PR21

Gaming with Accelerometer

Version 1.0

August 2008

Cytron Technologies Sdn. Bhd.

OVERVIEW

This document describes the development of Cytron Technologies DIY (Do It Yourself) Project PR21. This project is using PIC18F452 microcontroller together with the ADXL330 accelerometer to measure the gravity force and DS-LCD-TG12864E-03 Graphical LCD (GLCD) for display. Combination of these devices can be used for the gaming purposes. This DIY project will demonstrate how to make a simple game with these devices. The corresponding schematic and source code for the microcontroller will be provided.

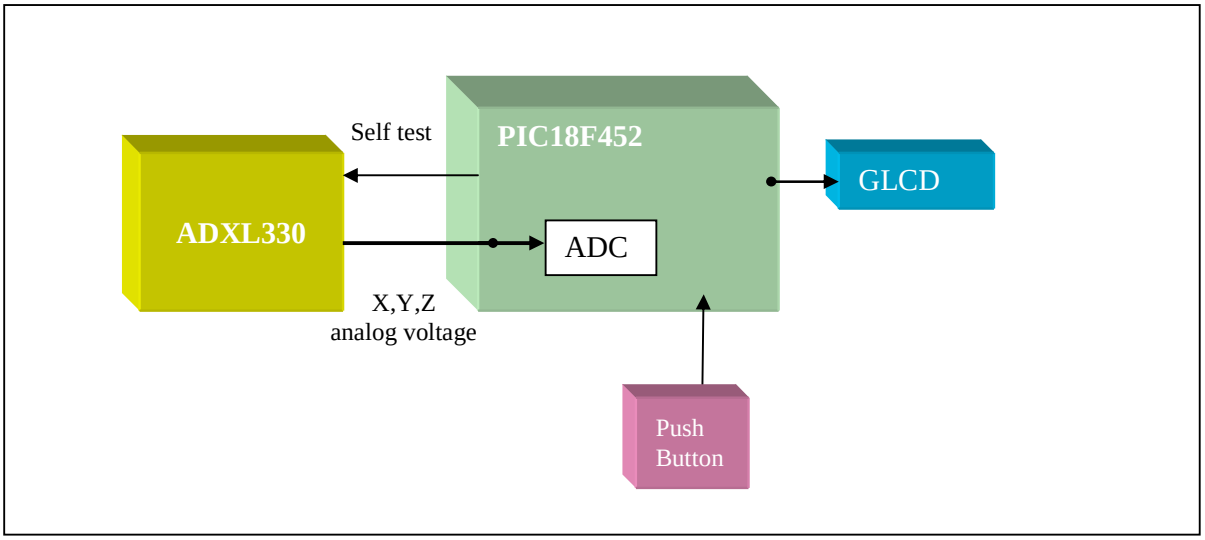
FEATURES

PIC18F452 Microcontroller
- 8-bit microcontroller with 33 I/O
- Operate with 5V supply
- Operating speed up to 40MHz

ADXL330 Accelerometer
- Sensor range: +/-3g
- Operate with 3.3V supply

GLCD 128x64 (DS-LCD-TG12864E-03)
- 128x64 Graphical LCD display
- Blue backlight

SYSTEM OVERVIEW



GENERAL DESCRIPTION

Accelerometer can be used in so many applications such as static tilt detection, vibration sensing, crash test for automobile and etc. This DIY Project will show how to use the accelerometer for tilt detection in gaming device.

PIC18F452 Microcontroller

This powerful (100 ns instruction cycle) yet easy-to-program (only 75 single word instructions) CMOS FLASH-based 8-bit microcontroller packs Microchip's powerful PIC® architecture into a 40 or 44-pin package and is backward compatible with the PIC16C5X, PIC12CXXX, PIC16FXXX and PIC16C7X devices. Features of this device are:

- C compiler optimized architecture/instruction sets
  - Source code compatible with the PIC16 and PIC17 instruction sets
- 256 bytes of EEPROM data memory
- Self programming
- ICD (in circuit debugging function)
- 2 Comparators
- 8 channels of 10-bit Analog-to-Digital (A/D) converter
- 2 capture/compare/PWM functions
- Synchronous serial port can be configured as either 3-wire Serial Peripheral Interface (SPI™) or the 2-wire Inter-Integrated Circuit (I²C™) bus
- Universal Asynchronous Receiver Transmitter (UART).

These features make it an ideal device for advanced A/D applications in automotive, industrial, appliances and consumer applications.

