
Pillbox Alarm Application for the AVR® P4 FEB

Introduction

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The AVR® P4 Field Engagement Board (FEB) allows a user to investigate trade-offs and techniques for optimizing the power consumption, pin count, performance, and precision (P4) of an AVR microcontroller (MCU). By default, the MCU on the P4 board is programmed with a pillbox alarm application. The application allows the user to set up to four different daily alarm times, such as reminders to take pills at required times. When an alarm occurs, a piezoelectric buzzer generates a pulsating sound and the LED associated with that alarm flashes.

This document describes the implementation of the pillbox alarm application software that runs on the P4 board.

Features

- Current Time and up to Four Alarms Per Day
- Alarm Generates Pulsating Sound and Flashes LED
- Power Minimization Techniques

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1. Relevant Devices

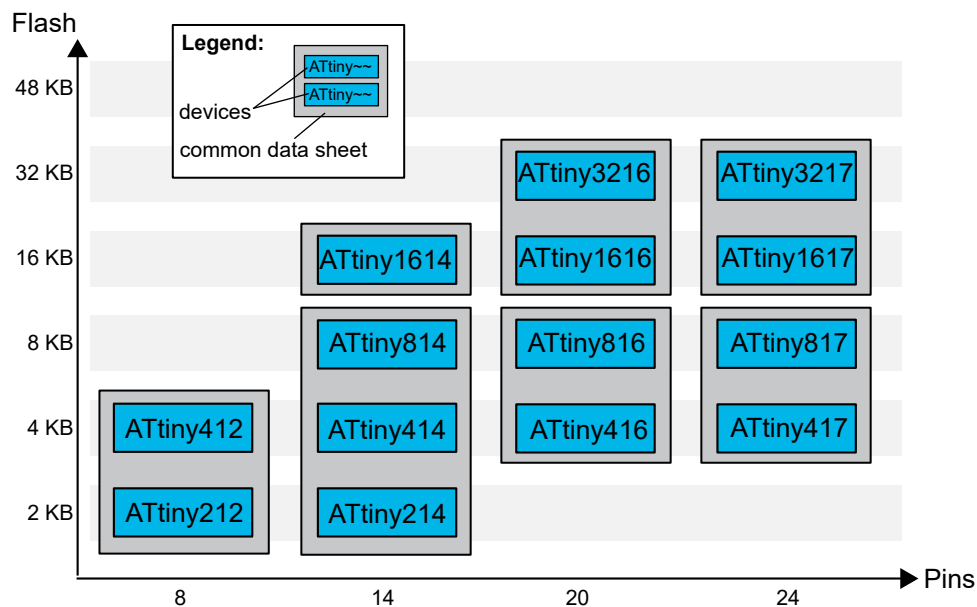
This chapter lists the relevant devices for this document.

1.1 tinyAVR 1-series

The figure below shows the tinyAVR® 1-series devices, illustrating pin count variants and memory sizes.

- Vertical migration upwards is possible without code modification, as these devices are pin compatible and provide the same or more features. Downward migration may require code modification due to fewer available instances of some peripherals.
- Horizontal migration to the left reduces the pin count and therefore the available features.

