M480 8K Mouse

Example Code Introduction for 32-bit NuMicro® Family

Information

Application	This example code uses M480 HS-USBD to simulate a HID mouse with 8K report rate and support remote wake-up.
BSP Version	M480 Series BSP CMSIS v3.03.000
Hardware	NuMaker-ETM-M487 v1.2 NuMaker-PFM-M487 v3.0

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1 Overview

This example code uses HS-USBD to simulate a HID mouse and supports these features:

- Supports 8K report rate
- Supports remote wake-up
- Enters Power-down mode when receiving SUSPEND signal, and exits Power-down mode when receiving RESUME signal

The resume packet issues USB bus from J-state to K-state and keeps K-state at least 20ms, makes M480 enter the LLPD (low leakage power-down) mode and wires an I/O (PA.6) to the HSUSBD_D+ and detects the falling edge to wake up the system from LLPD mode.

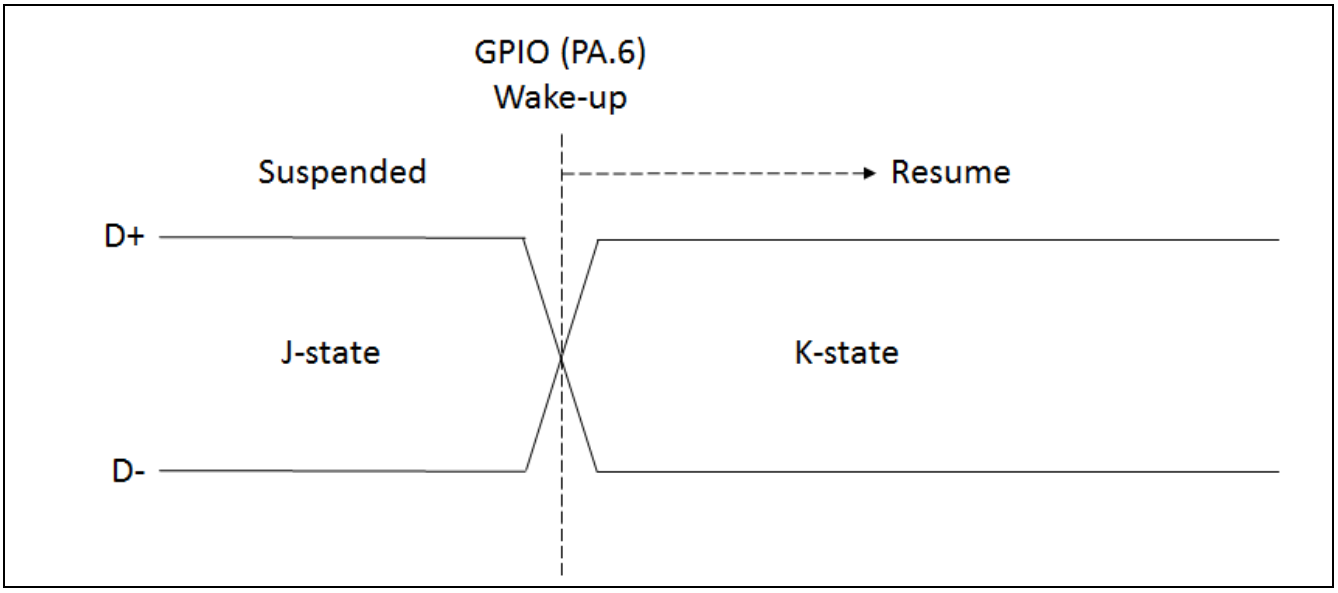
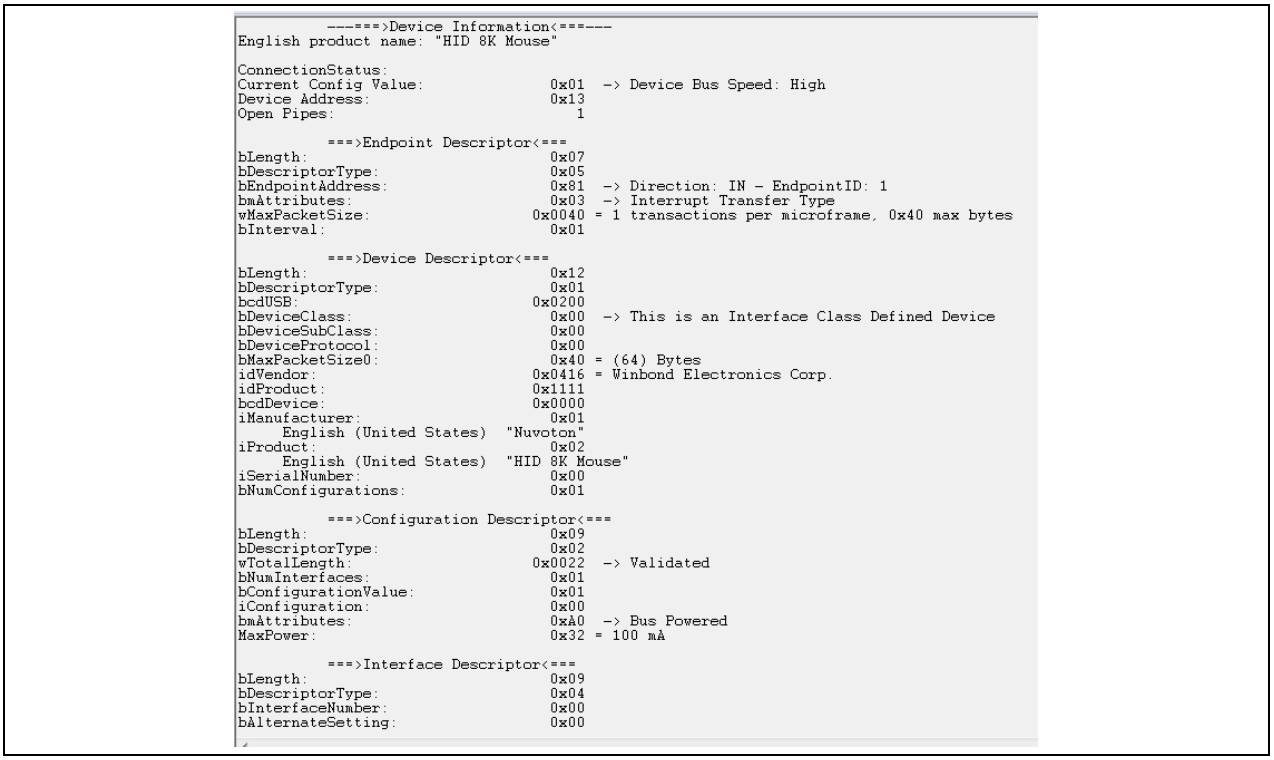


