Using PiDroidAlpha

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PiDroidAlpha User Manual v0.83

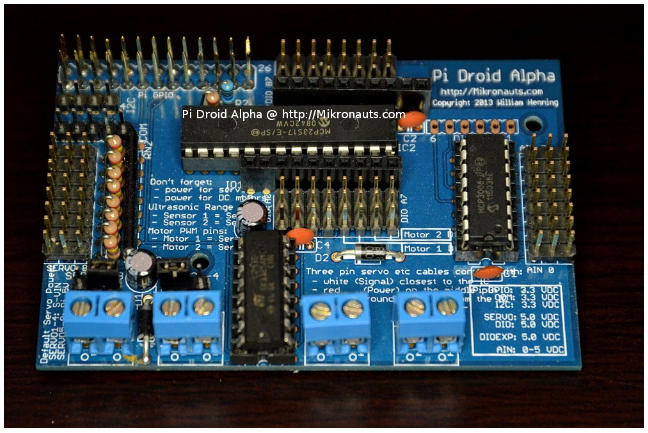
Photo 1: Fully assembled PiDroidAlpha v1.00

The most up to date documentation will always be available at:

http://www.mikronauts.com/raspberry-pi/pi-droid-alpha/

PRELIMINARY RELEASE

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Introducing PiDroidAlpha

This manual will show you how to control your robot chassis with PiDroidAlpha.

You will need to have already assembled your PiDroidAlpha controller board before you can try controlling your robot. Please see the **PiDroidAlpha Build Manual** for assembly instructions.

PiDroidAlpha was designed specifically for STEM robotics education and hobbyists at home.

Features

- 8 servo headers for up to eight servos, PWM outputs or digital I/O
- 16 servo compatible headers for 5V digital I/O via MCP23S17
- 8 servo compatible headers for an eight channel 0-5V MCP3008 analog to digital converter
- L293D dual h-bridge motor driver (shares two servo headers and four digital I/O headers)
- screw terminals for servo power, motor power, motor 1 and motor 2
- uses 26 pin stacking GPIO header for compatibility with 26 and 40 pin Raspberry Pi's
- two ten-pin Mikronauts I/O module expansion connectors for the MCP23S17 I/O expander
- 4 pin I2C expansion header for the Raspberry Pi
- 5 pin HCOM connector (optional)
- 6 pin SPI connector for up to seven additional MCP23S17 I/O expanders (optional)
- silk screened "cheat sheet" for voltages and I/O connections on the PCB
- mounting holes matching Rev.2 Model A and Model B
- Mikronauts EZasPi prototyping board can stack below Pi Droid Alpha
- Mikronauts Pi Jumper can stack on top of Pi Droid Alpha
- Mikronauts SchoolBoard][and other Propeller products are compatible with Pi Droid Alpha

Compatibility

Pi Droid Alpha is compatible with the following Raspberry Pi models:

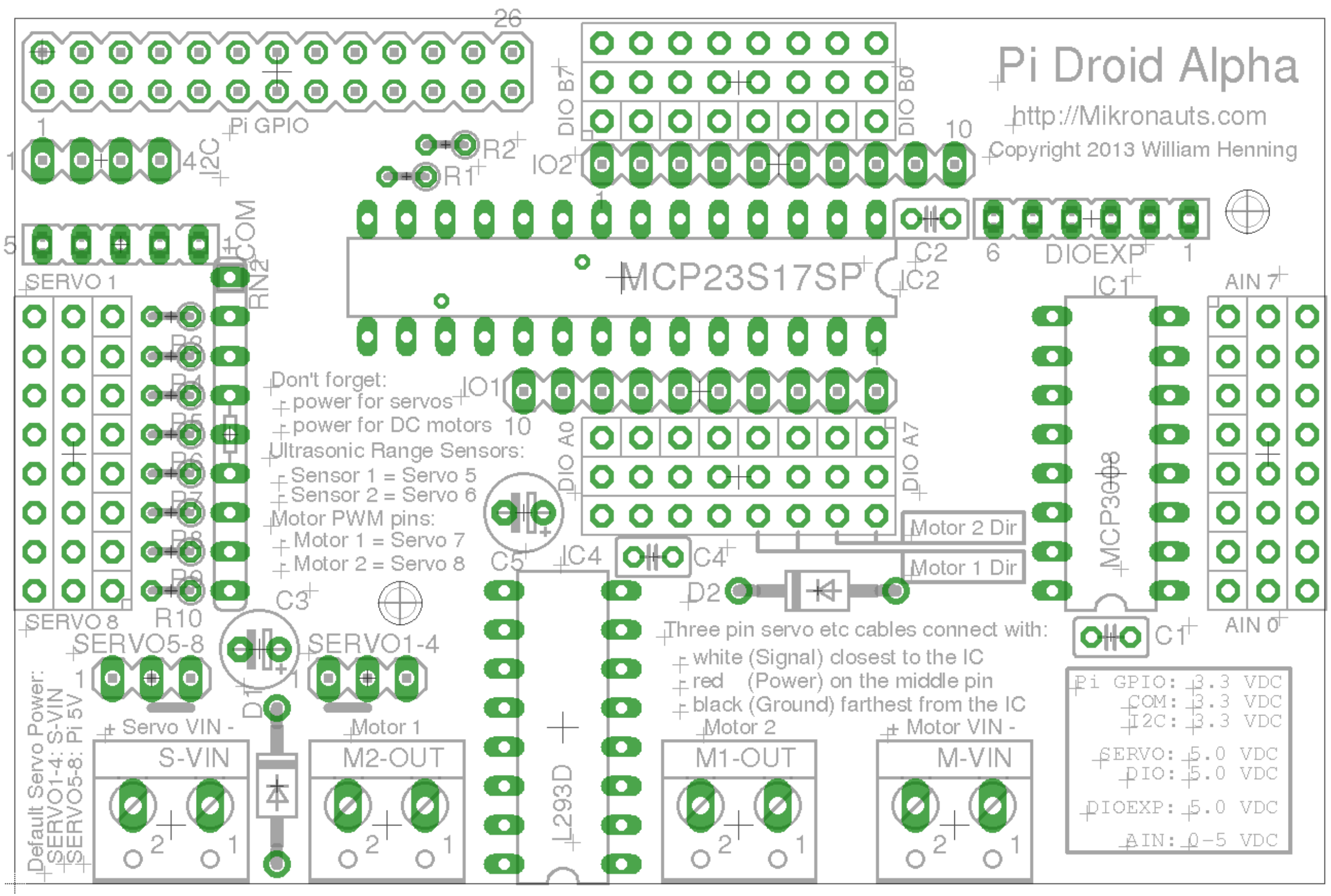
- Raspberry Pi 2 Model B
- Raspberry Pi Model A
- Raspberry Pi Model B
- Raspberry Pi Model A+
- Raspberry Pi Model B+

Pi Droid Alpha is currently supported for Raspbian with the pigpio library.

Pi Droid Alpha should be compatible with any operating system on the above model Raspberry Pi's as long as the pigpio library is available for the users choice of operating system.

Other single board computers that have a 26 pin Raspberry Pi compatible header are electrically compatible with Pi Droid Alpha, however if pigpio and/or servo blaster has not been ported to the other SBC, servo and PWM functionality will not be available.