Figure 1-1. tinyAVR® 1-Series Device Overview

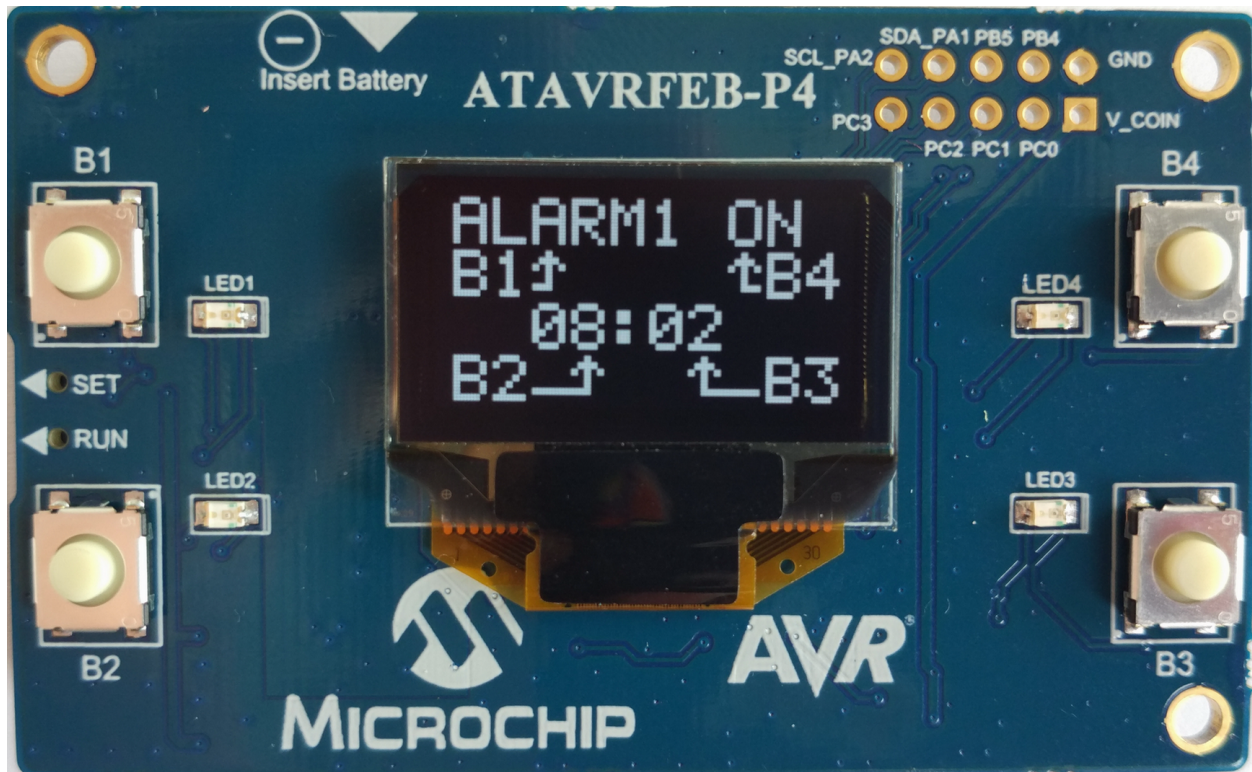


Devices with different Flash memory size typically also have different SRAM and EEPROM.

2. Pillbox Alarm Software Overview

The pillbox alarm application allows the user to set up to four different daily alarm times, as reminders to take pills at required times. To set up the current time and the alarm times, the user must place the SET/RUN slide switch in the SET position. As shown in the photograph below, an Organic Light-Emitting Diode (OLED) display and four pushbuttons are used to implement a simple interface for adjusting the alarms.

