AN1780
APPLICATION NOTE

STR71X REAL TIME CLOCK APPLICATION EXAMPLE

INTRODUCTION

The purpose of this application note is to explain how to use the STR71x Real Time Clock (RTC) peripheral. As an application example, it demonstrates how to setup the RTC peripheral, in terms of prescaler and interrupts, to be used to keep the time and date and to generate Alarm interrupts.The STR71x RTC has a 32-bit binary counter register. The 32-bit binary counters are designed to continuously count time in seconds. This application note addresses how to convert the 32-bit time value into a date and time value that can be put in the following-form MM/DD/YYYY, HH:MM:SS.

The date used in this application note is the same used with the UNIX operating system, the reference date January 1, 1970, often referred to as Unix Epoch.

This document in organized in two sections, the first presents the STR71x RTC peripheral and how to configure it and generate a fixed time base, the second part describes the related software required for the application.

This application note deals with various techniques for keeping time with the STR71x.

For more information about the STR71x RTC peripheral refer to STR71x Reference Manual.

Note: Because of the reference date used and the use of a 32-bit counter, this algorithm rolls over on Tuesday, January 19, 03:14:07, 2038.

The following application note developed using RVDK Toolchain V1.6.1 and the STR710 Evalboard.

You must have the ARM Real View Developer Kit to get the most out of this Application Note.

1 WHAT IS A REAL TIME CLOCK?

A real time clock is a clock that keeps track of the time even when the system is turned off. In contrast, clocks that are not real-time do not function when the system is off. Most of the real-time clocks operate at 32.768KHz.

2 APPLICATIONS—TIME AND ATTENDANCE

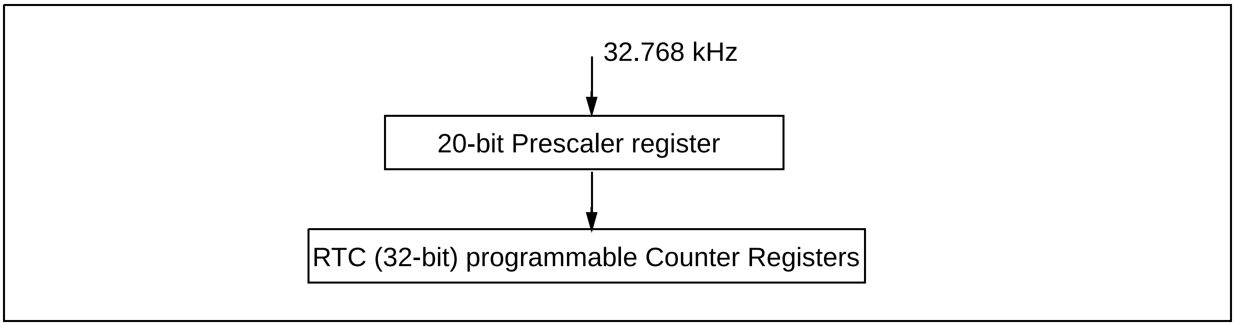
Real Time Clocks are usually found in portable systems such as a data collection terminals and smart card readers which are required to keep track of the day and time of certain tasks taking place. After the tasks are completed, usually the portable system will return to a stand-by mode to conserve power. The alarm can be set to wake up the system at certain time intervals to perform other tasks or to repeat the process. For example, in an access control application, when someone tries to access the building through certain doors, the day and time of the entry is recorded and this information can be used for accounting and security purposes, etc.

3 STR71X RTC PERIPHERAL

The RTC peripheral implemented in the STR71x family is a 32-bit continuously running counter that can be used, with a few configuration parameters, to provide a precise clock-calendar function.

The RTC peripheral is mapped on the APB2 bridge and clocked by an external 32.768 kHz oscillator through a 32-bit prescaler register, this prescaler can be used to vary the RTC clock from 32.768 kHz to 0.5 Hz.

