Propteus rev. 2.0 Build Manual

Manual v1.00
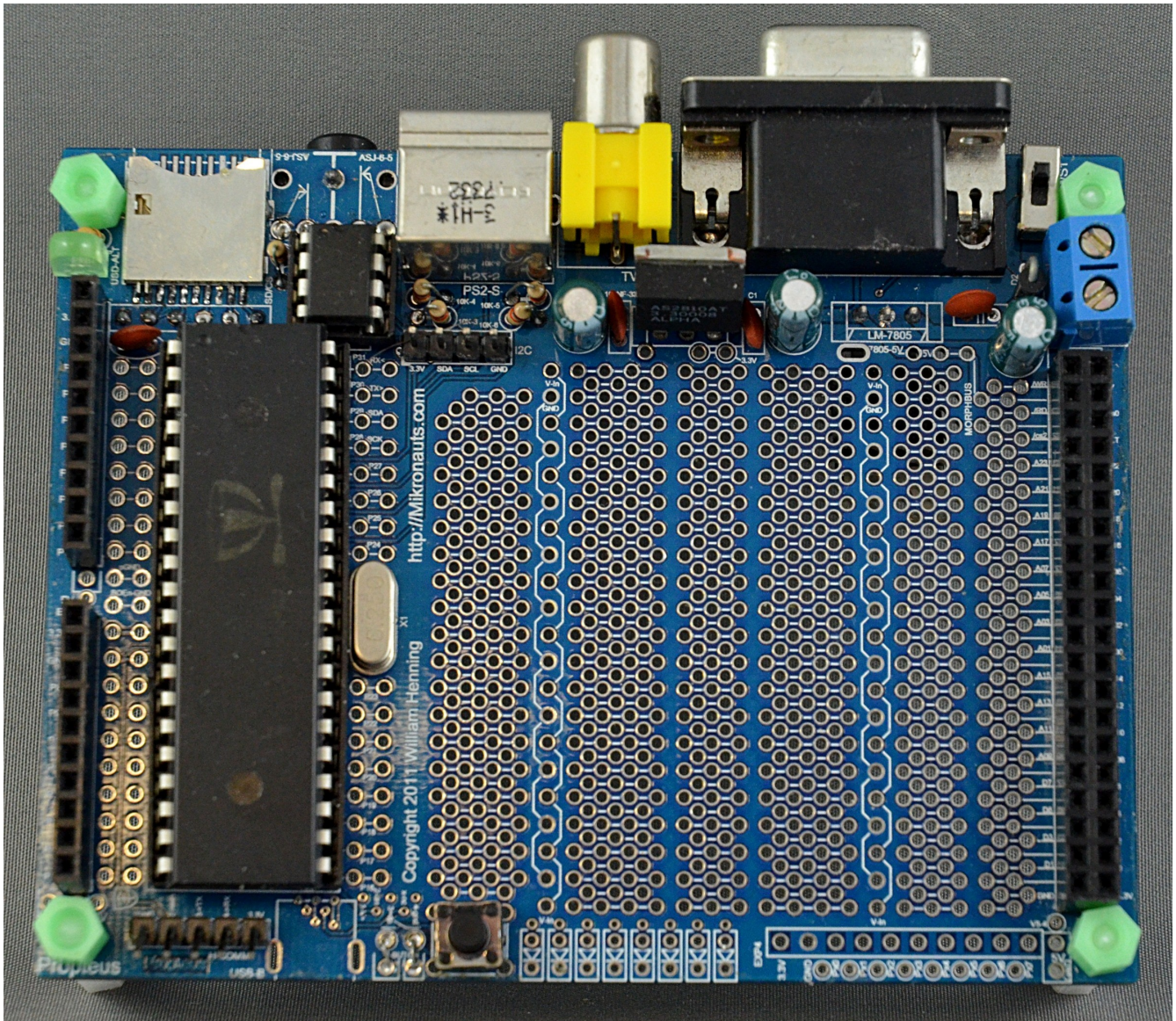

Figure 1: Fully Assembled Propteus rev. 2.0 printed circuit board

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Introduction

Thank you for purchasing the Propteus development board for the Parallax Propeller microcontroller.

In 2009 I introduced four boards:

- Morpheus - advanced dual processor Propeller based single board computer with 512KB fast parallel memory and high resolution bit-mapped VGA graphics with up to 256 colours per pixel
- Mem+ - a 2MB memory expansion board for Mem+ which also added 16 bits of parallel I/O and support for a full size SD card that stacks on top of Morpheus
- Proteus – a simple bussed prototyping board that stacks on top of Morpheus or Propteus
- Propteus – a simple Propeller development board with a large prototyping area

Propteus rev. 2.0 is the latest version of the original Propteus; and it significantly improves on the original Propteus by adding support for the most popular features of the Propeller Demo board and supporting an optional micro SD card.

Propteus rev. 2.0 is designed to be built in a number of different ways:

1. minimal Propeller development board with just voltage regulation, processor and eeprom
2. full Propeller system with VGA, TV, PS/2 keyboard, Audio and micro SD card
3. any custom configuration you desire

Where possible, the standard Parallax Proto Board and Demo Board pin assignments were used for Propteus so that it would be compatible with Obex objects.

Propteus Features

- 32KB or 64KB EEPROM

- Parallax Propeller (tm) P8X32 microcontroller

- 80MHz (5MHz crystal) or 100Mhz (6.25MHz crystal) operation

- screw terminal for 7-9VDC power input

- mini power switch

- LM7805 based 5V regulated power supply

- LT1117-3.3V based 3.3V regulated power supply

- two EXP 10 pin module connectors

- one MORPHBUS connector

- PropPlug / SerPlug compatible HCOMM connector

- four pin I2C expansion connector

- power LED

- large high density advanced prototyping area

- unique zig-zag power bus for prototyping area

- optional micro SD socket

- optional TV output

- optional VGA output

- optional stereo 1/8" audio jack

- optional PS/2 keyboard/mouse connector

- optional additional 10 pin header location

- optional area for 8 LED's

- optional user/reset switch

The large prototyping area can be used to implement application-specific circuitry, and if more prototyping real estate is needed, there are a number of Mikronauts prototyping printed circuit boards that can stack on top of Propteus.

