EE 478 Capstone Final Report
RFID Interaction Suite

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1 ABSTRACT

2 INTRODUCTION

3 DISCUSSION OF THE LAB

3.1 Design Specification

A reference to Table 1 and one to the Design Specification, Section 3.2.

- Overall summary description of the module - 2-3 paragraphs maximum (explanation of use cases goes here)
  - Specification of the public interface to the module
    - Inputs
    - Outputs
    - Side effects
  - Psuedo English description of algorithms, functions, or procedures
  - Timing constraints
  - Error handling

Animal	Description	Price ($)
Gnat	per gram	13.65
	each	0.01
Gnu	stuffed	92.50
Emu	stuffed	33.33
Armadillo	frozen	8.99

Table 1: Example table

3.2 Design Specification

3.2.1 Design Requirement

3.2.2 Identified Use Cases

3.2.3 Detailed Specifications

3.2.4 Functional Decomposition

3.3 Hardware Implementation

3.3.1 Top Level Design

3.3.2 Low Level Design

3.4 Software Implementation

3.4.1 Top Level Design

3.4.2 Low Level Design

4 PRESENTATION, DISCUSSION, AND ANALYSIS OF THE RESULTS

4.1 Results

4.2 Discussion of Results

4.3 Analysis of Any Errors

4.4 Analysis of Implementation Issues and Workarounds

5 TEST PLAN

5.1 Test Specification

5.2 Test Cases

6 SUMMARY AND CONCLUSION

6.1 Final Summary

6.2 Project Conclusions

A BREAKDOWN OF LAB PERSON-HOURS (ESTIMATED)

Person	Design Hrs	Code Hrs	Test/Debug Hrs	Documentation Hrs
Patrick	x	x	x	x
Alyanna	x	x	x	x
Ryan	x	x	x	x

By initializing/signing above, I attest that I did in fact work the estimated number of hours stated. I also attest, under penalty of shame, that the work produced during the lab and contained herein is actually my own (as far as I know to be true). If special considerations or dispensations are due others or myself, I have indicated them below.

B HARDWARE DIAGRAMS

C FUNCTIONAL DECOMPOSITION DIAGRAM

D STATE DIAGRAMS

D.1 System State Diagram

D.2 General Gameplay State Diagram

E CONTROL FLOW DIAGRAMS

F PROJECT SCHEDULE

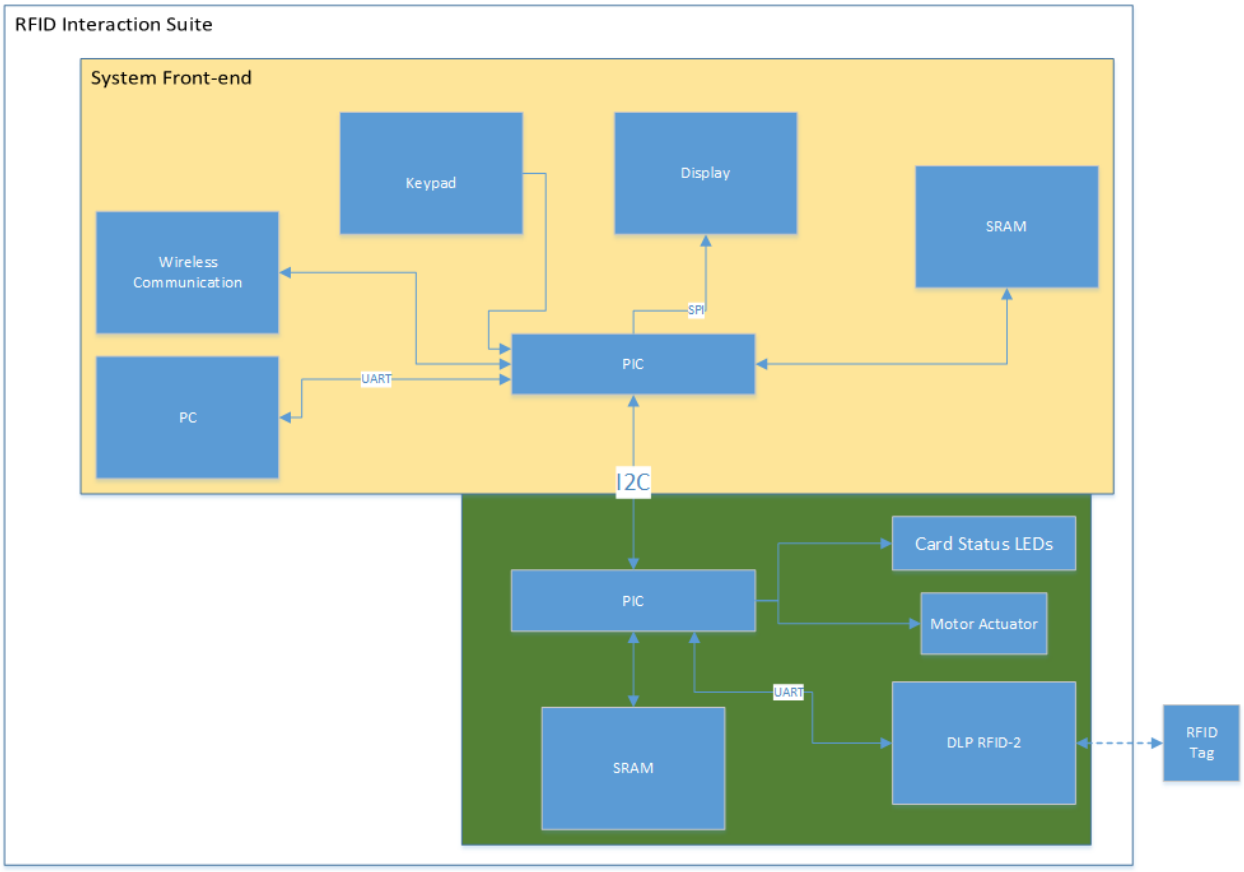


Figure 1: High level block diagram of the system hardware components

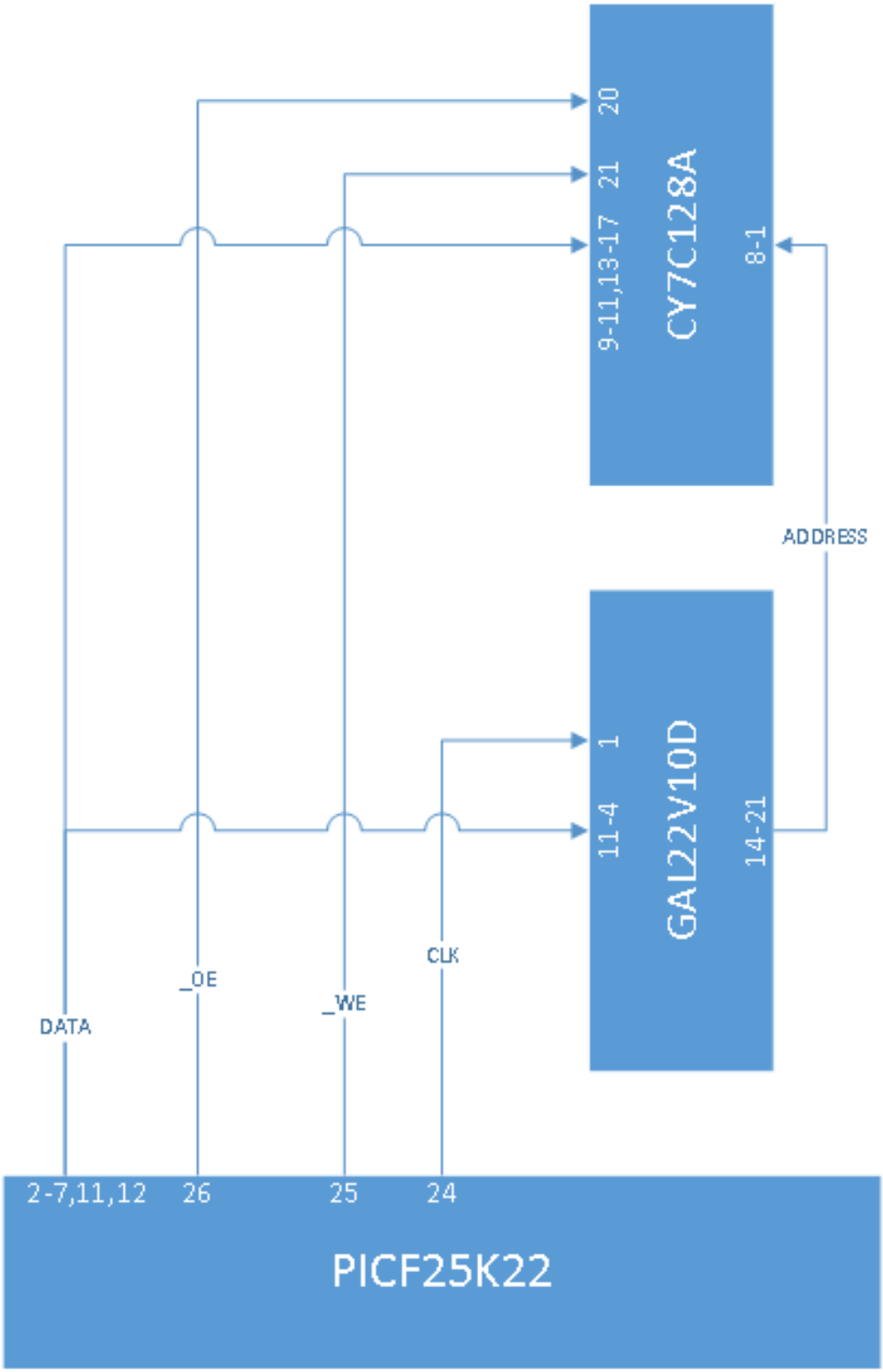


Figure 2: Block diagram of the SRAM hardware system

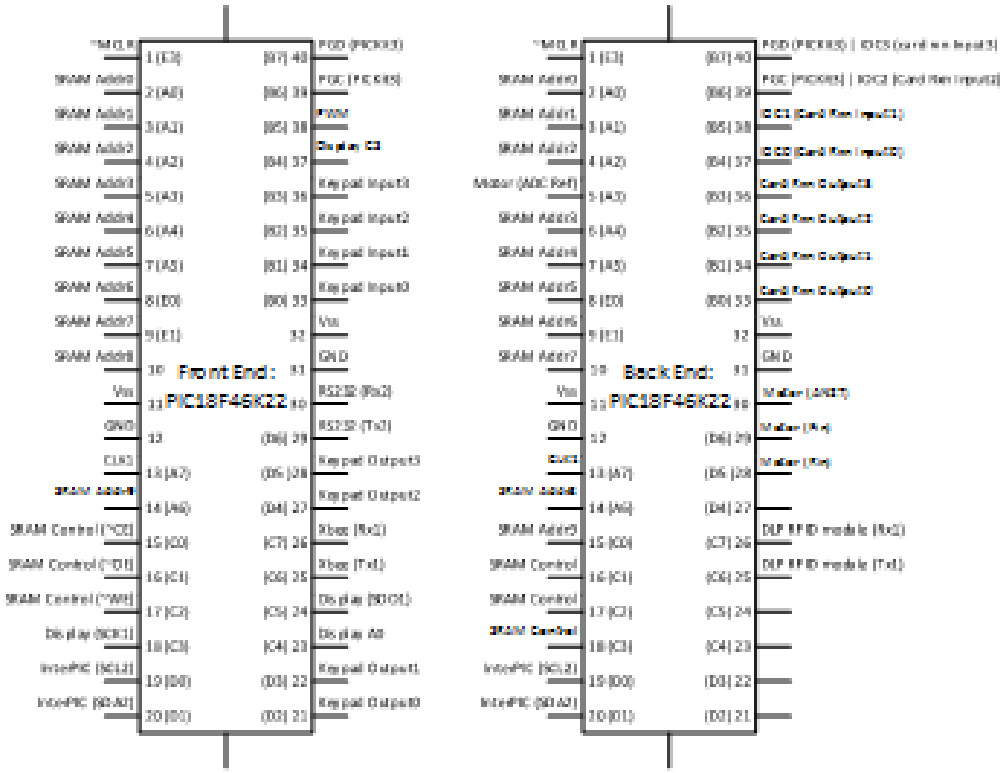


Figure 3: Pinouts to the front- and back-end microcontrollers

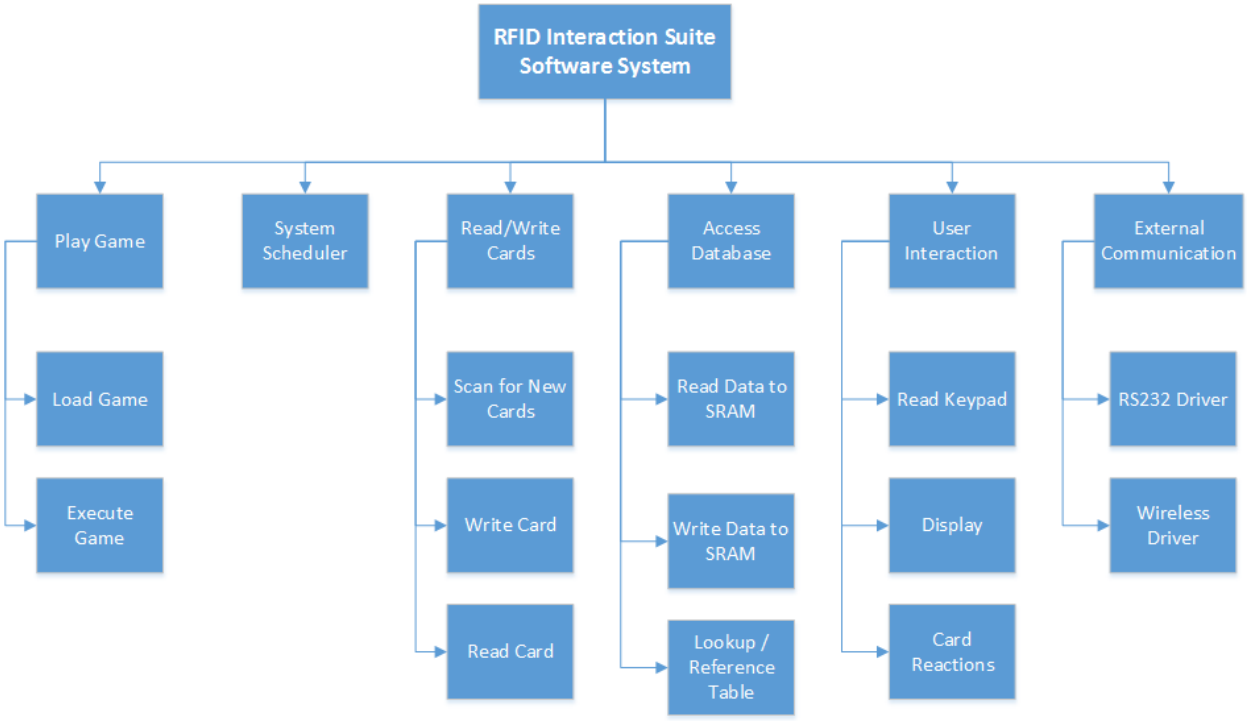
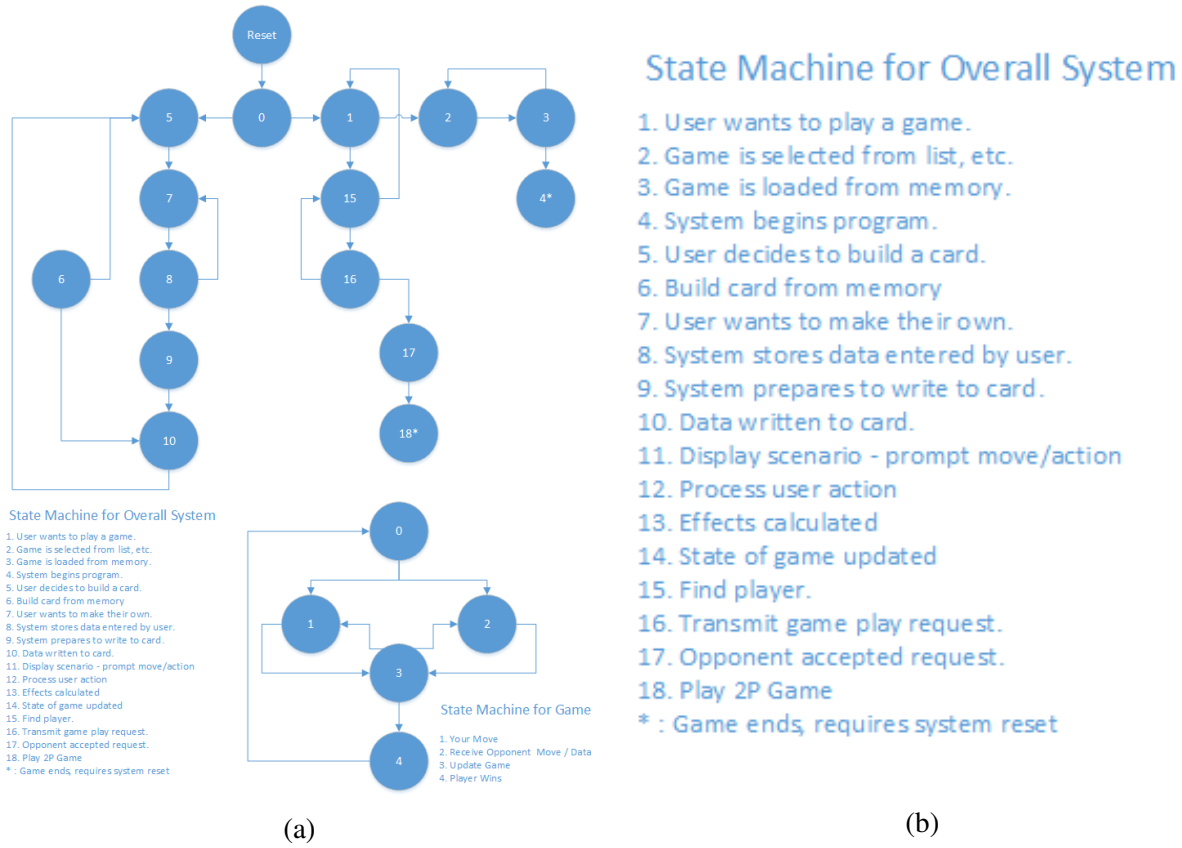


Figure 4: Software functional decomposition showing the major functional divisions and tasks



(a) (b)

Figure 5: State diagram of the primary operating system. Figure 5a shows the states while Figure 5b provides a legend

