Application Note

An RZK Application Using the Real-Time Clock of the eZ80F91 MCU

AN018803-0316

Abstract

This application note describes a Zilog Real-time Kernal (RZK) application that uses the real-time clock (RTC) peripheral of Zilog's eZ80F91 MCU to function as a world clock.

A 4X4 keypad and LCD display interface is provided to set and view the local time and local date of a country, set the local time with daylight saving, and also to operate a stopwatch. The current time is maintained in the 24-hour format.

Note: *The source code associated with this application note,* `AN0188-SC01.zip`*, is available for download at* www.zilog.com.

RZK Overview

The Zilog Real-time Kernel (RZK) is a real-time, preemptive, multitasking kernel designed for time-critical embedded applications. It is currently available for use with Zilog's eZ80Acclaim*Plus!*™ family of microcontrollers and microprocessors.

A real-time multitasking kernel (also called a real-time operating system, RTOS) is software which ensures that time-critical events are processed as efficiently as possible.The use of an RTOS generally simplifies the design process of a system by allowing the application to be divided into multiple independent elements called tasks.

Features of RZK

The RZK functional architecture is configurable, scalable and modular in design and provides a rich set of features and easy-to-use APIs. RZK features are tuned to the stringent memory and performance requirements of the 8-bit domain.

RZK is compact with minimal footprint and can be accommodated in the Flash area of the target processor. RZK allows rapid context switching between threads besides offering quick interrupt responses. It features a preemptive, priority-based, multitasking scheduler, and provides timing support for delays, time-outs and other periodic events. Users can take advantage of RZK's time-slicing option with adjustable time slices. In addition to various configuration options, RZK provides priority inheritance facility.

RZK Objects

RZK objects used for real-time application development are threads, message queues, event groups, semaphores, timers, partitions and regions (memory objects), and interrupts. All RZK objects use the kernel services for resource management and provide a set of APIs to interface to the application.The application optionally uses the objects, based on its requirements.

A brief overview of the RZK Thread Control API functions is presented below.

Thread Control API

Thread Control API functions are used to create threads and perform the following operations on a created thread:

- Suspending a thread finitely or infinitely
- Resuming a thread that suspends infinitely
- Deleting a thread
- Changing the priority of a thread
- Yielding control to other threads

- Getting thread parameters

For more information on RZK, please refer to the *RZK Reference Manual* (RM0006) that is available on the Zilog website.

eZ80Acclaim*Plus!*™ Real-Time Clock

The eZ80F91 device is a member of Zilog's family of eZ80Acclaim*Plus!* Flash Microcontrollers.The eZ80F91 is a high-speed single-cycle instruction-fetch microcontroller with a maximum clock speed of 50 MHz.The rich peripheral set of the eZ80F91 MCU makes it suitable for a variety of applications, including industrial control, embedded communication, and point-of-sale terminals.

The following section discusses the real-time clock peripheral of the eZ80F91 MCU, which is used in this application note.

Real-Time Clock

The eZ80F91 MCU features a real-time clock with an on-chip 32 KHz oscillator, a selectable 50/60 Hz input, and a separate V_{DD} pin for battery backup. The real-time clock (RTC) keeps time by maintaining a count of seconds, minutes, hours, day-of-the-week, day-of-the-month, year, and century. The current time is maintained in the 24-hour format.

The format for all of the count and alarm registers is selectable between binary and binary-coded-decimal (BCD) operations.The calendar operation maintains the correct day of the month and automatically compensates for a leap year only when binary-coded-decimal operation is enabled.

For more details on the real-time clock refer to the *eZ80F91 Product Specification* (PS0192), available on the Zilog web site.

Developing the RZK-RTC Application

This application note focuses on how to use RZK in a multi-threaded environment along with the RZK timer. The RZK software timer accuracy is enhanced by increasing the number of ticks per second.

This section contains the hardware and software implementation details for developing the RZK-RTC application.

Hardware Architecture

Figure 1 is a block diagram of the hardware architecture featuring the eZ80 Development Platform with the eZ80F91 Module, the keypad, and the Character LCD module.

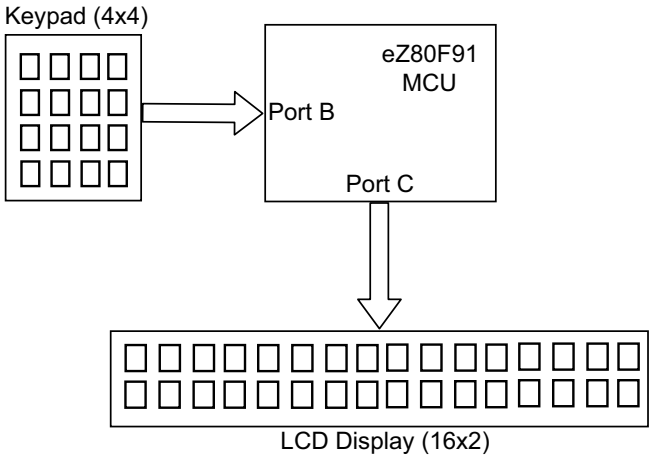

Figure 1. Block Diagram for the Embedded RTC-RZK application Architecture

Port C of the eZ80F91 MCU is connected to the Character LCD module that displays the time and date. Port B of the eZ80F91 MCU is connected to the keypad that scans the keys continuously. The columns of the keypad are pulled up with 10-K resistance, making them HIGH normally. Figure 2 on the following page contains the details of this connection.

