Subsystem Design

Parallel IO to UART Bridge

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Design Description

Many applications need to capture status change of several GPIOs at the same time, update, and then send the status to host through UART. Cost-effective microcontroller (MCU) with enough GPIO resource can implement parallel-to-serial and send data through UART to host, for example PC side, in real time. Download the code for this example.

Figure 1-1 shows a functional diagram of this subsystem.

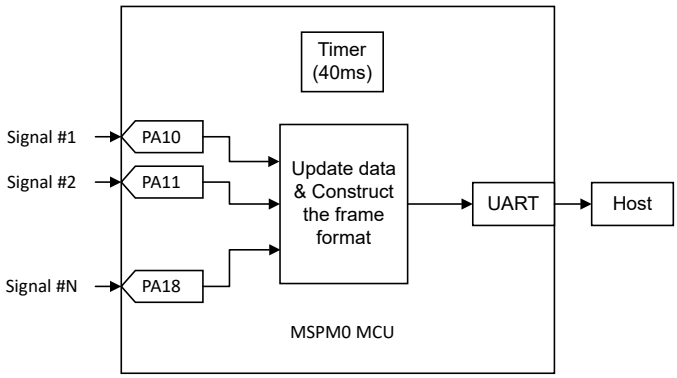


Figure 1-1. Subsystem Functional Block Diagram

Required Peripherals

This application requires 9 GPIO, 1 timers, and 1 UART.

Table 1-1. Required Peripherals

Sub-block Functionality	Peripheral Use	Notes
IO input	9 pins	Called *GROUP1_IRQHandler* in code
Timer interval	TIMG0	Called *TIMG0_IRQHandler* in code
UART output	UART0	Called *transmitPacketBlocking* in code

Compatible Devices

Based on the requirements in Table 1-1, this example is compatible with the devices in Table 1-2. The corresponding EVM can be used for prototyping.

Table 1-2. Compatible Devices

Compatible Devices	EVM
MSPM0L1xx	LP-MSPM0L1306
MSPM0G3xx/1xx	LP-MSPM0G3507

Design Steps

1. Capture 9 GPIO switches' status.
2. Fill these 9 bits in data segment and transmit one completed frame to host PC through UART.
3. Update the data when any operation is detected or every 40ms.

Design Considerations

This implementation uses 9 GPIO Pins (PA10-PA18) to capture the switches' status represented the corresponding operations shown in Table 1-3:

Table 1-3. Correspondence Between Pins and Operations

GPIO Pins	Operations
PA10	GPIO_Signal_10
PA11	GPIO_Signal_11
PA12	GPIO_Signal_12
PA13	GPIO_Signal_13
PA14	GPIO_Signal_14
PA15	GPIO_Signal_15
PA16	GPIO_Signal_16
PA17	GPIO_Signal_17
PA18	GPIO_Signal_18

In the above pins, PA14 is connected to S2 fixedly in Launch Pad and when S2 is pressed, PA14 is pulled down to Ground. For the other pins, each pin can be connected to S1 through J11 and when S1 is pressed, the pin can be pulled up to 3V3. For example, if the S1 is connected to PA18 and both SWs is pressed at same time, the data updates shown in Table 1-4:

Table 1-4. Data Format of the 9 Pins

	Bit15	Bit14	Bit13	Bit12	Bit11	Bit10	Bit9	Bit8	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
GPIO Pin								PA18	PA17	PA16	PA15	PA14	PA13	PA12	PA11	PA10
Default	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
PA18&14	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0

When any SW is pressed, MCU can update the data segment (2 Bytes) and check sum immediately and send the new data, which is composed in the following format, through UART to PC.

If no SW is pressed for every 40ms, MCU can send the current status to PC. The package sent to PC has the format shown in Table 1-5:

Table 1-5. Package Format Sent by UART

Bytes	Header (2Byte)		Data Length (1Byte)	Source ID (1Byte)	Destination ID (1Byte)	Command (1Byte)	Data index (1Byte)	Data (N Byte)	Checksum (2Byte)	
Value	0x5A	0xA5	N	0~63	0~63	0~255	0~255	Data	CSumL	CSumH

Software Flowchart

Figure 1-2 shows the code flow diagram of main loop which is main function and GPIO interrupt handling which is GROUP1_IRQHandler function.

TIMG0 interrupt handling is very simple which is entering Timer interrupt and send current data every 40ms,