Printed Circuit Board

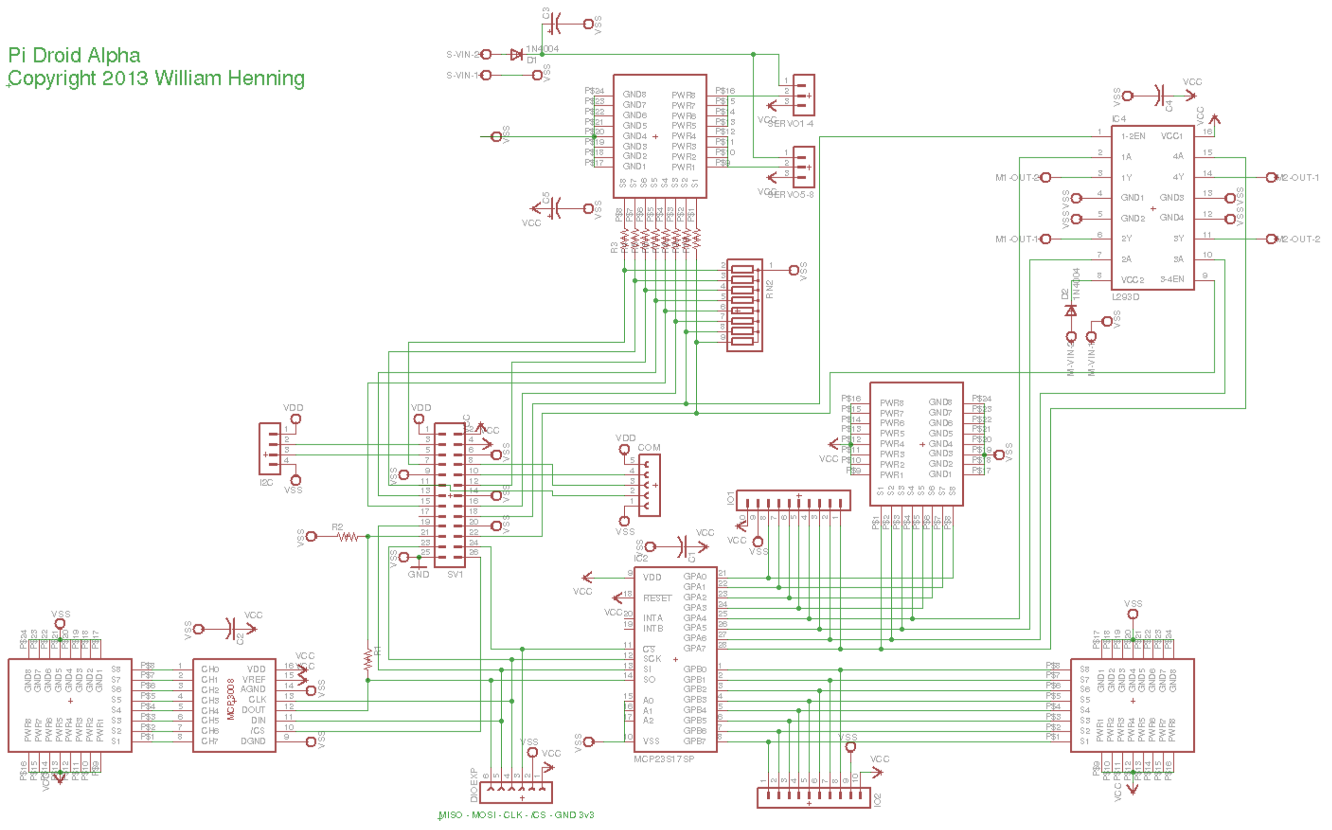


The image above shows the parts layout of Pi Droid Alpha.

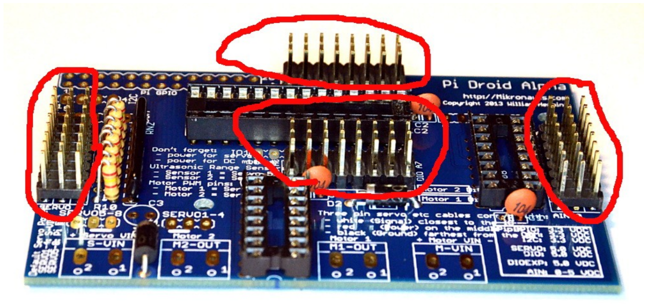
You can refer to this image when connecting servos, motors, sensors and other devices to Pi Droid Alpha.

Schematics

The schematic below shows you how Pi Droid Alpha works, and may help you decide how to connect your sensors etc to Pi Droid Alpha.



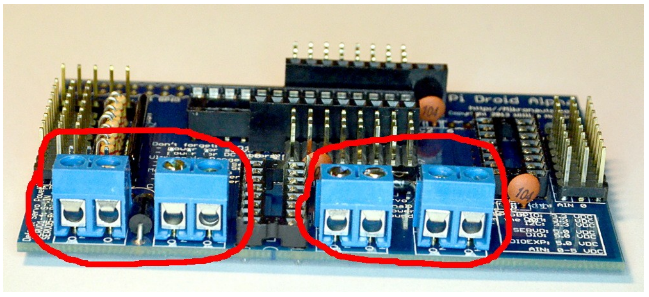
3x8 servo headers (SERVO, DIO A, DIO B, AIN)



The servo headers are used to connect standard servos, and other 5V input and output signals.

- SERVO1-SERVO8 are connected to Raspberry Pi pins through a voltage divider
- DIO A0-A7 and DIO B0-B7 are connected to the MCP23S17 I/O expander pins.
- AIN 0-7 are connected to the MCP3008 analog to digital converter.

Wago Screw Terminals (Servo VIN, Motor VIN, Motor 1, Motor 2)



There are four screw terminals on Pi Droid Alpha.

From left to right:

- Servo VIN – external power for servo motors
- Motor 2 – connector for motor 2 of the L293D dual h-bridge motor driver
- Motor 1 – connector for motor 1 of the L293D dual h-bridge motor driver
- Motor VIN – external power for the motors connected to Motor 1 & Motor 2

Please note that Servo VIN and Motor VIN have protection diodes in case you accidentally connect the batteries in reverse.