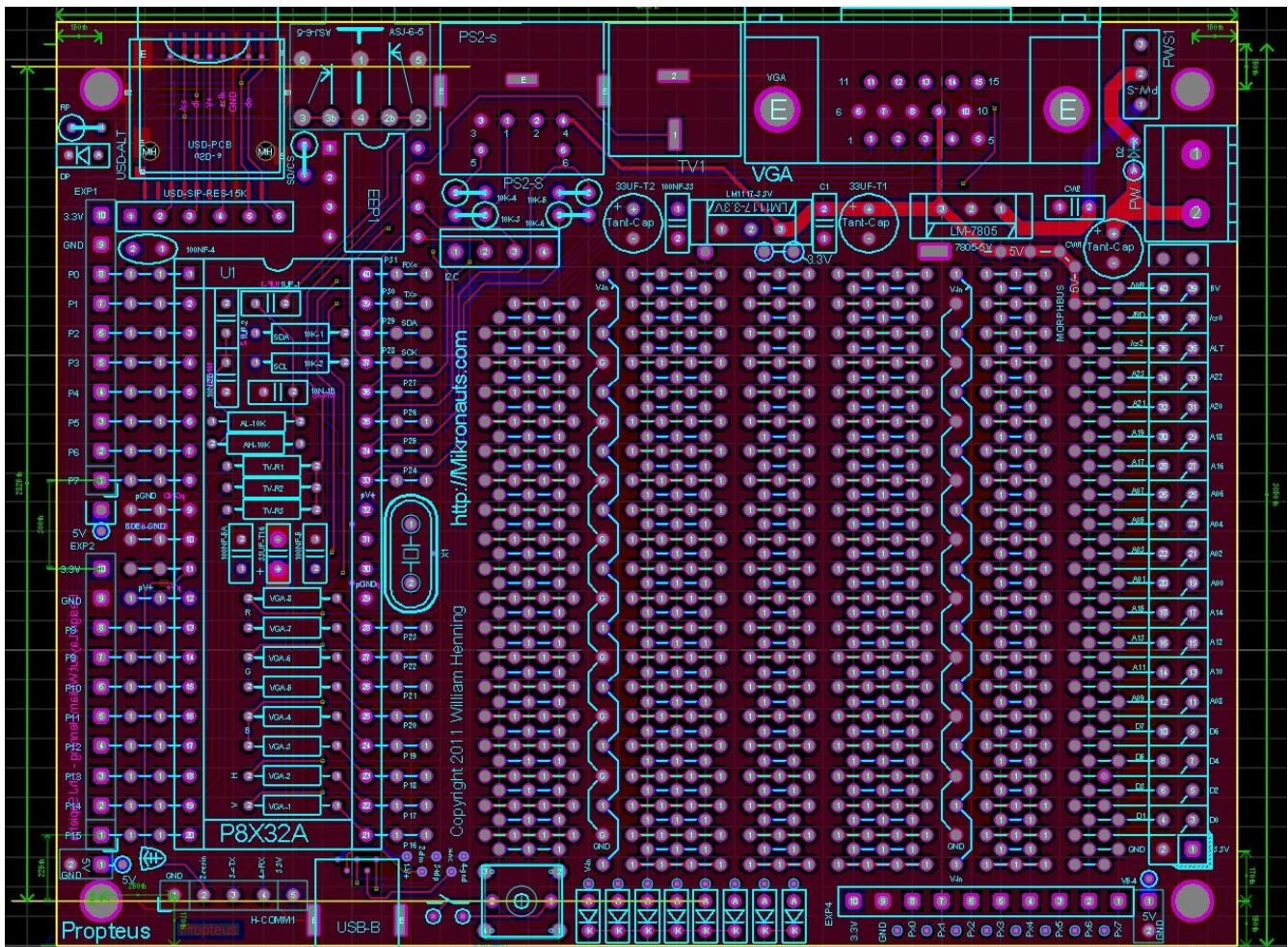If Propteus is equipped with stacking connectors, other boards can even be stacked below Propteus.

Figure 2: Propteus rev.2 Printed Circuit Board rendering

You can see where the various components and connectors can be mounted on the rendering above.

Due to its flexible layout, there are many ways of assembling Propteus.

In this manual, we will build the board section by section for easy troubleshooting.

Kit Contents

Propteus is available as a "Base Kit" and a number of add-on kits. You can also get a "Full Kit" which is simply a combination of the "Base Kit" and all of the add-on kits.

Base Kit

Qty	Description	Digikey Part No.
1	Mikronauts Propteus rev.2 PCB	n/a
1	DIP-40 Propeller P8X32	P8X32A-D40-ND
1	DIP-8 24LC256 EEPROM	24LC256-I/P-ND
1	DIP-40 socket	3M5471-ND
1	DIP-8 socket	3M5473-ND
1	2x20 Female standard header	SAM1086-20-ND
2	1x10 Female standard header	SAM1122-10-ND
3	12 pin male headers	SAM1035-07-ND
1	5 pin male prog header	SAM1035-05-ND
1	4 pin male i2c header	SAM1035-04-ND
1	4 pin female short header	SAM1086-02-ND
1	SPDT mini slide switch	CKC5124-ND
1	Momentary SPST switch	P8007S-ND
1	LED Red for power indicator	754-1201-ND
4	LED Green user indicators	67-1127-ND
1	5MHz Crystal	X410-ND
1	LM7805	LM7805CT-ND
1	AS2810 or LM1117 3.3 Vreg	LM1117T-3.3-ND
1	1N4007 protection diode	1N4007FSCT-ND
5	470R resistors	470EBK-ND
3	10K resistor for reset switch	CF1/810KJRCT-ND
1	33uF electrolytic capacitor	P10320-ND
3	47uF electrolytic capacitor	P5137-ND
5	100nF ceramic capacitors	490-3873-ND
1	Wagp .500 2 screw terminal	A97996-ND

