M460 Series CMSIS BSP Guide

Directory Introduction for 32-bit NuMicro™ Family

Directory Information

Please extract the “M460_Series_BSP_CMSIS_V3.00.001.zip” file firstly, and then put the “M460_Series_BSP_CMSIS_V3.00.001” folder into the working folder (e.g. .\Nuvoton\BSP Library\).

To experience the powerful features of M460 in few minutes, please select the sample code to download and execute on the M460 board. Open the project files to build them with Keil® MDK, IAR or Eclipse, and then download and trace them on the M460 board to see how it works.

This BSP folder contents:

Document	Device driver reference manual and reversion history.
Library	Device driver header and source files.
SampleCode	Device driver sample code.
ThirdParty	Libraries of third parties.

For additional information or questions, please contact: Nuvoton Technology Corporation.

www.nuvoton.com

TABLE OF CONTENTS

1 Document

CMSIS.html	Introduction of CMSIS version 5. CMSIS components included CMSIS-CORE, CMSIS-Driver, CMSIS-DSP, etc. ● CMSIS-CORE: API for the Cortex-M0 processor core and peripherals. ● CMSIS-Driver: Defines generic peripheral driver interfaces for middleware making it reusable across supported devices. ● CMSIS-DSP: DSP Library Collection with over 60 Functions for various data types: fix-point (fractional q7, q15, q31) and single precision floating-point (32-bit).
Revision History.pdf	The revision history of M460 Series BSP.
NuMicro M460 Series Driver Reference Guide.chm	The usage of drivers in M460 Series BSP.

2 Library

CMSIS	Cortex® Microcontroller Software Interface Standard (CMSIS) V5 definitions by ARM® Corp.
CryptoAccellerator	Library for mbed TLS crypto.
Device	CMSIS compliant device header file.
NuMaker	Specific libraries for M460 NuMaker board.
SmartcardLib	Library for accessing a smartcard.
StdDriver	All peripheral driver header and source files.
UsbHostLib	USB host library source code.

3 Sample Code

CortexM4	Cortex®-M4 sample code.
Crypto	Crypto sample code using MbedTLS library.
Hard_Fault_Sample	Show hard fault information when hard fault happened. The hard fault handler show some information included program counter, which is the address where the processor was executing when the hard fault occur. The listing file (or map file) can show what function and instruction that was. It also shows the Link Register (LR), which contains the return address of the last function call. It can show the status where CPU comes from to get to this point.
ISP	Sample codes for In-System-Programming.
NuMaker_M467HJ	Sample codes for NuMaker-PFM-M460 board.
PowerManagement	Power management sample code.
StdDriver	Demonstrate the usage of M460 series MCU peripheral driver APIs.
Template	A project template for M460.
XOM	Demonstrate how to create XOM library and use it.

4 ThirdParty

FatFs	An open source FAT/exFAT file system library. A generic FAT file system module for small embedded systems. Its official website is: http://elm-chan.org/fsw/ff/00index_e.html.
FreeRTOS	A real time operating system available for free download. Its official website is: http://www.freertos.org/.
libjpeg	A software implements JPEG baseline, extended-sequential, and progressive compression processes maintained and published by the Independent JPEG Group (IJG). Its official website is: http://ijg.org/.
LibMAD	A MPEG audio decoder library that currently supports MPEG-1 and the MPEG-2 extension to lower sampling frequencies, as well as the de facto MPEG 2.5 format. All three audio layers — Layer I, Layer II, and Layer III (i.e. MP3) are fully implemented. This library is distributed under GPL license. Please contact Underbit Technologies (http://www.underbit.com/)for the commercial license.
lwIP	A widely used open source TCP/IP stack designed for embedded systems. Its official website is: http://savannah.nongnu.org/projects/lwip/.
mbedtls-2.13.0	A portable, easy to use, readable and flexible SSL library. Unless specifically indicated otherwise files are licensed under the Apache 2.0 license. The official website: https://tls.mbed.org/.
mbedtls-3.1.0	mbed TLS offers an SSL library with an intuitive API and readable source code, so you can actually understand what the code does. Also the mbed TLS modules are as loosely coupled as possible and written in the portable C language. This allows you to use the parts you need, without having to include the total library. The official website: https://tls.mbed.org/.
paho.mqtt.embedded-c	Eclipse Paho MQTT C/C++ client for Embedded platforms. Its official website is: https://www.eclipse.org/paho/clients/c/embedded/.

shine	A blazing fast MP3 encoding library implemented in fixed-point arithmetic. Its official website is: https://github.com/toots/shine.

5 SampleCode\CortexM4

BitBand	Demonstrate the usage of Cortex®-M4 Bit-band.
DSP_FFT	Demonstrate how to call ARM CMSIS DSP library to calculate FFT.
MPU	Demonstrate the usage of Cortex®-M4 MPU.