Figure 1-1 USB Signal

1.1 Demo Result

- HID Mouse

  The M480 is played as a HID mouse when connected with a computer, and uses one interrupt-in endpoint whose interval is '0x01' (125us).



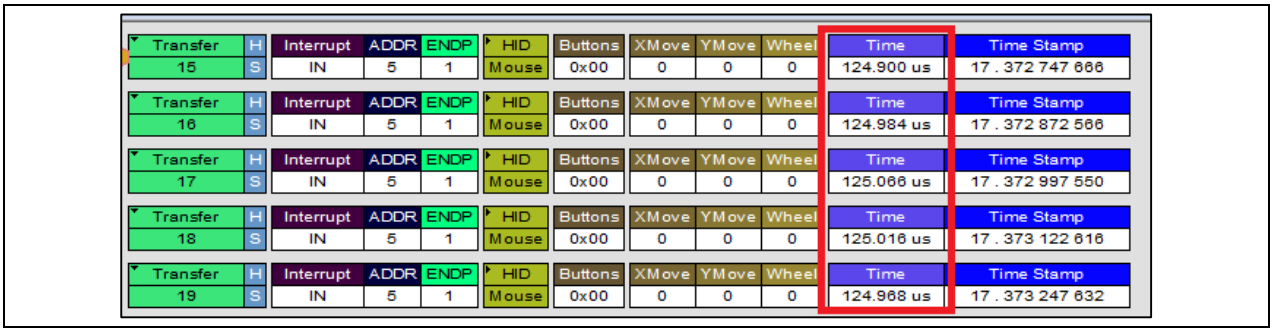
```
          ---===>Device Information<===---
English product name: "HID 8K Mouse"

ConnectionStatus:
Current Config Value:              0x01  -> Device Bus Speed: High
Device Address:                    0x13
Open Pipes:                           1

          ===>Endpoint Descriptor<===
bLength:                           0x07
bDescriptorType:                   0x05
bEndpointAddress:                  0x81  -> Direction: IN - EndpointID: 1
bmAttributes:                      0x03  -> Interrupt Transfer Type
wMaxPacketSize:                  0x0040 = 1 transactions per microframe, 0x40 max bytes
bInterval:                         0x01

          ===>Device Descriptor<===
bLength:                           0x12
bDescriptorType:                   0x01
bcdUSB:                          0x0200
bDeviceClass:                      0x00  -> This is an Interface Class Defined Device
bDeviceSubClass:                   0x00
bDeviceProtocol:                   0x00
bMaxPacketSize0:                   0x40 = (64) Bytes
idVendor:                        0x0416 = Winbond Electronics Corp.
idProduct:                       0x1111
bcdDevice:                       0x0000
iManufacturer:                     0x01
     English (United States)  "Nuvoton"
iProduct:                          0x02
     English (United States)  "HID 8K Mouse"
iSerialNumber:                     0x00
bNumConfigurations:                0x01

          ===>Configuration Descriptor<===
bLength:                           0x09
bDescriptorType:                   0x02
wTotalLength:                    0x0022  -> Validated
bNumInterfaces:                    0x01
bConfigurationValue:               0x01
iConfiguration:                    0x00
bmAttributes:                      0xA0  -> Bus Powered
MaxPower:                          0x32 = 100 mA

          ===>Interface Descriptor<===
bLength:                           0x09
bDescriptorType:                   0x04
bInterfaceNumber:                  0x00
bAlternateSetting:                 0x00
```