VGA add-on (optional)

Qty	Description	Digikey Part No.
1	VGA DB15HD Female PCB connector	A35116-ND
3	240 ohm resistors	240EBK-ND
2	270 ohm resistors	270EBK-ND
3	470 ohm resistors	470EBK-ND
1	100nF ceramic capacitors	490-3873-ND

TV output add-on (optional)

Qty	Description	Digikey Part No.
1	RCA jack	CP-1421-ND
1	270 ohm resistors	270EBK-ND
2	560 ohm resistors	560EBK-ND
1	1.1k ohm resistor	P1.1KBACT-ND

micro SD add-on (optional)

Description	Digikey Part No.
15k 6 pin sip	4606X-1-153LF-ND
15k ohm resistor	CF14JT15K0CT-ND
100nF ceramic capacitor	490-3873-ND
micro SD card socket	see note below

NOTE:

The SD card socket should be the first part installed on Propteus, so you should get this add-on if think you might ever want to use a micro SD card for storage on Propteus.

If you did not install a Mikronauts micro SD connector first, you may be able to install a hinged micro SD card connector Hirose DM3C-SF (Mouser part number 798-DM3C-SF, Digikey part number HR1940CT-ND) as the printed circuit footprint was designed to accommodate both types of micro SD connectors.

PS/2 keyboard / mouse add-on (optional)

Qty	Description	Digikey Part No.
4	10K resistor for PS/2 connector	CF1/810KJRCT-ND
1	PS/2 socket	CP-2260-ND

Stereo 1/8" line-level audio jack add-on (optional)

Qty	Description	Digikey Part No.
2	10k resistors for audio out	CF1/810KJRCT-ND
2	10nF ceramic capacitors	399-4326-ND
2	1uF ceramic or electrolytic capacitors	478-3195-ND
1	1/8" audio jack	CP1-3523N-ND

LED add-on (optional)

Qty	Description	Digikey Part No.
4	LED Green user indicators	67-1127-ND

You will need to add appropriate current limiting resistors for the optional LED's.

The resistor values depend on the forward voltage drop of the LED's, their maximum current and what voltage you are powering them from.

The web site below has a very nice LED current limiting resistor calculator that you can use:

http://led.linear1.org/1led.wiz

Building Propteus rev. 2.0 Base Kit

If you intend to install the micro SD card socket, it is best to install it first, before any other component, as that will allow for the easiest soldering of the surface mount leads of the micro SD socket.

As a general rule of thumb, it is easiest to assemble printed circuit boards with the shortest components being placed first.

Some components will mounted on the bottom of the printed circuit board so that SchoolBoard][will easily stack on top of Propteus.
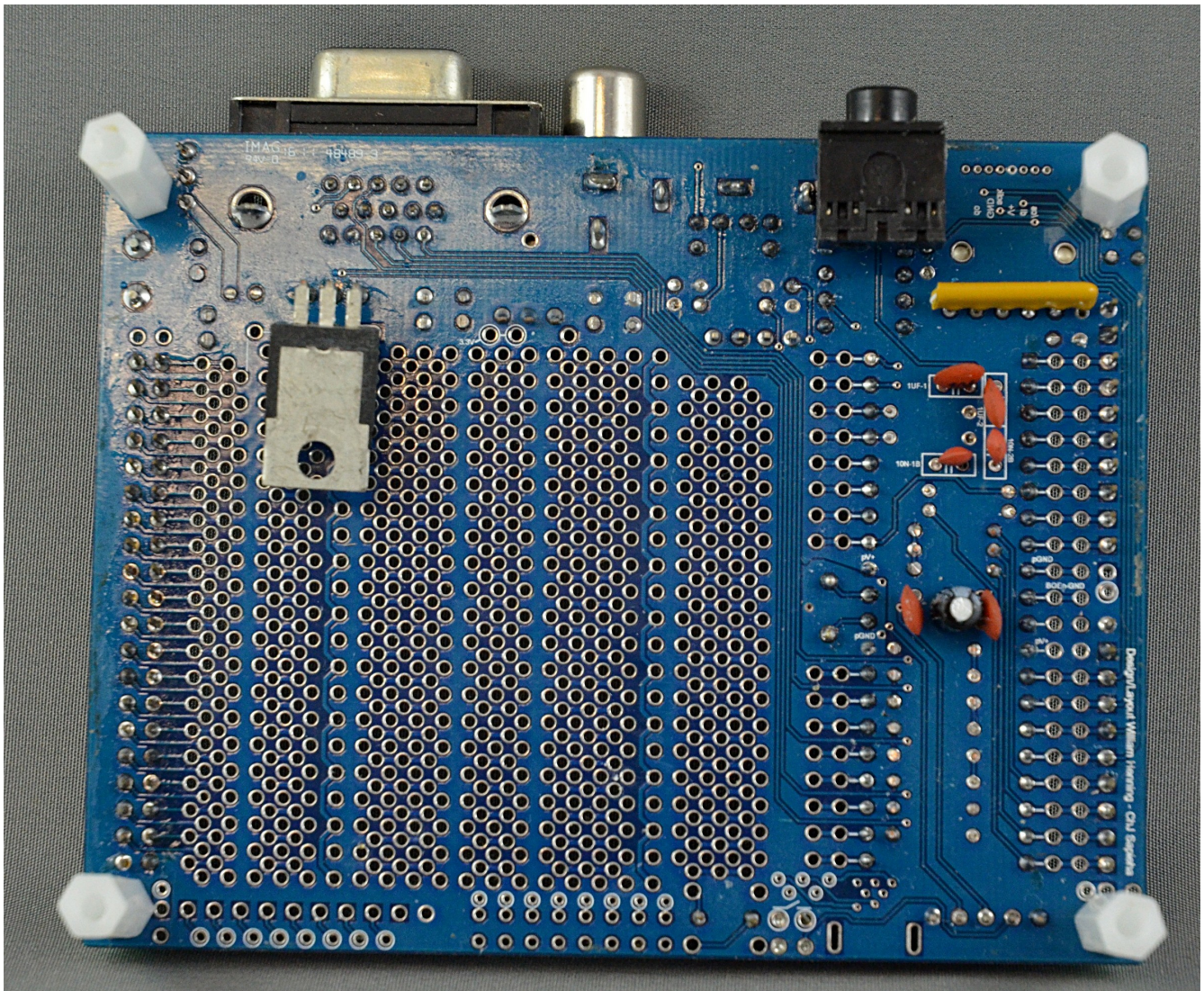