Figure 1. RTC Peripheral



In this application, the RTC counter registers have to be incremented every second, this can be configured by using a prescaler value of 0x8000 (32768) to slow down the RTC clock from 32768 Hz to 1 Hz. This allows the RTC to keep time in seconds in the 32-bit counter.

4 CONFIGURATION MODE

To write in the RTC_PRL, RTC_CNT, RTC_ALR registers, the peripheral must enter Configuration mode. This is done by setting the CNF bit in the RTC_CRL register.

In addition, writing to any RTC register is only enabled if the previous write operation is finished.

To enable the software to detect this situation, the RTOFF status bit is provided in the RTC_CR register to indicate that an update of the registers is in progress. A new value can be written to the RTC counters only when the RTOFF status bit value is ’1’.

Configuration Procedure:

1. Poll RTOFF, wait until its value goes to ‘1’

2. Set CNF bit to enter configuration mode

2. Write to one or more RTC registers

3 Clear CNF bit to exit configuration mode

The write operation only executes when the CNF bit is cleared and it takes at least two Clock32 cycles to complete.

5 32-BIT COUNTER TIME CONVERSION

This application note explains how to convert the 32-bit time value into a date and time value that can be put in the form of MM/DD/YYYY, HH:MM:SS. Many functions provided by the ARM compiler used to convert from a date and time to seconds are also described.

These functions are modified in order to explore the STR71x RTC to deliver time and date.

5.1 C LIBRARY FUNCTIONS USED

5.1.1 RTC prescaler Initialisation:

Before start-up we must adjust the STR71x RTC prescaler register value in order to have the RTC counter registers incremented every second, this can be configured by using a prescaler value of 0x8000 (32768) to slow down the RTC clock from 32768 Hz to 1 Hz.

5.1.2 Origin Date Adjust

Since the date used in this application note is the same used with the UNIX operating system, the reference date January 1, 1970, often referred to as Unix Epoch, we must add this number 0x3FF36300 to the value obtained from the STR71x RTC Counter register with intent to have a start date = 01/01/2004.

NOTE: 0x3FF36300 is the number of seconds from 01/01/1970 to 01/01/2004.

5.1.3 C Functions used

5.1.3.1 localtime

Converts time in seconds since Unix Epoch to local time.

- SYNOPSIS

```
#include <time.h>
extern struct tm *localtime(const time_t * /*timer*/);
```

- Description

Converts the calendar time pointed to by timer into a broken-down time, expressed a local time.

- Returns

Returns pointer `(ptim)` to static data, it converts a time as returned by the time function to a 9-element list with the time analysed for the local time zone. Typically use the following tm structure:

```
struct tm {
 int tm_sec;  /* seconds after the minute, 0 to 60 (0 - 60 allows for the occasional
leap second) */
 int tm_min;  /* minutes after the hour, 0 to 59 */
 int tm_hour; /* hours since midnight, 0 to 23 */
 int tm_mday; /* day of the month, 1 to 31 */
 int tm_mon;  /* months since January, 0 to 11 */
 int tm_year; /* years since 1900 */
 int tm_wday; /* days since Sunday, 0 to 6 */
 int tm_yday; /* days since January 1, 0 to 365 */
 int tm_isdst; /* Daylight Savings Time flag */
};
```

5.1.3.2 mktime()

Converts local time to seconds since the Unix Epoch

- SYNOPSIS

```
#include <time.h>
extern time_t mktime(struct tm * /*timeptr*/);
```

- DESCRIPTION

The mktime() function converts the broken-down time, expressed as local time, in the structure pointed to by timeptr into a calendar time value with the same encoding as that of the values returned by the time() function.

5.1.4 Code Description

This application note addresses how to convert the 32-bit time value into a date and time value that can be put in the form of MM/DD/YYYY, HH:MM:SS.

The code should be set up so that:

– The UART0 and HyperTerminal are used to enter a current TIME and DATE after start-up.

