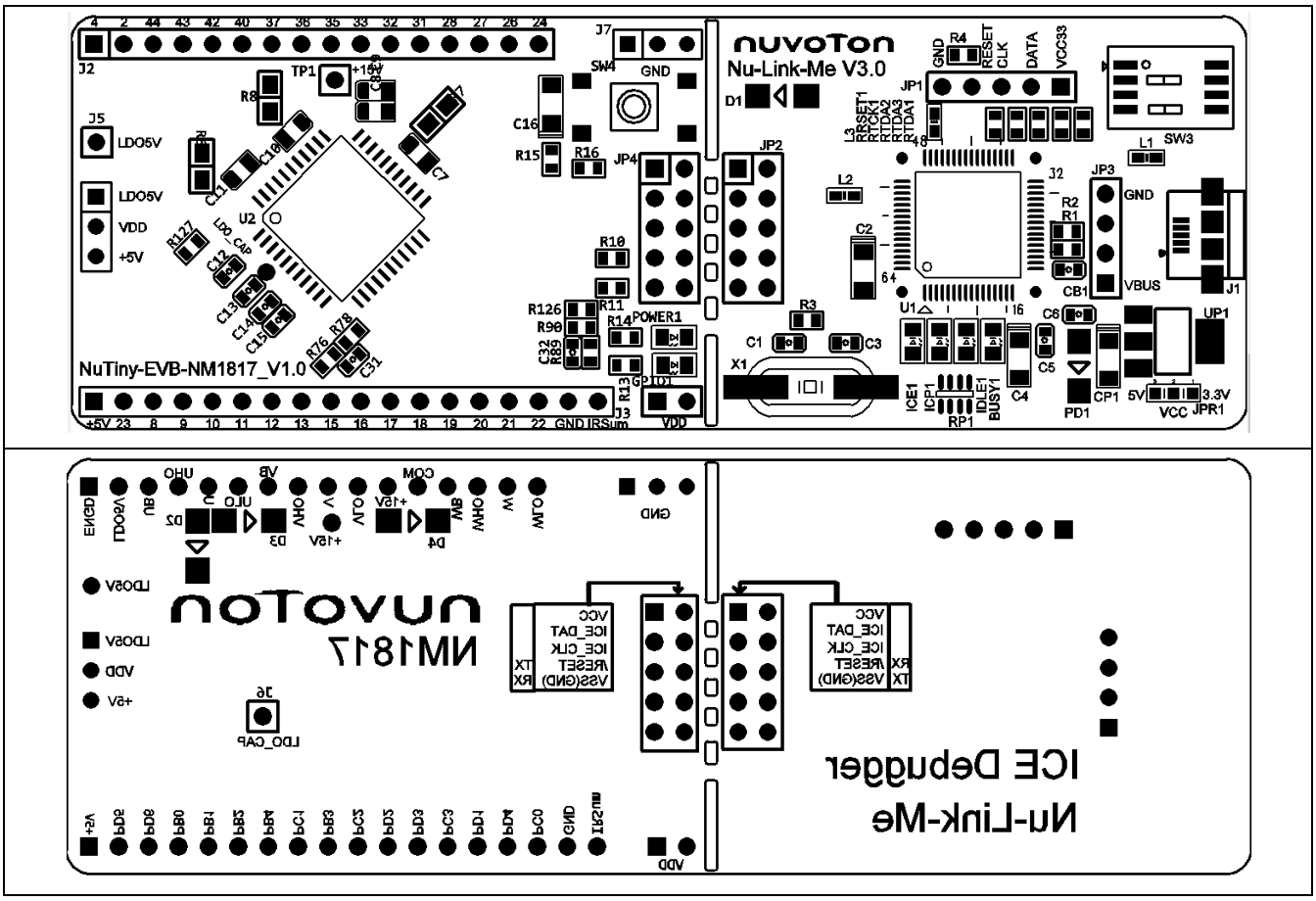


Figure 7-1 NuTiny-EVB-NM1817 PCB Placement

7.5 Nu-HVMDM-MOS(NM1817) PCB Placemen

Users can refer to Figure 7-1 for the Nu-HVMDM-MOS(NM1817) PCB placements.