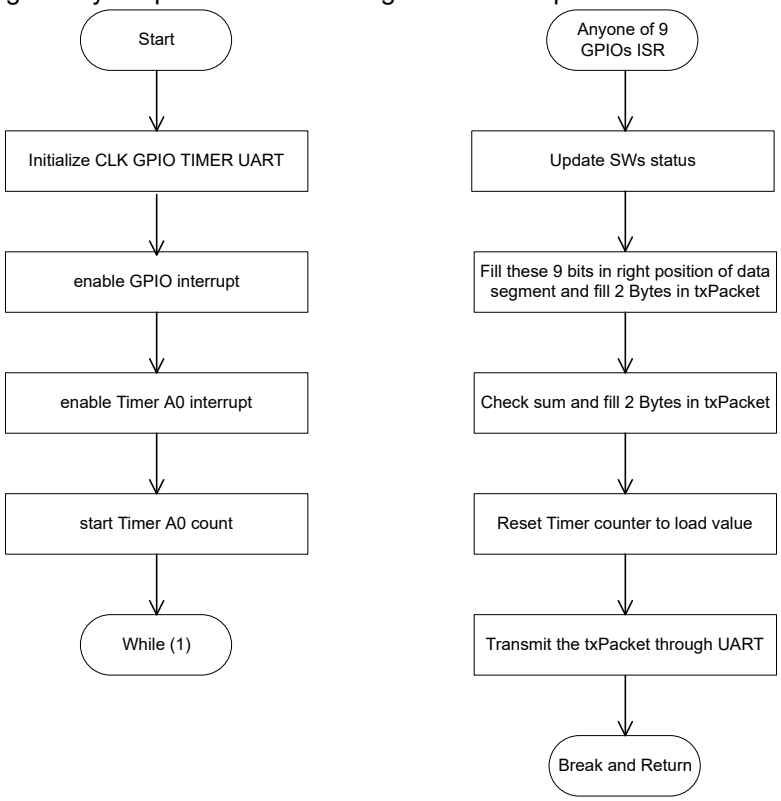


Figure 1-2. Application Software Flowchart

Application code

Main loop

```
    SYSCFG_DL_init();
    NVIC_EnableIRQ(GPIO_MULTIPLE_GPIOA_INT_IRQN);
    NVIC_EnableIRQ(TIMER_0_INST_INT_IRQN);
    DL_TimerG_startCounter(TIMER_0_INST);
    while (1) {
        __WFI();
}
```

TIMG0_IRQHandler

```
    switch (DL_TimerG_getPendingInterrupt(TIMER_0_INST)) {
        case DL_TIMER_IIDX_ZERO:
            transmitPacketBlocking(gTxPacket,UART_PACKET_SIZE);
            break;
```

GPIO GROUP1_IRQHandler

```
    if (DL_Interrupt_getPendingGroup(DL_INTERRUPT_GROUP_1)) {

        dataStatus = (GPIOA->DIN31_0);
        dataTemp = (dataStatus >> 10);
        gTxPacket[7] = dataTemp >> 8;
        gTxPacket[8] = dataTemp & 0xFF;

        siganlChecksum = checkSum1ByteIn2ByteOut((gTxPacket+2),7);
```

```
        gTxPacket[10] = siganlChecksum >> 8;
        gTxPacket[9] = siganlChecksum & 0xFF;

        DL_TimerG_stopCounter(TIMER_0_INST);
        DL_TimerG_setTimerCount(TIMER_0_INST,TIMER_0_INST_LOAD_VALUE);
        DL_TimerG_startCounter(TIMER_0_INST);

        transmitPacketBlocking(gTxPacket,UART_PACKET_SIZE);
}
```

Results

Using Logical Analysis to capture data flow and show more details.

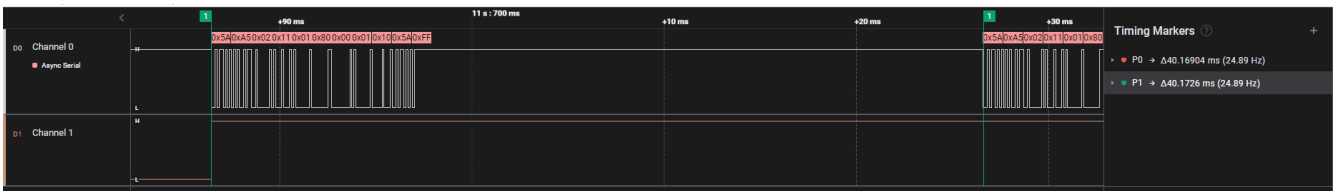
Channel 0 ----> UART Tx

Channel 1 ----> PA18

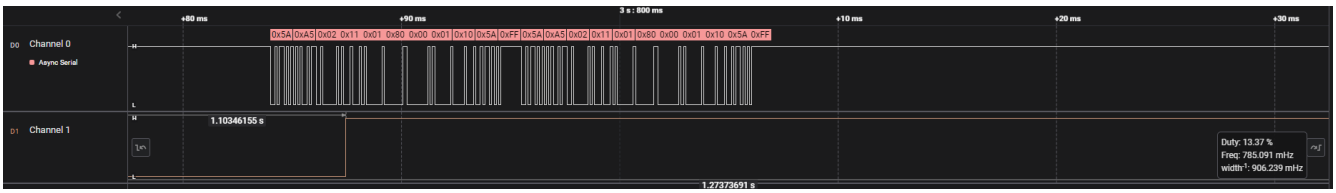
The following images show:

When no SWs pressed, MCU sends default value every 40ms

When S1 is pressed, PA18 occurs rising edge and data update. Then MCU sends the update data every 40ms.



If the rising edge occurs, but the last package has not been finished, MCU sends a data update after the last transmission is accomplished.



Additional Resources

- *Download the MSPM0 SDK*
- *Learn more about SysConfig*
- *MSPM0G Technical Reference Manual (TRM)*
- *MSPM0L Technical Reference Manual (TRM)*
- *MSPM0G LaunchPad development kit*
- *MSPM0L LaunchPad development kit*
- *MSPM0 TIMER academy*
- *MSPM0 UART academy*

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