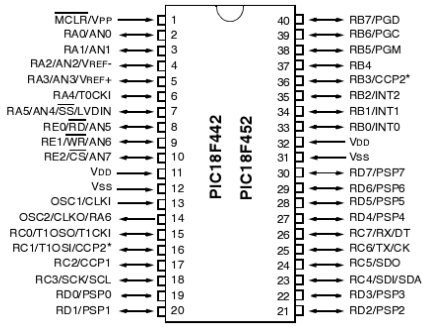


Figure 1

Figure 1 shows the pin diagram of the PIC18F452. For more information about the PIC microcontroller, please refer to the datasheet. The datasheet can be downloaded from the Microchip web site at http://www.microchip.com

ADXL330 Accelerometer

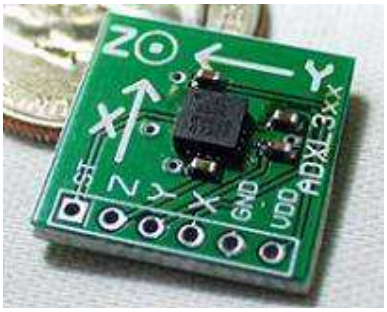


Figure 2

Figure 2 is the breakout board for the ADXL330 accelerometer from Analog Devices. The ADXL330 is a triple axis accelerometer with extremely low noise and power consumption which is only 320uA! It has the measurement range of +/-3g. The board comes fully assembled and tested with external components installed. Features of this device are:

- 3-axis acceleration sensing
- Small and low-profile package
- 4 mm × 4 mm × 1.45 mm LFCSP
- 200 µA at V_s =2.0 V (typical)
- Single-supply operation (2.0 V to 3.6 V)
- 10,000 g shock survival
- Excellent temperature stability
- BW adjustment with a single capacitor per axis
- RoHS/WEEE lead-free compliant

Data sheet can be downloaded from
http://www.sparkfun.com/datasheets/Components/ADXL330_0.pdf

GLCD 128X64 (DS-LCD-TG12864E-03)

Figure 3

- 128x64 graphical LCD display
- With blue backlight
- Chinese character input (DS-LCD-TG12864E-03)

HARDWARE

This project requires the following hardwares:

a. 1 x PIC18F452
b. 1 x PR21 Printed Circuit Board (PCB)
c. 1 x ADXL330 breakout board
d. 1 x GLCD (DS-LCD-TG12864E-03)
e. Related electronic components

Please refer to Appendix A for the PCB layout of PR21. The PCB layout is provided free; therefore Cytron Technologies will not be responsible for any further modification or improvement.

Interface the ADXL330 with PIC18F452

The ADXL330 is a complete 3-axis acceleration measurement system on a single monolithic IC. The output signals are analog voltages that are proportional to the measured accelerations. The A/D converter in the PIC18F452 can be used to convert these analog voltages.

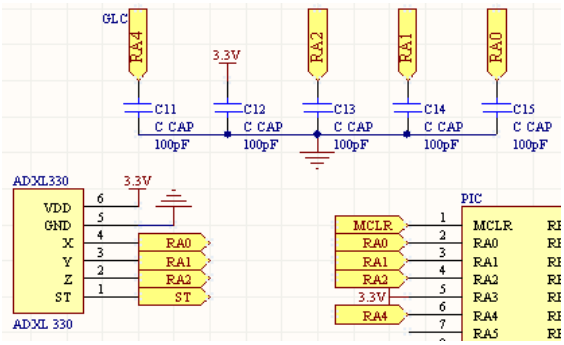


Figure 4

Figure 4 shows how the ADXL330 is connected to the PIC18F452. Since the ADXL330 is powered by 3.3V, we need to use 3.3V as +Vref to maximize the A/D converter resolution. The ADCON1 register of the PIC18F452 should be configured to use the AN3 as +Vref as well. Capacitors are connected to the analog pins to reduce the measurement noise.

Interface the GLCD 128x64 with PIC18F452

The connection is similar with the LCD 16x2 except that it has extra four pins (2 x NC, Reset and PSB).