Figure 2-1. Photograph of the Pillbox Alarm Software Running on the P4 Board

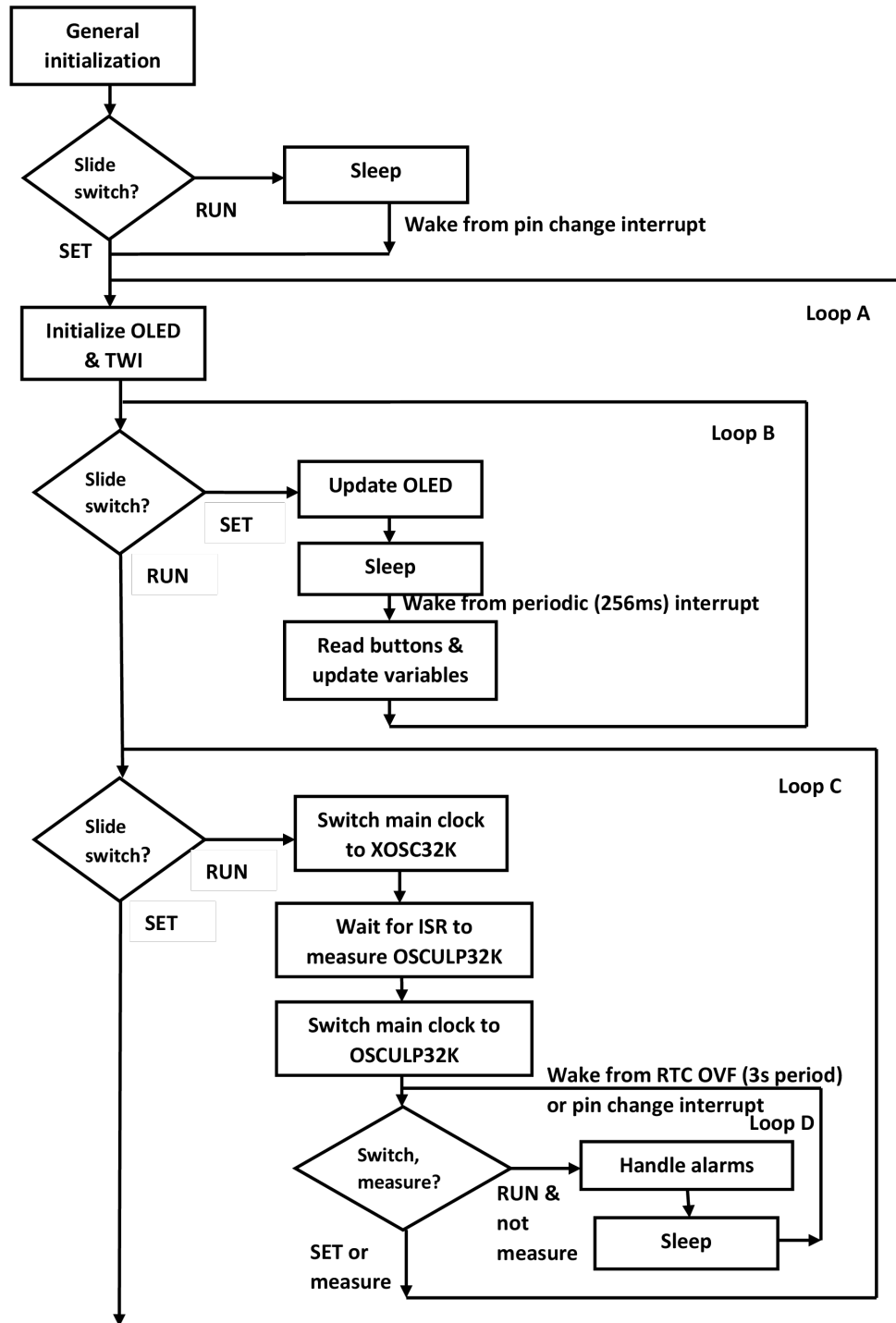


After alarm setup is complete, the user places the SET/RUN slide switch in the RUN position and the OLED display is shut off to conserve power. When an alarm occurs, a piezoelectric buzzer generates a pulsating sound and the LED associated with that alarm flashes until the adjacent pushbutton is pressed to reset the alarm.

3. Pillbox Alarm Software Description

A flowchart for the pillbox alarm application software is shown in the figure below.

Figure 3-1. Pillbox Alarm Application Flowchart



After a battery is inserted in the P4 board, the software starts by performing general initialization. The ports and peripherals required by the application are set up. As a simple start-up test, each red LED is turned ON for 50 milliseconds, and the piezoelectric buzzer is driven with a 4 kHz signal for five milliseconds to produce a short chirp.

Next, the slide switch on the P4 board is checked to determine if it is in the RUN or SET position. If the switch is in the RUN position, the device goes into STANDBY Sleep mode until it is awakened by a pin change interrupt. Once the switch is in the SET position, the CPU enters a forever loop (Loop A on the flowchart) that starts with the initialization of the OLED and Two-Wire Interface (TWI). The TWI is used for sending data to the OLED.

After the OLED and TWI have been initialized, the software enters a loop (Loop B on the flowchart) that starts by checking the position of the slide switch. If the slide switch is in the RUN position, the code escapes the loop and continues to another section of code. On the other hand, if the slide switch is in the SET position, the software stays in Loop B. This loop is responsible for implementing the alarm/time setting interface using the OLED display and four push buttons.