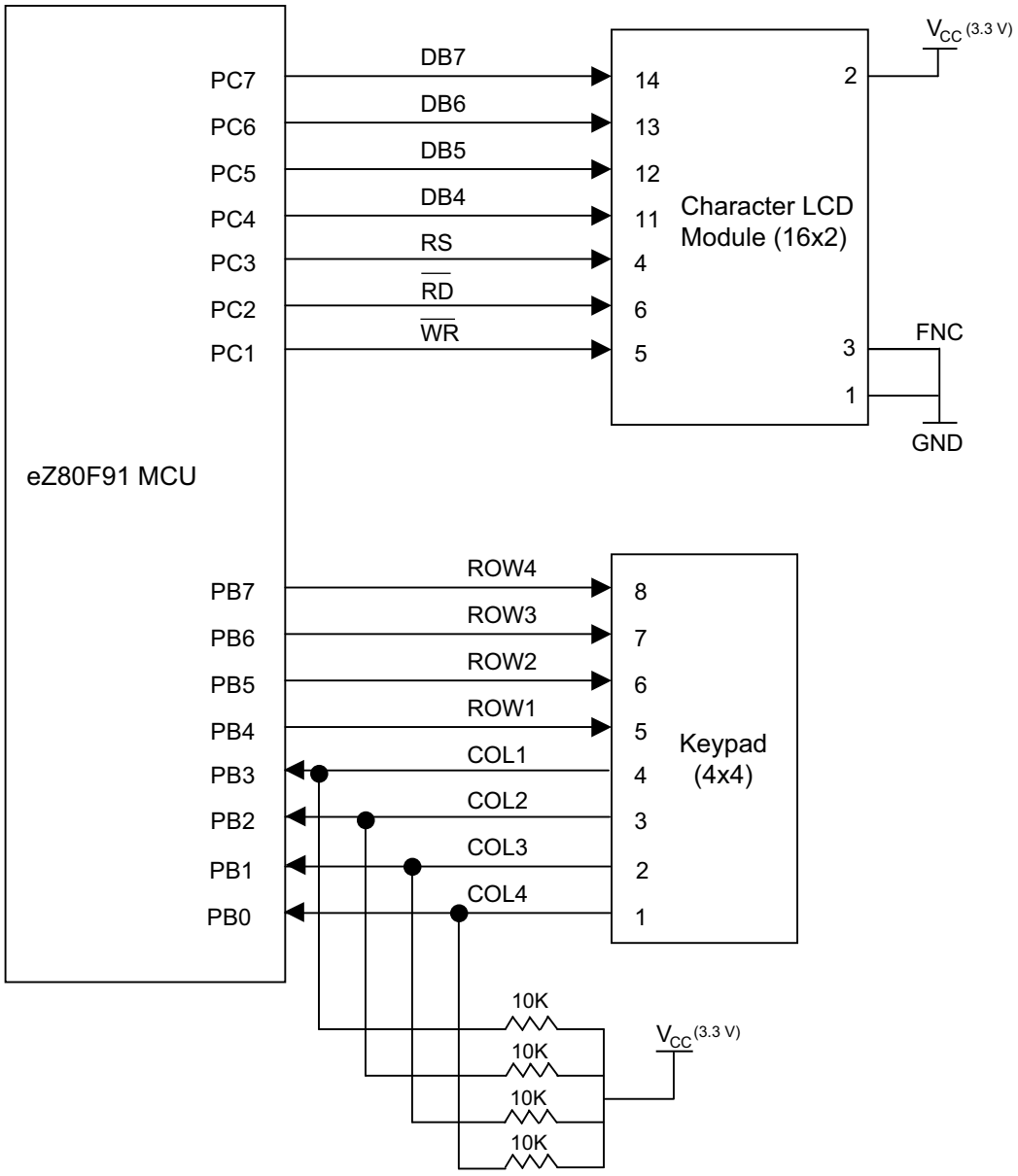

Figure 2. Connection Details Between the eZ80F91 MCU, LCD Module, and Keypad

Figure 3 on page 5 illustrates the details of the keypad.The keypad is marked with numeric keys (0-9) and function keys (A-F).The function keys are:

- Key A - to set local time
- Key B - to set local date
- Key C - to enter a function or terminate a function (enter/exit key)
- Key D - to activate the stopwatch
- Key E - to se lect de fault country/set the daylight saving
- Key F - to view country time

