PICSimLab 0.8.9

Luis Claudio Gambôa Lopes <lcgamboa@yahoo.com>

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Chapter 1

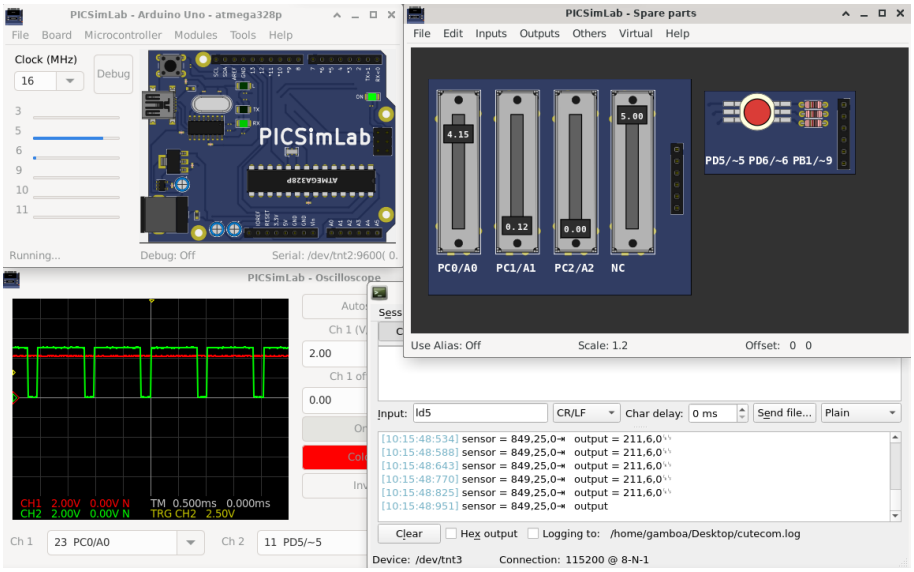
Introduction

PICSimLab means Programmable IC Simulator Laboratory

PICSimLab is a realtime emulator of development boards with integrated MPLABX/avr-gdb debugger. PICSimLab supports some picsim microcontrollers and some simavr microcontrollers. PICSimLab have integration with MPLABX/Arduino IDE for programming the boards microcontrollers. As the purpose of PICSimLab is to emulate real hardware it does not have any source code editing support. For code editing and debugging the same tools used for a real board should be used with PICSimLab, such as MPLABX or Arduino IDE.

PICSimLab supports several devices (spare parts) that can be connected to the boards for simulation. As for example LEDs and push buttons for simple outputs and inputs and some more complex ones like the ethernet shield w5500 for internet connection or the color graphic display ili9340 with touchscreen. The the complete list of parts can be accessed in the chapter Spare Parts.

The experimental version boards supports uCsim, gpsim and qemu-stm32 simulators in addition to the stable ones.


PICSimLab - Arduino Uno - atmega328p
File Board Microcontroller Modules Tools Help
Clock (MHz)
16
Debug
PICSimLab
Running...
Debug: Off
PICSimLab - Spare parts
File Edit Inputs Outputs Others Virtual Help
4.15
0.12
0.00
5.00
PC0/A0 PC1/A1 PC2/A2 NC
PD5/~5 PD6/~6 PB1/~9
Use Alias: Off
Scale: 1.2
Offset: 0 0
PICSimLab - Oscilloscope
CH1 2.00V 0.00V N
CH2 2.00V 0.00V N
TM 0.500ms 0.000ms
TRG CH2 2.50V
Ch 1
23 PC0/A0
Ch 2
11 PD5/~5
Input:
ld5
CR/LF
Char delay:
0 ms
Send file...
Plain
[10:15:48:534] sensor = 849,25,0 output = 211,6,0
[10:15:48:588] sensor = 849,25,0 output = 211,6,0
[10:15:48:643] sensor = 849,25,0 output = 211,6,0
[10:15:48:770] sensor = 849,25,0 output = 211,6,0
[10:15:48:825] sensor = 849,25,0 output = 211,6,0
[10:15:48:951] sensor = 849,25,0 output
Clear
Hex output
Logging to: /home/gamboa/Desktop/cutecom.log
Device: /dev/tnt3
Connection: 115200 @ 8-N-1

Chapter 2

Install

2.1 Stable version executables download

If you are on Linux or Windows you can download the last version at:
https://github.com/lcgamboa/picsimlab/releases
If you are on macOS you can run PICSimLab using Wine:

1. Download and install [‘xquartz‘](https://www.xquartz.org)
2. Download and install [Wine](https://dl.winehq.org/wine-builds/macosx/download.html)
3. Download the executable and double-click it to run the installer

2.2 Install from source

2.2.1 Linux

In Debian Linux and derivatives Linux native:
Using a user with permission to run the sudo command:
In first time build:

```
git clone --depth=1 https://github.com/lcgamboa/picsimlab.git
cd picsimlab
./picsimlab_build_all_and_install.sh
```

To recompile use:

```
make -j4
```

2.2.2 Windows

Cross-compiling for Windows (from Linux or [WSL](https://docs.microsoft.com/windows/wsl/install-win10) on win10)

In first time build in Debian Linux and derivatives target Windows 64 bits:

```
git clone https://github.com/lcgamboa/picsimlab.git
cd picsimlab
./picsimlab_build_w64.sh
```

To recompile use:

```
make FILE=Makefile.cross -j4
```

For target Windows 32 bits:

```
git clone https://github.com/lcgamboa/picsimlab.git
cd picsimlab
./picsimlab_build_w32.sh
```

To recompile use:

```
make FILE=Makefile.cross_32 -j4
```

2.2.3 macOS

macOS from source

Theoretically it is possible to compile PICSimLab natively on macOS. But I do not have access to any computer with macOS to try to compile and until today nobody has communicated that they managed to do it. (help wanted)

2.2.4 Experimental version

Experimental version

Experimental version can be built using the parameter "exp" on scripts:

```
./picsimlab_build_all_and_install.sh exp
./picsimlab_build_w64.sh exp
./picsimlab_build_w32.sh exp
```

And recompiled using the parameter "exp" on Makefiles:

```
make -j4 exp
make FILE=Makefile.cross -j4  exp
make FILE=Makefile.cross_32 -j4 exp
```

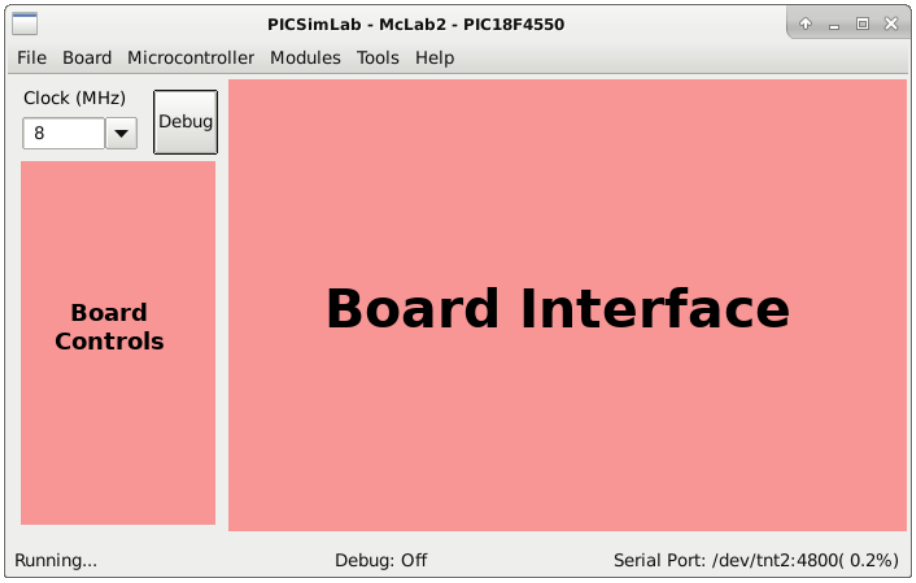
Chapter 3

Simulator Interface

3.1 Main Window

The main window consists of a menu, a status bar, a frequency selection combobox, an on/off button to trigger debugging, some board-specific controls and the part of the board interface itself.

In the title of the window is shown the name of the simulator PICSimLab, followed by the board and the microcontroller in use.



The frequency selection combobox directly changes the working speed of the microcontroller, when the "Clock (MHz)" label goes red indicates that the computer is not being able to run the program in real time for the selected clock. In this case

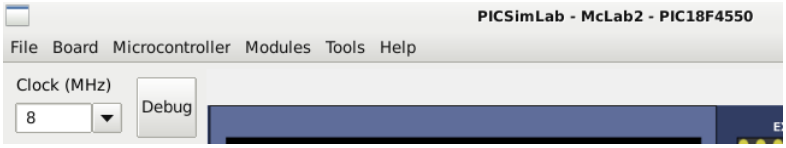
the simulation may present some difference than expected and the CPU load will be increased.

The on/off button to enable debugging is used to enable debugging support, with the active support there is a higher simulation load.

The menus and their functions are listed below:

- File
  - Load Hex - Load .hex files
  - Reload Last - Reload the last used .hex file
  - Save Hex - Save memory in a .hex file
  - Configure - Open the configuration windows
  - Save Workspace - Saves all current workspace settings to a .pzw file
  - Load Workspace - Loads saved settings from a .pzw file
  - Exit
- Board
  - Breadboard - Choose board Breadboard
  - McLab1 - Choose board McLab1
  - K16F - Choose board K16F
  - McLab2 - Choose board McLab2
  - PICGenios - Choose board PICGenios
  - Arduino Uno - Choose board Arduino Uno
- Microcontroller
  - xxxxx - Selects the microcontroller to be used (depends on the selected board)
- Modules
  - Oscilloscope - Open the oscilloscope window
  - Spare parts - Open the spare parts window
- Tools
  - Serial Terminal - Open the serial terminal Cutecom
  - Serial Remote Tank - Open the remote tank simulator
  - Esp8266 Modem Simulator - Open the Esp8266 Modem Simulator
  - Arduino Bootloader - Load microcontroller with Arduino serial bootloader
  - MPLABX Debugger Plugin - Open the web page to download the MPLABX Debugger Plugin
  - Pin Viewer - Open the Pin Viewer

- Help
  - Contents - Open the Help window
  - Board - Open the Board Help window
  - Examples - Load the examples
  - About Board - Show message about author and version of board
  - About PICSimLab - Show message about author and version of PICSimLab



The first part of the status bar shows the state of the simulation, in the middle part the status of the debug support and in the last part the name of the serial port used, its default speed and the error in relation to the real speed configured in the microcontroller.

3.2 Interaction with the Board

On the interface area of the board it is possible to interact in some ways:

- Click in ICSP connector to load an .hex file.
- Click in PWR button to ON/OFF the emulator..
- The buttons can be activated through mouse or keys 1, 2, 3 e 4.

3.3 Command Line

PICSimLab supports two command lines format:
One for load a PICSimLab Workspace file (.pzw)

```
picsimlab file.pzw
```

And other for load .hex files

```
picsimlab boardname microcontroller [file.hex] [file.pcf]
```

3.4 Remote Control Interface

The remote control interface allows other programs to control the PICSimLab simulation through a TCP/IP socket using text formatted commands.

The PICSimLab remote control interface supports TCP connections using telnet or nc (netcat).

The default port is 5000 and can be changed in configuration windows.

The 'rlwrap' command can be used for best command edition support in telnet or nc:

```
 rlwrap nc 127.0.0.1 5000
```

The supported commands can be shown using the "help" command:

```
 help
List of supported commands:
  dumpe [a] [s]- dump internal EEPROM memory
  dumpf [a] [s]- dump Flash memory
  dumpr [a] [s]- dump RAM memory
  exit         - shutdown PICSimLab
  get ob       - get object value
  help         - show this message
  info         - show actual setup info and objects
  pins         - show pins directions and values
  pinsl        - show pins formated info
  quit         - exit remote control interface
  reset        - reset the board
  set ob vl    - set object with value
  sync         - wait to syncronize with timer event
  version      - show PICSimLab version
Ok
```

The "info" command show all available "objects" and values:

```
info
Board:     Arduino Uno
Processor: atmega328p
Frequency:   16000000 Hz
Use Spare: 1
    board.out[00] LD_L= 254
  part[00]: LEDs
    part[00].out[08] LD_1= 254
    part[00].out[09] LD_2= 30
    part[00].out[10] LD_3= 254
    part[00].out[11] LD_4= 254
    part[00].out[12] LD_5 254
    part[00].out[13] LD_6= 254
    part[00].out[14] LD_7= 254
  part[01]: Buzzer
```

```
    part[01].out[02] LD_1= 140
  part[02]: Push buttons
    part[02].in[00] PB_1= 1
    part[02].in[01] PB_2= 0
    part[02].in[02] PB_3= 1
    part[02].in[03] PB_4= 1
    part[02].in[04] PB_5= 1
    part[02].in[05] PB_6= 1
    part[02].in[06] PB_7= 1
    part[02].in[07] PB_8= 1
Ok
```

The “pins” command show all pins directions and digital values:

```
pins
  pin[01] ( PC6/RST) < 0                pin[15] (  PB1/~9) > 0
  pin[02] (   PD0/0) < 1                pin[16] ( PB2/~10) > 0
  pin[03] (   PD1/1) < 1                pin[17] ( PB3/~11) > 0
  pin[04] (   PD2/2) < 1                pin[18] (  PB4/12) < 0
  pin[05] (  PD3/~3) > 0                pin[19] (  PB5/13) > 0
  pin[06] (   PD4/4) < 1                pin[20] (     +5V) < 1
  pin[07] (     +5V) < 1                pin[21] (    AREF) < 0
  pin[08] (     GND) < 0                pin[22] (     GND) < 0
  pin[09] (  PB6/X1) < 0                pin[23] (  PC0/A0) < 0
  pin[10] (  PB7/X2) < 0                pin[24] (  PC1/A1) < 0
  pin[11] (  PD5/~5) < 1                pin[25] (  PC2/A2) < 0
  pin[12] (  PD6/~6) < 1                pin[26] (  PC3/A3) < 0
  pin[13] (   PD7/7) < 1                pin[27] (  PC4/A4) > 0
  pin[14] (   PB0/8) > 0                pin[28] (  PC5/A5) > 0
Ok
```

The “pinsl” command show all pins info in text formatted output:

```
pinsl
28 pins [atmega328p]:
  pin[01] D I 0 000 0.000 "PC6/RST "
  pin[02] D I 1 200 0.000 "PD0/0   "
  pin[03] D I 1 200 0.000 "PD1/1   "
  pin[04] D I 1 200 0.000 "PD2/2   "
  pin[05] D O 0 007 0.000 "PD3/~3  "
  pin[06] D I 1 200 0.000 "PD4/4   "
  pin[07] P I 1 200 0.000 "+5V     "
  pin[08] P I 0 000 0.000 "GND     "
  pin[09] D I 0 000 0.000 "PB6/X1  "
  pin[10] D I 0 000 0.000 "PB7/X2  "
  pin[11] D I 1 200 0.000 "PD5/~5  "
  pin[12] D I 1 200 0.000 "PD6/~6  "
  pin[13] D I 1 200 0.000 "PD7/7   "
  pin[14] D O 0 000 0.000 "PB0/8   "
```

```
  pin[15] D O 0 000 0.000 "PB1/~9  "
  pin[16] D O 0 000 0.000 "PB2/~10 "
  pin[17] D O 0 006 0.000 "PB3/~11 "
  pin[18] D I 0 000 0.000 "PB4/12  "
  pin[19] D O 0 000 0.000 "PB5/13  "
  pin[20] P I 1 200 0.000 "+5V     "
  pin[21] R I 0 000 0.000 "AREF    "
  pin[22] P I 0 000 0.000 "GND     "
  pin[23] A I 0 000 0.875 "PC0/A0  "
  pin[24] A I 0 000 1.925 "PC1/A1  "
  pin[25] A I 0 000 2.700 "PC2/A2  "
  pin[26] A I 0 000 4.275 "PC3/A3  "
  pin[27] D O 1 179 0.000 "PC4/A4  "
  pin[28] D O 1 186 0.000 "PC5/A5  "
Ok
```

You can view one input/output state using the “get” command:

```
get board.out[00]

get part[02].in[01]
```

Its possible use the “get” command to view individual pins state:

```
#digital state
get pin[19]
pin[19]= 0
Ok

#digital mean value (0-200)
get pinm[19]
pin[18]= 100
Ok

#analog state
get apin[25]
apin[25]= 2.700
Ok

#all info
get pinl[13]
pin[13] D I 1 200 0.000 "PD7/7   "
Ok
```

And set value of one input using the “set” command:

```
set part[02].in[01]  0
set part[02].in[01]  1
```

Or set value of one pin using the “set” command:

```
#digital
set pin[10]  2

#analog
set apin[20] 2.345
```

For windows users putty telnet client is a good option.

Chapter 4

Boards

PICSimLab currently supports five backend simulators. The stable version supports picsim and simavr. The experimental version supports uCsim, gpsim and qemu-stm32 in addition to the stable ones.

The Figure 4.1 shows which cards are based on which backend simulator:

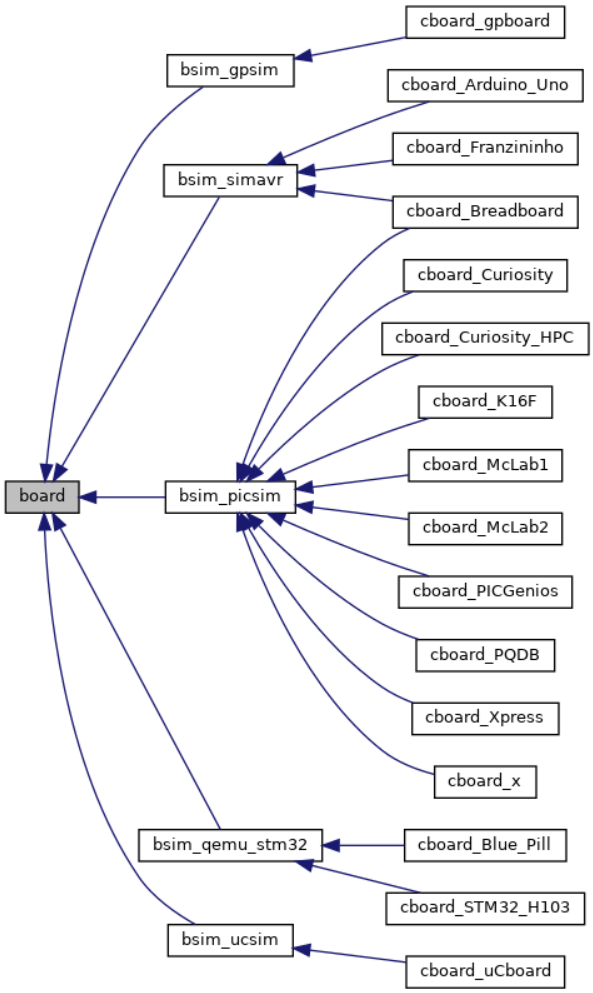


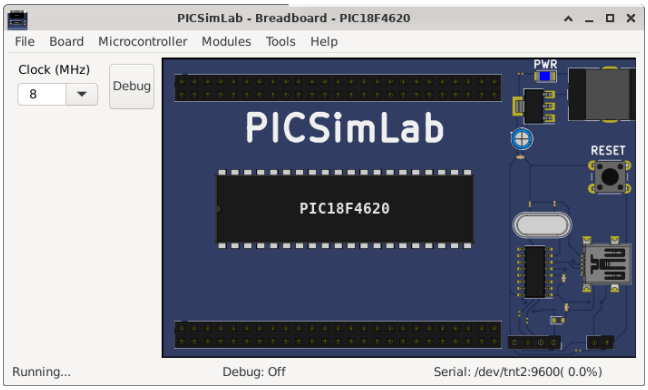
Figure 4.1: Boards backend simulators

The below table show the supported debug interface of each simulator:

Backend	Debug Support
picsim	MPLABX Integrated Debug (see section 7.1)
simavr	MPLABX Integrated Debug (see section 7.1) and remote avr-gdb (see section 7.3)
qemu-stm32	remote arm-gdb (see Chapter 7.4)
uCsim	uCsim remote console (telnet) (see section 7.5)
gpsim	none yet

4.1 Breadboard

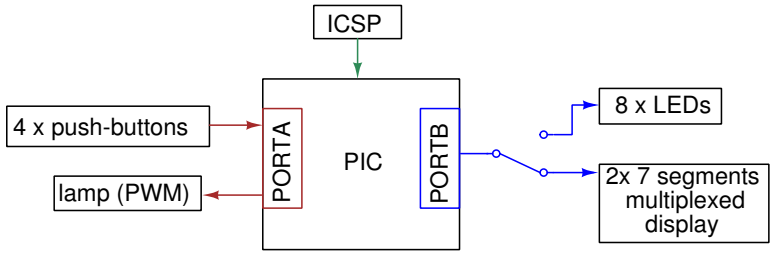
It is a generic board only with reset, serial and crystal circuits and support to multiple microcontrollers of picsim and simavr.

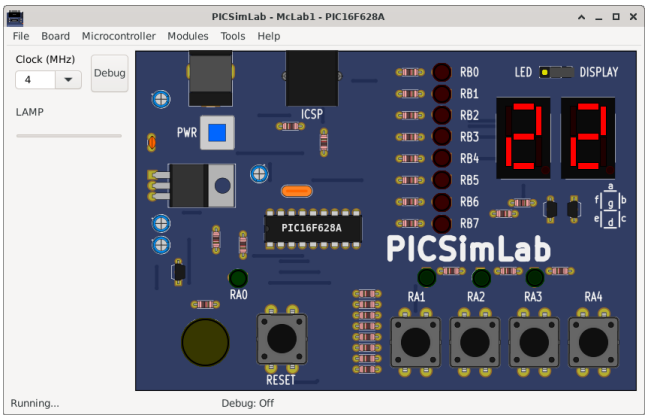


Examples

4.2 McLab1

It emulates the Labtools development board McLab1 that uses one PIC16F84, PIC16F628 or PIC16F648 of picsim.





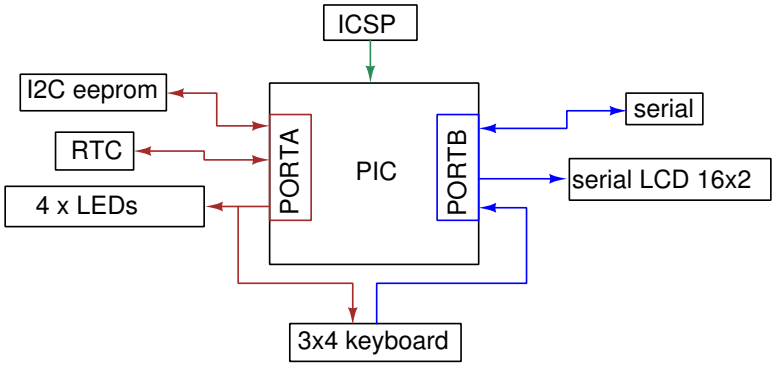
Board McLab1 schematics.

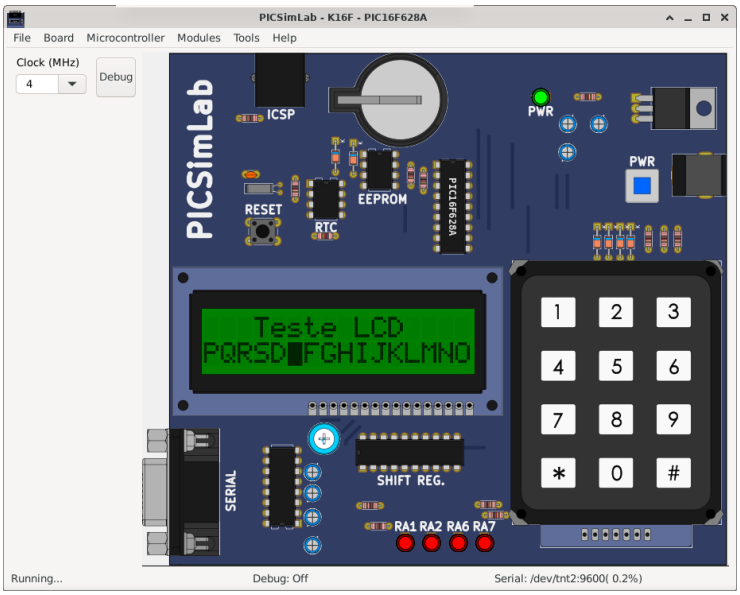
The code examples can be loaded in PICSimLab menu **Help->Examples**.

The source code of board McLab1 examples using MPLABX and XC8 compiler are in the link: board_McLab1.

4.3 K16F

It emulates an didactic board developed by author that uses one PIC16F84, PIC16F628 or PIC16F648 of picsim.





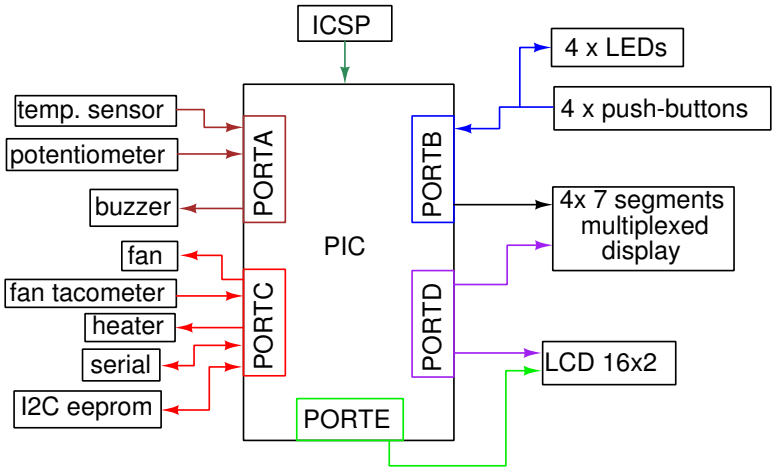
Board K16F schematics.

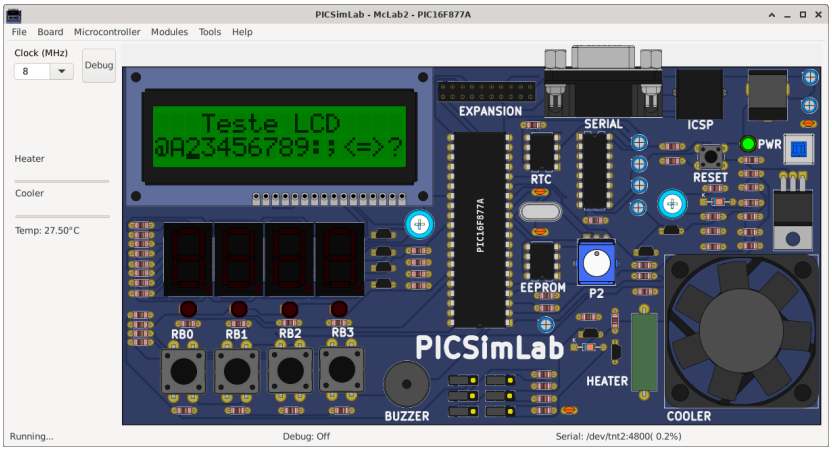
The code examples can be loaded in PICSimLab menu **Help->Examples**.

The source code of board K16F examples using MPLABX and XC8 compiler are in the link: board_K16F.

4.4 McLab2

It emulates the Labtools development board McLab2 that uses one PIC16F777, PIC16F877A, PIC18F452, PIC18F4520, PIC18F4550 or PIC18F4620 of picsim.