Loop B updates the OLED display based on several variables that store the alarm settings, current time, etc. All variables are in Static Random-Access Memory (SRAM). The device then goes to Sleep until it is awakened by a periodic interrupt with a period of 256 milliseconds. After the interrupt, the push buttons are read and alarm/time variables are updated accordingly, then program flow proceeds back to the beginning of Loop B.

When Loop B is exited, Loop C is entered. Loop C starts by checking the position of the slide switch. If the slide switch is in the SET position, the code escapes the loop and continues back to the beginning of Loop A. On the other hand, if the slide switch is in the RUN position, the software stays in Loop C.

Loop C is responsible for keeping track of time. It is also responsible for handling alarms by turning them ON or OFF at appropriate times. It starts by switching the main clock to the external 32.768 kHz crystal oscillator (XOSC32K). An interrupt service routine uses XOSC32K and the Timer Counter B peripheral (TCB) to precisely measure the frequency of the internal ultra-low-power 32 kHz oscillator (OSCULP32K). This is a method of calibrating the OSCULP32K so that it can be used for keeping track of time without the additional power consumption of the XOSC32K. After the measurement is completed, the main clock is switched back to OSCULP32K and XOSC32K is disabled.

Next, the RUN/SET switch is checked and the *measure* variable is checked. (The *measure* variable is updated in an interrupt service routine so that a new oscillator measurement is triggered every 15 minutes.) If the slide switch is still in the RUN position and it is not time for another oscillator measurement, alarms are checked and handled. Then the device is put into STANDBY Sleep mode.

When the device is awakened, either by a periodic (three seconds) Real-Time Counter (RTC) interrupt or pin change interrupt, the flow returns to the top of Loop D where the slide switch and *measure* variable are checked. If the slide switch is in the SET position or the *measure* variable indicates that another oscillator measurement is needed, the flow returns to the top of Loop C. Otherwise, the flow remains in Loop D.

Power consumption is minimized in the software by keeping the device in STANDBY Sleep mode most of the time, with only the OSCULP32K running to clock the RTC. The device only has to leave Sleep mode for a short interval every three seconds to handle the RTC interrupt, and it also has to leave Sleep mode every 15 minutes to perform a new measurement of the OSCULP32K frequency. The XOSC32K only runs for a few seconds every 15 minutes in order to perform the frequency measurement – otherwise, it is disabled and does not consume power. In hardware, the P4 board minimizes power consumption by disconnecting power from the OLED display when the slide switch is in the RUN position.

Because all variables are stored in SRAM, no alarm settings are retained when the battery is removed or depleted.

4. Get Source Code from Atmel | START

The example code is available through Atmel | START, which is a web-based tool that enables configuration of application code through a Graphical User Interface (GUI). The code can be downloaded for both Atmel Studio and IAR Embedded Workbench® via the direct example code-link(s) below or the *BROWSE EXAMPLES* button on the Atmel | START front page.

Atmel | START web page: <http://microchip.com/start>

Example Code

Pillbox Alarm P4

- http://start.atmel.com/#example/Atmel:pillbox_alarm_p4:1.0.0::Application:Pollbox_Alarm_P4:

Press *User guide* in Atmel | START for details and information about example projects. The *User guide* button can be found in the example browser, and by clicking the project name in the dashboard view within the Atmel | START project configurator.

Atmel Studio

Download the code as an .atzip file for Atmel Studio from the example browser in Atmel | START, by clicking *DOWNLOAD SELECTED EXAMPLE*. To download the file from within Atmel | START, click *EXPORT PROJECT* followed by *DOWNLOAD PACK*.

Double-click the downloaded .atzip file and the project will be imported to Atmel Studio 7.0.

IAR Embedded Workbench

For information on how to import the project in IAR Embedded Workbench, open the Atmel | START user guide, select *Using Atmel Start Output in External Tools*, and *IAR Embedded Workbench*. A link to the Atmel | START user guide can be found by clicking *About* from the Atmel | START front page or *Help And Support* within the project configurator, both located in the upper right corner of the page.

5. Revision History

Doc. Rev.	Date	Comments
B	10/2018	Performed editorial updates; updated tinyAVR® 1-series device overview figure.
A	12/2017	Initial document release.

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