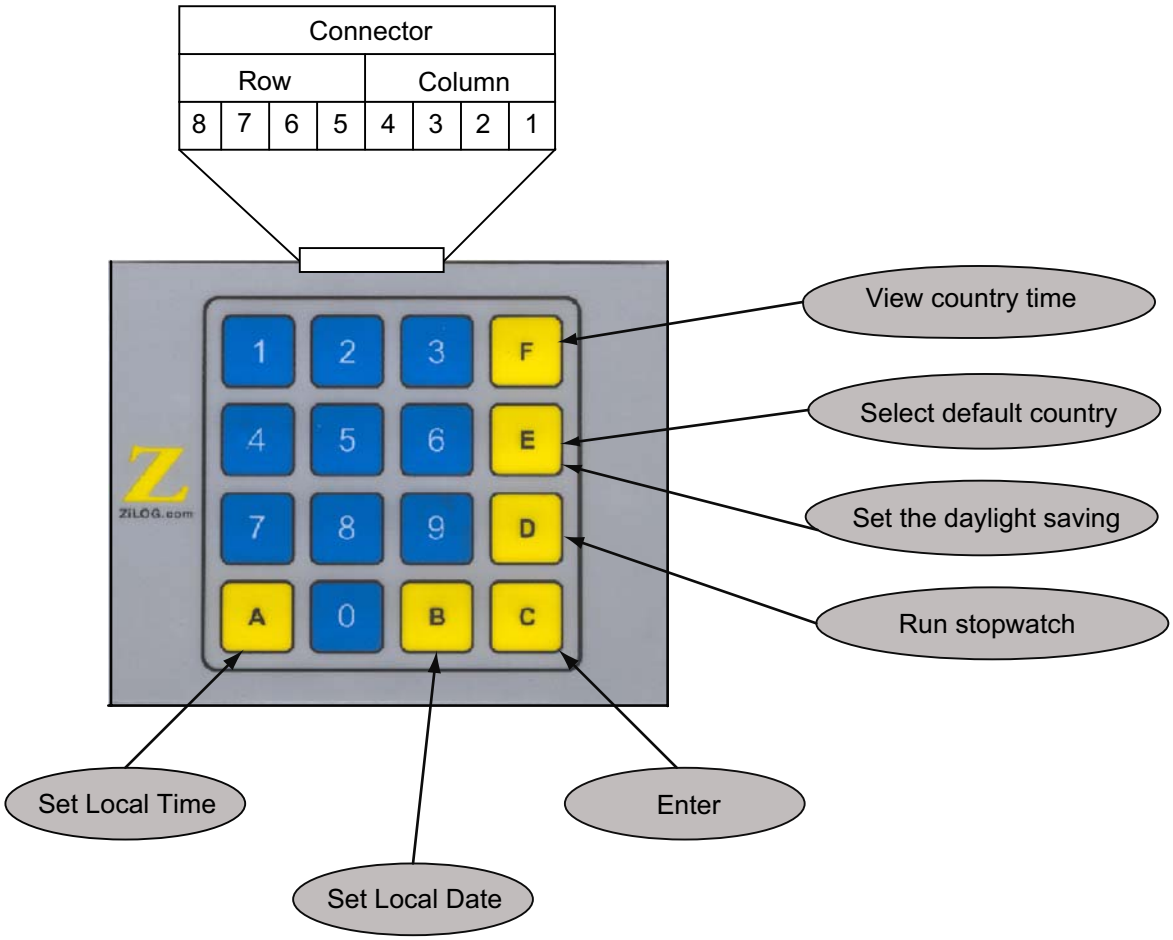

Figure 3. Functions of the Keypad Keys

Software Implementation

There are two RZK tasks—the LCD task and the Keypad task—which perform the basic functionality of setting and displaying the country, time and date, as also the stopwatch operations. Auxiliary functions, such as conversion from binary to ASCII, ASCII to BCD, time addition and subtraction, and other manipulation functions required by the tasks, are provided in the `AuxFunc.c` file (see `AN0188-SC01.zip`, available for dow nload on www.zilog.com).

Figure 4 on page 6 illustrates the basic software flow implemented for the RZK-RTC application.

