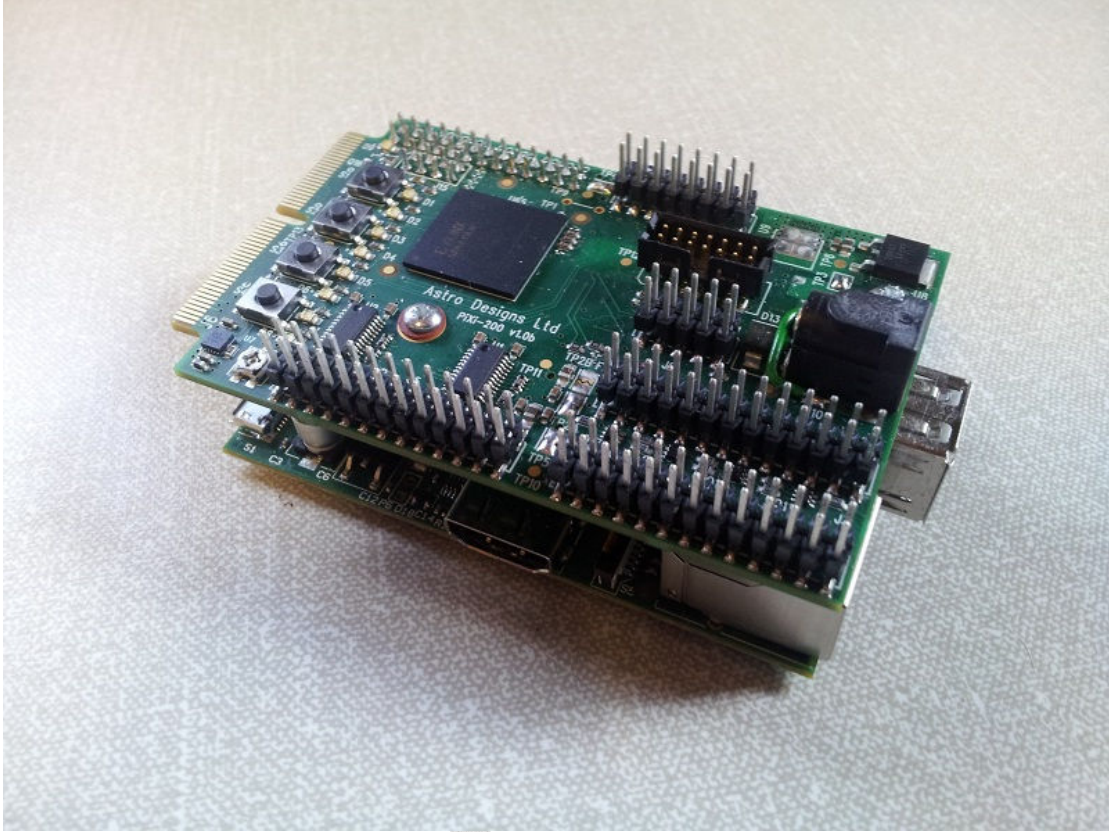


## Application Note AN-0019 (v1.0)

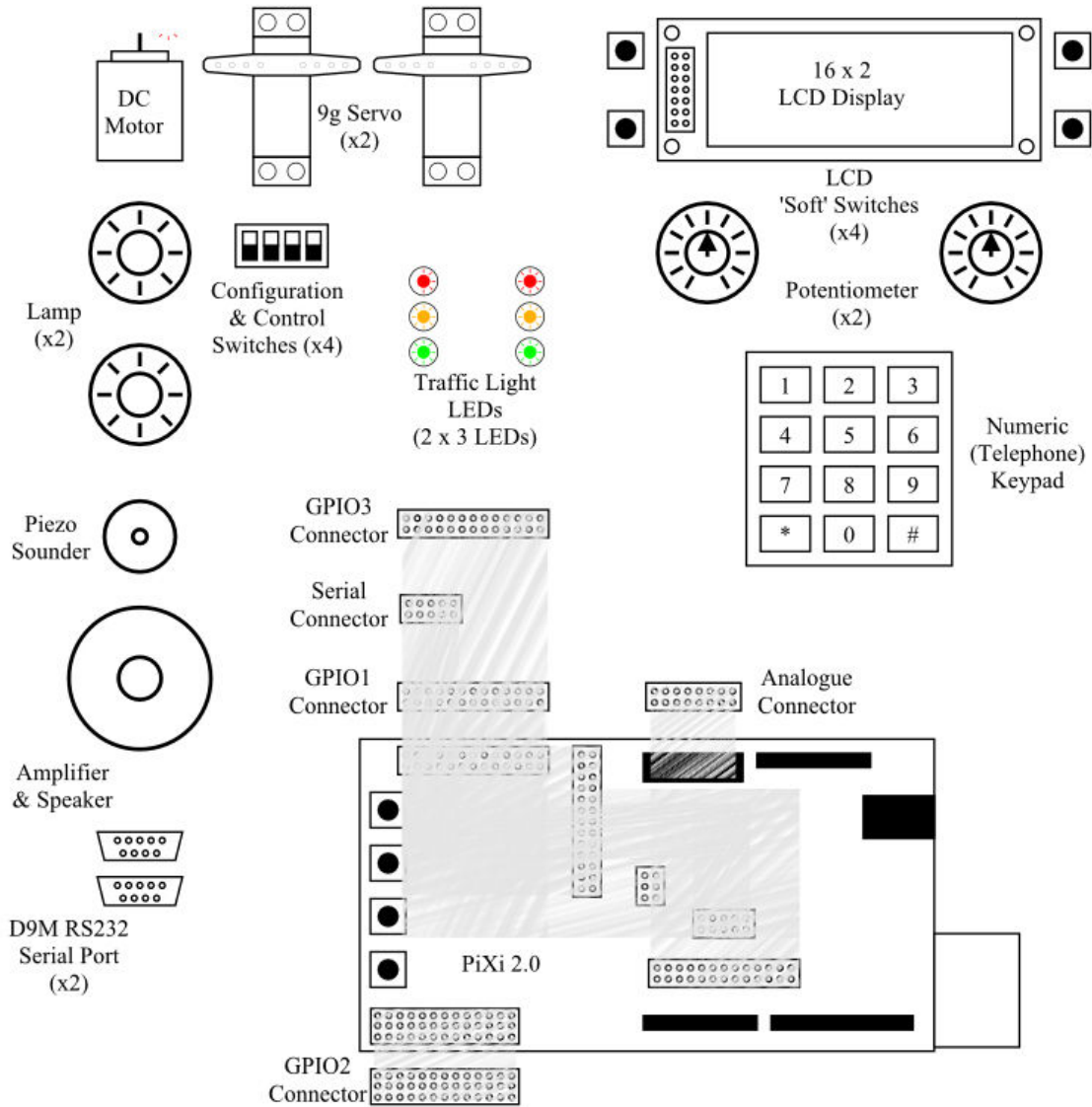
### Introducing the PiXi Experimenter



#### Summary

The Pixi (2.0) add-on for the Raspberry Pi is designed to expand the general-purpose I/O capabilities of the Raspberry Pi and provide a low cost means of introducing the user to the world of digital electronics and FPGA technology as well as giving the 'Pi Enthusiast' a few more features to play with. The low product cost and feature-packed specification of the PiXi-200 makes it ideal for applications in computing, hobby-electronics, education, training and product development.

This application note introduces the PiXi Experimenter board which is provided as an example design that uses and helps demonstrate some of the features of the PiXi to encourage the use of the PiXi in education.



### PiXi Experimenter Concept v1.001

**Figure 1 The basics of the PiXi Experimenter**

## Functions

The PiXi Experimenter provides a number of functions to entice any user who may be new to FPGAs into learning more about the VHDL & Verilog design languages and about FPGA technology.

Please note that while this product is in development, the specification and functions provided are subject to change.

### 1. PiXi Interface

Connectors are provided to allow the PiXi to be connected to the PiXi Experimenter using easily assembled ribbon cables & IDC connectors. This includes the GPIO1, GPIO2, GPIO3, Serial & Analogue interface connectors.

### 2. LCD Display

A 16 character, 2 line LCD module is provided, connected to GPIO3 on the PiXi. The user can use both the Raspberry Pi & FPGA to write messages to the display

### 3. Numeric Keypad

A 12 key (4 row x 3 column) telephone style keypad is provided, connected to GPIO1 on the PiXi. The user can use the Raspberry Pi & FPGA to detect & read key presses on the keypad.

