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| --- | --- | --- |
| |  | | --- | | **Software Design Notes** | |  | |
| **FOR EDUCATIONAL USE ONLY** |

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| [www.minipcb.com](http://www.minipcb.com)  This document is available for free as a download from the GitHub repository: <https://github.com/miniPCB>  This document is associated with the miniPCB Channel on YouTube:  <https://www.youtube.com/@minipcb> |

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# Introduction

## Purpose

The purpose of this document is to record software design notes for the 13A-777 miniPCB.

## Scope

The scope of this document is limited to specifications and requirements, source code, and firmware releases.

## File Locations

|  |  |
| --- | --- |
| **FILE NAME** | **FILE LOCATION** |
| [ALL] | https://github.com/miniPCB/EAGLE/tree/main/miniPCB/13/A/13A-777 |

## Definitions and Abbreviations

* Convitae, the ratio of a response per input behavior.
* DHM, device histogram matrix, used to organize and access data.
* HPC, histogram program counter, used to track most recent game.
* HVC, histogram vector counter, used to track most recent entry.

# Specification Requirements

#### SSR1 – Hardware Abstraction

No text (title)

#### SSR1.1 Target Microcontroller

PIC16LF1789-I/PT

#### SSR1.2 Microcontroller Pinout

| **PIN** | **NAME** | **FUNCTION** | **DESCRIPTION** |
| --- | --- | --- | --- |
| 1 | RC7 | GPIO | LCD-D2 |
| 2 | RD4 | GPIO | LCD-D3 |
| 3 | RD5 | GPIO | LCD-D4 |
| 4 | RD6 | GPIO | LCD-D5 |
| 5 | RD7 | GPIO | LCD-D6 |
| 6, 29 | VSS | Return | Ground |
| 7, 28 | VDD | Source | Power |
| 8 | RB0 | GPIO | LCD-D7 |
| 9 | RB1 | No Connection |  |
| 10 | RB2 | No Connection |  |
| 11 | RB3 | GPIO | LCD-BACKLIGHT-ENABLE |
| 12, 13 | NC | No Connection | No pin function |
| 14 | RB4 | GPIO | LED1, Active Low |
| 15 | RB5 | GPIO | Button input, Active Low |
| 16 | RB6 | ICSPCLK | In Circuit Serial Programming |
| 17 | RB7 | ICSPDAT | In Circuit Serial Programming |
| 18 | RE3 | MCLR | In Circuit Serial Programming |
| 19 | RA0 | ADC | Battery voltage |
| 20 | RA1 | GPIO | Enable battery voltage divider. Active High. |
| 21 | RA2 | DAC1OUT1 | Adjusts LCD contrast. |
| 22 | RA3 | GPIO | Adjusts LCD contrast, Switches between high and low ranges |
| 23 | RA4 | GPIO | LCD Enable, Active High |
| 24 | RA5 | GPIO | Encoder Button Switch, Active Low |
| 25 | RE0 | GPIO | Encoder Red LED, Active Low |
| 26 | RE1 | GPIO | Encoder B input |
| 27 | RE2 | GPIO | Encoder A input |
| 30 | RA7 | No Connection |  |
| 31 | RA6 | No Connection |  |
| 32 | RC0 | No Connection |  |
| 33, 34 | NC | No Connection | No pin function |
| 35 | RC1 | GPIO | Encoder Green LED, Active Low |
| 36 | RC2 | GPIO | Encoder Blue LED, Active Low |
| 37 | RC3 | No Connection |  |
| 38 | RD0 | No Connection |  |
| 39 | RD1 | No Connection |  |
| 40 | RD2 | GPIO | LCD-RS |
| 41 | RD3 | GPIO | LCD-RW |
| 42 | RC4 | GPIO | LCD-RE |
| 43 | RC5 | GPIO | LCD-D0 |
| 44 | RC6 | GPIO | LCD-D1 |

#### SSR1.3 – Power

Manage power with these functional modes:

|  |  |
| --- | --- |
| **FUNCTION** | **DESCRIPTION** |
| sleepDeep | Minimal power consumption mode. |
| sleepActive | Low power consumption mode without sleeping. |
| activeGame | High power consumption mode. |
| batteryVoltage | Reads the current battery voltage. |