- Servo VIN should not exceed the maximum voltage for the servos you are using by more than 0.7V, for example 6.7V is the maximum Servo VIN if all your servos support 6V
- Motor VIN should not exceed the maximum voltage for the gear motors you are using > 1.4V, so for example if your motors maximum voltage is 6V, do not exceed more than 7.4V

Choosing Servo power source with shunts

SERVO1-4 & SERVO5-8

Do not try to run the motors from the Pi's 5V supply!

Programming PiDroidAlpha

You can program your Pi Droid Alpha in any language on the Raspberry Pi that supports pigpio and/or servoblaster.

Mikronauts provides an easy to use Python API for Pi Droid Alpha (PDALib.py) that is compatible with our RoboPi API (RoboPiLib.py) allowing you to write code that will run with either of our robot controllers.

PiDroidAlpha I/O pin definitions

You can use the handy pin header table below to plan your robot:

Label	GPIO	RoboPi API	Used For	Planned Use for my Robot
SERVO 1	GPIO4	0	-	
SERVO 2	GPIO17	1	HCOM	*(not available if HCOM is used)*
SERVO 3	GPIO18	2	-	
SERVO 4	GPIO27	3	-	
SERVO 5	GPIO22	4	-	
SERVO 6	GPIO23	5	-	
SERVO 7	GPIO24	6	Motor1 PWM	*(not available if L293D is used)*
SERVO 8	GPIO25	7	Motor2 PWM	*(not available if L293D is used)*
DIO A0	-	8	-	
DIO A1	-	9	-	
DIO A2	-	10	-	
DIO A3	-	11	-	
DIO A4	-	12	Motor1 DirA	*(not available if L293D is used)*
DIO A5	-	13	Motor1 DirB	*(not available if L293D is used)*
DIO A6	-	14	Motor2 DirA	*(not available if L293D is used)*
DIO A7	-	15	Motor2 DirB	*(not available if L293D is used)*
DIO B0	-	16	-	
DIO B1	-	17	-	
DIO B2	-	18	-	
DIO B3	-	19	-	
DIO B4	-	20	-	
DIO B5	-	21	-	
DIO B6	-	22	-	
DIO B7	-	23	-	
AIN 1	-	0	-	
AIN 2	-	1	-	
AIN 3	-	2	-	
AIN 4	-	3	-	
AIN 5	-	4	-	
AIN 6	-	5	-	
AIN 7	-	6	-	
AIN 8	-	7	-	

SERVO 1-8	5V safe digital input/output direct to Raspberry Pi GPIO's
DIO A0-A7, B0-B7	5V digital input/output provided by MCP23S17
AIN 1-7	0-5V analog to digital input channels

Installing Required Software

Raspbian

Please download the latest version of Raspbian from http://www.raspberrypi.org/downloads/

Then follow the instructions you can find at the link below to install Raspbian.

https://www.raspberrypi.org/documentation/installation/installing-images/README.md

After you have installed Raspbian, please type the following into a terminal session:

sudo raspi-config

From the 'advanced menu', please enable SPI and I2C, and then choose

'expand filesystem', finish and re-boot.

Adding a WiFi adapter

Please follow the instructions provided by the Raspberry Pi Foundation at

https://www.raspberrypi.org/documentation/configuration/wireless/

pigpio

Please follow the instructions at the link below to install pigpio

http://abyz.co.uk/rpi/pigpio/download.html

The PiDroidAlpha demos require that pigpio is installed on your Raspberry Pi.

PDALib.py

Please download PDALib_py.txt from http://www.mikronauts.com/raspberry-pi/pi-droid-alpha/

use “*mv PDALib_py.txt PDALib.py*” from the command line, or use the file manager to rename it.

Introducing PDALib

PDALib is a library designed to provide an easy to use Python interface for Pi Droid Alpha on a Raspberry Pi.

PDALib was designed to make it easy to write programs on the Raspberry Pi that use all of the features of Pi Droid Alpha, and was designed to be familiar to those coming to Pi Droid Alpha from WiringPi, Arduino or Wiring environments.

The Python PDALib interface is almost identical to the RoboPiLib Python interface for Mikronauts RoboPi Advanced Robot Controller – allowing you to write robot applications in Python that will work with either of our robot controller boards.