Figure 3: Bottom of Propteus rev. 2.0 with all options imstalled

(100nF ceramic capacitors were substituted for the 1uF ceramic or electrolytic capacitors above.)

NOTE

The voltage regulator, Propeller capacitors, audio capacitors, audio jack and SIP resistor for the micro SD socket are mounted on the bottom of the printed circuit board.

While the Propteus base kit does not include the optional parts needed for the micro SD section, if you want to have micro SD support right on Propteus, it is the first thing you should install.

Step 1: Install optional micro SD socket first

The only part on Propteus that may be difficult for you to install is the micro SD socket, which is why we suggest that if you ever intend to install it, you install it before you install any other parts.

Unfortunately, the micro SD connector is a surface mount device, with most pins being spaced 0.05" (1.27mm) apart – and two pins are even a bit closer!

Don't panic – it is not as difficult to solder as it may appear at first glance. If you have any problems, just use solder wick to remove the excess solder. Don't be afraid to ask for help from a teacher or a friend if you have problems.
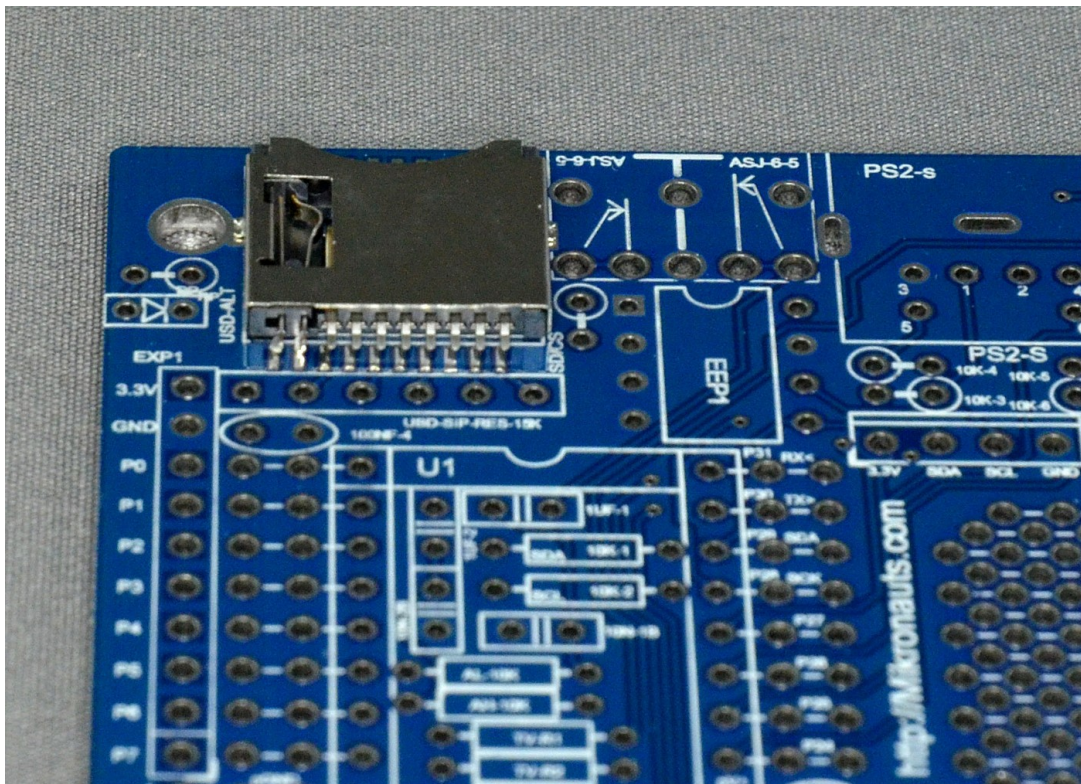

Figure 4: Mikronauts standard micro SD socket placement

Place the socket on the printed circuit board – you will notice that once it is in the right place, it will

pretty much stay there due to the small mounting holes for the plastic "feet" on the bottom of the socket.

With the socket in the correct position, you can use a rubber band to hold it in place while you solder the grounding tabs on the sides of the socket – but please make sure that the small legs are sitting on the printed circuit footprint; if they are "up in the air" than the socket is not seated properly.

Place the tip of a fine-tip soldering iron on each small leg and footprint, applying heat for about three seconds, then just touch thin solder to the leg/footprint. **USE ONLY A TINY AMOUNT OF SOLDER** and you should get a nice shiny good connection to the board.

Don't worry if two pins are bridged – you can use solder wick to remove the excess solder.

