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LSI Application Notes Excerption

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About This Manual

■ Configuration of This Manual

This LSI application note is consists of the following sections.

Chapter 1 Overview

This chapter describes the overview of this application note.

Chapter 2 Startup Program

This chapter describes a startup process necessary for executing a program.

Chapter 3 Register Setup of Each Function

This chapter describes the setting method and setting examples of registers having MN101C49LSI function.

Chapter 4 Sample Program 1

This chapter describes sample programs for using each peripheral device referring to sample circuits.

Chapter 5 Sample Program 2

This chapter provides an explanation of a startup process necessary before executing a sample program in "5.1 Startup", and an explanation of sample programs utilizing basic functions of this LSI in "5.2 Sample Program Using Timer Function" and "5.3 Sample Program Using Serial Function". Each sample program is described following the sections below.

(1) Program operation and display

(2) Function used

(3) State transition diagram

(4) Software

Chapter 6 Appendix 1

This chapter provides a circuit diagram operated in "Chapter 3 Register Setup of Each Function" and "Chapter 4 Sample Program 1" and supplementary explanations.

Chapter 7 Appendix 2

This chapter describes a sample program file organization and directory block diagram of "Chapter 5 Sampler Program 2", and Makefile.

■ Related Manuals

Note that the following related documents are available.

"MN101C49G/49H/49K/F49K/P49K LSI User's Manual"

"MN101C Series C Compiler User's Manual: Language Description"

<Describes the syntax of the C Compiler.>

"MN101C Series C Compiler User's Manual: Library Reference"

<Describes the standard library of the C Compiler.>

"MN101C/MN101E Series C Compiler User's Manual: Usage Guide"

<Describes the installation, the commands, and options of the C Compiler.>

"MN101C/MN101E Series Cross-assembler User's Manual"

<Describes the assembler syntax and notation.>

"MN101C Series Instruction Manual"

<Describes the instruction set.>

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3.9 8-bit Timer, Initializing Peripherals

There are five 8-bit timers comprising timer 0 to 4.

The timer comprises a binary counter, a compare register and a mode register. You can combine two 8-bit timers, timer 0 and 1 or 2 and 3, to use as a 16-bit timer.

Binary counter

This counter counts a clock selected by the prescaler or the mode register.

Compare register

This register determines the time base of a timer by specifying clock number counted by the binary counter.

Mode register

This register enables/disables the timer operation, and selects the clock source. The setting content of the mode register depends on the timer.

Timer 0:

BIT7: Unused

BIT6: Unused

BIT5: "0" Normal operation

"1" P22(IRQ2), pulse width measurement

BIT4: "0" Normal operation

"1" PWM operation

BIT3: "0" Stop count

"1" Count operation

BIT2, 1, 0: Clock source selection

000: High speed crystal clock oscillation frequency

001: Timer 0, prescaler output signal

010: Low speed crystal clock oscillation frequency

011: Synchronous low speed crystal clock oscillation frequency

110: Timer 0, pin input external signal

111: Synchronous timer 0, pin input external signal

Timer 1:

BIT7: Not used

BIT6: Not used

BIT5: Not used

BIT4: "0" Normal operation

"1" Cascade connection

BIT3: "0" Stop count

"1" Count operation

BIT2, 1, 0: Clock source selection

000: High speed crystal clock oscillation frequency

001: Timer 1, prescaler output signal

010: Low speed crystal clock oscillation frequency

011: Synchronous low speed crystal clock oscillation frequency

110: Timer 1, pin input external signal

111: Synchronous timer 1, pin input external signal

Timer 2:

BIT7: Unused

BIT6: Unused

BIT5: "0" Normal operation

"1" P23(IRQ3), pulse width measurement

BIT4: "0" Normal operation

"1" PWM operation

BIT3: "0" Stop count

"1" Count operation

BIT2, 1, 0: Clock source selection

000: High speed crystal clock oscillation frequency

001: Timer 2, prescaler output signal

010: Low speed crystal clock oscillation frequency

011: Synchronous low speed crystal clock oscillation frequency

110: Timer 2, pin input external signal

111: Synchronous timer 2, pin input external signal

Timer 3:

BIT7: Unused

BIT6: Unused

BIT5: Unused

BIT4: "0" Normal operation

"1" Cascade connection

BIT3: "0" Stop count

"1" Count operation

BIT2, 1, 0: Clock source selection

000: High speed crystal clock oscillation frequency

001: Timer 3, prescaler output signal

010: Low speed crystal clock oscillation frequency

011: Synchronous low speed crystal clock oscillation frequency

110: Timer 3, pin input external signal

111: Synchronous timer 3, pin input external signal

Timer 4:

BIT7: Unused

BIT6: Unused

BIT5: "0" Normal operation

"0" P24(IRQ4), pulse width measurement

BIT4: "0" Normal operation

"1" PWM operation

BIT3: "0" Stop count

"1" Count operation

BIT2, 1, 0: Clock source selection

000: High speed crystal clock oscillation frequency

001: Timer 4, prescaler output signal

010: Low speed crystal clock oscillation frequency

011: Synchronous low speed crystal clock oscillation frequency

110: Timer 4, pin input external signal

111: Synchronous timer 4, pin input external signal

The synchronization synchronizes with the timing of the system clock. See the "LSI User's Manual".

3.9.1 Types of setting for 8-bit timer

Interval timer

You can apply interval timer setting to all 8-bit timers ranging from the timer 0 to 4. Your source clock selection and compare register setting determines the generation cycle of the timer interrupt. The timer generates the interrupt on the next count after it matches the set value on the compare register, then clears the count. You write a count which is equivalent to a period setting minus 1 to the compare register.

The following is the example for setting the interval timer with 10 milli seconds.

To set to the interval timer with 10 milli seconds, convert the time base to the frequency first.

Formula: 1 / 10 milli seconds = 100 Hz

Setting by using high speed oscillation clock:

The prescaler can set the high speed oscillation clock to 4, 16, 32 or 64 divisions.

20 MHz / 64 = 312500 312500 / 100 = 3125

This setting is not available with the 8-bit timer.

Setting by using low speed oscillation clock:

32.768 kHz/ 4 = 8192 8192 / 100 = 81.92 = approx. 82

If you set the formula 82 – 1 = 81, the interval timer with 10 milli seconds will be set.

The following section describes a sample program.

```
/* Control data declaration */
#define TM0MOD    0x00      /* 0b00000000 Normal timer operation */
#define TM0PWM    0x00      /* 0b00000000 Timer operation */
#define TM0EN     0x08      /* 0b00001000 Count operation */
#define TM0CK     0x01      /* 0b00000001 Prescaler output */

/* Determine time for interval timer */
#define TM0PSC    0x00      /* 4 division setting */
#define TIME      81        /* Timer count value */

/* Register address declaration */
#define TM0BC_adr 0x3F50
#define TM0BC               (*(volatile unsigned char *)TM0BC_adr)
#define TM0OC_adr 0x3F52
#define TM0OC               (*(volatile unsigned char *)TM0OC_adr)
#define TM0MD_adr 0x3F54
#define TM0MD               (*(volatile unsigned char *)TM0MD_adr)
#define CK0MD_adr 0x3F56
#define CK0MD               (*(volatile unsigned char *)CK0MD_adr)

/* Setting program */
        CK0MD = TM0PSC;                     /* Set prescaler */
        TM0OC = TIME;                       /* Set timer value */
        TM0MD = TM0MOD | TM0PWM | TM0EN | TM0CK;
```

This sample is stored in the CD.

Stored directory: Sample\chapter3,4\Initial\ASM\TIMER\INTERVAL8\

Stored directory: Sample\chapter3,4\Initial\C\TIMER\INTERVAL8\

Event count

The event count uses a binary counter to count an external signal supplied from the timer pin.

You can set a measurement count value to the compare register for generating an interrupt as for the interval timer.

The following section describes a sample program.

```
 /* Control data declaration */
#define TM0CAS    0x00      /* 0b00000000 Normal timer operation */
#define TM0EN     0x08      /* 0b00001000 Count operation */
#define TM0CK     0x06      /* 0b00000110 External input signal */

/* Set value to interrupt, interrupt on 5th signal */
#define COUNT     0x04

/* Register address declaration */
#define TM0BC_adr 0x3F50
```

```
#define TM0BC              (*(volatile unsigned char *)TM0BC_adr)
#define TM0OC_adr 0x3F52
#define TM0OC              (*(volatile unsigned char *)TM0OC_adr)
#define TM0MD_adr 0x3F54
#define TM0MD              (*(volatile unsigned char *)TM0MD_adr)
#define CK0MD_adr 0x3F56
#define CK0MD              (*(volatile unsigned char *)CK0MD_adr)

/* Setting program*/
        /* Operation is based on external signal, and prescaler is not set */
        TM0OC = COUNT;              /* Set timer value */
        TM0MD = TM0CAS | TM0EN | TM0CK;
```

This sample is stored in the CD.