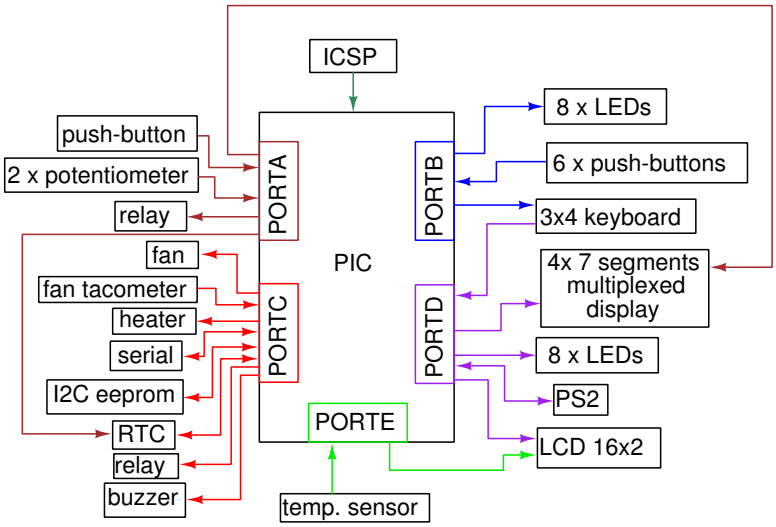
Board McLab2 schematics.

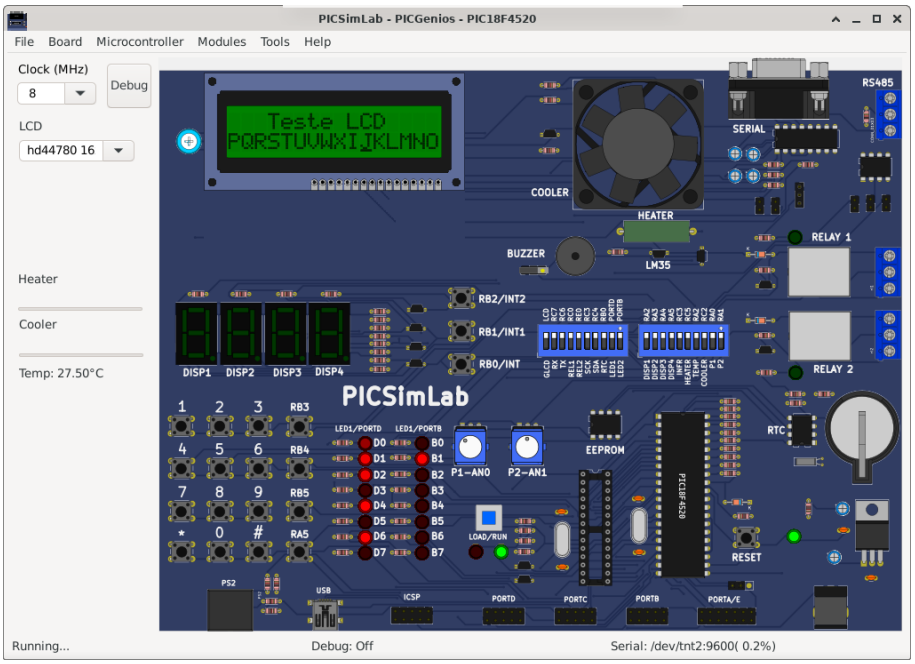
The code examples can be loaded in PICSimLab menu **Help->Examples**.

The source code of board McLab2 examples using MPLABX and XC8 compiler are in the link: board_McLab2.

4.5 PICGenios

It emulates the microgenius development board PICGenios PIC18F e PIC16F Microchip that uses one PIC16F777, PIC16F877A, PIC18F452, PIC18F4520, PIC18F4550 or PIC18F4620 of picsim.





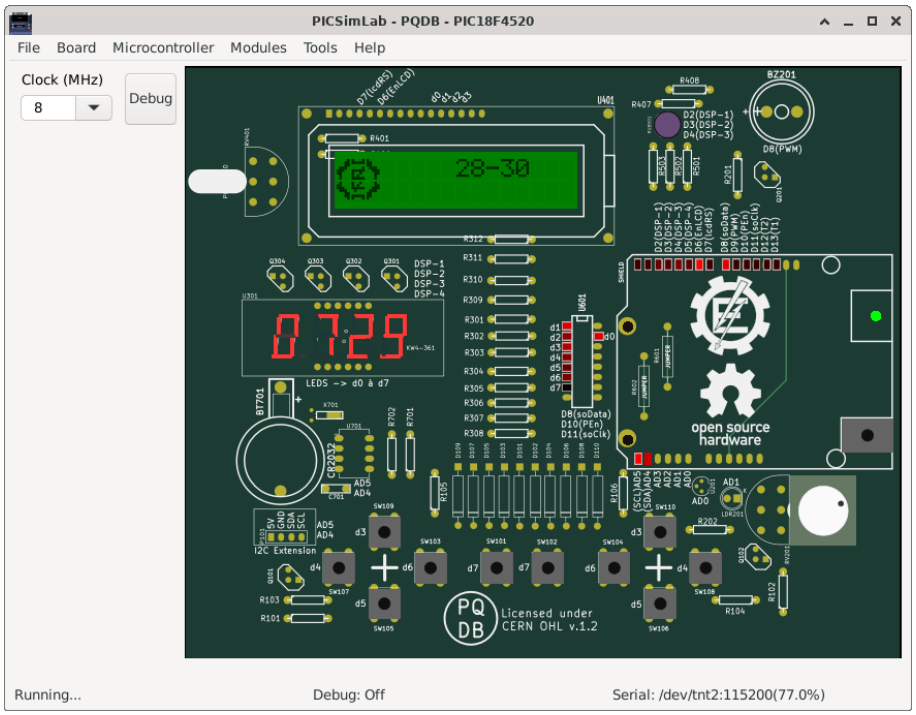
Board PICGenios schematics.

The code examples can be loaded in PICSimLab menu **Help->Examples**.

The source code of board PICGenios examples using MPLABX and XC8 compiler are in the link: board_PICGenios.

4.6 PQDB

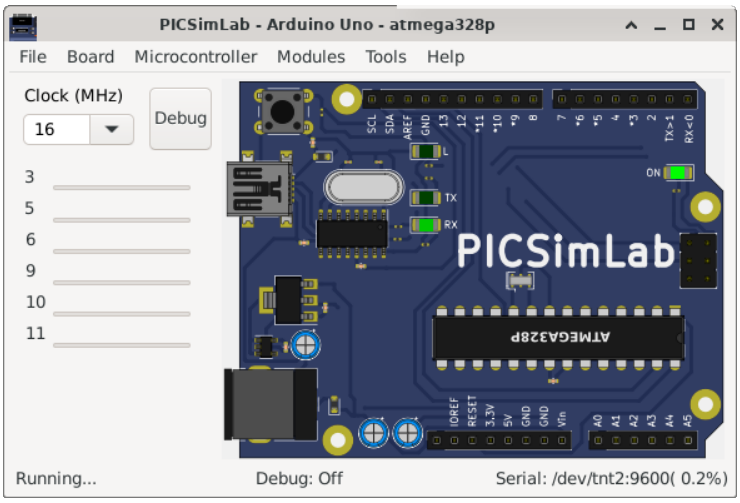
The PQDB board is an opensource/openhardware project, more info at https://github.com/projetopqdb/. It was developed to be used with arduino/freedom boards, but adapted to use the microcontroller PIC18F4520 of picsim on PICSImLab.



Examples

4.7 Arduino Uno

It emulates the Arduino Uno development board that uses one ATMEGA328P microcontroller of simavr.



Board Arduino Uno schematics.

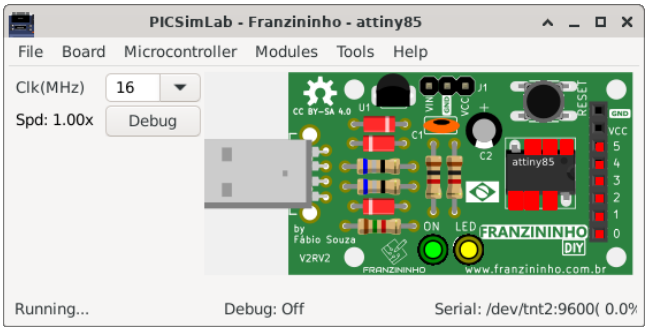
The code examples can be loaded in PICSimLab menu **Help->Examples**.

The source code of board Arduino Uno examples using the Arduino IDE with avr-gcc are in the link: board_Arduino_Uno.

More information about the Arduino in www.arduino.cc

4.8 Franzininho

The Franzininho DIY board is an openhardware project, more info at https://franzininho.com.br/. It was developed to be used with the microcontroller ATtiny85 of of simavr.



Examples

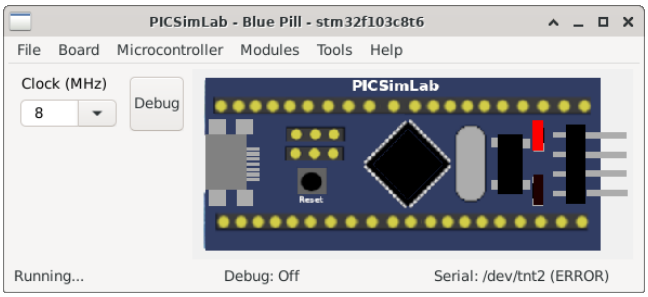
Chapter 5

Experimental Boards

Boards in the experimental phase. Probably with some bugs and missing features.

5.1 Blue Pill

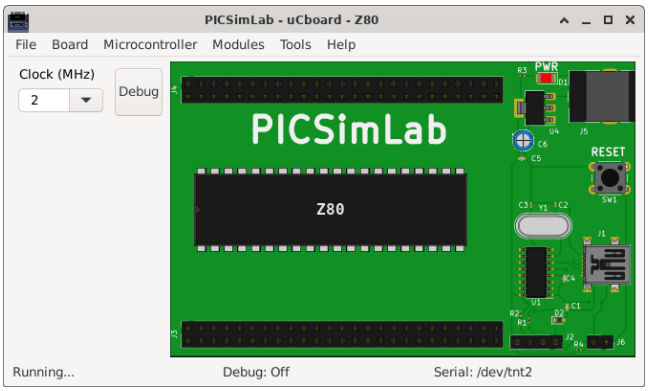
It is a generic board only with reset, serial and crystal circuits and support to stm32f103c8t6 microcontroller of qemu-stm32.



Examples

5.2 uCboard

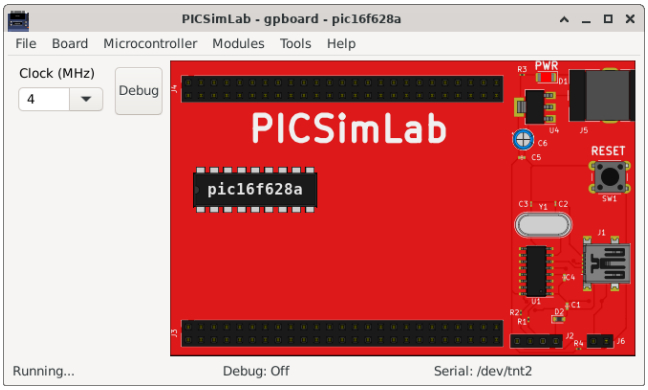
It is a generic board only with reset, serial and crystal circuits and support to multiple microcontrollers (initially C51, Z80 and STM8S103)of uCsim.



Examples

5.3 gpboard

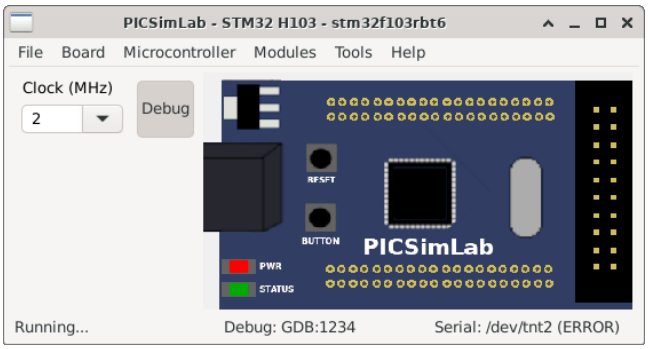
It is a generic board only with reset, serial and crystal circuits and support to multiple microcontrollers of gpsim.



Examples

5.4 STM32 H103

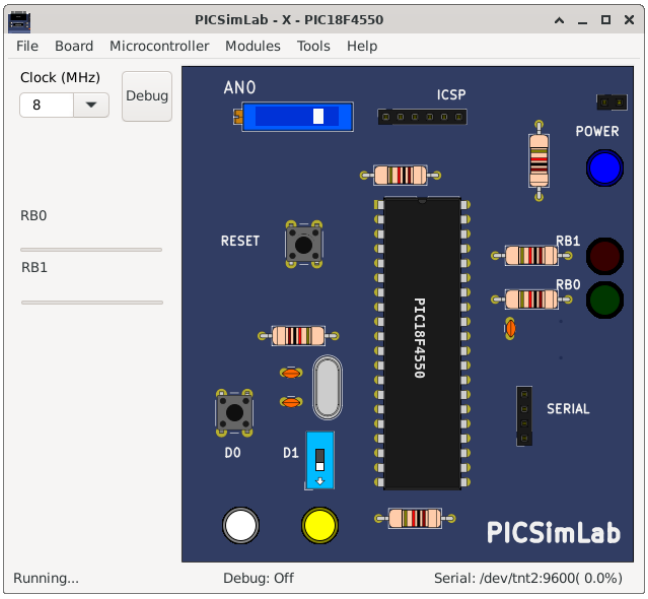
It is a generic board only with reset, one push button, serial and crystal circuits and support to stm32f103rbt6 microcontroller of qemu-stm32.



Examples

5.5 X

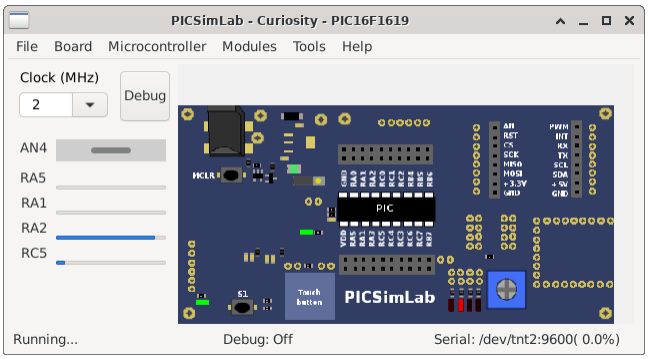
It is a generic board, used as example in How to Compile PICsimLab and Create New Boards.



Examples

5.6 Curiosity

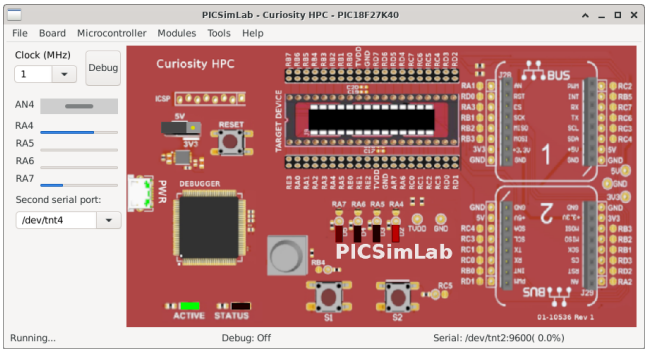
This is a simple PIC microcontroller development board that uses picsim.



Examples

5.7 Curiosity HPC

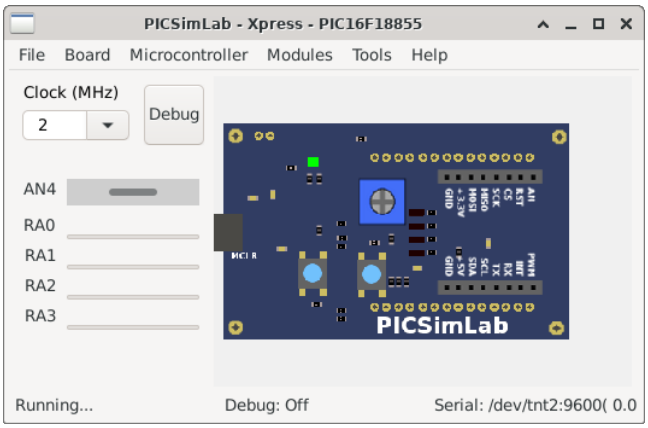
This is a simple PIC microcontroller development board that uses picsim.



Examples

5.8 Xpress

This is a simple PIC microcontroller development board that uses picsim.


PICSimLab - Xpress - PIC16F18855
File
Board
Microcontroller
Modules
Tools
Help
Clock (MHz)
2
Debug
AN4
RA0
RA1
RA2
RA3
PICSimLab
Running...
Debug: Off
Serial: /dev/tnt2:9600(0.0

Examples

Chapter 6

Serial Communication

To use the simulator serial port, install a NULL-MODEM emulator:

- Windows: com0com http://sourceforge.net/projects/com0com/
- Linux: tty0tty https://github.com/lcgamboa/tty0tty

For communication the PICSimLab should be connected in one port of the NULL-MODEM emulator and the other application connected in the other port. Configuration examples linking PICSimLab to Cutecom for serial communication:

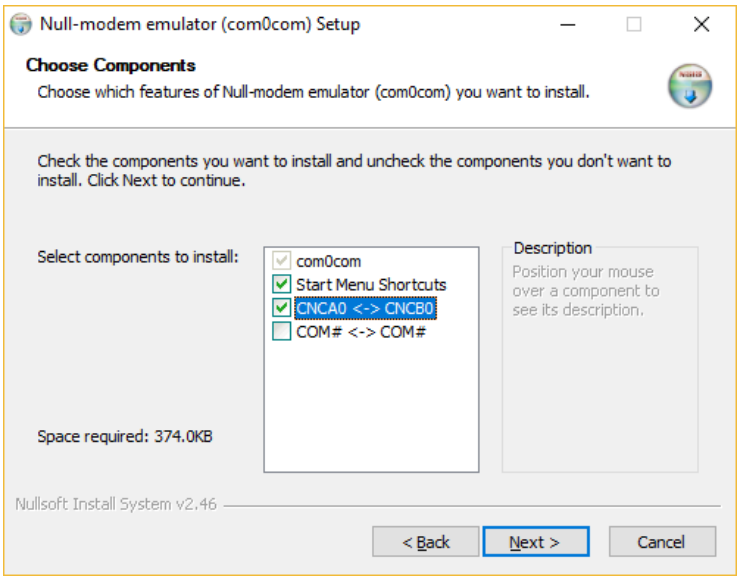
OS	PicsimLab port	Cutecom port	NULL-Modem prog.	Connection
Windows	com1	com2	com0com	com1<=>com2
Linux	/dev/tnt2	/dev/tnt3	tty0tty	/dev/tnt2<=>/dev/tnt3

6.1 Com0com Installation and Configuration(Windows)

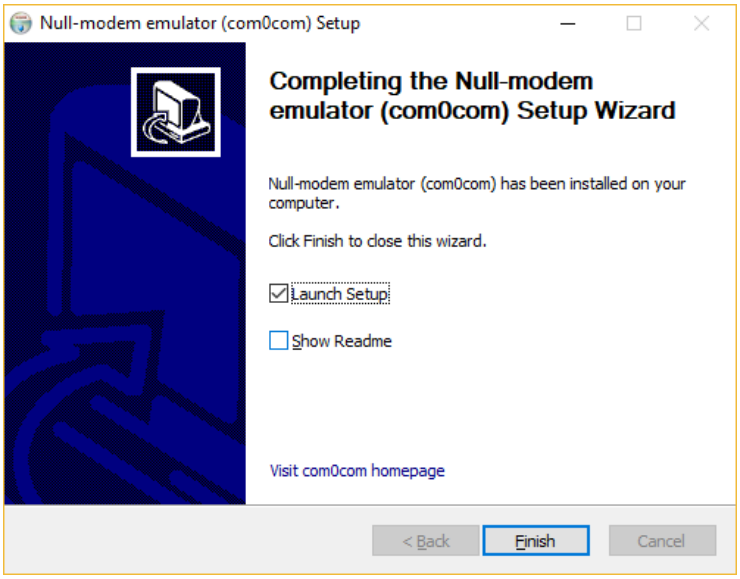
Download the signed version of com0com.

Unzip the downloaded .zip file and run the specific installer of your operating system, x86 for windows 32-bit or x64 for windows 64-bit.

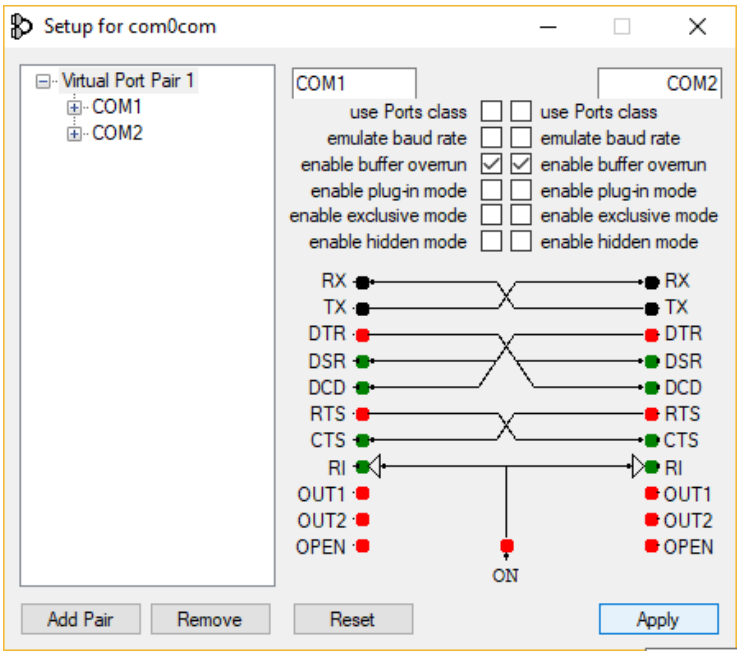
Configure the “choose components” window as the figure below:



In the last configuration window, check the "Launch setup" option:



In the setup window, change the port names to COM1, COM2, COM3 .... Just check the "enable buffer overrun" option on the two ports, click in the "Apply" button and close the setup. In the configuration shown in the figure below, the COM1 and COM2 ports form a NULL-MODEM connection, where one port must be used by the PICSimLab and another by the application with serial communication.



6.2 tty0tty Installation and Configuration (Linux)

Download the href https://github.com/lcgamboa/tty0tty/archive/master.zip tty0tyy. Unzip the downloaded folder.

Open a terminal and enter in the tty0tty/module/ folder and enter the following commands:

```
sudo apt-get update
sudo apt-get -y upgrade
sudo apt-get -y install gcc make linux-headers-`uname -r`
make
sudo make install
```

The user must be in the **dialout** group to access the ports. To add your user to **dialout** group use the command:

```
sudo usermod -a -G dialout your_user_name
```

after this is necessary logout and login to group permissions take effect.

Once installed, the module creates 8 interconnected ports as follows:

```
/dev/tnt0  <=>  /dev/tnt1
/dev/tnt2  <=>  /dev/tnt3
/dev/tnt4  <=>  /dev/tnt5
/dev/tnt6  <=>  /dev/tnt7
```

the connection between each pair is of the form:

```
TX   ->  RX
RX   <-  TX
RTS  ->  CTS
CTS  <-  RTS
DSR  <-  DTR
CD   <-  DTR
DTR  ->  DSR
DTR  ->  CD
```

Any pair of ports form a NULL-MODEM connection, where one port must be used by the PICSimLab and another by the application with serial communication.

Chapter 7

Debug Support

The type of debug interface depends on the backend simulator utilized.

7.1 MPLABX Integrated Debug (picsim and simavr)

To use the MPLABX IDE for debug and program the PicsimLab, install the plugin com-picsim-picsimlab.nbm in MPLABX.

The plugin connect to Picsimlab through a TCP socket using port 1234 (or other defined in configuration window), and you have to allow the access in the firewall.

Tutorial: how to use MPLABX to program and debug PICsimLab.

It's possible import and debug a Arduino sketch into MPLABX using the Arduino import plugin.

7.2 Arduino IDE Integration (simavr)

For integrated use with the Arduino IDE, simply configure the serial port as explained in the section 6 and load the Arduino bootloader. The bootloader can be loaded from the "Tools->Arduino bootloader" menu.

In Windows, considering com0com making a NULL-MODEM connection between COM1 and COM2, simply connect the PICSimLab on the COM1 port (defined in configuration window) and the Arduino IDE on the COM2 port or vice versa.

On Linux the operation is the same, but using for example the ports /dev/tnt2 and /dev/tnt3.

In Linux for the virtual ports to be detected in Arduino it is necessary to replace the library lib/liblistSerialsj.so of the Arduino with a version which support the detection of tty0tty ports, that can be downloaded in the link listSerialC with tty0tty support.

7.3 avr-gdb Debug (simavr)

With debug support enabled you can use avr-gdb to debug the code used in the simulator. Use the configuration window to choose between MDB (MPLABX) or GDB to debug AVR microcontrollers.

Use avr-gdb with the .elf file as the parameter:

```
avr-gdb compiled_file.elf
```

and the command below to connect (1234 is the default port):

```
target remote localhost:1234
```

Graphic debug mode can be made using eclipse IDE with Sloeber Arduino plugin.

7.4 arm-gdb Debug (qemu-stm32)

With debug support enabled you can use arm-none-eabi-gdb (or gdb-multiarch) to debug the code used in the simulator.

Use arm-none-eabi-gdb with the .elf file as the parameter:

```
arm-none-eabi-gdb compiled_file.elf
```

and the command below to connect (1234 is the default port):

```
target remote localhost:1234
```

Graphic debug mode can be made using eclipse IDE with Eclipse Embedded CDT.

7.5 uCsim Debug

The uCsim debug console can be accessed with the telnet (1234 is the default port):

```
telnet localhost 1234
```

All uCsim commands are supported.
For windows users putty telnet client is a good option to access the uCsim console.

Chapter 8

Tools

8.1 Serial Terminal

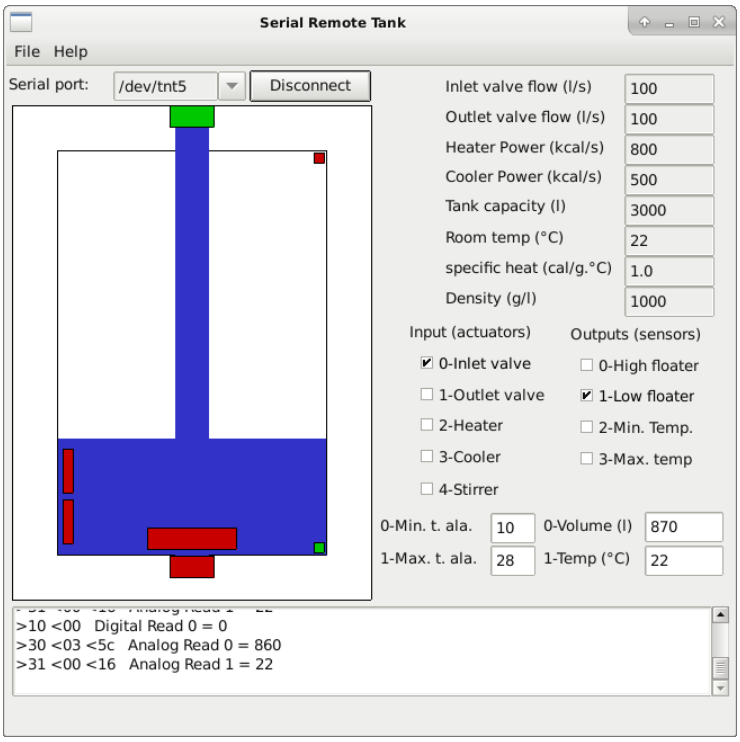
To use this tool with PICSimLab you first need to configure a virtual serial port as described in Chapter: Serial Communication. It is possible to use this tool with a real serial port connected to a real device.