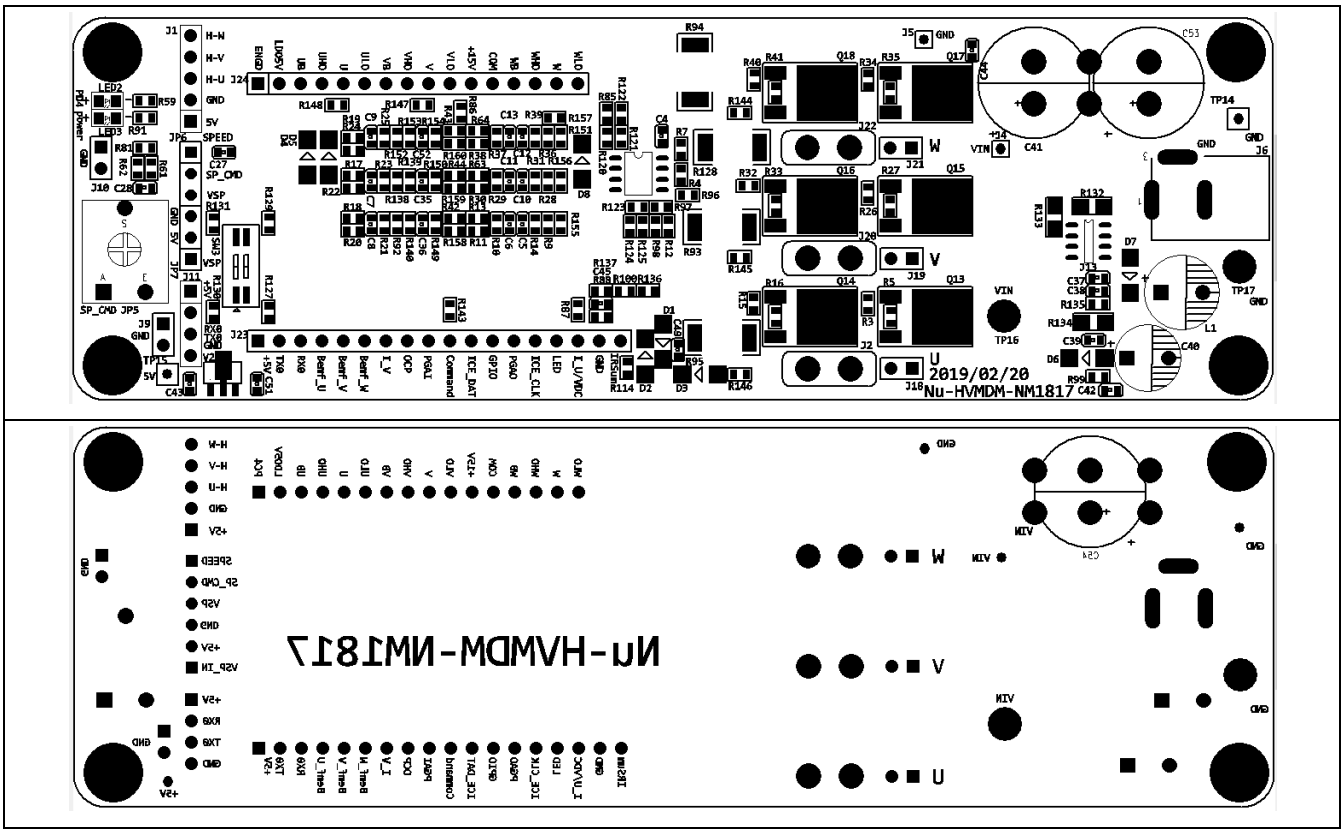


Figure 7-2 NuTiny-EVB-NM1817 PCB Placement

8 NU-HVMDM-MOS(NM1817) APPLICATION CIRCUIT DESCRIPTION

8.1 Hall Sensor Description

If want use “Hall sensor”, the R21, R23, R25 need use 0Ω connect to Bemf_(U,V,W). But want use back electromotive force, the R21, R23, R25 need remove it.