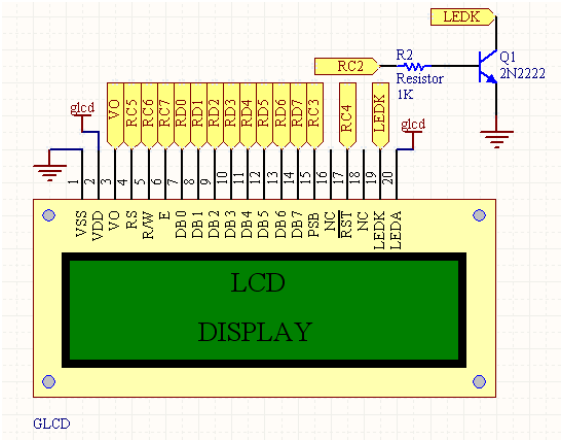


Figure 5

Pin	Name	Pin function	Connection
1	VSS	Ground	GND
2	VDD	Positive supply for GLCD	5V(for GLCD only)
3	VO	Brightness adjust	Connected to a preset to adjust brightness
4	RS	Select register (Instruction or data register)	RC5

5	R/W	Select read or write	RC6
6	E	Start data read or write	RC7
7	DB0	Data bus pin	RD0
8	DB1	Data bus pin	RD1
9	DB2	Data bus pin	RD2
10	DB3	Data bus pin	RD3
11	DB4	Data bus pin	RD4
12	DB5	Data bus pin	RD5
13	DB6	Data bus pin	RD6
14	DB7	Data bus pin	RD7
15	PSB	Parallel or Serial	RC3
16	NC	Not connected	
17	/RST	Reset	RC4
18	NC	Not connected	
18	LEDK	Backlight positive input	RC2 through Transistor
19	LEDA	Backlight negative input	5V(for GLCD only)

For more details please refer to the datasheet at http://www.cytron.com.my/datasheet/TG12864E.pdf

The diagram below shows the relationship between the display pixel and the CGRAM.