Step 2: Install the capacitors for the Propeller chip

First, install the two 100nF ceramic and 33uF electrolytic capacitor on the bottom of the PCB under the Propeller socket, then install the 100nF ceramic capacitor to the left of the DIP40 socket

Step 3: Install the I2C pullup resistors

Install the two 10K resistors towards the top of the DIP 40 socket for the Propeller. Be careful, the resistors fit tightly against the socket, so try to fit the socket against the resistors before soldering the socket. If you need to, you can trim some of the plastic at on the bottom of the DIP 40 socket with an XActo knive to make it fit nicely.

Step 4: Install the Crystal

Install the 5.0MHz or 6.25MHz crystal where shown on the printed circuit board.

Step 5: Install the DIP sockets and RESET switch

Install the 40 pin DIP socket for the Propeller, and the 8 pin dip socket for the EEPROM where indicated on the printed circuit board.

Step 6: Install the Power LED and Power Switch

On the top left of the board, to the left of the micro SD connector footprint, install the red power LED with the long lead going into the "triangle" side of the LED symbol, then install the associated 470 ohm resistor.

The power switch needs to be installed in the upper right corner of the board.

Step 7: Install the H-COMM programming header

Install the five pin male H-COMM header where indicated on the bottom left side of the board.

Step 8: Install the I2C expansion header

Install the four pin male I2C header where indicated on the top left side of the board below the footprint for the PS/2 connector.

Step 9: Install the EXP1, EXP2 and MORPHBUS headers

Install the two 10 pin headers on the left side of Propteus, and the 40 pin header on the right hand side of Propteus.

You will find their positions labeled EXP1, EXP2 and MORPHBUS on the printed circuit board.

Step 10: Install the power connector and switch

Install the power switch, the diode, 47uF and 100nF capacitor in the power supply area

This would be a great time to connect power to Propteus, and use a volt meter to verify that you are getting the input voltage (minus 0.7V for the diode) so if you are using a 9V power supply, you should read 8.3V between the IN pin of the LM7805 and ground.

If you get power at the screw terminal, but not at the input to the LM7805, and you have turned the power switch on, the most likely problem is installing the diode backwards.

Step 11: Install the 5V regulator section

Install the LM7805 voltage regulator on the bottom of the board as shown in *Figure 3* and the 100nF and 47uF capacitors on top of the board as shown.

At this point you should verify that you are getting a regulated 5V output from the LM7805 voltage regulator; you can test right on the pins of the regulator, or between any ground pin and the labelled 5V holes near the 10 pin headers on the left side of the board.

If you don't get 5V, and passed the test in Step 10, then the most likely problem is installing the LM7805 backwards.

Note: the power LED will not come on until the 3.3V regulation section is installed and works.

Step 12: Install the 3.3V regulator section

Now install the 3.3V voltage regulator and associated 100nF and 47uF capacitors as shown – and you are done with the base build!

Just to make sure, you should test to make sure that you are getting a regulated 3.3V at the 10 pin sockets; and the power LED should also light up. If there is no 3.3V, or the voltage is not between 3.25V and 3.35V, check your soldering, or you may have a defective 3.3V regulator.

BASE KIT ONLY: Install Propeller and EEPROM in the DIP sockets

If you are building a Propteus Base Kit, without the optional sections, and you have verified that the 3.3V power supply is functioning properly, you may now insert your Propeller chip into the 40 pin DIP socket, and the EEPROM into the 8 pin DIP socket, then you will be ready to start programming your Propeller board with a PropPlug or SerPlug!

Installing Optional Features on Propteus

PLEASE NOTE:

The following sections are NOT needed for a "Base Kit", and are only included in the "Full Kit", or purchased separately.

Micro SD subsystem

If you purchased the micro SD section for your Propteus, you should have installed the micro SD socket in Step 1 above.

It IS possible to add the micro SD socket at a later date, but it is quite difficult due to all the components around it. If you must install the micro SD socket at a later date, you may prefer to install the alternate Hirose connector listed below, as that may be easier to install after the fact.
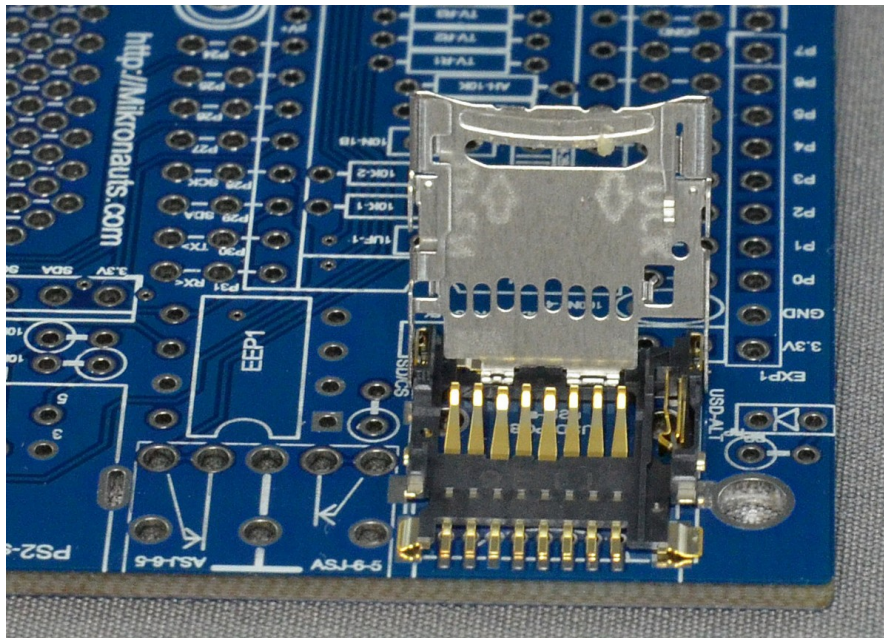

Figure 5: Hirose DM3C-SF micro SD connector on Propteus

Hirose DM3C-SF (Mouser part number 798-DM3C-SF, Digikey part number HR1940CT-ND)

Please note that the DM3C-SF connectors pins face to the outside of the board; you have to open the connector and solder very carefully on the inside. It is easier to install the Mikronauts micro SD connector at the start of the build process.