6 SampleCode\Crypto

mbedTLS_AES	Show how mbedTLS AES function works.
mbedTLS_ECDH	Show how mbedTLS ECDH function works.
mbedTLS_ECDSA	Show how mbedTLS ECDSA function works.
mbedTLS_RSA	Show how mbedTLS RSA function works.
mbedTLS_SHA256	Show how mbedTLS SHA256 function works.

7 SampleCode\ISP

ISP_CAN	In-System-Programming Sample code through CAN interface.
ISP_DFU	In-System-Programming Sample code through USB interface and following Device Firmware Upgrade Class Specification.
ISP_DFU_20	In-System-Programming Sample code through HSUSBD interface and following Device Firmware Upgrade Class Specification.
ISP_HID	In-System-Programming Sample code through USB HID interface.
ISP_HID_20	In-System-Programming Sample code through HSUSBD HID interface.
ISP_I2C	In-System-Programming Sample code through I^2C interface.
ISP_RS485	In-System-Programming Sample code through RS485 interface.
ISP_SPI	In-System-Programming Sample code through SPI interface.
ISP_UART	In-System-Programming Sample code through UART interface.

8 SampleCode\NuMaker_M467HJ

Blinky	A simple LED toggle sample code. It could be used as the startup of M460 NuMaker board.
lwIP	Common drivers for LwIP samples.
LwIP_httpd_netconn	A simple HTTP server that demonstrates LwIP netconn API under FreeRTOS™. This HTTP server's IP address can be configured statically to 192.168.1.2, or assigned by DHCP server.
LwIP_httpd_socket	A simple HTTP server that demonstrates LwIP socket API under FreeRTOS™. This HTTP server's IP address can be configured statically to 192.168.1.2, or assigned by DHCP server.
LwIP_MQTT	A MQTT client sample. The lower level MQTT client functions are from eclipse paho.
LwIP_SSL_Client	A simple HTTPS client that sends a fixed request and displays the response.
LwIP_SSL_Server	A simple HTTPS server that sends a fixed response. It serves a single client at a time.
LwIP_TCP_EchoClient	A TCP echo client which is implemented with LwIP under FreeRTOS™. This client sends "nuvoton" string to server.
LwIP_TCP_EchoServer	A TCP echo server which is implemented with LwIP under FreeRTOS™. The server listens to port 80, and its IP address can be configured statically to 192.168.1.2 or assigned by DHCP server. This server replies "Hello World!!" if the received string is "nuvoton", otherwise replies "Wrong Password!!" to its client.
LwIP_tftp_client	A TFTP client sample that can receive a file from TFTP server or send a file to TFTP server.
LwIP_tftp_server	A TFTP server sample that communicates with TFTP client.
LwIP_UDP_EchoClient	A UDP echo client which is implemented with LwIP under FreeRTOS™. This client sends "Hi there…" string to the server.

LwIP_UDP_EchoServer	A UDP echo server which is implemented with LwIP under FreeRTOS™. The echo server listens to port 80, and its IP address can be configured statically to 192.168.1.2 or assigned by DHCP server. After receiving any string from its peer, this server echoes that string back.
MP3_Player	MP3 player sample plays MP3 files stored on SD memory card.
MP3_Recorder	MP3 recorder sample records sound to MP3 files stored on SD memory card and press button to play it.

9 SampleCode\PowerManagement

SYS_DPDMode_Wakeup	Show how to wake up system form DPD Power-down mode by Wake-up pin(PC.0), Wake-up Timer, RTC Tick, RTC Alarm or RTC Tamper 0.
SYS_PowerDown_MinCurrent	Demonstrate how to minimize power consumption when entering power down mode.
SYS_PowerDownMode	Show how to enter to different Power-down mode and wake-up by RTC.
SYS_PowerMode	Show how to set different core voltage and main voltage regulator type.
SYS_SPDMode_Wakeup	Show how to wake up system form SPD Power-down mode by GPIO pin(PC.0), Wake-up Timer, Wake-up ACMP, RTC Tick, RTC Alarm, RTC Tamper 0, BOD or LVR.

10 SampleCode\StdDriver

System Manager (SYS)

SYS_BODWakeup	Show how to wake up system form Power-down mode by brown-out detector interrupt.
SYS_PLLClockOutput	Change system clock to different PLL frequency and output system clock from CLKO pin.
SYS_TrimIRC	Demonstrate how to use LXT to trim HIRC.

Clock Controller (CLK)

CLK_ClockDetector	Show the usage of clock fail detector and clock frequency monitor function.

Flash Memory Controller (FMC)

FMC_APPROT	Demonstrate how to use FMC APROM Protect function.
FMC_CRC32	Demonstrate how to use FMC CRC32 ISP Command to calculate the CRC32 checksum of APROM and LDROM.
FMC_DualBank	Demonstrate how dual processes work in dual bank flash architecture.
FMC_DualBankFwUpgrade	Implement a firmware update mechanism based on dual bank flash architecture.
FMC_ExeInSRAM	Implement a code and execute in SRAM to program embedded Flash (support KEIL MDK only).
FMC_FwUpgradeApplication	Bank remap sample code.
FMC_IAP	Show how to call LDROM function from APROM.
FMC_MultiBoot	Implement a multi-boot system to boot from different applications in APROM. A LDROM code and 4 APROM code are implemented in this sample code.
FMC_MultiWordProgram	Show how to read/program embedded flash by ISP function.