Stored directory: Sample\chapter3,4\Initial\ASM\TIMER\EVENT8\

Stored directory: Sample\chapter3,4\Initial\C\TIMER\EVENT8\

Timer pulse output setting

The timer pulse output can provide a pulse signal at an arbitrary frequency.

The period of the timer pulse output is twice as long as the period set on the compare register.

To provide timer pulse, set the output mode register (special register) of the port 1 to the timer output, and set the input/output setting register to output. See "3.7.2 Port 1".)

The timer setting for timer pulse output setting is identical to that for the interval timer.

PWM operation

The PWM output generates the PWM basic component and provides it from the timer output pin when the binary counter and the compare register of a timer match or on the overflow timing of the binary counter.

Since the PWM output uses the overflow of the binary counter, you can use only the frequency component generated by the overflow of the timer. The resolution of the PWM output is fixed to the one 255th due to the 8-bit counter.

The PWM output provides "1" until it counts up to the count set on the compare register after count start (00), and then provides "0" until it overflows after the match to the compare register.

Since the frequency components use the timer overflow, they are determined by the prescaler setting. This sample uses the low speed oscillation clock (assuming its oscillation is at 32.768 kHz) to set the 1/4 duty output for the 128 Hz frequency.

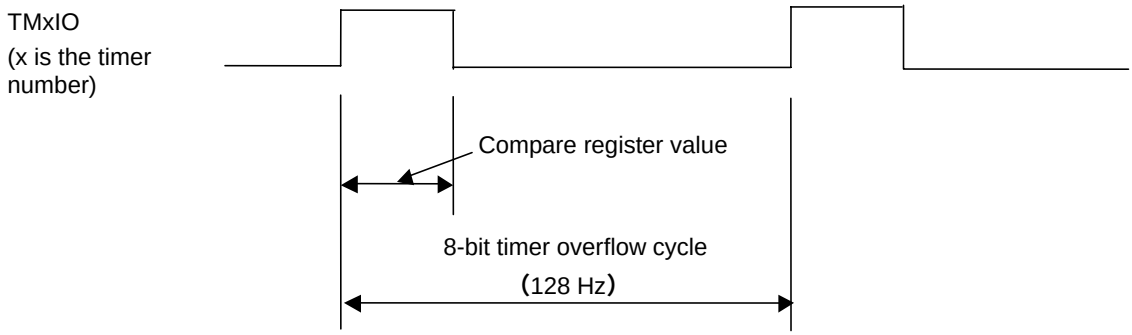

Figure 3 8-bit timer PWM operation timing chart

The following section describes a sample program.

```
 /* Control data declaration */
#define TM4MOD    0x00      /* 0b00000000 Pulse width measurement control (normal timer
                                          operation)*/
#define TM4PWM    0x10      /* 0b00010000 PWM operation */
#define TM4EN     0x08      /* 0b00001000 Count operation */
#define TM4CK     0x02      /* 0b00000010 Use low speed oscillation clock*/
                                                  /* 32.768 kHz / 256 = 128 Hz */

/* Determine width for High period of PWM output */
#define TIME      64                          /* 1/4 duty (64/256)*/

/* Register address declaration */
#define TM4BC_adr 0x3F60
#define TM4BC               (*(volatile unsigned char *)TM4BC_adr)
#define TM4OC_adr 0x3F62
#define TM4OC               (*(volatile unsigned char *)TM4OC_adr)
#define TM4MD_adr 0x3F64
#define TM4MD               (*(volatile unsigned char *)TM4MD_adr)
#define CK4MD_adr 0x3F66
#define CK4MD               (*(volatile unsigned char *)CK4MD_adr)


/* Setting program */
        TM4OC = TIME;                         /* Set pulse width */
        TM4MD = TM4MOD | TM4PWM | TM4EN | TM4CK;
```

This sample is stored in the CD.

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Synchronous output operation

The synchronous output operation provides the output from the port D at the count up timing of the timer. You can use the timer 1 and 2 for the synchronous output.

You use the port D to set the synchronous output operation. See "3.7.12 Port D".)