You also need to install the six pin SIP resistor package with pin 1 (which has a dot on the SIP) close to the edge of the board, and the SD/CS 15K resistor in order to complete the micro SD section.

VGA output

Install VGA resistors VGA-1 to VGA-8 where indicated inside the boundaries of the DIP40 socket for the Propeller. Please see the schematic to see which resistor value goes where.

Install the VGA D-SUB connector where indicated on the printed circuit board.

TV output

Install the TV output resistors TV-R1 to TV-R3 where indicated within the boundaries of the DIP40 socket for the Propeller. Please see the schematic to see which resistor value goes where.

Install the TV1 RCA jack where indicated on the printed circuit board.

PS/2 keyboard / mouse input

Install the PS/2 resistors 10K-3 to 10K-6 where indicated near the PS/2 connector socket.

Install the PS/2-S socket where indicated on the printed circuit board.

Stereo 1/8" line-level audio jack output

Due to space limitations, the AS-J-6-5 audio jack must be installed on the bottom of the printed circuit board, please look at *Figure 3* to see where it goes.

Install the audio resistors AH-10K and AL-10K within the boundaries of the DIP40 socket, and install the audio capacitors 10n-1B, 0n-2B ceramic capacitors, 1uF-1 and 1uF-2 ceramic or electrolytic (+ towards propeller) capacitors on the back of the printed circuit board.

If needed, you can substitute 100nF ceramic capacitors for 1uF-1 and 1uF-2.

LED section (optional)

Install four to eight LED's with the shorter legs near the edge of the printed circuit board.

Please note that the LED's do not have current limiting resistors attached to them, so make sure you use a 470 ohm (or 330 ohm, or 220 ohm) current limiting resistor between the Propeller pin you want to connect to an LED and the LED itself - otherwise you can easily damage that pin on your Propeller.

FULL KIT or BASE KIT with OPTIONS: Install Propeller and EEPROM

After you have verified that the 3.3V power supply is functioning properly, you may now insert your Propeller chip and EEPROM into their sockets, and start programming your Propeller board with a PropPlug or SerPlug!
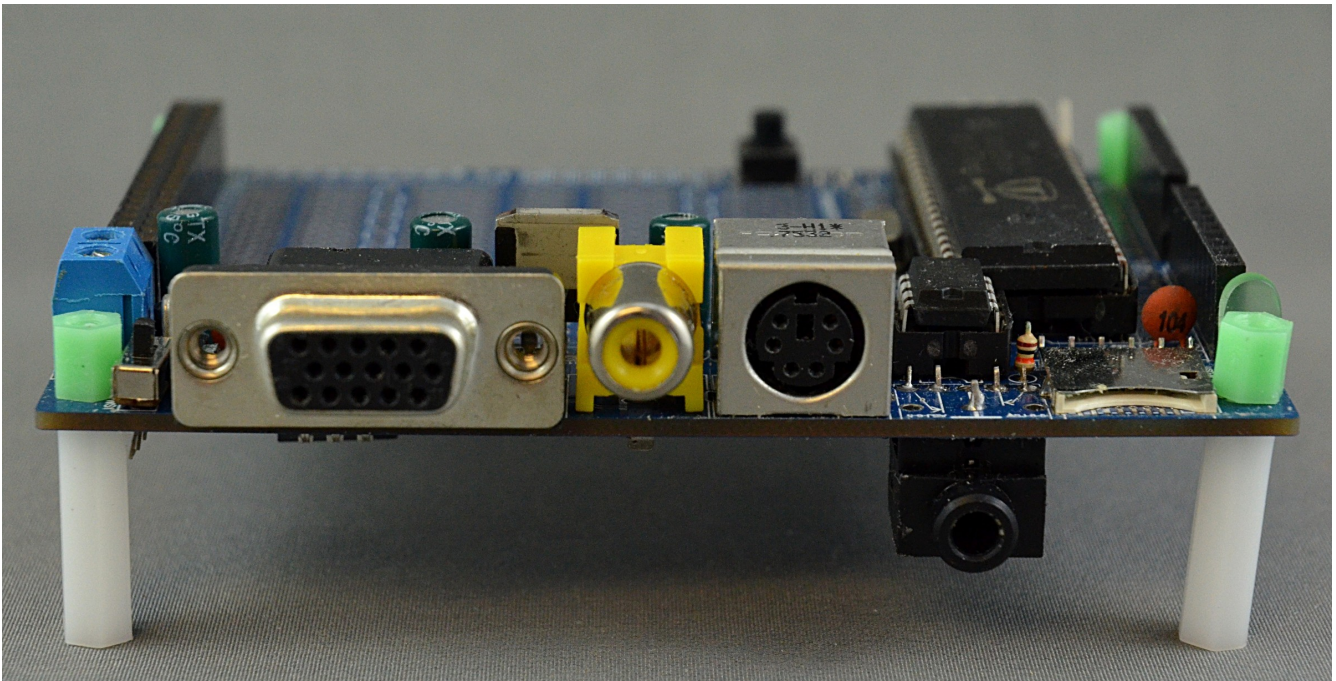
Back Panel Connectors

Figure 6: Back panel I/O connections on Propteus

If you have built a full kit, you will have the following connectors available:

- Screw power terminal (Left side, towards the rear)
- Small power switch
- VGA connector
- RCA TV connector
- PS/2 keyboard/mouse connector
- Stereo 1/8" line level output (on bottom of board)
- micro SD socket
- Power LED
- I2C expansion connector (behind PS/2 jack)
- H-COMM connector for PropPlug or SerPlug (behind the Propeller)