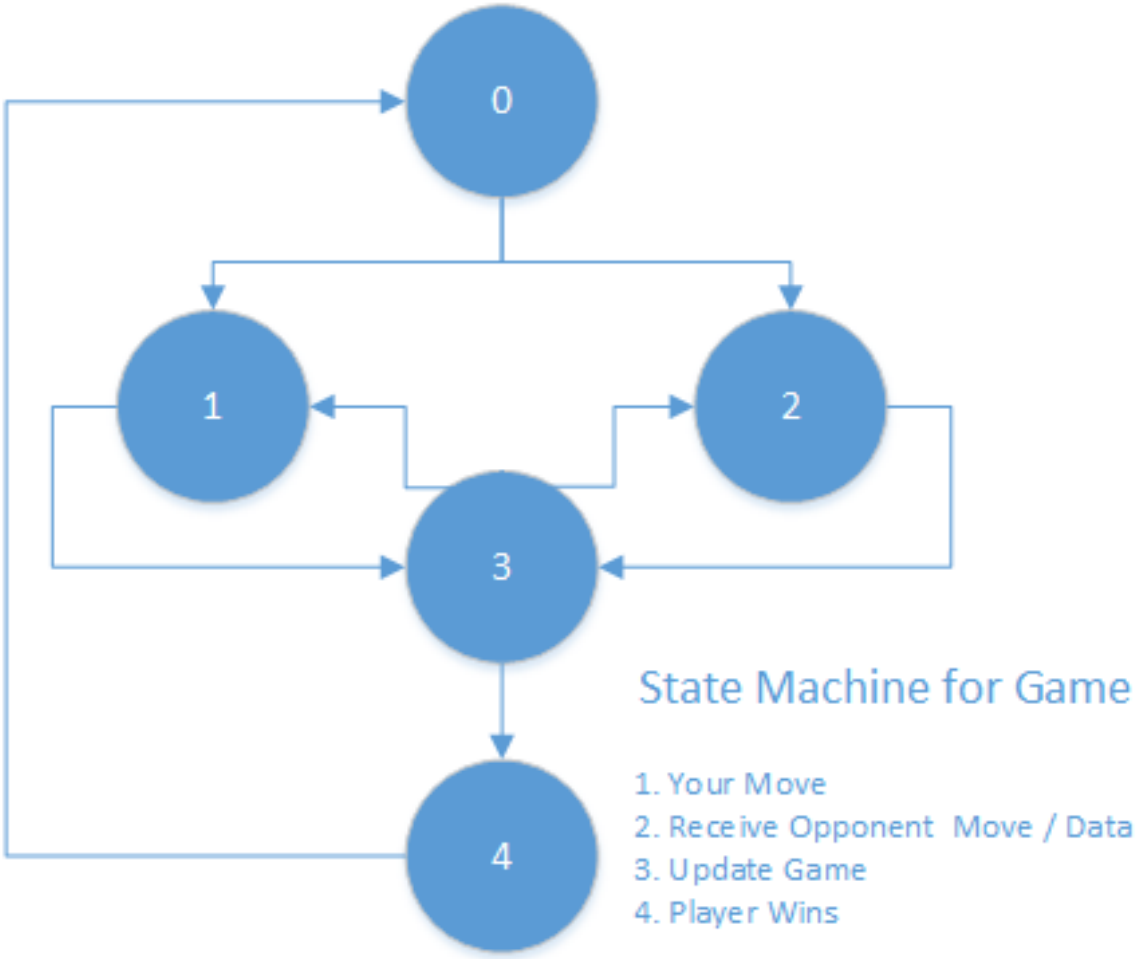


Figure 6: State diagram of basic turn-based game

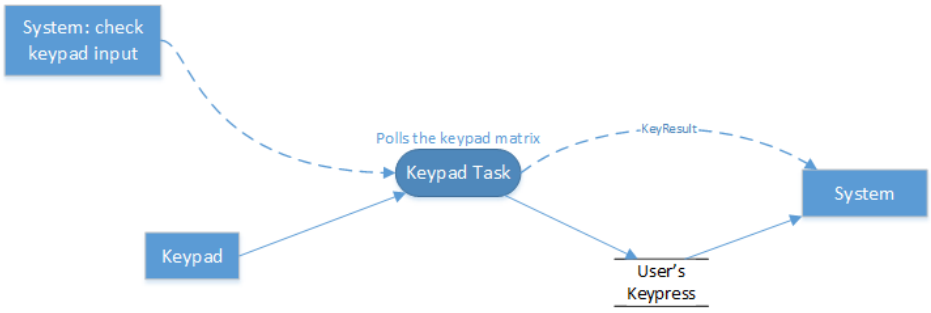


Figure 7: Keypad response

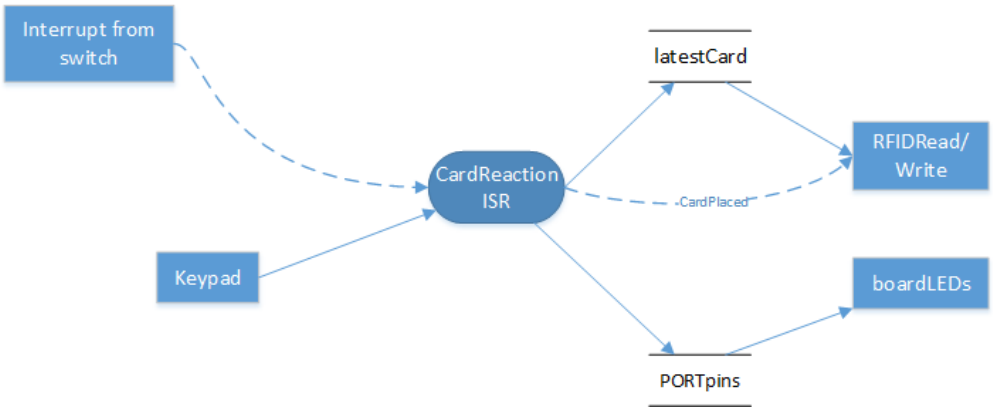


Figure 8: Card Reaction LEDs

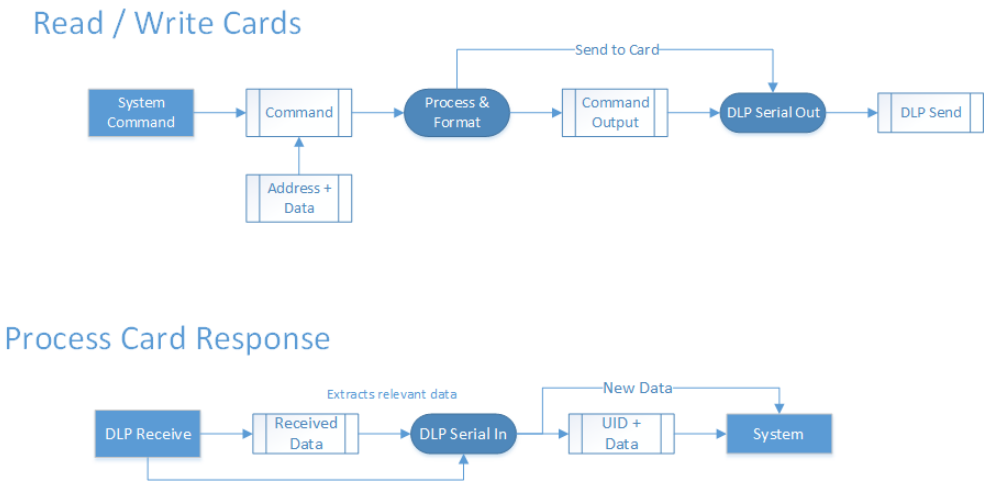
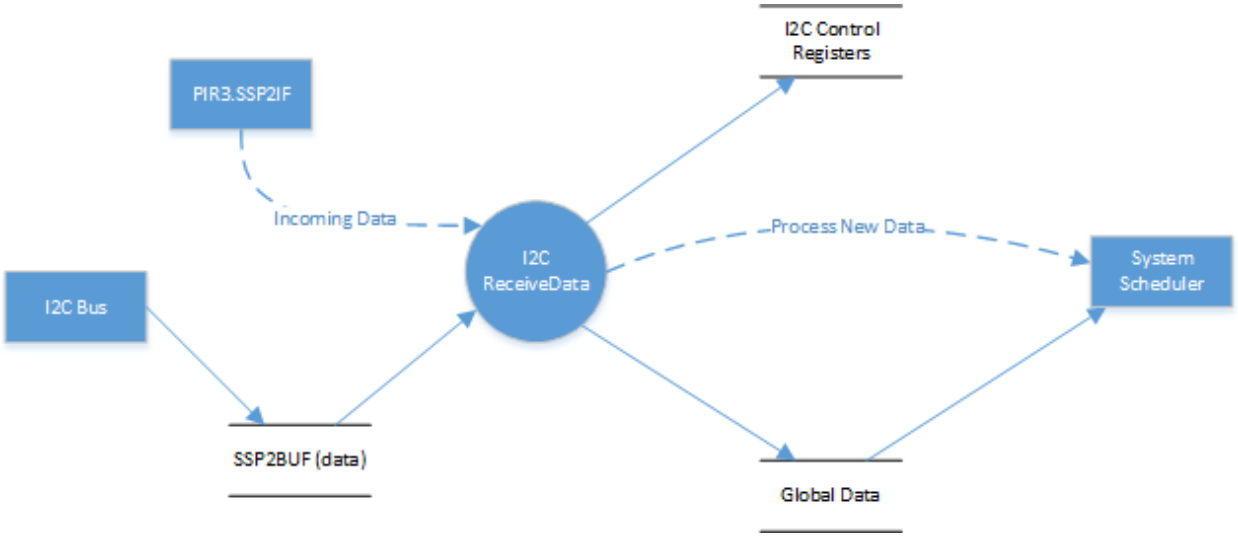
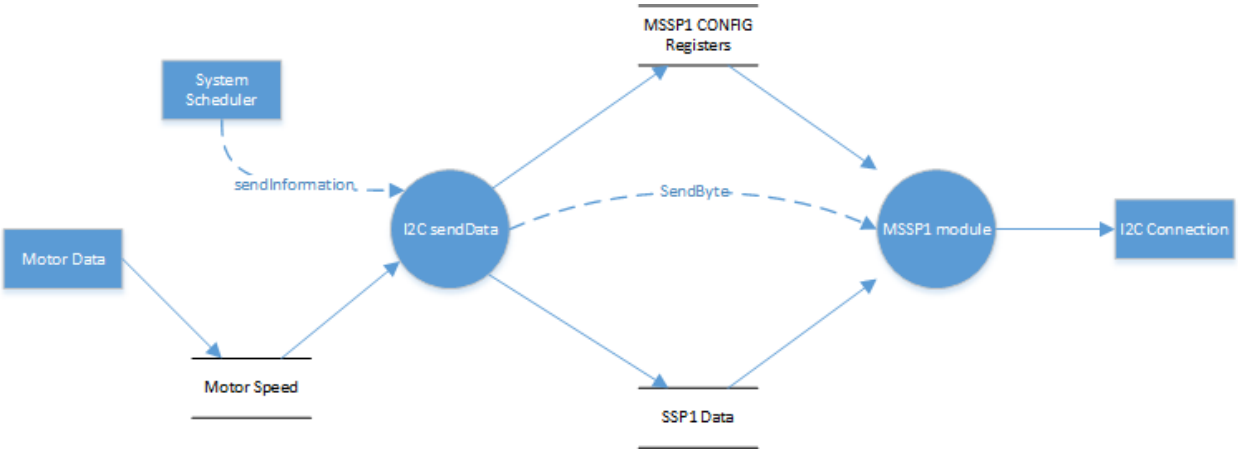


Figure 9: RFID tag reader subsystem

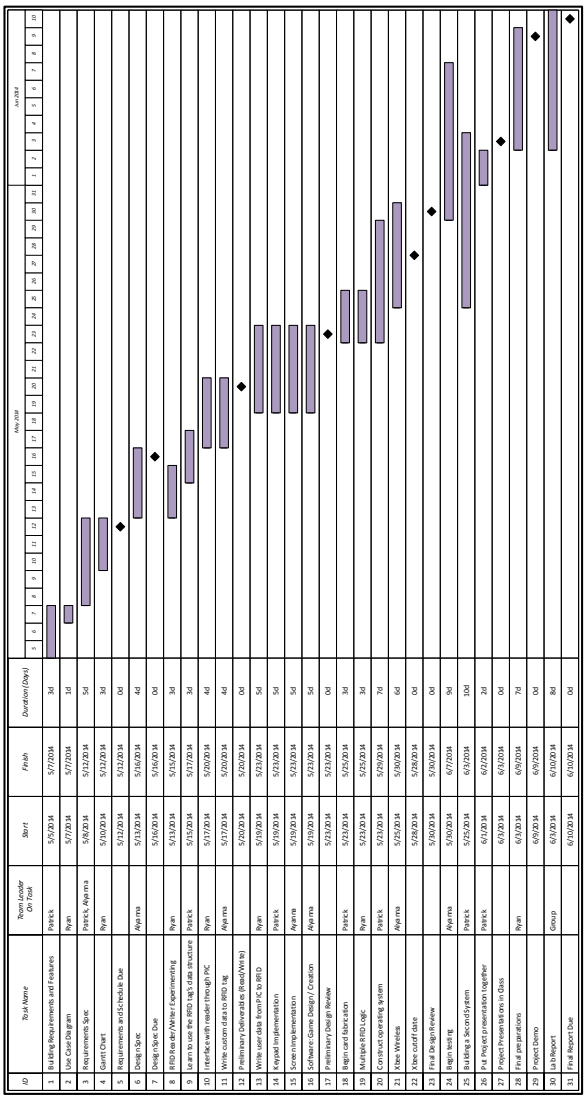


(a)



(b)

Figure 10: I2C communication between microcontrollers. Figure 10a shows the flow for received data and Figure 10b shows the flow for transmitted data.



ID	Task Name	Team Leader Or Task	Start	Finish	Duration (days)
1	Building Requirements and Features	Patrick	5/5/2014	5/7/2014	3d
2	Use Case Diagram	Ryan	5/7/2014	5/7/2014	1d
3	Requirements Spec	Patrick, Aiyanna	5/8/2014	5/12/2014	5d
4	Gantt Chart	Ryan	5/12/2014	5/12/2014	1d
5	Requirements and Schedule Due		5/12/2014	5/12/2014	0d
6	Design Spec	Aiyanna	5/13/2014	5/16/2014	4d
7	Design Spec Due		5/16/2014	5/16/2014	0d
8	RFID Reader/Writer Experimenting	Ryan	5/13/2014	5/15/2014	3d
9	Learn to use the RFID Tag's data structure	Patrick	5/15/2014	5/17/2014	3d
10	Interface with reader through PIC	Ryan	5/17/2014	5/20/2014	4d
11	Write custom data to RFID tag	Aiyanna	5/17/2014	5/20/2014	4d
12	Preliminary Deliverable (Read/Write)		5/20/2014	5/20/2014	0d
13	Write user data from PC to RFID	Ryan	5/19/2014	5/23/2014	5d
14	Keypad Implementation	Patrick	5/19/2014	5/23/2014	5d
15	Screen Implementation	Aiyanna	5/19/2014	5/23/2014	5d
16	Software Game Design / Creation	Aiyanna	5/19/2014	5/23/2014	5d
17	Preliminary Design Review		5/23/2014	5/23/2014	0d
18	Begin card fabrication	Patrick	5/23/2014	5/25/2014	3d
19	Multiple RFID Logic	Ryan	5/23/2014	5/25/2014	3d
20	Construct operating system	Patrick	5/23/2014	5/29/2014	7d
21	Xbee Wireless	Aiyanna	5/25/2014	5/30/2014	6d
22	Xbee cutoff date		5/28/2014	5/28/2014	0d
23	Final Design Review		5/30/2014	5/30/2014	0d
24	Begin testing	Aiyanna	5/30/2014	6/7/2014	9d
25	Building a Second System	Patrick	5/25/2014	6/3/2014	10d
26	Put Project presentation together	Patrick	6/1/2014	6/2/2014	2d
27	Project Presentations in Class		6/3/2014	6/3/2014	0d
28	Final preparations	Ryan	6/3/2014	6/9/2014	7d
29	Project Demo		6/9/2014	6/9/2014	0d
30	Lab Report	Group	6/3/2014	6/10/2014	8d
31	Final Report Due		6/10/2014	6/10/2014	0d

Figure 11: Project Gantt Chart

G SOURCE CODE

Source code for this project is provided below.

G.1 System Scheduler

The system-wide global definitions and variables are also given here for convenience.

../FrontEnd.X/globals.h

```
/*
 * File:   globals.h
 * Author: Patrick
 *
 * Created on May 27, 2014, 4:44 PM
 */

#ifndef GLOBALS_H
#define GLOBALS_H

#ifdef __cplusplus
extern "C" {
#endif

    // microchip libraries
#include <p18f46k22.h>
#include <usart.h>
#include <spi.h>
#include <delays.h>
#include <pwm.h>
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include "usart.h"
#include "delays.h"
#include <adc.h>
#include <timers.h>
#include "i2c.h"
#include "LED.h"

    // our headers
#include "rs232.h"
#include "keypadDriver.h"
#include "LCD.h"
#include "startup.h"
#include "interrupts.h"
#include "rfidReader.h"
#include "motorDriver.h"
#include "game.h"
#include "i2cComm.h"
```

```
#include "xbee.h"

#define FRONT_NOT_BACK 0 // is this the Front end or backend (should move to
    globals)

#define CARDSLOT_1 0b00010000
#define CARDSLOT_2 0b00100000
#define CARDSLOT_3 0b01000000
#define CARDSLOT_4 0b10000000
#define CARDBLOCKSIZE 4 // in bytes


    enum _myBool {
        FALSE = 0, TRUE = 1
    };
    typedef enum _myBool Boolean;

    typedef struct globaldata {
        short displayPage;
        Boolean keyFlag;
        Boolean displayedKey;
        Boolean goBack;
        Boolean xbeeFlag;
        Boolean firstTime;
        int keyPress;
        int keyStatus;
        int cursorPos;
        int mainMenuSpots[3]; // Find better way to do this
        int status;
        int mode;
  int cardSelect[4];
  int selectMove[4][3];
        int game;

        /* card block data read in*/
        unsigned char dataBlockNum;
        unsigned char dataSlotNum;
        unsigned char dataBlock[4]; // 32 bits of data

        Boolean getInventory;

        Boolean sendI2C; // i2c command prepped for transmission
        Boolean gotI2C; // i2c command was received

        Boolean updateLEDFlag;
        char lastCards;
        char readCard;  // flag indicating which card slot needs to be read
        Boolean runGetUpdatedCards;
    } GlobalState;
```

```
89      extern GlobalState globalData;
90
91  #ifdef  __cplusplus
92  }
93  #endif
94
95  #endif  /* GLOBALS_H */
```

../FrontEnd.X/interrupts.h

```
1   /*
2    * File:   interrupts.h
3    * Author: castia
4    *
5    * Created on April 24, 2014, 10:16 PM
6    */
7
8   #ifndef INTERRUPTS_H
9   #define INTERRUPTS_H
10
11  #ifdef  __cplusplus
12  extern "C" {
13  #endif
14
15  void rcISR(void);
16
17
18
19  #ifdef  __cplusplus
20  }
21  #endif
22
23  #endif  /* INTERRUPTS_H */
```

../FrontEnd.X/SchedMain.c

```
1   /*
2    * File:   SchedMain.c
3    * Author: Patrick
4    *
5    * Created on May 27, 2014, 4:35 PM
6    */
7
8   #include <stdio.h>
9   #include <stdlib.h>
10  #include <p18f46k22.h>
11
12  // included files for each sw function
13  #include "globals.h"
14  #include "rs232.h"
```

```
15
16
17 // Function prototypes
18 void systemSetup(GlobalState *data);
19 void setupPWM(void);
20
21 void processUID(char* uid);
22
23
24 // PIC configuration settings
25 /**************Clocking set up ********************/
26 #pragma config WDTEN = OFF     // turn off watch dog timer
27 #pragma config FOSC = ECHPIO6     // Ext. Clk, Hi Pwr
28 #pragma config PRICLKEN = OFF // disable primary clock
29
30 /**************USART set up ********************/
31 #pragma config FCMEN = OFF
32 #pragma config IESO = OFF
33 /************************************************/
34
35 /*
36  *
37  */
38 RFIDDriver readerData;
39 GlobalState globalData;
40 extern I2cDataStruct i2cData;
41
42
43 #pragma code high_vector=0x08
44
45 void interrupt_at_high_vector(void) {
46     _asm GOTO rcISR _endasm
47 }
48 #pragma code
49
50 #pragma interrupt rcISR
51
52 void rcISR(void) {
53     // The input character from UART2 (the RFID reader)
54 #if FRONT_NOT_BACK
55
56 #else
57     unsigned char input;
58     /*
59      * RFID interrupt
60      */
61
62     if (PIR1bits.RC1IF) {
63         input = RCREG1; // Read fast by directly looking at RCREG
```

```
64          //          If we are processing an Inventory command
65          if (readerData.invCom == 1 || readerData.readFlag_1 == 1 || readerData.
    writeFlag_1 == 1) {
66              if (input == 'D' && readerData.nextBlock == 0) {
67                  // Reset the inventory command flag
68                  readerData.invCom = 0;
69
70                  // Begin reading what is inside a block of square brackets
71
72              } else if (input == '[') {
73                  // Go to the beginning of the array, indicate that a block is
    being read
74                  readerData.inputSpot2 = 0;
75                  readerData.nextBlock = 1;
76
77                  // If we are at the end of a block of square brackets
78              } else if (input == ']' && readerData.numUID < MAX_UIDS &&
    readerData.nextBlock == 1) {
79                  // If there is a comma as the first character inside a block,
    then
80                  // discard what is read.  Otherwise, terminate the string and
    increment
81                  // the number of UIDs successfully read.
82                  if (readerData.readFlag_1 == 1) {
83                      readerData.readData[readerData.inputSpot2] = '\0';
84                      readerData.availableData++;
85                  } else if (readerData.readUID[readerData.numUID][0] != ',' &&
    readerData.writeFlag_1 != 1) {
86                      readerData.readUID[readerData.numUID][readerData.inputSpot2
    ] = '\0';
87                      readerData.numUID++;
88                  }
89
90                  // Block of square brackets has be read, set the indicator to
    zero
91                  readerData.nextBlock = 0;
92
93                  // Disable read 1 flag
94                  if (readerData.readFlag_1 == 1) {
95                      readerData.readFlag_1 = 0;
96                  }
97
98                  // Disable write 1 flag
99                  if (readerData.writeFlag_1 == 1) {
100                     readerData.writeFlag_1 = 0;
101                 }
102
103                 // Put anything inside of a square bracket into the UID array
```

```
104             } else if (readerData.nextBlock == 1 && readerData.inputSpot2 <
    UID_SIZE && readerData.numUID < MAX_UIDS) {
105                 if (readerData.readFlag_1 == 1) {
106                     readerData.readData[readerData.inputSpot2] = input;
107                     readerData.inputSpot2++;
108                 } else if (readerData.writeFlag_1 != 1) {
109                     readerData.readUID[readerData.numUID][readerData.inputSpot2
    ] = input;
110                     readerData.inputSpot2++;
111                 }
112 
113                 // If we are outside of a block, reset read position and ensure
     that the block
114                 // state indicator is zero.
115             } else {
116                 readerData.inputSpot2 = 0;
117                 readerData.nextBlock = 0;
118                 // Echo back typed character
119                 //Write2USART(input);
120             }
121 
122             // In config mode, count the line feeds
123         } else if (readerData.configFlag == 1) {
124             if (input == '\n') {
125                 readerData.lineFeeds++;
126             }
127         } else {
128             // Echo back typed character
129             //Write2USART(input);
130         }
131         PIR1bits.RC1IF = 0;
132     }/*
133          * LED status interrupt
134          * Card slots are:
135          * 0b00010000 = slot 1
136          * 0b00100000 = slot2
137          * 0b01000000 = slot3
138          * 0b10000000 = slot 4
139          */
140     else if (INTCONbits.RBIF == 1) {
141         char presentCards = PORTB;
142 
143         globalData.lastCards ^= presentCards; // find which port is triggered
144 
145         // set corresponding led status based on current port status
146         // tell rfid moudule to read the card (if needed)
147         if (globalData.lastCards & CARDSLOT_1) { //first slot
148             if (!(presentCards & CARDSLOT_1)) { // card is placed
149                 ledData.ledStatus[0] = 0;
```

```
150                 globalData.readCard |= CARDSLOT_1;
151             } else {
152                 ledData.ledStatus[0] = 3;
153             }
154         } else if (globalData.lastCards & CARDSLOT_2) { //second slot
155             if (!(presentCards & CARDSLOT_2)) { // card is placed
156                 ledData.ledStatus[1] = 0;
157                 globalData.readCard |= CARDSLOT_2;
158             } else {
159                 ledData.ledStatus[1] = 3;
160             }
161         } else if (globalData.lastCards & CARDSLOT_3) { //third slot
162             if (!(presentCards & CARDSLOT_3)) { // card is placed
163                 ledData.ledStatus[2] = 0;
164                 globalData.readCard |= CARDSLOT_3;
165             } else {
166                 ledData.ledStatus[2] = 3;
167             }
168         } else if (globalData.lastCards & CARDSLOT_4) { // fourth slot
169             if (!(presentCards & CARDSLOT_4)) { // card is placed
170                 ledData.ledStatus[3] = 0;
171                 globalData.readCard |= CARDSLOT_4;
172             } else {
173                 ledData.ledStatus[3] = 3;
174             }
175         }
176         globalData.updateLEDFlag = TRUE; // tell led driver to update leds
177         globalData.lastCards = presentCards;
178         PORTB = presentCards;
179         INTCONbits.RBIF = 0; // reset int flag
180     }
181 #endif
182     if (PIR3bits.SSP2IF == 1) { // process i2c interrupt
183         int temp = 0;
184         static unsigned char byteNumber = 0;
185 
186         //        PORTAbits.AN0 = 1;
187 
188         if (SSP2STATbits.P == 1) { // stop condition
189             i2cData.inDataSequence = FALSE;
190             i2cData.inLength = byteNumber;
191             byteNumber = 0;
192             if (!i2cData.transmitting) {
193                 globalData.gotI2C = 1; // alert the scheduler
194             }
195         } else if ((SSP2STATbits.D_A == 0) && (SSP2STATbits.BF == 1)) { //
    check if address
196             //            SSP2CON2bits.ACKDT = 0;
197             //            SSP2CON1bits.CKP = 1;
```

```
198 //            i2cData.dataOut[byteNumber++] = SSP2BUF;
199                       temp = SSP2BUF; // get rid of address
200         } else if ((SSP2STATbits.D_A == 1) && (SSP2STATbits.BF == 1)) { //
    check if data
201             i2cData.dataIn[byteNumber++] = SSP2BUF;
202             //            SSP2CON2bits.ACKDT = 0;
203             //            SSP2CON1bits.CKP = 1;
204 
205         } else if (SSP2STATbits.S == 1) { // start condition
206             i2cData.inDataSequence = TRUE;
207         }
208         PIR3bits.SSP2IF = 0; // clear the interrupt
209 
210         //        PORTAbits.AN0 = 1;
211 
212     }
213 
214     // Clear interrupts
215 
216 //    PIR1bits.TX1IF = 0;
217     PIR1bits.RC1IF = 0;
218     PIR3bits.TX2IF = 0;
219     PIR3bits.RC2IF = 0;
220 }
221 
222 void main() {
223     int i = 0;
224     int j = 0;
225     char test[2] = {'2', '\0'};
226 
227     systemSetup(&globalData);
228 
229 #if FRONT_NOT_BACK
230     TRISAbits.RA0 = 0;
231     ANSELAbits.ANSA0 = 0;
232 #else
233     //    TRISDbits.RD4 = 0;
234     //    ANSELDbits.ANSD4 = 0;
235     //    PORTDbits.RD4 = 1;
236 #endif
237 
238     //    // lcd test code
239     //    printMainMenu(&globalData);
240 
241     while (1) {
242 #if FRONT_NOT_BACK
243 
244 
245         // get the updated cards
```

```
246         if (globalData.runGetUpdatedCards == 1) {
247             getUpdatedCards();
248             globalData.runGetUpdatedCards = FALSE;
249         }
250 #else
251         // move the reader -- if we had one -- to the proper location
252 
253 
254         /*
255          * run LED driver
256          */
257         if (globalData.updateLEDFlag) {
258             globalData.updateLEDFlag = FALSE;
259             updateLEDs();
260         }
261 #endif
262 
263         // process pending i2c tasks
264         if (globalData.sendI2C == 1) {
265             sendBytes(i2cData.dataOut, i2cData.outLength);
266             globalData.sendI2C = FALSE;
267         }
268         if (globalData.gotI2C == 1) {
269             processI2C();
270             globalData.gotI2C = 0;
271         }
272 
273 #if FRONT_NOT_BACK
274         //         if (!globalData.keyFlag) {
275         //             keypad(&globalData);
276         //         }
277 
278         //         mainMenu(&globalData);
279 
280         //
281         //         if (globalData.keyFlag && !globalData.displayedKey) { // TODO
    this goes into a display function
282         //             globalData.keyFlag = FALSE;
283         //             globalData.displayedKey = TRUE;
284         //
285         ////             processDisplay(globalData);
286         //
287         //         }
288 
289 
290 #else
291         //Doing an inventory command from the Build card menu
292         if (globalData.readCard != 0) {
293 
```

```
294 //            globalData.getInventory = TRUE;
295 //        }
296 //        if (globalData.getInventory == TRUE) {
297             // get the inventory of cards
298             inventoryRFID();
299 
300             // Print out each on to the LCD
301             for (i = 0; i < readerData.availableUIDs; i++) {
302                 if (readerData.readUID[i][0] != ',') {
303                     // Get rid of commas
304                     processUID(readerData.readUID[i]);
305                     //                    printrs(0, 24 + 8 * i, BLACK, RED,
    readerData.readUID[i], 1); // print first UID
306                 }
307             }
308 
309             // got inventory, tell frontend
310             i2cData.dataOut[0] = CARD_CHANGE;
311             i2cData.outLength = 1;
312             globalData.sendI2C = TRUE;
313             i2cData.transmissionNum = 0; // begin counting slots
314 
315             // Tell UID to be quiet - Works but needs to have at least one uid
    in this state
316             // quietRFID(readerData.readUID[0]);
317 
318             //            if (readerData.availableUIDs > 0) {
319             //
320             //                // block 0 high bits being 0x0000 indicates
    factory card, not custom
321             //                // block 0 high bits being 0x0001 indicates
    custom card
322             //                // block 0 low bits indicate the game the card is
     for. 0x0001 is the monster game
323             //                writeRFID(readerData.readUID[0], 0x00, 0x0000, 0
    x0001); // 7654 3210
324             //                writeRFID(readerData.readUID[0], 0x01, 0x0010, 0
    x0001); // hex 7-5 are for level 0x001 is level 1
325             //                // hex 4 is for type 0 1 2 3
326             //                // 0x0 fire, 0x1 water, 0x3 earth
327             //                // last 4 are monster ID
328             //
329             //                //writes 8 chars in 2 addresses of memory (0x02
    and 0x03 here)
330             //                char8RFID(readerData.readUID[0], 0x02, "FIREDUDE
    ");
331             //                writeRFID(readerData.readUID[0], 0x04, 0x0003, 0
    x0201); // Move list by id, has moves 03, 02, and 01
332             //                readRFID(readerData.readUID[0], 0x00);
```

```
333             //                  printrs(0, 32, BLACK, RED, readerData.readData,
    1); // print 1st block
334             //                  readRFID(readerData.readUID[0], 0x01);
335             //                  printrs(0, 40, BLACK, RED, readerData.readData,
    1); // print 2nd block
336             //                  readRFID(readerData.readUID[0], 0x02);
337             //                  printrs(0, 48, BLACK, RED, readerData.readData,
    1); // print 3rd block
338             //                  readRFID(readerData.readUID[0], 0x03);
339             //                  printrs(0, 56, BLACK, RED, readerData.readData,
    1); // print 4th block
340             //                  readRFID(readerData.readUID[0], 0x04);
341             //                  printrs(0, 64, BLACK, RED, readerData.readData,
    1); // print 5th block
342             //              }
343             //
344             //
345             //              readRFID(readerData.readUID[0], 0x01);
346             //              // Print out block on to the LCD
347             //              for (j = 0; j < readerData.availableUIDs; j++) {
348             //                  if (readerData.readUID[j][0] != ',') {
349             //                      // Get rid of commas
350             //                      printrs(0, 24 + 8 * i + 8 * j, BLACK, RED,
    readerData.readUID[j], 1); // print first UID
351             //                  }
352             //              }
353             //
354             //              prints(0, H - 8, BLACK, RED, "Press B to go back.",
    1);
355             //              // Turn off inventory flag
356
357 //              globalData.getInventory = FALSE;
358             globalData.readCard = 0;
359         }
360 #endif
361     }
362     return;
363
364
365 }
366
367 // Reads the UID up until the comma
368
369 void processUID(char* uid) {
370     int i = 0;
371     while (uid[i] != ',') {
372
373         i++;
374     }
```

```
375     uid[i] = '\0';
376 }
377
378 void systemSetup(GlobalState *data) {
379
380     rs232Setup2(); // configure USART2
381     rs232Setup1(); // configure USART1
382     i2CSetup();
383     RFIDSetup();
384
385 #if FRONT_NOT_BACK
386     initSPI1();
387     initLCD();
388     keypadSetup(); // configure keypad
389     setupPWM();
390 #else
391     LEDSetup();
392 #endif
393
394     data->displayPage = 0;
395     data->keyFlag = FALSE;
396     data->displayedKey = FALSE;
397     data->keyPress = -1;
398     data->cursorPos = 0;
399     // Select Game Menu
400     data->mode = -1;
401     data->game = -1;
402     // Find better way to do this
403     data->mainMenuSpots[0] = 40;
404     data->mainMenuSpots[1] = 80;
405     data->mainMenuSpots[2] = 120;
406     data->getInventory = FALSE;
407     data->xbeeFlag = FALSE;
408     data->goBack = FALSE;
409     // Game Related Globals
410     data->keyStatus = -1;
411     memset(data->selectMove, 0, sizeof(int) * 4 * 3);
412     data->selectMove[0][1] = 10;
413     data->cardSelect[0] = 1;
414     data->cardSelect[1] = 0;
415     data->cardSelect[2] = 0;
416     data->cardSelect[3] = 0;
417     data->firstTime = TRUE;
418     data->updateLEDFlag = TRUE;
419     data->lastCards = 0;
420     data->readCard = 0;
421     data->dataBlockNum = 0;
422     data->dataSlotNum = 0;
423     memset(data->dataBlock, 0, sizeof(char) * CARDBLOCKSIZE);
```

```
424     data->runGetUpdatedCards = FALSE;
425     data->gotI2C = 0;
426     data->sendI2C = 0;
427 
428     OpenTimer0(TIMER_INT_OFF & T0_SOURCE_INT & T0_PS_1_32);
429 
430     return;
431 }
432 
433 void setupPWM(void) {
434     // configure PWM
435 
436     TRISBbits.RB5 = 1; // disable PWM output
437     CCPTMRS0 = 0b01000000; // set CCP3 to use Timer 4
438     T4CON = 0b00000111; // set timer prescale 1:16, turn on timer4
439     PR4 = 0xFF; // PR = 77 for 4kHz (cool sound). set to 0xff because will be
440     // set based on the key pressed
441 
442 
443     CCP3CON = 0b00011100; // set LSB of duty yle, select pwm mode
444     CCPR4L = 0x3E; // set MSB of duty cycle
445     PIR5 = 0b00000000; // clear timer interrupt flag
446     TRISBbits.RB5 = 1; //disable PWM output
447     SetDCPWM4(50); // Square wave
448 }
```

