HT8 MCU Timer Module Application Note (3) – Using the TM Timer Mode to implement a Software UART Function

D/N：AN0446E

Introduction

The Holtek HT8 MCUs provide various types of Time Modules, such as the Compact Type TM, Standard Type TM and Periodic Type TM. In actual product applications, communication with peripheral devices is often implemented using the fully integrated SPI, I^2C and UART interface functions. This application note shows how to use the Timer Module STM Timer/Counter Mode to implement UART transmitter and receiver functions using software control. This specific application shows that MCUs that do not have an integrated UART function can also implement UART transmitter and receiver functions by using their TM functions.

Operating Principle

Standard Type TM Structure Description

The Standard Type TM has an external input pin and one or two external output pins and can run in five operating modes which are Compare Match Output, Timer/Event Counter, Capture Input, Single Pulse Output and PWM Output modes.

The core of the Standard TM is composed of a count-up counter, a Comparator A and a Comparator P. The count-up counter is driven by an internal or external TCKn pin clock source. The Comparator A and Comparator P will compare the counter value with the CCRA and CCRP registers respectively. The TPn output signal state is determined by the operating mode. Taking the following figure as an example, the counter value is compared with the 16-bit CCRA register and the high 8-bit CCRP register. The counter will be cleared automatically by a counter overflow, changing the TnON bit from low to high or by a compare match with one of its associated comparators.
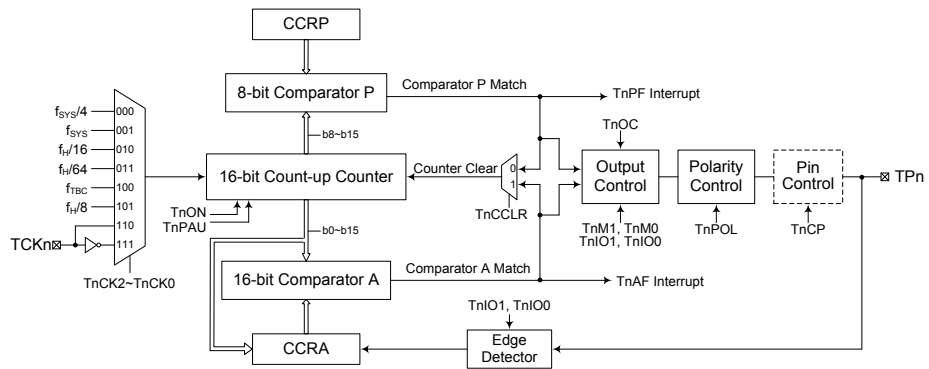
Fig 1. TM-STM Structure

Note：The actual bit number of the count-up counter, comparator A and comparator P can be found in the selected MCU datasheet.

Timer/Counter Mode Description

The Timer/Counter mode is the most widely used mode. To select this mode, bits TnM1 and TnM0 should be set to 11 respectively. When operating in this mode timing values can be determined using the TnCCLR bit. When a compare match occurs from Comparator A with the TnCCLR bit set high or when a compare match occurs from the Comparator P with the TnCCLR bit cleared low, the counter will be cleared after which it will resume counting. At this point, the comparator A or comparator P interrupt request flag, TnAF or TnPF, will be set. Whether the interval time is reached or not can be checked by two methods which are polling the interrupt flags and the related interrupts.

Note: The TM interrupt request flags, TnAF and TnPF, have to be cleared by the application program.

Asynchronous Serial Port Operating Principle

Asynchronous communication transmits data in a frame format which is composed of characters. The time interval between two characters is not fixed, however each bit within a character is transmitted at a fixed time interval, which means that the time interval between characters is not necessarily an integral multiples of bit intervals, while the time interval between bits in the same character is an integral multiples of bit intervals.

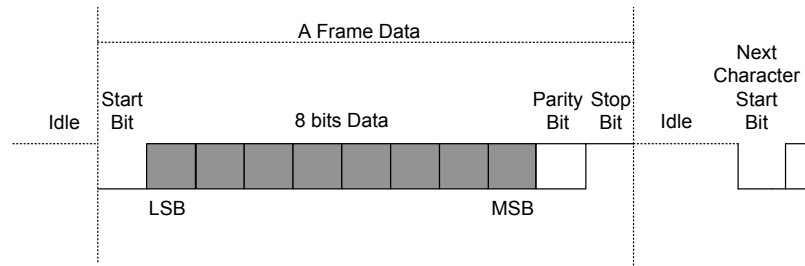The communication format is shown below.