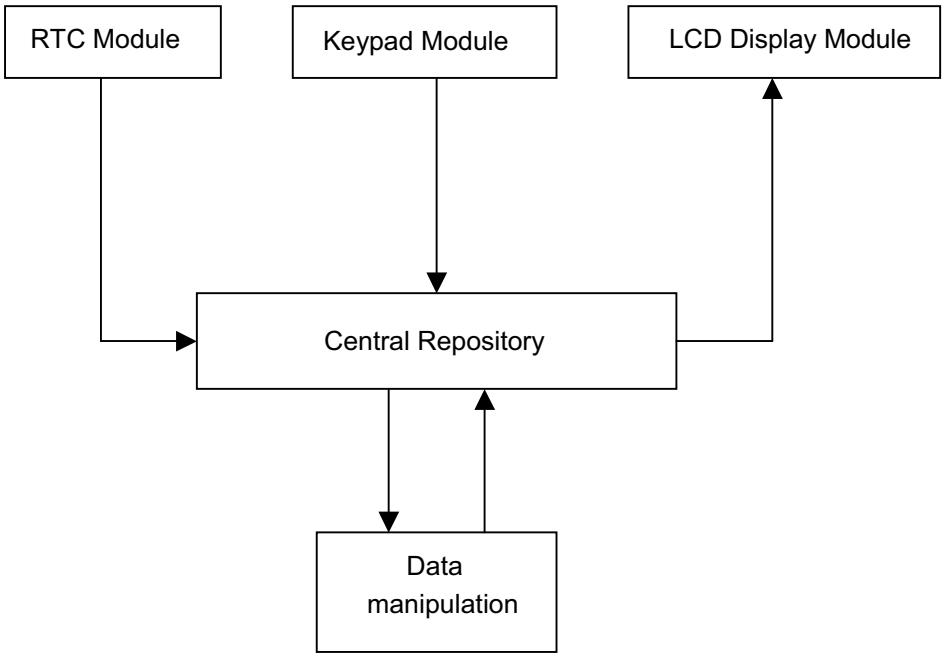

Figure 4. Block Diagram for World Clock Application with RTC and RZK

The RTC module updates the Central Repository every second. The Keypad module scans all the keys continuously for key hits. The LCD Display module reads the date from the Central Repository continuously and updates the time and date on the LCD display.The Data Manipulation module takes care of changing the data format appropriately and processing the data.

Two RZK functions—`RZKApplicationEntry()` function and the `RZKTImer1()` routine—are explained in the following sections before the two application tasks are explained.

RZKApplicationEntry()

This RZK function is the main entry point for any application into RZK. The application program entry function performs the following operations:

- Initializes all the peripherals
- Creates thre ads for LCD a nd Keypa d (`LCD-Task()` and `KeyPadTask()`)
- Creates the RZK timer
- Resumes all the threads

RZKTimer1()

This RZK software timer interrupt service routine (ISR) reads the real-time clock registers—second, minute, hour, day, month, and year—and updates the global variables and the Central Repository.

LCDTask()

The `LCDTask()` thread continuously updates the time and the date on the LCD display. When the user selects any functional key (mode selection), the `LCDTask()` thread displays the appropriate string on the Character LCD Module. Pressing the key C instead of the number keys terminates the selected functionality and the `LCDTask()` thread resumes displaying the current time and date on the LCD.

The main operations performed by this thread are:

- Checks if any mode selection keys are pressed for a specific functionality.

- If any of the mode selection keys (A, B, D, E, or F) followed by key C is pressed, this thread reads the appropriate string in the Central Repository displays it on the LCD module.
- If the user does not press any number keys and instead presses the key C, the selected function is terminated and the LCD module is updated with the current time and date.
- If the user does not select any mode selection key, this thread updates the LCD module with the current time and date.

KeyPadTask()

This thread continuously scans the keypad. When any mode selection key is pressed, it detects the key press and is ready to take the user input in the form of other key presses to set the time or set the date or select a country.The thread then updates the Central Repository with this data.

The main operations performed by this thread are:

- Scan the keys, row- and column-wise
- Check if a mode selection key is pressed
- If mode selection key is pressed, wait for other key presses
- Update the repository with data fed by the number keys

Adding the Application Project to Standard RZK

This section contains the details of adding the RZK-RTC application project file to the standard RZK and downloading it to the internal Flash memory of the eZ80F91 MCU.

The RZK software is available on the Zilog web site and can be downloaded to a PC with a user registration key. RZK can be installed in any location as specified by the user; its default location is `C:\Program Files\ZiLOG`.

Perform the following steps to add the application files to the RZK directory:

1. Connect the eZ80F91 Development Kit, ZPA-KII, and the PC as shown in Figure 5.

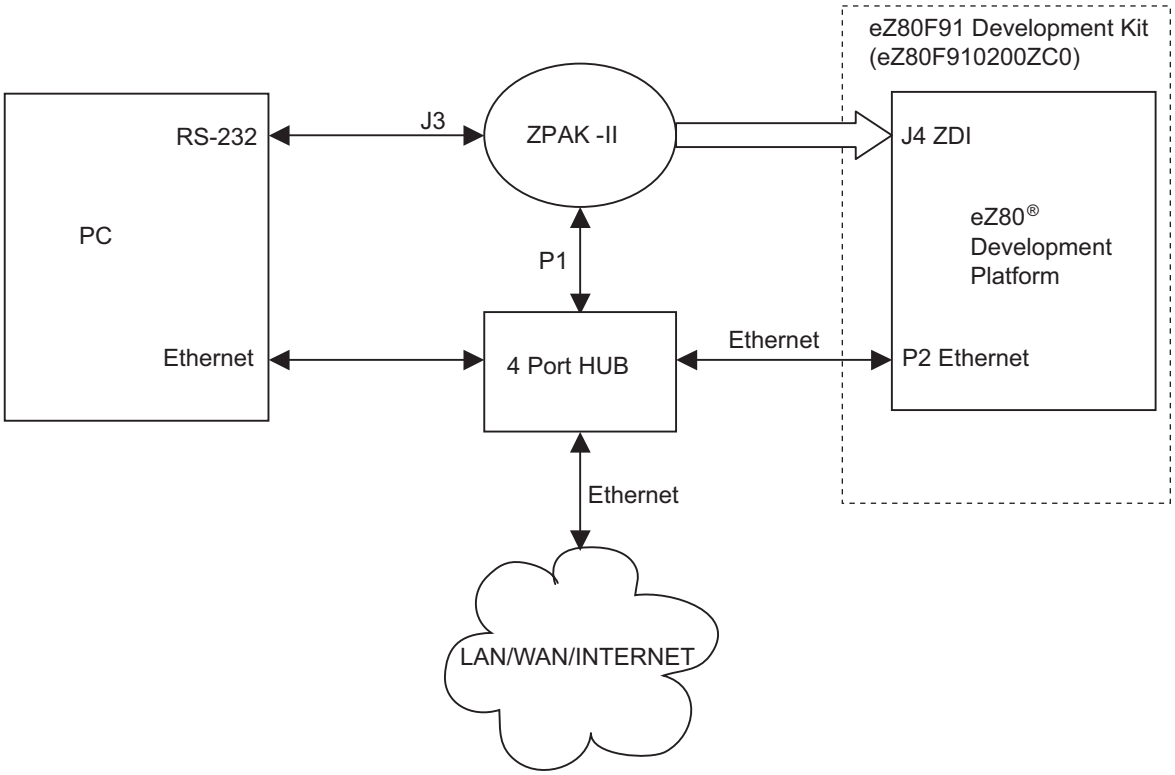

Figure 5. Connection to Download RZK-RTC Application to eZ80F91 MCU

2. Using the PC, download RZK, browse to the location where RZK is downloaded, and open the `..\eZ80F91\Sample Programs` folder.
3. Download the `AN0188-SC01.zip` file and extract its contents to a folder on your PC. Notice that there is a folder `\RTC` within the extracted folder.
4. Copy the `\RTC` folder and paste it into the `..\eZ80F91\Sample Programs` folder. Notice that there are two folders within the `\RTC` folder:
   - `\IntFlash`

     This folder contains the `RTC.pro` file to be downloaded to internal Flash memory of the MCU.
   - `\Ram`

     This folder contains the `RTC.pro` file to be downloaded to RAM memory of the MCU.
5. Launch the HyperTerminal program on the PC to set the IP address for ZPAKII for downloading the application program.

   Note: *Refer to the ZPAKII Product User Guide (PUG0015) for details.*
6. Launch ZDS II—eZ80Acclaim!® 4.7.0, and open the RTC project located in the path: `<RZK Installed Dir>\rzk1.0.0\eZ80F91\Sample Programs\Rtc\<RAM or Flash>\RTC.pro`
7. Build the project and download it to the eZ80F91 MCU using ZDS II.

Note: *Please do not modify any of the project settings in any of the RZK project files. Refer to the* ZDS II—eZ80Acclaim!® User Manual *(UM0144).*

Testing

This section describes how the RZK-RTC application is tested.

Test Setup

Figure 5 illustrates the connection diagram between a PC, LAN/WAN, and the eZ80F91 Development Kit. Figure 2 illustrates the connection diagram between the eZ80F91 MCU, the Keypad and the LCD module.

Equipment Used

- eZ80F91 Development Kit with the eZ80F91 Module
- 4x4 Keypad
- 16x2 Character LCD Module fitted with a Hitachi HD44780 controller

Test Procedure

1. Make sure that the project file, `RTC.pro` is built and downloaded to the eZ80F91 MCU. (See Adding the Application Project to Standard RZK on page 7.)
2. Connect the eZ80F91 Module to the Keypad and Character LCD Module as shown in Figure 2 on page 4.
3. From within ZDS II, run the RTC project.
4. Press the Keypad keys to select a country as default, set the local time and the local date, or run a stopwatch. Refer to the Using the RZK-RTC Application section for details on using the features of this application.

Using the RZK-RTC Application

The RZK-RTC application can be used in the following ways.

To Set Default Country for Display

1. Press F on keypad repeatedly to select the country; stop when you see the country of your choice displayed on the LCD display.
2. Press E to enter the selected country as the default country.
3. Pressing the key E displays the daylight saving status. Users can set/change daylight saving at this point by pressing key E again; daylight saving is enabled/disabled depending on its current status (see To Set/Change Daylight Saving section below). Users can defer daylight saving settings by pressing the key C immediately after the key E is pressed the first time.
4. Press C to exit from the process.

To Set/Change Daylight Saving

1. To set or change daylight saving settings, press key E on the keypad; the current daylight saving status is displayed. By default, the daylight saving is disabled; the LCD displays NO. Key E can be toggled to enable or disable daylight saving.
2. To enable daylight saving, press E key and the function is enabled. The LCD displays the daylight saving status as YES.
3. To disable daylight saving, press key E. The LCD displays NO, indicating that daylight saving is disabled.
4. Press C to enter the selected daylight saving setting.

To Set Local Time

1. For first-time setting, repeat the process to set default country.
2. Now press A; the *Set Local Time* message appears on the LCD display.

3. Press the number keys to enter the current time; the current time is displayed.
4. Press C to set the local time and to exit from the process.