G.2 Creating Cards

../FrontEnd.X/buildCard.c

```
1  void printBuildMenu(GlobalState* globalData) {
2    int i = 0;
3 
4    prints(7, 10, BLACK, RED, "Available Cards:", 1);
5    processPrintCursor(globalData, size, RED, BLACK);
6  }
7 
8  void buildCardMenu(GlobalState* globalData) {
9    char* buildOptions[3] = {"Add Name", "Add Move", "Remove Move"};
10   int build;
11   printMenu(buildOptions, PINK, WHITE, BLACK, BLACK, 3};
12   build = processPrintCursor(globalData, 3, BLACK, PINK);
13   switch(build) {
14     // Add Name
15     case 0:
16       addName();
17       break;
18     // Add Move
```

```
19      case 1:
20        addMove();
21        break;
22      // Remove Move
23      case 2:
24        removeMove();
25        break;
26      // Go Back
27      case 0xFF:
28        globalData->goBack = TRUE;
29        break;
30    }
31  }
32
33  void printAddNameMenu(GlobalState* globalData) {
34    clean(RED);
35    prints(35, 7, RED, BLACK, "Add the following name?", 1);
36
37    // Draw Box with name inside
38      drawBoxFill(0, 20, 20, V - 1, WHITE);
39      drawBoxBorder(0, 20, 20, V - 1, 2, BLACK, 8);
40    printrs(35, 25, BLACK, WHITE, name, 1);
41    prints(35, 40, RED, BLACK, "1. Yes", 1);
42    prints(35, 60, RED, BLACK, "2. No", 1);
43    prints(0, H - 8, RED, BLACK, "Press B to return.", 1);
44  }
45
46  void addName(GlobalState* globalData) {
47    char* name[9] = "";
48    printKeyboard(globalData, name, "NAME?", 9);
49
50  }
51
52
53  /*          //Doing an inventory command from the Build card menu
54          if (globalData.getInventory == TRUE) {
55              // get the inventory of cards
56              inventoryRFID();
57
58              // Print out each on to the LCD
59              for (i = 0; i < readerData.availableUIDs; i++) {
60                  if (readerData.readUID[i][0] != ',') {
61                      // Get rid of commas
62                      processUID(readerData.readUID[i]);
63                      printrs(0, 24 + 8 * i, BLACK, RED, readerData.readUID[i],
      1); // print first UID
64                  }
65              }
```

```
66          // Tell UID to be quiet - Works but needs to have at least one uid
    in this state
67          // quietRFID(readerData.readUID[0]);
68
69          if (readerData.availableUIDs > 0) {
70
71              // block 0 high bits being 0x0000 indicates factory card, not
    custom
72              // block 0 high bits being 0x0001 indicates custom card
73              // block 0 low bits indicate the game the card is for. 0x0001
    is the monster game
74              writeRFID(readerData.readUID[0], 0x00, 0x0000, 0x0001); // 7654
     3210
75              writeRFID(readerData.readUID[0], 0x01, 0x0010, 0x0001); // hex
    7-5 are for level 0x001 is level 1
76              // hex 4 is for type 0 1 2 3
77              // 0x0 fire, 0x1 water, 0x3 earth
78              // last 4 are monster ID
79
80              //writes 8 chars in 2 addresses of memory (0x02 and 0x03 here)
81              char8RFID(readerData.readUID[0], 0x02, "FIREDUDE");
82              writeRFID(readerData.readUID[0], 0x04, 0x0003, 0x0201); // Move
     list by id, has moves 03, 02, and 01
83              readRFID(readerData.readUID[0], 0x00);
84              printrs(0, 32, BLACK, RED, readerData.readData, 1); // print 1
    st block
85              readRFID(readerData.readUID[0], 0x01);
86              printrs(0, 40, BLACK, RED, readerData.readData, 1); // print 2
    nd block
87              readRFID(readerData.readUID[0], 0x02);
88              printrs(0, 48, BLACK, RED, readerData.readData, 1); // print 3
    rd block
89              readRFID(readerData.readUID[0], 0x03);
90              printrs(0, 56, BLACK, RED, readerData.readData, 1); // print 4
    th block
91              readRFID(readerData.readUID[0], 0x04);
92              printrs(0, 64, BLACK, RED, readerData.readData, 1); // print 5
    th block
93          }
94
95
96          readRFID(readerData.readUID[0], 0x01);
97          // Print out block on to the LCD
98          for (j = 0; j < readerData.availableUIDs; j++) {
99              if (readerData.readUID[j][0] != ',') {
100                 // Get rid of commas
101                 printrs(0, 24 + 8 * i + 8 * j, BLACK, RED, readerData.
    readUID[j], 1); // print first UID
102             }
```

```
            }

            prints(0, H - 8, BLACK, RED, "Press B to go back.", 1);
            // Turn off inventory flag

            globalData.getInventory = FALSE;
        } */
```

G.3 Example Game

Both a single player and multiplayer version of the same game are provided.

../FrontEnd.X/game.h

```
#include "globals.h"

typedef enum _myTypes {
    FIRE = 0, WATER = 1, EARTH = 2
}Type;

typedef struct _move {
    char moveName[9];
    Type moveType;
    int baseDamage;
    int uses;
} Move;

typedef struct _monster {
    char monsterName[9];
    int monsterID;
    int level;
    Type monsterType;
    Move movelist[3];
} Monster;

typedef struct _gameData {
    int myScore;
    int oppScore;
    short turn;
    int gameOver;
    Monster* myMonster;
    Monster* oppMonster;
    Move* myMove;
    Move* oppMove;
    char name[5];
} gameData;

void setupGame();

```

```
36 void printKeyboard(GlobalState* globalData, char* name);
37
38 // Game Prototypes
39 void singlePlayer(GlobalState* globalData);
40 void multiPlayer(GlobalState* globalData);
41 void buildCards(GlobalState* globalData);
42 void getCards(void);
43
44 // Helper Prototypes
45 int findPlayer(GlobalState* globalData);
46 int gameStatus(void);
47 int attack(Move* attack, Monster* monster, int targetScore);
48 Monster* selectCard(GlobalState* globalData);
49 Move* pickMove(GlobalState* globalData);
50
51 // Xbee Prototypes
52 void sendMove(void);
53 void receiveMove(void);
54 void sendScore(void);
55 int receiveScore(void);
56
57 // Game Display Prototypes
58 void printGame(GlobalState* globalData);
59 void printSelect(GlobalState* globalData);
60 void printAttackMenu(GlobalState* globalData, Monster* card);
61 void printResults(void);
62
63 /*
64 typedef struct _gameData {
65     int myScore;
66     int oppScore;
67     short turn;
68     int gameOver;
69     int myMove;
70     int oppMove;
71     char* moveName;
72 } gameData;
73
74 */
```

../FrontEnd.X/game.c

```
1 /*
2
3
4  */
5 #include <stdio.h>
6 #include <stdlib.h>
7 #include "globals.h"
```

```
8  #include "game.h"
9  #include "LCD.h"
10
11 #define HEALTH 100
12
13
14 gameData game;
15 Monster myMonsterList[4];
16
17 void setupGame() {
18     game.myScore = HEALTH;
19     game.oppScore = HEALTH;
20     game.turn = 0;
21     game.gameOver = 0;
22     game.myMove = NULL;
23     game.oppMove = NULL;
24     game.myMonster = NULL;
25     game.oppMonster = NULL;
26     srand(ReadTimer0());
27 }
28
29 void singlePlayer(GlobalState* globalData) {
30     int tempScore;
31     // First time playing?
32     // Read first time from SRAM
33     if (globalData->firstTime == TRUE) {
34         printKeyboard(globalData, game.name, "NAME?", 5);
35         globalData->firstTime = FALSE;
36     }
37
38     // Setup new game
39     setupGame();
40     getCards();// Assume cards already read by interrupts on switches (?)
41     game.turn = rand() % 2;
42     printGame(globalData);
43
44     // Wait till someone presses D to continue
45     keypad(globalData);
46     while (globalData->keyPress != 0x0D) {
47         keypad(globalData);
48     }
49
50     // Begin game with computer
51     while (!game.gameOver) {
52         // Situation depends on game.turn
53         if (game.turn) {
54             game.myMove = pickMove(globalData);
55             game.myMove.uses--;
56             printGame(globalData);
```

```
57              tempScore = game.oppScore;
58              game.oppScore = attack(game.myMove, game.myMonster, game.oppScore);
59              if (game.oppScore == tempScore) {
60                  prints(0, 10, RED, BLACK, "                    ", 1);
61                  prints(0, 18, RED, BLACK, "                    ", 1);
62                  prints(0, 26, RED, BLACK, "                    ", 1);
63                  prints(0, 10, RED, BLACK, "Missed!", 1);
64              } else {
65                  prints(0, 10, RED, BLACK, "                    ", 1);
66                  prints(0, 18, RED, BLACK, "                    ", 1);
67                  prints(0, 26, RED, BLACK, "                    ", 1);
68                  prints(0, 10, RED, BLACK, "Your", 1);
69                  printrs(30,10, RED, BLACK, game.myMonster->monsterName, 1);
70                  prints(84, 10, RED, BLACK, "used", 1);
71                  printrs(0, 18,RED, BLACK, game.myMove->moveName, 1);
72                  prints(0, 26, RED, BLACK, "-    ", 1);
73                  integerprint(6, 26, RED, BLACK, tempScore - game.oppScore, 1);
74              }
75          } else {
76              // Computer randomly picks a monster and attack
77              game.oppMonster = &myMonsterList[rand() % 4 ];
78              game.oppMove = &game.oppMonster->movelist[rand() % 3];
79              tempScore = game.myScore;
80              game.myScore = attack(game.oppMove, game.oppMonster, game.myScore);
81              if (game.myScore == tempScore) {
82                  prints(0, 10, RED, BLACK, "                    ", 1);
83                  prints(0, 18, RED, BLACK, "                    ", 1);
84                  prints(0, 26, RED, BLACK, "                    ", 1);
85                  prints(0, 10, RED, BLACK, "Enmy Missed!", 1);
86              } else {
87                  prints(0, 10, RED, BLACK, "                    ", 1);
88                  prints(0, 18, RED, BLACK, "                    ", 1);
89                  prints(0, 26, RED, BLACK, "                    ", 1);
90                  prints(0, 10, RED, BLACK, "Enmy", 1);
91                  printrs(30, 10, RED, BLACK, game.oppMonster->monsterName, 1);
92                  prints(84, 10, RED, BLACK, "used", 1);
93                  printrs(0, 18, RED, BLACK, game.oppMove->moveName, 1);
94                  prints(0, 26, RED, BLACK, "-    ", 1);
95                  integerprint(6, 26, RED, BLACK, tempScore - game.myScore, 1);
96              }
97          }
98          prints(0, 40, YELLOW, BLACK, "Your Score: ", 1);
99          prints(0, 55, YELLOW, BLACK, "      ", 1);
100         integerprint(0, 55, YELLOW, BLACK, game.myScore, 1);
101         prints(0, 70, WHITE, BLACK, "Opponent Score: ", 1);
102         prints(0, 85, WHITE, BLACK, "      ", 1);
103         integerprint(0, 85, WHITE, BLACK, game.oppScore, 1);
104
105         keypad(globalData);
```

```
106         while (globalData->keyPress != 0x0D) {
107             keypad(globalData);
108         };
109 
110         // Check game status
111         game.gameOver = gameStatus();
112         game.turn = !game.turn;
113     }
114     // Display results once there is a lost
115     printResults();
116 }
117 
118 void multiPlayer(GlobalState* globalData) {
119     int connect = 0;
120     int hostOrFind = 0; // 0 host game, 1 find game
121     char* mySelections[2] = {"Host Game", "Find Game"};
122     setupXbee();
123     printMenu(mySelections, BLACK, GRAY, WHITE, YELLOW, 2);
124     prints(25, 7, YELLOW, GRAY, "Multiplayer", 1);
125     hostOrFind = processPrintCursor(globalData, 2, BLACK, YELLOW);
126     switch (hostOrFind) {
127         case 0:
128             prints(3, 48, YELLOW, GRAY, "Waiting for players...", 1);
129             hostGame();
130             break;
131         case 1:
132             prints(3, 88, YELLOW, GRAY, "Looking for games...", 1);
133             findGame();
134             break;
135         case 0xFF:
136             return;
137             break;
138     }
139 
140 
141 
142     setupGame();
143 
144 //     // Find other players
145 //     while (!connect) {
146 //         connect = findPlayer();
147 //     }
148 //
149 //     // NOTE: Need to build something to determine who goes first
150 //     // Compare Xbee ID's perhaps?
151 //
152 //     // Begin game
153 //     while (!game.gameOver && connect) {
154 //         if (game.turn) {
```

```
155 //             // Pick Move
156 //             game.myMove = pickMove(globalData);
157 //             // Send Move
158 //             sendMove();
159 //             // Receive new score after opponent takes damage
160 //             game.oppScore = receiveScore();
161 //             printGame(globalData);
162 //             prints(0, 10, RED, BLACK, "                    ", 1);
163 //             prints(0, 10, RED, BLACK, "Opponent took damage:", 1);
164 //             prints(0, 21, RED, BLACK, "-", 1);
165 //             integerprint(6, 21, RED, BLACK, game.myMove, 1);
166 //         } else {
167 //             // Receive player move and take damage
168 //             game.myScore = attack(receiveMove(), game.myScore);
169 //             prints(0, 10, RED, BLACK, "                    ", 1);
170 //             prints(0, 10, RED, BLACK, "Taken damage:", 1);
171 //             prints(0, 21, RED, BLACK, "-", 1);
172 //             integerprint(6, 21, RED, BLACK, game.oppMove, 1);
173 //             // Send new score
174 //             sendScore();
175 //         }
176 //         prints(0, 45, YELLOW, BLACK, "        ", 1);
177 //         integerprint(0, 45, YELLOW, BLACK, game.myScore, 1);
178 //         prints(0, 75, WHITE, BLACK, "        ", 1);
179 //         integerprint(0, 75, WHITE, BLACK, game.oppScore, 1);
180 //         // Check game status
181 //         game.gameOver = gameStatus();
182 //         game.turn =!game.turn;
183 //     }
184 //     if (!connect) {
185 //         printBSOD();
186 //     } else {
187 //         printResults();
188 //     }
189 }
190
191
192 // Program data on the card
193 // Monster ID
194 // Attack ID
195
196 void buildCard(GlobalState* globalData) {
197     // Read Card to be built
198
199     // Enter data to be stored in card
200
201     // Write data to card
202 }
203
```

```
204 /* The following functions are helper commands for the main games.
205  * Set Up
206  * Moves
207  * Display
208  */
209
210 // Sets up connection with other players
211
212 int findPlayer(GlobalState* globalData) {
213 //     printMultiplayerSetup(globalData);
214     return 0;
215 }
216
217 // Checks if a winner has been found
218
219 int gameStatus() {
220     return (0 == game.oppScore || 0 == game.myScore);
221 }
222
223 // Regame.turns new score of player after taking damage
224
225 int attack(Move* attack, Monster* monster, int targetScore) {
226     int hitPCT = (3*monster->level) + 75;
227     int totalDmg = attack->baseDamage + 2*(monster->level);
228
229     if (hitPCT > (rand() % 101))  {
230
231         if (attack->moveType == monster->monsterType) {
232             totalDmg = (totalDmg*120) / 100;
233         } else if (attack->moveType == (Type)(((3 + monster->monsterType) - 1)
    % 3)) {
234             totalDmg = (totalDmg*80) / 100;
235         }
236     } else {
237         totalDmg = 0;
238     }
239     if (totalDmg < targetScore) {
240         return (targetScore - totalDmg);
241     } else {
242         return 0;
243     }
244 }
245
246 // User selects move based off of available cards
247 // Regame.turns damage of chosen move
248
249 Monster* selectCard(GlobalState* globalData) {
250     printSelect(globalData);
251     prints(0, 5, WHITE, RED, "Choose a card by its slot number:", 1);
```

```
252
253
254
255     // Waits till valid keypad input
256     globalData->keyStatus = 1;
257     while (0 != globalData->keyStatus) {
258         keypad(globalData);
259         // Invalid keypad input
260         if (globalData->keyPress >= 0) {
261             // Beep off
262             TRISBbits.RB5 = 1;
263             if ((0 == globalData->keyPress || globalData->keyPress > 5)) {
264                 globalData->keyStatus = 1;
265                 prints(0, 5, WHITE, RED, "
                    ", 1);
266                 prints(0, 5, WHITE, RED, "Invalid input. Please enter a key
    between 1 to 4:", 1);
267                 // No card available
268             } else if (NULL == &myMonsterList[globalData->keyPress - 1]) {
269                 globalData->keyStatus = 2;
270                 prints(0, 5, WHITE, RED, "                                  ", 1)
    ;
271                 prints(0, 5, WHITE, RED, "No card found. Please try again:", 1)
    ;
272                 // Selected card is available
273             } else {
274                 globalData->keyStatus = 0;
275             }
276         }
277     }
278     return &myMonsterList[globalData->keyPress - 1];
279 }
280
281 void getCards() {
282     strcpypgm2ram(myMonsterList[0].monsterName, "FIREDUDE");
283     myMonsterList[0].monsterID = 0x01;
284     myMonsterList[0].monsterType = FIRE;
285     myMonsterList[0].level = 2;
286     strcpypgm2ram(myMonsterList[0].movelist[0].moveName, "EMBER");
287     myMonsterList[0].movelist[0].baseDamage = 10;
288     myMonsterList[0].movelist[0].moveType = FIRE;
289     myMonsterList[0].movelist[0].uses = 10;
290     strcpypgm2ram(myMonsterList[0].movelist[1].moveName, "SCRATCH");
291     myMonsterList[0].movelist[1].baseDamage = 6;
292     myMonsterList[0].movelist[1].moveType = EARTH;
293     myMonsterList[0].movelist[1].uses = 15;
294     strcpypgm2ram(myMonsterList[0].movelist[2].moveName, "HOTFLAME");
295     myMonsterList[0].movelist[2].baseDamage = 20;
296     myMonsterList[0].movelist[2].moveType = FIRE;
```

```
297     myMonsterList[0].movelist[2].uses = 3;
298
299     strcpypgm2ram(myMonsterList[1].monsterName, "EARTHGUY");
300     myMonsterList[1].monsterID = 0x02;
301     myMonsterList[1].monsterType = EARTH;
302     myMonsterList[1].level = 1;
303     strcpypgm2ram(myMonsterList[1].movelist[0].moveName, "PEBBLE");
304     myMonsterList[1].movelist[0].baseDamage = 12;
305     myMonsterList[1].movelist[0].moveType = EARTH;
306     myMonsterList[1].movelist[0].uses = 5;
307     strcpypgm2ram(myMonsterList[1].movelist[1].moveName, "POUND");
308     myMonsterList[1].movelist[1].baseDamage = 3;
309     myMonsterList[1].movelist[1].moveType = EARTH;
310     myMonsterList[1].movelist[1].uses = 20;
311     strcpypgm2ram(myMonsterList[1].movelist[2].moveName, "ROCKSLDE");
312     myMonsterList[1].movelist[2].baseDamage = 30;
313     myMonsterList[1].movelist[2].moveType = EARTH;
314     myMonsterList[1].movelist[2].uses = 2;
315
316
317     strcpypgm2ram(myMonsterList[2].monsterName, "WATERMAN");
318     myMonsterList[2].monsterID = 0x03;
319     myMonsterList[2].monsterType = WATER;
320     myMonsterList[2].level = 1;
321     strcpypgm2ram(myMonsterList[2].movelist[0].moveName, "SQUIRT");
322     myMonsterList[2].movelist[0].baseDamage = 12;
323     myMonsterList[2].movelist[0].moveType = WATER;
324     myMonsterList[2].movelist[0].uses = 7;
325     strcpypgm2ram(myMonsterList[2].movelist[1].moveName, "SCRATCH");
326     myMonsterList[2].movelist[1].baseDamage = 6;
327     myMonsterList[2].movelist[1].moveType = EARTH;
328     myMonsterList[2].movelist[1].uses = 15;
329     strcpypgm2ram(myMonsterList[2].movelist[2].moveName, "SOAK");
330     myMonsterList[2].movelist[2].baseDamage = 15;
331     myMonsterList[2].movelist[2].moveType = WATER;
332     myMonsterList[2].movelist[2].uses = 5;
333
334     strcpypgm2ram(myMonsterList[3].monsterName, "COMBOGRL");
335     myMonsterList[3].monsterID = 0x04;
336     myMonsterList[3].monsterType = EARTH;
337     myMonsterList[3].level = 3;
338     strcpypgm2ram(myMonsterList[3].movelist[0].moveName, "SOAK");
339     myMonsterList[3].movelist[0].baseDamage = 15;
340     myMonsterList[3].movelist[0].moveType = WATER;
341     myMonsterList[3].movelist[0].uses = 5;
342     strcpypgm2ram(myMonsterList[3].movelist[1].moveName, "PEBBLE");
343     myMonsterList[3].movelist[1].baseDamage = 12;
344     myMonsterList[3].movelist[1].moveType = EARTH;
345     myMonsterList[3].movelist[1].uses = 5;
```

```
346     strcpypgm2ram(myMonsterList[3].movelist[2].moveName, "EMBER");
347     myMonsterList[3].movelist[2].baseDamage = 10;
348     myMonsterList[3].movelist[2].moveType = FIRE;
349     myMonsterList[3].movelist[2].uses = 10;
350
351
352 }
353
354 // User selects move based off of available cards
355 // Regame.turns damage of chosen move
356
357 Move* pickMove(GlobalState* globalData) {
358     Monster* card = selectCard(globalData);
359     game.myMonster = card;
360     printAttackMenu(globalData, card);
361
362     prints(8, 5, WHITE, BLUE, "Please select an attack: ", 1);
363     globalData->keyStatus = 1;
364     // Checks keypad input and outputs a message to user if incorrect
365     while (0 != globalData->keyStatus) {
366         keypad(globalData);
367         if (globalData->keyPress >= 0) {
368             // Keypad input is not valid
369             if (((0x0A > globalData->keyPress) || (globalData->keyPress > 0x0C)
    )) {
370                 globalData->keyStatus = 1;
371                 prints(8, 5, WHITE, BLUE, "
                                ", 1);
372                 prints(8, 5, WHITE, BLUE, "Invalid attack input. Please select
    from the options below: ", 1);
373                 // Selected attack does nothing
374             /*} else if (0 == globalData->selectMove[card][(globalData->
    keyPress) - 10]) {
375                 globalData->keyStatus = 2;
376                 prints(0, 5, WHITE, BLUE, "
                    ", 1);
377                 prints(0, 5, WHITE, BLUE, "This will have no effect! Select a
    better option.", 1);
378                 // Input is valid and passes all checks
379                */
380             } else {
381                 globalData->keyStatus = 0;
382                 prints(8, 5, WHITE, BLUE, "                          ", 1);
383                 prints(8, 5, WHITE, BLUE, "Please select an attack: ", 1);
384             }
385         }
386     }
387
388     // Thing to consider: User pressing a key multiple times???
```

```
389     // Regame.turn the amount of damage the move makes
390     switch (globalData->keyPress) {
391         case 0x0A:
392             return &card->movelist[0];
393             break;
394         case 0x0B:
395             return &card->movelist[1];
396             break;
397         case 0xC:
398             return &card->movelist[2];
399             break;
400     }
401 }
402 
403 /* Xbee functions for multiplayer
404  *
405  */
406 
407 // Xbee: Send move to opponent
408 
409 void sendMove() {
410     game.myMove;
411 }
412 
413 // Xbee: Receive move from opponent
414 
415 void receiveMove() {
416     game.oppMove = 0;
417 }
418 
419 // Xbee: Send my score to opponent after taking damage
420 
421 void sendScore() {
422     game.myScore;
423 }
424 
425 // Xbee: Receive new score from opponent after attacking
426 
427 int receiveScore() {
428     return 0;
429 }
430 
431 /* Display Functions for the Game
432  * These functions are built to display the game screen.
433  */
434 
435 
436 
437 void printGame(GlobalState* globalData) {
```

```
438     // LCD menu
439     // Beep off
440     TRISBbits.RB5 = 1;
441     clean(BLACK);
442     prints(0, 0, YELLOW, BLACK, "NAME: ", 1);
443     printrs(36, 0, YELLOW, BLACK, game.name, 1);
444     if (game.turn) {
445         prints(0, 18, YELLOW, BLACK, "Your move!", 1);
446     } else {
447         prints(0, 18, YELLOW, BLACK, "Opponent's turn.", 1);
448     }
449
450     prints(0, 40, YELLOW, BLACK, "Your Score: ", 1);
451     integerprint(0, 55, YELLOW, BLACK, game.myScore, 1);
452     prints(0, 70, WHITE, BLACK, "Opponent Score: ", 1);
453     integerprint(0, 85, WHITE, BLACK, game.oppScore, 1);
454
455     prints(0, H - 8, WHITE, BLACK, "Press D to continue.", 1);
456 }
457
458 void printMultiplayerSetup(GlobalState* globalData) {
459     // LCD menu
460     clean(GREEN);
461     drawBoxFill(0, 0, 20, V - 1, GREEN);
462     drawBox(0, 0, 20, V - 1, 2, WHITE);
463     prints(35, 7, WHITE, BLACK, "Main Menu", 1);
464     prints(35, globalData->mainMenuSpots[0], WHITE, GREEN, "Host Game", 1);
465     prints(35, globalData->mainMenuSpots[1], WHITE, GREEN, "Join Game", 1);
466     prints(35, globalData->mainMenuSpots[2], WHITE, GREEN, "Nevermind.", 1);
467     prints(0, H - 8, WHITE, BLUE, "2-UP,8-DOWN,D-ENTER", 1);
468     prints(25, globalData->mainMenuSpots[globalData->cursorPos], WHITE, GREEN,
        ">", 1);
469 }
470
471 void printKeyboard(GlobalState* globalData, char* name, char* inputType, int
        size) {
472     short pos[] = {0, 0};
473     short letters = 0;
474   int i = 0;
475     clean(BLUE);
476     prints(0, H-32, WHITE, BLUE, "B-DELETE",1);
477     prints(0, H-24, WHITE, BLUE, "2-UP,8-DOWN",1);
478     prints(0, H-16, WHITE, BLUE, "4-LEFT,6-RIGHT",1);
479     prints(0, H-8, WHITE, BLUE, "D-SEL,#-DONE",1);
480     prints(0, 0, WHITE, BLUE, inputType,1);
481   for (i = 0; i < size-1; i++) {
482     prints(12*i, 8, WHITE, BLUE, " _", 1);
483   }
484     drawBox(0, 16, 40, V - 1, 2, WHITE);
```

```
485     drawBox(0, 19, 34, V - 1, 1, WHITE);
486     prints(3, 23, WHITE, BLUE, " A B C D E F G H I J", 1);
487     prints(3, 33, WHITE, BLUE, " K L M N O P Q R S T", 1);
488     prints(3, 43, WHITE, BLUE, " U V W X Y Z [ \\ ] ^", 1);
489     prints(3+12 * pos[0], 10 * pos[1] + 23, WHITE, BLUE, ">", 1);
490     keypad(globalData);
491
492     while (globalData->keyPress != 0x0F) {
493         keypad(globalData);
494         if (globalData->keyFlag && !globalData->displayedKey) {
495             globalData->keyFlag = FALSE;
496             globalData->displayedKey = TRUE;
497
498             switch (globalData->keyPress) {
499                 case 0x08:
500                     prints(3+ 12 * pos[0], 10 * pos[1] + 23, WHITE, BLUE, " ",
    1);
501                     if (pos[1] < 2) {
502                         pos[1]++;
503                     }
504                     prints(3+12 * pos[0], 10 * pos[1] + 23, WHITE, BLUE, ">",
    1);
505                     break;
506                 case 0x02:
507                     prints(3+12 * pos[0], 10 * pos[1] + 23, WHITE, BLUE, " ",
    1);
508                     if (pos[1] > 0) {
509                         pos[1]--;
510                     }
511                     prints(3+12 * pos[0], 10 * pos[1] + 23, WHITE, BLUE, ">",
    1);
512                     break;
513                 case 0x04:
514                     prints(3+12 * pos[0], 10 * pos[1] + 23, WHITE, BLUE, " ",
    1);
515                     if (pos[0] > 0) {
516                         pos[0]--;
517                     }
518                     prints(3+12 * pos[0], 10 * pos[1] + 23, WHITE, BLUE, ">",
    1);
519                     break;
520                 case 0x06:
521                     prints(3+12 * pos[0], 10 * pos[1] + 23, WHITE, BLUE, " ",
    1);
522                     if (pos[0] < 9) {
523                         pos[0]++;
524                     }
525                     prints(3+12 * pos[0], 10 * pos[1] + 23, WHITE, BLUE, ">",
    1);
```

```
526                     break;
527                 case 0x0D:
528                     if (letters < size-1) {
529                         name[letters] = (char) (65 + pos[0] + 10 * pos[1]);
530                         name[letters + 1] = '\0';
531                         ASCII(6 + 12 * letters, 8, WHITE, BLUE, name[letters],
    1);
532                         letters = letters + 1;
533                         if (letters == size-1) {
534                             prints(42 + 12 * 5, 0, WHITE, BLUE, "end", 1);
535                         }
536                     }
537                     break;
538                 case 0x0B:
539                     if (letters > 0) {
540                         if (letters == size-1) {
541                             prints(42 + 12 * 5, 0, WHITE, BLUE, "   ", 1);
542                         }
543                         letters--;
544                         ASCII(6 + 12 * letters, 8, WHITE, BLUE, '_', 1);
545                         name[letters] = '\0';
546                     }
547                     break;
548 
549             }
550         }
551     }
552 
553 }
554 
555 // Select a card to play
556 void printSelect(GlobalState* globalData) {
557     int i = 0;
558     // Beep off
559     TRISBbits.RB5 = 1;
560 
561     // LCD menu
562     clean(RED);
563     // Display commands to select a slot - the LED's should indicate if a card
    is read
564 //    drawBoxFill(15, 29, 26, 85, BLACK)
565     for (i = 0; i < 4; i++) {
566         drawBoxFill(15, 29 + 35*i, 26, 85, BLACK);
567         printrs(20, 38 + 35*i, WHITE, BLACK, myMonsterList[i].monsterName, 1);
568         prints(20, 38 + 8 + 35*i, WHITE, BLACK, "Lvl:", 1);
569         integerprint(38, 38 + 8 + 35*i, WHITE, BLACK, myMonsterList[i].level,
    1);
570         switch (myMonsterList[i].monsterType) {
571             case FIRE:
```

```
572                 drawBoxFill(61, 38 + 8 + 35*i-1, 8, 30, RED);
573                 prints(62, 38 + 8 + 35*i, WHITE, RED, "FIRE", 1);
574                 break;
575             case WATER:
576                 drawBoxFill(61, 38 + 8 + 35*i-1, 8, 35, CYAN);
577                 prints(62, 38 + 8 + 35*i, WHITE, CYAN, "WATER", 1);
578                 break;
579             case EARTH:
580                 prints(62, 38 + 8 + 35*i, WHITE, BLACK, "EARTH", 1);
581                 break;
582         }
583     }
584     prints(20, 30, WHITE, BLACK, "Slot 1", 1);
585     prints(20, 65, WHITE, BLACK, "Slot 2", 1);
586     prints(20, 100, WHITE, BLACK, "Slot 3", 1);
587     prints(20, 135, WHITE, BLACK, "Slot 4", 1);
588 }
589
590 // Select an attack.
591 void printAttackMenu(GlobalState* globalData, Monster* card) {
592     int i = 0;
593     // Beep off
594     TRISBbits.RB5 = 1;
595
596     // LCD menu
597     clean(BLUE);
598
599     switch(card->monsterType) {
600         case FIRE:
601             drawBoxFill(0, 31, 8, 48, RED);
602             printrs(0,32,WHITE, RED, card->monsterName,1);
603             break;
604         case WATER:
605             drawBoxFill(0, 31, 8, 48, CYAN);
606             printrs(0,32,WHITE, CYAN, card->monsterName,1);
607             break;
608         case EARTH:
609             drawBoxFill(0, 31, 8, 48, BLACK);
610             printrs(0,32,WHITE, BLACK, card->monsterName,1);
611             break;
612     }
613     prints(54,32,WHITE, BLUE, "Lvl:",1);
614     integerprint(84,32, WHITE, BLUE, card->level,1);
615
616     prints(0, 40, YELLOW, BLUE, "A. Attack with:", 1);
617     prints(0, 80, YELLOW, BLUE, "B. Attack with: ", 1);
618     prints(0, 120, YELLOW, BLUE, "C. Attack with: ", 1);
619
620     for (i = 0; i < 3; i++) {
```

```
621         switch (card->movelist[i].moveType) {
622             case FIRE:
623                 drawBoxFill(0, 40+40*i + 8-1, 8, 83, RED);
624                 printrs(0, 40+ 40*i + 8, WHITE, RED, card->movelist[i].moveName
    , 1);
625                 prints(54, 40+40*i + 8, WHITE, RED, "FIRE", 1);
626                 break;
627             case WATER:
628                 drawBoxFill(0, 40+40*i + 8-1, 8, 83, CYAN);
629                 printrs(0, 40+ 40*i + 8, WHITE, CYAN, card->movelist[i].
    moveName, 1);
630                 prints(54, 40+40*i + 8, WHITE, CYAN, "WATER", 1);
631                 break;
632             case EARTH:
633                 drawBoxFill(0, 40+40*i + 8-1, 8, 83, BLACK);
634                 printrs(0, 40+ 40*i + 8, WHITE, BLACK, card->movelist[i].
    moveName, 1);
635                 prints(54, 40+40*i + 8, WHITE, BLACK, "EARTH", 1);
636                 break;
637         }
638         prints(0, 40 + 40*i + 16, WHITE, BLUE, "Min damage:", 1);
639         integerprint(60, 40+ 40*i + 16, YELLOW, BLUE, card->movelist[i].
    baseDamage, 1);
640         prints(0, 40+ 40*i + 24, WHITE, BLUE, "Uses left:", 1);
641         integerprint(72, 40+ 40*i + 24, YELLOW, BLUE, card->movelist[i].uses,
    1);
642     }
643 }
644
645 // Displays Game Results
646 void printResults() {
647     // Beep off
648     TRISBbits.RB5 = 1;
649     prints(0, 15, YELLOW, BLACK, "GAME OVER", 1);
650
651     if (game.myScore > game.oppScore) {
652         clean(BLACK);
653         prints(0, 15, YELLOW, BLACK, "You won!", 1);
654         prints(0, 30, YELLOW, BLACK, "Your Score: ", 1);
655         integerprint(0, 45, YELLOW, BLACK, game.myScore, 1);
656         prints(0, 60, WHITE, BLACK, "Opponent Score: ", 1);
657         integerprint(0, 75, WHITE, BLACK, game.oppScore, 1);
658     } else {
659         clean(RED);
660         prints(0, 15, BLACK, RED, "You lost", 1);
661         prints(0, 30, BLACK, RED, "Your Score: ", 1);
662         integerprint(0, 45, WHITE, RED, game.myScore, 1);
663         prints(0, 60, YELLOW, RED, "Opponent Score: ", 1);
664         integerprint(0, 75, YELLOW, RED, game.oppScore, 1);
```

```
665     }
666 }
```