Open the serial terminal Cutecom

8.2 Serial Remote Tank

To use this tool with PICSimLab you first need to configure a virtual serial port as described in Chapter: Serial Communication. It is possible to use this tool with a real serial port connected to a real device.

Serial Remote Tank



8.2.1 Sensors and Actuators

Actuators

Digital inputs

1. Inlet valve
2. Outlet valve
3. Heater
4. Cooler
5. Stirrer

Analog inputs

1. Minimal temperature alarm trigger level
2. Maximal temperature alarm trigger level

Sensors

Digital outputs

1. High floater
2. Low floater
3. Minimal temperature
4. Maximal temperature

Analog outputs

1. Volume
2. Temperature

8.2.2 Communication Protocol

Writing on Digital Input

Sent one byte in 0x0N hexadecimal format where N is the number of input followed by a second byte with value 0x00 for disable or 0x01 for enable.

Example to turn on the input 2:

```
Serial_write(0x02);
Serial_write(0x01);
```

Reading Digital Output

Sent one byte in 0x1N hexadecimal format where N is the number of output and read one byte. The byte readed have value 0x00 for disable or 0x01 for enable.

Example to read output 3:

```
Serial_write(0x13);
valor=Serial_read(0);
```

Writing on Analog Input

Sent one byte in 0x2N hexadecimal format where N is the number of input followed by two bytes with the 16 bits value.

Example to write the value 230 on analog input 1:

```
Serial_write(0x21);
valor=230;
Serial_write((valor&0xFF00)>>8);
Serial_write(valor&0x00FF);
```

Reading Analog Output

Sent one byte in 0x3N hexadecimal format where N is the number of output and read two bytes to form the 16 bits value.

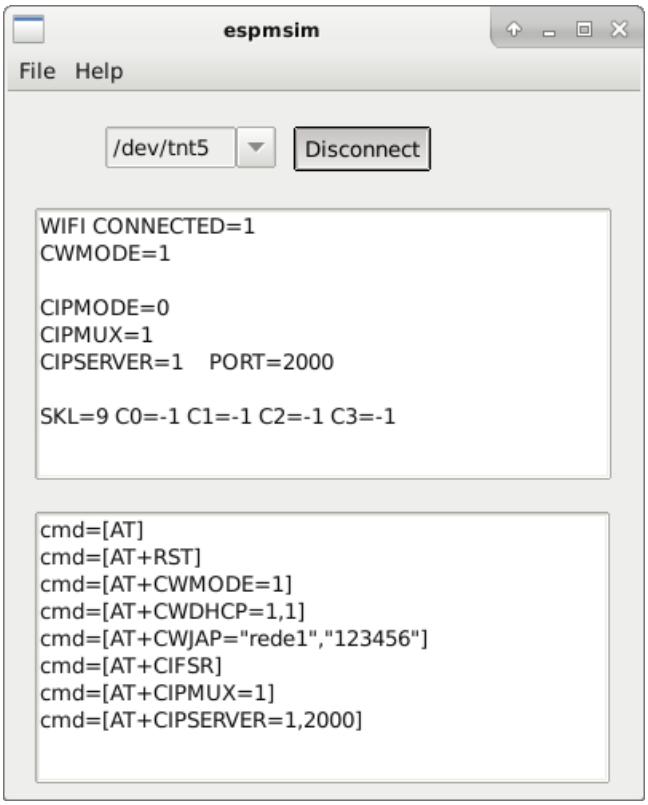
Example to read analog output 2:

```
Serial_write(0x32);
valorh=Serial_read(0);
valorl=Serial_read(0);
valor=(valorh<<8)|valorl;
```

8.3 Esp8266 Modem Simulator

To use this tool with PICSimLab you first need to configure a virtual serial port as described in Chapter: Serial Communication. It is possible to use this tool with a real serial port connected to a real device.

ESP8266 Modem Simulator



8.3.1 Supported Commands

- AT
- AT+RST
- AT+GMR
- AT+CWMODE=1
- AT+CWDHCP=1,1
- AT+CWLAP
- AT+CWJAP="rede1","123456"
- AT+CIFSR
- AT+CIPMUX=1
- AT+CIPSERVER=1,2000
- AT+CIPSEND=0,10
- AT+CIPCLOSE=0

8.4 Arduino Bootloader

To use this tool with PICSimLab you first need to configure a virtual serial port as described in Chapter: Serial Communication.

Load microcontroller with Arduino serial bootloader

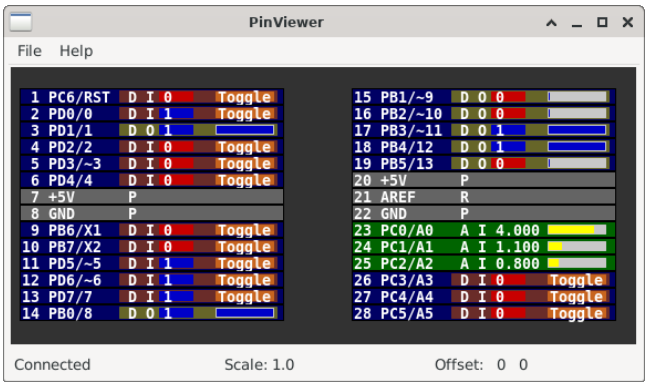
8.5 MPLABX Debugger Plugin

Open the web page to download the plugin

8.6 Pin Viewer

Open the Pin status viewer program.

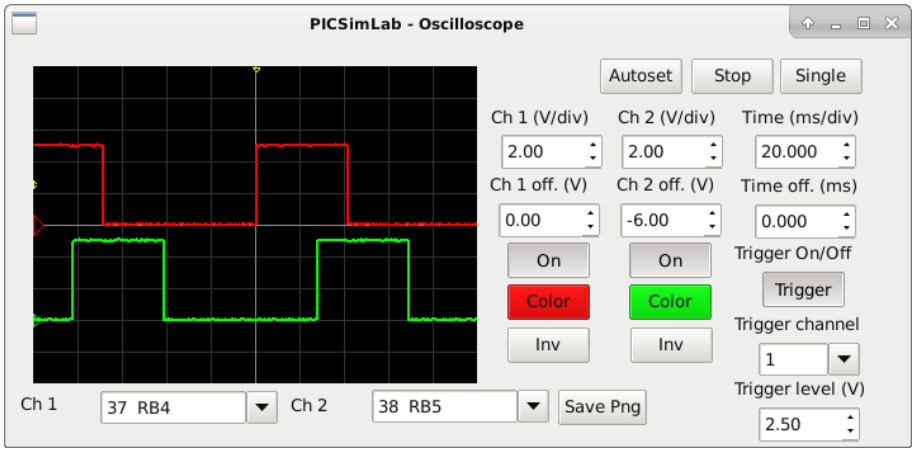
PinViewer connects to PICSimLab through the rcontrol interface and allows viewing the status and direction of all microcontroller pins. It is also possible to change the state of the digital pins and adjust the voltage value on the analog pins configured as input. Pins configured as outputs also show the average value, useful for evaluating the functioning of PWM outputs.


PinViewer
File Help
1 PC6/RST D I 0 Toggle
2 PD0/0 D I 1 Toggle
3 PD1/1 D O 1
4 PD2/2 D I 0 Toggle
5 PD3/~3 D I 0 Toggle
6 PD4/4 D I 0 Toggle
7 +5V P
8 GND P
9 PB6/X1 D I 0 Toggle
10 PB7/X2 D I 0 Toggle
11 PD5/~5 D I 1 Toggle
12 PD6/~6 D I 1 Toggle
13 PD7/7 D I 1 Toggle
14 PB0/8 D O 1
15 PB1/~9 D O 0
16 PB2/~10 D O 0
17 PB3/~11 D O 1
18 PB4/12 D O 1
19 PB5/13 D O 0
20 +5V P
21 AREF R
22 GND P
23 PC0/A0 A I 4.000
24 PC1/A1 A I 1.100
25 PC2/A2 A I 0.800
26 PC3/A3 D I 0 Toggle
27 PC4/A4 D I 0 Toggle
28 PC5/A5 D I 0 Toggle
Connected
Scale: 1.0
Offset: 0 0

Chapter 9

Oscilloscope

The PICSimLab has a basic two-channel oscilloscope that can be used to view the signal on any pin of the microcontroller. The oscilloscope can be accessed through the "Modules->Oscilloscope" menu.



Chapter 10

Spare Parts

The PICSimLab has a window that allows the connection of spare parts to the microcontroller, it can be accessed through the menu " Modules-> Spare parts ".

The main window has the menu with the following functions:

- File
  - New configuration - Clear the spare parts window
  - Save configuration - Saves the current settings of the spare parts into .pcf file
  - Load configuration - Loads the settings from .pcf file
  - Save pin alias - Saves the current pin alias to .ppa text file
  - Load pin alias - Loads the pin alias from .ppa file
- Edit
  - Clear pin alias - Clear the pin alias
  - Toggle pin alias - Enable/Disable pin alias use
  - Edit pin alias - Open current pin alias .ppa file in text editor
  - Reload pin alias - Reload the current .ppa pin alias file (need after edit .ppa file)
  - Zoom in - Increase draw scale
  - Zoom out - Decrease draw scale
- Inputs
  - Encoder - Adds a rotary quadrature encoder with push button
  - Gamepad - Adds a gamepad
  - Gamepad (Analogic) - Adds a gamepad with one analogic output
  - Keypad - Adds one matrix keypad

  - LM35 - Adds a analog temperature sensor
  - MPU6050 - Adds a accelerometer and gyroscope (only raw values)
  - Potentiometers - Adds 4 potentiometers
  - Potentiometers (Rotary) - Adds 4 rotary potentiometers
  - Push Buttons - Adds 8 push buttons
  - Push Buttons (Analogic) - Adds 8 push buttons with analog output
  - Switchs - Adds eight switchs
  - Ultrasonic HC-SR04 - Adds a ultrasonic range sensor
- Outputs
  - 7 Segments Display - Adds four multiplexed 7 segments displays
  - 7 Segments Display (w/dec) - Adds four multiplexed 7 segments displays with decoder
  - Buzzer - Adds a active/passive buzzer
  - DC Motor - Adds a DC motor with H-bridge and quadrature encoder
  - LCD hd44780 - Adds a text display hd44780
  - LCD ili9340 - Adds a color graphic display ili9340 with touchscreen
  - LCD pcd8544 - Adds a monochrome graphic display pcd8544 (Nokia 5110)
  - LCD pcf8833 - Adds a color graphic display pcf8833
  - LCD ssd1306 - Adds a monochrome graphic display ssd1306
  - LED Matrix - Adds a 8x8 LED matrix with MAX72xx controller
  - LEDs - Adds 8 red LEDs
  - RGB LED - Adds one RGB LED
  - Servo Motor - Adds a servo motor
  - Step Motor - Adds a step motor
- Others
  - ETH w5500 - Adds a ethernet shield w5500
  - IO 74xx595 - Adds a 74xx595 SIPO 8 bit shift register
  - IO MCP23S17 - Adds a MCP23S17 serial SPI IO expander
  - IO PCF8574 - Adds a PCF8574 serial I2C IO expander
  - IO UART - Adds a UART serial port
  - Jumper Wires - Adds sixteen jumper wires
  - MEM 24CXXX - Adds a 24CXXX serial I2C EEPROM memory
  - RTC ds1307 - Adds a ds1307 real time clock
  - RTC pfc8563 - Adds a pfc8563 real time clock

  - SD Card - Adds a SD card shield
  - Temperature System - Adds a temperature control system

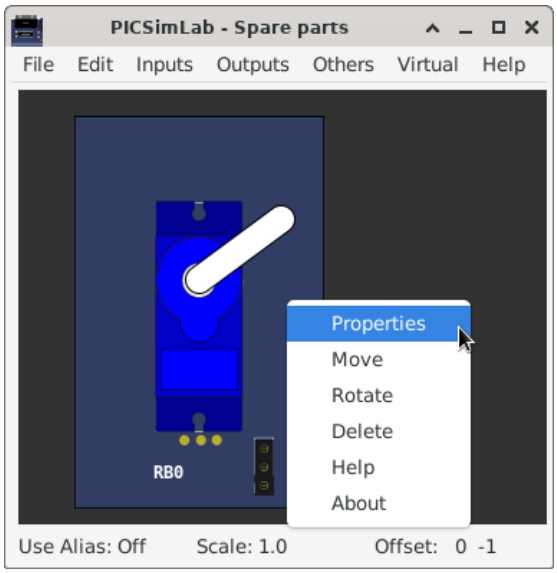
- Virtual
  - D. Transfer Function - Adds a discrete transfer function mathematical model
  - IO Virtual term - Adds a virtual serial terminal
  - Signal Generator - Adds a virtual signal generator
  - VCD Dump - Adds a digital value file dump recorder
  - VCD Dump (Analogic) - Adds a analog value file dump recorder
  - VCD Play - Adds a digital value file dump player

- Help
  - Contents - Open Help window
  - About - Show message about author and version

After adding the part, with a right click of the mouse you can access the options menu of the part with the options:

- Properties - Opens the connection settings window
- Move - Unlocks the part to move
- Rotate - Change the orientation of part

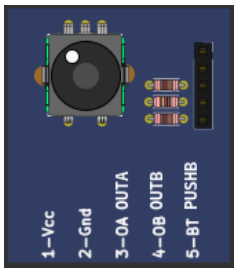
- Delete - Remove part
- Help - Open Help window of part
- About - Show message about author and version of part



10.1 Inputs

10.1.1 Encoder

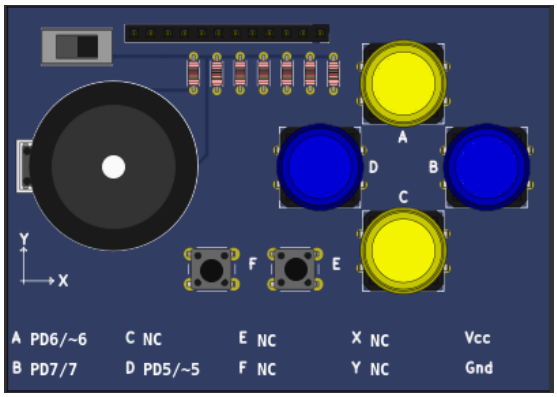
This part is a rotary quadrature encoder with push button. The output is twenty pulses per revolution.

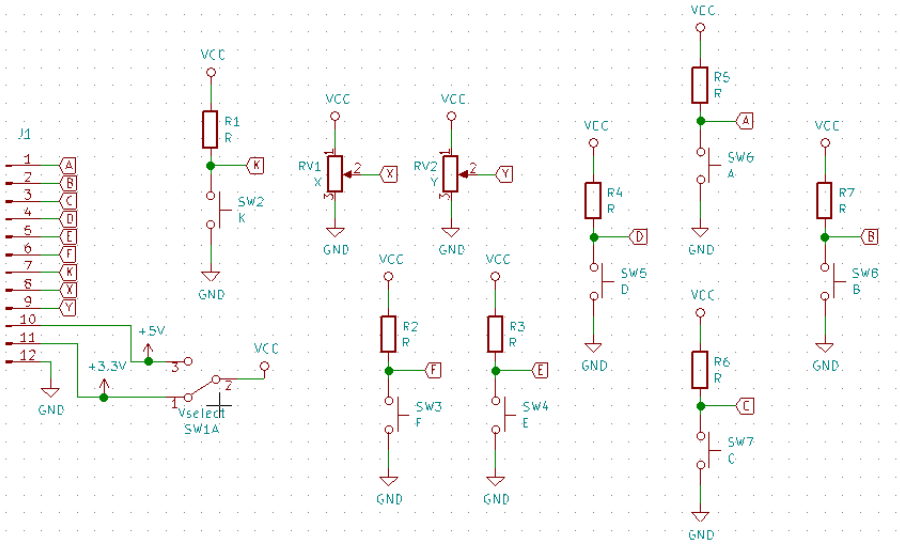


Examples

10.1.2 Gamepad

This part is a gamepad with two analog axis and 7 push buttons.





The gamepad can be controlled by keyboards keys:

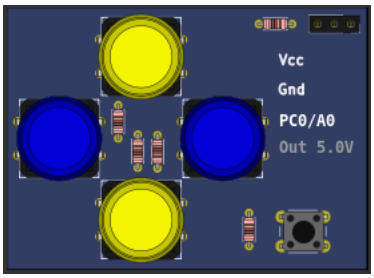
- X axis - keys 'A' and 'D'
- Y axis - keys 'W' and 'S'
- Button A - key 'I'
- Button B - key 'L'
- Button C - key 'K'

- Button D - key ’J’
- Button E - key ’E’
- Button F - key ’O’
- Button K - key ’R’

Examples

10.1.3 Gamepad Analogic

This part is a gamepad with 5 push buttons and one analogic output.



The gamepad can be controlled by keyboards keys:

- Button A - key ’L’
- Button B - key ’I’
- Button C - key ’K’
- Button D - key ’J’
- Button E - key ’O’

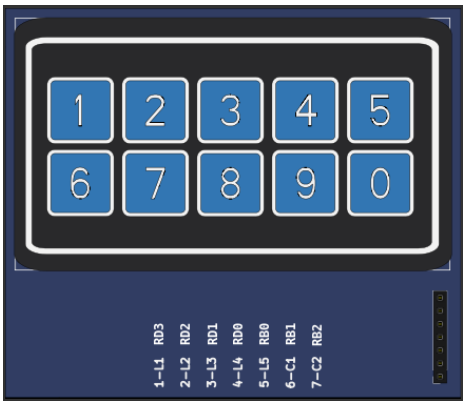
Examples

10.1.4 Keypad

It is a matrix keyboard configurable to 4x3 , 4x4 or 2x5 rows/columns.


1
2
3
4
5
6
7
8
9
*
0
#
1-L1 RD3
2-L2 RD2
3-L3 RD1
4-L4 RD0
5-C1 RB0
6-C2 RB1
7-C3 RB2

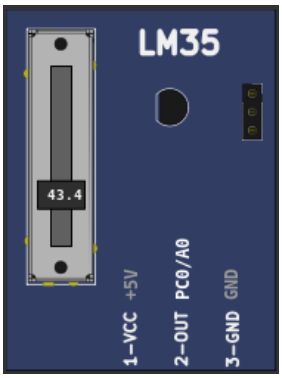

1
2
3
A
4
5
6
B
7
8
9
C
*
0
#
D
1-L1 RD3
2-L2 RD2
3-L3 RD1
4-L4 RD0
5-C1 RB0
6-C2 RB1
7-C3 RB2
8-C4 RB3



Examples

10.1.5 LM35

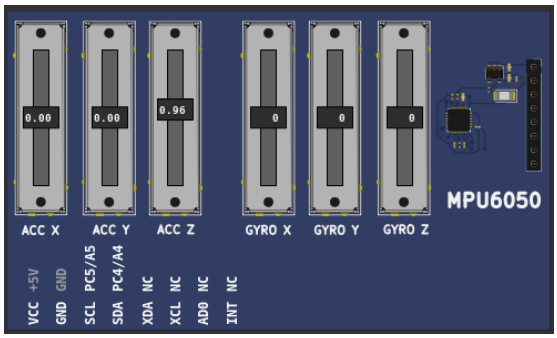
This part is LM35 analog temperature sensor. The voltage output is 10mV/C.



Examples

10.1.6 MPU6050

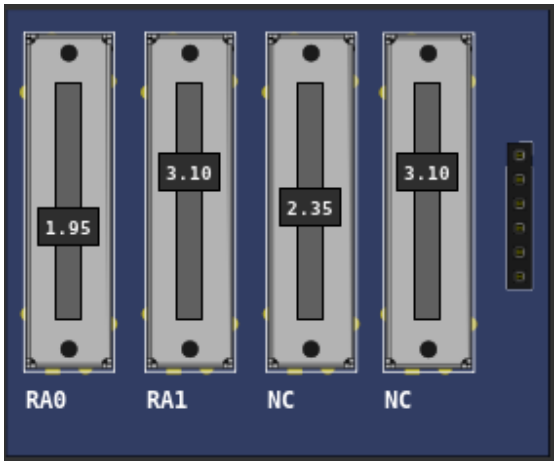
This part is MPU6050 accelerometer and gyroscope with I2C interface. Only raw values are available, DMP is not supported.

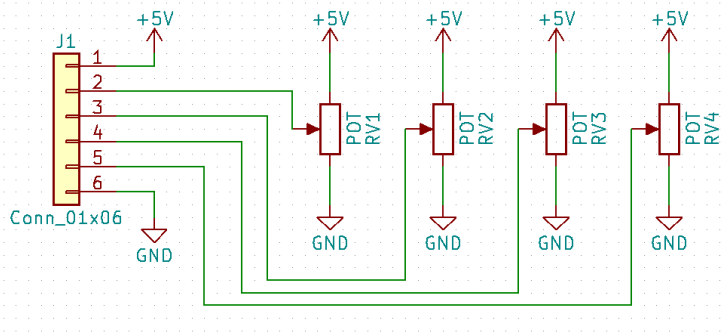


Examples

10.1.7 Potentiometers

This part is formed by 4 potentiometers connected between 0 and 5 volts, the output is connected to the cursor and varies within this voltage range.

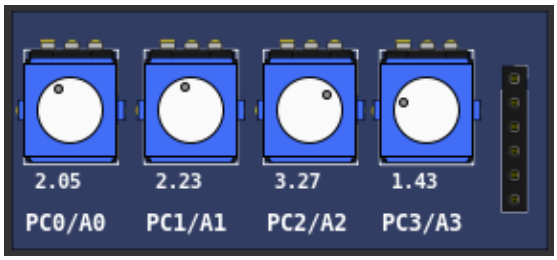


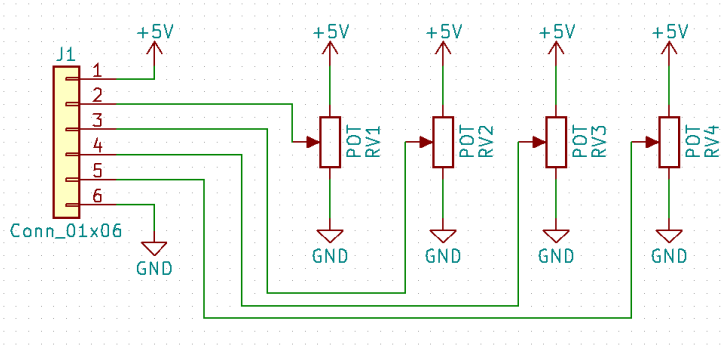


Examples

10.1.8 Potentiometers (Rotary)

This part is formed by 4 rotary potentiometers connected between 0 and 5 volts, the output is connected to the cursor and varies within this voltage range.

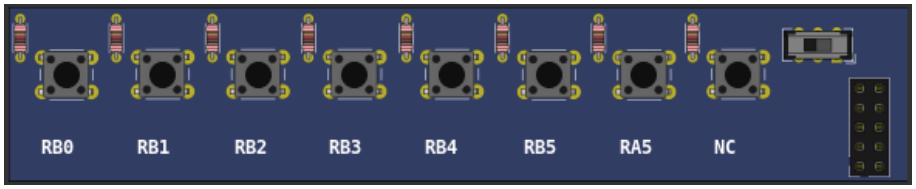


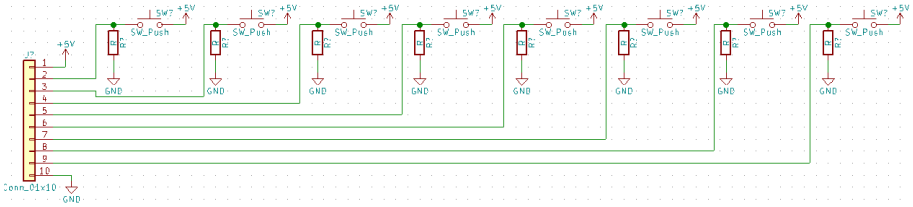


Examples

10.1.9 Push Buttons

This part consists of 8 push buttons. The output active state can be configurable.

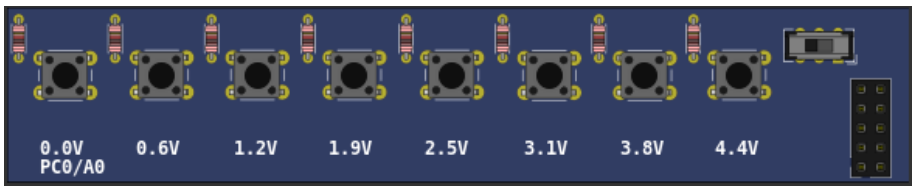




Examples

10.1.10 Push Buttons (Analogic)

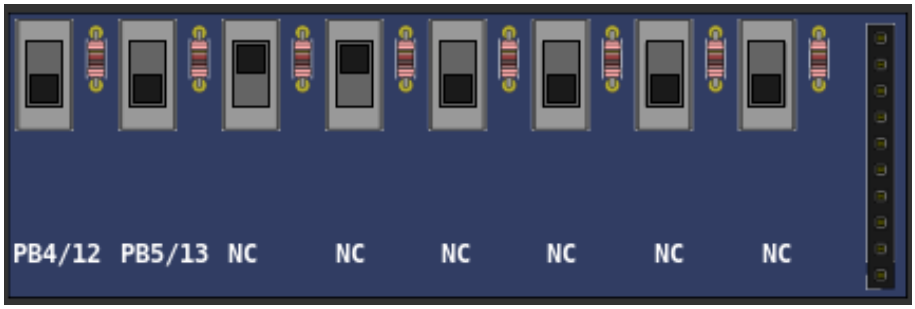
This part consists of 8 push buttons connected in a resistive ladder.

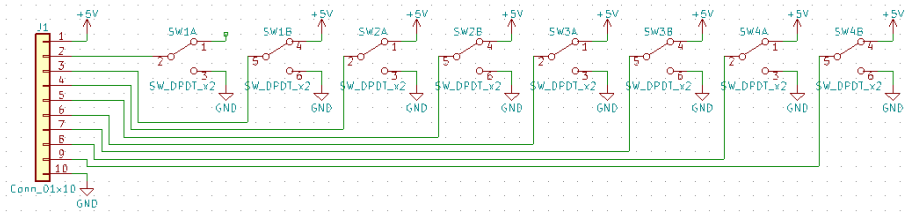


Examples

10.1.11 Switchs

This part consists of 8 keys with on or off position (0 or 1).





Examples

10.1.12 Ultrasonic HC-SR04

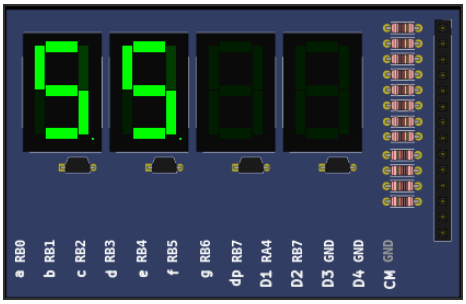
This part is ultrasonic range meter sensor.

Examples

10.2 Outputs

10.2.1 7 Segments Display

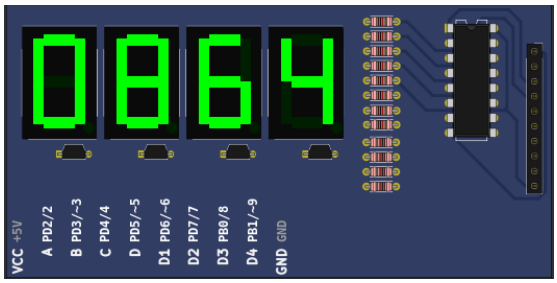
This is a four multiplexed 7 segments displays.