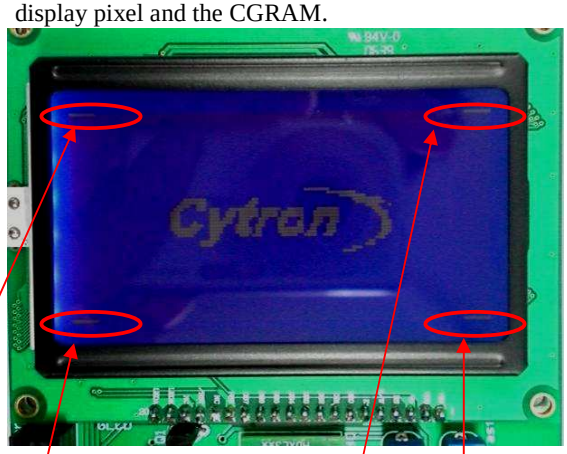


Figure 6

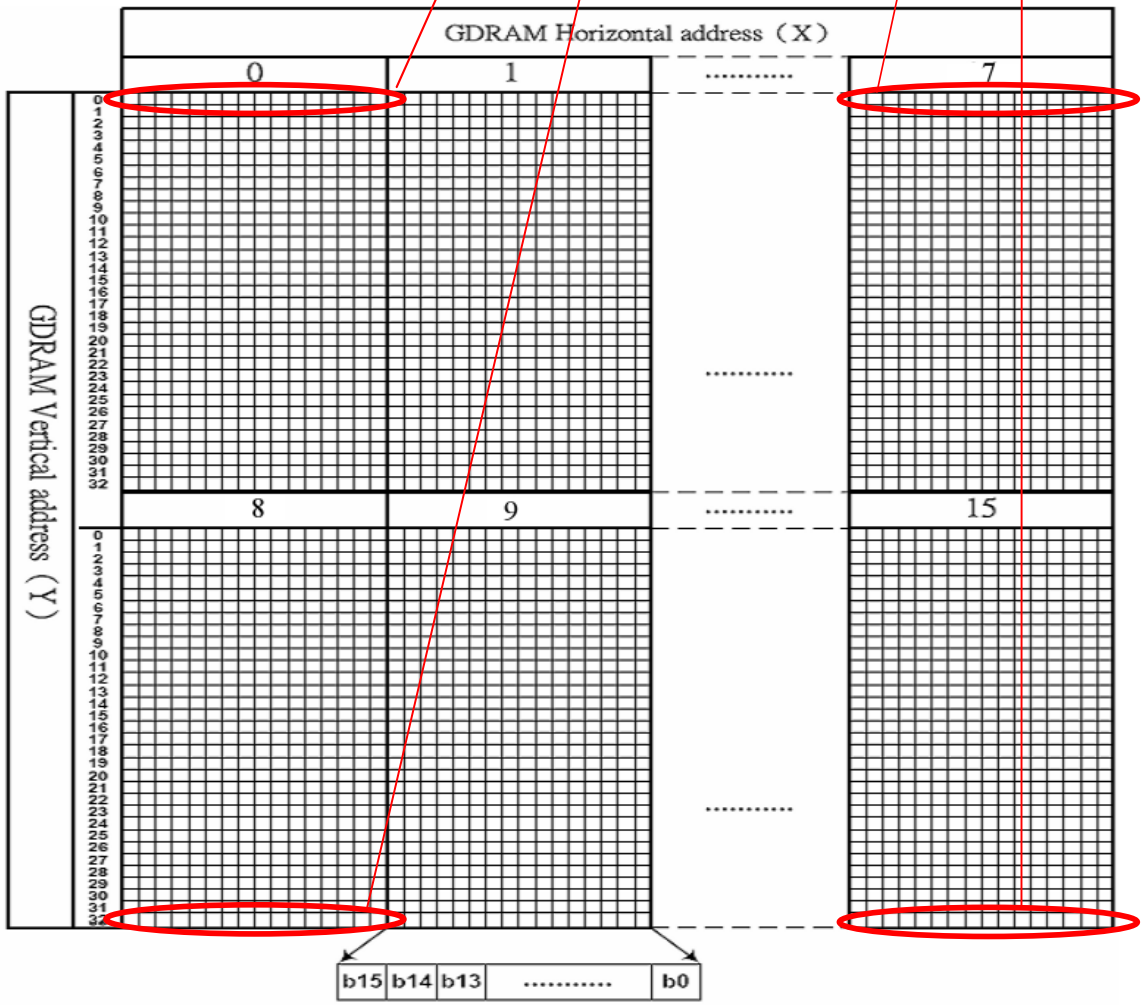


Figure 7

Fastlcd can be used to convert a graphic into the binary code for the GLCD. It can be downloaded form www.fastavr.com/Downloads_act.htm.

Steps to use the Fastlcd:

1. Run the Fastlcd and click "new".

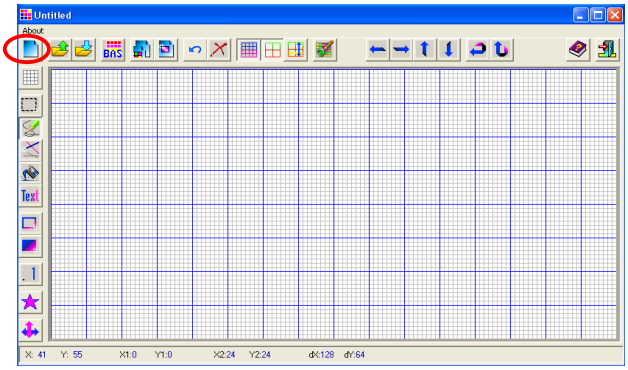


Figure 8

2. Change the image size to 128x64.

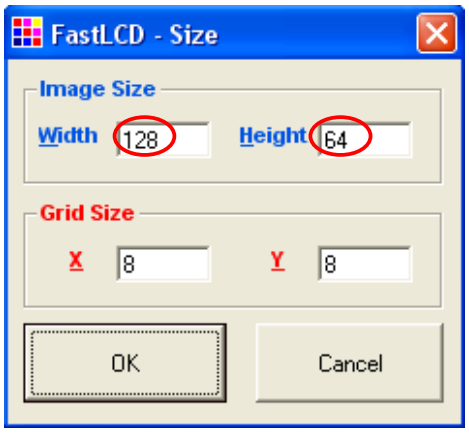


Figure 9

3. Draw the picture and generate the bas table by click "BUS".

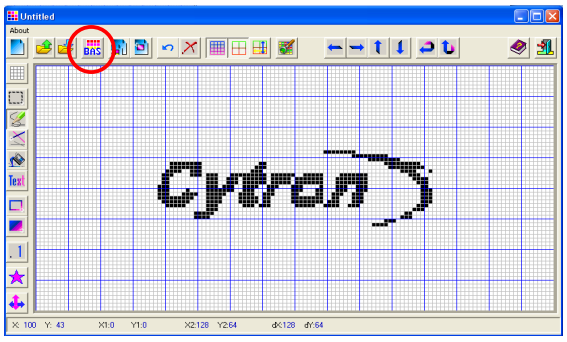


Figure10

4. Select "T6963c" as the type of graphic controller and "0 (8 bits, font 8x8)" as the font select pin.

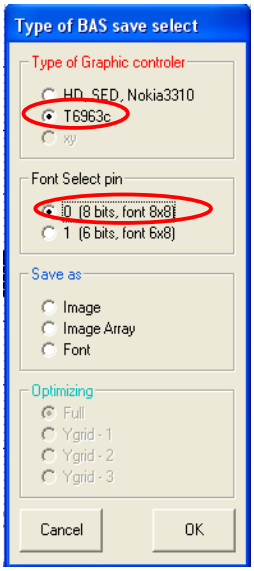


Figure 11

5. Save the bas table.

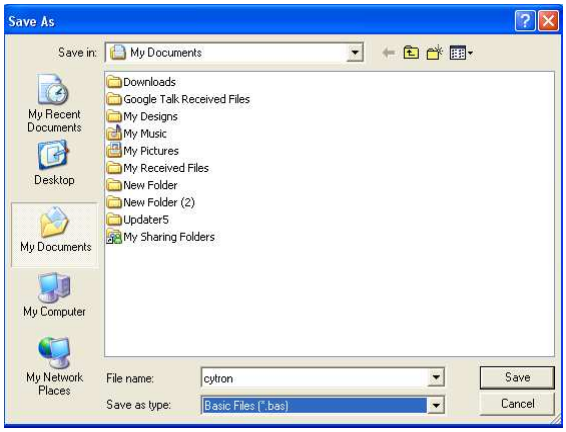


Figure 12

6. Open the saved file with notepad.

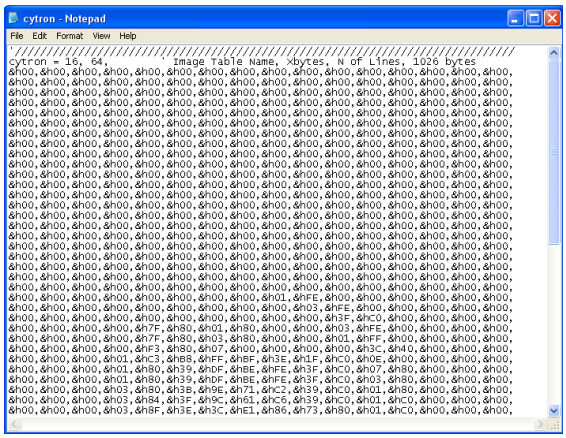


Figure 13

7. Select “Edit >> Replace”.

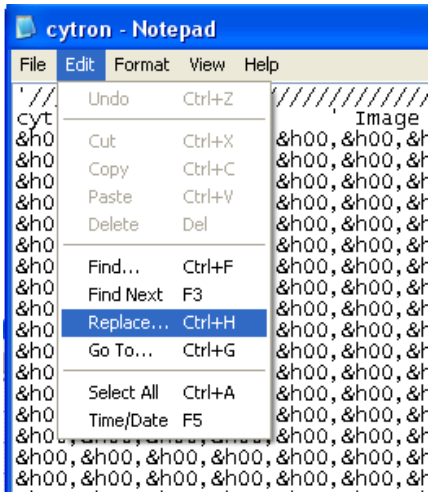


Figure 14

8. Replace all the “&h” with “0x”.

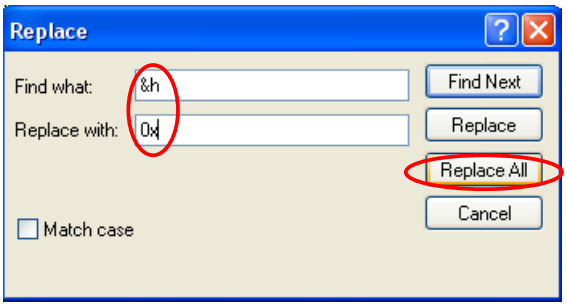


Figure 15

9. Copy the replaced table data.

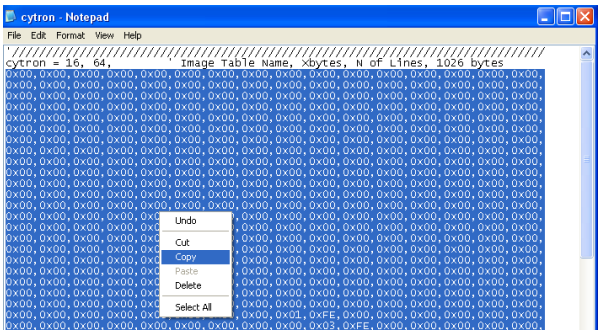


Figure 16

10. Paste the copied data at the “rom char graphic” section in the source code which comes together with the project.

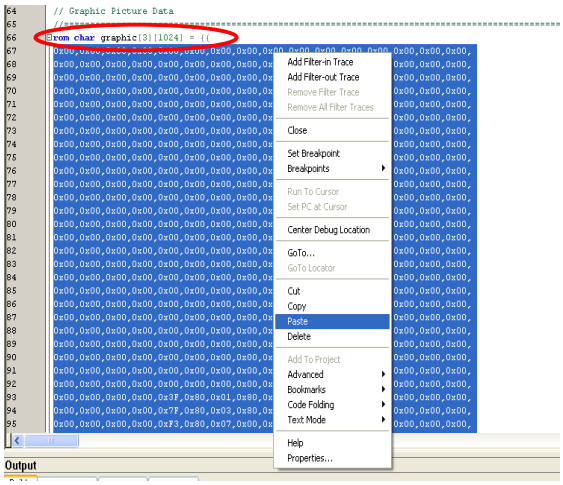


Figure 17

5V Power Supply for the Circuit

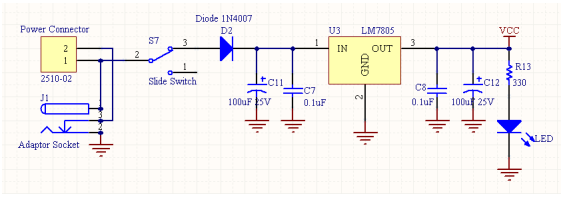


Figure 18

User can choose either the AC to DC adaptor (not included in the DIY project set) or 9V-12V battery (not included in the DIY project set) to power the circuit. Higher input voltage will produce more heat at LM7805 voltage regulator. Typical voltage is 12V. Anyhow, LM7805 will still generate some heat at 12V. There are two type of power connector for the circuit, DC plug (J1) and 2510-02 (Power Connector). Normally AC to DC adaptor can be plugged to J1 type connector.