G.4 I²C InterPIC Communication

../FrontEnd.X/i2cComm.h

```
1  /*
2   * File:   i2cComm.h
3   * Author: Patrick
4   *
5   * Created on June 5, 2014, 2:22 AM
6   */
7
8  #ifndef I2CCOMM_H
9  #define I2CCOMM_H
10
11 #ifdef __cplusplus
12 extern "C" {
13 #endif
14 #include "globals.h"
15
16 #define MAX_IN_LENGTH 20
17 #define MAX_OUT_LENGTH 20
18
19     /*
20      * Configures the MSSP2 module for master/slave-idle at 100kHz
21      */
22     void i2CSetup();
23
24     /*
25      * Sends the first numBytes bytes of the char array
26      */
27     int sendBytes(char *data, int numBytes);
28
29     /*
30      * Processes received data and commands
31      */
32     void processI2C();
33
34     typedef struct i2cDataStruct {
35         char inDataSequence;
36         char destAddr;
37         char myAddr;
38         char dataOut[MAX_OUT_LENGTH]; // data from the i2c
39         unsigned char outLength;
40         char dataIn[MAX_IN_LENGTH];
41         unsigned char inLength;
```

```
42          int transmissionNum; // the curent transmission length
43          char transmitting; // are we transmitting
44      } I2cDataStruct;
45
46      /************Inter-PIC Commands*****************************/
47  #define INVALID_COMMAND      0xFF //received command is not recognized
48  #define RECEIVE_ERROR        0xFE //received command cannot be fulfilled
49  #define END_OF_TRANSMISSION  0xFD //
50      /*--------------------Front End SendS-------------------------------*/
51  #define REQUEST_CARD_UPDATE  0x02 // Ask for cards present
52  #define REQUEST_CARD_DATA    0x04 //  Requests data from a block
53  #define WRITE_CARD_BLOCK     0xFC // Write 32-bit data to card block
54  #define WRITE_AFI            0xFB // Write data to Attribute Family Identifier
55  #define WRITE_DSFID          0xFA // Write data to Data Structure Format ID
56      /*--------------------Back End Sends-------------------------------*/
57  #define CARD_CHANGE          0x01 // Indicates cards in play changed
58  #define CARD_UID             0x02 // Sending slot# + UID
59  #define CARD_DATA_BLOCK     0x04 // Sends requested block data
60      /*************************************************************/
61
62  #ifdef  __cplusplus
63  }
64  #endif
65
66  #endif  /* I2CCOMM_H */
```

../FrontEnd.X/i2cComm.c

```
1  /*
2   * Created by: Patrick
3   * June 2, 2014
4   *
5   * I2C system for the front and back ends. The system is configured as a
6   * Master/slave-idle. The i2c uses MSSP2 for communication
7   */
8
9  #include "globals.h"
10
11 /********Configuration Settings*****************************/
12 #define MASTER   0b00001000 //I2C  Master mode
13 #define SLAVE    0b00000110 // I2C slave mode, 7-bit address
14 #define SSPEN    0b00100000  /* Enable serial port and configures SCK, SDO, SDI
       */
15 #define SSPDIS   0b11011111   // disable serial port
16 #define SLEW_OFF 0b10000000 /* Slew rate disabled for 100kHz mode */
17 #define BAUD     0x31;  // master address value for 100kHz baud rate
18 ///************Inter-PIC Commands*****************************/
19 //#define INVALID_COMMAND      0xFF //received command is not recognized
20 //#define RECEIVE_ERROR        0xFE //received command cannot be fulfilled
```

```
21 //#define END_OF_TRANSMISSION 0xFD //
22 ///*----------------------Front End SendS-----------------------------------*/
23 //#define REQUEST_CARD_UPDATE 0x02 // Ask for cards present
24 //#define REQUEST_CARD_DATA   0x04 //  Requests data from a block
25 //#define WRITE_CARD_BLOCK    0xFC // Write 32-bit data to card block
26 //#define WRITE_AFI           0xFB // Write data to Attribute Family Identifier
27 //#define WRITE_DSFID         0xFA // Write data to Data Structure Format ID
28 ///*----------------------Back End Sends-----------------------------------*/
29 //#define CARD_CHANGE         0x01 // Indicates cards in play changed
30 //#define CARD_UID            0x02 // Sending slot# + UID
31 //#define CARD_DATA_BLOCK    0x04 // Sends requested block data
32 ///*************************************************************/
33
34 I2cDataStruct i2cData;
35
36 /*******Private prototypes*******************/
37 void switchToSlave(void);
38 void switchToMaster(void);
39 void sendStop(void);
40 void sendStart(void);
41 /*********************************************/
42
43 /*
44  * Initialization function for the i2c module
45  */
46 void i2CSetup() {
47     // setup the struct
48 #if FRONT_NOT_BACK
49     i2cData.destAddr = 0xFE; // 8-bit address, 7-bit address is 0x7F
50     i2cData.myAddr = 0x00;
51 #else
52     i2cData.destAddr = 0x00; // 0b0000000
53     i2cData.myAddr = 0xFE;
54 #endif
55
56     i2cData.inDataSequence = FALSE;
57     memset(i2cData.dataIn, '\0', sizeof(char) * MAX_IN_LENGTH);
58     memset(i2cData.dataOut, '\0', sizeof(char) * MAX_OUT_LENGTH);
59     i2cData.inLength = 0;
60     i2cData.outLength = 0;
61     i2cData.transmissionNum = 0;
62     i2cData.transmitting = 0;
63
64     // setup D0, D1 as inputs
65     TRISDbits.TRISD0 = 1;
66     TRISDbits.TRISD1 = 1;
67
68     // setup associated ANSEL bits as digital
69     ANSELDbits.ANSD0 = 0;
```

```
70      ANSELDbits.ANSD1 = 0;
71
72      // enable the interrupt priority bits
73      INTCONbits.GIEH = 1; // global int enable
74      INTCONbits.PEIE = 1; // peripheral int enable
75      IPR3bits.SSP2IP = 1; // MSSP interrupt high priority
76      PIE3bits.SSP2IE = 1; // MSSP interrupt enable
77
78      // configure MSSP2 for i2c communication
79      SSP2CON1 &= SSPDIS; // disable module
80      SSP2STAT |= SLEW_OFF;
81
82      SSP2CON1 = SLAVE;
83      SSP2ADD = i2cData.myAddr;
84
85      SSP2CON2 = 0b00000000; // disable general call interrupt
86      SSP2CON3 = 0b01100000; // enable stop int, enable start int, addr/data hold
87
88      SSP2CON1 |= SSPEN; // enable module
89
90  }
91
92  /*
93   * Process received commands
94   */
95  void processI2C() {
96      unsigned int slotNum;
97      unsigned int i;
98      unsigned char blockNum;
99      unsigned char data[4];
100 #if FRONT_NOT_BACK // receives backends commands
101     // switch on command
102     // parse data into parts
103     switch (i2cData.dataIn[0]) {
104         case CARD_CHANGE:
105             globalData.runGetUpdatedCards = TRUE;
106             readerData.availableUIDs = 0;
107             break;
108         case CARD_UID:
109             slotNum = i2cData.dataIn[1]; // slot number
110             strncpy(&readerData.readUID[slotNum], &i2cData.dataIn[2], 16); //
        move UID
111             readerData.availableUIDs++;
112             if (readerData.availableUIDs < 4) { // get the next card
113                 globalData.runGetUpdatedCards = TRUE;
114             }
115             break;
116         case CARD_DATA_BLOCK:
117             globalData.dataSlotNum = i2cData.dataIn[1]; // get the clot number
```

```
118             globalData.dataBlockNum = i2cData.dataIn[2]; // get the block
    number
119             strncpy(&globalData.dataBlock[0], &i2cData.dataIn[3], 4); // copy
    the blcok data
120             break;
121         case INVALID_COMMAND:
122
123             break;
124         case RECEIVE_ERROR:
125
126             break;
127         case END_OF_TRANSMISSION:
128
129             break;
130         default:
131             i2cData.dataOut[0] = INVALID_COMMAND;
132             i2cData.outLength = 1;
133             break;
134     }
135 #else
136     switch (i2cData.dataIn[0]) {
137         case REQUEST_CARD_UPDATE:
138             //send all four cards TODO:
139             // need to make sure all of these are sent somehow
140             slotNum = i2cData.transmissionNum++; // get our count
141             i2cData.dataOut[0] = CARD_UID;
142             i2cData.dataOut[1] = slotNum;
143             strncpy(&i2cData.dataOut[2], &readerData.readUID[slotNum], 16);
144             i2cData.outLength = 10;
145             globalData.sendI2C = TRUE;
146             break;
147         case REQUEST_CARD_DATA:
148             slotNum = i2cData.dataIn[1]; // get the requested slot
149             blockNum = i2cData.dataIn[2]; // get the requested block
150             i2cData.dataOut[0] = CARD_DATA_BLOCK; // cmd
151             i2cData.dataOut[1] = slotNum; // slot
152             i2cData.dataOut[2] = blockNum; // block
153
154             for (i = 3; i < 7; i++) {// read from sram
155                 i2cData.dataOut[i] = readData(256 * slotNum + 4 * blockNum + (i
    - 3));
156             }// format response
157             i2cData.outLength = 7;
158             globalData.sendI2C = TRUE; // send the data
159             break;
160         case WRITE_CARD_BLOCK:
161             slotNum = i2cData.dataIn[1]; // get slot
162             blockNum = i2cData.dataIn[2]; //get block
163             strncpy(&data[0], &i2cData.dataIn[3], 4); // get data bytes
```

```
164             // move to card
165             writeRFID(readerData.readUID[slotNum], blockNum, (data[0] << 8 |
    data[1]), (data[2] << 8 | data[3])); // write
166             break;
167         case WRITE_AFI:
168 
169             break;
170         case WRITE_DSFID:
171 
172             break;
173         case INVALID_COMMAND:
174 
175             break;
176         case RECEIVE_ERROR:
177 
178             break;
179         case END_OF_TRANSMISSION:
180 
181             break;
182         default:
183             i2cData.dataOut[0] = INVALID_COMMAND;
184             i2cData.outLength = 1;
185             break;
186     }
187 #endif
188 
189 }
190 
191 /* send bytes as the master.  checks the status of the bus before entering
192  * master mode. Returns a negative number if error occurs during writing,
193  * otherwise exits with 0. Exit state: slave mode.
194  */
195 
196 int sendBytes(char *data, int numBytes) {
197     int i = 0;
198     signed char status = 0;
199 
200     // enter masater mode if no data is being sent (stop bit last seen)
201     if (!i2cData.inDataSequence) {
202         switchToMaster();
203 
204     } else {
205         return -1;
206     }
207 
208     sendStart();
209 
210     status = WriteI2C2(i2cData.destAddr & 0b11111110); // send address with
    write
```

```
211     if (status < 0) {// if collision, revert to slave, reset data sequence flag
        to transfer ok
212         sendStop();
213         switchToSlave();
214         return status;
215     } else { // if no collision,
216         for (i = 0; i < numBytes; i++) { //write out Numbytes of data
217             status = WriteI2C2(data[i]);
218             if (status < 0) {// if nack or wcol, break
219                 sendStop();
220                 switchToSlave();
221                 return status;
222             }
223         }
224     }
225     sendStop();
226     switchToSlave(); // switch back to slave mode
227 }
228
229 /*
230  * Sets module to master mode. Note this clears various flags in the module
231  */
232 void switchToMaster() {
233     // set address reg to baud rate?
234     // switch out of RCEN mode?
235     SSP2CON1 &= SSPDIS; // diable module
236     SSP2CON1 = MASTER; // change mode
237     SSP2ADD = BAUD; // Set baud rate
238     SSP2CON1 |= SSPEN; // enable module
239     i2cData.transmitting = 1;
240 }
241
242 /*
243  * Sets module to slave mode. Note this clears various flags in the module
244  */
245 void switchToSlave() {
246     SSP2CON1 &= SSPDIS; // diable module
247     SSP2CON1 = SLAVE; // change mode
248     SSP2ADD = i2cData.myAddr; // update address buffer
249     SSP2CON1 |= SSPEN; // enable module
250     i2cData.transmitting = 0;
251 }
252
253 /*
254  * Sends a stop bit. Module must be in Master mode
255  */
256 void sendStop() {
257     SSP2CON2bits.PEN = 1; // send stop
258     while (SSP2CON2bits.PEN == 1);
```

```
259     i2cData.inDataSequence = FALSE;
260 }
261
262 /*
263  * Sends a start bit. Module must be in Master mode
264  */
265 void sendStart() {
266     SSP2CON2bits.SEN = 1; // send start bit
267     i2cData.inDataSequence = TRUE;
268     while (SSP2CON2bits.SEN == 1); // or use IdleI2C2()
269 }
270
271 //Front end only: requests the updated cards from the backend
272
273 void getUpdatedCards() {
274 #if FRONT_NOT_BACK
275     i2cData.dataOut[0] = REQUEST_CARD_UPDATE; // get update
276     i2cData.outLength = 1;
277     globalData.sendI2C = TRUE; // send the command
278 #endif
279 }
```