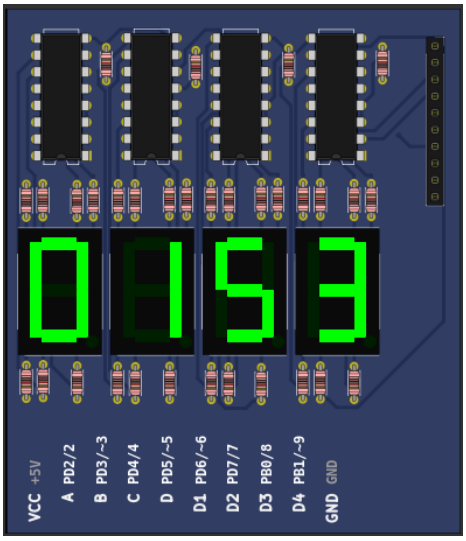


Examples

10.2.2 7 Segments Display (Decoder)

This is a four multiplexed 7 segments displays with BCD to 7 segments decoder (CD4511).





Examples

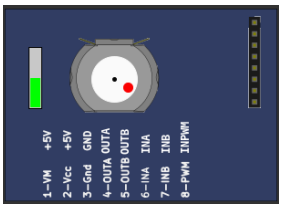
10.2.3 Buzzer

This is a active/passive buzzer.

Examples

10.2.4 DC Motor

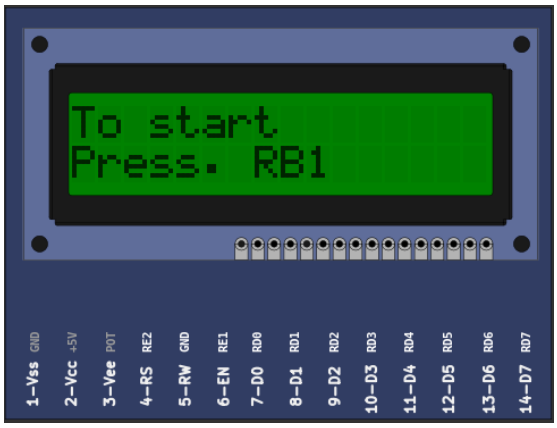
This part is DC motor with H-bridge driver and quadrature encoder.

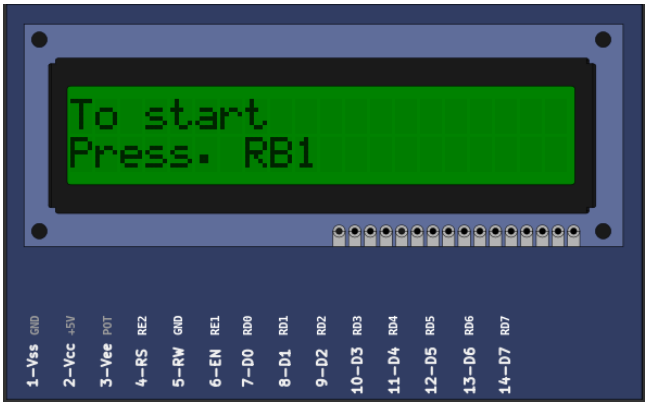


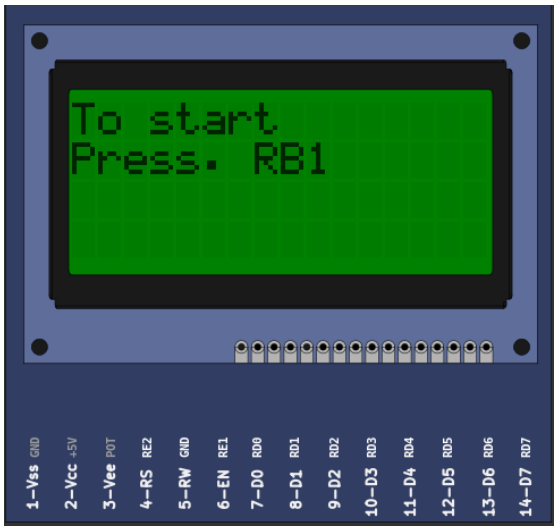
Examples

10.2.5 LCD hd44780

This part is a text display with 2 (or 4) lines by 16 (or 20) columns.



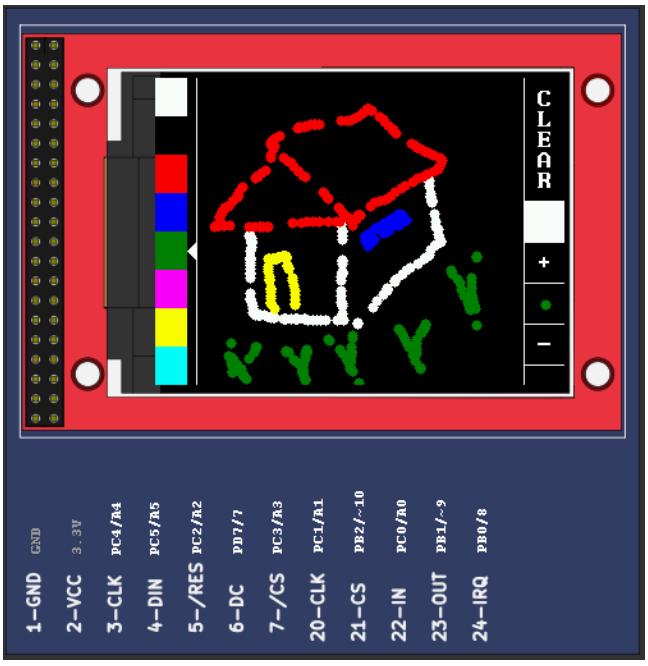




Examples

10.2.6 LCD ili9341

This part is a color graphic display with 240x320 pixels with touchscreen (xpt2046 controller). Only 4 SPI mode and 8 bits parallel mode is avaliable.



Examples

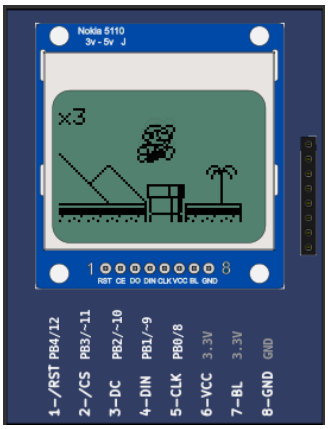
10.2.7 LCD pcf8833

This part is a color graphic display with 132x132 pixels.

Examples

10.2.8 LCD pcd8544

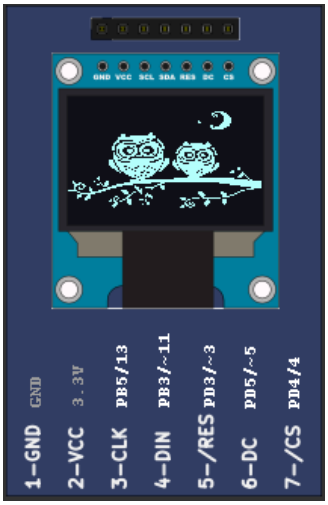
This part is a monochrome graphic display with 48x84 pixels. (Nokia 5110)



Examples

10.2.9 LCD ssd1306

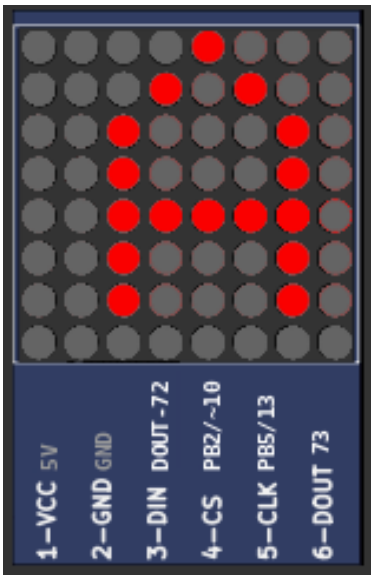
This part is a monochrome oled graphic display with 128x64 pixels. The part suport I2C and 4 SPI serial mode.



Examples

10.2.10 LED Matrix

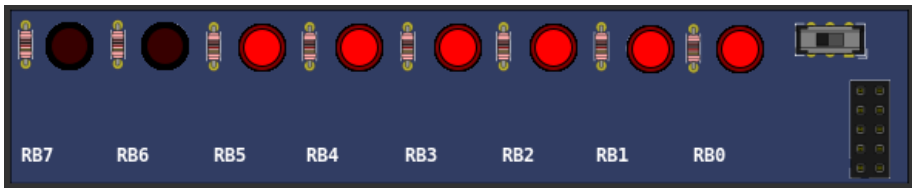
It is a 8x8 LED matrix with MAX72xx controller.

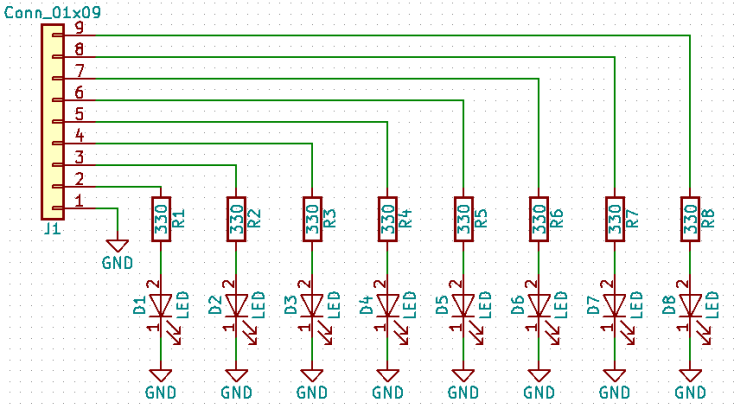


Examples

10.2.11 LEDs

This part is a bar of 8 independent red LEDs.

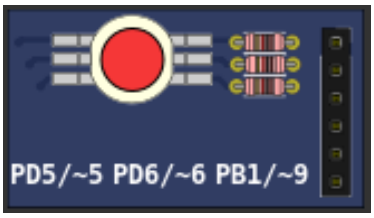


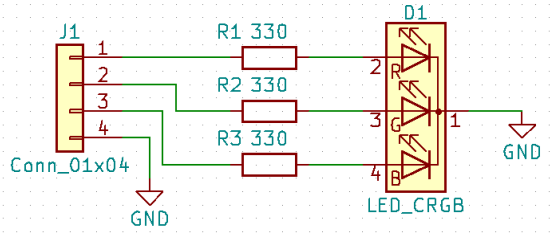


Examples

10.2.12 RGB LED

This part consists of a 4-pin RGB LED. Each color can be triggered independently. Using PWM it is possible to generate several colors by combining the 3 primary colors.

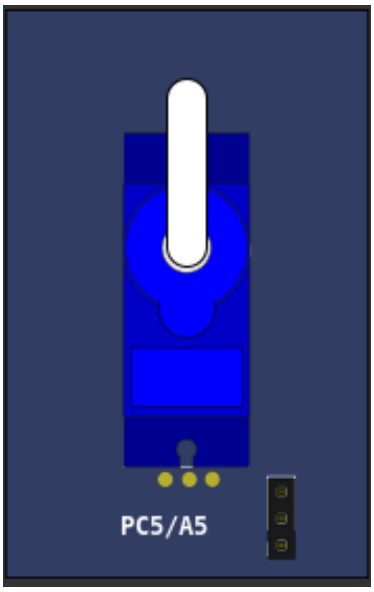


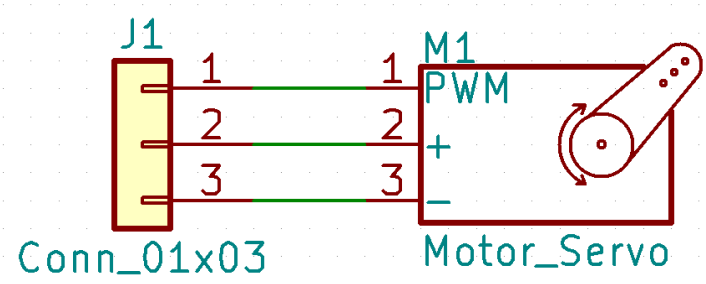


Examples

10.2.13 Servo Motor

The servo motor is a component that must be activated with a pulse of variable width from 1ms to 2ms every 20 ms. A pulse of 1ms positions the servo at -90º, one from 1.5ms to 0º and one from 2ms to 90º.

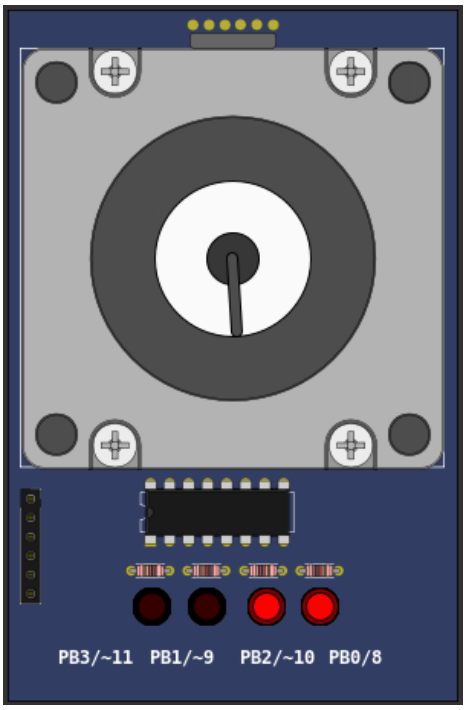


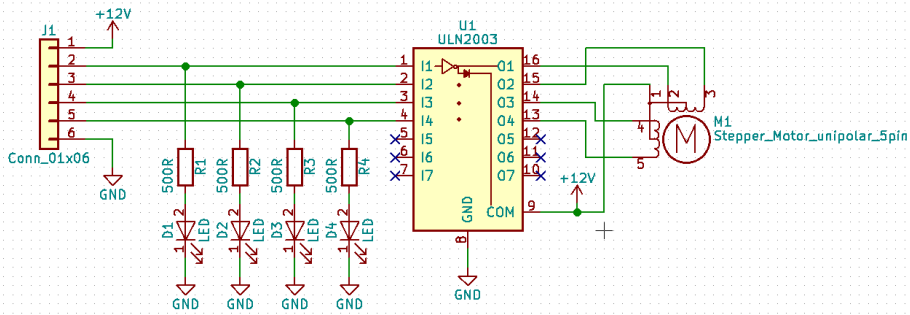


Examples

10.2.14 Step Motor

The stepper motor is a component with 4 coils that must be driven in the correct order to rotate the rotor. Each step of the motor is 1.8º.





Examples

10.3 Others

10.3.1 ETH w5500

This part is a ethernet shield w5500 with support to 8 sockets simultaneously.

Only TCP/UDP unicast address sockets is supported. DHCP is emulated and return a fake ipv4 address.

All listening ports below 2000 are increased by 2000 to avoid operational system services ports. For example listening on port 80 becomes 2080.

w5500 Status Legend:

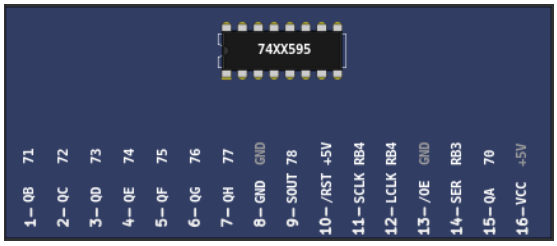
1º Letter - Type	2º Letter - Status	3º Letter - Error
C - Closed	C - Closed	B - Bind
T - TCP	I - Initialized	S - Send
U - UDP	L - Listen	R - Receive
M - MACRAW (don't supported)	S - Syn sent	L - Listen
	E - Established	U - Reuse
	W - Close wait	C - Connecting
	U - UDP	D - Shutdown
	M - MACRAW (don't supported)	

Click on connector to toggle link status.

Examples

10.3.2 IO 74xx595

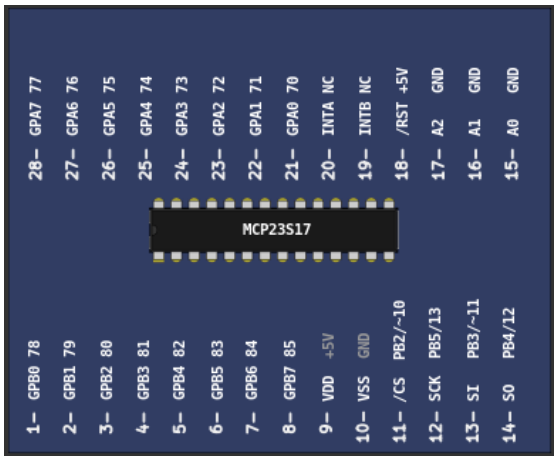
This is one 74xx595 serial input and parallel output 8 bit shift register.



Examples

10.3.3 IO MCP23S17

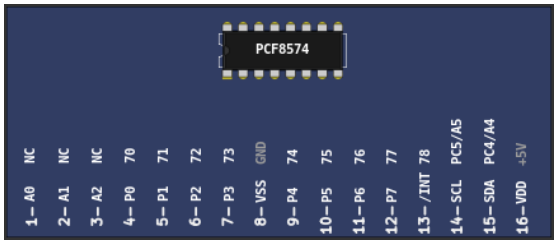
It is a MCP23S17 serial SPI IO expander part.



Examples

10.3.4 IO PCF8574

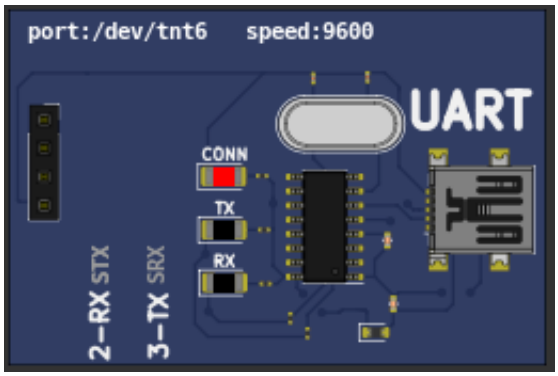
It is a PCF8574 serial I2C IO expander.



Examples

10.3.5 IO UART

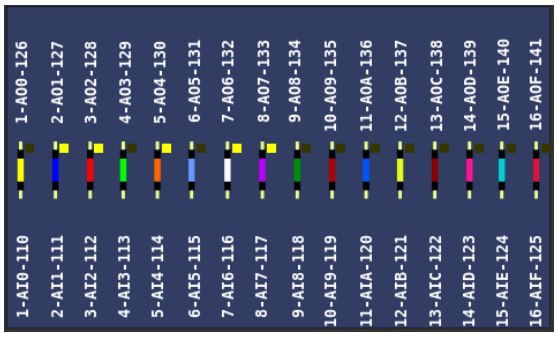
This part is a UART serial port. This part connects the hardware/software UART IO pins of microcontroller to one real/virtual PC serial port. To use virtual port is need to install a virtual port software, as described in 6.



Examples

10.3.6 Jumper Wires

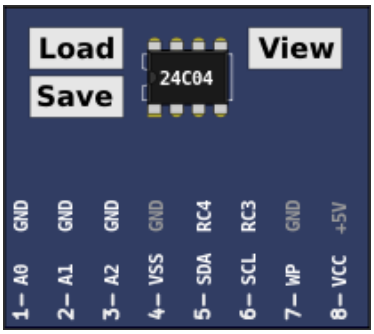
This part are formed by sixteen jumper wires. Each jumper has one input and one output. The jumper input must be connected to one pin output, the jumper output can be connected to multiple pin inputs. The jumper can be used to connect microcontroller pins or make connection between spare parts pins.



Examples

10.3.7 MEM 24CXXX

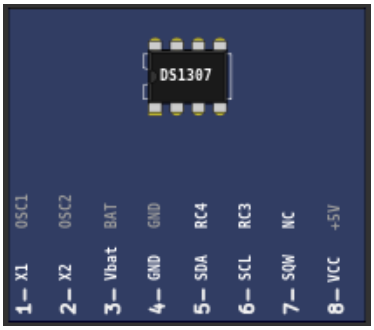
It is a 24CXXX serial I2C EEPROM part. There are support to the models 24C04 and 24C512.



Examples

10.3.8 RTC ds1307

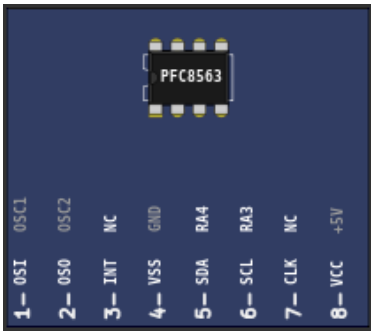
This part is a ds1307 real time clock with serial I2C interface.



Examples

10.3.9 RTC pfc8563

This part is a pfc8563 real time clock with serial I2C interface.



Examples

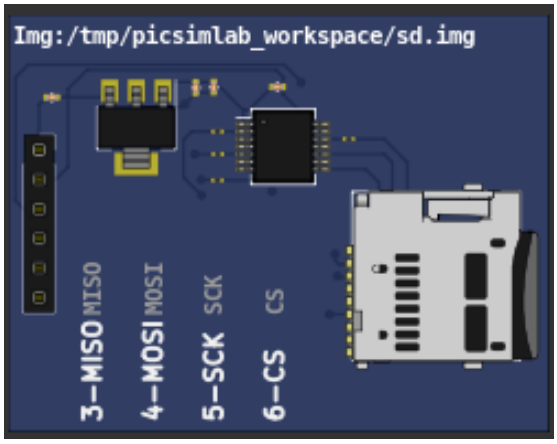
10.3.10 SD Card

This part is a SD Card shield. It's necessary set one sd card file image before use it. (Click on SD card connector to open file dialog)

On Linux one empty image can be created with this command:

```
dd if=/dev/zero of=sd.img bs=1M count=32
```

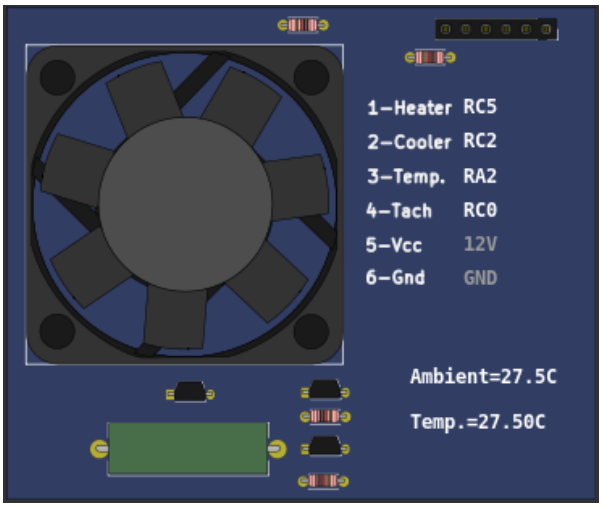
This empty image can be used with raw sd card access, to work with FAT file system the image need to be formatted before the use. (using SdFormatter.ino for example)



Examples

10.3.11 Temperature System

This part is a temperature control system. The temperature control system consists of a heating resistor, an LM35 temperature sensor, a cooler and an infrared tachometer.

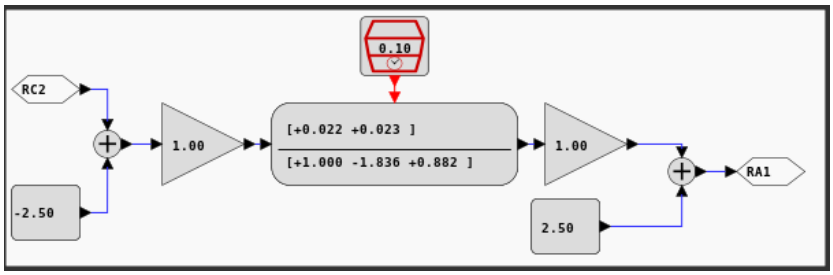


Examples

10.4 Virtual

10.4.1 D. Transfer Function

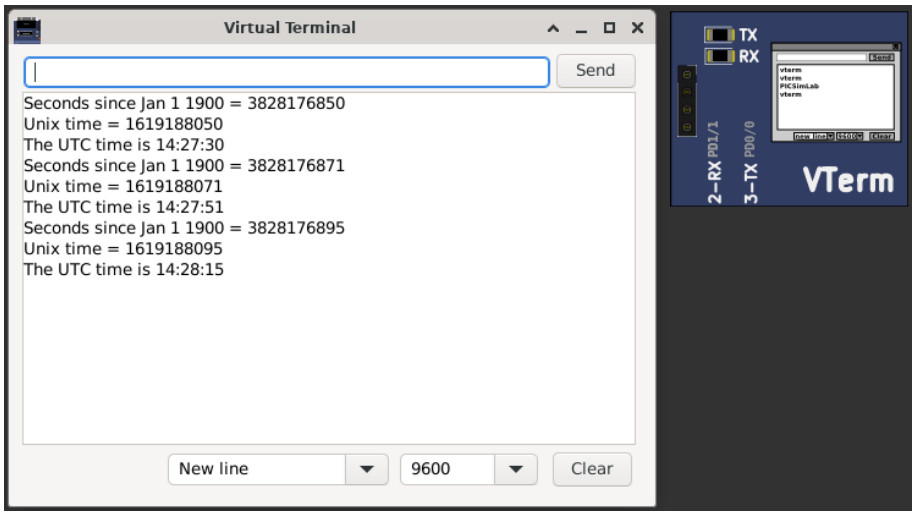
This is a discrete transfer function mathematical model.



Examples

10.4.2 IO Virtual Term

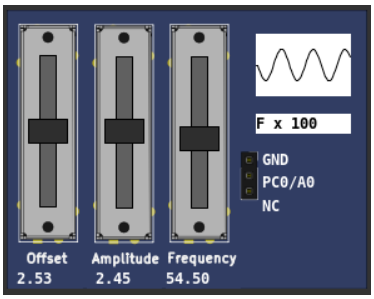
This part is a virtual serial terminal. This part can be used to read and write RX/TX pins UART signals. This part don't need the use or install of virtual serial ports on computer. Clik on terminal picture to open the terminal window.



Examples

10.4.3 Signal Generator

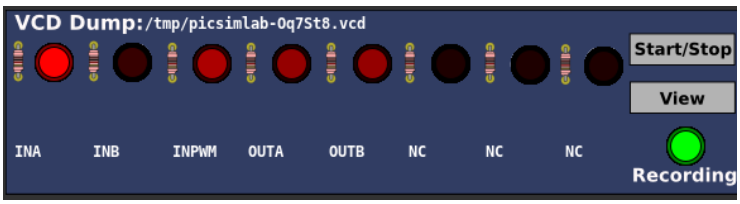
This part is a virtual signal generator with support for sine, square and triangular waves generation with amplitude and frequency adjustment.

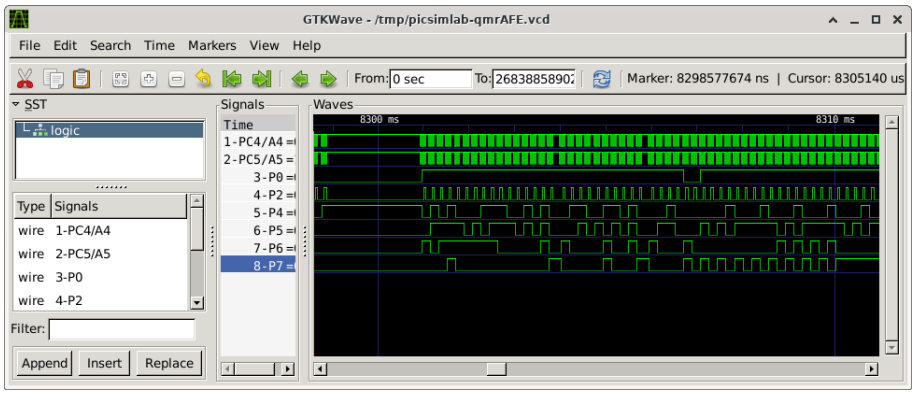


Examples

10.4.4 VCD Dump

This part is a digital value file dump recorder. The file can be visualized with gtkwave.