Python RoboLib Constants

Digital pins can be configured for one of the following four modes:

INPUT	pin mode for a digital input
OUTPUT	pin mode for a digital output
PWM	pin mode for a PWM output (0..255)
SERVO	pin mode for a servo output (0..2500)

Python RoboPiLib Functions

RoboPiInit(device, bps)		use RoboPiInit("/dev/ttyAMA0",115200)
RoboPiExit()		close the serial connection with RoboPi
readMode(pin)	returns int	returns INPUT/OUTPUT/SERVO/PWM
pinMode(pin, mode)		set pin to one of INPUT/OUTPUT/SERVO/PWM
digitalRead(pin)	returns int	returns 0 or 1 state of pin
digitalWrite(pin, val)		sets pin to 0 or 1
analogRead(chan)	returns int	returns 0..1023 from specified channel
analogReadRaw(pin)	returns int	returns 0..4095 from specified channel
analogWrite(pin, val)		write 0..255 to PWM pin (off to full on)
servoRead(pin)	returns int	return last servo value written to pin
servoWrite(pin, val)		set servo on pin to val (0..2500 us)
readDistance(pin)		*future expansion, not available at this time*

RoboPiInit(device, bps)

Initialize the robot interface library

Returns

0	if initialization was successful
-1	if there was an error

For RoboPi and PiDroidAlpha, use

RoboPiInit("/dev/ttyAMA0",115200)

Pi Droid Alpha will ignore the parameters, it only accepts them for portability.

RoboPiInit("",0)

Will work just as well on PiDroid Alpha (but not on RoboPi)

RoboPiExit()

Free the resources used by PDALib, call before exiting your program.

Returns

0	if freeing resources was successful
-1	if there was an error while freeing resources

readMode(pin)

returns int	returns INPUT/OUTPUT/SERVO/PWM/PING

Returns

mode	the current mode of the specified pin
-1	if the pin is invalid

pin = 0..7 Raspberry Pi pins used for SERVO1-8 support the following modes

INPUT	returns 0 or 1 from digital input
OUTPUT	sets digital output to 0 or 1
SERVO	set servo position to 0 or 500-2500us
PWM	set PWM output from 0..255
PING	reserved for future Propeller Ping and other ultrasonic sensor support

pin = 8..24 for the DIO pins A0-A7, B0-B7

INPUT	returns 0 or 1 from digital input
OUTPUT	sets digital output to 0 or 1

Returns

0	if the mode was set correctly
-1	if the pin or mode was invalid

pinMode(pin, mode)

set pin to one of INPUT/OUTPUT/SERVO/PWM

pin = 0..7 **Raspberry Pi pins used for SERVO1-8 support the following modes**

INPUT	returns 0 or 1 from digital input
OUTPUT	sets digital output to 0 or 1
SERVO	set servo position to 0 or 500-2500us
PWM	set PWM output from 0..255
PING	reserved for future Propeller Ping and other ultrasonic sensor support

pin = 8..24 **for the DIO pins A0-A7, B0-B7**

INPUT	returns 0 or 1 from digital input
OUTPUT	sets digital output to 0 or 1

Returns

0	if the mode was set correctly
-1	if the pin or mode was invalid

digitalRead(pin)

returns int	returns 0 or 1 state of pin

Returns

0	if the mode was set correctly
-1	if the pin or mode was invalid

digitalWrite(pin, val)

Returns int	sets pin to 0 or 1

Returns

0	if the pin was written
-1	if the pin was invalid

analogRead(chan)

returns int	returns 0..1023 from specified channel

Returns

value	the current analog value of the specified channel
-1	if the channel was invalid

analogReadRaw(chan)

returns int	returns 0..4095 from specified channel

Returns

value	the current analog value of the specified channel
-1	if the channel was invalid

As Pi Droid Alpha uses the ten bit MCP3008 Analog-to-Digital converter, analogReadRaw() returns the ten bit result shifted left two bits to generate a 12 bit number at this time.

Future API releases may change to returning the sum of four consecutive samples in order to generate a 12 bit result.

analogWrite(pin, val)

write 0..255 to PWM pin (off to full on)

You must

pinMode(pin,robot.PWM)

before you can analogWrite() to the pin

Returns

0	if the PWM value was set
-1	if the PWM channel was invalid

servoRead(pin)

returns int	return last servo value written to pin

Returns

0	if the pin was written
-1	if the pin was invalid

servoWrite(pin, val)

set servo on pin (0..7) to val (0..2500 us)

Returns

0	if the pin was written
-1	if the pin was invalid

Note: the specified pin must be configured for servo output in order for the servoWrite() to take effect.

readDistance(int pin)