To Set Local Date

1. For first-time setting, repeat the process to set default country.
2. Now press B; the *Set Local Date* message appears on the LCD display.
3. Press the number keys to enter the current date; the current date is displayed.
4. Press C to set the local date and to exit from the process.

To View Country Time

1. Press F repeatedly to select the country; stop when you see the country of your choice displayed on the LCD display.
2. Press C to exit from the process; the selected country's local time and date is displayed.

To Use the Stopwatch

1. Press D to select the stopwatch.
2. Press D again to start or stop the stopwatch.
3. Press C to exit from the process.

The RZK-RTC application successfully runs on the eZ80F91 MCU. Selecting a country and setting local time and local date works satisfactory.

Summary

This application note highlights the capability of the Zilog Real-time Kernel (RZK) to efficiently scan the keypad inputs and display the world clock time and date using the real-time clock peripheral of the eZ80F91 MCU. The RZK application also provides a stopwatch feature.

Going forward, the embedded real-time clocks, as described in this application note, can be used for simple tasks such as setting alarms, or for synchronizing other RZK-related tasks, such as home automation, where a user can set the time for switching OFF/ON certain home appliances from a remote location using Zilog's TCP/IP stack—ZTP.

Appendix A—References

Further details about the eZ80F91 MCU, ZDS II IDE, and RZK can be found in the references listed in Table 1.

Table 1. List of References

Topic	Document Name
eZ80F91 MCU	*eZ80F91 Flash MCU with Ethernet MAC Product Specification* (PS0192)
	eZ80F91 Module Product Specification (PS0193)
ZDS II IDE	*Zilog Developer Studio II—eZ80Acclaim! User Manual* (UM0144)
RZK	*RZK Reference Manual* (RM0006)
	RZK User Manual (UM0075)
	RZK Quick Start Guide (QS0027)

Note: These documents are available on the Zilog web site.

Appendix B—Flowcharts

This appendix lists the flowcharts for the various tasks performed by the RZK-RTC application described in this application note.

The RZK Application entry task flowchart is illustrated in Figure 6.

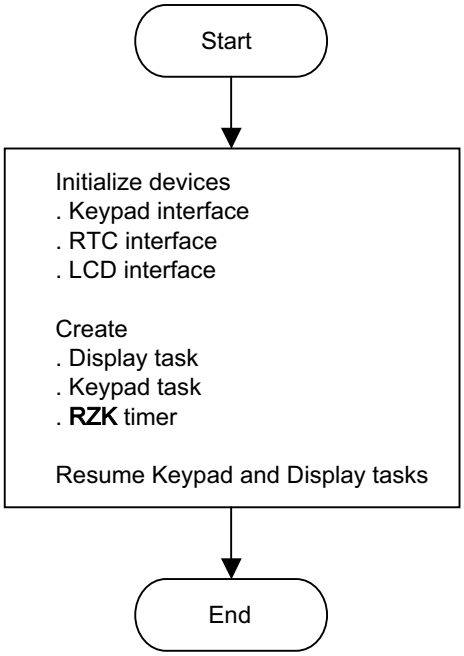

Figure 6. Flowchart for the Application Entry Task

The flowchart for the RZK timer ISR is illustrated in Figure 7.

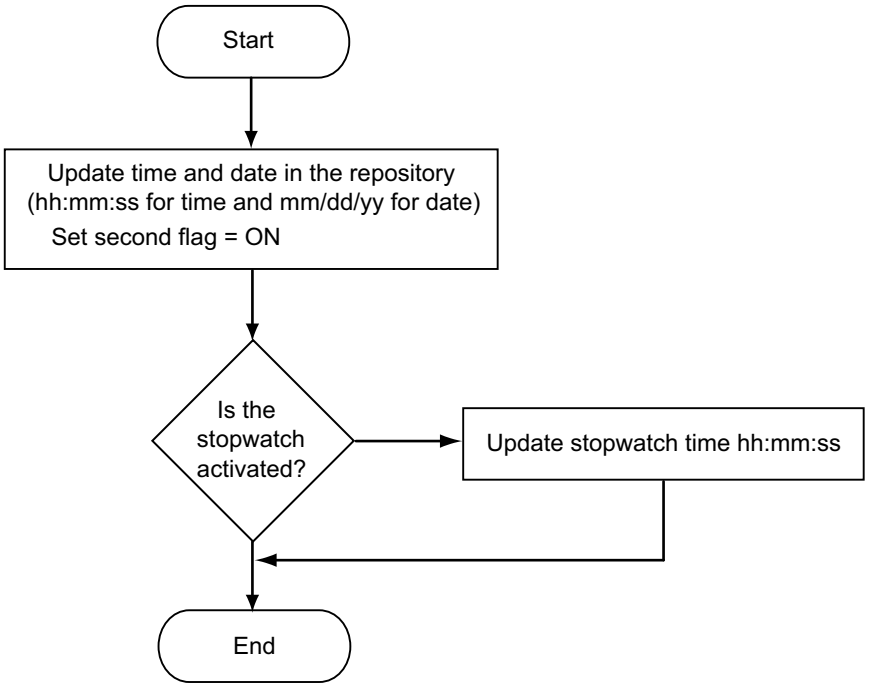

Figure 7. Flowchart for the RZK Timer ISR

The flowchart for the first part of the Keypad task is illustrated in Figure 8.