FMC_OTP	Demonstrate how to program, read and lock OTP.
FMC_ReadAllOne	Demonstrate how to use FMC Read-All-One ISP command to verify APROM/LDROM pages are all 0xFFFFFFFF or not.
FMC_RW	Demonstrate how to read/program embedded Flash by ISP function.
FMC_XOM	This sample code shows how to configure and setup an XOM region the perform XOM function.

General Purpose I/O (GPIO)

GPIO_EINTAndDebounce	Show the usage of GPIO external interrupt function and de-bounce function.
GPIO_INT	Show the usage of GPIO interrupt function.
GPIO_OutputInput	Show how to set GPIO pin mode and use pin data input/output control.
GPIO_PowerDown	Show how to wake up system from Power-down mode by GPIO interrupt.

HyperBus Interface Controller (HBI)

HBI_ExeInHRAM	Implement a code to execute in HyperRAM.
HBI_RW	Show HyperRAM read/write control via HyperBus Interface.
HBI_RW_MemMap	Show HyperRAM read/write through HyperBus Interface.

PDMA Controller (PDMA)

PDMA_BasicMode	Use PDMA0 Channel 2 to transfer data from memory to memory.
PDMA_ScatterGather	Use PDMA0 channel 4 to transfer data from memory to memory by scatter-gather mode.
PDMA_ScatterGather_PingPongBuffer	Use PDMA0 to implement Ping-Pong buffer by scatter-gather mode(memory to memory).

PDMA_StrideRepeat	Use PDMA0 channel 0 to transfer data from memory to memory with stride and repeat.
PDMA_TimeOut	Demonstrate PDMA0 channel 1 get/clear timeout flag with UART1.

Timer Controller (TIMER)

TIMER_ACMPTrigger	Use ACMP to trigger Timer0 counter reset mode.
TIMER_CaptureCounter	Show how to use the timer2 capture function to capture timer2 counter value.
TIMER_Delay	Demonstrate the usage of TIMER_Delay() API to generate a 1 second delay.
TIMER_EventCounter	Demonstrates the timer event counter function.
TIMER_FreeCountingMode	Use the timer0 pin PA.11 to demonstrate timer free counting mode function. And displays the measured input frequency to UART console.
TIMER_InterTimerTriggerMode	Use the timer pin PB.5 to demonstrate inter timer trigger mode function. Also display the measured input frequency to UART console.
TIMER_Periodic	Use the timer periodic mode to generate timer interrupt every 1 second.
TIMER_PeriodicINT	Implement timer counting in periodic mode.
TIMER_PWM_AccumulatorINTStopMode	Demonstrate TIMER PWM accumulator interrupt to stop counting.
TIMER_PWM_AccumulatorINTTriggerPDMA	Demonstrate TIMER PWM accumulator interrupt to trigger PDMA transfer.
TIMER_PWM_Brake	Demonstrate how to use Timer0 PWM brake function..
TIMER_PWM_ChangeDuty	Change duty cycle and period of output waveform in PWM down count type.
TIMER_PWM_DeadTime	Demonstrate Timer PWM Complementary mode and Dead-Time function.
TIMER_PWM_OuputWavefo	Demonstrate output different duty waveform in

rm	Timer0~Timer5 PWM.
TIMER_TimeoutWakeup	Use timer to wake up system from Power-down mode periodically
TIMER_ToggleOut	Demonstrate the timer0 toggle out function on pin PB.5.

Watchdog Timer (WDT)

WDT_TimeoutWakeupAndReset	Implement WDT time-out interrupt event to wake up system and generate time-out reset system event while WDT time-out reset delay period expired.

Window Watchdog Timer (WWDT)

WWDT_CompareINT	Show how to reload the WWDT counter value.

Real Timer Clock (RTC)

RTC_Alarm_Test	Demonstrate the RTC alarm function. It sets an alarm 10 seconds after execution.
RTC_Alarm_Wakeup	Use RTC alarm interrupt event to wake up system.
RTC_Dynamic_Tamper	Demonstrate the RTC dynamic tamper function.
RTC_Spare_Access	Demonstrate the RTC spareregister read/write function and displays test result to the UART console.
RTC_Static_Tamper	Demonstrate the RTC static tamper function.
RTC_Time_Display	Demonstrate the RTC function and displays current time to the UART console.

Basic PWM Generator and Capture Timer (BPWM)

BPWM_Capture	Use BPWM0 Channel 0 to capture the BPWM1 Channel 0 Waveform.
BPWM_DoubleBuffer	Change duty cycle and period of output waveform by BPWM Double Buffer function.

BPWM_OutputWaveform	Demonstrate how to use BPWM counter output waveform.
BPWM_SwitchDuty	Change duty cycle of output waveform by configured period.
BPWM_SyncStart	Demonstrate how to use BPWM counter synchronous start function.