Figure 1-2 USB Device Information

Pressing the buttons on the NuMaker-ETM-M487/ NuMaker-PFM-M487 can control the cursor to move right or left.

- 8K Report Rate

  The interval between each interrupt-in packet is around 125us, which means this device has 8K report rate.



Transfer	H/S	Interrupt	ADDR	ENDP	HID	Buttons	XMove	YMove	Wheel	Time	Time Stamp
15	S	IN	5	1	Mouse	0x00	0	0	0	124.900 us	17.372747666
16	S	IN	5	1	Mouse	0x00	0	0	0	124.984 us	17.372872566
17	S	IN	5	1	Mouse	0x00	0	0	0	125.066 us	17.372997550
18	S	IN	5	1	Mouse	0x00	0	0	0	125.016 us	17.373122616
19	S	IN	5	1	Mouse	0x00	0	0	0	124.968 us	17.373247632

Figure 1-3 8K Report Rate

- Remote Wake-up
  Before PC enters the sleep mode, the HOST sends the SET_FEATURE request to enable the remote wake-up function and let the USB bus enter SUSPEND.

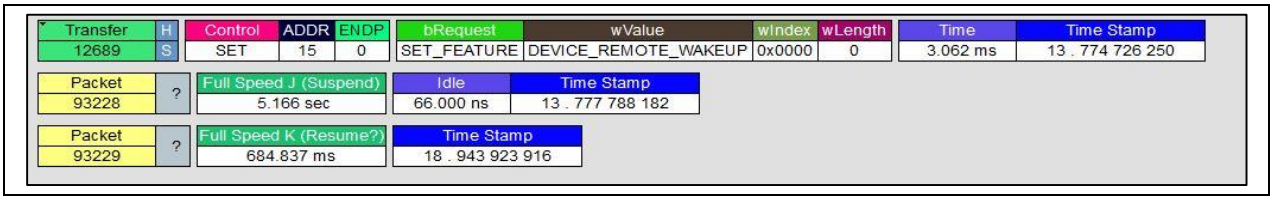


Figure 1-4 Remote Wake-up Packet

2 Code Description

- HID Mouse Report Descriptor

```
//
// HID_MouseReportDescriptor
//
uint8_t HID_MouseReportDescriptor[] __attribute__((aligned(4))) = {
    0x05, 0x01,     /* Usage Page(Generic Desktop Controls) */
    0x09, 0x02,     /* Usage(Mouse) */
    0xA1, 0x01,     /* Collection(Application) */
    0x09, 0x01,     /* Usage(Pointer) */
    0xA1, 0x00,     /* Collection(Physical) */
    0x05, 0x09,     /* Usage Page(Button) */
    0x19, 0x01,     /* Usage Minimum(0x1) */
    0x29, 0x03,     /* Usage Maximum(0x3) */
    0x15, 0x00,     /* Logical Minimum(0x0) */
    0x25, 0x01,     /* Logical Maximum(0x1) */
    0x75, 0x01,     /* Report Size(0x1) */
    0x95, 0x03,     /* Report Count(0x3) */
    0x81, 0x02,     /* Input(3 button bit) */
    0x75, 0x05,     /* Report Size(0x5) */
    0x95, 0x01,     /* Report Count(0x1) */
    0x81, 0x01,     /* Input(5 bit padding) */
    0x05, 0x01,     /* Usage Page(Generic Desktop Controls) */
    0x09, 0x30,     /* Usage(X) */
    0x09, 0x31,     /* Usage(Y) */
    0x09, 0x38,     /* Usage(Wheel) */
    0x15, 0x81,     /* Logical Minimum(0x81)(-127) */
    0x25, 0x7F,     /* Logical Maximum(0x7F)(127) */
    0x75, 0x08,     /* Report Size(0x8) */
    0x95, 0x03,     /* Report Count(0x3) */
    0x81, 0x06,     /* Input(1 byte wheel) */
    0xC0,           /* End Collection */
    0xC0,           /* End Collection */
};
```