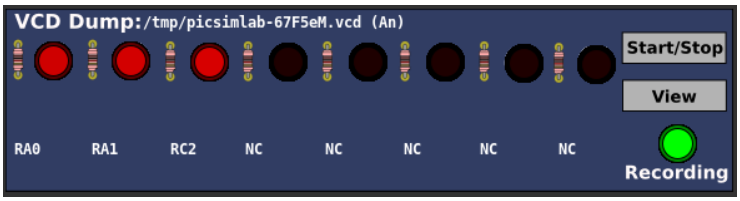


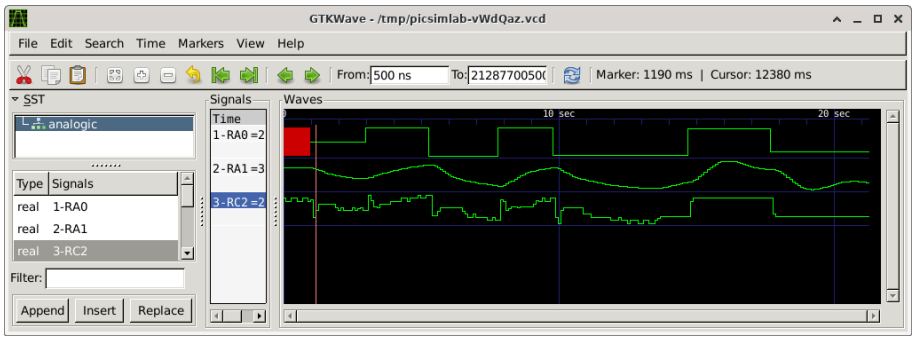


Examples

10.4.5 VCD Dump (Analogic)

This part is a analog value file dump recorder. The file can be visualized with gtkwave.

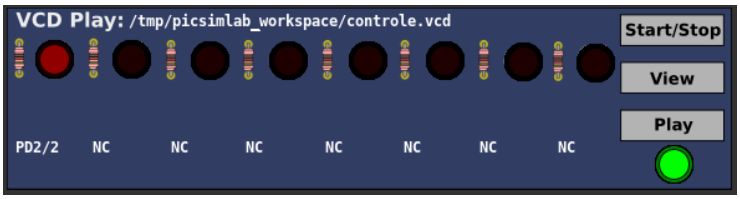




Examples

10.4.6 VCD Play

This part play a VCD file saved from VCD Dump part.


VCD Play: /tmp/picsimlab_workspace/controle.vcd
Start/Stop
View
Play
PD2/2
NC
NC
NC
NC
NC
NC
NC

Examples

Chapter 11

Troubleshooting

The simulation in PICSimLab consists of 3 parts:

- The microcontroller program
- Microcontroller simulation (made by [picsim](https://github.com/lcgamboa/picsim) and [simavr](https://github.com/buserror/simavr))
- Simulation of boards and parts

When a problem occurs it is important to detect where it is occurring.

One of the most common problems is the error in the microcontroller program. Before creating an issue, test your code on a real circuit (even partially) to make sure the problem is not there.

Errors in the microcontroller simulation can be detected using code debugging. Any instruction execution or peripheral behavior outside the expected should be reported in the project of simulator used ([picsim](https://github.com/lcgamboa/picsim) or [simavr](https://github.com/buserror/simavr)).

If the problem is not in either of the previous two options, the problem is probably in PICSimLab. A good practice is to send a source code together with a PICSimLab workspace (.pzw file) to open the issue about the problem.

Chapter 12

Use with MPLABX

Use with MPLABX to program and Debug

12.1 Installing the Necessary Tools

12.1.1 Install MPLABX IDE and XC8 Compiler

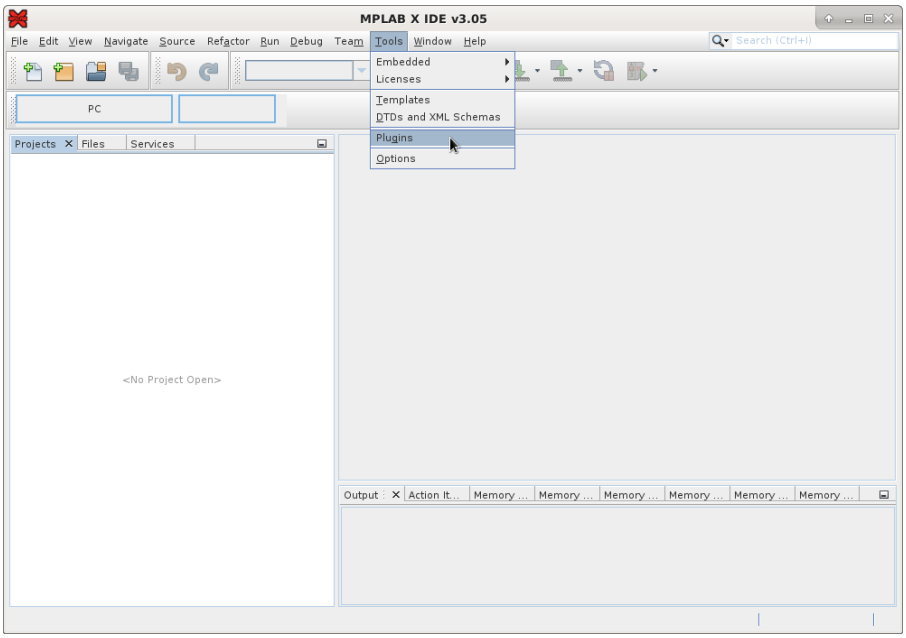
Links for download MPLABX IDE and XC8 Compiler installers. Download and install.

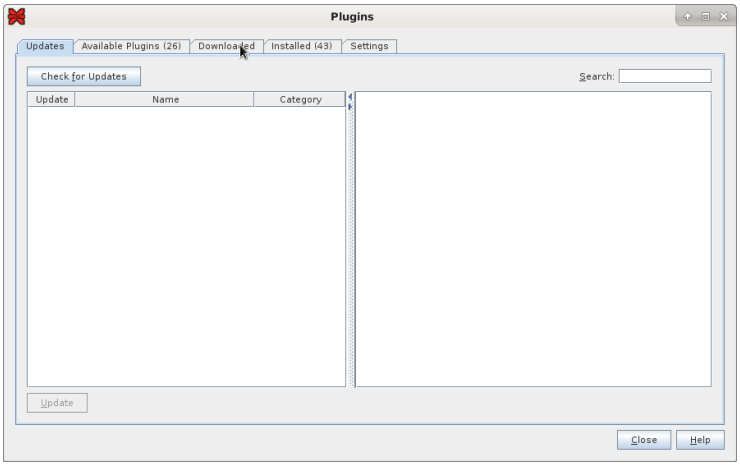
12.1.2 Install PICsimLab

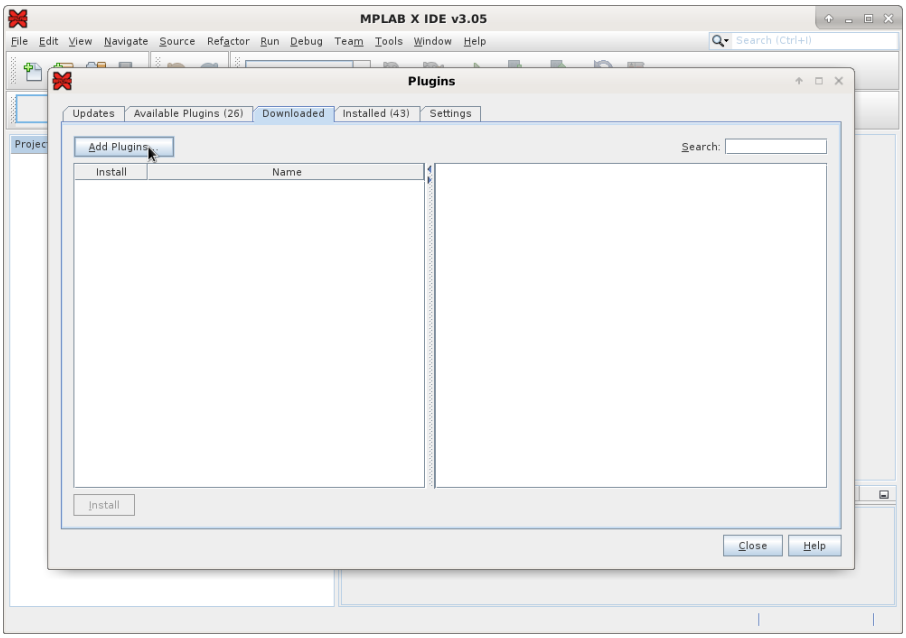
Link for download PICsimLab-0.6 installer. Download and install

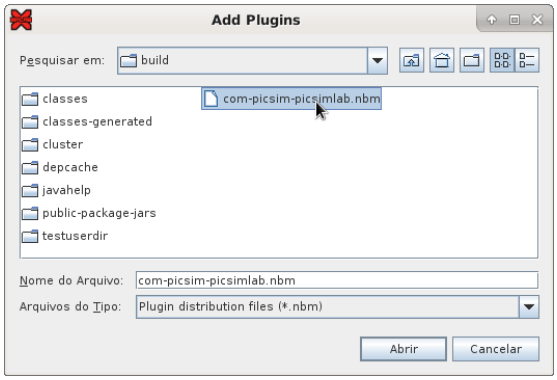
12.1.3 How to Install PicsimLab MPLABX Debugger plugin

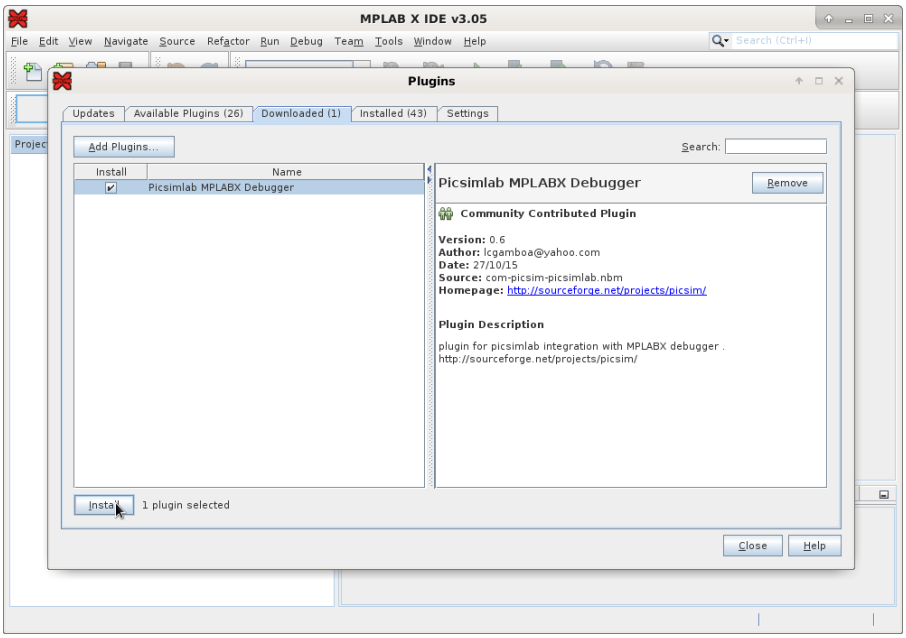
Link for download PicsimLab MPLABX Debugger plugin (com-picsim-picsimlab.nbm)

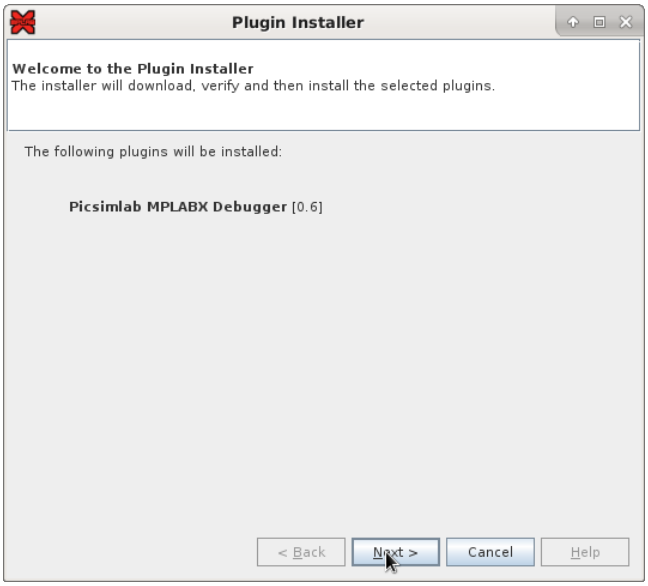

MPLAB X IDE v3.05
File Edit View Navigate Source Refactor Run Debug Team Tools Window Help
Search (Ctrl+I)
Embedded
Licenses
Templates
DTDs and XML Schemas
Plugins
Options
PC
Projects
Files
Services
<No Project Open>
Output
Action It...
Memory ...

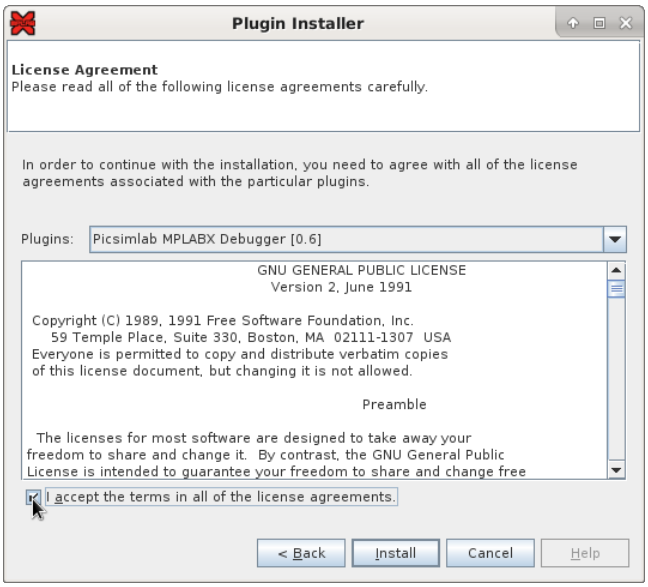

Plugins
Updates
Available Plugins (26)
Downloaded
Installed (43)
Settings
Check for Updates
Search:
Update
Name
Category
Update
Close
Help


MPLAB X IDE v3.05
File Edit View Navigate Source Refactor Run Debug Team Tools Window Help
Search (Ctrl+I)
Plugins
Updates
Available Plugins (26)
Downloaded
Installed (43)
Settings
Add Plugins...
Search:
Install
Name
Install
Close
Help

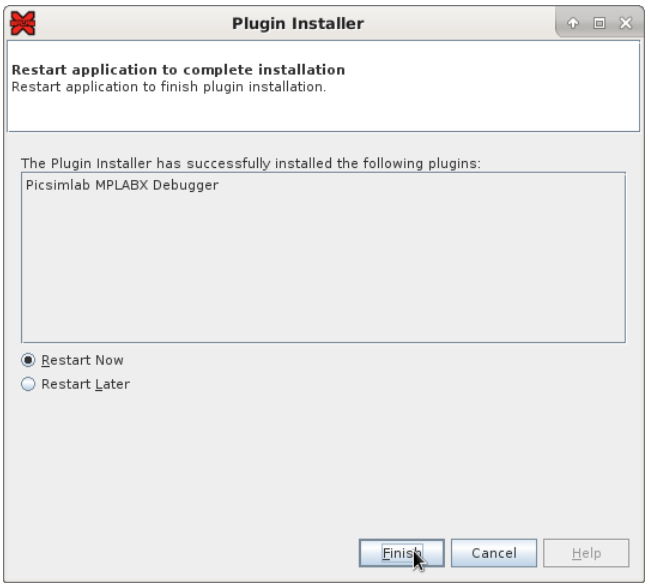

Add Plugins
Pesquisar em:
build
classes
classes-generated
cluster
depcache
javahelp
public-package-jars
testuserdir
com-picsim-picsimlab.nbm
Nome do Arquivo:
com-picsim-picsimlab.nbm
Arquivos do Tipo:
Plugin distribution files (*.nbm)
Abrir
Cancelar


MPLAB X IDE v3.05
File Edit View Navigate Source Refactor Run Debug Team Tools Window Help
Search (Ctrl+I)
Plugins
Updates
Available Plugins (26)
Downloaded (1)
Installed (43)
Settings
Add Plugins...
Search:
Install
Name
Picsimlab MPLABX Debugger
Picsimlab MPLABX Debugger
Remove
Community Contributed Plugin
Version: 0.6
Author: lcgamboa@yahoo.com
Date: 27/10/15
Source: com-picsim-picsimlab.nbm
Homepage: http://sourceforge.net/projects/picsim/
Plugin Description
plugin for picsimlab integration with MPLABX debugger .
http://sourceforge.net/projects/picsim/
Install
1 plugin selected
Close
Help


Plugin Installer
Welcome to the Plugin Installer
The installer will download, verify and then install the selected plugins.
The following plugins will be installed:
Picsimlab MPLABX Debugger [0.6]
< Back
Next >
Cancel
Help

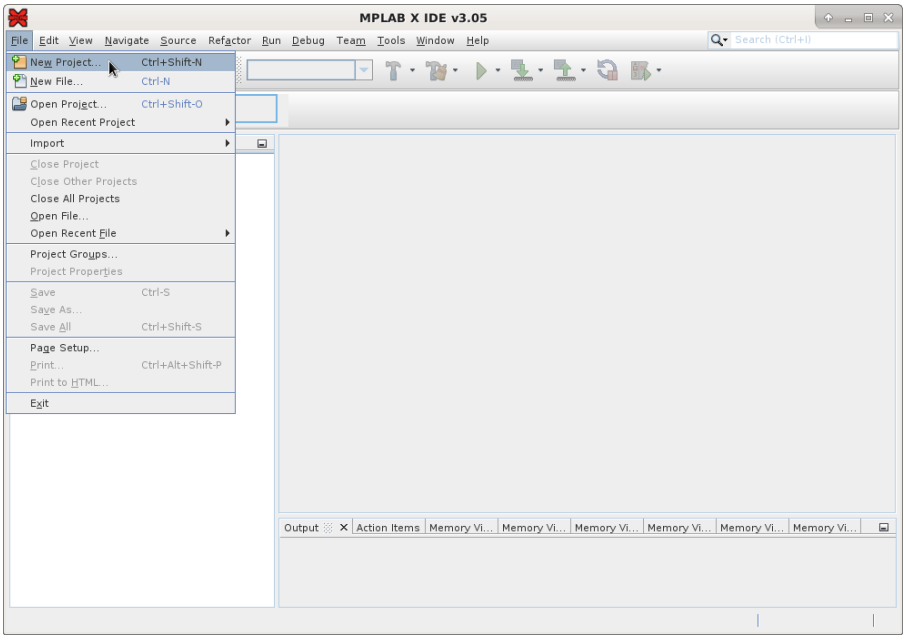

Plugin Installer
License Agreement
Please read all of the following license agreements carefully.
In order to continue with the installation, you need to agree with all of the license agreements associated with the particular plugins.
Plugins:
Picsimlab MPLABX Debugger [0.6]
GNU GENERAL PUBLIC LICENSE
Version 2, June 1991
Copyright (C) 1989, 1991 Free Software Foundation, Inc.
59 Temple Place, Suite 330, Boston, MA 02111-1307 USA
Everyone is permitted to copy and distribute verbatim copies
of this license document, but changing it is not allowed.
Preamble
The licenses for most software are designed to take away your
freedom to share and change it. By contrast, the GNU General Public
License is intended to guarantee your freedom to share and change free
I accept the terms in all of the license agreements.
< Back
Install
Cancel
Help

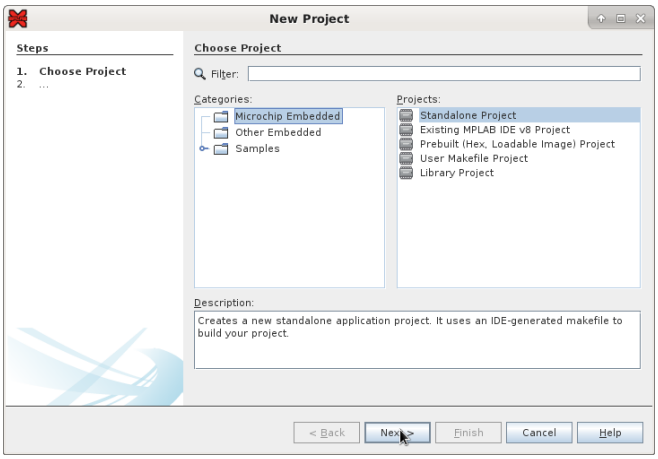

Validation Warning
The following plugins are not signed:
Picsimlab MPLABX Debugger
Warning: Installing untrusted plugins is potentially insecure. Use unsigned or untrusted plugins at your own risk.
Continue
Cancel

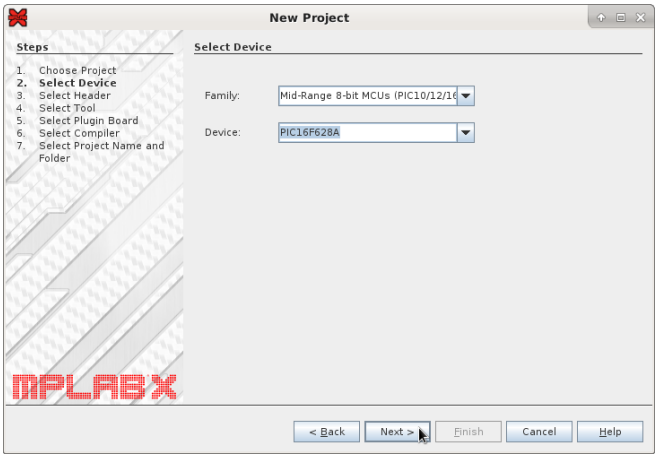


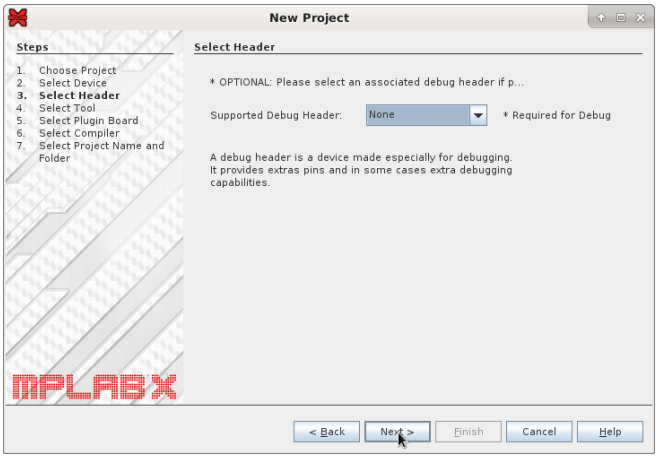
12.2 Configuring a New Project in MPLABX

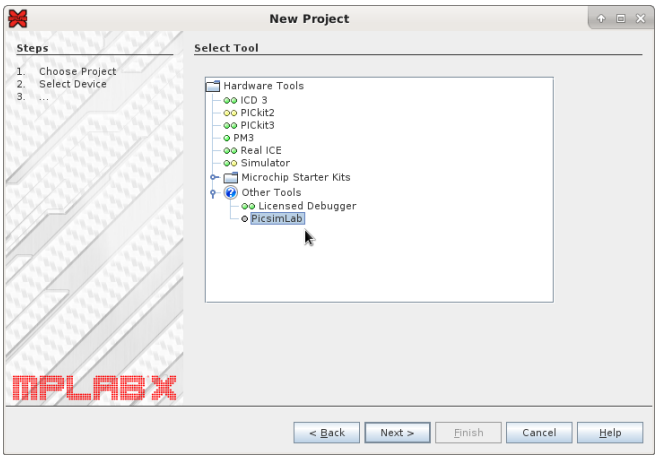
12.2.1 Project Creation

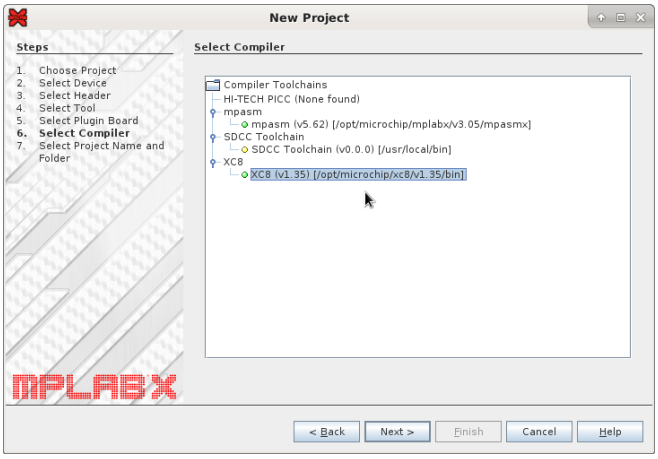


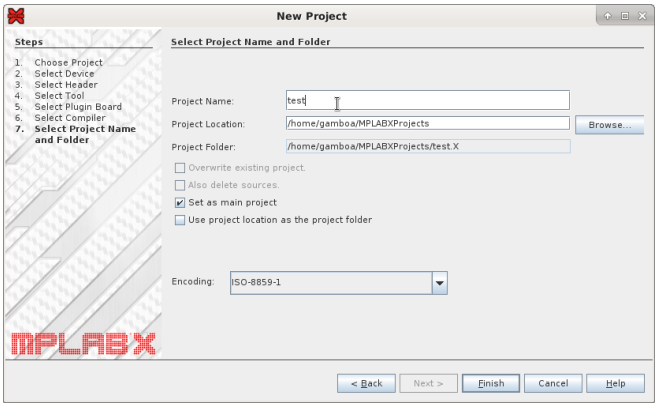

New Project
Steps
1. Choose Project
2. ...
Choose Project
Filter:
Categories:
Microchip Embedded
Other Embedded
Samples
Projects:
Standalone Project
Existing MPLAB IDE v8 Project
Prebuilt (Hex, Loadable Image) Project
User Makefile Project
Library Project
Description:
Creates a new standalone application project. It uses an IDE-generated makefile to build your project.
< Back
Next >
Finish
Cancel
Help


New Project
Steps
1. Choose Project
2. Select Device
3. Select Header
4. Select Tool
5. Select Plugin Board
6. Select Compiler
7. Select Project Name and Folder
Select Device
Family:
Mid-Range 8-bit MCUs (PIC10/12/16
Device:
PIC16F628A
MPLAB X
< Back
Next >
Finish
Cancel
Help

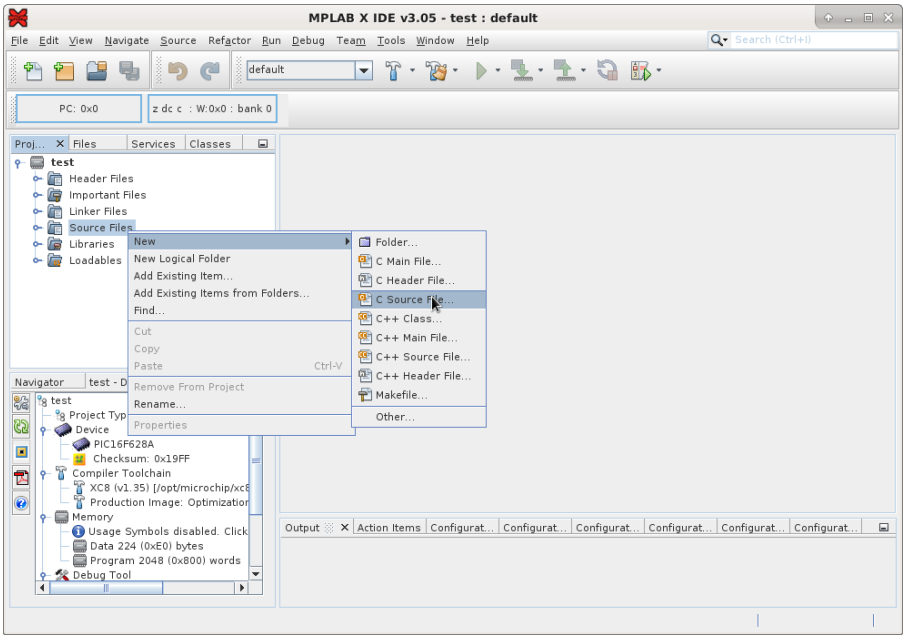

New Project
Steps
1. Choose Project
2. Select Device
3. Select Header
4. Select Tool
5. Select Plugin Board
6. Select Compiler
7. Select Project Name and Folder
Select Header
* OPTIONAL: Please select an associated debug header if p...
Supported Debug Header:
None
* Required for Debug
A debug header is a device made especially for debugging.
It provides extras pins and in some cases extra debugging capabilities.
MPLAB X
< Back
Next >
Finish
Cancel
Help