Enhance PWM Generator and Capture Timer (EPWM)

EPWM_AccumulatorINT_TriggerPDMA	Demonstrate EPWM accumulator interrupt trigger PDMA.
EPWM_AccumulatorStopMode	Demonstrate EPWM accumulator stop mode.
EPWM_Brake	Demonstrate how to use EPWM brake function.
EPWM_Capture	Capture the EPWM1 Channel 0 waveform by EPWM1 Channel 2.
EPWM_DeadTime	Demonstrate how to use EPWM Dead Zone function.
EPWM_DoubleBuffer	Change duty cycle and period of output waveform by EPWM Double Buffer function (Period loading mode).
EPWM_OutputWaveform	Demonstrate how to use EPWM output waveform.
EPWM_PDMA_Capture	Capture the EPWM1 Channel 0 waveform by EPWM1 Channel 2, and use PDMA to transfer captured data.
EPWM_SwitchDuty	Change duty cycle of output waveform by configured period.
EPWM_SyncStart	Demonstrate how to use EPWM counter synchronous start function.

Enhanced Quadrature Encoder Interface (EQEI)

EQEI_CompareMatch	Show the usage of EQEI compare function.

UART Interface Controller (UART)

UART_AutoBaudRate	Show how to use auto baud rate detection function.

UART_Autoflow	Transmit and receive data using auto flow control.
UART_IrDA	Transmit and receive data in UART IrDA mode.
UART_LIN	Transmit LIN frame including header and response in UART LIN mode.
UART_PDMA	Transmit and receive UART data with PDMA.
UART_RS485	Transmit and receive data in UART RS485 mode.
UART_SingleWire	Transmit and receive data by UART Single-Wire mode.
UART_TxRxFunction	Transmit and receive data from PC terminal through RS232 interface.
UART_Wakeup	Show how to wake up system from Power-down mode by UART interrupt.

Smart Card Host Interface (SC)

SC_ReadATR	Read the smartcard ATR from smartcard 0 interface.
SC_ReadSIM_PhoneBook	Demonstrate how to read phone book information in the SIM card.
SC_Timer	Demonstrate how to use SC embedded timer.

I²S Controller (I²S)

I2S_Codec	This is an I²S demo using NAU8822/88L25 audio codec, and used to play back the input from line-in.
I2S_Codec_PDMA	This is an I²S demo with PDMA function connected with codec.
I2S_MP3PLAYER	MP3 player sample plays MP3 files stored on SD memory card.
I2S_WAVPLAYER	This is a WAV file player which plays back WAV file stored in SD memory card.

Serial Peripheral Interface (SPI)

SPI_Flash	Access SPI flash through SPI interface.
SPI_HalfDuplex	Demonstrate SPI half-duplex mode. SPI0 will be configured as Master mode and SPI1 will be configured as Slave mode. Both SPI0 and SPI1 will be configured as half-duplex mode.
SPI_Loopback	Implement SPI Master loop back transfer. This sample code needs to connect MISO pin and MOSI pin together. It will compare the received data with transmitted data.
SPI_MasterFIFOMode	Configure SPI0 as Master mode and demonstrate how to communicate with an off-chip SPI Slave device with FIFO mode. This sample code needs to work with SPI_SlaveFIFOMode sample code.
SPI_PDMA_LoopTest	Demonstrate SPI data transfer with PDMA. QSPI0 will be configured as Master mode and SPI1 will be configured as Slave mode. Both TX PDMA function and RX PDMA function will be enabled.
SPI_SlaveFIFOMode	Configure SPI0 as Slave mode and demonstrate how to communicate with an off-chip SPI Master device with FIFO mode. This sample code needs to work with SPI_MasterFIFOMode sample code.
SPII2S_Master	Configure SPI0 as I^2S Master mode and demonstrate how I^2S works in Master mode. This sample code needs to work with SPII2S_Slave sample code.
SPII2S_PDMA_Codec	This is an I^2S demo with PDMA function connected with audio codec.
SPII2S_PDMA_Play	This is an I^2S demo for playing data and demonstrate how I2S works with PDMA.
SPII2S_PDMA_PlayRecord	This is an I^2S demo for playing and recording data with PDMA function.
SPII2S_PDMA_Record	This is an I^2S demo for recording data and demonstrate how I2S works with PDMA.
SPII2S_Slave	Configure SPI0 as I^2S Slave mode and demonstrate how I^2S works in Slave mode. This sample code needs to work with SPII2S_Master sample code.

SPI Synchronous Serial Interface Controller (SPIM)

SPIM_CIPHER	Demonstrate SPIM DMA read/write with cipher enabled. This sample also dumps SPI flash content via I/O mode read to prove it is encrypted cipher context.
SPIM_DMA_RW	Show SPIM DMA mode read/write function.
SPIM_DMA_RW	Demonstrate SPIM DMM mode read function. This sample programs SPI flash with DMA write and verify flash with DMA read and DMM mode CPU read respectively.
SPIM_DMM_RUN_CODE	This sample shows how to make an application booting from APROMwith a sub-routine resided on SPIM flash.
SPIM_IO_RW	This sample demonstrates how to issue SPI flash erase, program, and read commands under SPIM I/O mode.