#### SSR1.4 – LCD

Control the 2x16 LCD with these functions:

|  |  |
| --- | --- |
| **FUNCTION** | **DESCRIPTION** |
| setContrast | Controls the voltage controlling the LCD contrast. |
| setBacklight | Controls the voltage controlling the LCD backlight. |
| refreshScreen | Writes the full screen to the LCD module. |

#### SSR1.5 – LED

Control the LED indicator with these functions:

|  |  |
| --- | --- |
| **FUNCTION** | **DESCRIPTION** |
| setLED | Turns an LED indicator on. |
| clearLED | Turns an LED indicator off. |
| toggleLED | Toggles an LED indicator from off to on, or on to off. |

#### SSR1.6 – Primary Select Button

Interface with the primary select button with this function:

|  |  |
| --- | --- |
| **FUNCTION** | **DESCRIPTION** |
| readSelectButton | Signals include: (1) wake, (2) confirm, (3) select. |

#### SSR1.7 – Rotary Encoder

Interface with a rotary encoder with these functions:

|  |  |
| --- | --- |
| **FUNCTION** | **DESCRIPTION** |
| setEncoderRGB | Sets color of the RGB LED on the encoder. |
| readEncoderButton | Reads the encoder button switch. |
| readEncoderRotation | Reads the encoder rotation count and direction. |

#### SSR1.8 – Device Clock

Maintain a device clock with 1 second resolution with these functions:

|  |  |
| --- | --- |
| **FUNCTION** | **DESCRIPTION** |
| setTimer | Sets value in timer counter. |
| getTimer | Reads value in timer counter. |
| incTimer | Increments value in timer counter. |
| spareTime | Returns with the counts available in the long (8 bytes). |
| timerRatio | Returns with the ratio of current\_count per max\_count. |

#### SSR1.9 – Device Histogram

No text (title)

#### SSR1.9.1 – Histogram Programming Interface

Maintain a device histogram with these functions:

|  |  |
| --- | --- |
| **FUNCTION** | **DESCRIPTION** |
| writeHistogram | Adds a new record to the device histogram.  Clears user interaction counters: buttonpress, encoderpress, and rotation. |
| writeHistogramValue | Writes a value to a device histogram. |
| playHistogram | Moves each value of the device histogram through the working register. |
| readHistorgram | Reads the histogram matrix. |
| readHistogramValue | Reads a value from the histogram matrix. |

#### SSR1.9.2 – Game Results

Results from games are saved.

#### SSR1.9.3 – Count Ratios

Device count ratios are computed by dividing a count-value by the max-count-value.

#### SSR1.9.4 – Rolling Memory

Write over the oldest data in the matrix to accommodate new data.

#### SSR1.9.5 – Histogram Program Counter (HPC)

Use a histogram counter to keep track of the most recent histogram entry.

#### SSR1.9.6 – Histogram Vector Counter (HVC)

Use a histogram counter to keep track of the most recent vector entry.

#### SSR1.9.7 – Histogram Memory

Device histogram is placed in RAM memory from 2A0h (bank 5) to 3EFh (bank 7).

|  |  |  |  |
| --- | --- | --- | --- |
| **#** | **HPC** | **HVC = 0**  **MEMORY ADDRESS** | **HVC = 15**  **MEMORY ADDRESS** |
| **0** | 0 | 2A0h | 2AFh |
| **1** | 1 | 2B0h | 2BFh |
| **2** | 2 | 2C0h | 2CFh |
| **3** | 3 | 2D0h | 2DFh |
| **4** | 4 | 2E0h | 2EFh |
| **5** | 5 | 320h | 32Fh |
| **6** | 6 | 330h | 33Fh |
| **7** | 7 | 340h | 34Fh |
| **8** | 8 | 350h | 35Fh |
| **9** | 9 | 360h | 36Fh |
| **10** | 10 | 3A0h | 3AFh |
| **11** | 11 | 3B0h | 3BFh |
| **12** | 12 | 3C0h | 3CFh |
| **13** | 13 | 3D0h | 3DFh |
| **14** | 14 | 3E0h | 3EFh |

#### SSR1.9.8 – Memory

Data is lost when the device loses power.

#### SSR2 – Toy Functionality

No text (title)

#### SSR2.1 – Sleep

The device will enter a low power mode when not in use.

#### SSR2.2 – Wakeup

The device will wake from low power mode when the Primary Select Button is pressed.

#### SSR3 – Game Functionality

No text (title)

#### SSR3.1 – PowerBall Lottery

No text (title)

#### SSR3.1.1 – Game Description

Select five (5) numbers from a set of sixty nine (69) numbers, and select one (1) number from a set of twenty six (26).