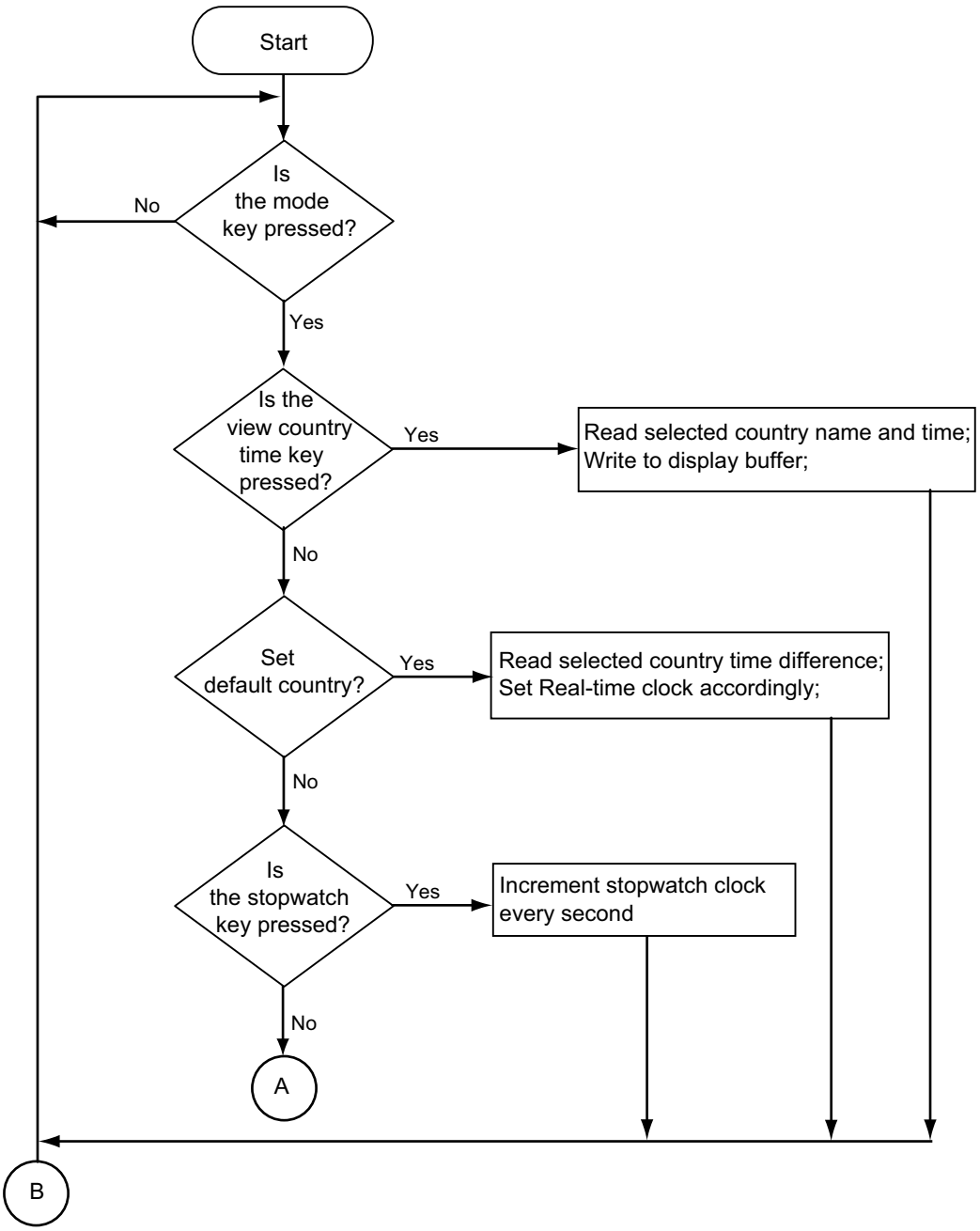

Figure 8. Flowchart for the Keypad Thread Entry Task

The flowchart for the concluding part of the Keypad task is illustrated in Figure 9.