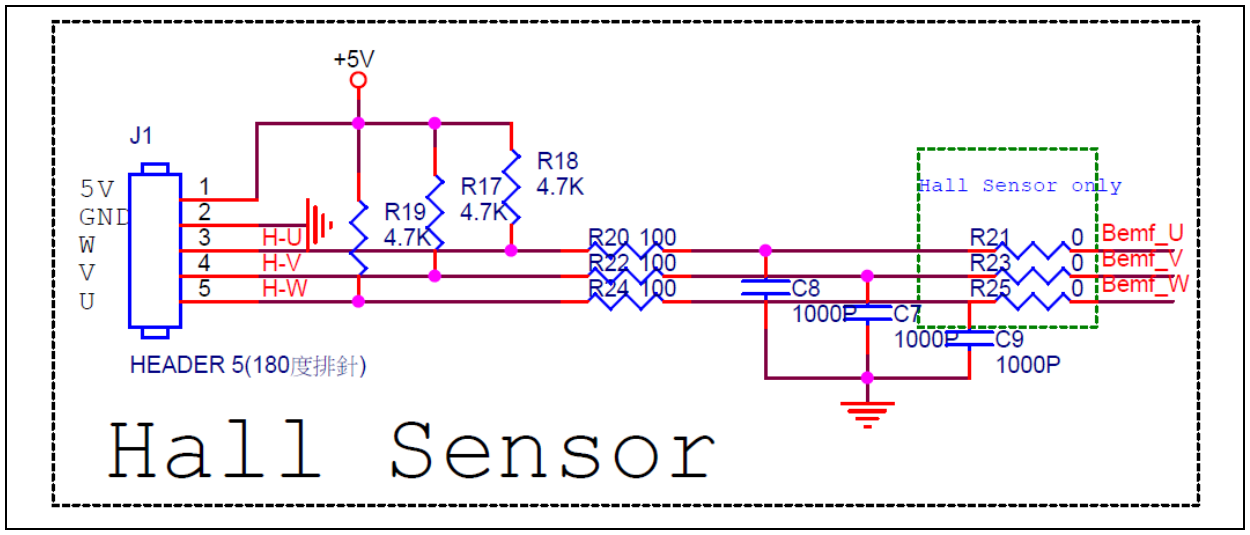


Figure 8-1 NuTiny-EVB-NM1817 PCB Placement

8.2 VR and PPM Command Function Description

The “speed” signal is use variable resistance(JP5) to provide voltage changes. The VSP is PWM filter signal to MCU(JP7), user can detect voltage to changes motor rotating speed. The JP6 is choose “speed” or “VSP” input to MCU.