Refer to Figure 18, the D2 is use to protect the circuit from wrong polarity supply. C7 and C11 is use to stabilize the voltage at the input side of the LM7805 voltage regulator, while the C8 and C12 is use to stabilize the voltage at the output side of the LM7805 voltage supply. LED is a green LED to indicate the power status of the circuit. R13 is resistor to protect LED from over current that will burn the LED.

3.3V Power Supply for the ADXL330

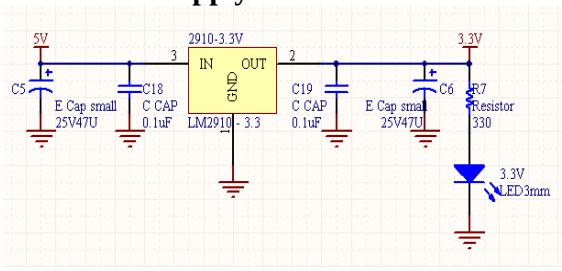


Figure 19

A 3.3V regulator is needed to supply the power to the ADXL303. The 3.3V regulator used in this DIY project set is 2910-3.3V. Input for the 2910-3.3V is the regulated 5V from LM7805. Basically the connection is almost the same with LM7805 except that the pin number is different. Pin 1 is GND, pin 2 is output and pin 3 is input.

Push Button as Input for the PIC Microcontroller

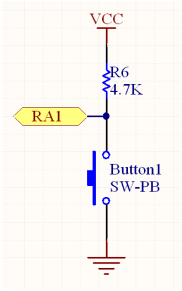


Figure 20

One I/O pin is needed for one push button as input of PIC microcontroller. The connection of the push button to the I/O pin is shown in Figure 20. The I/O pin should be pulled up to 5V using a resistor (with value range 1K-10K) and this configuration will result an active-low input. When the button is pressed, reading of I/O pin will be in logic 0, when the button is not pressed, reading of that I/O pin will be logic 1.