G.5 Keypad Driver

../FrontEnd.X/keypadDriver.h

```
1  /*
2   * File:   keypadDriver.h
3   * Author: ma
4   *
5   * Created on May 23, 2014, 9:10 PM
6   */
7
8  #ifndef KEYPADDRIVER_H
9  #define KEYPADDRIVER_H
10
11 #ifdef __cplusplus
12 extern "C" {
13 #endif
14
15 #include "globals.h"
16     // prototypes
17     /*
18      * keypadSetup() initializes the GPIO pins used by the keypad module.
19      * Pins B0–B3 are used as digital inputs with internal weak pull up to Vcc
20      * Pins C0–C3 are used as digital outputs
21      */
22     void keypadSetup(void);
```

```
23
24      /*
25       * scans the keypad and returns a numeric value of the key
26       * which is pressed, or -1 otherwise. The codding is:
27       *  numbers = corresponding number
28       * A = 10
29       * B = 11
30       * C = 12
31       * D = 13
32       * * = 14
33       * # = 15
34       */
35      void keypad(struct globaldata *gData);
36
37
38  #ifdef  __cplusplus
39  }
40  #endif
41
42  #endif  /* KEYPADDRIVER_H */
```

../FrontEnd.X/keypadDriver.c

```
1   /*
2    * Created: Patrick Ma
3    * Date: May 21, 2014
4    *
5    * keypadDriver.c
6    *
7    * The software driver for the keypad. The current option uses 8 pins and polls
8    * the matrix looking for key presses. Each row is polled (pins 4-7) and the
9    * keys are read from pins 0-3
10   *
11   * The keypad has a layout like this:
12   *
13   *     1|   2|   3|   A| pin
14   *   ------------------ 4
15   *     4|   5|   6|   B|
16   *   ------------------ 5
17   *     7|   8|   9|   C|
18   *   ------------------ 6
19   *     *|   0|   #|   D|
20   *   ------------------ 7
21   *      |    |    |    |
22   *  pin 0    1    2    3
23   *
24   */
25
26  #define __KEYPAD_DEBUG 0
```

```
27
28 #include <stdio.h>
29 #include <stdlib.h>
30 #include <usart.h>
31 #include <delays.h>
32
33 #include "keypadDriver.h"
34
35 #ifdef __KEYPAD_DEBUG
36 #include "rs232.h"  // use serial for debugging
37 #include <p18f46k22.h>
38
39 ///***************Clocking set up *********************/
40 //#pragma config WDTEN = OFF     // turn off watch dog timer
41 //#pragma config FOSC = ECHP     // Ext. Clk, Hi Pwr
42 //#pragma config PRICLKEN = OFF // disable primary clock
43 ///*****************************************************/
44 //#pragma config PBADEN = OFF    // turn off the ADCs for whatever pins I'm
       using
45
46 /*****************************************************/
47 #endif
48
49 int resetPins(int key);
50 int checkForInput(void);
51
52 //void main() {
53 //     char keyNum = 0;
54 //     keypadSetup();
55 //     rs232Setup1(); // setup the serial port
56 //
57 //     while (1) { // just loop for test
58 //         keyNum = (char) checkForInput() + ''';
59 //         Write1USART(keyNum);
60 //
61 //         Delay1KTCYx(1);
62 //     }
63 //
64 //}
65
66 #define CODE_SIZE 6
67 #define NUM_KEYS 16
68 #define DEBUG_BSOD 6
69
70 // Sounds range from 4600Hz to 1600 Hz
71 int keySounds[NUM_KEYS] = {81, 141, 74, 194, 67, 119, 91, 97, 173, 110, 86,
       129, 70, 155, 103, 77};
72
73 // EEDEGF# (1318.51), (1318.51) (2349.32) (1318.51) (3135.96) (2959.96)
```

```
74 int secretSounds[CODE_SIZE] = {118, 118, 132, 118, 99, 118};
75 int secretCode[CODE_SIZE] = {6,6,6,4,2,0};
76 short codeCounter = 0;
77
78 // 6 Stars will make a BSOD happen
79 short debugCount = 0;
80 /*
81  * Polls the keypad for a key press. The key is stored in the global data
       struct given.
82  */
83 void keypad(GlobalState *gData) {
84     gData->keyPress = checkForInput();
85     if (gData->keyPress >= 0 && !gData->displayedKey) {
86         gData->keyFlag = TRUE;
87         // Weak debounce
88         Delay10TCYx(20);
89
90         if (gData->keyPress == 14) {
91             debugCount++;
92         } else {
93             debugCount = 0;
94         }
95
96         if (debugCount == DEBUG_BSOD) {
97             gData->keyPress = 0xFF;
98         }
99
100        if (gData->keyPress == secretCode[codeCounter]) {
101            PR4 = secretSounds[codeCounter];
102            codeCounter = (codeCounter + 1) % CODE_SIZE;
103        } else {
104            // Set tone
105            PR4 = keySounds[gData->keyPress];
106            codeCounter = 0;
107        }
108
109        // Beep on
110        TRISBbits.RB5 = 0;
111    } else if (gData->keyPress < 0) {
112        gData->displayedKey = FALSE;
113        // Beep off
114        TRISBbits.RB5 = 1;
115    }
116 }
117
118 // checks the keypad for key press. returns the first key press sensed.
119 // Returns the number of the key pressed (* = 14, # = 15)
120
121 int checkForInput() {
```

```
122     char scan;
123
124     PORTDbits.RD2 = 0; // check row1
125     Delay10TCYx(10);
126     scan = (PORTBbits.RB3 << 3 | PORTBbits.RB2 << 2 | PORTBbits.RB1 << 1 |
        PORTBbits.RB0);
127     switch (scan) {
128         case 0b00001110: // is on Bbits.RB3
129             return resetPins(1);
130         case 0b00001101: // on pin 5
131             return resetPins(2);
132         case 0b00001011: // on pin 6
133             return resetPins(3);
134         case 0b00000111: // on pin 7
135             return resetPins(10);
136     }
137
138     PORTDbits.RD2 = 1; // check row2
139     PORTDbits.RD3 = 0;
140     Delay10TCYx(10);
141     scan = (PORTBbits.RB3 << 3 | PORTBbits.RB2 << 2 | PORTBbits.RB1 << 1 |
        PORTBbits.RB0);
142     switch (scan) {
143         case 0b00001110: // is on Bbits.RB3
144             return resetPins(4);
145         case 0b00001101: // on pin 5
146             return resetPins(5);
147         case 0b00001011: // on pin 6
148             return resetPins(6);
149         case 0b00000111: // on pin 7
150             return resetPins(11);
151     }
152
153
154     PORTDbits.RD3 = 1; // check row3
155     PORTDbits.RD4 = 0;
156     Delay10TCYx(10);
157     scan = (PORTBbits.RB3 << 3 | PORTBbits.RB2 << 2 | PORTBbits.RB1 << 1 |
        PORTBbits.RB0);
158     switch (scan) {
159         case 0b00001110: // is on Bbits.RB3
160             return resetPins(7);
161         case 0b00001101: // on pin 5
162             return resetPins(8);
163         case 0b00001011: // on pin 6
164             return resetPins(9);
165         case 0b00000111: // on pin 7
166             return resetPins(12);
167     }
```

```
168
169     PORTDbits.RD4 = 1; // check row4
170     PORTDbits.RD5 = 0;
171     Delay10TCYx(10);
172     scan = (PORTBbits.RB3 << 3 | PORTBbits.RB2 << 2 | PORTBbits.RB1 << 1 |
        PORTBbits.RB0);
173     switch (scan) {
174         case 0b00001110: // is on Bbits.RB3
175             return resetPins(14);
176         case 0b00001101: // on pin 5
177             return resetPins(0);
178         case 0b00001011: // on pin 6
179             return resetPins(15);
180         case 0b00000111: // on pin 7
181             return resetPins(13);
182     }
183
184     return resetPins(-1); // assume no key was pressed.
185 }
186
187
188 // resets the driving pins
189
190 int resetPins(int key) {
191     PORTDbits.RD5 = 1; // set outputs HIGH
192     PORTDbits.RD4 = 1;
193     PORTDbits.RD3 = 1;
194     PORTDbits.RD2 = 1;
195     return key;
196 }
197
198 /* sets all pins to input or output and disables analog in;
199  * sets initial port outputs to HIGH
200  */
201 void keypadSetup() {
202     // initialize pins 4-7 HIGH
203     PORTDbits.RD2 = 1;
204     PORTDbits.RD3 = 1;
205     PORTDbits.RD4 = 1;
206     PORTDbits.RD5 = 1;
207
208     // pins 4-7 are toggled, pins 0-3 are monitored
209     TRISDbits.RD5 = 0;
210     TRISDbits.RD4 = 0;
211     TRISDbits.RD3 = 0;
212     TRISDbits.RD2 = 0;
213
214     TRISBbits.RB0 = 1;
215     TRISBbits.RB1 = 1;
```

```
216     TRISBbits.RB2 = 1;
217     TRISBbits.RB3 = 1;
218
219     ANSELBbits.ANSB3 = 0; // disable analog input
220     ANSELBbits.ANSB2 = 0;
221     ANSELBbits.ANSB1 = 0;
222     ANSELBbits.ANSB0 = 0;
223     ANSELDbits.ANSD2 = 0;
224     ANSELDbits.ANSD3 = 0;
225     ANSELDbits.ANSD4 = 0;
226     ANSELDbits.ANSD5 = 0;
227
228
229     // enable weak pull ups on ports b0-b3
230     WPUB = WPUB & 0b11111111;
231     // enable pull ups on portB globally
232     INTCON2 = INTCON2 & 0b01111111;
233
234     return;
235 }
```

G.6 LCD Driver

../FrontEnd.X/LCD.h

```
1  /*
2   * File:   LCD.h
3   * Author: castia
4   *
5   * Created on May 25, 2014, 7:53 PM
6   */
7
8  #ifndef LCD_H
9  #define LCD_H
10
11 #ifdef __cplusplus
12 extern "C" {
13 #endif
14
15 #include "globals.h"
16
17 #define V 128
18 #define H 160
19
20 #define RGB565(r,g,b) ((((r>>3)<<11) | (g>>3) | ((b>>2)<<5)))
21
22 #define ST7735_NOP      0x00
23 #define ST7735_SWRESET 0x01
```

```
24 #define ST7735_RDDID    0x04
25 #define ST7735_RDDST    0x09
26
27 #define ST7735_SLPIN    0x10
28 #define ST7735_SLPOUT   0x11
29 #define ST7735_PTLON    0x12
30 #define ST7735_NORON    0x13
31
32 #define ST7735_INVOFF   0x20
33 #define ST7735_INVON    0x21
34 #define ST7735_DISPOFF  0x28
35 #define ST7735_DISPON   0x29
36 #define ST7735_CASET    0x2A
37 #define ST7735_RASET    0x2B
38 #define ST7735_RAMWR    0x2C
39 #define ST7735_RAMRD    0x2E
40
41 #define ST7735_PTLAR    0x30
42 #define ST7735_COLMOD   0x3A
43 #define ST7735_MADCTL   0x36
44
45 #define ST7735_FRMCTR1  0xB1
46 #define ST7735_FRMCTR2  0xB2
47 #define ST7735_FRMCTR3  0xB3
48 #define ST7735_INVCTR   0xB4
49 #define ST7735_DISSET5  0xB6
50
51 #define ST7735_PWCTR1   0xC0
52 #define ST7735_PWCTR2   0xC1
53 #define ST7735_PWCTR3   0xC2
54 #define ST7735_PWCTR4   0xC3
55 #define ST7735_PWCTR5   0xC4
56 #define ST7735_VMCTR1   0xC5
57
58 #define ST7735_RDID1    0xDA
59 #define ST7735_RDID2    0xDB
60 #define ST7735_RDID3    0xDC
61 #define ST7735_RDID4    0xDD
62
63 #define ST7735_PWCTR6   0xFC
64
65 #define ST7735_GMCTRP1  0xE0
66 #define ST7735_GMCTRN1  0xE1
67
68 // Color definitions
69 #define BLACK RGB565(0,0,0)
70 #define RED RGB565(255,0,0)
71 #define GREEN RGB565(0,255,0)
72 #define BLUE RGB565(0,0,255)
```

```
73 #define YELLOW RGB565(255,255,0)
74 #define CYAN RGB565(0,255,255)
75 #define PINK RGB565(255,0,255)
76 #define GRAY RGB565(192,192,192)
77 #define WHITE RGB565(255,255,255)
78
79
80 #define CS 0b00010000 //Low = select, High = deselect.
81 #define RE 0b00000010 //High = normal, Low = reset.
82 #define A0 0b00010000 //Low = Command, High = Data.
83
84 void delay(int x);
85 void sendcomand(char input);
86 void senddata(char input);
87 void SetPix(char x, char y, int color);
88 void clean(int color);
89 void initLCD(void);
90 void ASCII(char x, char y, int color, int background, char letter, char size);
91
92
93 int customColor(int r, int g, int b);
94 void drawBoxFill(char x, char y,char height, char width, int color);
95 void drawBox(char x, char y, char height, char width, int border, int color);
96
97 typedef struct globaldata GlobalState;
98
99 // Print Functions
100 void prints(char x, char y, int color, int background, const char message[],
      char size);
101 void printrs(char x, char y, int color, int background, char* message, char
      size);
102 void integerprint(char x, char y, int color, int background,int integer, char
      size);
103 void printMenu(char** select, int background, int box, int boxBorder, int text,
       int size);
104 int processPrintCursor(GlobalState* globalData, int size, int background, int
      text);
105
106 // System Specific functions
107 void mainMenu(GlobalState* globalData);
108 void selectGameMenu(GlobalState* globalData);
109
110 // System Specific Print Functions
111 void printBSOD(void);
112 void printMainMenu(GlobalState* globalData);
113 void printSelectGame(GlobalState* globalData);
114
115 // Test Purposes
116 void printBuildCard1(GlobalState *globalData);
```

```
117
118 // depreciated
119 //void box(char x, char y, char high, char breth, int color);
120 //void processDisplay(GlobalState* globalData);
121 //void nextPage(GlobalState* globalData, int cursorPos);
122
123 #ifdef __cplusplus
124 }
125 #endif
126
127 #endif /* LCD_H */
```