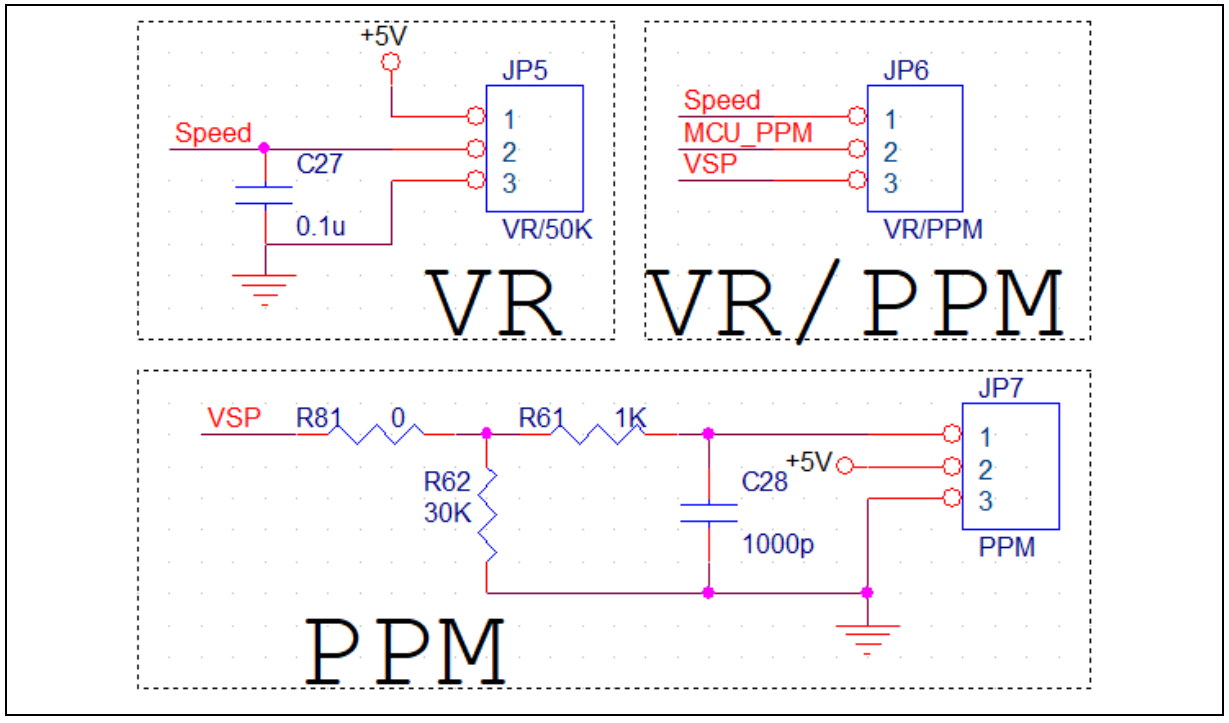


Figure 8-2 NuTiny-EVB-NM1817 PCB Placement

8.3 Nu-HVMDM-MOS(NM1817) Function Mode Switch Description

The Nu-HVMDM-MOS(NM1817) can switch to “Sine wave Back electromotive force”, “Square wave Back electromotive force” and “Hall sensor” mode. Please follow the table to choose.

	R9	R10	R11	R13	R14	C5	C6
Mode1: Sine wave Back electromotive force	V	X	X	V	V	V	X
Mode2: Square wave Back electromotive force	V	V	V	X	V	V	V
Mode3: Hall sensor	X	X	X	X	X	X	X

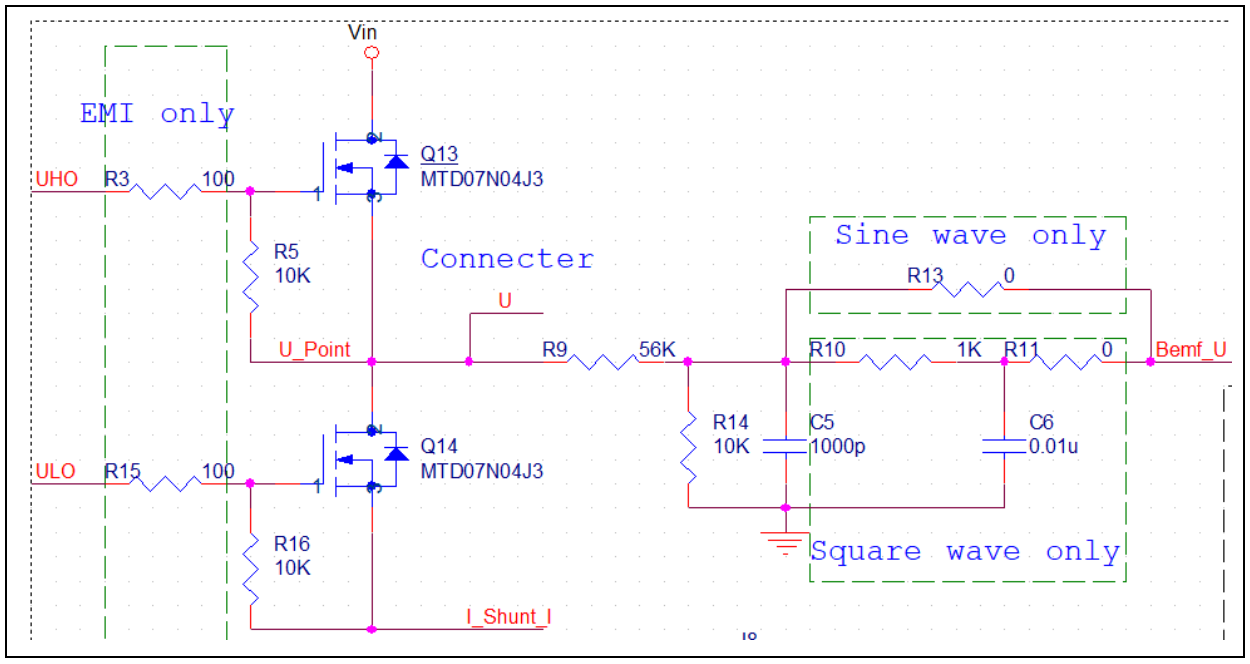


Figure 8-3 NuTiny-EVB-NM1817 PCB Placement

9 MOTOR HALL AND MOTOR LINE MEASUREMENT STEPS

9.1 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.