– The following hyperterminal configuration is used:

■ *HyperTerminal configuration*:

- Bits per second ----> 38 400
- Data bit ---------------> 8
- Parity -----------------> None
- Stop bits -------------> 1
- Flow control ---------> None

– After reset, the RTC prescaler is configured to have the RTC counter incremented every second.

– Alarm configuration (an alarm is configured after 5s).

– Then enable the RTC alarm interrupt via the EIC configuration.

– A current Date and Time will display on the LCD.

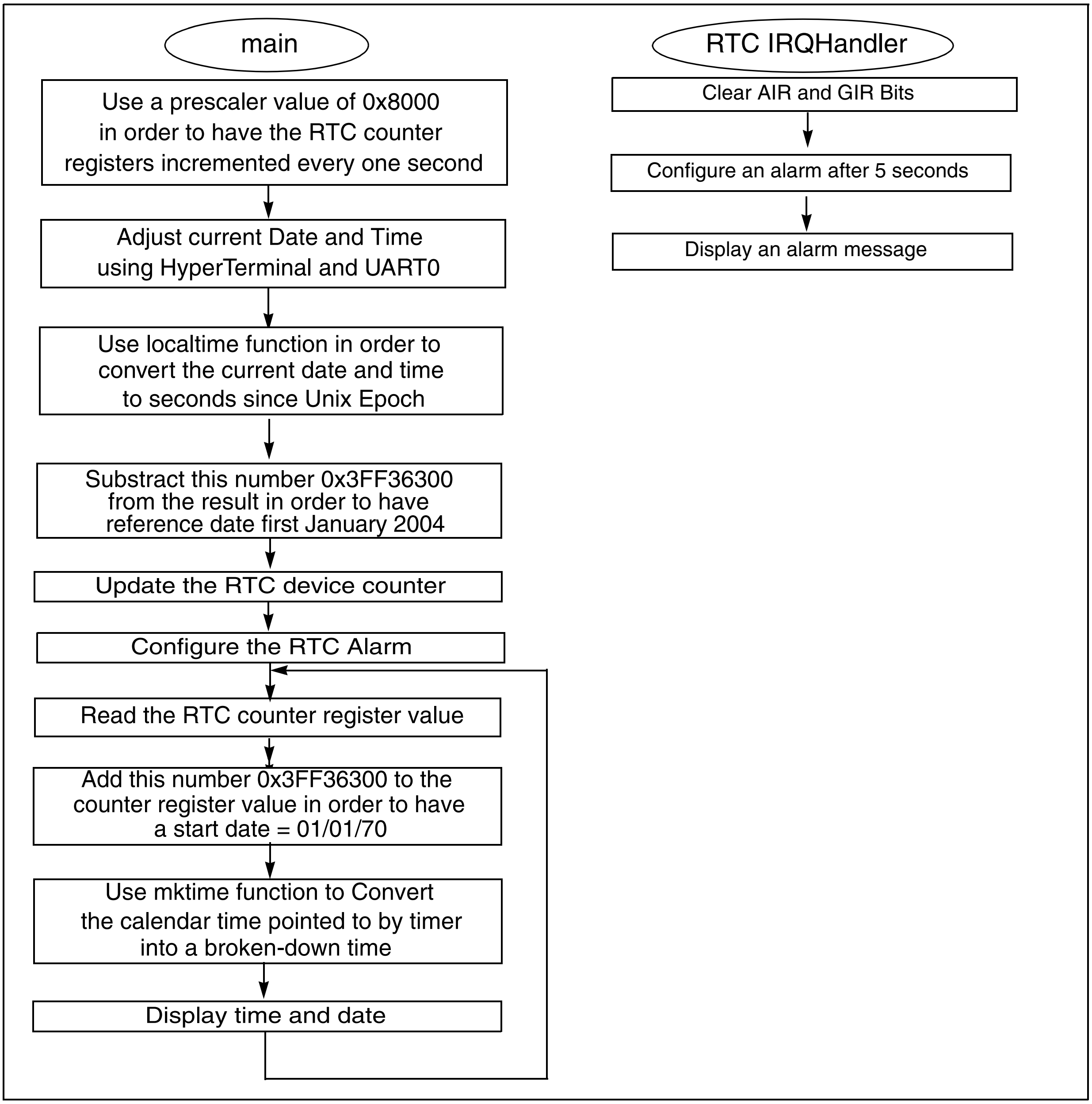
The RTC interrupt service routine:

– Clear the RTC interrupt flag.

– The RTC alarm will be fired after 5 second and the RTC_IRQHandler routine will be executed. An alarm message will be displayed for 2s and the RTC will be configured to generate an other alarm interrupt after 5s.

Figure 2 shows the code flow of the algorithm used to convert raw seconds to a date/time.

Figure 2. C Code Flow:



Here is a section of code taken from main.c which performs the steps shown above in Figure 2 above:

```
#include "71x_lib.h"
#include "lcd.h"
#include <stdio.h>
#include <time.h>
#include <stdlib.h>
#define RTC_PRESC 0x8000
```

```
 time_t TIME;
 struct tm *ptim;
 RCCU_ResetSources ResetSources;
int main(void)
{
       RTC_FlagClear ( RTC_OWIR );
       RTC_FlagClear ( RTC_AIR );
       RTC_FlagClear ( RTC_SIR );
       RTC_FlagClear ( RTC_GIR );
       RTC_PrescalerConfig(RTC_PRESC);
       ptim=malloc(sizeof(*ptim));
       printf("s:");
       scanf("%d, ",&ptim->tm_sec);
       printf("m:");
       scanf("%d, ",&ptim->tm_min);
       printf("h:");
       scanf("%d",&ptim->tm_hour);
       printf("D:");
       scanf("%d,",&ptim->tm_mday);
       printf("M:");
       scanf("%d,",&ptim->tm_mon);
       ptim->tm_mon--;
       printf("Y:");
       scanf("%d",&ptim->tm_year);
       ptim->tm_year-=1900;
       TIME = mktime(ptim)-0x3FF36300;
       RTC_WaitForLastTask();
       RTC_EnterCfgMode();            // Enter In Configuration Mode
       RTC_WaitForLastTask();         // Wait For Last Task Completion
       RTC->CNTL = TIME & 0x0000FFFF;
       RTC_WaitForLastTask();         // Wait For Last Task Completion
       RTC->CNTH = ( TIME & 0xFFFF0000 ) >> 16;
       RTC_WaitForLastTask();         // Wait For Last Task Completion
       RTC_ExitCfgMode ();            // Exit From Configuration Mode
               // RTC_AlarmConfig(TIME+15);
       RTC_AlarmConfig(RTC_CounterValue()+5);
       EIC_IRQChannelConfig( RTC_IRQChannel, ENABLE );// Enable RTC IRQ channel
       EIC_IRQChannelPriorityConfig( RTC_IRQChannel, 1);
       EIC_IRQConfig( ENABLE );

       RTC_ITConfig( RTC_AIT|RTC_GIT, ENABLE );     // Enable alarm Interrupt
               // LCD_UnderlineCursorOff();
       gotoxy(1,1);
       printf("          ");
       gotoxy(1,2);
```

```
        printf("        ");
        while(1)
        {
                TIME=RTC_CounterValue()+0x3FF36300;
                ptim = localtime(&TIME);
                gotoxy(1,1);
                printf("  %02d/",ptim->tm_mday);
                printf("%02d/",ptim->tm_mon+1);
                printf("%4d\r\n",ptim->tm_year+1900);
                gotoxy(1,2);
                printf(" %02d : ",ptim->tm_hour);
                printf("%02d : ",ptim->tm_min);
                printf("%02d\r\n",ptim->tm_sec);
        }
}
```

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