#### SSR3.1.2 – Histogram Contents

Selected numbers are saved in the device histogram.

#### SSR3.1.2 – Device Histogram Matrix (DHM)

Use the histogram counters to form a matrix.

#### SSR1.9.8 – Histogram Vector

Device histogram for PowerBall lottery is comprised of a matrix of vectors defined below.

|  |  |  |  |
| --- | --- | --- | --- |
| **#** | **DATA NAME** | **TYPE** | **INTUITIVE FOCUS** |
| **0** | GAME RESULT 0 | char | GAME CONVITAE \* USER CONVITAE |
| **1** | GAME RESULT 1 | char |
| **2** | GAME RESULT 3 | char |
| **3** | GAME RESULT 4 | char |
| **4** | GAME RESULT 5 | char |
| **5** | GAME RESULT 6 | char |
| **6** | GAME RESULT 7 | char |
| **7** | GAME RESULT 8 | char |
| **8** | SECOND COUNT RATIO | char | DEVICE CONVITAE |
| **9** | BUTTONPRESS COUNT RATIO | char |
| **A** | ROTATION COUNT RATIO | char |
| **B** | ENCODERPRESS COUNT RATIO | char |
| **C** | BATTERY VOLTAGE RATIO | char |
| **D** | USER SIGNAL 0 (LIVE) | char | DEVICE CONVITAE \* USER CONVITAE |
| **E** | USER SIGNAL 1 (LOVE) | char |
| **F** | USER SIGNAL 2 (LEARN) | char |

#### SSR1.9.9 – Histogram Memory Map

Device histogram will be mapped according to the memory map defined below.

|  |  |  |  |
| --- | --- | --- | --- |
| **#** | **HPC** | **HVC = 0**  **MEMORY ADDRESS** | **HVC = 15**  **MEMORY ADDRESS** |
| **0** | 0 | 2A0h | 2AFh |
| **1** | 1 | 2B0h | 2BFh |
| **2** | 2 | 2C0h | 2CFh |
| **3** | 3 | 2D0h | 2DFh |
| **4** | 4 | 2E0h | 2EFh |
| **5** | 5 | 320h | 32Fh |
| **6** | 6 | 330h | 33Fh |
| **7** | 7 | 340h | 34Fh |
| **8** | 8 | 350h | 35Fh |
| **9** | 9 | 360h | 36Fh |
| **10** | 10 | 3A0h | 3AFh |
| **11** | 11 | 3B0h | 3BFh |
| **12** | 12 | 3C0h | 3CFh |
| **13** | 13 | 3D0h | 3DFh |
| **14** | 14 | 3E0h | 3EFh |

# Source Code

Table – \FilePath\FileName1.ext

|  |
| --- |
| INSERT CODE HERE |

Table – \FilePath\FileName2.ext

|  |
| --- |
| INSERT CODE HERE |

Table – \FilePath\FileName3.ext

|  |
| --- |
| INSERT CODE HERE |

Table – \FilePath\FileName4.ext

|  |
| --- |
| INSERT CODE HERE |

# Firmware Release History

Table – Release 000-000-0-NM.DDMMMYYYY

|  |  |
| --- | --- |
| **File Name** |  |
| **File Size** |  |
| **File Location** |  |
| **Target Hardware** |  |
| **Maturity Level** |  |
| **Compiler Notes** |  |

# Revision History

|  |  |  |  |
| --- | --- | --- | --- |
| REV | DESCRIPTION | ECO | DATE |
| A | Initial Release | N/A | DDMMMYYYY |
|  |  |  |  |

# Related Content

|  |  |  |  |
| --- | --- | --- | --- |
| # | TYPE | DESCRIPTION | LOCATION |
| 1 | Sale Posting | eBay |  |
| 2 | Sale Posting | Mouser |  |
| 3 | Repository | Engineering Files | https://github.com/miniPCB/EAGLE/tree/main/miniPCB/13/A/13A-777 |
| 4 | Video | Preparation | https://youtu.be/YeX36dg0lwk |
| 5 | Video | Design | https://youtu.be/6YcOx\_vTpKk |
| 6 | Video | Documentation | https://youtu.be/-dhOiV1X4uM |
| 7 | Video | Development |  |
| 8 | Video | Testing |  |
|  | Video | Engineering Release |  |