Programmable Serial I/O (PSIO)

PSIO_1Wire	Demonstrate how to implement 1-Wire protocol by PSIO.
PSIO_DMX512	Demonstrate how to implement DMX512 protocol by PSIO.
PSIO_IR	Demonstrate how to implement NEC IR protocol by PSIO.
PSIO_LED	Demonstrate how to light up the WS1812B LED array.
PSIO_PS2_Device	Demonstrate how to implement PS/2 slave protocol by PSIO.
PSIO_PS2_Host	Demonstrate how to implement PS/2 host protocol by PSIO.
PSIO_Wiegand	Demonstrate how to implement Wiegand26 protocol by PSIO.

Quad Serial Peripheral Interface (QSPI)

QSPI_DualMode_Flash	Access SPI flash using QSPI dual mode.
QSPI_QuadMode_Flash	Access SPI flash using QSPI quad mode.
QSPI_Slave3Wire	Configure QSPI0 as Slave 3 wire mode and demonstrate how tocommunicate with an off-chip SPI Master device with FIFO mode.This sample code needs to work with SPI_MasterFIFOMode sample code.

I²C Serial Interface Controller (I²C)

I2C_EEPROM	Demonstrate how to access EEPROM through a I²C interface
I2C_Loopback	Demonstrate how a Master accesses Slave.
I2C_Master	Demonstrate how a Master accesses Slave. This sample code needs to work with I2C_Slave sample code.
I2C_MultiBytes_Master	Demonstrate how to use multi-bytes API to access slave. This sample code needs to work with I2C_Slave sample code.
I2C_PDMA_TRX	Demonstrate I2C PDMA mode and need to connect I2C0(Master) and I2C1(Slave).
I2C_SingleByte_Master	Demonstrate how to use single byte API to access slave. This sample code needs to work with I2C_Slave sample code.
I2C_Slave	Demonstrate how to set I²C in slave mode to receive the data from a Master. This sample code needs to work with I2C_Master sample code.
I2C_SMBus	Demonstrate how to control SMBus interface and use SMBus protocol between Host and Slave.
I2C_Wakeup_Slave	Show how to wake up MCU from Power-down mode through I2C interface. This sample code needs to work with I2C_Master sample code.

Universal Serial Control Interface Controller - UART Mode (USCI-UART)

USCI_UART_AutoBaudRate	Show how to use auto baud rate detection function.
USCI_UART_Autoflow	Transmit and receive data using auto flow control.
USCI_UART_PDMA	Transmit and receive UART data with PDMA.
USCI_UART_RS485	Transmit and receive data in RS485 mode.
USCI_UART_TxRxFunction	Transmit and receive data from PC terminal through a RS232 interface.
USCI_UART_Wakeup	Show how to wake up system from Power-down mode by USCI interrupt in UART mode.

Universal Serial Control Interface Controller - SPI Mode (USCI-SPI)

USCI_SPI_Loopback	Implement USCI_SPI1 Master loop back transfer. This sample code needs to connect USCI_SPI1_MISO pin and USCI_SPI1_MOSI pin together. It will compare the received data with transmitted data.
USCI_SPI_MasterMode	Configure USCI_SPI1 as Master mode and demonstrate how to communicate with an off-chip SPI Slave device. This sample code needs to work with USCI_SPI_SlaveMode sample code.
USCI_SPI_SlaveMode	Configure USCI_SPI1 as Slave mode and demonstrate how to communicate with an off-chip SPI Master device. This sample code needs to work with USCI_SPI_MasterMode sample code.

Universal Serial Control Interface Controller - I²C Mode (USCI-I2C)

USCI_I2C_EEPROM	Demonstrate how to access EEPROM through a USCI_I2C interface.
USCI_I2C_Master	Demonstrate how a Master access Slave. This sample code needs to work with USCI_I2C_Slave sample code.
USCI_I2C_Master_10bit	Demonstrate how a Master use 10-bit addressing access Slave. This sample code needs to work with USCI_I2C_Slave_10bit sample code.
USCI_I2C_Monitor	Demonstrate how USCI_I2C Monitors transmission between I2C Master and I2C Slave.
USCI_I2C_MultiBytes_Master	Demonstrate how to use multi-bytes API to access slave. This sample code needs to work with USCI_I2C_Slave sample code.
USCI_I2C_SingleByte_Master	Demonstrate how to use single byte API to access slave. This sample code needs to work with USCI_I2C_Slave sample code.
USCI_I2C_Slave	Demonstrate how to set I²C in slave mode to receive the data from a Master. This sample code needs to work with USCI_I2C_Master sample code.
USCI_I2C_Slave_10bit	Demonstrate how to set I²C in 10-bit addressing slave mode to receive the data from a Master. This sample code needs to

	work withUSCI_I2C_Master_10bit sample code.
USCI_I2C_Wakeup_Slave	Demonstrate how to set I²C to wake up MCU from Power-down mode. This sample code needs to work USCI_I2C_Master sample code.