../FrontEnd.X/LCD.c

```
1
2 #include "globals.h"
3 #include "LCD.h"
4
5 const rom char font[255][5] = {
6     {0x00, 0x00, 0x00, 0x00, 0x00},
7     {0x3E, 0x5B, 0x4F, 0x5B, 0x3E},
8     {0x3E, 0x6B, 0x4F, 0x6B, 0x3E},
9     {0x1C, 0x3E, 0x7C, 0x3E, 0x1C},
10    {0x18, 0x3C, 0x7E, 0x3C, 0x18},
11    {0x1C, 0x57, 0x7D, 0x57, 0x1C},
12    {0x1C, 0x5E, 0x7F, 0x5E, 0x1C},
13    {0x00, 0x18, 0x3C, 0x18, 0x00},
14    {0xFF, 0xE7, 0xC3, 0xE7, 0xFF},
15    {0x00, 0x18, 0x24, 0x18, 0x00},
16    {0xFF, 0xE7, 0xDB, 0xE7, 0xFF},
17    {0x30, 0x48, 0x3A, 0x06, 0x0E},
18    {0x26, 0x29, 0x79, 0x29, 0x26},
19    {0x40, 0x7F, 0x05, 0x05, 0x07},
20    {0x40, 0x7F, 0x05, 0x25, 0x3F},
21    {0x5A, 0x3C, 0xE7, 0x3C, 0x5A},
22    {0x7F, 0x3E, 0x1C, 0x1C, 0x08},
23    {0x08, 0x1C, 0x1C, 0x3E, 0x7F},
24    {0x14, 0x22, 0x7F, 0x22, 0x14},
25    {0x5F, 0x5F, 0x00, 0x5F, 0x5F},
26    {0x06, 0x09, 0x7F, 0x01, 0x7F},
27    {0x00, 0x66, 0x89, 0x95, 0x6A},
28    {0x60, 0x60, 0x60, 0x60, 0x60},
29    {0x94, 0xA2, 0xFF, 0xA2, 0x94},
30    {0x08, 0x04, 0x7E, 0x04, 0x08},
31    {0x10, 0x20, 0x7E, 0x20, 0x10},
32    {0x08, 0x08, 0x2A, 0x1C, 0x08},
33    {0x08, 0x1C, 0x2A, 0x08, 0x08},
34    {0x1E, 0x10, 0x10, 0x10, 0x10},
35    {0x0C, 0x1E, 0x0C, 0x1E, 0x0C},
```

```
    {0x30, 0x38, 0x3E, 0x38, 0x30},
    {0x06, 0x0E, 0x3E, 0x0E, 0x06},
    {0x00, 0x00, 0x00, 0x00, 0x00},
    {0x00, 0x00, 0x5F, 0x00, 0x00},
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    {0x24, 0x2A, 0x7F, 0x2A, 0x12},
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    {0x00, 0x08, 0x07, 0x03, 0x00},
    {0x00, 0x1C, 0x22, 0x41, 0x00},
    {0x00, 0x41, 0x22, 0x1C, 0x00},
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    {0x00, 0x00, 0x60, 0x60, 0x00},
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    {0x00, 0x42, 0x7F, 0x40, 0x00},
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    {0x21, 0x41, 0x49, 0x4D, 0x33},
    {0x18, 0x14, 0x12, 0x7F, 0x10},
    {0x27, 0x45, 0x45, 0x45, 0x39},
    {0x3C, 0x4A, 0x49, 0x49, 0x31},
    {0x41, 0x21, 0x11, 0x09, 0x07},
    {0x36, 0x49, 0x49, 0x49, 0x36},
    {0x46, 0x49, 0x49, 0x29, 0x1E},
    {0x00, 0x00, 0x14, 0x00, 0x00},
    {0x00, 0x40, 0x34, 0x00, 0x00},
    {0x00, 0x08, 0x14, 0x22, 0x41},
    {0x14, 0x14, 0x14, 0x14, 0x14},
    {0x00, 0x41, 0x22, 0x14, 0x08},
    {0x02, 0x01, 0x59, 0x09, 0x06},
    {0x3E, 0x41, 0x5D, 0x59, 0x4E},
    {0x7C, 0x12, 0x11, 0x12, 0x7C},
    {0x7F, 0x49, 0x49, 0x49, 0x36},
    {0x3E, 0x41, 0x41, 0x41, 0x22},
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    {0x7F, 0x09, 0x09, 0x09, 0x01},
    {0x3E, 0x41, 0x41, 0x51, 0x73},
    {0x7F, 0x08, 0x08, 0x08, 0x7F},
    {0x00, 0x41, 0x7F, 0x41, 0x00},
    {0x20, 0x40, 0x41, 0x3F, 0x01},
    {0x7F, 0x08, 0x14, 0x22, 0x41},
    {0x7F, 0x40, 0x40, 0x40, 0x40},
    {0x7F, 0x02, 0x1C, 0x02, 0x7F},
    {0x7F, 0x04, 0x08, 0x10, 0x7F},
```

```
    {0x3E, 0x41, 0x41, 0x41, 0x3E},
    {0x7F, 0x09, 0x09, 0x09, 0x06},
    {0x3E, 0x41, 0x51, 0x21, 0x5E},
    {0x7F, 0x09, 0x19, 0x29, 0x46},
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    {0x03, 0x01, 0x7F, 0x01, 0x03},
    {0x3F, 0x40, 0x40, 0x40, 0x3F},
    {0x1F, 0x20, 0x40, 0x20, 0x1F},
    {0x3F, 0x40, 0x38, 0x40, 0x3F},
    {0x63, 0x14, 0x08, 0x14, 0x63},
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    {0x61, 0x59, 0x49, 0x4D, 0x43},
    {0x00, 0x7F, 0x41, 0x41, 0x41},
    {0x02, 0x04, 0x08, 0x10, 0x20},
    {0x00, 0x41, 0x41, 0x41, 0x7F},
    {0x04, 0x02, 0x01, 0x02, 0x04},
    {0x40, 0x40, 0x40, 0x40, 0x40},
    {0x00, 0x03, 0x07, 0x08, 0x00},
    {0x20, 0x54, 0x54, 0x78, 0x40},
    {0x7F, 0x28, 0x44, 0x44, 0x38},
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    {0x38, 0x54, 0x54, 0x54, 0x18},
    {0x00, 0x08, 0x7E, 0x09, 0x02},
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    {0x7F, 0x08, 0x04, 0x04, 0x78},
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    {0x20, 0x40, 0x40, 0x3D, 0x00},
    {0x7F, 0x10, 0x28, 0x44, 0x00},
    {0x00, 0x41, 0x7F, 0x40, 0x00},
    {0x7C, 0x04, 0x78, 0x04, 0x78},
    {0x7C, 0x08, 0x04, 0x04, 0x78},
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    {0xFC, 0x18, 0x24, 0x24, 0x18},
    {0x18, 0x24, 0x24, 0x18, 0xFC},
    {0x7C, 0x08, 0x04, 0x04, 0x08},
    {0x48, 0x54, 0x54, 0x54, 0x24},
    {0x04, 0x04, 0x3F, 0x44, 0x24},
    {0x3C, 0x40, 0x40, 0x20, 0x7C},
    {0x1C, 0x20, 0x40, 0x20, 0x1C},
    {0x3C, 0x40, 0x30, 0x40, 0x3C},
    {0x44, 0x28, 0x10, 0x28, 0x44},
    {0x4C, 0x90, 0x90, 0x90, 0x7C},
    {0x44, 0x64, 0x54, 0x4C, 0x44},
    {0x00, 0x08, 0x36, 0x41, 0x00},
    {0x00, 0x00, 0x77, 0x00, 0x00},
    {0x00, 0x41, 0x36, 0x08, 0x00},
    {0x02, 0x01, 0x02, 0x04, 0x02},
    {0x3C, 0x26, 0x23, 0x26, 0x3C},
```

```
    {0x1E, 0xA1, 0xA1, 0x61, 0x12},
    {0x3A, 0x40, 0x40, 0x20, 0x7A},
    {0x38, 0x54, 0x54, 0x55, 0x59},
    {0x21, 0x55, 0x55, 0x79, 0x41},
    {0x21, 0x54, 0x54, 0x78, 0x41},
    {0x21, 0x55, 0x54, 0x78, 0x40},
    {0x20, 0x54, 0x55, 0x79, 0x40},
    {0x0C, 0x1E, 0x52, 0x72, 0x12},
    {0x39, 0x55, 0x55, 0x55, 0x59},
    {0x39, 0x54, 0x54, 0x54, 0x59},
    {0x39, 0x55, 0x54, 0x54, 0x58},
    {0x00, 0x00, 0x45, 0x7C, 0x41},
    {0x00, 0x02, 0x45, 0x7D, 0x42},
    {0x00, 0x01, 0x45, 0x7C, 0x40},
    {0xF0, 0x29, 0x24, 0x29, 0xF0},
    {0xF0, 0x28, 0x25, 0x28, 0xF0},
    {0x7C, 0x54, 0x55, 0x45, 0x00},
    {0x20, 0x54, 0x54, 0x7C, 0x54},
    {0x7C, 0x0A, 0x09, 0x7F, 0x49},
    {0x32, 0x49, 0x49, 0x49, 0x32},
    {0x32, 0x48, 0x48, 0x48, 0x32},
    {0x32, 0x4A, 0x48, 0x48, 0x30},
    {0x3A, 0x41, 0x41, 0x21, 0x7A},
    {0x3A, 0x42, 0x40, 0x20, 0x78},
    {0x00, 0x9D, 0xA0, 0xA0, 0x7D},
    {0x39, 0x44, 0x44, 0x44, 0x39},
    {0x3D, 0x40, 0x40, 0x40, 0x3D},
    {0x3C, 0x24, 0xFF, 0x24, 0x24},
    {0x48, 0x7E, 0x49, 0x43, 0x66},
    {0x2B, 0x2F, 0xFC, 0x2F, 0x2B},
    {0xFF, 0x09, 0x29, 0xF6, 0x20},
    {0xC0, 0x88, 0x7E, 0x09, 0x03},
    {0x20, 0x54, 0x54, 0x79, 0x41},
    {0x00, 0x00, 0x44, 0x7D, 0x41},
    {0x30, 0x48, 0x48, 0x4A, 0x32},
    {0x38, 0x40, 0x40, 0x22, 0x7A},
    {0x00, 0x7A, 0x0A, 0x0A, 0x72},
    {0x7D, 0x0D, 0x19, 0x31, 0x7D},
    {0x26, 0x29, 0x29, 0x2F, 0x28},
    {0x26, 0x29, 0x29, 0x29, 0x26},
    {0x30, 0x48, 0x4D, 0x40, 0x20},
    {0x38, 0x08, 0x08, 0x08, 0x08},
    {0x08, 0x08, 0x08, 0x08, 0x38},
    {0x2F, 0x10, 0xC8, 0xAC, 0xBA},
    {0x2F, 0x10, 0x28, 0x34, 0xFA},
    {0x00, 0x00, 0x7B, 0x00, 0x00},
    {0x08, 0x14, 0x2A, 0x14, 0x22},
    {0x22, 0x14, 0x2A, 0x14, 0x08},
    {0xAA, 0x00, 0x55, 0x00, 0xAA},
```

```
183     {0xAA, 0x55, 0xAA, 0x55, 0xAA},
184     {0x00, 0x00, 0x00, 0xFF, 0x00},
185     {0x10, 0x10, 0x10, 0xFF, 0x00},
186     {0x14, 0x14, 0x14, 0xFF, 0x00},
187     {0x10, 0x10, 0xFF, 0x00, 0xFF},
188     {0x10, 0x10, 0xF0, 0x10, 0xF0},
189     {0x14, 0x14, 0x14, 0xFC, 0x00},
190     {0x14, 0x14, 0xF7, 0x00, 0xFF},
191     {0x00, 0x00, 0xFF, 0x00, 0xFF},
192     {0x14, 0x14, 0xF4, 0x04, 0xFC},
193     {0x14, 0x14, 0x17, 0x10, 0x1F},
194     {0x10, 0x10, 0x1F, 0x10, 0x1F},
195     {0x14, 0x14, 0x14, 0x1F, 0x00},
196     {0x10, 0x10, 0x10, 0xF0, 0x00},
197     {0x00, 0x00, 0x00, 0x1F, 0x10},
198     {0x10, 0x10, 0x10, 0x1F, 0x10},
199     {0x10, 0x10, 0x10, 0xF0, 0x10},
200     {0x00, 0x00, 0x00, 0xFF, 0x10},
201     {0x10, 0x10, 0x10, 0x10, 0x10},
202     {0x10, 0x10, 0x10, 0xFF, 0x10},
203     {0x00, 0x00, 0x00, 0xFF, 0x14},
204     {0x00, 0x00, 0xFF, 0x00, 0xFF},
205     {0x00, 0x00, 0x1F, 0x10, 0x17},
206     {0x00, 0x00, 0xFC, 0x04, 0xF4},
207     {0x14, 0x14, 0x17, 0x10, 0x17},
208     {0x14, 0x14, 0xF4, 0x04, 0xF4},
209     {0x00, 0x00, 0xFF, 0x00, 0xF7},
210     {0x14, 0x14, 0x14, 0x14, 0x14},
211     {0x14, 0x14, 0xF7, 0x00, 0xF7},
212     {0x14, 0x14, 0x14, 0x17, 0x14},
213     {0x10, 0x10, 0x1F, 0x10, 0x1F},
214     {0x14, 0x14, 0x14, 0xF4, 0x14},
215     {0x10, 0x10, 0xF0, 0x10, 0xF0},
216     {0x00, 0x00, 0x1F, 0x10, 0x1F},
217     {0x00, 0x00, 0x00, 0x1F, 0x14},
218     {0x00, 0x00, 0x00, 0xFC, 0x14},
219     {0x00, 0x00, 0xF0, 0x10, 0xF0},
220     {0x10, 0x10, 0xFF, 0x10, 0xFF},
221     {0x14, 0x14, 0x14, 0xFF, 0x14},
222     {0x10, 0x10, 0x10, 0x1F, 0x00},
223     {0x00, 0x00, 0x00, 0xF0, 0x10},
224     {0xFF, 0xFF, 0xFF, 0xFF, 0xFF},
225     {0xF0, 0xF0, 0xF0, 0xF0, 0xF0},
226     {0xFF, 0xFF, 0xFF, 0x00, 0x00},
227     {0x00, 0x00, 0x00, 0xFF, 0xFF},
228     {0x0F, 0x0F, 0x0F, 0x0F, 0x0F},
229     {0x38, 0x44, 0x44, 0x38, 0x44},
230     {0x7C, 0x2A, 0x2A, 0x3E, 0x14},
231     {0x7E, 0x02, 0x02, 0x06, 0x06},
```

```
232     {0x02, 0x7E, 0x02, 0x7E, 0x02},
233     {0x63, 0x55, 0x49, 0x41, 0x63},
234     {0x38, 0x44, 0x44, 0x3C, 0x04},
235     {0x40, 0x7E, 0x20, 0x1E, 0x20},
236     {0x06, 0x02, 0x7E, 0x02, 0x02},
237     {0x99, 0xA5, 0xE7, 0xA5, 0x99},
238     {0x1C, 0x2A, 0x49, 0x2A, 0x1C},
239     {0x4C, 0x72, 0x01, 0x72, 0x4C},
240     {0x30, 0x4A, 0x4D, 0x4D, 0x30},
241     {0x30, 0x48, 0x78, 0x48, 0x30},
242     {0xBC, 0x62, 0x5A, 0x46, 0x3D},
243     {0x3E, 0x49, 0x49, 0x49, 0x00},
244     {0x7E, 0x01, 0x01, 0x01, 0x7E},
245     {0x2A, 0x2A, 0x2A, 0x2A, 0x2A},
246     {0x44, 0x44, 0x5F, 0x44, 0x44},
247     {0x40, 0x51, 0x4A, 0x44, 0x40},
248     {0x40, 0x44, 0x4A, 0x51, 0x40},
249     {0x00, 0x00, 0xFF, 0x01, 0x03},
250     {0xE0, 0x80, 0xFF, 0x00, 0x00},
251     {0x08, 0x08, 0x6B, 0x6B, 0x08},
252     {0x36, 0x12, 0x36, 0x24, 0x36},
253     {0x06, 0x0F, 0x09, 0x0F, 0x06},
254     {0x00, 0x00, 0x18, 0x18, 0x00},
255     {0x00, 0x00, 0x10, 0x10, 0x00},
256     {0x30, 0x40, 0xFF, 0x01, 0x01},
257     {0x00, 0x1F, 0x01, 0x01, 0x1E},
258     {0x00, 0x19, 0x1D, 0x17, 0x12},
259     {0x00, 0x3C, 0x3C, 0x3C, 0x3C},
260     {0x00, 0x00, 0x00, 0x00, 0x00}
261 };
262
263 void delay(int x) {
264     int j = 0;
265     for (j = 0; j < x; j++);
266 }
267
268 // Sends a "command" to the LCD
269
270 void sendcomand(char input) {
271     int j = 0;
272     PORTC &= ~A0;
273     PORTB &= ~CS;
274     SSP1BUF = input;
275     for (j = 0; j < 1; j++);
276     PORTB |= CS;
277 }
278
279 // Sends "data" to the LCD
280
```

```
281 void senddata(char input) {
282     int j = 0;
283     PORTC |= A0;
284     PORTB &= ~CS;
285     SSP1BUF = input;
286     for (j = 0; j < 1; j++);
287     PORTB |= CS;
288 }
289
290 // Sets individual pixels at coords x and y  to the given color
291
292 void SetPix(char x, char y, int color) {
293     char Hig = 0;
294     char Low = color & 0x00ff;
295     color >>= 8;
296     Hig = color;
297
298     sendcomand(ST7735_CASET); // Column addr set
299     senddata(0x00);
300     senddata(x); // XSTART
301     senddata(0x00);
302     senddata(x + 1); // XEND
303
304     sendcomand(ST7735_RASET); // Row addr set
305     senddata(0x00);
306     senddata(y); // YSTART
307     senddata(0x00);
308     senddata(y + 1); // YEND
309
310     sendcomand(ST7735_RAMWR);
311
312     senddata(Low);
313     senddata(Hig);
314 }
315
316
317
318 // Returns a custom color in RGB values
319
320 int customColor(int r, int g, int b) {
321     return RGB565(r, g, b);
322 }
323
324 // Draw a border in a box shape at upper left x, y coords
325 // Box will be height tall, width wide, have a border of the given size and
    color
326 // of the given color
327
328 void drawBox(char x, char y, char height, char width, int border, int color) {
```

```
329     border -= 1;
330     drawBoxFill(x, y, border, width, color);
331     drawBoxFill(x + width - border, y, height, border, color);
332     drawBoxFill(x, y + height - border, border, width, color);
333     drawBoxFill(x, y, height, border, color);
334 }
335 
336 // Draws a box and fills it in with the given color
337 
338 void drawBoxFill(char x, char y, char height, char width, int color) {
339     char Hig = 0;
340     char Low = color & 0x00ff;
341     int i = 0;
342     int j = 0;
343     Hig = color >> 8;
344 
345     sendcomand(ST7735_CASET); // Column addr set
346     senddata(0x00);
347     senddata(x); // XSTART
348     senddata(0x00);
349     senddata(x + width); // XEND
350 
351     sendcomand(ST7735_RASET); // Row addr set
352     senddata(0x00);
353     senddata(y); // YSTART
354     senddata(0x00);
355     senddata(y + height); // YEND
356 
357     sendcomand(ST7735_RAMWR);
358 
359     for (j = 0; j <= width; j++) {
360         for (i = 0; i <= height; i++) {
361             senddata(Low);
362             senddata(Hig);
363         }
364     }
365 }
366 
367 // Cleans the entire screen as a certain color
368 
369 void clean(int color) {
370 
371     char Hig = 0;
372     int x = 0;
373     int y = 0;
374     char Low = color & 0x00ff;
375     color >>= 8;
376     Hig = color;
377 
```

```
378     sendcomand(ST7735_CASET); // Column addr set
379     senddata(0x00);
380     senddata(0); // XSTART
381     senddata(0x00);
382     senddata(V); // XEND
383 
384     sendcomand(ST7735_RASET); // Row addr set
385     senddata(0x00);
386     senddata(0); // YSTART
387     senddata(0x00);
388     senddata(H); // YEND
389 
390     sendcomand(ST7735_RAMWR);
391 
392     for (x = 0; x < V; x++) {
393         for (y = 0; y < H; y++) {
394             senddata(Low);
395             senddata(Hig);
396         }
397     }
398 }
399 
400 // Initializes the LCD screen by sending a bajillion commands
401 
402 void initLCD() {
403     PORTB &= ~CS;
404     delay(0);
405     //     PORTC |= RE;
406     //     delay(100);
407     //     PORTC &= ~RE;
408     //     delay(100);
409     //     PORTC |= RE;
410     delay(10000);
411     sendcomand(ST7735_SWRESET); //  1: Software reset, 0 args, w/delay 150ms 0
    x01
412     delay(1000);
413     sendcomand(ST7735_SLPOUT); //  2: Out of sleep mode, 0 args, w/delay 500ms
    0x11
414     delay(10000);
415     sendcomand(ST7735_FRMCTR1); //  3: Frame rate ctrl - normal mode) 3 args: 0
    xb1
416     senddata(0x01);
417     senddata(0x2C);
418     senddata(0x2D); //      Rate = fosc/(1x2+40) * (LINE+2C+2D)
419     sendcomand(ST7735_FRMCTR2); //  4: Frame rate control - idle mode) 3 args:
    0xb2
420     senddata(0x01);
421     senddata(0x2C);
422     senddata(0x2D); //      Rate = fosc/(1x2+40) * (LINE+2C+2D)
```

```
423     sendcomand(ST7735_FRMCTR3); //  5: Frame rate ctrl - partial mode) 6 args:
        0xb3
424     senddata(0x01);
425     senddata(0x2C);
426     senddata(0x2D); //      Dot inversion mode
427     senddata(0x01);
428     senddata(0x2C);
429     senddata(0x2D); //      Line inversion mode
430     sendcomand(ST7735_INVCTR); //  6: Display inversion ctrl) 1 arg) no delay:
        0xb4
431     senddata(0x07); //      No inversion
432     sendcomand(ST7735_PWCTR1); //  7: Power control) 3 args) no delay: 0xc0
433     senddata(0xA2);
434     senddata(0x02); //      -4.6V
435     senddata(0x84); //      AUTO mode
436     sendcomand(ST7735_PWCTR2); //  8: Power control) 1 arg) no delay: 0xc1
437     senddata(0xC5); //      VGH25 = 2.4C VGSEL = -10 VGH = 3 * AVDD
438     sendcomand(ST7735_PWCTR3); //  9: Power control) 2 args) no delay: 0xc2
439     senddata(0x0A); //      Opamp current small
440     senddata(0x00); //      Boost frequency
441     sendcomand(ST7735_PWCTR4); // 10: Power control) 2 args) no delay:
442     senddata(0x8A); //      BCLK/2) Opamp current small & Medium low
443     senddata(0x2A);
444     sendcomand(ST7735_PWCTR5); // 11: Power control) 2 args) no delay:
445     senddata(0x8A);
446     senddata(0xEE);
447     sendcomand(ST7735_VMCTR1); // 12: Power control) 1 arg) no delay:
448     senddata(0x0E);
449     sendcomand(ST7735_INVOFF); // 13: Don't invert display) no args) no delay 0
        x20
450     sendcomand(ST7735_MADCTL); // 14: Memory access control (directions)) 1 arg
        :
451     senddata(0xC8); //      row addr/col addr); bottom to top refresh
452     sendcomand(ST7735_COLMOD); // 15: set color mode); 1 arg); no delay:
453     senddata(0x05); //      16-bit color
454     sendcomand(ST7735_GMCTRP1); // Gamma correction
455     senddata(0x0f);
456     senddata(0x1a);
457     senddata(0x0f);
458     senddata(0x18);
459     senddata(0x2f);
460     senddata(0x28);
461     senddata(0x20);
462     senddata(0x22);
463     senddata(0x1f);
464     senddata(0x1b);
465     senddata(0x23);
466     senddata(0x37);
467     senddata(0x00);
```

```
468     senddata(0x07);
469     senddata(0x02);
470     senddata(0x10);
471     sendcomand(ST7735_GMCTRN1);
472     senddata(0x0f);
473     senddata(0x1b);
474     senddata(0x0f);
475     senddata(0x17);
476     senddata(0x33);
477     senddata(0x2c);
478     senddata(0x29);
479     senddata(0x2e);
480     senddata(0x30);
481     senddata(0x30);
482     senddata(0x39);
483     senddata(0x3f);
484     senddata(0x00);
485     senddata(0x07);
486     senddata(0x03);
487     senddata(0x10);
488
489     sendcomand(ST7735_NORON); //  3: Normal display on, no args, w/delay 10ms 0
        x13
490     delay(100);
491     sendcomand(ST7735_DISPON); //  4: Main screen turn on, no args w/delay 100
        ms 0x29
492     delay(1000);
493 }
494
495 // Looks up the pixels to set when writing ascii character
496
497 void ASCII(char x, char y, int color, int background, char letter, char size) {
498     char data;
499     char q = 0;
500     char z = 0;
501     char d = 0;
502     char b = 0;
503
504     for (q = 0; q < 5; q++) {
505         data = font[letter][q];
506         for (z = 0; z < 8 * size; z++) {
507             if ((data & 1) != 0) {
508                 for (d = 0; d < size; d++) {
509                     for (b = 0; b < size; b++) {
510                         SetPix(x + (q * size) + d, y + (z * size) + b, color);
511                     }
512                 }
513             } else {
514                 for (d = 0; d < size; d++) {
```

```
515                     for (b = 0; b < size; b++) {
516                         SetPix(x + (q * size) + d, y + (z * size) + b,
    background);
517                     }
518                 }
519             }
520             data >>= 1;
521         }
522     }
523 }
524
525 // Prints a string that is sent in " " marks
526 // It will start at coords x and y, with background colors and text colors
527 // Font size can be specified.
528
529 // Each line with size 1 should be around 8 pixels apart, font will wrap around
530 // the screen if it's too long
531
532 void prints(char x, char y, int color, int background, const char messageOld[],
     char size) {
533     const far rom char* message = (const far rom char*) messageOld;
534     while (*message) {
535         ASCII(x, y, color, background, *message++, size);
536         x += 6 * size;
537         if (x > 120) {
538             x = 0;
539             y += 8 * size;
540         }
541     }
542 }
543
544 // Prints a string saved in ram already
545 // It will start at coords x and y, with background colors and text colors
546 // Font size can be specified.
547
548 // Each line with size 1 should be around 8 pixels apart, font will wrap around
549 // the screen if it's too long
550
551 void printrs(char x, char y, int color, int background, char* message, char
    size) {
552     while (*message) {
553         ASCII(x, y, color, background, *message++, size);
554         x += 6 * size;
555         if (x > 120) {
556             x = 0;
557             y += 8 * size;
558         }
559     }
560 }
```

```
561
562 // Prints an INT value to the screen
563
564 void integerprint(char x, char y, int color, int background, int integer, char
    size) {
565     unsigned char tenthousands = 0;
566     unsigned char thousands = 0;
567     unsigned char hundreds = 0;
568     unsigned char tens = 0;
569     unsigned char ones = 0;
570     if (integer >= 10000) {
571         tenthousands = integer / 10000;
572         ASCII(x, y, color, background, tenthousands + 48, size);
573     }
574     if (integer >= 1000) {
575         thousands = ((integer - tenthousands * 10000)) / 1000;
576         x += 6;
577         ASCII(x, y, color, background, thousands + 48, size);
578     }
579     if (integer >= 100) {
580         hundreds = (((integer - tenthousands * 10000) - thousands * 1000)) /
    100;
581         x += 6;
582         ASCII(x, y, color, background, hundreds + 48, size);
583     }
584     if (integer >= 10) {
585         tens = (integer % 100) / 10;
586         x += 6;
587         ASCII(x, y, color, background, tens + 48, size);
588     }
589     ones = integer % 10;
590     x += 6;
591     ASCII(x, y, color, background, ones + 48, size);
592 }
593
594 // Prints menu for operating system functions
595 void printMenu(char** select, int background, int box, int boxBorder, int text,
     int size) {
596     int i;
597     // Beep off
598     TRISBbits.RB5 = 1;
599     // Change background
600     clean(background);
601
602     // Draw Box
603     drawBoxFill(0, 0, 20, V - 1, box);
604     drawBox(0, 0, 20, V - 1, 2, boxBorder);
605
606     // Write Select Options
```

```
607     for (i = 0; i < size; i++) {
608         // Do I have to deference this pointer?
609         prints(35, 20 * i + 40, text, background, select[i], 1);
610     }
611 }
612
613 // Prints cursor and processes the selection based off of the index i
614 // Top of List [ 0 1 2 3] Bottom of List
615 int processPrintCursor(GlobalState* globalData, int size, int background, int
        text) {
616     int i = 0;
617     prints(25, 40, text, background, ">", 1);
618     globalData->keyPress = -1;
619     // Continue scanning the keypad until the user hits "D" for enter
620     while (globalData->keyPress != 0x0D) {
621         // Check keystroke
622         keypad(globalData);
623         if (globalData->keyFlag && !globalData->displayedKey) {
624             globalData->keyFlag = FALSE;
625             globalData->displayedKey = TRUE;
626             // Change index i based off of whether user moves up or down
627             switch (globalData->keyPress) {
628                  // Move up = Press 2
629                 case 0x02:
630                     // Clear original cursor
631                     prints(25, 20 * i + 40, text, background, " ", 1);
632
633                     // Find new position of cursor
634                     i = ((size + i) - 1) % size;
635
636                     // Print cursor in new position
637                     prints(25, 20 * i + 40, text, background, ">", 1);
638                     break;
639                 // Move down = Press 8
640                 case 0x08:
641                     // Clear original cursor
642                     prints(25, 20 * i + 40, text, background, " ", 1);
643
644                     // Find new position of cursor
645                     i = (i + 1) % size;
646
647                     // Print cursor in new position
648                     prints(25, 20 * i + 40, text, background, ">", 1);
649                     break;
650                 // Hit back button "B"
651                 case 0x0B:
652                     i = 0xFF;
653                     // Break out of while loop - hitting B takes priority
654                     globalData->keyPress = 0x0D;
```

```
655                     break;
656                 case 0x0D:
657                     prints(25, 20 * i + 40, text, background, ">>>", 1);
658                     break;
659                 default:
660                     break;
661             }
662         }
663     }
664     // Return index to indicate cursor position
665     return i;
666 }
667
668 /* The following functions are print functions for the operating system of the
669  * device.
670  */
671
672 // Prints the main menu
673 void printMainMenu(GlobalState* globalData) {
674     // LCD menu
675     // Main Menu Array
676     const rom char *mainMenu[3] = {"Single", "Multiplayer", "Build Card"};
677     printMenu(mainMenu, BLUE, CYAN, WHITE, WHITE, 3);
678     prints(35, 7, WHITE, CYAN, "Main Menu", 1);
679
680     /*
681     clean(BLUE);
682     drawBoxFill(0, 0, 20, V - 1, CYAN);
683     drawBox(0, 0, 20, V - 1, 2, WHITE);
684
685     prints(35, globalData->mainMenuSpots[0], WHITE, BLUE, "Single Player", 1);
686     prints(35, globalData->mainMenuSpots[1], WHITE, BLUE, "Multiplayer", 1);
687     prints(35, globalData->mainMenuSpots[2], WHITE, BLUE, "Build Cards", 1);
688      */
689     prints(0, H - 8, WHITE, BLUE, "2-UP,8-DOWN,D-ENTER", 1);
690 }
691
692 // Print menu for selecting available games.
693 void printSelectGame(GlobalState *globalData) {
694     char* selectGame[4] = {"Duel Game", "Clue", "Empty", "Empty"};
695
696     printMenu(selectGame, GREEN, YELLOW, BLACK, BLACK, 4);
697     prints(25, 7, BLACK, YELLOW, "Available Games:", 1);
698     prints(0, H - 8, BLACK, YELLOW, "2-UP,8-DOWN,D-ENTER", 1);
699 }
700
701 // Print blue screen of death
702 void printBSOD() {
703     // Beep off
```

```
704     TRISBbits.RB5 = 1;
705     clean(BLUE);
706 
707     drawBoxFill(30, 39, 8, 60, GRAY);
708     prints(35, 40, BLUE, GRAY, " Windows ", 1);
709 
710     prints(0, 50, WHITE, BLUE, "An error has occurred,", 1);
711     prints(0, 58, WHITE, BLUE, "To continue:", 1);
712     prints(0, 74, WHITE, BLUE, "Remove the battery or", 1);
713     prints(0, 82, WHITE, BLUE, "power supply.", 1);
714     prints(0, 98, WHITE, BLUE, "Error: 0E : BFF9B3D4", 1);
715 
716     prints(10, 114, WHITE, BLUE, "Dumping memory...", 1);
717     while (1);
718 }
719 
720 // Draws the build card menu, begins an inventory read
721 
722 void printBuildCard1(GlobalState *globalData) {
723     // first page of build card
724     clean(RED);
725     prints(0, 0, BLACK, RED, "It looks like you want to build a card.", 1);
726     prints(0, 16, BLACK, RED, "Available cards:", 1);
727 
728     // Tell system we need to do an inventory command
729     globalData->getInventory = TRUE;
730 }
731 
732 /*
733  * Select Menus for the operating system
734  * Menu goes back to previous menu after being done with a certain process
735  */
736 
737 void mainMenu(GlobalState* globalData) {
738 //     // If returning from a previous menu, re-print main menu
739 //     if(globalData->goBack) {
740 //         printMainMenu(globalData);
741 //         globalData->mode = processPrintCursor(globalData, 3, BLUE, WHITE);
742 //         globalData->goBack = FALSE;
743 //     }
744 //     // Keep checking cursor until they stop hitting back button
745 //     while(globalData->mode == 0xFF) {
746 //         globalData->mode = processPrintCursor(globalData, 3, BLUE, WHITE);
747 //     }
748     if(globalData->goBack) {
749         printMainMenu(globalData);
750         globalData->goBack = FALSE;
751     }
752     globalData->mode = processPrintCursor(globalData, 3, BLUE, WHITE);
```

```
753     // Switch menus based off of selection
754     switch (globalData->mode) {
755         // Single Player
756         case 0:
757             selectGameMenu(globalData);
758             break;
759         // Multiplayer
760         case 1:
761             selectGameMenu(globalData);
762             break;
763         // Build Card
764         case 2:
765             printBuildCard1(globalData);
766             break;
767     }
768 }
769
770 // Select game to play based off of the mode (single/multiplayer)
771 void selectGameMenu(GlobalState* globalData) {
772     // Print select game menu
773     printSelectGame(globalData);
774     globalData->game = processPrintCursor(globalData, 4, GREEN, BLACK);
775     // Run chosen game based off of the multiplayer/single-player mode
776     switch (globalData->game) {
777         // Game Slot 1
778         case 0:
779             if(0 == globalData->mode) {
780                 singlePlayer(globalData);
781             } else {
782                 multiPlayer(globalData);
783             }
784             break;
785         // Game Slot 2
786         case 1:
787             clean(BLACK);
788             prints(0, 35, WHITE, BLACK, "In Progress",1);
789             break;
790         // Game Slot 3
791         case 2:
792             printBSOD();
793             break;
794         // Game Slot 4
795         case 3:
796             clean(BLACK);
797             prints(0, 35, WHITE, BLACK, "In Progress",1);
798             break;
799         // Hit Back Button
800         case 0xFF:
801             globalData->goBack = TRUE;
```

```
802             break;
803     }
804 
805     globalData->keyPress = -1;
806     // Continue scanning the keypad until the user hits "D" for enter
807     while (globalData->keyPress != 0x0B) {
808         keypad(globalData);
809         if (globalData->keyFlag && !globalData->displayedKey) {
810             globalData->keyFlag = FALSE;
811             globalData->displayedKey = TRUE;
812         }
813     }
814     // Return to main menu after finished.
815     globalData->goBack = TRUE;
816 }
817 
818 // Depreciated
819 
820 /*
821 // Visuals and navigation for operating system menus
822 void processDisplay(GlobalState* globalData) {
823     // Different controls for each page being displayed
824     switch (globalData->displayPage) {
825         // Main menu
826         case 0:
827             switch (globalData->keyPress) {
828                 // Press 2 to move up
829                 case 0x02:
830                     // Moves the cursor up 1 space.  Loops around
831                     prints(25, globalData->mainMenuSpots[globalData->cursorPos
    ], WHITE, BLUE, " ", 1);
832                     globalData->cursorPos = ((3 + globalData->cursorPos) - 1) %
     3;
833                     prints(25, globalData->mainMenuSpots[globalData->cursorPos
    ], WHITE, BLUE, ">", 1);
834                     break;
835                 // Press 8 to move down
836                 case 0x08:
837                     // Moves the cursor down 1 space.  Loops around
838                     prints(25, globalData->mainMenuSpots[globalData->cursorPos
    ], WHITE, BLUE, " ", 1);
839                     globalData->cursorPos = (globalData->cursorPos + 1) % 3;
840                     prints(25, globalData->mainMenuSpots[globalData->cursorPos
    ], WHITE, BLUE, ">", 1);
841                     break;
842                 // D is the enter key. Figure out the next page
843                 case 0x0D:
844                     prints(25, globalData->mainMenuSpots[globalData->cursorPos
    ], WHITE, BLUE, ">>>", 1);
```

```
845
846                     // Cursor position determines next page. Add 1 to remove
    main menu "case 0" from the
847                     // list of options when navigating out of the main menu
848                     nextPage(globalData, globalData->cursorPos + 1);
849                     break;
850                 case 0xFF: // Debug BSOD
851                     nextPage(globalData, 255);
852                 default:
853                     break;
854             }
855             break;
856         // Singleplayer
857         case 1:
858             switch (globalData->keyPress) {
859                 // B to go back
860                 case 0x0B:
861                     nextPage(globalData, 0);
862                     break;
863                 default:
864                     break;
865             }
866             break;
867         // Multiplayer
868         case 2:
869             switch (globalData->keyPress) {
870                 // B to go back
871                 case 0x0B:
872                     nextPage(globalData, 0);
873                     break;
874                 default:
875                     break;
876             }
877             break;
878         // build cards
879         case 3:
880             switch (globalData->keyPress) {
881                 // B to go back
882                 case 0x0B:
883                     nextPage(globalData, 0);
884                     break;
885                 default:
886                     break;
887             }
888             break;
889         default:
890             printBSOD();
891     }
892 }
```

```
893
894 void nextPage(GlobalState* globalData, int cursorPos) {
895     // Beep off
896     TRISBbits.RB5 = 1;
897
898     switch (cursorPos) {
899             // Send a 0 to go to main menu
900         case 0:
901             globalData->displayPage = 0;
902             printMainMenu(globalData);
903             break;
904             // Getting a position of 1 does singleplayer
905         case 1:
906             globalData->displayPage = 1;
907             // Print singleplayer menu
908             globalData->displayPage = 1;
909             singlePlayer(globalData);
910             break;
911             // Getting a position of 2 does multiplayer
912         case 2:
913             globalData->displayPage = 2;
914             // Print multiplayer menu
915             clean(GREEN);
916             globalData->xbeeFlag = TRUE;
917             prints(0, 0, BLACK, WHITE, "Nothing here. Press B to go back.", 1);
918             break;
919             // Getting a position of 3 does build cards
920         case 3:
921             globalData->displayPage = 3;
922             // Print build cards menu
923             printBuildCard1(globalData);
924             break;
925             // Error
926         default:
927             // BSOD
928             clean(BLUE);
929             globalData->keyFlag = TRUE;
930             globalData->displayedKey = FALSE;
931             globalData->displayPage = 255;
932     }
933 }
934
935 */
```