Using your Propteus rev. 2.0 Propeller Development Board
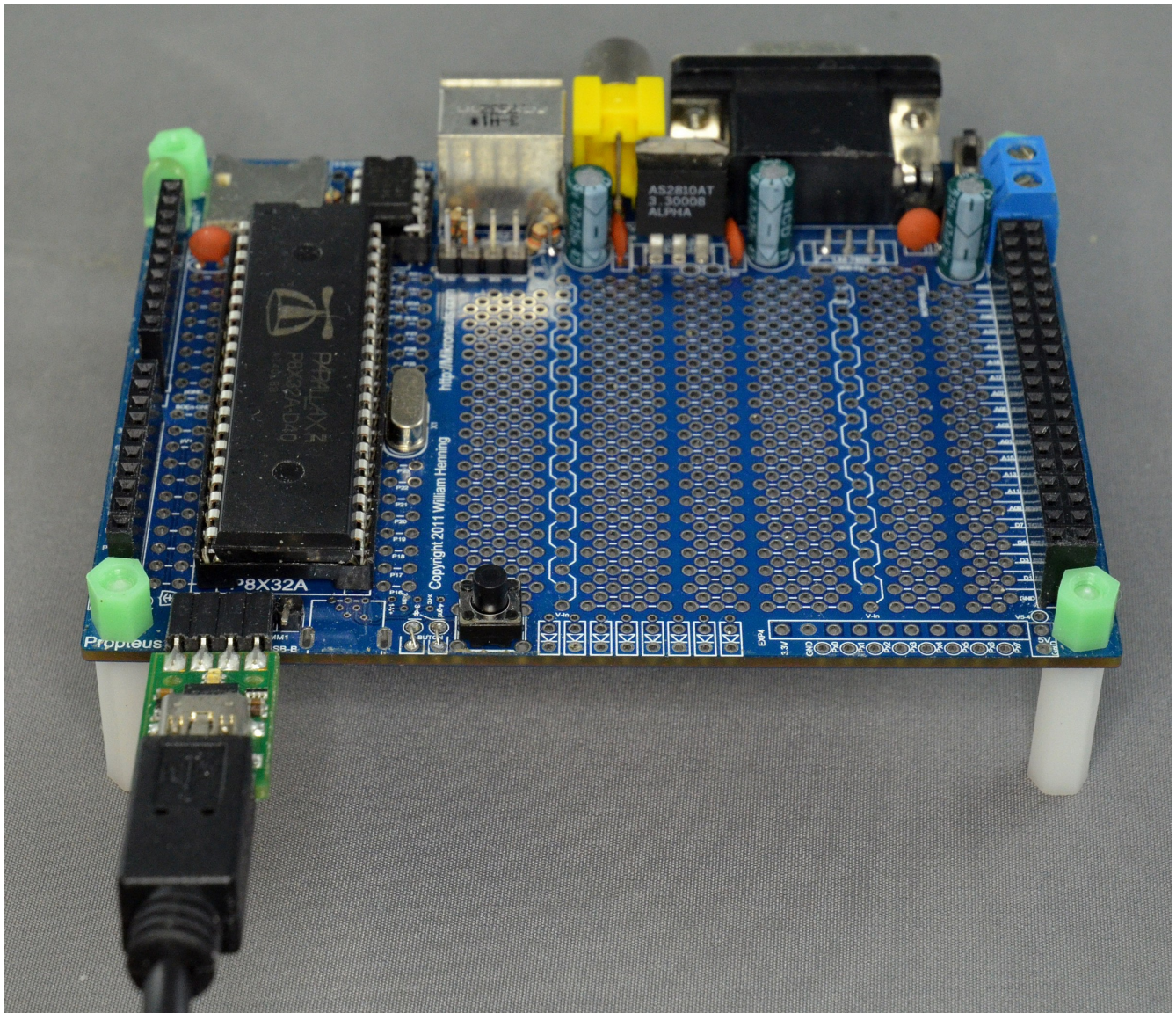
There are plenty of projects for you to try at http://learn.parallax.com

If you want even more ideas of what you can do, you can download the PE Kit manual, and try some of the experiments on your Propteus and SchoolBoard][combination!

Developing Spin and Assembly programs without a PC

If you add the following to Propteus, you can develop Propeller software right on Propteus – without needing a PC!

- micro SD option
- Keyboard/Mouse option
- TV option (or VGA option, or both)
- PS/2 keyboard
- TV (or VGA monitor)
- micro SD card (1GB-32GB) with SphinxOS

Most demonstration programs and games for the Propeller will only require you to change the pins for Audio and micro SD to run on Propteus – and you can develop your own programs – including games – right on Propteus.

You can easily connect a Wii Numchuk or Classic Controller, Atari/Sega compatible, or Nintendo 64 compatible joystick to Propteus.

If you use a TV (or NTSC monitor) you will still have 16 Propeller pins available for your experiments, as if the VGA option is not installed, P0-P7 and P16-P23 will still be available for your circuits.

Propteus Propeller Pin Map

P0-P7	unassigned
P8-P11	micro SD option (/CS, CLK, DIO, DO)
P12-P15	TV output option (TV-R1, TV-R2, TV-R3, TV-R4), P15 is also AUDIO_L
P16-P23	VGA output option (VS, HS, B-2, B-1, G-2, G-1, R-2, R-1)
P24-P25	PS/2 mouse (DAT, CLK), P24 is also AUDIO_R
P26-P27	PS/2 keyboard (DAT, CLK)
P28-P29	I2C bus SCL & SDA
P30-P31	PropPlug / SerPlug TX & RX

If you use a PS/2 Y cable so that you can connect a keyboard and mouse at the same time, you can still get mono sound from P15.

As most Propeller programs do not use a mouse, leaving P24 free, you can normally get full stereo sound from your Propteus. Amplified computer speakers work great with Propteus.

Running Propteus at 80Mhz

Most Parallax Propeller boards are run at 80Mhz, and as such, most demonstration programs and objects in the Parallax Obex are configured for 80Mhz operation with a 5MHz crystal.