External Bus Interface (EBI)

EBI_NOR	Configure EBI interface to access MX29LV320T (NOR Flash) on EBI interface.
EBI_SRAM	Configure EBI interface to access BS616LV4017(SRAM) on EBI interface.

USB 1.1 Device Controller (USBD)

USBD_Audio_Codec	Demonstrate how to implement a USB audio class device.
USBD_Audio_Headset	Demonstrate how to implement a USB audio class device. Codec is used in this sample code to play the audio data from Host. It also supports to record data from codec to Host.
USBD_HID_Keyboard	Demonstrate how to implement a USB keyboard device. It supports to use GPIO to simulate key input.
USBD_HID_Mouse	Show how to implement a USB mouse device. The mouse cursor will move automatically when this mouse device connecting to PC by USB.
USBD_HID_MouseKeyboard	Simulate an USB HID mouse and HID keyboard. Mouse draws circle on the screen and Keyboard use GPIO to simulate key input.
USBD_HID_RemoteWakeup	Demonstrate how to implement a USB mouse device.It uses PA0 ~ PA5 to control mouse direction and mouse key.It also supports USB suspend and remote wakeup.
USBD_HID_Touch	Demonstrate how to implement a USB touch digitizer device. Two lines demo in Paint.
USBD_HID_Transfer	Demonstrate how to transfer data between USB device and PC through USB HID interface. A windows tool is also included in this sample code to connect with a USB device.

USBD_HID_Transfer_And_Keyboard	Demonstrate how to implement a composite device (HID Transfer and Keyboard). Transfer data between USB device and PC through USB HID interface. A windows tool is also included in this sample code to connect with a USB device.
USBD_HID_Transfer_And_MSC	Demonstrate how to implement a composite device (HID Transfer and Mass storage). Transfer data between USB device and PC through USB HID interface. A windows tool is also included in this sample code to connect with a USB device.
USBD_HID_Transfer_CTRL	Use USB Host core driver and HID driver. It shows how to submit HID class request and how to read data from control pipe. A windows tool is also included in this sample code to connect with a USB device.
USBD_Mass_Storage_CDROM	Demonstrate the emulation of USB Mass Storage Device CD-ROM.
USBD_Mass_Storage_Flash	Use Flash as storage to implement a USB Mass-Storage device.
USBD_Mass_Storage_SD	Use SD card as storage to implement a USB Mass-Storage device.
USBD_Mass_Storage_SRAM	Use internal SRAM as back end storage media to simulate a 44 KB USB pen drive.
USBD_Micro_Printer	Demonstrate how to implement a USB micro printer device.
USBD_Printer_And_HID_Transfer	Demonstrate how to implement a composite device(USB micro printer device and HID Transfer). Transfer data between a USB device and PC through a USB HID interface. A windows tool is also included in this sample code to connect with a USB device.
USBD_VCOM_And_HID_Keyboard	Demonstrate how to implement a composite device(VCOM and HID Keyboard).
USBD_VCOM_And_HID_Transfer	Demonstrate how to implement a composite device(VCOM and HID Transfer). It supports one virtual COM port and transfers data between a USB device and PC through a USB HID interface. A windows tool is also included in this sample code to connect with a USB device.
USBD_VCOM_And_Mass_S	Demonstrate how to implement a composite device (Virtual COM port and Mass storage device).

torage	
USBD_VCOM_DualPort	Demonstrate how to implement a USB dual virtual COM port device.
USBD_VCOM_SerialEmulator	Demonstrate how to implement a USB virtual COM port device.
USBD_VCOM_SerialEmulator_DoubleBuffer	Demonstrate how to implement a USB virtual COM port device using double buffer mode.
USBD_VENDOR_LBK	This sample works as a proprietary Vendor LBK device. It's created for sample USBH_VENDOR_LBK of this BSP. Vendor LBK device includes Control, Bulk, Interrupt, and Isochronous in/out endpoint pairs. Each endpoint pair receive data from host via the out-endpoint and send data back to host via the in-endpoint.

High Speed USB 2.0 Device Controller (HSUSBD)

HSUSBD_Audio10_Codec	An UAC1.0 sample used to record and play the sound sent from PC through the USB interface.
HSUSBD_Audio10_Headset	An UAC1.0 sample and used to plays the sound send from PC through the USB interface.
HSUSBD_Audio20_Codec	An UAC2.0 sample used to record and play the sound sent from PC through the USB interface.
HSUSBD_Audio20_Headset	An UAC2.0 sample used to play the sound sent from PC through the USB interface.
HSUSBD_HID_Mouse	Simulate a USB mouse and draws circle on the screen.
HSUSBD_HID_MouseKeyboard	Simulate a USB mouse and a USB keyboard.
HSUSBD_HID_Transfer	Demonstrate how to transfer data between USB device and PC through USB HID interface. A windows tool is also included in this sample code to connect with a USB device.
HSUSBD_HID_Transfer_And_MSC	Demonstrate how to implement a composite device (HID Transfer and Mass storage). Transfer data between USB device and PC through the USB HID interface. A windows tool is also included in this sample code to connect with a USB device.
HSUSBD_Mass_Storage_DataFlash	Use embedded Data Flash as storage to implement a USB Mass-Storage device.
HSUSBD_Mass_Storage	Demonstrate the usage of USBD DMA scatter gather function.