### 4. DC Motor

A simple 5V DC motor is provided, connected to one of the 2-amp open-collector outputs on the PiXi's GPIO2 port. The user can use the Raspberry Pi & PiXi FPGA to control the motor both as simple on/off control or through pulse-width modulation to control the speed of the motor.

### 5. Miniature Servo (x2)

Two miniature 'radio-control' or 'hobby' analogue servos are provided, connected to two of the eight low-current open-collector outputs on the PiXi's GPIO2 port. The user can use either the Raspberry Pi or FPGA to control the position & movement of the servos.

### 6. Lamp

Two simple 5v torch bulbs, each on a MES style base are provided, connected to two of the eight 2-amp open-collector outputs on the PiXi's GPIO2 port. The user can use either the Raspberry Pi or PiXi FPGA to control the lamp using simple on/off control or through pulse width modulation to control the brightness of the lamp.

### 7. Piezo Sounder

A basic piezo sounder is provided for audio output functions, connected to one of the eight low-current open-collector outputs on the PiXi's GPIO2 port. The user can use the Raspberry Pi & PiXi FPGA to both enable the sounder and control the frequency of the tone out of the sounder.

## 8. Amplifier & Speaker

A low-power mono audio amplifier and speaker are provided for audio output functions, connected to one of the four DAC outputs from the PiXi's Analogue port. The user can use the Raspberry Pi to stream data to the DAC via I2C to generate a limited range of audio including tones, music & speech.

## 9. Potentiometer

Two potentiometers are provided for analogue inputs, connected to two of the eight ADC channels on the PiXi's Analogue port. The user can use the Raspberry Pi to read the data from the potentiometers over SPI.

## 10. BNC connector

Two BNC connectors are provided for analogue input functions, connected to two of the eight ADC channels on the PiXi's Analogue port. The user can use these connectors to create a simple low frequency oscilloscope or analogue (voltage) recording function.

## 11. L293D motor driver & connector

A four-channel motor driver is provided for external motor driver functions, connected to six of the 24 GPIO ports on the PiXi's GPIO1 port. The user can use the L293D to their own control stepper motors or brushed DC motors, including the use of PWM drivers in the PiXi FPGA to control both motor speed & direction.

## 12. Breadboard / prototyping area

We can't think of everything, so this area allows the user to add their own components and create their own input / output functions.

## 13. Switches

Around the outside of the LCD are four 'soft' switches that can be used with the LCD as menu controls, option selection etc., connected to four of the 24 GPIO ports on the PiXi's GPIO1 port. The user can use the Raspberry Pi and / or PiXi FPGA to scan these switches and act accordingly.

## 14. "Traffic Light" LEDs

We thought this would be a great little starter project so we added two sets of traffic lights (LEDs) that the user can create their own traffic light controller, either in software or in VHDL / Verilog. They are driven from six of the 24 GPIO ports on the PiXi's GPIO1 port. The user can use either the Raspberry Pi or PiXi FPGA to create a simple traffic-light control system.

## 15. Dual RS232 serial ports on 9-pin 'D' connectors

Two serial ports, running at RS232 levels are provided, connected to the PiXi's Serial port. The user can use the Raspberry Pi and / of PiXi FPGA to communicate with RS232 / serial peripherals through these ports.

## 16. Power & GPIO sockets

All of the power & GPIO functions available on the PiXi GPIO headers are brought out to sockets next to the breadboard prototyping area so that the user

can use any GPIO connection (that isn't already being used) on the prototyping area.

17. Something else?

## Further Reading

The PiXi User Manual (UM-002) has complete information on all features and interfaces on the PiXi.

If you want to learn more about programming the FPGA on the PiXi to customise the welcome message, please take a look at application notes AN-002 "Programming the FPGA on the PiXi" and AN-003 "FPGA Development on the PiXi".

PiXi-Tools is described in more detail in application note AN-020 "Installing PiXi-Tools on the Raspberry Pi".

All of these documents are available for download from [www.astro-designs.com](http://www.astro-designs.com).

## Acknowledgements

"Raspberry Pi" is a trademark of the Raspberry Pi Foundation.

Preliminary