Example with 5Mhz crystal:

```
CON

    _clkmode = xtal1 + pll16x
    _xinfreq = 5_000_000
```

Propteus was designed so it could operate at either 80Mhz or 100Mhz, so you could choose between extra performance, or more compatibility with demonstration programs.

Running Propteus at 100Mhz

If you run your Propteus at 100Mhz you will have to adjust the _clkmode and _xinfreq settings in demonstration programs and Obex objects before they will work.

Example with 6.25Mhz crystal:

```
CON

    _clkmode = xtal1 + pll16x
    _xinfreq = 6_250_000
```

Running at 100Mhz allows finer grained timing, 25% faster execution speed, and can run some objects that need the extra performance to operate – such as Mikronauts single cog 80 column VGA text driver.

Expanding Propteus

Propteus is designed to be expanded with the following Mikronauts prototyping boards:

- SchoolBoard][
- Proteus
- uCProto
- miniPro

Propteus can also be expanded with any of Mikronauts modules such as:

- SerPlug
- 485Plug (upcoming)
- miniMods (upcoming)
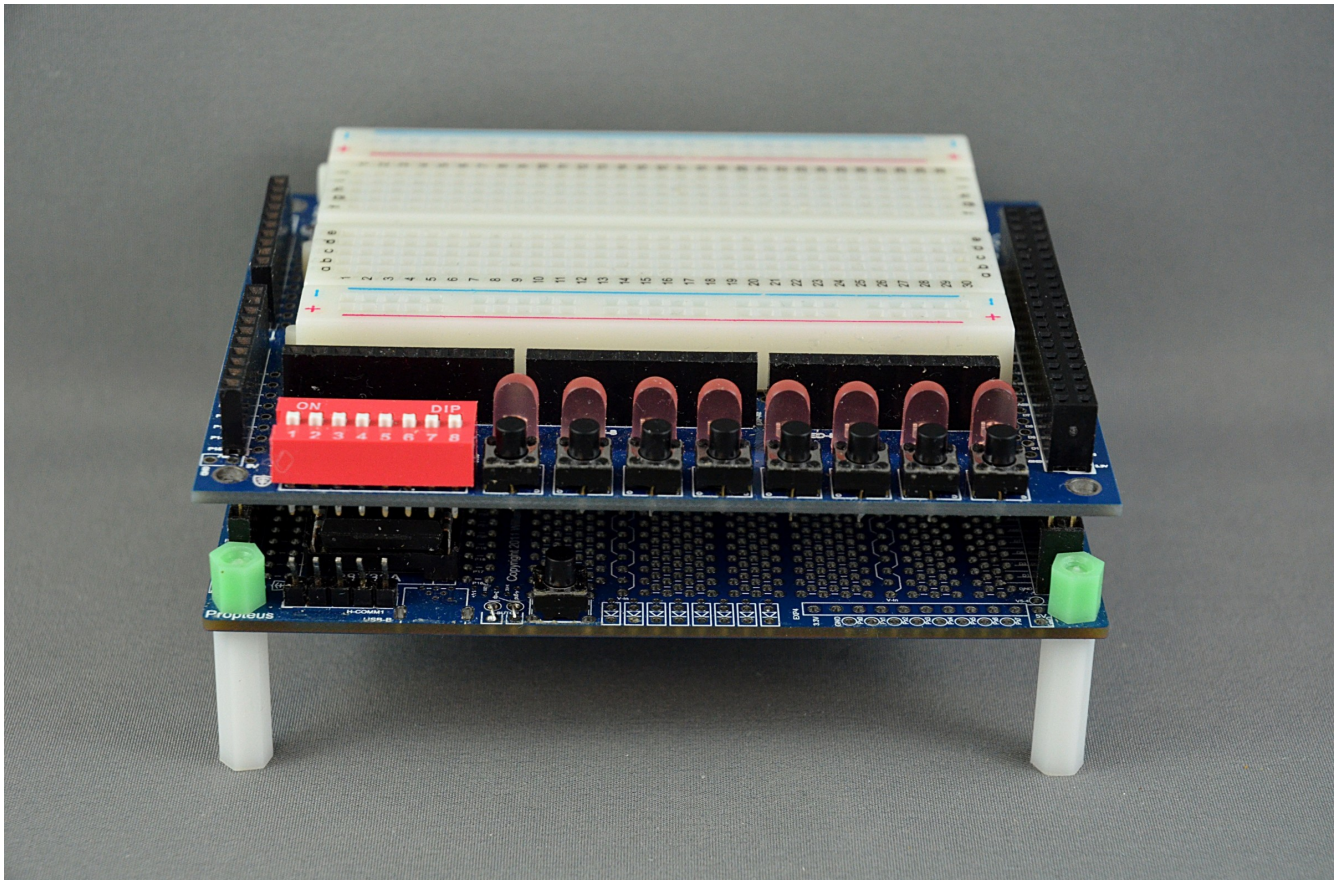- many other upcoming modules

Adding SchoolBoard][to Propteus

Figure 5: SchoolBoard][on Propteus rev. 2.0

References

http://Mikronauts.com/schoolboard	SchoolBoard][home page
http://learn.parallax.com	Parallax's excellent educational site
http://www.parallaxsemiconductor.com/appnotes	ParallaxSemiconductor Application Notes
http://www.parallax.com/go/pekit	Parallax PE Kit downloads and resources

Manufacturers Home Pages

http://Mikronauts.com	Mikronauts home page
http://www.parallax.com	Parallax home page
http://www.parallaxsemiconductor.com	Parallax Semiconductor home page

General Electronics References

http://led.linear1.org/1led.wiz	LED current limiting resistor calculator

Credits

- Chip and Parallax for the Propeller
- Sapieha for the beautiful PCB layout