- HID Mouse Handler

```
//
// HID_mouseViaReportIf
//
void HID_mouseViaReportIf(void)
{
    uint32_t volatile i;

    if (g_u8EPAReady) {

         switch(user_btn_detect()) {
             case USER_BTN0:
                epa_buf[0] = 0x00;
                epa_buf[1] = 25;
                epa_buf[2] = 0x00;
                epa_buf[3] = 0x00;
                  break;
             case USER_BTN1:
                epa_buf[0] = 0x00;
                epa_buf[1] = (-25);
                epa_buf[2] = 0x00;
                epa_buf[3] = 0x00;
                  break;
             case NONE:
             default:
                epa_buf[0] = 0x00;
                epa_buf[1] = 0x00;
                epa_buf[2] = 0x00;
                epa_buf[3] = 0x00;
                  break;
        }

        g_u8EPAReady = 0;

        for (i = 0; i < 4; i++) {
            HSUSBD->EP[EPA].EPDAT_BYTE = epa_buf[i];
        }

        HSUSBD->EP[EPA].EPRSPCTL = HSUSBD_EP_RSPCTL_SHORTTXEN;
        HSUSBD_ENABLE_EP_INT(EPA, HSUSBD_EPINTEN_INTKIEN_Msk);
    }
}
```

- HID Mouse Power-Down Handler

```
//
// HID_powerDownHandler
//
void HID_powerDownHandler(void)
{
    if (g_u8pwrdwn) {
        g_u8pwrdwn = 0;

        SYS_UnlockReg();

        printf("Enter Power-Down Mode\r\n");
        while(!UART_IS_TX_EMPTY(UART0));

        //
        // Enable IRQ
        //
        NVIC_EnableIRQ(GPA_IRQn);
        NVIC_EnableIRQ(GPF_IRQn);
        NVIC_EnableIRQ(GPG_IRQn);

        //
        // Disable HS-USBD engine
        //
        HSUSBD->PHYCTL &= ~HSUSBD_PHYCTL_PHYEN_Msk;
        /* should delay > 2.5us between USB PHY suspend and system power down */
        CLK_SysTickDelay(50);

        //
        // Enable PA6 interrupt
        //
        GPIO_CLR_INT_FLAG(PA, BIT6);
        GPIO_ENABLE_DIGITAL_PATH(PA, BIT6);
        GPIO_EnableInt(PA, 6, GPIO_INT_FALLING);

        //
        // Enter LLPD mode
        //
        CLK_SetPowerDownMode(CLK_PMUCTL_PDMSEL_LLPD);
        CLK_PowerDown();

        //
        // Disable PA.6 interrupt
        //
        GPIO_CLR_INT_FLAG(PA, BIT6);
        GPIO_DisableInt(PA, 6);
        GPIO_DISABLE_DIGITAL_PATH(PA, BIT6);

        //
        // Enable HS-USBD engine
        //
        HSUSBD->PHYCTL |= HSUSBD_PHYCTL_PHYEN_Msk;

        //
        // Wait HS-USBD PHY clock ready
        //
        while (1) {
            HSUSBD->EP[EPG].EPMPS = 0x20ul;
            if (HSUSBD->EP[EPG].EPMPS == 0x20ul) {
                break;
            }
        }

        //
        // Disable IRQ
```

```
        //
        NVIC_DisableIRQ(GPF_IRQn);
        NVIC_DisableIRQ(GPG_IRQn);
        NVIC_DisableIRQ(GPA_IRQn);

        printf("Exit Power-Down Mode\r\n");
        switch(g_wakeupSrc) {
        case USB_RESUME:
            printf("Wakeup by USB resume\r\n");
            g_wakeupSrc = SRC_NONE;
            break;
        case USB_RESET:
            printf("Wakeup by USB Reset\r\n");
            g_wakeupSrc = SRC_NONE;
            break;
        case USER_BUTTON:
            printf("Wakeup by I/O button\r\n");
            g_wakeupSrc = SRC_NONE;

            //
            // Perform remote wake-up
            //
            HID_remoteWakeupProcess();
            break;
        case SRC_NONE:
        default:
            break;
        }
        SYS_LockReg();
    } else {
        g_wakeupSrc = SRC_NONE;
    }
}
```