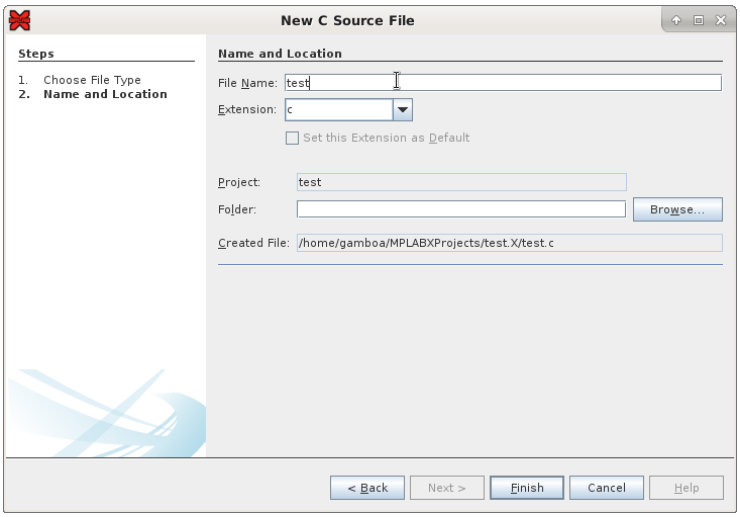

New Project
Steps
1. Choose Project
2. Select Device
3. ...
Select Tool
Hardware Tools
ICD 3
PICkit2
PICkit3
PM3
Real ICE
Simulator
Microchip Starter Kits
Other Tools
Licensed Debugger
PicsimLab
MPLABX
< Back
Next >
Finish
Cancel
Help


New Project
Steps
1. Choose Project
2. Select Device
3. Select Header
4. Select Tool
5. Select Plugin Board
6. Select Compiler
7. Select Project Name and Folder
Select Compiler
Compiler Toolchains
HI-TECH PICC (None found)
mpasm
mpasm (v5.62) [/opt/microchip/mplabx/v3.05/mpasmx]
SDCC Toolchain
SDCC Toolchain (v0.0.0) [/usr/local/bin]
XC8
XC8 (v1.35) [/opt/microchip/xc8/v1.35/bin]
MPLABX
< Back
Next >
Finish
Cancel
Help

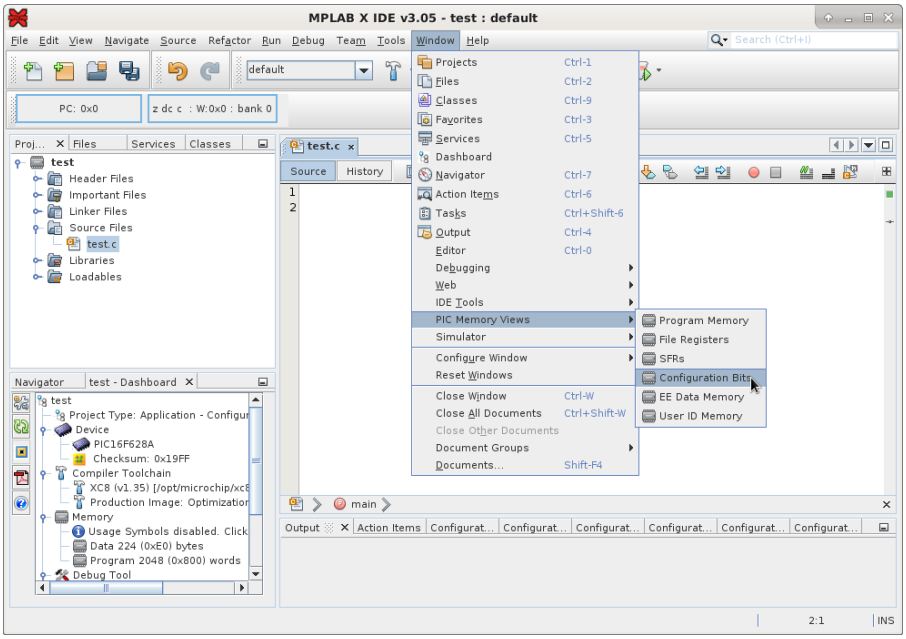

New Project
Steps
1. Choose Project
2. Select Device
3. Select Header
4. Select Tool
5. Select Plugin Board
6. Select Compiler
7. Select Project Name and Folder
Select Project Name and Folder
Project Name:
test
Project Location:
/home/gamboa/MPLABXProjects
Browse...
Project Folder:
/home/gamboa/MPLABXProjects/test.X
Overwrite existing project.
Also delete sources.
Set as main project
Use project location as the project folder
Encoding:
ISO-8859-1
MPLABX
< Back
Next >
Finish
Cancel
Help

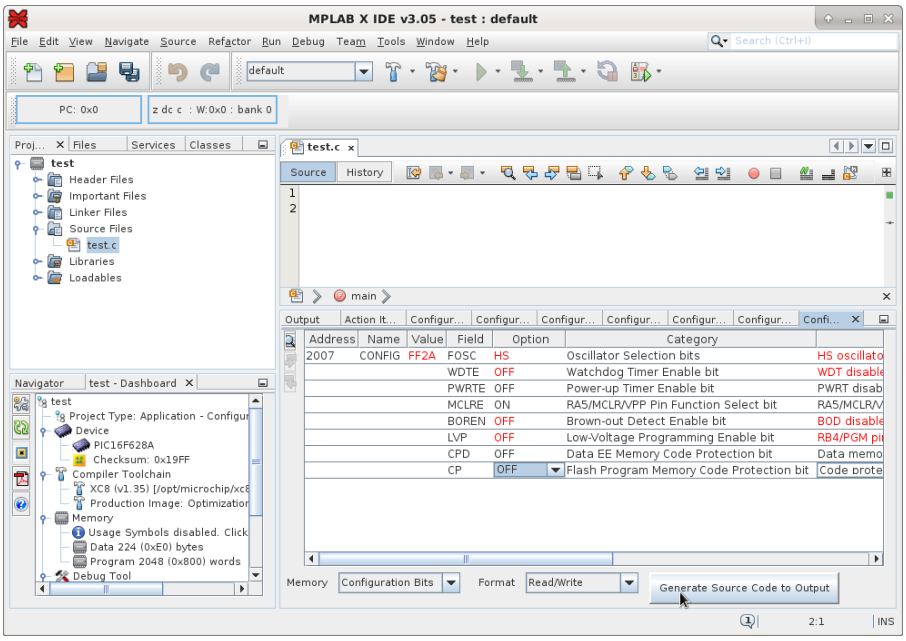
12.2.2 File Creation

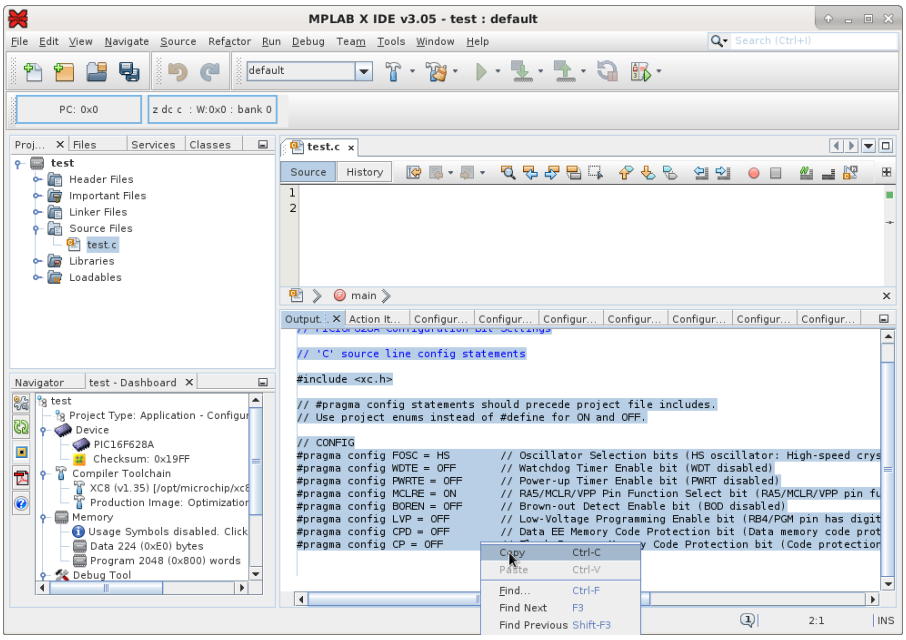




12.2.3 PIC Configuration Bits



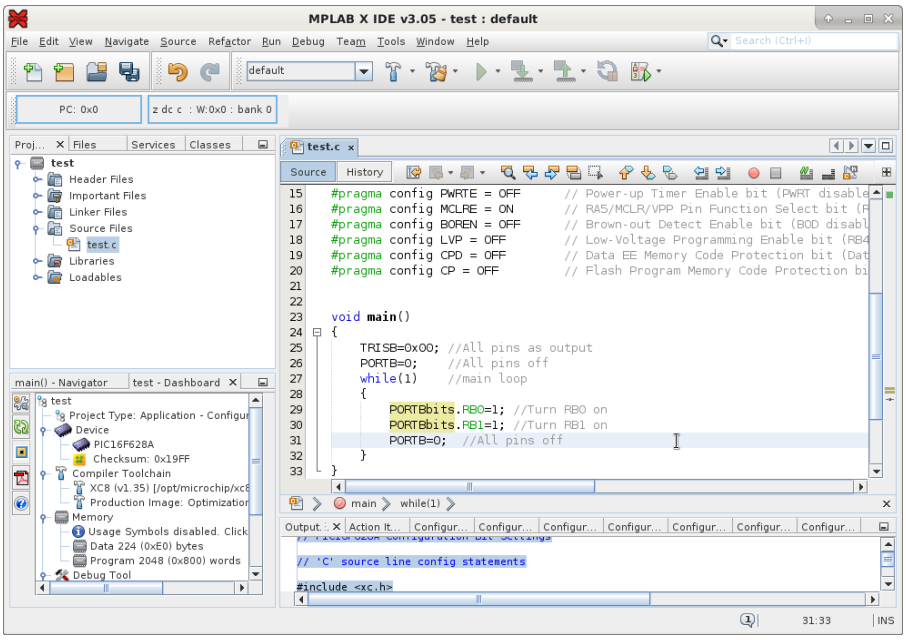




12.2.4 Code Example

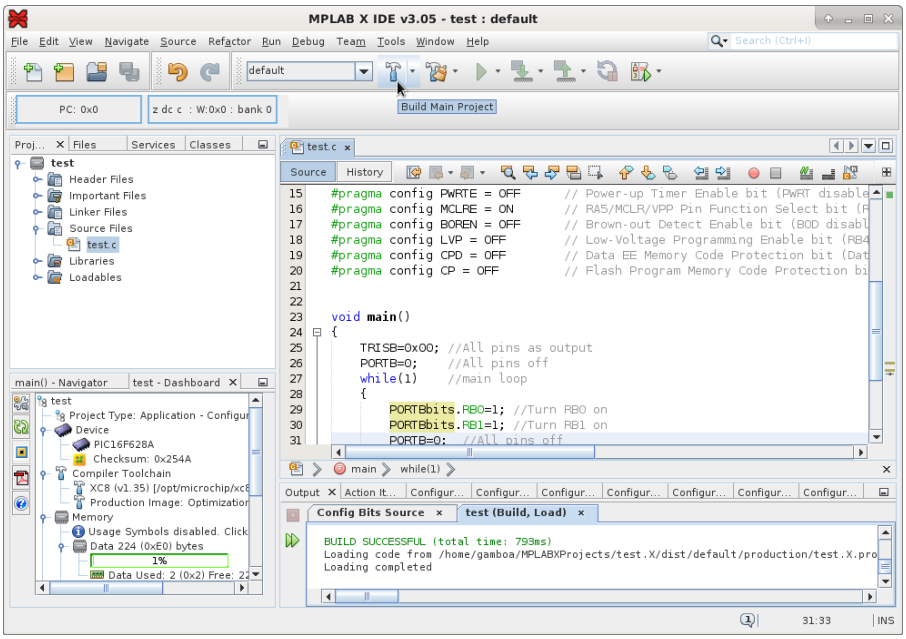
Paste the configuration and this simple code example in test.c:

```
void main()
{
    TRISB=0x00; //All pins as output
    PORTB=0;    //All pins off
    while(1)    //main loop
    {
        PORTBbits.RB0=1; //Turn RB0 on
        PORTBbits.RB1=1; //Turn RB1 on
        PORTB=0;  //All pins off
    }
}
```



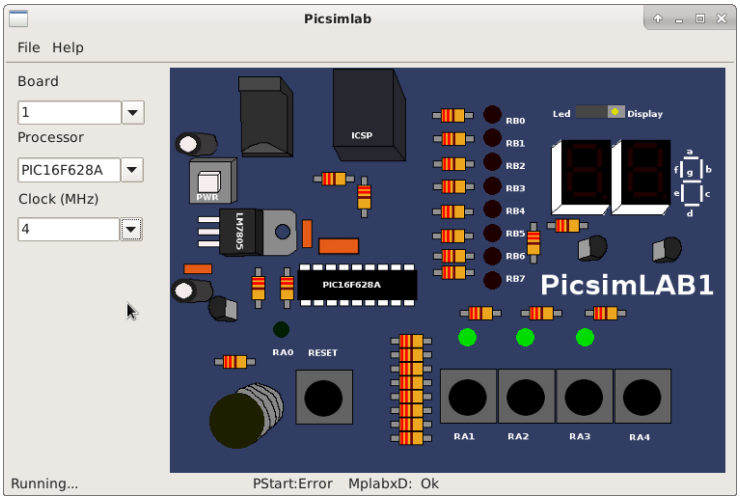
12.2.5 Building the Project

Use the **Build** button and wait for the message "BUILD SUCCESSFUL".



12.3 Program and Debug PICsimLab With MPLABX

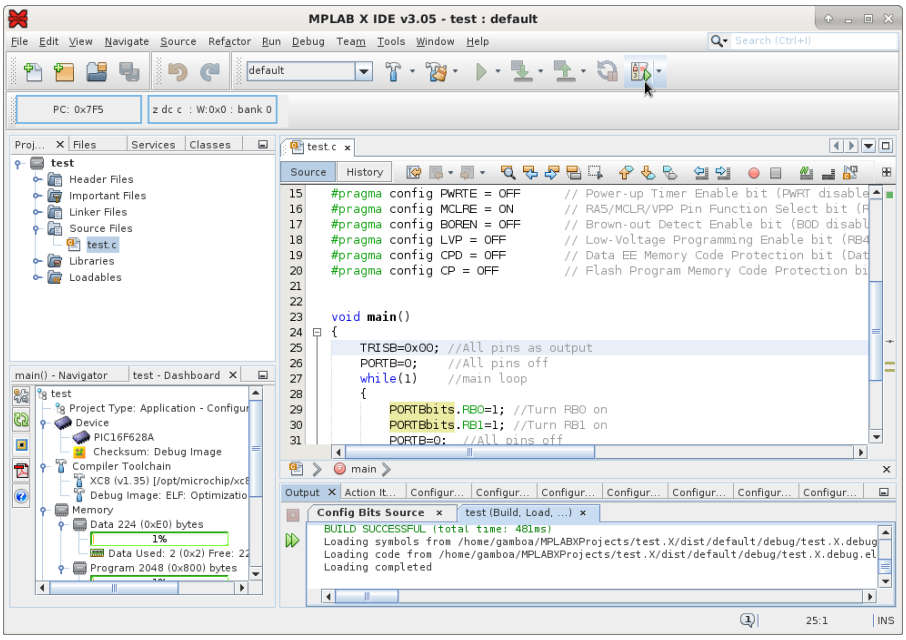
12.3.1 Starting PICsimLab



The plugin connect to Picsimlab through a TCP socket using port 1234, and you have to allow the access in the firewall. Verify in the PICsimLab statusbar the message "MplabxD: Ok". It's show debugger server state.

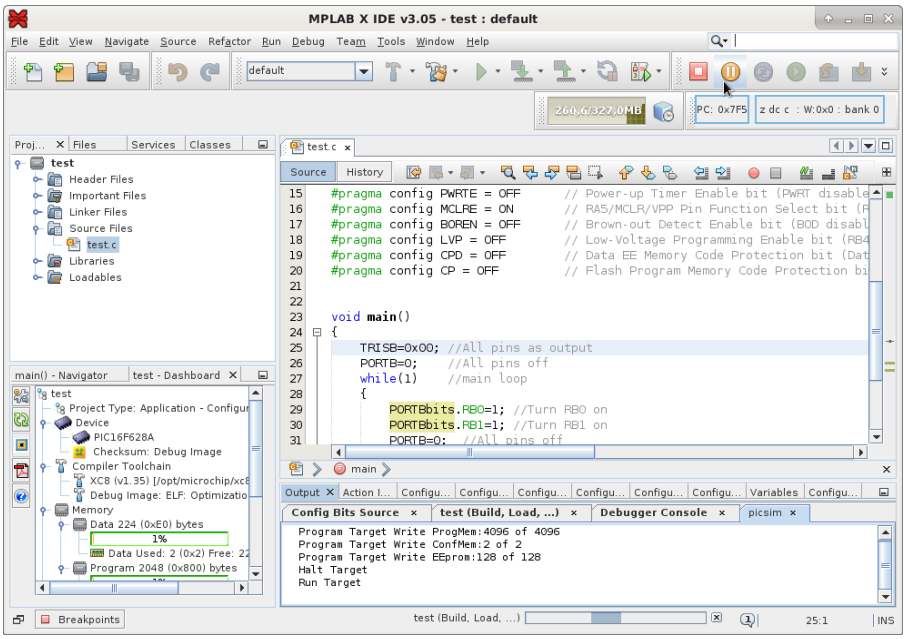
12.3.2 Programming PICsimLab

Use the **Debug** button to programming PICsimLab.



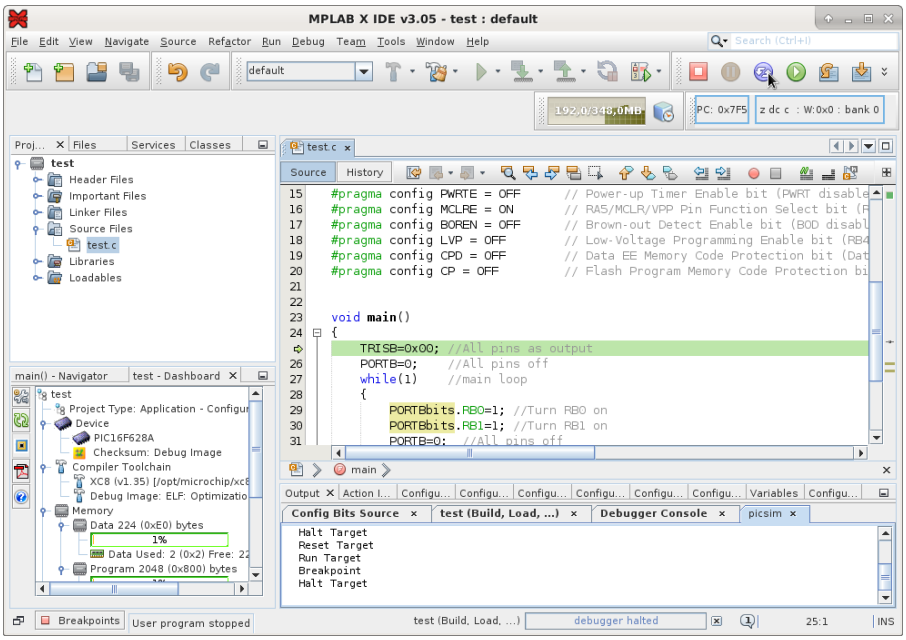
12.3.3 Pausing the Program

Use the **Pause** button to stop the program and inspect the code and memory.



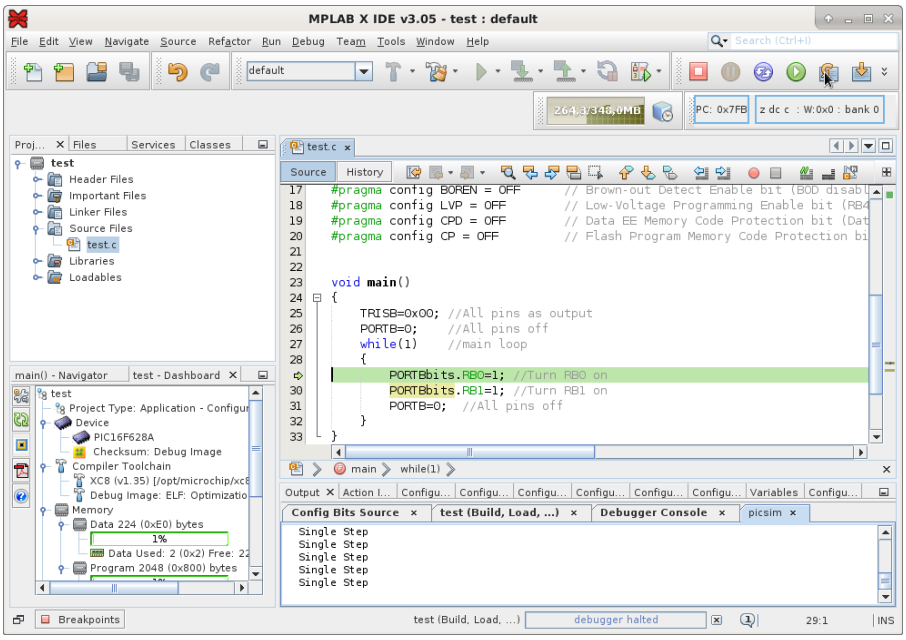
12.3.4 Restarting the Program

Use the **Restart** button to restart the program.

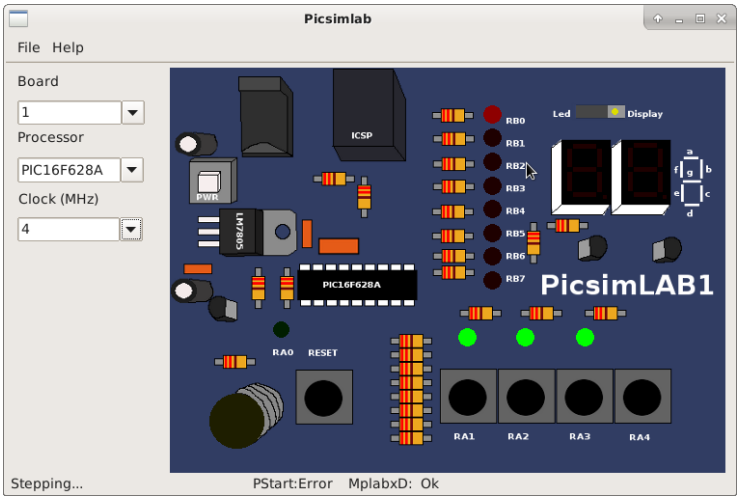


12.3.5 Running Step by Step

Use the **Step** or **Step Over** button to run the program step by step.

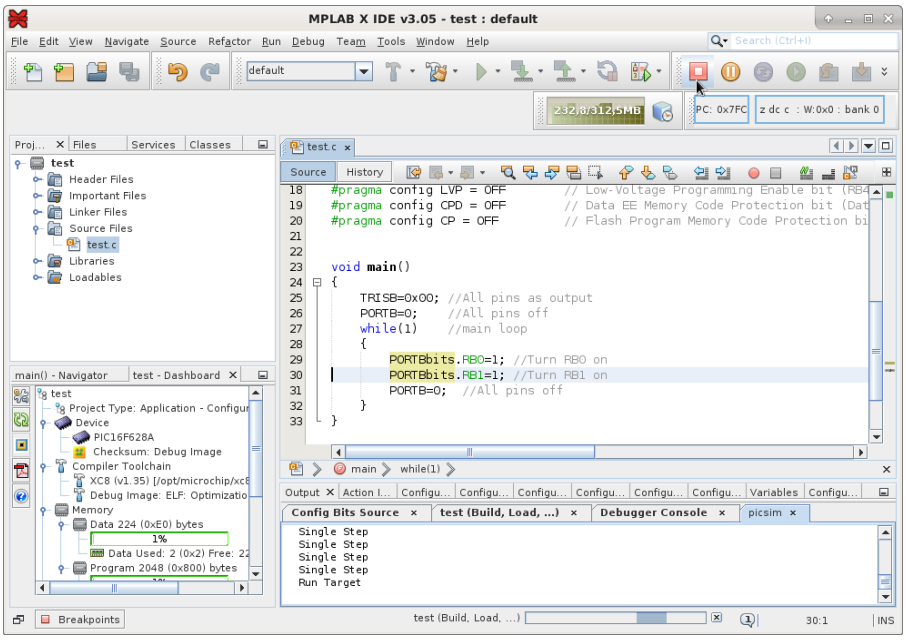


See in the PICsimLab the changes of each step.



12.3.6 Stopping Debugger

Use the **Stop** button to turn off the MPLABX debugger. The program continues running in PICsimLab after MPLABX debugger is stopped.



12.4 This Tutorial in Video

Link for Youtube video version of this tutorial: How to use MPLABX to program and debug PicsimLab 0.6

Chapter 13

Creating New Boards

13.1 How to Compile PICsimLab

13.1.1 In Debian Linux and derivatives

```
git clone https://github.com/lcgamboa/picsimlab.git
cd picsimlab
./picsimlab_build_all_and_deps.sh
```

To build experimental version use the argument "exp" with the *picsimlab_build_all_and_deps.sh* script

13.1.2 Cross-compiling for windows

For Windows 64 bits version from Debian Linux and derivatives or WSL (Windows Subsystem for Linux) on win10

```
git clone https://github.com/lcgamboa/picsimlab.git
cd picsimlab
./picsimlab_build_w64.sh
```

For 32 bits version:

```
git clone https://github.com/lcgamboa/picsimlab.git
cd picsimlab
./picsimlab_build_w32.sh
```

To build experimental version use the argument "exp" with the scripts.