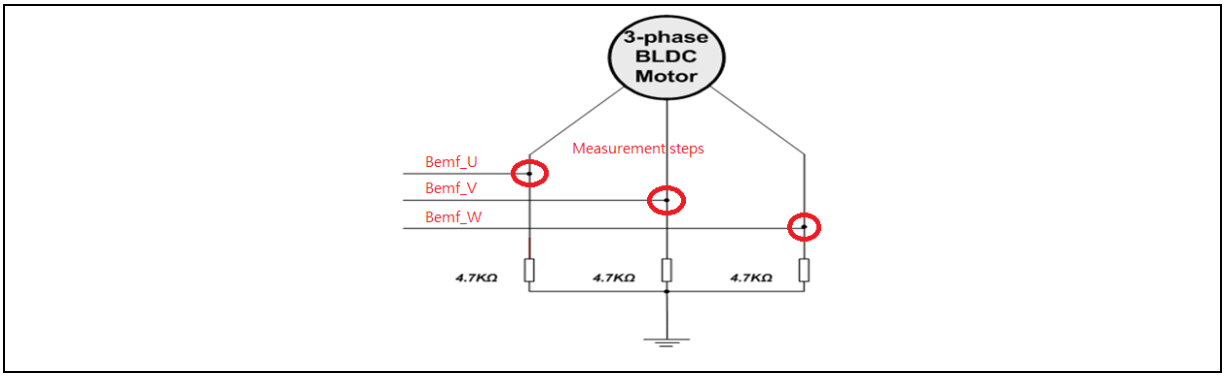


Figure 9-1 NuTiny-EVB-NM1817 PCB Placement