ICSP for Programming the PIC Microcontroller

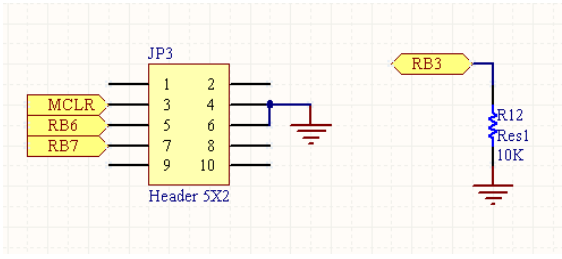


Figure 21

MCLR, RB6 and RB7 need to be connected to the USB In Circuit Programmer (UIC00A) to program the PIC microcontroller. At the same time, RB3 need to be pulled low to GND to disable low voltage programming because the programmer is using high voltage programming. The programmer (UIC00A) is not included in this DIY project set since it can be used several time for different project set. User can also choose other type of PIC programmer to load the program.

For the instruction of using PIC programmer, please refer to the particular PIC programmer user's manual at: http://www.cytron.com.my/listProductCategory.asp?cid=81

PCB circuit board

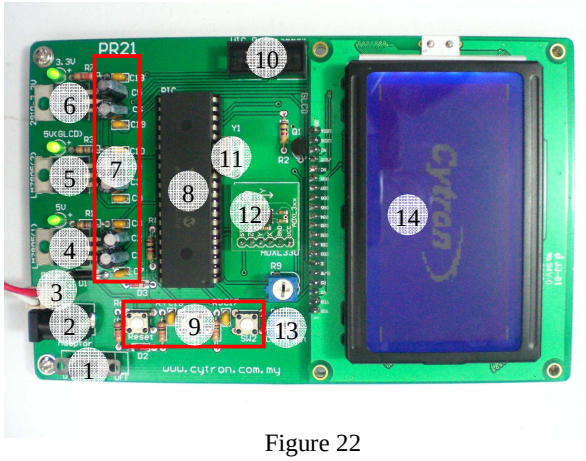


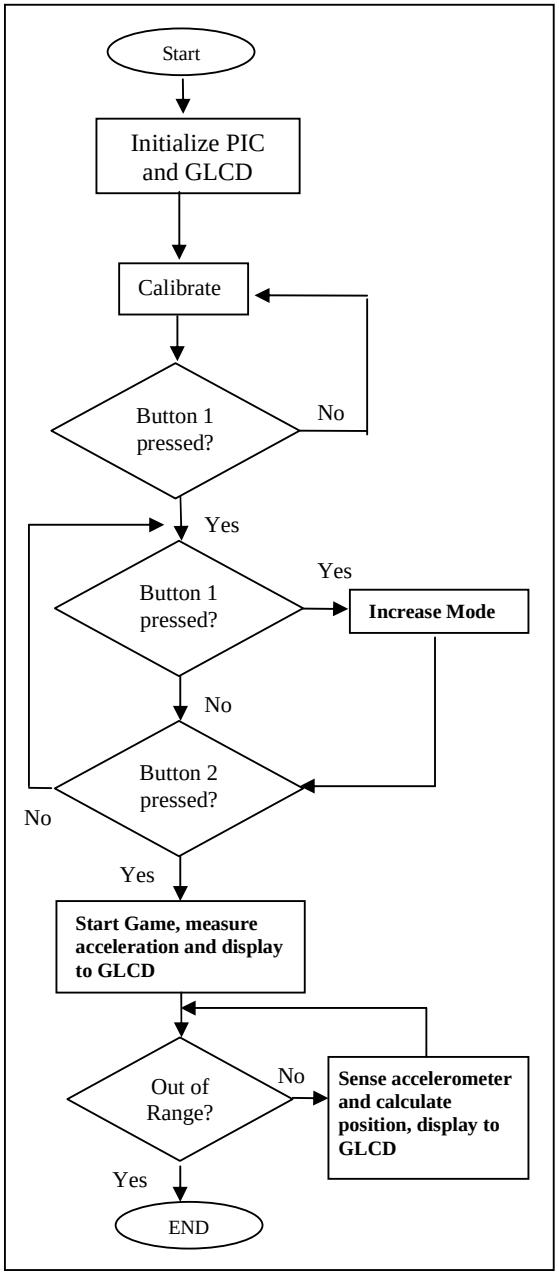
Figure 22

Component:

1. Slide switch (to ON or OFF the circuit).
2. AC-DC adaptor socket (to use power supply from AC-DC adaptor).
3. 2510-02 connector, (to use either 9V battery or 12V battery).
4. LM7805 (voltage regulator, supply 5V for PIC).
5. LM7805 (voltage regulator, supply 5V for GLCD).
6. 2910-3.3V (voltage regulator, supply 3.3V for ADXL330).
7. Capacitors (to stabilize the output voltage of the 7805 voltage regulator).
8. PIC18F452 (the main brain of the system).
9. Push button.
10. ICSP box header (to connect to PIC programmer to program the microcontroller).
11. Crystal (20MHz).
12. ADXL330 (measure accelerations in 3 axis).
13. Preset for GLCD contrast.
14. GLCD (for display).