You can use the timer setting both in the interval timer mode and event count mode. You can also set

the interval output for the interval timer.

Serial interface transfer clock generation

You can use the ouput signal from a timer to generate a serial transfer clock.

You can use the interval timer and timer output setting to set the timer.

The following timers are available for the serial interface communication.

	Timer 2	Timer 3	Timer 4
Serial 0	Available	Not available	Available
Serial 1	Not available	Not available	Available
Serial 2	Not available	Available	Not available
Serial 3	Not available	Available	Not available

When you use the timer as transfer clock for the serial interface communication, the transfer speed will be the half of the setting value.

Declare the setting value in advance because it varies depending on the communication transfer speed.

This sample uses the case when the communication transfer speed is 19200 bps.

See the setting value list of the serial interface transfer speed in the LSI User's Manual for the setting value.

The following section describes a sample program.

```
/* Control data declaration */
#define TM2MOD    0x00      /* 0b00000000 Pulse width measurement control (normal timer operation)
*/
#define TM2PWM    0x00      /* 0b00000000 Timer operation */
#define TM2EN     0x08      /* 0b00001000 Count operation */
/* Control data declaration */
/* 1200 baud */
#define S12       0x01      /* 16 divisions */
#define C12       0x64
#define CK12      0x01      /* Prescaler input */
/* 2400 baud */
#define S24       0x00      /* 4 divisions */
#define C24       0x129
#define CK24      0x01      /* Prescaler input */
/* 4800 baud */
#define S48       0x00      /* 4 divisions */
#define C48       0x64
#define CK48      0x01      /* Prescaler input */
/* 9600 baud */

#define S96       0x00      /* 4 divisions */
#define C96       0x129
#define CK96      0x00      /* Clock direct input */
/* 19200 baud */
#define S192      0x00      /* 4 divisions */
#define C192      0x64
#define CK192     0x00      /* Clock direct input */
/* Link set values above */
/* For 19200 baud */
#define TM2CK     CK192                       /*        */
#define TM2PSC    S192                        /* Clock source */
#define TIME      C192                        /* Timer count value */
```

```
/* Register address declaration */
#define  TM2BC_adr 0x3F58
#define  TM2BC              (*(volatile unsigned char *)TM2BC_adr)
#define  TM2OC_adr 0x3F5A
#define  TM2OC              (*(volatile unsigned char *)TM2OC_adr)
#define  TM2MD_adr 0x3F5C
#define  TM2MD              (*(volatile unsigned char *)TM2MD_adr)
#define  CK2MD_adr 0x3F5E
#define  CK2MD              (*(volatile unsigned char *)CK2MD_adr)

/* Setting program */
        CK2MD = TM2PSC;                      /* Set prescaler */
        TM2OC = TIME;                        /* Set timer value */
        TM2MD = TM2MOD | TM2PWM | TM2EN | TM2CK;
```

This sample is stored in the CD.

Stored directory: Sample\chapter3,4\Initial\ASM\TIMER\Sclock\

Stored directory: Sample\chapter3,4\Initial\C\TIMER\Sclock\

Simple pulse width measurement

The simple pulse width measurement uses timer count to measure the pulse width when the interrupt input signal stays "Low". 3 timers, timers 0, 2, and 4, are available for the simple pulse width measurement.

The following section describes a sample program.

```
/* Control data declaration */
#define  TM0MOD    0x20      /* 0b00100000 Pulse width measurement */
#define  TM0PWM    0x00      /* 0b00000000 Timer operation */
#define  TM0EN     0x08      /* 0b00001000 Count operation */

/* Determine time for interval timer */
#define  TIME      0xFF      /* Timer count value, maximum value */

/* Register address declaration */
#define  TM0BC_adr 0x3F50
#define  TM0BC              (*(volatile unsigned char *)TM0BC_adr)
#define  TM0OC_adr 0x3F52
#define  TM0OC              (*(volatile unsigned char *)TM0OC_adr)
#define  TM0MD_adr 0x3F54
#define  TM0MD              (*(volatile unsigned char *)TM0MD_adr)
#define  CK0MD_adr 0x3F56
#define  CK0MD              (*(volatile unsigned char *)CK0MD_adr)

/* Setting program */
TM0OC = TIME;               /* Set timer value (counter clear) */
TM0MD = TM0MOD | TM0PWM | TM0EN | TM0CK;
```

This sample is stored in the CD.

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