Fig. 2 Serial Port Communication Format

Note：MSB is the most significant bit and LSB is the least significant bit。
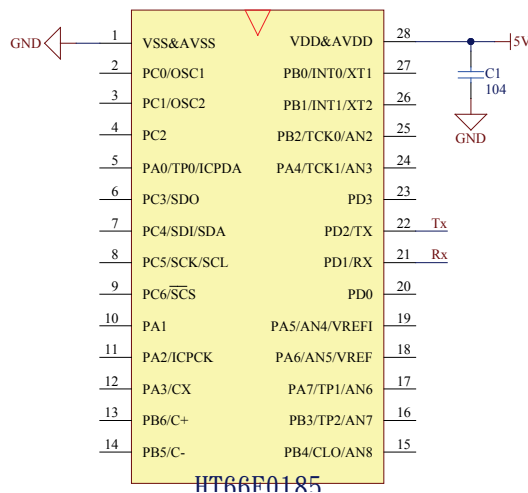
Application Circuit

Fig. 3 HT66F0185 Serial Port Circuit Simulation

The HT66F0185 MCU is used to implement the circuit in the above figure. The TX pin is used as the serial port transmitter pin and the RX pin is used as the serial port receiver pin. RX and TX can be changed to any location. Users can define RXD and TXD to the actual pins by modifying the stm.h file.

Software Description

This application uses the HT66F0185 to describe how to use the STM to simulate serial ports.

T : Timer interval time; Tbit : Time for sending a bit

Relationship between them: 4T = Tbit

Baud Rate : Baudrate = 1/Tbit

The simulation serial port transmits the data to the variable buffer first, and then transmits the buffer data bit out one by one every Tbit seconds.

When the simulation serial port is receiving data the MCU will enter the interrupt program every T seconds to detect whether the RXD pin is at a low level or not. This is to detect whether the start bit has been received or not. If the RXD pin is low, a middle sampling method can be used to receive a data bit one every Tbit seconds. The data bits can then be stored in the input variables.

As an example, use the HT66F0185 STM to setup T=52μs and use a baud rate of 4800. The register setup steps are as follows:

Step	Operating Content	Register	Bit	Function Description	Software Selection
	Setup steps for STM operating in the Timer/Counter mode				
1	Setup clock source	TM0C0	T0CK2~T0CK0： 000：f_{SYS}/4 001：f_{SYS} 010：f_H/16 011：f_H/64 100：f_{TBC} 101：f_H/8 110：TCKn rising edge clock 111：TCKn falling edge clock	Select STM clock source	T0CK[2:0]=001=f_{SYS}=8M
2	Setup operating mode	TM0C1	T0M1~T0M0： 00：Compare Match Output Mode 01：Capture Input Mode 10：PWM Output Mode or Single Pulse Output Mode 11：Timer/Counter Mode	Select STM operating mode	T0M[1:0]=11= Timer/Counter Mode
3	Setup counter clear condition	T0CCLR	0: Comparator P match 1: Comparator A match	Select STM counter clear condition	T0CCLR=1
4	Setup CCRA register value	TM0AH TM0AL	All bits	Write the timer period	TM0AH=0x01 TM0AL=0xa0
5	Setup count control bit	TM0C0	0：Off 1：On	Enable STM counter to run	T0ON=1

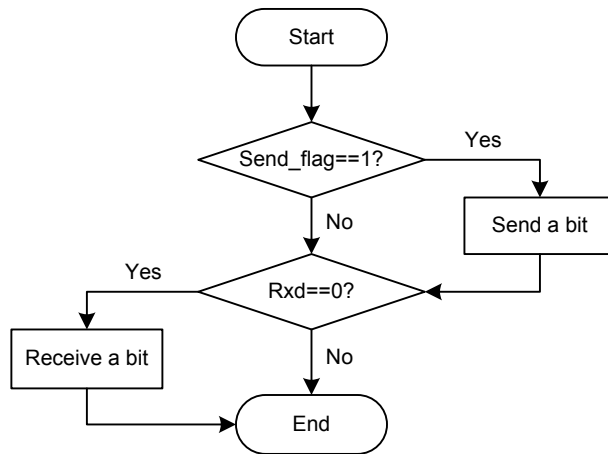## Software Design Flowchart

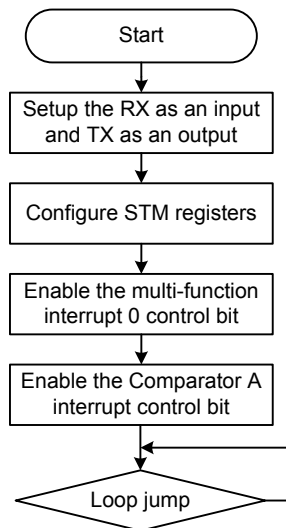**Fig. 4 STM Interrupt Service Subroutine Flowchart**

Fig. 5 Main Program Flowchart

"U" Type Character Output Waveform

Program Example

C Language Example

HT8 MCU Timer Module Application Note (3).zip

Program Example Instruction

- <stm.h>：Used to modify the simulated I/O pins and to change the baud rate.

- void Init_Timer_Uart()：

  Serial port simulation initialisation function, can also be used after initialisation.

- uchar Send_Byte(uchar output)：

  This parameter is used for the transmitted data. If the data is successfully transmitted, return a 1 value. If not return a 0 value.

- This program uses input variables to receive data. These variables can be processed at the location that the ISR function has marked.

Conclusion

This application note should assist users to understand how to use the Standard TM to simulate serial ports.

Reference Files

Reference File: HT66F0185 DataSheet.

For more information, refer to the Holtek official website http://www.holtek.com.

Versions and Modification Information

Date	Author	Issue Release and Modification
2016.07.10	鐘傳猛(Mounch)	First Version

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