13.2 Creating a New Board

The first step is get the schematic and all information about the board hardware. The second step is the creation of five files in PICSimLab dir (consider replace the 'x' of

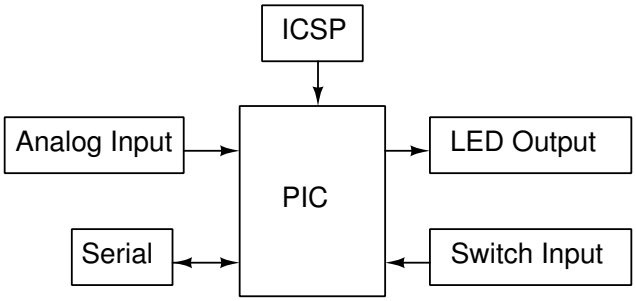
board_x for a number or name in your case):

- Board Picture (share/boards/x/board.png);
- Board input map (share/boards/x/input.map);
- Board output map (share/boards/x/output.map);
- Board header (src/boards/board_x.h);
- Board C++ code (src/boards/board_x.cc);

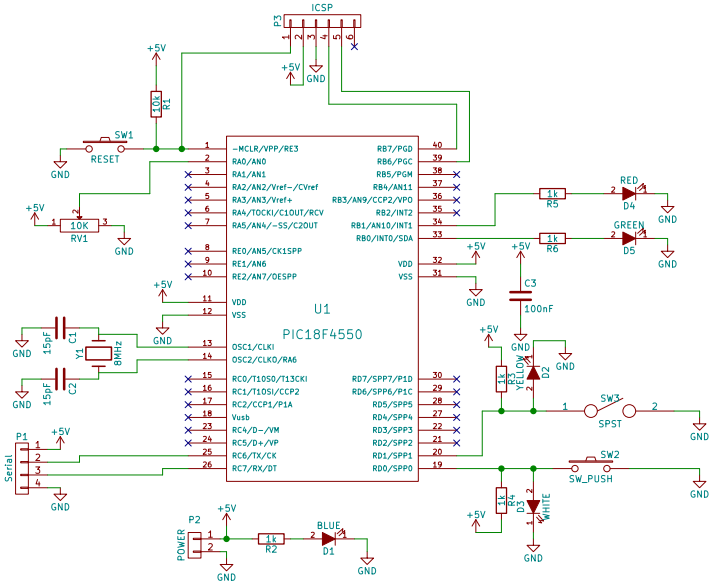
The third and last step is recompiling PICSimLab with new board support.

13.2.1 Board Hardware and Schematic

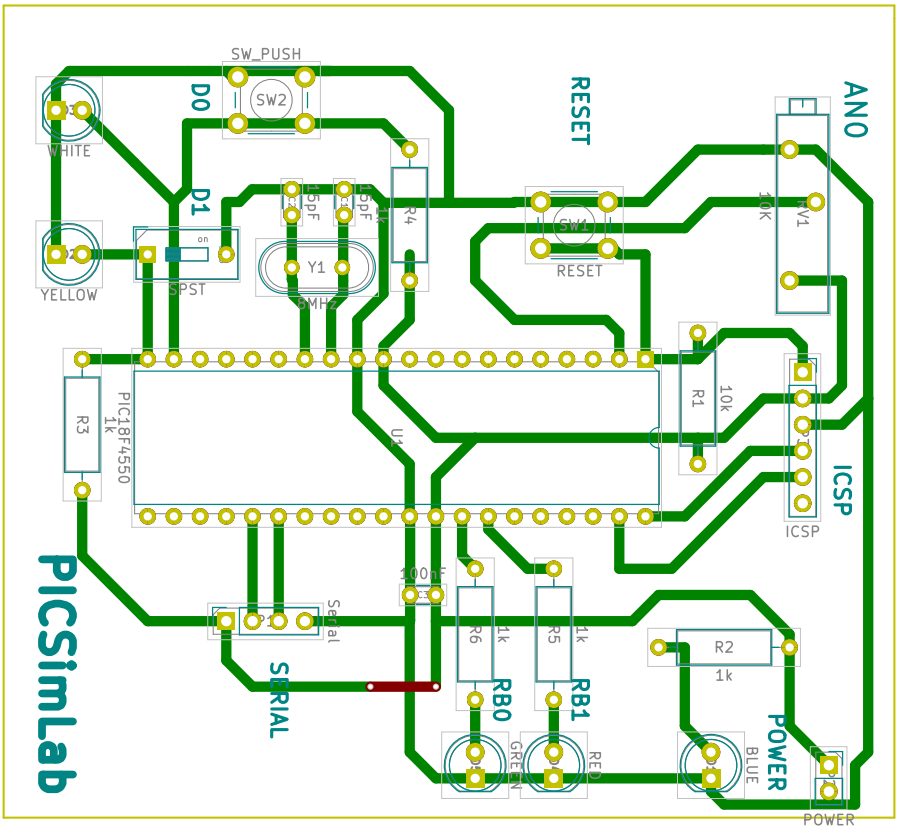
For this tutorial, the board created have the hardware shown in diagram below:



The schematic for the tutorial board made in Kicad.

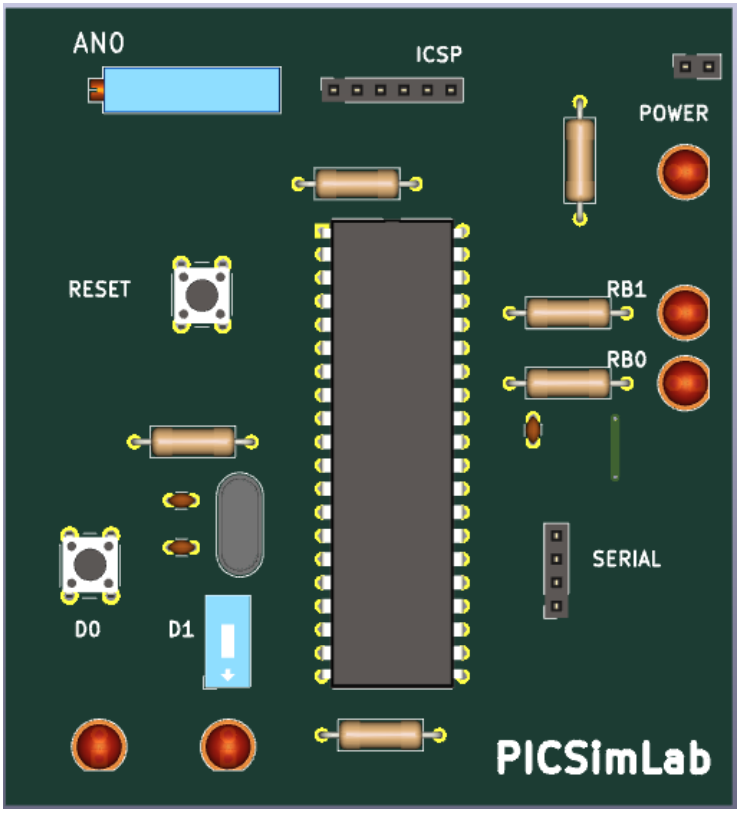

ICSP
P3
+5V
GND
10K
R1
SW1
RESET
U1
PIC18F4550
-MCLR/VPP/RE3
RA0/AN0
RA1/AN1
RA2/AN2/Vref-/CVref
RA3/AN3/Vref+
RA4/T0CKI/C1OUT/RCV
RA5/AN4/-SS/C2OUT
RE0/AN5/CK1SPP
RE1/AN6
RE2/AN7/OESPP
VDD
VSS
OSC1/CLKI
OSC2/CLKO/RA6
RC0/T1OSO/T13CKI
RC1/T1OSI/CCP2
RC2/CCP1/P1A
Vusb
RC4/D-/VM
RC5/D+/VP
RC6/TX/CK
RC7/RX/DT
RB7/PGD
RB6/PGC
RB5/PGM
RB4/AN11
RB3/AN9/CCP2/VPO
RB2/INT2
RB1/AN10/INT1
RB0/INT0/SDA
VDD
VSS
10K
RV1
C1
15pF
C2
15pF
Y1
8MHz
C3
100nF
1k
R5
RED
D4
1k
R6
GREEN
D5
1k
R3
YELLOW
D2
SW3
SPST
SW2
SW_PUSH
1k
R4
D3
WHITE
P1
Serial
P2
POWER
1k
R2
BLUE
D1

And the PCB layout was made in Kicad too. The PCB is not necessary if you have a real board.

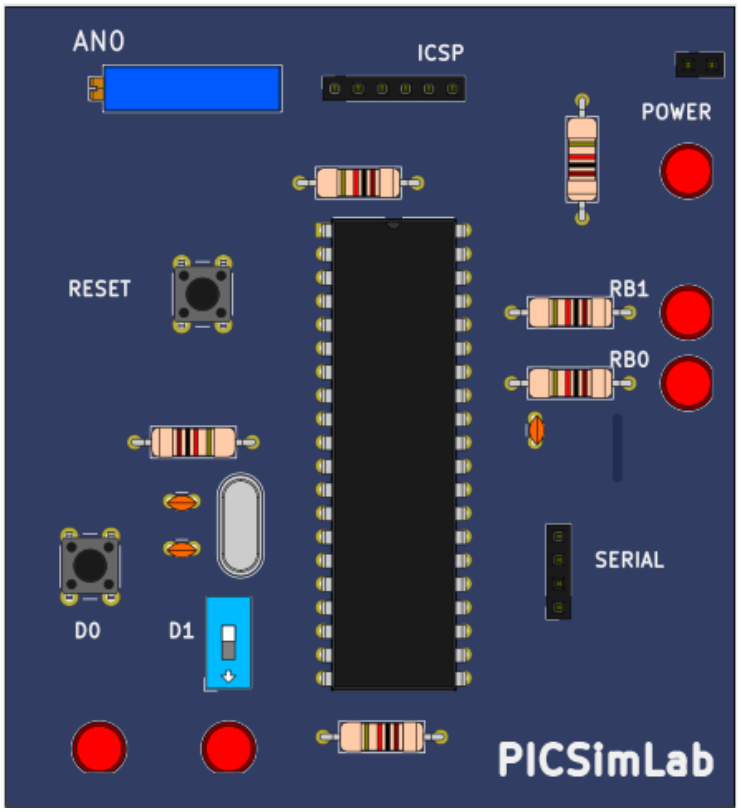


13.2.2 Board Picture

Because the real board of this tutorial never has been built, the board picture was taken from Kicad 3D viewer. The picture image is saved as "share/board/x/board.png".



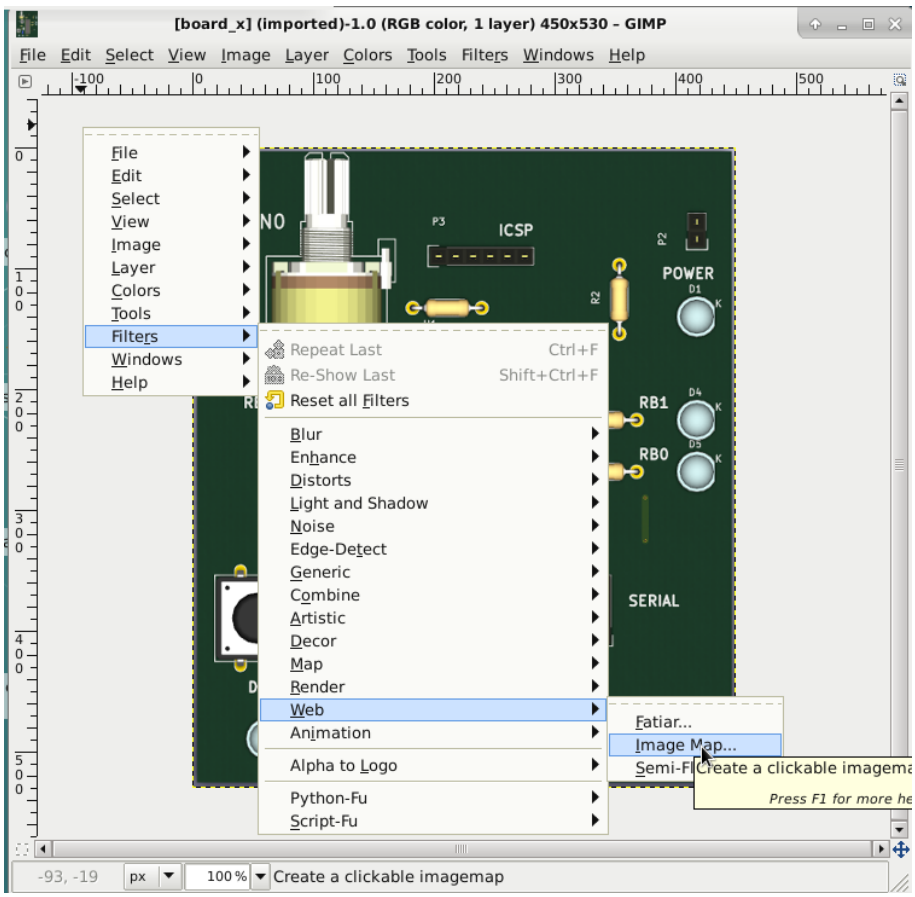
It is also possible to use images in SVG format for better viewing quality. PCBDraw can be used to convert a Kicad PCB project to an SVG image.


AN0
ICSP
POWER
RESET
RB1
RB0
SERIAL
D0
D1
PICSimLab

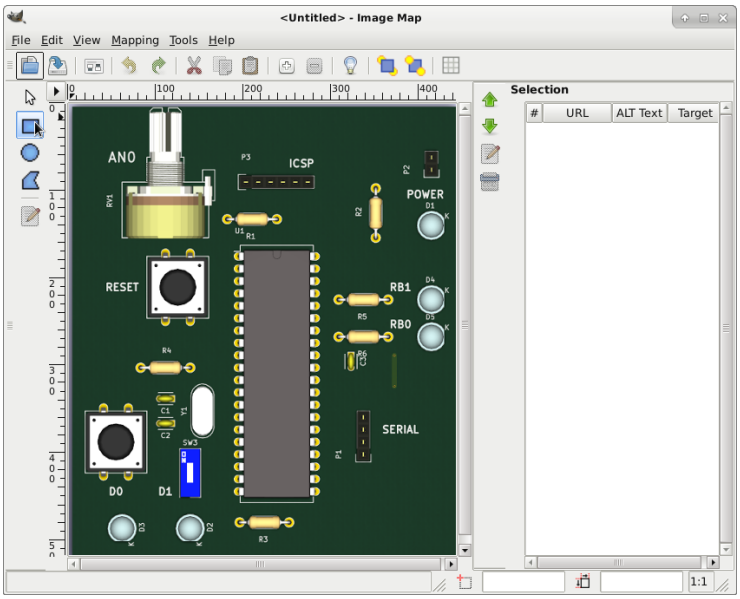
13.2.3 Picture maps

The PICSimLab use two type of image maps. The input map mark the areas in board picture which user can interact (by mouse click). The output map mark the areas in board picture to be redraw according simulator status. The picture maps used for PICSimLab are normal HTML image-map. They can be made by hand or using any software which can handle image maps. The original PICSimLab maps are made using Gimp image editor.

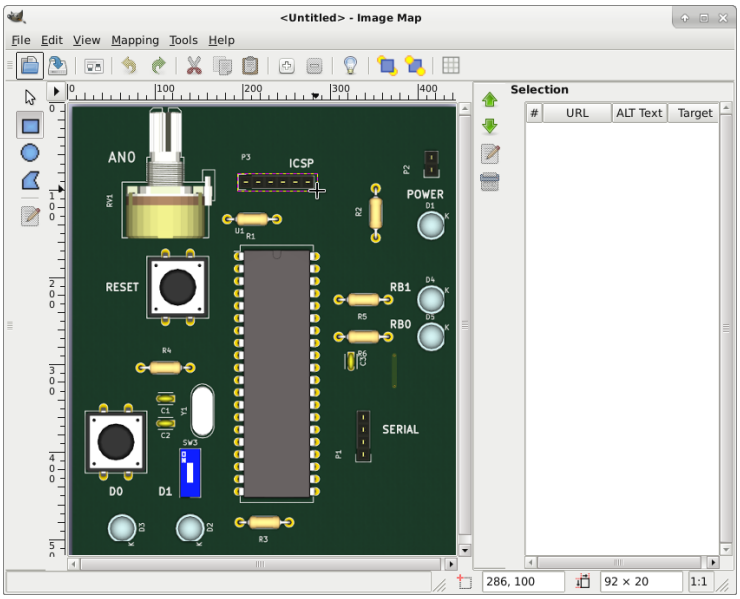
To start, in the GIMP, use the Filters->Web->Image Map to open image map editor window.



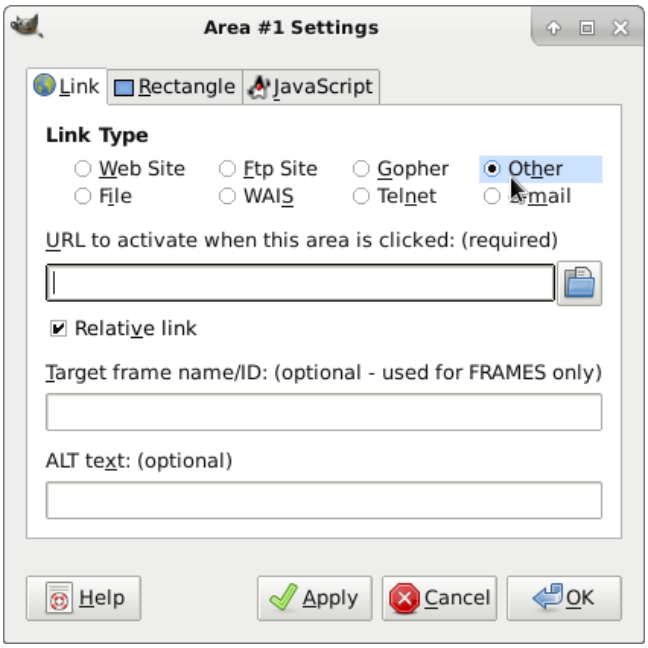
Then select rectangle or circle map on toolbar.



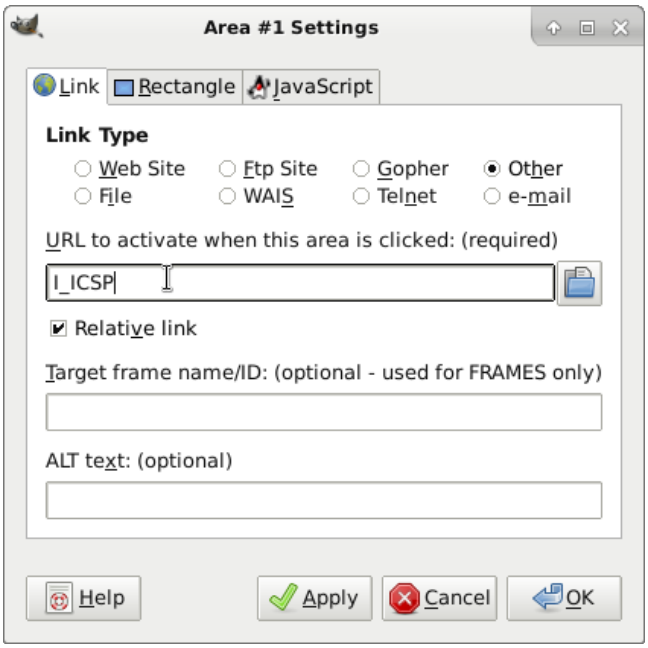
And mark the area in picture.



After area is select, in the settings windows select the link type for “Other”.



And write the name of area. The name must describe the area function on the board.



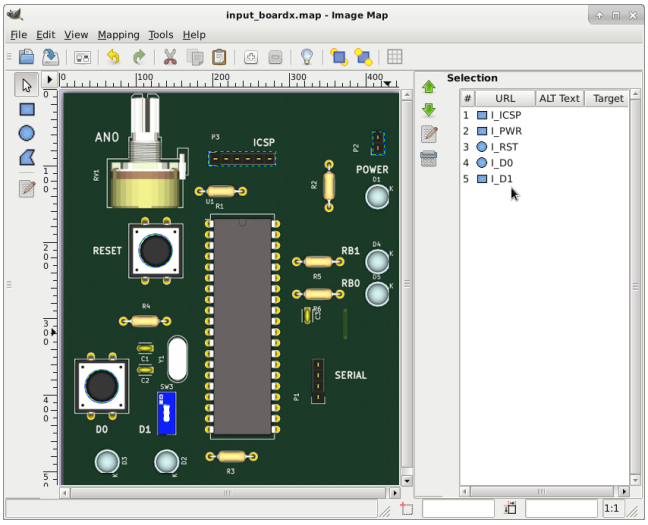
Board map

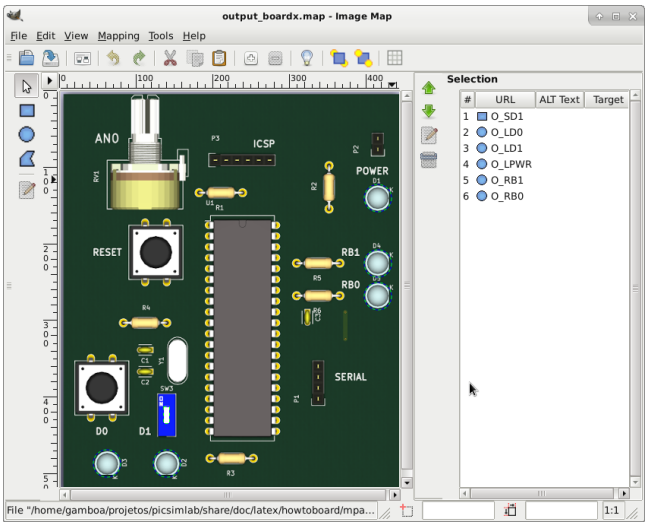
For this tutorial board, five input areas are marked:

- I_ICSP - where user click to load hexfile.
- I_PWR - where user click to turn on/off the board.
- I_RST - Button to reset board.
- I_D0 - Button connected in RD0.
- I_D1 - Switch connected in RD1.

For this tutorial board, six output areas are marked:

- O_SD1 - draw the switch on/off.
- O_LD0 - draw LED connected in button.
- O_LD1 - draw LED connected in switch.
- O_LPWR - draw power LED indicator.
- O_RB0 and O_RB1 - draw LEDs connected in RB0 and RB1.





Board map generated by Gimp image map editor and saved as “share/boards/X/board.map”.

```
<img src="[board_x] (imported)" width="448" height="491" border="0" usemap="#map" />

<map name="map">
<!-- #$-:Image map file created by GIMP Image Map plug-in -->
<!-- #$-:GIMP Image Map plug-in by Maurits Rijk -->
<!-- #$-:Please do not edit lines starting with "#$" -->
<!-- #$VERSION:2.3 -->
<!-- #$AUTHOR:lcganmboa@yahoo.com          -->
<area shape="rect" coords="196,45,280,58" href="I_PG_ICSP" />
<area shape="rect" coords="409,30,441,46" href="I_SW_PWR" />
<area shape="rect" coords="133,379,142,401" href="B_SW_D1" />
<area shape="rect" coords="74,42,156,61" href="B_PO_1" />
<area shape="rect" coords="105,162,138,195" href="B_PB_RST" />
<area shape="rect" coords="37,327,70,360" href="B_PB_D0" />
<area shape="circle" coords="59,454,17" href="O_LD_LD0" />
<area shape="circle" coords="137,454,17" href="O_LD_LD1" />
<area shape="circle" coords="418,102,17" href="O_LD_LPWR" />
<area shape="circle" coords="418,189,17" href="O_LD_RB1" />
<area shape="circle" coords="418,232,17" href="O_LD_RB0" />
<area shape="rect" coords="227,220,247,328" href="O_MP_CPU" />
</map>
```

The kicad project files can be download from github PICSimLab repository.

13.2.4 Board code

The header file and c++ code file with comments are listed in the next two subsections. This files control the behavior of board in simulator.

board_x.h

board_x.h online file.
board_x.h online doxygen version.

```
/* ########################################################################

   PICsimLab - PIC laboratory simulator

   ########################################################################

   Copyright (c) : 2015-2021  Luis Claudio Gambôa Lopes

   This program is free software; you can redistribute it and/or modify
   it under the terms of the GNU General Public License as published by
   the Free Software Foundation; either version 2, or (at your option)
   any later version.

   This program is distributed in the hope that it will be useful,
   but WITHOUT ANY WARRANTY; without even the implied warranty of
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   GNU General Public License for more details.

   You should have received a copy of the GNU General Public License
   along with this program; if not, write to the Free Software
   Foundation, Inc., 675 Mass Ave, Cambridge, MA 02139, USA.

   For e-mail suggestions :  lcgamboa@yahoo.com
   ######################################################################## */

#ifndef BOARD_x_H
#define        BOARD_x_H

#include<lxrad.h>

#include "bsim_picsim.h"

#define        BOARD_x_Name "X"

//new board class must be derived from board class defined in board.h
class cboard_x:public bsim_picsim
{
  private:
     unsigned char p_BT1;           //first board push button in RD0
     unsigned char p_BT2;           //second board switch in RD1

     //value of potentiometer
     unsigned char pot1;
     //flag to control if potentiometer is active
```

```
45        unsigned char active;
46
47        //controls to be added in simulator window
48        CGauge *gauge1;   //gauge to show mean value of RB0
49        CGauge *gauge2;   //gauge to show mean value of RB1
50        CLabel *label2;   //label of gauge RB0
51        CLabel *label3;   //label of gauge RB1
52
53        //Register controls for remote interface called once on board creation
54        void RegisterRemoteControl(void);
55
56        lxColor color1;//LEDs color 1
57        lxColor color2;//LEDs color 2
58        lxFont font;
59      public:
60         //Constructor called once on board creation
61         cboard_x(void);
62         //Destructor called once on board destruction
63         ~cboard_x(void);
64         //Return the board name
65         lxString GetName(void) {return lxT(BOARD_x_Name); };
66         //Return the about info of board
67         lxString GetAboutInfo(void){return lxT("L.C. Gamboa \n <lcgamboa@yahoo.com>");};
68         //Called ever 100ms to draw board
69         void Draw(CDraw *draw);
70         void Run_CPU(void);
71         //Return a list of board supported microcontrollers
72         lxString GetSupportedDevices(void){return lxT("PIC16F877A,PIC18F4550,PIC18F4620,");};
73         //Reset board status
74         void Reset(void);
75         //Event on the board
76         void EvMouseButtonPress(uint button, uint x, uint y,uint state);
77         //Event on the board
78         void EvMouseButtonRelease(uint button, uint x, uint y,uint state);
79         //Event on the board
80         void EvMouseMove(uint button, uint x, uint y, uint state);
81         //Event on the board
82         void EvKeyPress(uint key,uint mask);
83         //Event on the board
84         void EvKeyRelease(uint key,uint mask);
85         //Called ever 1s to refresh status
86         void RefreshStatus(void);
87         //Called to save board preferences in configuration file
88         void WritePreferences(void);
89         //Called whe configuration file load  preferences
90         void ReadPreferences(char *name,char *value);
91         //return the input ids numbers of names used in input map
92         unsigned short get_in_id(char * name);
```

```
93        //return the output ids numbers of names used in output map
94        unsigned short get_out_id(char * name);
95  };
96
97  #endif        /* BOARD_x_H */
```