SOFTWARE

Flow Chart:



For more information about the software for this system, please refer to the source code provided. The explanation of each instruction is provided in the source code as the comment of each line.

The source code is provided free and Cytron Technologies will not be responsible for any further modification or improvement.

GETTING START

User can obtain the hardware set for this project (PR21) either by online purchasing (www.cytron.com.my) or purchase it in Cytron Technologies Shop.

1. Once user has the hardware set, soldering process can be started. Please solder the electronic components one by one according the symbols or overlays on the Printed Circuit Board (PCB). Ensure the component value and polarity is correctly soldered. Please refer to PCB Layout in Appendix A.

Caution: Make sure all the connectors (2510) are soldered in proper side. Those electronic components have polarity such as capacitor, diode, PIC, LM7805, 2910-3.3V and LED should be soldered in right polarity or it may cause the circuit board fail to work.

Warning:Before the battery (Power) is plugged in, make sure the polarity is correct to prevent the explosion. Wrong polarity of capacitor also may cause explosion.

2. Please download the necessary files and document from Cytron Technologies website. These included documentation, sample source code, schematic, component list and software.

3. The next step is to install MPLAB IDE and Microchip C18 Compiler into a computer. The MPLAB IDE and C18 Compiler can be downloaded from www.cytron.com.my Please refer document to install MPLAB software and C18 compiler software.

4. After the installation complete, open the project file provided using MPLAB IDE. Please refer **Installation of C18 compiler and open project_18F document** to open project.

5. Plug in power supply for the circuit. User can choose to use battery or AC to DC adaptor.

AC to DC Adaptor:

Figure 23 (not included in DIY project set)

9V Battery Connector:

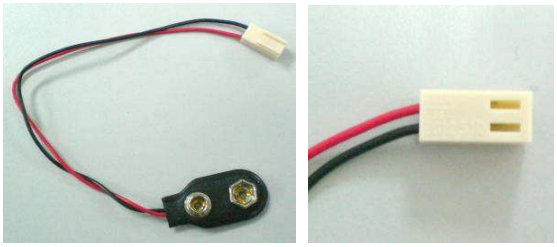


Figure 24 (not included in DIY project set)

Connection to the PCB Board:

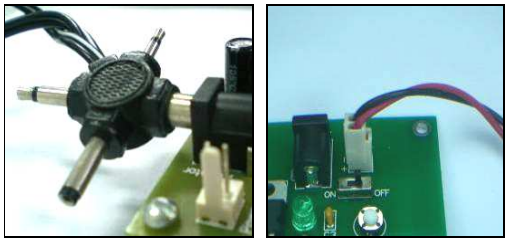


Figure 25

6. Build the project and load the hex file into the PIC microcontroller using the USB In Circuit Programmer (UIC00A). When user build the project, MPLAB IDE will generate hex file. The hex file generated from MPLAB IDE will be named according to project name, not C file name. Cytron Technologies also provide hex file for user. Do not forget to switch ON the power. The programmer is not included in the hardware set but it can be found at Cytron website. (User manual is provided at website).

7. Run and Play the Program.

8. Modify the program.

9. Have fun!

Test Method

1. Switch ON the power, the LED for 5V, 5V(GLCD) and 3.3V will turn ON.
2. After PIC has been programmed, the GLCD will display Cytron logo and ask for calibration.
3. Put the board on the flat surface and press SW1 to calibrate.
4. After that, the GLCD will display the menu for choosing the game “Freespace” or “Friction”. Press SW1 to change the selected game. Press SW2 to start the selected game. In “Freespace”, the speed of ball will not decrease if no net force is acting against it. While in “Friction”, the speed of ball will decrease even thought there is not any net force acting against it.
5. Enjoy!

WARRANTY

No warranty will be provided as this is DIY project. Thus, user is advice to check the polarity of each electronic component before soldering it to board.

Appendix A

PCB Layout:

*** Cytron Technologies reserved the right to replace the component in the list with component of the same functionality without prior notice.**

***2910-3.3V is replaced with LM1117T- 3.3V.**

***Left Preset (R9) and C Cap (C11) without solder the component.**

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