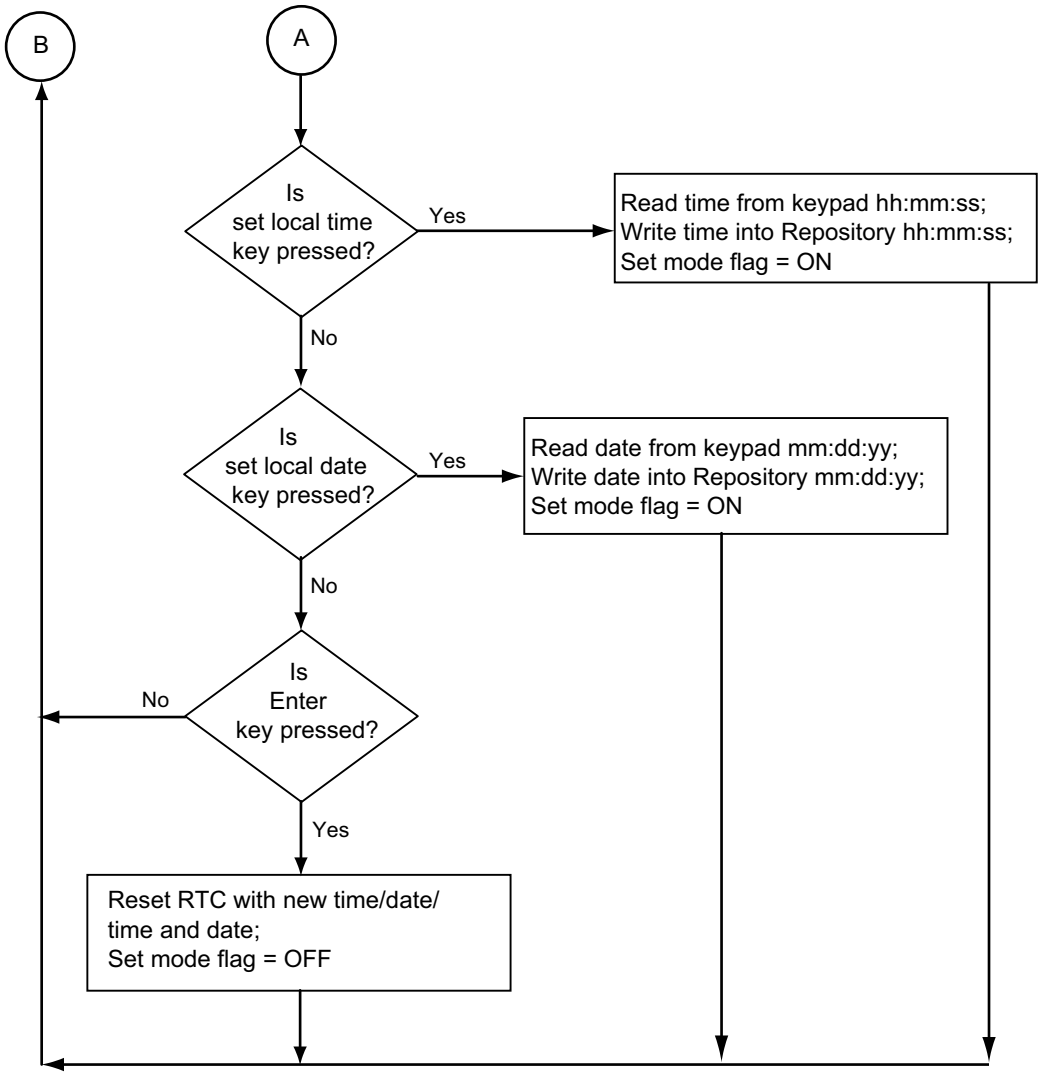

Figure 9. Flowchart for the Keypad Thread End Task

The flowchart for the LCD task is illustrated in Figure 10.

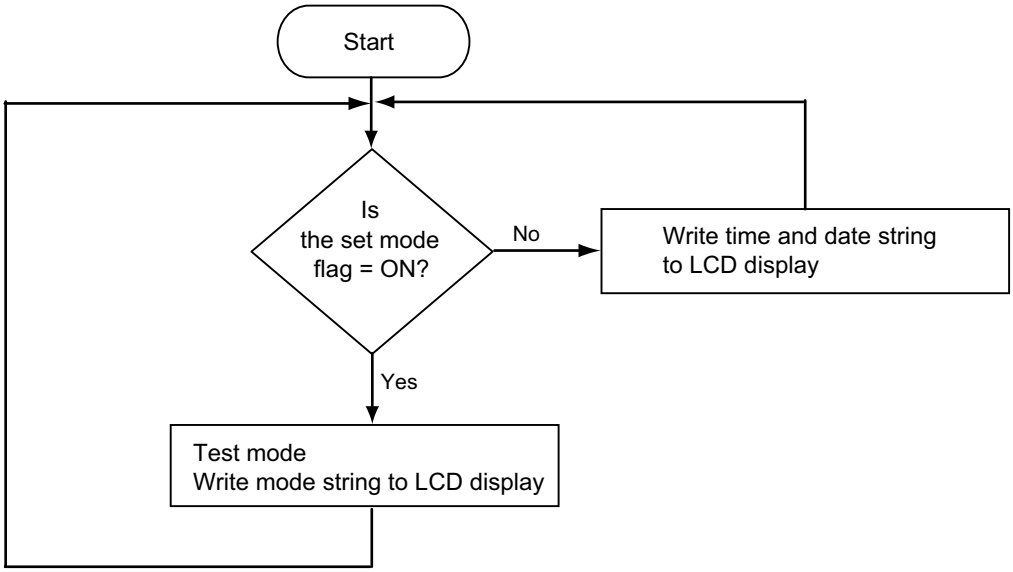

Figure 10. Flowchart for the LCD Thread Entry Task

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