SactterGather	
HSUSBD_Mass_Storage_SD	Implement a SD card reader.
HSUSBD_Mass_Storage_ShortPacket	Implement a mass storage class sample to demonstrate how to receive a USB short packet.
HSUSBD_Mass_Storage_SRAM	Use internal SRAM as back end storage media to simulate a 30 KB USB pen drive.
HSUSBD_VCOM_SerialEmulator	Demonstrate how to implement a USB virtual com port device.
HSUSBD_VENDOR_LBK	Implement a proprietary Vendor LBK device. This sample requires a M460 USB host running sample HSUSBD_USBH_VENDOR_LBK to be connected.

USB 1.1/2.0 Host Controller (HSUSBH)

HSUSBH_USBH_AudioClass	Demonstrate how to use USBH Audio Class driver. It shows the mute, volume, auto-gain, channel, and sampling rate control.
HSUSBH_USBH_DEV_CONN	Use connect/disconnect callback functions to handle of device connect and disconnect events.
HSUSBH_USBH_Firmware_Update	Automatically search and read new firmware from USB drive, if found, update APROM Flash with it.
HSUSBH_USBH_HID	Use USB Host core driver and HID driver. This sample demonstrates how to submit HID class request and read data from interrupt pipe. This sample supports dynamic device plug/un-plug and multiple HID devices
HSUSBH_USBH_HID_Keyboard	Demonstrate reading key inputs from USB keyboards. This sample includes an USB keyboard driver which is based on the HID driver.
HSUSBH_USBH_HIDMouse_ Keyboard	Demonstrates how to support USB mouse and keyboard input.
HSUSBH_USBH_MassStorage	Use a command-shell-like interface to demonstrate how to use USBH mass storage driver and make it work as a disk driver under the FATFS file system.
HSUSBH_USBH_SPIM_Writer	Provide a command line interface for reading files from USB disk and writing to SPIM Flash. This sample code also provides functions of dump SPIM Flash, compares USB disk file with SPIM Flash, and branches to run code on SPIM.

HSUSBH_USBH_UAC_HID	Show how to use USBH Audio Class driver and HID driver at the same time. The target device is a Game Audio (UAC+HID composite device).
HSUSBH_USBH_UAC_ LoopBack	Receive audio data from an UAC device, and immediately send back to the UAC device.
HSUSBH_USBH_VCOM	Demonstrate how to use the USB Host core driver and CDC driver to connect a CDC class VCOM device.
HSUSBH_USBH_VENDOR_ LBK	Show how to do transfer on a known device with a vendor driver. This sample requires a M460 USB device running sample HSUSBD_VENDOR_LBK or USBD_VENDOR_LBK to be connected.

USB On-The-Go (OTG)

OTG_Dual_Role_UMAS	An OTG sample code that will become a USB host when connected with a Micro-A cable, and can access the pen drive when plugged in. It will become a removable disk when connected with a Micro-B cable, and then plug into PC.
OTG_HNP	Show HID mouse with OTG HNP protocol.

High Speed USB On-The-Go (HSOTG)

HSOTG_Dual_Role_UMAS	An OTG sample code that will become a USB host when connected with a Micro-A cable, and can access the pen drive when plugged in. It will become a removable disk when connected with a Micro-B cable, and then plug into PC.
HSOTG_HNP	Show HID mouse with OTG HNP protocol.

Ethernet MAC Controller (EMAC)

EMAC_lwiperf	A LwIP iperf sample on M460.
EMAC_TxRx	This Ethernet sample tends to get a DHCP lease from DHCP server. After IP address configured, this sample can reply to PING packets.

CRC Controller (CRC)

CRC_CCITT	Implement CRC in CRC-CCITT mode and get the CRC checksum result.

CRC_CRC8	Implement CRC in CRC-8 mode and get the CRC checksum result.
CRC_CRC32	Implement CRC in CRC-32 mode with PDMA transfer.