board_x.cc

board_x.cc online file.
board_x.cc online doxygen version.

```
/* ######################################################################

   PICsimLab - PIC laboratory simulator

   ######################################################################

   Copyright (c) : 2015-2021  Luis Claudio Gambôa Lopes

   This program is free software; you can redistribute it and/or modify
   it under the terms of the GNU General Public License as published by
   the Free Software Foundation; either version 2, or (at your option)
   any later version.

   This program is distributed in the hope that it will be useful,
   but WITHOUT ANY WARRANTY; without even the implied warranty of
   MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
   GNU General Public License for more details.

   You should have received a copy of the GNU General Public License
   along with this program; if not, write to the Free Software
   Foundation, Inc., 675 Mass Ave, Cambridge, MA 02139, USA.

   For e-mail suggestions :  lcgamboa@yahoo.com
   ###################################################################### */

//include files
#include"../picsimlab1.h"
#include"../picsimlab4.h" //Oscilloscope
#include"../picsimlab5.h" //Spare Parts
#include"board_x.h"

/* ids of inputs of input map*/
enum
{
 I_POT1, //potentiometer
 I_ICSP, //ICSP connector
 I_PWR, //Power button
 I_RST, //Reset button
 I_D0, //RD0 push button
 I_D1 //RD1 switch
};

/* ids of outputs of output map*/
enum
```

```
45  {
46   O_POT1, //potentiometer
47   O_RST, //Reset button
48   O_SD1, //switch position (On/Off)
49   O_LD0, //LED on RD0 push button
50   O_LD1, //LED on RD1 switch
51   O_LPWR, //Power LED
52   O_RB0, //LED on RB0 output
53   O_RB1, //LED on RB1 output
54   O_BD0, //RD1 switch
55   O_CPU //CPU name
56  };
57
58  //return the input ids numbers of names used in input map
59
60  unsigned short
61  cboard_x::get_in_id(char * name)
62  {
63   if (strcmp (name, "PG_ICSP") == 0)return I_ICSP;
64   if (strcmp (name, "SW_PWR") == 0)return I_PWR;
65   if (strcmp (name, "PB_RST") == 0)return I_RST;
66   if (strcmp (name, "PB_D0") == 0)return I_D0;
67   if (strcmp (name, "SW_D1") == 0)return I_D1;
68   if (strcmp (name, "PO_1") == 0)return I_POT1;
69
70   printf ("Error input '%s' don't have a valid id! \n", name);
71   return -1;
72  }
73
74  //return the output ids numbers of names used in output map
75
76  unsigned short
77  cboard_x::get_out_id(char * name)
78  {
79
80   if (strcmp (name, "SW_D1") == 0)return O_SD1;
81   if (strcmp (name, "LD_LD0") == 0)return O_LD0;
82   if (strcmp (name, "LD_LD1") == 0)return O_LD1;
83   if (strcmp (name, "LD_LPWR") == 0)return O_LPWR;
84   if (strcmp (name, "LD_RB1") == 0)return O_RB1;
85   if (strcmp (name, "LD_RB0") == 0)return O_RB0;
86   if (strcmp (name, "PB_D0") == 0)return O_BD0;
87   if (strcmp (name, "PO_1") == 0)return O_POT1;
88   if (strcmp (name, "PB_RST") == 0)return O_RST;
89   if (strcmp (name, "MP_CPU") == 0)return O_CPU;
90
91   printf ("Error output '%s' don't have a valid id! \n", name);
92   return 1;
```

```
93  }
94
95  //Constructor called once on board creation
96
97  cboard_x::cboard_x(void) :
98  font(10, lxFONTFAMILY_TELETYPE, lxFONTSTYLE_NORMAL, lxFONTWEIGHT_BOLD)
99  {
100  Proc = "PIC18F4550"; //default microcontroller if none defined in preferences
101  ReadMaps (); //Read input and output board maps
102
103  pot1 = 100;
104
105  active = 0;
106
107  //controls properties and creation
108  //gauge1
109  gauge1 = new CGauge ();
110  gauge1->SetFOwner (&Window1);
111  gauge1->SetName (lxT ("gauge1_px"));
112  gauge1->SetX (13);
113  gauge1->SetY (382 - 160);
114  gauge1->SetWidth (140);
115  gauge1->SetHeight (20);
116  gauge1->SetEnable (1);
117  gauge1->SetVisible (1);
118  gauge1->SetRange (100);
119  gauge1->SetValue (0);
120  gauge1->SetType (4);
121  Window1.CreateChild (gauge1);
122  //gauge2
123  gauge2 = new CGauge ();
124  gauge2->SetFOwner (&Window1);
125  gauge2->SetName (lxT ("gauge2_px"));
126  gauge2->SetX (12);
127  gauge2->SetY (330 - 160);
128  gauge2->SetWidth (140);
129  gauge2->SetHeight (20);
130  gauge2->SetEnable (1);
131  gauge2->SetVisible (1);
132  gauge2->SetRange (100);
133  gauge2->SetValue (0);
134  gauge2->SetType (4);
135  Window1.CreateChild (gauge2);
136  //label2
137  label2 = new CLabel ();
138  label2->SetFOwner (&Window1);
139  label2->SetName (lxT ("label2_px"));
140  label2->SetX (12);
```

```
141   label2->SetY (306 - 160);
142   label2->SetWidth (60);
143   label2->SetHeight (20);
144   label2->SetEnable (1);
145   label2->SetVisible (1);
146   label2->SetText (lxT ("RB0"));
147   label2->SetAlign (1);
148   Window1.CreateChild (label2);
149   //label3
150   label3 = new CLabel ();
151   label3->SetFOwner (&Window1);
152   label3->SetName (lxT ("label3_px"));
153   label3->SetX (13);
154   label3->SetY (357 - 160);
155   label3->SetWidth (60);
156   label3->SetHeight (20);
157   label3->SetEnable (1);
158   label3->SetVisible (1);
159   label3->SetText (lxT ("RB1"));
160   label3->SetAlign (1);
161   Window1.CreateChild (label3);
162  }
163
164  //Destructor called once on board destruction
165
166  cboard_x::~cboard_x(void)
167  {
168   //controls destruction
169   Window1.DestroyChild (gauge1);
170   Window1.DestroyChild (gauge2);
171   Window1.DestroyChild (label2);
172   Window1.DestroyChild (label3);
173  }
174
175  //Reset board status
176
177  void
178  cboard_x::Reset(void)
179  {
180   pic_reset (1);
181
182   p_BT1 = 1; //set push button  in default state (high)
183
184   //write button state to pic pin 19 (RD0)
185   pic_set_pin (19, p_BT1);
186   //write switch state to pic pin 20 (RD1)
187   pic_set_pin (20, p_BT2);
188
```

```
189
190  //verify serial port state and refresh status bar
191 #ifndef _WIN_
192  if (pic.serial[0].serialfd > 0)
193 #else
194  if (pic.serial[0].serialfd != INVALID_HANDLE_VALUE)
195 #endif
196   Window1.statusbar1.SetField (2, lxT ("Serial: ") +
197                                lxString::FromAscii (SERIALDEVICE) + lxT (":") + itoa (pic.serial[0].
198                                lxString ().Format ("%4.1f", fabs ((100.0 * pic.serial[0].serialexbau
199                                                                   pic.serial[0].serialbaud) / pic.s
200  else
201   Window1.statusbar1.SetField (2, lxT ("Serial: ") +
202                                lxString::FromAscii (SERIALDEVICE) + lxT (" (ERROR)"));
203
204  if (use_spare)Window5.Reset ();
205
206  RegisterRemoteControl ();
207 }
208
209 //Register variables to be controled by remote control
210
211 void
212 cboard_x::RegisterRemoteControl(void)
213 {
214  for (int i = 0; i < inputc; i++)
215   {
216    switch (input[i].id)
217     {
218     case I_D0:
219      input[i].status = &p_BT1;
220      break;
221     case I_D1:
222      input[i].status = &p_BT2;
223      break;
224     case I_POT1:
225      input[i].status = &pot1;
226      break;
227     }
228   }
229
230  for (int i = 0; i < outputc; i++)
231   {
232    switch (output[i].id)
233     {
234     case O_RB0:
235      output[i].status = &pic.pins[32].oavalue;
236      break;
```

```
237       case O_RB1:
238        output[i].status = &pic.pins[33].oavalue;
239        break;
240       case O_LD0:
241        output[i].status = &pic.pins[18].oavalue;
242        break;
243       case O_LD1:
244        output[i].status = &pic.pins[19].oavalue;
245        break;
246       }
247     }
248   }
249
250   //Called ever 1s to refresh status
251
252   void
253   cboard_x::RefreshStatus(void)
254   {
255    //verify serial port state and refresh status bar
256   #ifndef _WIN_
257    if (pic.serial[0].serialfd > 0)
258   #else
259    if (pic.serial[0].serialfd != INVALID_HANDLE_VALUE)
260   #endif
261     Window1.statusbar1.SetField (2, lxT ("Serial: ") +
262                                  lxString::FromAscii (SERIALDEVICE) + lxT (":") + itoa (pic.serial[0].
263                                  lxString ().Format ("%4.1f", fabs ((100.0 * pic.serial[0].serialexbau
264                                                                     pic.serial[0].serialbaud) / pic.s
265    else
266     Window1.statusbar1.SetField (2, lxT ("Serial: ") +
267                                  lxString::FromAscii (SERIALDEVICE) + lxT (" (ERROR)"));
268
269   }
270
271   //Called to save board preferences in configuration file
272
273   void
274   cboard_x::WritePreferences(void)
275   {
276    //write selected microcontroller of board_x to preferences
277    Window1.saveprefs (lxT ("X_proc"), Proc);
278    //write switch state of board_x to preferences
279    Window1.saveprefs (lxT ("X_bt2"), lxString ().Format ("%i", p_BT2));
280    //write microcontroller clock to preferences
281    Window1.saveprefs (lxT ("X_clock"), lxString ().Format ("%2.1f", Window1.GetClock ()));
282    //write potentiometer position to preferences
283    Window1.saveprefs (lxT ("X_pot1"), lxString ().Format ("%i", pot1));
284   }
```

```
285
286 //Called whe configuration file load  preferences
287
288 void
289 cboard_x::ReadPreferences(char *name, char *value)
290 {
291  //read switch state of board_x of preferences
292  if (!strcmp (name, "X_bt2"))
293   {
294    if (value[0] == '0')
295     p_BT2 = 0;
296    else
297     p_BT2 = 1;
298   }
299  //read microcontroller of preferences
300  if (!strcmp (name, "X_proc"))
301   {
302    Proc = value;
303   }
304  //read microcontroller clock
305  if (!strcmp (name, "X_clock"))
306   {
307    Window1.SetClock (atof (value));
308   }
309
310  //read potentiometer position
311  if (!strcmp (name, "X_pot1"))
312   {
313    pot1 = atoi (value);
314   }
315 }
316
317
318 //Event on the board
319
320 void
321 cboard_x::EvKeyPress(uint key, uint mask)
322 {
323  //if keyboard key 1 is pressed then activate button (state=0)
324  if (key == '1')
325   {
326    p_BT1 = 0;
327    output_ids[O_BD0]->update = 1;
328   }
329
330  //if keyboard key 2 is pressed then toggle switch state
331  if (key == '2')
332   {
```

```
333     p_BT2 ^= 1;
334     output_ids[O_SD1]->update = 1;
335    }
336
337  }
338
339  //Event on the board
340
341  void
342  cboard_x::EvKeyRelease(uint key, uint mask)
343  {
344   //if keyboard key 1 is pressed then deactivate button (state=1)
345   if (key == '1')
346    {
347     p_BT1 = 1;
348     output_ids[O_BD0]->update = 1;
349    }
350
351  }
352
353  //Event on the board
354
355  void
356  cboard_x::EvMouseButtonPress(uint button, uint x, uint y, uint state)
357  {
358
359   int i;
360
361   //search for the input area which owner the event
362   for (i = 0; i < inputc; i++)
363    {
364     if (((input[i].x1 <= x)&&(input[i].x2 >= x))&&((input[i].y1 <= y)&&
365                                                    (input[i].y2 >= y)))
366      {
367
368       switch (input[i].id)
369        {
370         //if event is over I_ISCP area then load hex file
371        case I_ICSP:
372         Window1.menu1_File_LoadHex_EvMenuActive (NULL);
373         break;
374         //if event is over I_PWR area then toggle board on/off
375        case I_PWR:
376         if (Window1.Get_mcupwr ()) //if on turn off
377          {
378           Window1.Set_mcurun (0);
379           Window1.Set_mcupwr (0);
380           Reset ();
```

```
381             p_BT1 = 1;
382             Window1.statusbar1.SetField (0, lxT ("Stoped"));
383            }
384           else //if off turn on
385            {
386             Window1.Set_mcupwr (1);
387             Window1.Set_mcurun (1);
388             Reset ();
389             Window1.statusbar1.SetField (0, lxT ("Running..."));
390            }
391           output_ids[O_LPWR]->update = 1;
392           break;
393           //if event is over I_RST area then turn off and reset
394          case I_RST:
395           if (Window1.Get_mcupwr () && pic_reset (-1))//if powered
396            {
397             Window1.Set_mcupwr (0);
398             Window1.Set_mcurst (1);
399            }
400           p_RST = 0;
401           output_ids[O_RST]->update = 1;
402           break;
403           //if event is over I_D0 area then activate button (state=0)
404          case I_D0:
405           p_BT1 = 0;
406           output_ids[O_BD0]->update = 1;
407           break;
408           //if event is over I_D1 area then toggle switch state
409          case I_D1:
410           p_BT2 ^= 1;
411           output_ids[O_SD1]->update = 1;
412           break;
413          case I_POT1:
414           {
415            active = 1;
416            pot1 = (x - input[i].x1)*2.77;
417            if (pot1 > 199)pot1 = 199;
418            output_ids[O_POT1]->update = 1;
419           }
420           break;
421          }
422       }
423     }
424
425 }
426
427 //Event on the board
428
```

```
429 void
430 cboard_x::EvMouseMove(uint button, uint x, uint y, uint state)
431 {
432  int i;
433
434  for (i = 0; i < inputc; i++)
435   {
436    switch (input[i].id)
437     {
438     case I_POT1:
439      if (((input[i].x1 <= x)&&(input[i].x2 >= x))&&((input[i].y1 <= y)&&(input[i].y2 >= y)))
440       {
441        if (active)
442         {
443          pot1 = (x - input[i].x1)*2.77;
444          if (pot1 > 199)pot1 = 199;
445          output_ids[O_POT1]->update = 1;
446         }
447       }
448      break;
449     }
450   }
451 }
452
453 //Event on the board
454
455 void
456 cboard_x::EvMouseButtonRelease(uint button, uint x, uint y, uint state)
457 {
458  int i;
459
460  //search for the input area which owner the event
461  for (i = 0; i < inputc; i++)
462   {
463    if (((input[i].x1 <= x)&&(input[i].x2 >= x))&&((input[i].y1 <= y)&&
464                                                   (input[i].y2 >= y)))
465     {
466      switch (input[i].id)
467       {
468        //if event is over I_RST area then turn on
469       case I_RST:
470        if (Window1.Get_mcurst ())//if powered
471         {
472          Window1.Set_mcupwr (1);
473          Window1.Set_mcurst (0);
474
475          if (pic_reset (-1))
476           {
```

```
477             Reset ();
478            }
479          }
480         p_RST = 1;
481         output_ids[O_RST]->update = 1;
482         break;
483         //if event is over I_D0 area then deactivate button (state=1)
484        case I_D0:
485         p_BT1 = 1;
486         output_ids[O_BD0]->update = 1;
487         break;
488        case I_POT1:
489         {
490          active = 0;
491          output_ids[O_POT1]->update = 1;
492         }
493         break;
494        }
495      }
496    }
497
498 }
499
500
501 //Called ever 100ms to draw board
502 //This is the critical code for simulator running speed
503
504 void
505 cboard_x::Draw(CDraw *draw)
506 {
507  int update = 0; //verifiy if updated is needed
508  int i;
509
510
511  //board_x draw
512  for (i = 0; i < outputc; i++) //run over all outputs
513   {
514    if (output[i].update)//only if need update
515     {
516      output[i].update = 0;
517
518      if (!update)
519       {
520        draw->Canvas.Init (Scale, Scale);
521       }
522      update++; //set to update buffer
523
524      if (!output[i].r)//if output shape is a rectangle
```

```
525         {
526          if (output[i].id == O_SD1)//if output is switch
527           {
528            //draw a background white rectangle
529            draw->Canvas.SetBgColor (255, 255, 255);
530            draw->Canvas.Rectangle (1, output[i].x1, output[i].y1,
531                                    output[i].x2 - output[i].x1, output[i].y2 - output[i].y1);
532
533            if (!p_BT2) //draw switch off
534             {
535              //draw a grey rectangle
536              draw->Canvas.SetBgColor (70, 70, 70);
537              draw->Canvas.Rectangle (1, output[i].x1, output[i].y1 +
538                                      ((int) ((output[i].y2 - output[i].y1)*0.35)), output[i].x2 - outp
539                                      (int) ((output[i].y2 - output[i].y1)*0.65));
540             }
541            else //draw switch on
542             {
543              //draw a grey rectangle
544              draw->Canvas.SetBgColor (70, 70, 70);
545              draw->Canvas.Rectangle (1, output[i].x1,
546                                      output[i].y1, output[i].x2 - output[i].x1,
547                                      (int) ((output[i].y2 - output[i].y1)*0.65));
548             }
549           }
550          else if (output[i].id == O_BD0)
551           {
552            draw->Canvas.SetColor (102, 102, 102);
553            draw->Canvas.Circle (1, output[i].cx, output[i].cy, 10);
554            if (p_BT1)
555             {
556              draw->Canvas.SetColor (15, 15, 15);
557             }
558            else
559             {
560              draw->Canvas.SetColor (55, 55, 55);
561             }
562            draw->Canvas.Circle (1, output[i].cx, output[i].cy, 8);
563           }
564          else if (output[i].id == O_RST)
565           {
566            draw->Canvas.SetColor (102, 102, 102);
567            draw->Canvas.Circle (1, output[i].cx, output[i].cy, 10);
568
569            if (p_RST)
570             {
571              draw->Canvas.SetColor (15, 15, 15);
572             }
```

```
573           else
574            {
575             draw->Canvas.SetColor (55, 55, 55);
576            }
577           draw->Canvas.Circle (1, output[i].cx, output[i].cy, 8);
578          }
579         else if (output[i].id == O_POT1)
580          {
581           draw->Canvas.SetColor (0, 50, 215);
582           draw->Canvas.Rectangle (1, output[i].x1, output[i].y1, output[i].x2 - output[i].x1, output[
583           draw->Canvas.SetColor (250, 250, 250);
584           draw->Canvas.Rectangle (1, output[i].x1 + pot1 / 2.77, output[i].y1 + 2, 10, 15);
585          }
586         else if (output[i].id == O_CPU)
587          {
588           draw->Canvas.SetFont (font);
589           int x, y, w, h;
590           draw->Canvas.SetColor (26, 26, 26);
591           draw->Canvas.Rectangle (1, output[i].x1, output[i].y1, output[i].x2 - output[i].x1, output[
592
593           draw->Canvas.SetColor (230, 230, 230);
594           w = output[i].x2 - output[i].x1;
595           h = output[i].y2 - output[i].y2;
596           x = output[i].x1 + (w / 2) + 7;
597           y = output[i].y1 + (h / 2) + (Proc.length ());
598           draw->Canvas.RotatedText (Proc, x, y, 270);
599          }
600        }
601       else //if output shape is a circle
602        {
603         draw->Canvas.SetFgColor (0, 0, 0); //black
604
605         switch (output[i].id)//search for color of output
606          {
607           case O_LD0: //White using pin 19 mean value (RD0)
608            draw->Canvas.SetBgColor (pic.pins[18].oavalue, pic.pins[18].oavalue, pic.pins[18].oavalue);
609            break;
610           case O_LD1: //Yelllow using pin 20 mean value (RD1)
611            draw->Canvas.SetBgColor (pic.pins[19].oavalue, pic.pins[19].oavalue, 0);
612            break;
613           case O_LPWR: //Blue using mcupwr value
614            draw->Canvas.SetBgColor (0, 0, 200 * Window1.Get_mcupwr () + 55);
615            break;
616           case O_RB0: //Green using pin 33 mean value (RB0)
617            draw->Canvas.SetBgColor (0, pic.pins[32].oavalue, 0);
618            break;
619           case O_RB1: //Red using pin 34 mean value (RB1)
620            draw->Canvas.SetBgColor (pic.pins[33].oavalue, 0, 0);
```

```
621           break;
622          }
623
624         //draw a LED
625         color1 = draw->Canvas.GetBgColor ();
626         int r = color1.Red () - 120;
627         int g = color1.Green () - 120;
628         int b = color1.Blue () - 120;
629         if (r < 0)r = 0;
630         if (g < 0)g = 0;
631         if (b < 0)b = 0;
632         color2.Set (r, g, b);
633         draw->Canvas.SetBgColor (color2);
634         draw->Canvas.Circle (1, output[i].x1, output[i].y1, output[i].r + 1);
635         draw->Canvas.SetBgColor (color1);
636         draw->Canvas.Circle (1, output[i].x1, output[i].y1, output[i].r - 2);
637        }
638      }
639    }
640   //end draw
641
642   if (update)
643    {
644     draw->Canvas.End ();
645     draw->Update ();
646    }
647
648   //RB0 mean value to gauge1
649   gauge1->SetValue ((pic.pins[33].oavalue - 55) / 2);
650   //RB1 mean value to gauge2
651   gauge2->SetValue ((pic.pins[32].oavalue - 55) / 2);
652
653  }
654
655  void
656  cboard_x::Run_CPU(void)
657  {
658   int i;
659   int j;
660   unsigned char pi;
661   const picpin * pins;
662   unsigned int alm[40];
663
664   int JUMPSTEPS = Window1.GetJUMPSTEPS (); //number of steps skipped
665   long int NSTEP = Window1.GetNSTEP () / MGetPinCount (); //number of steps in 100ms
666
667
668   //reset pins mean value
```

```
669  memset (alm, 0, 40 * sizeof (unsigned int));
670
671  //read pic.pins to a local variable to speed up
672  pins = pic.pins;
673
674  //Spare parts window pre process
675  if (use_spare)Window5.PreProcess ();
676
677  j = JUMPSTEPS; //step counter
678  if (Window1.Get_mcupwr ()) //if powered
679   for (i = 0; i < Window1.GetNSTEP (); i++) //repeat for number of steps in 100ms
680    {
681
682     if (j >= JUMPSTEPS)//if number of step is bigger than steps to skip
683      {
684       pic_set_pin (pic.mclr, p_RST);
685       pic_set_pin (19, p_BT1); //Set pin 19 (RD0) with button state
686       pic_set_pin (20, p_BT2); //Set pin 20 (RD1) with switch state
687      }
688
689     //verify if a breakpoint is reached if not run one instruction
690     if (!mplabxd_testbp ())pic_step ();
691     //Oscilloscope window process
692     if (use_oscope)Window4.SetSample ();
693     //Spare parts window process
694     if (use_spare)Window5.Process ();
695
696     //increment mean value counter if pin is high
697     alm[i % pic.PINCOUNT] += pins[i % pic.PINCOUNT].value;
698
699     if (j >= JUMPSTEPS)//if number of step is bigger than steps to skip
700      {
701
702       //set analog pin 2 (AN0) with value from scroll
703       pic_set_apin (2, (5.0 * pot1 / 199));
704
705       j = -1; //reset counter
706      }
707     j++; //counter increment
708    }
709
710  //calculate mean value
711  for (pi = 0; pi < pic.PINCOUNT; pi++)
712   {
713    pic.pins[pi].oavalue = (int) (((200.0 * alm[pi]) / NSTEP) + 55);
714   }
715
716  //Spare parts window pre post process
```

```
717   if (use_spare)Window5.PostProcess ();
718
719   //verifiy if LEDS need update
720   if (output_ids[O_LD0]->value != pic.pins[18].oavalue)
721    {
722     output_ids[O_LD0]->value = pic.pins[18].oavalue;
723     output_ids[O_LD0]->update = 1;
724    }
725   if (output_ids[O_LD1]->value != pic.pins[19].oavalue)
726    {
727     output_ids[O_LD1]->value = pic.pins[19].oavalue;
728     output_ids[O_LD1]->update = 1;
729    }
730   if (output_ids[O_RB0]->value != pic.pins[32].oavalue)
731    {
732     output_ids[O_RB0]->value = pic.pins[32].oavalue;
733     output_ids[O_RB0]->update = 1;
734    }
735   if (output_ids[O_RB1]->value != pic.pins[33].oavalue)
736    {
737     output_ids[O_RB1]->value = pic.pins[33].oavalue;
738     output_ids[O_RB1]->update = 1;
739    }
740
741 }
742
743
744 //Register the board in PICSimLab
745 board_init(BOARD_x_Name, cboard_x);
```

13.2.5 Integration with PICsimLab

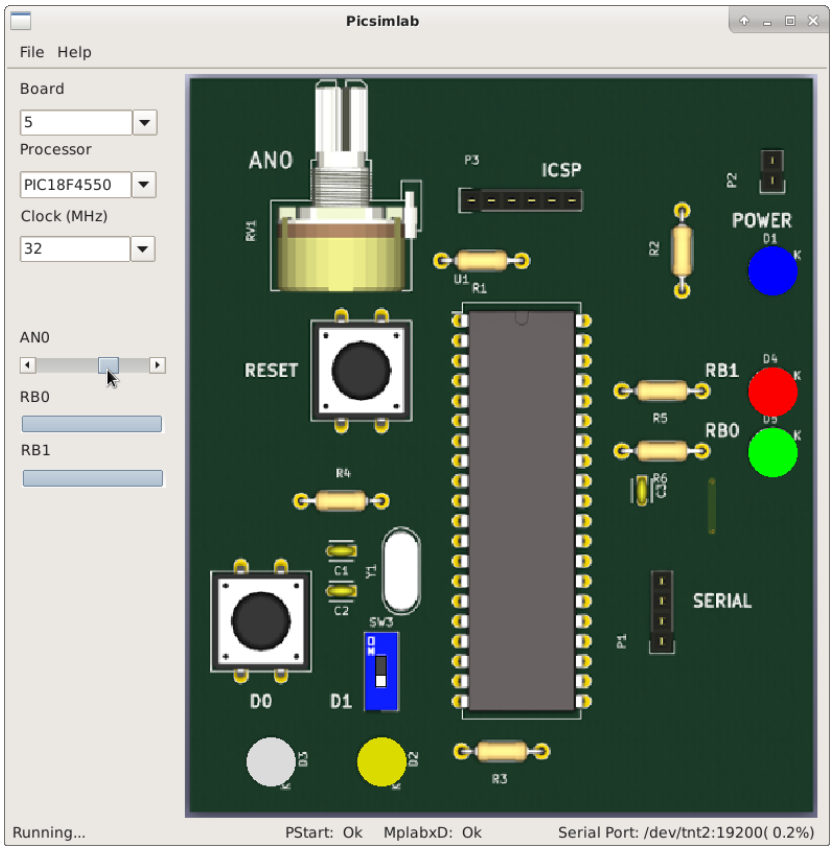
To integration of the new board in PICSimLab, are necessary edit one file.

The file is Makefile.Common. The only change to be made is include object **boards/board_board_x.o** in objects list. They can be added in variable OBJS or OBJS_EXP (used only in experimental version).

After change the Makefile.Common and include the five files created for new board, the PICSimLab can be recompiled, as described in first chapter.

13.2.6 Final Result

The PICSimLab board created for this tutorial are shown in the figure below.



The sample program below can be used to test new board, this code is write for XC8 compiler:

```
#include <xc.h>;

#include "config_4550.h"
#include "adc.h"
#include "serial.h"
#include "itoa.h"

void main()
{
  unsigned int  val;
  char buffer[10];

  ADCON1=0x02;
  TRISA=0xFF;
  TRISB=0xFC;
  TRISC=0xBF;
  TRISD=0xFF;
```

```
18    TRISE=0x0F;
19
20    adc_init();
21    serial_init();
22
23
24    while(1)
25    {
26        val=adc_amostra(0);
27
28        if(PORTDbits.RD1)
29        {
30          if(val > 340)
31             PORTBbits.RB0=1;
32          else
33            PORTBbits.RB0=0;
34
35          if(val > 680)
36            PORTBbits.RB1=1;
37          else
38            PORTBbits.RB1=0;
39        }
40        else
41        {
42            if(PORTDbits.RD0)
43            {
44                PORTBbits.RB0=1;
45                PORTBbits.RB1=0;
46            }
47            else
48            {
49                PORTBbits.RB0=0;
50                PORTBbits.RB1=1;
51            }
52
53        }
54
55        serial_tx_str(itoa(val,buffer));
56        serial_tx_str("\r\n");
57    }
58
59  }
```

Chapter 14

License