G.7 Card Reaction Control

../FrontEnd.X/LED.h

```
/*
 * Status LED control header file
 * June 8, 2014
 */

#ifndef LED_H
#define LED_H

#ifdef  __cplusplus
extern "C" {
#endif

#define NUM_SLOTS 4 // Number of card slots on board

    typedef struct {
        char ledStatus[NUM_SLOTS]; // each char represents a slot
    }LEDDriverStruct;

    extern LEDDriverStruct ledData;

    void LEDSetup(void);
    void updateLEDs(void);

#ifdef  __cplusplus
}
#endif

#endif  /* LED_H */
```

../FrontEnd.X/LED.c

```
#include "globals.h"

/*
 * Prototypes
 */
void LEDSelect(char card, char status);
void LEDColor(char status);


/*
 * Port RB1 = Red
 * Port RB0 = Green
 */

LEDDriverStruct ledData;

/*
 * Setup the LED Driver
```

```
19  */
20 void LEDSetup(void) {
21     TRISB = 0x30; //0xF0; // set pins 0:3 as outputs, 4:7 as inputs
22     ANSELB = 0x00; // disable analog input
23 
24     WPUB |= 0x30; //0xF0; // enable internal pullup on card inputs
25     INTCON2bits.RBPU = 0;
26 
27     // initialize ledData
28     memset(ledData.ledStatus, 0x03, sizeof(char) * NUM_SLOTS);
29     updateLEDs();
30 
31     PORTB = 0;
32     LATB = PORTB ; // clear existing mismatch conditions
33 
34     IOCB = 0x30; //0xF0; // enable IOC interrupts on pins B4:B7
35     INTCONbits.RBIE = 1; // enable PortB interrupts
36     INTCON2bits.RBIP = 1; // set priority level to high
37     INTCONbits.GIE = 1; // enable general purpose interrupts
38 
39 
40 }
41 
42 
43 /*
44  * Primary led driverr
45  */
46 void updateLEDs() {
47     char status = 0;
48     char card = 0;
49     for (card = 0; card < NUM_SLOTS; card++) {
50         status = ledData.ledStatus[card];
51         LEDSelect(card, status);
52     }
53 }
54 
55 
56 /*
57  * updates the LEDs with the appropriate status
58  */
59 void LEDColor(char status) {
60     switch (status) {
61         case 0:
62             // Yellow: Card registered, but not read.
63             PORTBbits.RB0 = 1;
64             PORTBbits.RB1 = 1;
65             break;
66         case 1:
67             // Green: Card successfully read.
```

```
68              PORTBbits.RB0 = 1; //green
69              PORTBbits.RB1 = 0; //red
70
71              break;
72          case 2:
73              // Red: Error, card not read.
74              PORTBbits.RB0 = 0;
75              PORTBbits.RB1 = 1;
76              break;
77          default:
78              // : Loading
79              PORTBbits.RB0 = 0;
80              PORTBbits.RB1 = 0;
81              break;
82      }
83  }
84
85  /* Alternate set up to reduce number of pins:
86   * 2 pins to select the LED
87   * 2 pins to select the LED color
88   */
89
90
91  void LEDSelect(char card, char status) {
92      switch (card) {
93          case 0:
94              // Select Card Reader 1
95              PORTBbits.RB3 = 0;
96              PORTBbits.RB2 = 0;
97              LEDColor(status);
98              break;
99          case 1:
100             // Select Card Reader 2
101             PORTBbits.RB3 = 0;
102             PORTBbits.RB2 = 1;
103             LEDColor(status);
104             break;
105         case 2:
106             // Select Card Reader 3
107             PORTBbits.RB3 = 1;
108             PORTBbits.RB2 = 0;
109             LEDColor(status);
110             break;
111         case 3:
112             // Select Card Reader 4
113             PORTBbits.RB3 = 1;
114             PORTBbits.RB2 = 1;
115             LEDColor(status);
116             break;
```

```
117         default:
118             break;
119     }
120 }
```

G.8 Motor Driver

Note: This feature was not implemented in the final product

../FrontEnd.X/motorDriver.h

```
1  /*
2   * File:   motorDriver.h
3   * Author: Patrick Ma
4   *
5   * Created on June 1, 2014, 12:28 AM
6   */
7
8  #ifndef MOTORDRIVER_H
9  #define MOTORDRIVER_H
10
11 #ifdef  __cplusplus
12 extern "C" {
13 #endif
14
15     void motorSetup(void);
16     void move(int location);
17
18
19 #ifdef  __cplusplus
20 }
21 #endif
22
23 #endif  /* MOTORDRIVER_H */
```

../FrontEnd.X/motorDriver.c

```
1  /*
2   *  software for controlling the motor actuator
3   */
4
5  #include "globals.h"
6
7  #define ADC_PRECISION 5 // precision of the ADC, to allow motor settling
8  void adjustMotor(int direction);
9
10 void motorSetup() {
11     // setup inputs & outputs
12     PORTAbits.VREFP = 1; // port A3 (vref plus)
13     PORTDbits.AN27 = 1; // analog input for motor feedback
```

```
14      PORTDbits.RD6 = 0; // Fin
15      PORTDbits.RD5 = 0; // Rin
16
17      // setup port A3, D7 for analog input, others as no analog
18      ANSELAbits.ANSA3 = 1;
19      ANSELDbits.ANSD7 = 1;
20      ANSELDbits.ANSD6 = 0;
21      ANSELDbits.ANSD5 = 0;
22
23      // setup ADC reader
24      OpenADC(ADC_FOSC_2 & ADC_RIGHT_JUST & ADC_12_TAD,
25              ADC_CH27 & ADC_INT_OFF,
26              ADC_REF_VDD_VREFPLUS & ADC_REF_VDD_VSS);
27
28      Delay10TCYx(5);
29  }
30
31  /*
32   * move the motor to the given location
33   */
34  void move(int location) {
35      int posn = 0;
36      ADCON0bits.GO = 1; //ConvertADC();
37      while (0 == ADCON0bits.GO); // spin while busy
38      posn = ((((unsigned int)ADRESH)<<8)|(ADRESL) - location) / ADC_PRECISION;
39      while (0 != posn) { // move forward or back depending on the location
40          if (posn < 0) {
41              adjustMotor(1);
42          } else {
43              adjustMotor(0);
44          }
45          Delay100TCYx(1);
46          ADCON0bits.GO = 1; //ConvertADC(); // determine new location and if any
        change is needed
47          while (0 == ADCON0bits.GO); // spin while busy
48          posn = ((((unsigned int)ADRESH)<<8)|(ADRESL) - location) /
       ADC_PRECISION;
49      }
50      PORTDbits.RD6 = 1; // lock the reader
51      PORTDbits.RD7 = 1;
52  }
53
54  // moves the motor forward (1) or backwards(0)
55
56  void adjustMotor(int direction) {
57      PORTDbits.RD6 = direction;
58      PORTDbits.RD7 = !direction;
59  }
```

G.9 RFID Reader Driver

../FrontEnd.X/rfidReader.h

```
/*
 * File:   rfidReader.h
 * Author: Patrick
 *
 * Created on May 29, 2014, 12:45 PM
 */

#ifndef RFIDREADER_H
#define RFIDREADER_H

#ifdef __cplusplus
extern "C" {
#endif

    /********ReaderData sizes**********************/
#define UID_SIZE 24
#define MAX_UIDS 5  // number of UIDs stored
#define RFID_BLOCK 10

void resetRFID(void);
void RFIDSetup(void);
void pingRFID(void);
void inventoryRFID(void);
void quietRFID(char* uid);
void sendToRFID2(char* myInput);
void writeRFID(char* uid, char block, int highData, int lowData);
void readRFID(char* uid, char block);
void char8RFID(char* uid, char block, char* myString);
//void processRFIDCmd(void);

typedef struct {
    // Read UIDs, length can be optimized
    // Currently can read only 3 UIDs before we get errors based on the size
    // of the array
    char readUID[MAX_UIDS][UID_SIZE];
    char readData[16];

    short lineFeeds;
    short configFlag;

    // Current spot in the array processing for input from RFID
    int inputSpot2;

    // The UID that we are reading. (first, second, etc)
    int numUID;
```

```
46
47      // Weather or not we are in a block of square brackets
48      short nextBlock;
49
50      // If the user input was an inventory command
51      short invCom;
52
53      // If the user input was a single block read command
54      short readFlag_1;
55
56      // Are the UIDs available to read? Number of available UIDS
57      int availableUIDs;
58
59      // Read mode set?
60      short readMode;
61
62      int availableData;
63
64      short writeFlag_1;
65  } RFIDDriver;
66  extern RFIDDriver readerData;
67
68  #ifdef  __cplusplus
69  }
70  #endif
71
72  #endif  /* RFIDREADER_H */
```

../FrontEnd.X/rfidReader.c

```
1   /*
2    * File:   ioBuffer.c
3    * Author: Patrick, Ryan
4    *
5    * Created on May 15, 2014
6    * a simple program that buffers user serial input then sends it out
7    * sequentially all at once.
8    */
9
10  #include "globals.h"
11
12  /********Command constants**********************/
13  #define READER_INPUT_LENGTH 64
14  #define QUIET_LEN 37
15  #define END_COM "0000" // End of a command
16  #define STAY_QUIET "0112000304182202" // Beginning part of stay quiet, add 0000
17  #define AGC "0109000304F0000000"
18  #define REG_WRITE "010C00030410002101020000"
19  #define PING "0108000304FF0000"
```

```
20 #define INVENTORY "010B0003041406010000000"
21 #define READ_SINGLE "0113000304182220"
22 #define WRITE_SINGLE "0117000304186221"
23 #define READ_SING_LEN 39
24 #define WR_SING_LEN 47
25
26 void sendToRFID(char* myString);
27 void setupRead(void);
28
29 // Set up on USART 2
30
31 // Send a ping commmand to the rfid
32
33 void pingRFID() {
34     sendToRFID(PING);
35 }
36
37 // Send an inventory command to the RFID
38
39 void inventoryRFID() {
40     // Set the inventory command flag for the interrupt
41     readerData.invCom = 1;
42     // If we have not set read mode yet, go to config mode
43     if (readerData.readMode == 0) {
44         // Config mode
45         readerData.configFlag = 1;
46
47         // Disable current flag
48         readerData.invCom = 0;
49
50         // Send read commands
51         setupRead();
52
53         // Turn off config
54         readerData.configFlag = 0;
55
56         // Turn back on inventory mode, indicate read set
57         readerData.invCom = 1;
58         readerData.readMode = 1;
59     }
60     // Send inventory command
61     sendToRFID(INVENTORY);
62
63     // Wait until interrupt finishes
64     while (readerData.invCom == 1);
65     readerData.availableUIDs = readerData.numUID;
66
67     // Reset the UID counters
68     readerData.numUID = 0;
```

```
69      readerData.lineFeeds = 0;
70  }
71
72  // Send a quiet command to the given uid
73
74  void quietRFID(char* uid) {
75      // Holds the command
76      char quietCommand[QUIET_LEN]; // {STAY_QUIET, uid, END_COM};
77      // Beginning part of command
78      strcatpgm2ram(quietCommand, STAY_QUIET);
79
80      // Concatenate the uid
81      strcat(quietCommand, uid);
82
83      // Add 0000 for the ending bits
84      strcatpgm2ram(quietCommand, END_COM);
85
86      // Do sendToRFID2 because it is already saved to ram
87      sendToRFID2(quietCommand);
88      return;
89  }
90
91  #define NAME_LEN 8
92  void char8RFID(char* uid, char block, char* myString1) {
93      int i = 0;
94      int myNumHigh = 0;
95      int myNumLow = 0;
96      char myString[9] = { 0 };
97      strcpypgm2ram(myString, myString1);
98      myNumHigh |= (int)myString[0] << 8;
99      myNumHigh |= (int)myString[1];
100     myNumLow |= (int)myString[2] << 8;
101     myNumLow |= (int)myString[3];
102
103     writeRFID(uid, block, myNumHigh, myNumLow); // name: first 4 chars left to
        right FI RE
104
105     myNumHigh = 0;
106     myNumLow = 0;
107
108     myNumHigh |= (int)myString[4] << 8;
109     myNumHigh |= (int)myString[5];
110     myNumLow |= (int)myString[6] << 8;
111     myNumLow |= (int)myString[7];
112
113     writeRFID(uid, block+1, myNumHigh, myNumLow); // name: last 4 chars left to
        right  DU DE
114
115
```

```
116 }
117
118 void writeRFID(char* uid, char block, int highData, int lowData) {
119     // Holds the command
120     char writeCommand[WR_SING_LEN]; // {STAY_QUIET, uid, END_COM};
121     char dataHex[5];
122     if (readerData.availableUIDs > 0) {
123         memset(writeCommand, '\0', WR_SING_LEN * sizeof(char));
124         readerData.writeFlag_1 = 1;
125         // If we have not set read mode yet, go to config mode
126         if (readerData.readMode == 0) {
127             // Config mode
128             readerData.configFlag = 1;
129             readerData.writeFlag_1 = 0;
130
131             // Send read commands
132             setupRead();
133
134             // Turn off config
135             readerData.configFlag = 0;
136             readerData.writeFlag_1 = 1;
137         }
138
139         // Beginning part of command
140         strcatpgm2ram(writeCommand, WRITE_SINGLE);
141
142         // Concatenate the uid and block
143         strcat(writeCommand, uid);
144
145         sprintf(dataHex, "%02x", (int) block);
146         strcat(writeCommand, dataHex);
147
148         sprintf(dataHex, "%04x", highData);
149         strcat(writeCommand, dataHex);
150
151         sprintf(dataHex, "%04x", lowData);
152         strcat(writeCommand, dataHex);
153
154         // Add 0000 for the ending bits
155         strcatpgm2ram(writeCommand, END_COM);
156
157         // Do sendToRFID2 because it is already saved to ram
158         sendToRFID2(writeCommand);
159
160         // Wait until interrupt finishes
161         while (readerData.writeFlag_1 == 1);
162     }
163     return;
164 }
```

```
165
166 void readRFID(char* uid, char block) {
167     // Holds the command
168     char readCommand[READ_SING_LEN]; // {STAY_QUIET, uid, END_COM};
169     char blockHex[3];
170     if (readerData.availableUIDs > 0) {
171         memset(readCommand, '\0', READ_SING_LEN * sizeof (char));
172         readerData.readFlag_1 = 1;
173         // If we have not set read mode yet, go to config mode
174         if (readerData.readMode == 0) {
175             // Config mode
176             readerData.configFlag = 1;
177
178             // Disable current flag
179             readerData.readFlag_1 = 0;
180
181             // Send read commands
182             setupRead();
183
184             // Turn off config
185             readerData.configFlag = 0;
186
187             readerData.readFlag_1 = 1;
188         }
189
190         // Beginning part of command
191         strcatpgm2ram(readCommand, READ_SINGLE);
192
193         // Concatenate the uid and block
194         strcat(readCommand, uid);
195
196         sprintf(blockHex,"%02x",(int)block);
197         strcat(readCommand, blockHex);
198
199         // Add 0000 for the ending bits
200         strcatpgm2ram(readCommand, END_COM);
201
202         // Do sendToRFID2 because it is already saved to ram
203         sendToRFID2(readCommand);
204
205         // Wait until interrupt finishes
206         while (readerData.readFlag_1 == 1);
207     }
208     return;
209 }
210
211 /* // Depreciated
212 void processRFIDCmd() {
213     int i;
```

```
214     //    // Controls the RESET for the RFID reader
215     //    TRISBbits.RB5 = 0;
216     //    ANSELBbits.ANSB5 = 0;
217
218     // Set up UART to computer and RFID
219     //    rs232Setup1(); // sets pc RX=C7, tx=C6
220     //    rs232Setup2(); // sets dlp rx=b7, tx=b6
221
222     // Start the RFID with a reset
223     //resetRFID();
224
225     // Get RFID attention
226     //sendToRFID("0");
227
228     //    while (1) {
229     //        // Read user input from computer
230     //        readBytesUntil(readerData.userInput2, '\r', READER_INPUT_LENGTH);
231     //        putc1USART('\r');
232     //        putc1USART('\n');
233
234     // Ping command
235     sendToRFID("\n");
236     if (strcmppgm2ram(readerData.userInput2, "ping") == 0) {
237         sendToRFID(PING);
238         // Inventory Command
239     } else if (strcmppgm2ram(readerData.userInput2, "inventory") == 0) {
240         // Set the inventory command flag for the interrupt
241         readerData.invCom = 1;
242
243         // Set the RFID reader to Read mode and send the Inventory command
244         if (readerData.readMode == 0) {
245             readerData.configFlag = 1;
246             readerData.invCom = 0;
247             setupRead();
248             readerData.configFlag = 0;
249             readerData.invCom = 1;
250             readerData.readMode = 1;
251         }
252         sendToRFID(INVENTORY);
253
254         // Wait until interrupt finishes
255         while (readerData.invCom == 1);
256         // Print all the UIDs
257         for (i = 0; i < readerData.numUID; i++) {
258             puts2USART(readerData.readUID[i]);
259             putc2USART('\r');
260             while (Busy2USART());
261             putc2USART('\n');
262         }
```

```
263         readerData.availableUIDs = readerData.numUID;
264
265         // Reset the number of UIDs read
266         readerData.numUID = 0;
267         readerData.lineFeeds = 0;
268
269         // Send the "Stay Quiet" command.
270         // WARNING: THIS IS HARDCODED TO ONLY WORK WITH THE PROTOCARD
271     } else if (strcmppgm2ram(readerData.userInput2, "quiet") == 0) {
272         sendToRFID(STAY_QUIET);
273
274         // Any errors will reset the RFID reader
275     } else {
276         //resetRFID();
277     }
278     //    }
279     return;
280 }
281  */
282
283 // Sends the string to the DLP RFID 2
284
285 void sendToRFID(char* myString) {
286     // Copy string into an input array
287     char myInput[READER_INPUT_LENGTH];
288     // Says whether the input has finished sending or not
289     short inputFinished = 0;
290     int i = 0;
291
292     // Copy string to ram so it can be read correctly
293     strcpypgm2ram(myInput, myString);
294
295     // Send character by character
296     while (!inputFinished) {
297         if (myInput[i] != '\0') {
298             while (Busy1USART());
299             Write1USART(myInput[i]);
300             i++;
301         } else {
302             inputFinished = 1;
303         }
304     }
305
306     // Short delay, try removing
307     Delay10TCYx(100);
308     return;
309 }
310
311 // Use this for when you need to send a string that isn't sent
```

```
312 // in double quotes (not this: "mystring!")
313 //
314 // see sendToRFID for more comments
315
316 void sendToRFID2(char* myInput) {
317     short inputFinished = 0;
318     int i = 0;
319     while (!inputFinished) {
320         if (myInput[i] != '\0') {
321             while (Busy1USART());
322             Write1USART(myInput[i]);
323             i++;
324         } else {
325             inputFinished = 1;
326         }
327     }
328     Delay10TCYx(100);
329     return;
330 }
331
332 // Set up read commands
333
334 void setupRead() {
335     // Set to register write mode
336     sendToRFID(REG_WRITE);
337
338     // Needs to read two line breaks from dlp before
339     // continuing.
340     while (readerData.lineFeeds < 2);
341
342     // Reset line feeds for next command
343     readerData.lineFeeds = 0;
344
345     // Set AGC mode
346     sendToRFID(AGC);
347
348     // We need to read only one line feed when setting AGC
349     while (readerData.lineFeeds < 1);
350
351     // Reset line feeds
352     readerData.lineFeeds = 0;
353
354     // Send new line to clear out any junk
355     // Try removing
356     sendToRFID("\n");
357     return;
358 }
359
360 // Depreciated - we don't use them anymore
```

```
361
362 void resetRFID() {
363
364     PORTBbits.RB5 = 1;
365     PORTBbits.RB5 = 0;
366     PORTBbits.RB5 = 1;
367
368 }
369
370 // initialize the RFID reader and variables
371
372 void RFIDSetup() {
373     // initialize local vars
374     readerData.inputSpot2 = 0;
375     readerData.numUID = 0;
376     readerData.nextBlock = 0;
377     readerData.invCom = 0;
378     readerData.readMode = 0;
379     readerData.lineFeeds = 0;
380     readerData.configFlag = 0;
381     readerData.availableUIDs = FALSE;
382     memset(readerData.readUID, '\0', MAX_UIDS * UID_SIZE * sizeof (char));
383     memset(readerData.readData, '\0', 16*sizeof(char));
384     readerData.readFlag_1 = 0;
385     readerData.writeFlag_1 = 0;
386     readerData.availableData = 0;
387
388
389 #if !FRONT_NOT_BACK
390     // Get RFID attention if not already
391     sendToRFID("\n");
392 #endif
393 }
```

G.10 EIA-232 Serial Connection

../FrontEnd.X/rs232.h

```
1  /*
2   * File:   rs232.h
3   * Author: castia
4   *
5   * Created on April 24, 2014, 10:10 PM
6   */
7  void rs232Setup1(void);
8  void rs232Setup2(void);
9  void readBytesUntil1USART(char* myStorage, char stopChar, int size);
10 void readBytesUntil2USART(char* myStorage, char stopChar, int size);
```