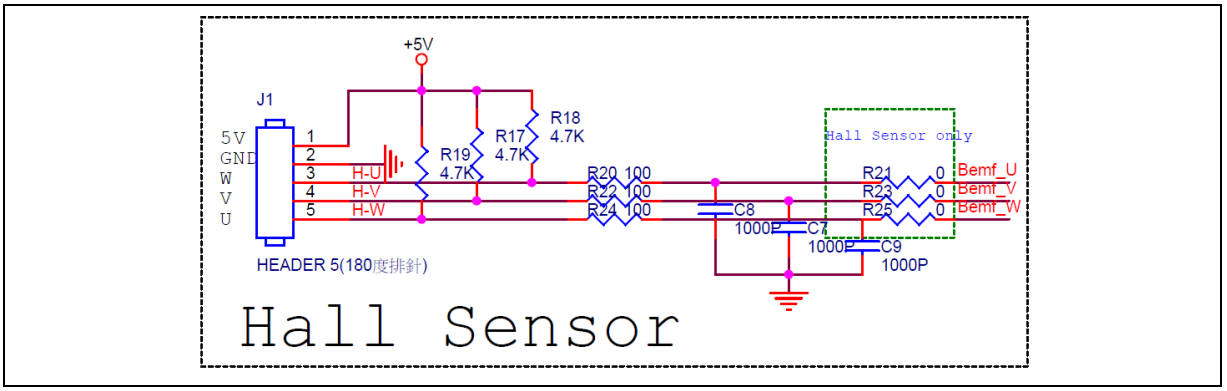
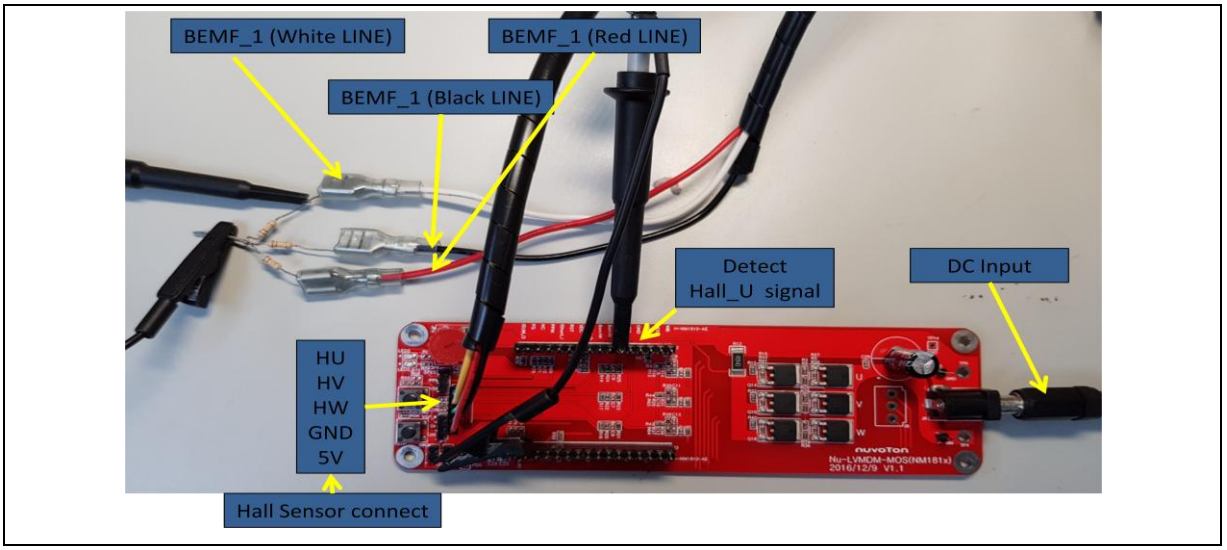
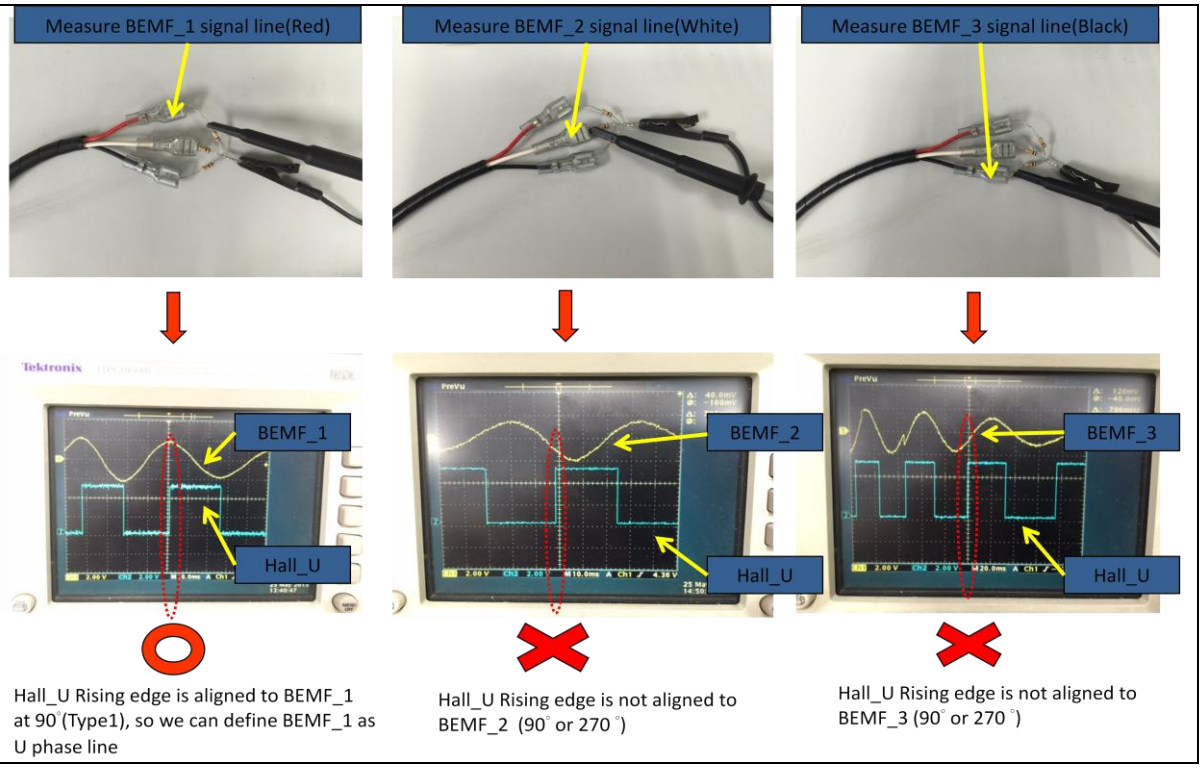