Enhance 12-bit Analog-to-Digital Converter (EADC)

EADC_Accumulate	Demonstrate how to get accumulate conversion result.
EADC_ADINT_Trigger	Use ADINT interrupt to do the EADC continuous scan conversion.
EADC_Average	Demonstrate how to get average conversion result.
EADC_BandGap	Convert Band-gap (Sample module 16) and print conversion result.
EADC_PDMA_EPWMTrigger	Demonstrate how to trigger EADC by EPWM and transfer conversion data by PDMA.
EADC_EPWMTrigger	Demonstrate how to trigger EADC by EPWM.
EADC_Pending_Priority	Demonstrate how to trigger multiple sample modules and got conversion results in order of priority.
EADC_ResultMonitor	Monitor the conversion result of channel 2 by the digital compare function.
EADC_SWTRG_Trigger	Trigger EADC by writing EADC_SWTRG register.
EADC_TempSensor	Convert temperature sensor (Sample module 17) and print conversion result.
EADC_TimerTrigger	Show how to trigger EADC by timer.
EADC_VBat	Convert VBAT/4 (Sample module 18) and print conversion result.

Digital-to-Analog Converter (DAC)

DAC_EPWMTrigger	Demonstrate how to trigger DAC by EPWM.
DAC_ExtPinTrigger	Demonstrate how to trigger DAC conversion by external pin.

DAC_GroupMode	Demonstrate DAC0 and DAC1 work in group mode
DAC_PDMA_EPWMTrigger	Demonstrate how to use PDMA and trigger DAC0 by EPWM.
DAC_PDMA_TimerTrigger	Demonstrate how to PDMA and trigger DAC by Timer.
DAC_SoftwareTrigger	Demonstrate how to trigger DAC conversion by software.
DAC_TimerTrigger	Demonstrate how to trigger DAC by timer.

Analog Comparator Controller (ACMP)

ACMP_CompareDAC	Demonstrate how ACMP compare DAC output with ACMP1_P1 value.
ACMP_CompareVBG	Demonstrate how ACMP compare VBG output with ACMP1_P1 value.
ACMP_Wakeup	Show how to wake up MCU from Power-down mode by ACMP wake-up function.
ACMP_WindowComapre	Demonstrate the usage of ACMP window compare function.

Biphase Mark Coding Controller (BMC)

BMC_Output	BMC output demo.
BMC_PDMA_Output	BMC with PDMA output demo.

Controller Area Network (CAN)

CANFD_CANFD_Loopback	Use CAN FD mode function to do internal loopback test.
CANFD_CANFD_TxRx	Transmit and receive CAN FD message through CAN interface.
CANFD_CANFD_TxRxINT	An example of interrupt control using CAN FD bus communication.

Camera Capture Interface Controller (CCAP)

CCAP_Mono_1Bit_Luma	Use luminance 8-bit to 1-bit conversion to store captured

	image from HM01B0 sensor to SRAM.
CCAP_Packet_DownScale	Use packet format (all the luma and chroma data interleaved) to store captured image from NT99141 sensor to SRAM.
CCAP_Packet_JpegEncode	Use packet format (all the luma and chroma data interleaved) to store captured image from NT99141 sensor to SRAM and encode the image to jpeg.

Key Store (KS)

KS_AESKey	Demo to use the AES in Key Store.
KS_ECDH	Demo to use ECC ECDH with Key Store.
KS_ECDSA	Demo to use the ECC ECDSA with Key Store.

Cryptographic Accelerator (CRYPTO)

CRYPTO_AES	Show Crypto IP AES-128 ECB mode encrypt/decrypt function.
CRYPTO_AES_CCM	Demonstrate how to encrypt/decrypt data by AES CCM.
CRYPTO_AES_GCM	Demonstrate how to encrypt/decrypt data by AES GCM.
CRYPTO_ECC_Demo	ECDSA signature and verification demo
CRYPTO_ECC_ECDH	ECDH demonstrate how to calculate share key by A private key and B private key.
CRYPTO_HMAC	Show Crypto IP HMAC function.
CRYPTO_RSA	Show how to use Crypto RSA engine to sign and verifysignatures.
CRYPTO_RSA_AccessKeyStore	Use Crypto RSA engine accesses key from key store to sign and verify signatures.
CRYPTO_RSA_CRTBypass	Show how to use Crypto RSA engine CRT/CRT bypass mode to sign two signatures.
CRYPTO_RSA_CRTBypassAccessKeyStore	Use Crypto RSA engine CRT/CRT bypass mode accesses key from key store to sign and verify signatures.

CRYPTO_SHA	Use Crypto IP SHA engine to run through known answer SHA1 test vectors.

Enhanced Input Capture Timer (ECAP)

ECAP_GetInputFreq	Show how to use ECAP interface to get input frequency
ECAP_GetQEIFreq	Show how to use ECAP interface to get QEI frequency.

Random Number Generator (RNG)

RNG_EntropyPoll	Demo to use ECC ECDH with Key Store.
RNG_Random	Demo to use ECC ECDH with Key Store.

SCUART

SCUART_TxRx	Demonstrate smartcard UART mode by connecting PB.4 and PB.5 pins.

Secure Digital Host Controller (SDH)

SDH_FATFS	Access a SD card formatted in FAT file system.

11 SampleCode\Template

Template	A project template for M460 MCU.

12 SampleCode\XOM

XOMLib	Demonstrate how to create XOM library.
XOMLibDemo	Demonstrate how to use XOMLib.

Important Notice

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