3 Software and Hardware Requirements

3.1 Software Requirements

- BSP version
- M480 Series BSP CMSIS v3.03.000
- IDE version
  - Keil uVersion 5.26

3.2 Hardware Requirements

- Circuit components
  - NuMaker-ETM-M487 / NuMaker-PFM-M487

To wake up the system from Power-down mode via the RESUME signal, you must wire a 100Ω resistor between HSUSBD_D+ and PA.6 pin.

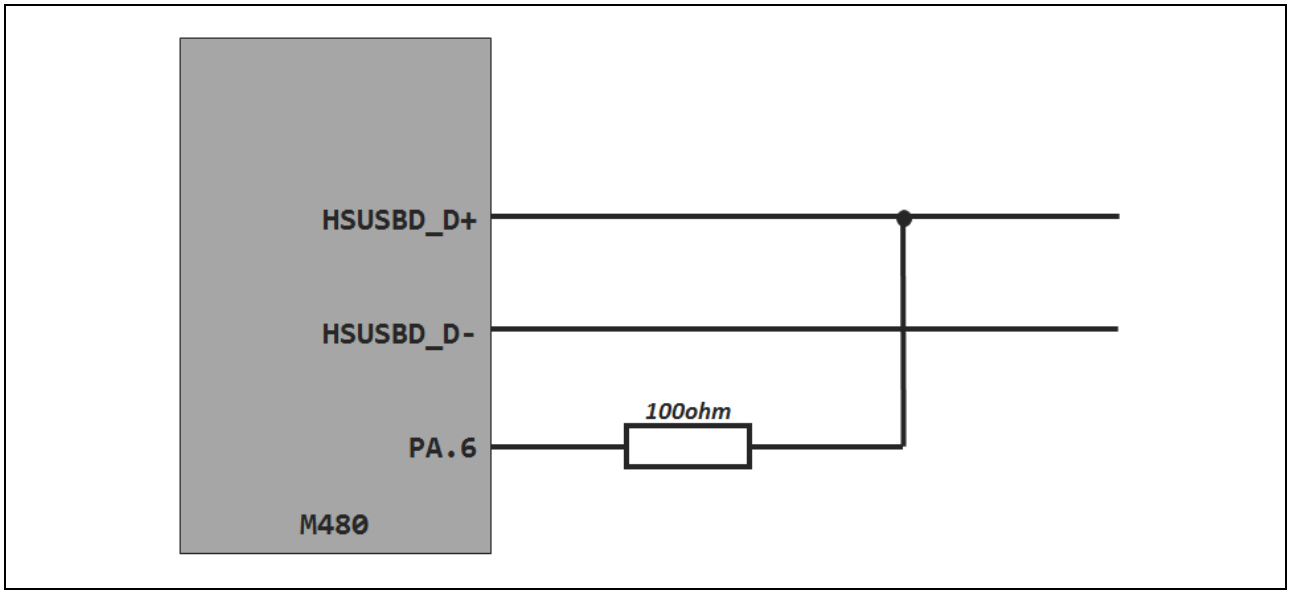


Figure 3-1 USB Circuit

4 Directory Information

The directory structure is shown below.

EC_M480_8K_Mouse_LLPD_V1.00	
Library	Sample code header and source files
CMSIS	Cortex® Microcontroller Software Interface Standard (CMSIS) by Arm® Corp.
Device	CMSIS compliant device header file
StdDriver	All peripheral driver header and source files
SampleCode	
ExampleCode	Source file of example code

5 Example Code Execution

1. Browse the sample code folder as described in the Directory Information section and double-click *M480_8K_Mouse_LLDP.uvproj*.
2. Enter Keil compile mode.
   - Build
   - Download
   - Start/Stop debug session
3. Enter debug mode.
   - Run

6 Revision History

Date	Revision	Description
2021.06.22	1.00	1. Initially issued.

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