Figure 9-2 NuTiny-EVB-NM1817 PCB Placement

9.2 Step2: Physical circuit connection

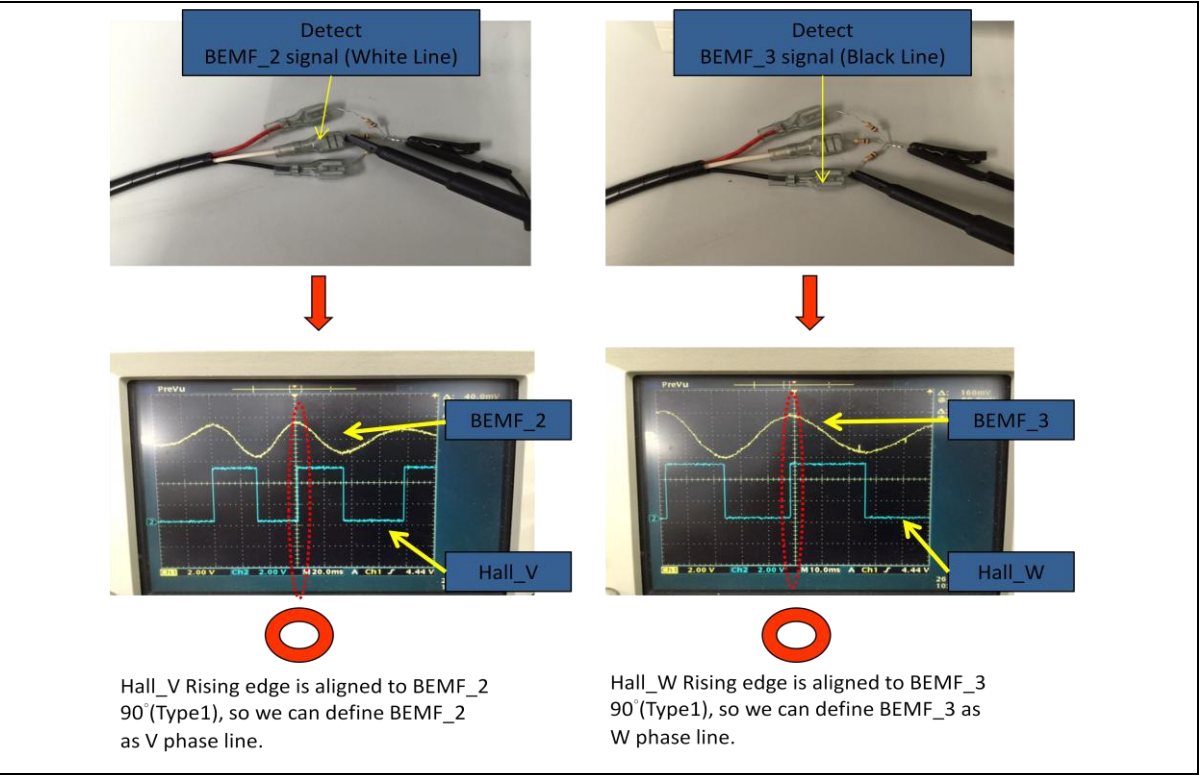


9.3 Step3: Find the signal of U phase



9.4 Step4: Find the signal of V & W phase

Find 1K ohm~10k ohm



9.5 Step5: Check Hall Type