../FrontEnd.X/rs232.c

```
1  //#include "rs232.h"
2  //#include <p18f25k22.h>
3  //#include <usart.h>
4  #include "globals.h"
5  // setup for USART1
6
7  void rs232Setup1() {
8      //  Set RX as input, TX as output
9      TRISCbits.TRISC7 = 1;
10     TRISCbits.TRISC6 = 0;
11     // Enable digital for all c pins
12     ANSELCbits.ANSC6 = 0;
13     ANSELCbits.ANSC7 = 0;
14
15     //  Configure UART, 115200 baud with 20MHz clock.
16     //Open1USART(USART_TX_INT_OFF & USART_RX_INT_ON & USART_ASYNCH_MODE &
       USART_EIGHT_BIT & USART_BRGH_HIGH, 10);
17     //  Configure UART, 9600 baud with 20MHz clock.
18 #if FRONT_NOT_BACK
19     Open1USART(USART_TX_INT_OFF & USART_RX_INT_OFF & USART_ASYNCH_MODE &
       USART_EIGHT_BIT & USART_BRGH_HIGH,129);
20 #else
21     Open1USART(USART_TX_INT_OFF & USART_RX_INT_ON & USART_ASYNCH_MODE &
       USART_EIGHT_BIT & USART_BRGH_HIGH,10);
22 #endif
23     // Enable Priority
24     RCONbits.IPEN = 1;
25     // High priority receive interrupt
26     IPR1bits.RCIP = 1;
27     // Enable all high priority interrupts
28     INTCONbits.GIEH = 1;
29 }
30
31 // setup for USART2
32
33 void rs232Setup2() {
34     //  Set RX as input, TX as output
35     TRISDbits.TRISD7 = 1;
36     TRISDbits.TRISD6 = 0;
37     ANSELDbits.ANSD6 = 0;
38     ANSELDbits.ANSD7 = 0;
39
40     //  Configure UART, 115200 baud with 20MHz clock.
41     Open2USART(USART_TX_INT_OFF & USART_RX_INT_ON & USART_ASYNCH_MODE &
       USART_EIGHT_BIT & USART_BRGH_HIGH, 10);
42
43     // Enable Priority
44     RCONbits.IPEN = 1;
```

```
45      // High priority receive interrupt
46      IPR3bits.RC2IP = 1;
47      // Enable all high priority interrupts
48      INTCONbits.GIEH = 1;
49  }
50
51  // Precondition: USART 1 is open & configured
52
53  void readBytesUntil1USART(char* myStorage, char stopChar, int size) {
54      int i = 0;
55      char message;
56
57      while (!DataRdy1USART());
58      message = getc1USART();
59      while (message != stopChar && i < (size - 1)) {
60          myStorage[i] = message;
61          i++;
62          while (!DataRdy1USART());
63          message = getc1USART();
64      }
65
66      myStorage[i] = '\0';
67      i = 0;
68  }
69  void readBytesUntil2USART(char* myStorage, char stopChar, int size) {
70      int i = 0;
71      char message;
72
73      while (!DataRdy2USART());
74      message = getc2USART();
75      while (message != stopChar && i < (size - 1)) {
76          myStorage[i] = message;
77          i++;
78          while (!DataRdy2USART());
79          message = getc2USART();
80      }
81
82      myStorage[i] = '\0';
83      i = 0;
84  }
```

G.11 SRAM Primary Memory

Note: There are two different files for each microcontroller due to hardware configurations

../FrontEnd.X/SRAM.h

```
1  /*
2   * File:    SRAM.h
```

```
 * Author: castia
 *
 * Created on April 24, 2014, 1:59 AM
 */

#ifndef SRAM_H
#define SRAM_H

#ifdef __cplusplus
extern "C" {
#endif

void SRAMsetUp(void);
void setUpIn(void);
void setUpOut(void);
int readData(int adx);
void writeData(int adx, int data);


#ifdef __cplusplus
}
#endif

#endif /* SRAM_H */
```

../FrontEnd.X/SRAMfront.c

```
//#include "GLOBALS_H"
#include <p18f46k22.h>
#include "SRAM.h"
#include <delays.h>

/*
 * This is used only for the Frontend
 */

#if FRONT_NOT_BACK
unsigned short OE;
unsigned short WE;
unsigned short store;

void SRAMsetUp() {
    // Write Enable
    TRISCbits.TRISC2 = 0;

    // Output Enable
    TRISCbits.TRISC1 = 0;
    // Store
    TRISCbits.TRISC0 = 0;
```

```
23
24      // Default Values
25      PORTCbits.RC2 = 1;
26      PORTCbits.RC1 = 1;
27      PORTCbits.RC0 = 1;
28
29      // Set digitalOut
30      ANSELAbits.ANSA0 = 0;
31      ANSELAbits.ANSA1 = 0;
32      ANSELAbits.ANSA2 = 0;
33      ANSELAbits.ANSA3 = 0;
34      ANSELAbits.ANSA5 = 0;
35      ANSELEbits.ANSE0 = 0;
36      ANSELEbits.ANSE1 = 0;
37      ANSELEbits.ANSE2 = 0;
38
39      ANSELCbits.ANSC2 = 0;
40      //ANSELCbits.ANSC1 = 0; NOT NEEDED FOR PORT C
41      //ANSELCbits.ANSC0 = 0;
42
43      setUpIn();
44  }
45
46  void setUpOut () {
47      // Set data outputs
48      TRISAbits.TRISA0 = 0;
49      TRISAbits.TRISA1 = 0;
50      TRISAbits.TRISA2 = 0;
51      TRISAbits.TRISA3 = 0;
52      TRISAbits.TRISA4 = 0;
53      TRISAbits.TRISA5 = 0;
54      TRISAbits.TRISA6 = 0;
55      TRISE &= 0b11111000;
56  }
57
58  void setUpIn () {
59      // Set data inputs
60      TRISA = 0xFF;
61      TRISE = 0xFF;
62  }
63
64  // Reading data
65  int readData (int adx) {
66      int myRead = 0;
67      SRAMsetUp();
68      setUpOut();
69
70      // Setting up Address
71      PORTAbits.RA0 = (adx >> 0) & 0x01;
```

```
72      PORTAbits.RA1 = (adx >> 1) & 0x01;
73      PORTAbits.RA2 = (adx >> 2) & 0x01;
74      PORTAbits.RA3 = (adx >> 3) & 0x01;
75      PORTAbits.RA4 = (adx >> 4) & 0x01;
76      PORTAbits.RA5 = (adx >> 5) & 0x01;
77      LATEbits.LATE0 = (adx >> 6) & 0x01; // problem?
78      LATEbits.LATE1 = (adx >> 7) & 0x01; // problem?
79      LATEbits.LATE2 = (adx >> 8) & 0x01; // problem?
80      PORTAbits.RA6 = (adx >> 9) & 0x01;
81
82      // Store in MAR
83      PORTCbits.RC0 = 0;
84      PORTCbits.RC0 = 1;
85
86      // I/O are inputs
87      setUpIn();
88
89      // Output Enable
90      PORTCbits.RC1 = 0;
91      Delay10TCYx(5);
92      // Get the first 6 bits of Port A and the first 2 bits of port E
93      myRead = (PORTA & 0x3F) | ((PORTE << 6) & 0xC0);
94  //    Delay10TCYx(5);
95      // Output Enable
96      PORTCbits.RC1 = 1;
97
98      return myRead;
99
100 }
101
102
103
104 // Writing data
105 void writeData(int adx, int data) {
106     SRAMsetUp();
107     setUpOut();
108
109     // Setting up Address
110     PORTAbits.RA0 = (adx >> 0) & 0x01;
111     PORTAbits.RA1 = (adx >> 1) & 0x01;
112     PORTAbits.RA2 = (adx >> 2) & 0x01;
113     PORTAbits.RA3 = (adx >> 3) & 0x01;
114     PORTAbits.RA4 = (adx >> 4) & 0x01;
115     PORTAbits.RA5 = (adx >> 5) & 0x01;
116     LATEbits.LATE0 = (adx >> 6) & 0x01; // problem?
117     LATEbits.LATE1 = (adx >> 7) & 0x01; // problem?
118     LATEbits.LATE2 = (adx >> 8) & 0x01; // problem?
119     PORTAbits.RA6 = (adx >> 9) & 0x01;
120
```

```
121     // Store in MAR
122     PORTCbits.RC0 = 0;
123     PORTCbits.RC0 = 1;
124 
125     // Send Data
126     PORTAbits.RA0 = (data >> 0) & 0x01;
127     PORTAbits.RA1 = (data >> 1) & 0x01;
128     PORTAbits.RA2 = (data >> 2) & 0x01;
129     PORTAbits.RA3 = (data >> 3) & 0x01;
130     PORTAbits.RA4 = (data >> 4) & 0x01;
131     PORTAbits.RA5 = (data >> 5) & 0x01;
132     LATEbits.LATE0 = (data >> 6) & 0x01; // problem?
133     LATEbits.LATE1 = (data >> 7) & 0x01; // problem?
134 
135     // Write Enable
136     PORTCbits.RC2 = 0;
137     //Delay10TCYx(10);
138     PORTCbits.RC2 = 1;
139 }
140 #endif
```

../FrontEnd.X/SRAMback.c

```
1  //#include "GLOBALS_H"
2  #include "globals.h"
3  #include "SRAM.h"
4  #include <delays.h>
5  
6  /*
7   * SRAM for the backend
8   */
9  
10 #if !FRONT_NOT_BACK
11 
12 unsigned short OE;
13 unsigned short WE;
14 unsigned short store;
15 
16 void SRAMsetUp() {
17     // Write Enable
18     TRISCbits.TRISC3 = 0;
19 
20     // Output Enable
21     TRISCbits.TRISC2 = 0;
22 
23     // Store
24     TRISCbits.TRISC1 = 0;
25 
26     // Default Values
```

```
27      PORTCbits.RC3 = 1;
28      PORTCbits.RC2 = 1;
29      PORTCbits.RC1 = 1;
30
31      // Set digitalOut
32      ANSELAbits.ANSA0 = 0;
33      ANSELAbits.ANSA1 = 0;
34      ANSELAbits.ANSA2 = 0;
35      ANSELAbits.ANSA5 = 0;
36      ANSELEbits.ANSE0 = 0;
37      ANSELEbits.ANSE1 = 0;
38      ANSELEbits.ANSE2 = 0;
39
40      ANSELCbits.ANSC3 = 0;
41      ANSELCbits.ANSC2 = 0;
42      //ANSELCbits.ANSC1 = 0; NOT NEEDED FOR PORT C
43
44      setUpIn();
45  }
46
47  void setUpOut() {
48      // Set data outputs
49      TRISAbits.TRISA0 = 0;
50      TRISAbits.TRISA1 = 0;
51      TRISAbits.TRISA2 = 0;
52      TRISAbits.TRISA4 = 0;
53      TRISAbits.TRISA5 = 0;
54      TRISAbits.TRISA6 = 0;
55      TRISE &= 0b11111000;
56      TRISCbits.TRISC0 = 0;
57  }
58
59  void setUpIn() {
60      // Set data inputs
61      TRISAbits.TRISA0 = 1;
62      TRISAbits.TRISA1 = 1;
63      TRISAbits.TRISA2 = 1;
64      TRISAbits.TRISA4 = 1;
65      TRISAbits.TRISA5 = 1;
66      TRISAbits.TRISA6 = 1;
67      TRISE = 0xFF;
68      TRISCbits.TRISC0 = 1;
69  }
70
71  // Reading data
72
73  int readData(int adx) {
74      int myRead = 0;
75      SRAMsetUp();
```

```
76      setUpOut();
77
78      // Setting up Address
79      PORTAbits.RA0 = (adx >> 0) & 0x01;
80      PORTAbits.RA1 = (adx >> 1) & 0x01;
81      PORTAbits.RA2 = (adx >> 2) & 0x01;
82      PORTAbits.RA4 = (adx >> 3) & 0x01;
83      PORTAbits.RA5 = (adx >> 4) & 0x01;
84      LATEbits.LATE0 = (adx >> 5) & 0x01; // problem?
85      LATEbits.LATE1 = (adx >> 6) & 0x01; // problem?
86      LATEbits.LATE2 = (adx >> 7) & 0x01; // problem?
87      PORTAbits.RA6 = (adx >> 8) & 0x01;
88      PORTCbits.RC0 = (adx >> 9) & 0x01;
89
90      // Store in MAR
91      PORTCbits.RC1 = 0;
92      PORTCbits.RC1 = 1;
93
94      // I/O are inputs
95      setUpIn();
96
97      // Output Enable
98      PORTCbits.RC2 = 0;
99      Delay10TCYx(5);
100     // Get the first 3 bits of Port A, bits 4-5 of port A, and the first 3 bits
        of port E
101     myRead = (PORTA & 0x07) | ((PORTA & 0x18) >> 1) | ((PORTE & 0x07) << 5);
102             //      Delay10TCYx(5);
103             // Output Enable
104             PORTCbits.RC2 = 1;
105
106     return myRead;
107
108 }
109
110
111
112 // Writing data
113
114 void writeData(int adx, int data) {
115     SRAMsetUp();
116     setUpOut();
117
118     // Setting up Address
119     PORTAbits.RA0 = (adx >> 0) & 0x01;
120     PORTAbits.RA1 = (adx >> 1) & 0x01;
121     PORTAbits.RA2 = (adx >> 2) & 0x01;
122     PORTAbits.RA4 = (adx >> 3) & 0x01;
123     PORTAbits.RA5 = (adx >> 4) & 0x01;
```

```
124     LATEbits.LATE0 = (adx >> 5) & 0x01; // problem?
125     LATEbits.LATE1 = (adx >> 6) & 0x01; // problem?
126     LATEbits.LATE2 = (adx >> 7) & 0x01; // problem?
127     PORTAbits.RA6 = (adx >> 8) & 0x01;
128     PORTCbits.RC0 = (adx >> 9) & 0x01;
129
130     // Store in MAR
131     PORTCbits.RC1 = 0;
132     PORTCbits.RC1 = 1;
133
134     // Send Data
135     PORTAbits.RA0 = (data >> 0) & 0x01;
136     PORTAbits.RA1 = (data >> 1) & 0x01;
137     PORTAbits.RA2 = (data >> 2) & 0x01;
138     PORTAbits.RA4 = (data >> 3) & 0x01;
139     PORTAbits.RA5 = (data >> 4) & 0x01;
140     LATEbits.LATE0 = (data >> 5) & 0x01; // problem?
141     LATEbits.LATE1 = (data >> 6) & 0x01; // problem?
142     LATEbits.LATE2 = (data >> 7) & 0x01; // problem?
143
144     // Write Enable
145     PORTCbits.RC3 = 0;
146     //Delay10TCYx(10);
147     PORTCbits.RC3 = 1;
148 }
149
150 #endif
```

G.12 SPI Initialization

Note: SPI used for communication with the LCD display

../FrontEnd.X/startup.h

```
1  /*
2   * File:   startup.h
3   * Author: castia
4   *
5   * Created on May 25, 2014, 8:00 PM
6   */
7
8  #ifndef STARTUP_H
9  #define STARTUP_H
10
11 #ifdef __cplusplus
12 extern "C" {
13 #endif
14
15 #include "globals.h"
```

```
16
17      void initClock(void);
18      void initSPI1(void);
19
20  #ifdef  __cplusplus
21  }
22  #endif
23
24  #endif  /* STARTUP_H */
```

../FrontEnd.X/startup.c

```
1   #include "startup.h"
2
3   // sets the external clock pin as input
4
5   void initClock() {
6       TRISAbits.RA7 = 1;
7   }
8
9   // sets up SPI port for Display communication
10
11  void initSPI1() {
12      // Could use the C18 function, but this gives more control
13      SSP1STAT = 0b01000000;
14      SSP1CON1 = 0b00000000;
15      SSP1CON1bits.SSPEN = 1;
16      SSP1CON2 = 0b00000000;
17
18      TRISCbits.RC4 = 0; // A0
19      //      TRISCbits.RC1 = 0; // RST
20      TRISBbits.RB4 = 0; // CS
21      TRISCbits.RC3 = 0; // SCK1
22      TRISCbits.RC5 = 0; // SDO1
23      ANSELBbits.ANSB4 = 0;
24      ANSELCbits.ANSC3 = 0;
25      ANSELCbits.ANSC4 = 0;
26      ANSELCbits.ANSC5 = 0;
27  }
```

G.13 Wireless Connectivity via Xbee

../FrontEnd.X/xbee.h

```
1   /*
2    * File:   xbee.h
3    * Author: castia
4    *
5    * Created on June 8, 2014, 2:20 PM
```

```
 */

#ifndef XBEE_H
#define XBEE_H

#ifdef __cplusplus
extern "C" {
#endif

#include "globals.h"

#define FIND_ID "1234"
#define PLAYER_ID "5555"
#define HOST_ID "6666"
#define SEARCH_NET "4444"
#define PLAY_NET "8765"

void hostGame(void);
void findGame(void);
void generateNetwork(char* newNetwork);
void generateID(char* otherID);
void setupHost(void);
void setupClient(void);

void resetXbee(void);
void setupXbee(void);
void setXbeeNetwork(char* myNetwork, char* myID, char* myDL);


#ifdef __cplusplus
}
#endif

#endif /* XBEE_H */
```

../FrontEnd.X/xbee.c

```
#include "globals.h"

char myATMY[5];

void hostGame() {
    char playerID[16] = {0};
    char newNetwork[5] = {0};
        // Beep off
    TRISBbits.RB5 = 1;
    srand(ReadTimer0());
    setupHost();
    while(Busy1USART());
```

```
13      while (!DataRdy1USART());
14      while (DataRdy1USART()) {
15          getc1USART();
16      }
17      putc1USART('2');
18      while(Busy1USART());
19  //      // Broadcast current ID for players
20  //      while (!DataRdy1USART()) {
21  //          puts1USART(myATMY);
22  //          while (Busy1USART());
23  //          putc1USART('\r');
24  //          while (Busy1USART());
25  //          Delay10TCYx(50);
26  //      }
27  //
28  //      // Read player id
29  //      readBytesUntil1USART(playerID, '\r', 16);
30  //
31  //      // Talk directly to player
32  //      setXbeeNetwork(SEARCH_NET, myATMY, (const rom char*)playerID);
33  //
34  //      // Create a private network
35  //      generateNetwork(newNetwork);
36  //
37  //      // Contact player with new network
38  //      putrs1USART(newNetwork);
39  //      while (Busy1USART());
40  //      putc1USART('\r');
41  //      while (Busy1USART());
42  //
43  //      // Change networks and broadcast until response
44  //      setXbeeNetwork(newNetwork, myATMY, (const rom char*)playerID);
45  //      while (!DataRdy1USART()) {
46  //          putc1USART('1');
47  //          while (Busy1USART());
48  //      }
49  //
50  //      // get response
51  //      getc1USART();
52  //
53  //      // send confirmation m
54  //      putc1USART('0');
55  //      while (Busy1USART());
56  }
57
58  void findGame() {
59      char hostID[16] = {0};
60      char newNetwork[16] = {0};
61          // Beep off
```

```
62      TRISBbits.RB5 = 1;
63      srand(ReadTimer0());
64      setupClient();
65
66      while(Busy1USART());
67      putc1USART('1');
68      while(Busy1USART());
69
70      while (!DataRdy1USART());
71      while (DataRdy1USART()) {
72          getc1USART();
73      }
74  //
75  //      while (!DataRdy1USART());
76  //      // want between two \r's, so do this twice
77  //      readBytesUntil1USART(hostID, '\r', 16);
78  //      readBytesUntil1USART(hostID, '\r', 16);
79  //      // Configure to send to host
80  //      setXbeeNetwork(SEARCH_NET, myATMY, (const rom char*)hostID);
81  //
82  //      // change own id to avoid getting any more input
83  //      generateID(hostID);
84  //
85  //      //broadcast new id
86  //      puts1USART(myATMY);
87  //      while (Busy1USART());
88  //      putc1USART('\r');
89  //      while (Busy1USART());
90  //
91  //      // wait for network
92  //      while (!DataRdy1USART());
93  //
94  //      // read new network
95  //      readBytesUntil1USART(newNetwork, '\r', 16);
96  //
97  //      // Change the network
98  //      setXbeeNetwork(newNetwork, myATMY, (const rom char*)hostID);
99  //
100 //      // Wait until contacted by host on new network
101 //      while (!DataRdy1USART());
102 //      getc1USART();
103 //
104 //      // respond
105 //      putc1USART('0');
106 //      while (Busy1USART());
107 //
108 //      // wait for confirmation
109 //      while (!DataRdy1USART());
110 //      getc1USART();
```

```
111 }
112
113 void generateNetwork(char* newNetwork) {
114     int network = 0;
115     while (network == 0 || (strcmppgm(newNetwork, SEARCH_NET) != 0)) {
116         network = rand() % 0xFFFE;
117         sprintf(newNetwork, "%04x", network);
118     }
119 }
120
121 void setupHost() {
122     // set network to SEARCH_NET
123     // set id to random
124     // set ATDL to FIND_ID
125
126 //    generateID("FFFE");
127 //    setXbeeNetwork(SEARCH_NET, myATMY, FIND_ID);
128     strcpypgm2ram(myATMY, HOST_ID);
129     setXbeeNetwork(SEARCH_NET, myATMY, FIND_ID);
130
131 }
132
133 void setupClient() {
134 //    strcpypgm2ram(myATMY, FIND_ID);
135 //    setXbeeNetwork(SEARCH_NET, myATMY, "0000");
136     strcpypgm2ram(myATMY, FIND_ID);
137     setXbeeNetwork(SEARCH_NET, myATMY, HOST_ID);
138     // set id to FIND_ID
139     // set network to SEARCH_NET
140 }
141
142 void generateID(char* otherID2) {
143     int ID = 0;
144
145     ID = rand();
146     sprintf(myATMY, "%04x", ID);
147 }
148
149 //void configureATDL(char* hostID) {
150 //    // Tx set low
151 //    TXSTA1bits.TXEN1 = 0;
152 //    PORTCbits.RC6 = 0;
153 //
154 //    resetXbee();
155 //    // Reenable Tx
156 //    TXSTA1bits.TXEN1 = 1;
157 //    putrs1USART("ATDL");
158 //    while (Busy1USART());
159 //    putrs1USART(hostID);
```

```
160 //     while (Busy1USART());
161 //
162 //     // ATWR,AC,CN - Write changes to nonVolatile memory
163 //     // ATAC - Apply changes
164 //     // ATCN - Exit config mode
165 //     //Carriage return
166 //     putrs1USART("WR,AC,CN\r");
167 //     while (Busy1USART());
168 //     while (!DataRdy1USART());
169 //
170 //}
171
172 void resetXbee(void) {
173     //Reset Pin- configure these to be outputs
174     //     PORTBbits.RB7 = 0;
175     PORTAbits.RA0 = 0;
176     // Delay 10 Instruction cycles, pulse must be at least 200ns;
177     Delay10TCYx(5);
178     //     PORTBbits.RB7 = 1;
179     PORTAbits.RA0 = 1;
180     // Two pulses/responses come in on startup
181     while (!DataRdy1USART());
182     while (!DataRdy1USART());
183 }
184
185 void setupXbee(void) {
186
187     //     TRISBbits.RB7 = 0;
188     //     PORTBbits.RB7 = 1;
189     TRISAbits.RA0 = 0;
190     ANSELAbits.ANSA0 = 0;
191     PORTAbits.RA0 = 1;
192 }
193
194 void setXbeeNetwork(char* myNetwork, char* myID, char* myDL) {
195     char myCom[12] = { 0 };
196     // Tx set low
197     TXSTA1bits.TXEN1 = 0;
198     PORTCbits.RC6 = 0;
199
200     resetXbee();
201     // Reenable Tx
202     TXSTA1bits.TXEN1 = 1;
203     while (DataRdy1USART()) {
204         getc1USART();
205     }
206     strcpypgm2ram(myCom, "ATID");
207     strcat(myCom, myID);
208     strcatpgm2ram(myCom, "\r");
```

```
209     puts1USART(myCom);
210     while (Busy1USART());
211     while (DataRdy1USART()) {
212         getc1USART();
213     }
214
215     strcpypgm2ram(myCom, "ATMY");
216     strcatpgm2ram(myCom, myNetwork);
217     strcatpgm2ram(myCom, "\r");
218     puts1USART(myCom);
219     while (Busy1USART());
220     while (DataRdy1USART()) {
221         getc1USART();
222     }
223
224     strcpypgm2ram(myCom, "ATDH");
225     strcatpgm2ram(myCom, "0000");
226     strcatpgm2ram(myCom, "\r");
227     puts1USART(myCom);
228     while (Busy1USART());
229     while (DataRdy1USART()) {
230         getc1USART();
231     }
232
233     strcpypgm2ram(myCom, "ATDL");
234     strcatpgm2ram(myCom, myDL);
235     strcatpgm2ram(myCom, "\r");
236     puts1USART(myCom);
237     while (Busy1USART());
238     while (DataRdy1USART()) {
239         getc1USART();
240     }
241
242     putrs1USART("ATWR,CN\r");
243     Delay1KTCYx(170);
244     putrs1USART("A");
245     while (DataRdy1USART()) {
246         getc1USART();
247     }
248 //
249 //    putrs1USART("ATCN\r");
250 //    while (Busy1USART());
251 //    while (!DataRdy1USART());
252 //    while (DataRdy1USART()) {
253 //        getc1USART();
254 //    }
255
256
257 //    //putrs1USART("ATID");
```

```
258 //      while (Busy1USART());
259 //      putrs1USART(myNetwork);
260 //      while (Busy1USART());
261 //      putrs1USART(",MY");
262 //      while (Busy1USART());
263 //      puts1USART(myID);
264 //      while (Busy1USART());
265 //      putrs1USART(",DL");
266 //      while (Busy1USART());
267 //      putrs1USART(myDL);
268 //      while (Busy1USART());
269 //      putrs1USART(",DH");
270 //      while (Busy1USART());
271 //      putrs1USART("0000");
272 //      while (Busy1USART());
273
274       // Config Commands
275       //Carriage return
276       // Config Commands
277       //Carriage return
278       // etc
279       // Exit
280
281       // ATWR,AC,CN - Write changes to nonVolatile memory
282       // ATAC - Apply changes
283       // ATCN - Exit config mode
284       //Carriage return
285 //      putrs1USART(",WR,AC,CN\r");
286 //      while (Busy1USART());
287 //      while (!DataRdy1USART());
288 //      while (DataRdy1USART()) {
289 //          getc1USART();
290 //      }
291       //
292       //      putrs1USART("ATID\r");
293       //      while(Busy1USART());
294       //      while (!DataRdy1USART());
295 }
```