Reserved name, currently being worked on

returns int	return distance to nearest object in milimeters

Returns

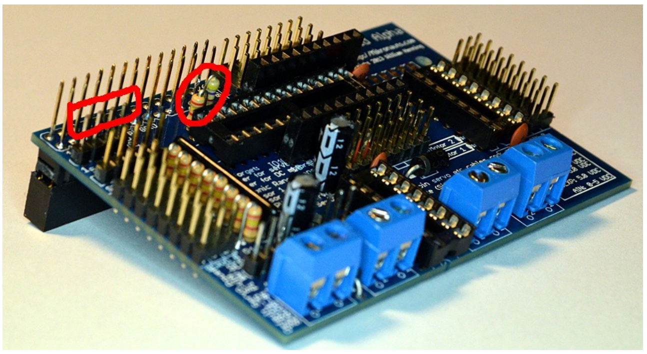
0	if the pin was written
-1	if the pin was invalid

readDistance() IS NOT AVAILABLE IN THIS RELEASE, RESERVED FOR FUTURE USE

Sample Program

```
import PDALib as robot

 # for RoboPi compatibility, Pi Droid Alpha ignores the parameters
robot.RoboPiInit(“/dev/ttyAMA0”,115200)

# set pin 16 to an output and write 1 to it
robot.pinMode(16,robot.OUTPUT)
robot.digitalWrite(16,1)

# set pin 1 to a PWM output and generate a 50% PWM on pin 17
robot.pinMode(1,RoboPi.PWM)
robot.analogWrite(1,127)

# read analog input 0
print robot.analogRead(0)
```

Adding I2C Modules



The I2C header is for future expansion modules for your robot such as compass modules.

R1 and R2 form a voltage divider so that the 5V MISO signal from the digital I/O expander and the analog to digital converter is divided down to 3.3V in order not to harm the Raspberry Pi.

Adding a Solderless Breadboard for experiments

There are several ways of experimenting with additional sensors and circuits for your robot:

- attach a solderless breadboard to your robot
- add a SchoolBoard][to your robot
  http://www.mikronauts.com/proto/schoolboard/
- stack a prototyping board between Pi Droid Alpha and your Raspberry Pi
  http://www.mikronauts.com/raspberry-pi/ezaspi/
  http://www.mikronauts.com/proto/ezaspieproto300/

You can then use Dupont wires to connect to the headers on Pi Droid Alpha.

Examples

Reading a bumper switch or whisker

Lighting an LED

Sounding a Buzzer

Controlling Gear Motors

Controlling a Servo

Reading an IR distance sensor

Random Driving Robot #1: Bumper Switches / Whiskers

Appendix A: Data Sheets

MCP3008 Analog to Digital converter

http://ww1.microchip.com/downloads/en/DeviceDoc/21295C.pdf

MCP23S17 Digital I/O expander

http://ww1.microchip.com/downloads/en/DeviceDoc/21952b.pdf

L293D motor driver

http://www.st.com/st-web-ui/static/active/en/resource/technical/document/datasheet/CD00000059.pdf

Appendix B: Support

Please visit our forums at:

http://forums.mikronauts.com

Once you register there, you can get support for Pi Droid Alpha in its support forum

Appendix C: Frequently Asked Questions

Q: Where can we buy PiDroidAlpha?

A: Currently you can buy PiDroidAlpha:

Directly from us – please email us at mikronauts@gmail.com with desired quantity and postal address, we will be happy to send you a quote. We accept PayPal from verified buyers.

From our Ebay store – please visit us at out Mikronauts Ebay store!

<add actual URL>

Distributors and dealers are welcome to contact us for quantity discounts – we would love to have you on-board!

Q: Are quantity and educational discounts available for PiDroidAlpha?

A: Yes! We are happy to offer quantity based discounts to our educational users and distributors.

Please contact us for a custom quote.

Q: Can we make our own PiDroidAlpha printed circuit boards?

A: I am afraid not. While PiDroidAlpha is an open platform in that it is fully documented, with source code

available for its libraries and demo applications, PiDroidAlpha is a commercial product, and may not becopied.

Q: Can we use the MCP3208 12 bit analog to digital converter instead of the MCP3008?

A: Yes, you can – but the driver needs to be modified, and the PiDroidAlpha libraries and demo programs assume that an MCP3008 is used.

Q: Do you have any distributors in <name of country>?

A: We are working hard to set up our distribution network. Please email your favorite web stores and have them contact us if they are interested in PiDroidAlpha.