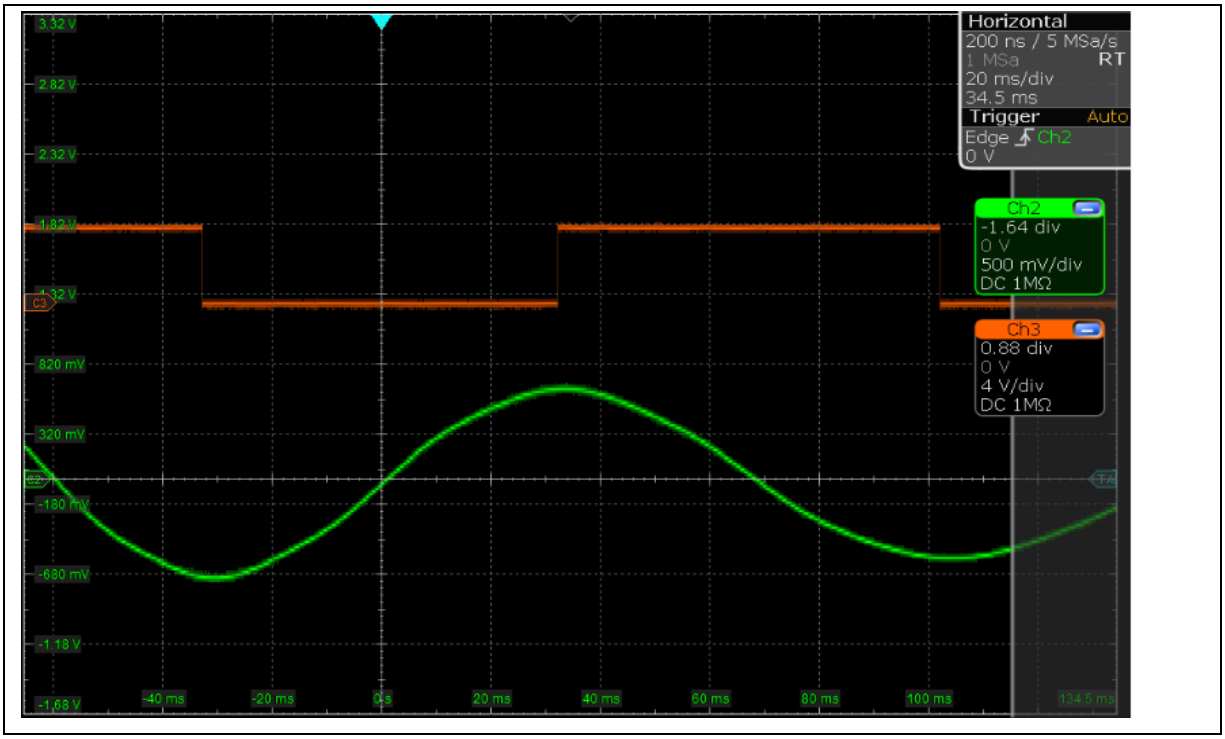


Figure 9-3 Type0 – Hall & BEMF

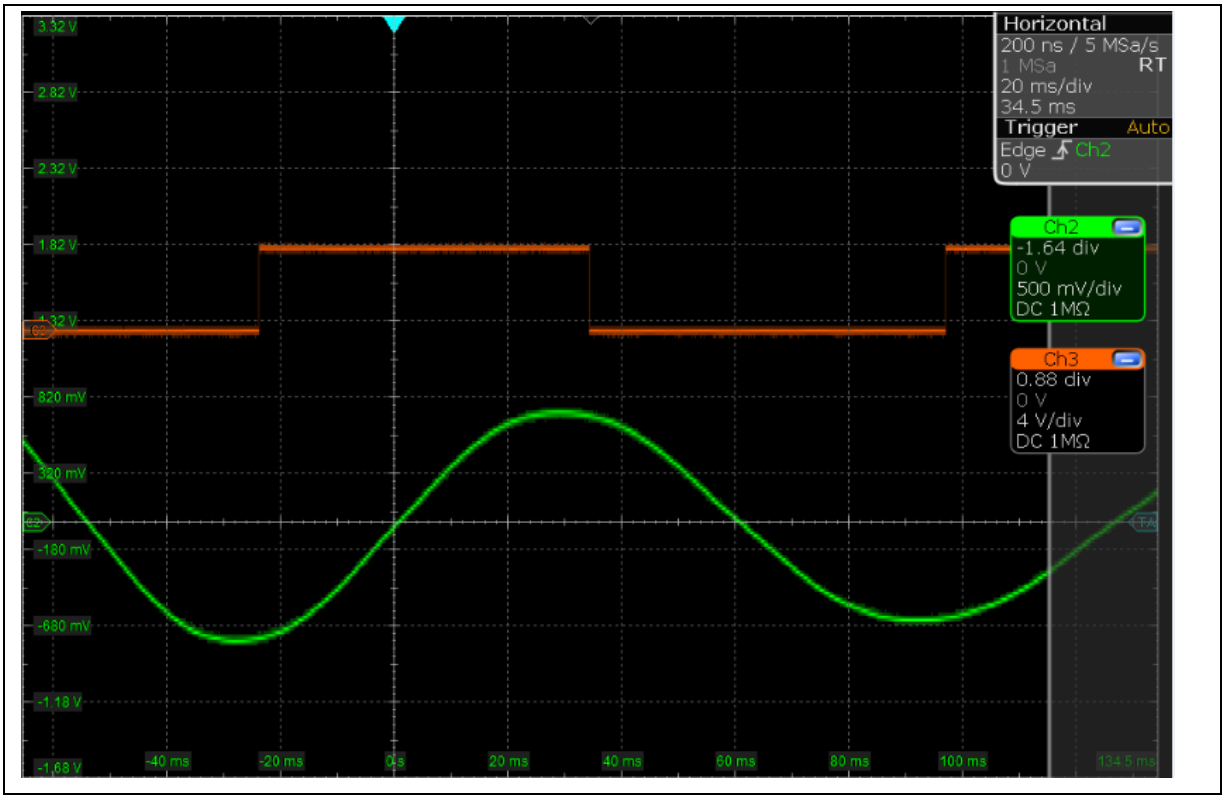


Figure 9-4 Type1 – Hall & BEMF

10 REVISION HISTORY

Date	Revision	Description
2019.04.02	1.00	1. Initially issued.

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