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Propeller Board of Education (#32900)

The form of the original Board of Education© meets the powerful function of the multicore Propeller™ microcontroller. A built-in set of peripherals makes it ready to support an amazing array of projects, prototypes, hands-on activities, and kits. The Propeller Board of Education is ideal for learning the basics of electronics, programming and robotics. It also simplifies advanced applications that require RF-linked communication, audio/visual peripherals, and gigabytes of SD memory.

Features

- Built-in Propeller microcontroller, 64 KB EEPROM and 5 MHz crystal oscillator.

- Breadboard, sockets for power and I/O access, and six servo ports with power-select jumpers for easy prototyping

- Automatically selects between USB and external power sources and provides USB over-current protection

- 9 V battery and center-positive 2.1 mm power connectors offer two external power options

- Convenient reset button and 3-position power switch

- Onboard mini stereo-audio jack, electret microphone, and VGA port for audio/visual projects

- Built-in microSD card and XBee wireless module sockets simplify advanced applications

- Dedicated analog header sockets provide three 10-bit inputs and two buffered variable-resolution outputs

- 2x20 header for connecting I/O pins to VGA, XBee, Propeller clock and reset, USB serial flow control, and up to 10 LEDs

- Indicator lights for system power, servo power, eight color-coded VGA channels, two analog output levels, XBee Tx/Rx, and USB Tx/Rx

- SEPIC 5 V switching regulator can deliver up to 3 A across the commercial temperature range

- Linear 3.3 V regulator can deliver up to 460 mA at room temperature

Key Specifications

- Power requirements: 4–16 VDC

- Communication: USB for programming

- Dimensions: 4.375 x 3.05 x 0.625 in (11.11 x 7.75 x 1.50 cm)

- Operating temp range: +32 to +158 °F (0 to +70 °C)

Application Ideas

- Mount on a Boe-Bot© robot chassis to create your own customizable Propeller robot

- Use in the classroom to teach electronics, programming, robotics, and the fundamentals of electronic product design with a multicore microcontroller

Packing List

- Propeller Board of Education PCB
- Strip of 4 rubber feet
- Jumper wires

Functional Description

(20) Status LEDs
VGA LEDs (active-high)
2 red, 2 green, 2 blue, 2 yellow (H & V sync)
XBee LEDs (active-low)
Active low: red (DI) and blue (DO)

(18) 2x10 Socket Access—J5 Header
Signal + LED connections:
VGA R1, R0, G1, G0, B1, B0, H, V
XBee DO, DI
Signal only
XBee /RTS, ASOC, /CTS, /DTR, /SSI, /RST
Propeller XI, /RST
Serial over USB flow control (/CTS, /RTS)

(19) Switching Regulator
In: 4-16 VDC
Out: 5V, 3A

(1) External Power Inputs
9 V battery clip
2.1 mm center-positive jack

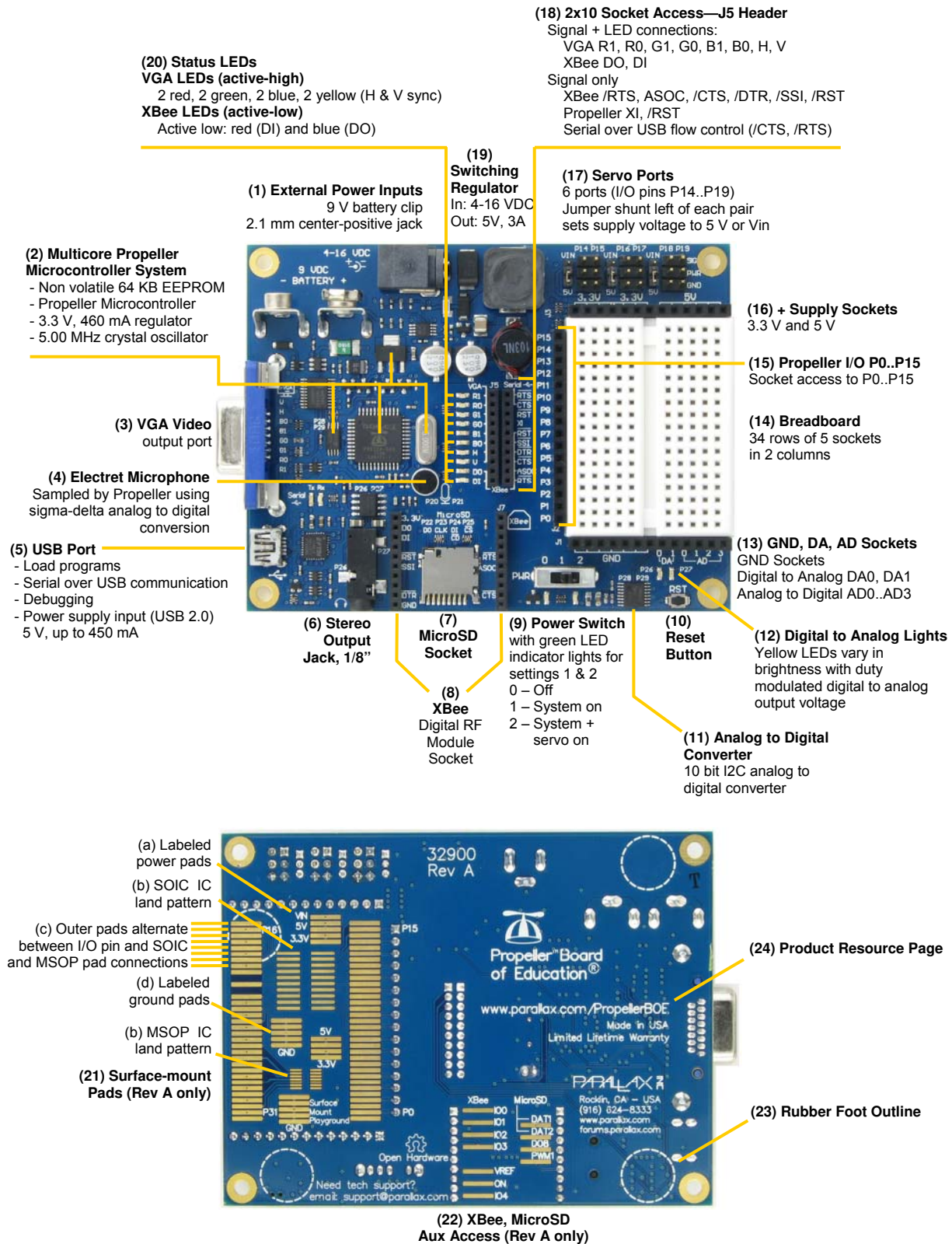**(17) Servo Ports**
6 ports (I/O pins P14..P19)
Jumper shunt left of each pair
sets supply voltage to 5 V or Vin

(2) Multicore Propeller Microcontroller System
- Non volatile 64 KB EEPROM
- Propeller Microcontroller
- 3.3 V, 460 mA regulator
- 5.00 MHz crystal oscillator

(16) + Supply Sockets
3.3 V and 5 V

(3) VGA Video
output port

(15) Propeller I/O P0..P15
Socket access to P0..P15

(4) Electret Microphone
Sampled by Propeller using
sigma-delta analog to digital
conversion

(14) Breadboard
34 rows of 5 sockets
in 2 columns

(5) USB Port
- Load programs
- Serial over USB communication
- Debugging
- Power supply input (USB 2.0)
5 V, up to 450 mA

(13) GND, DA, AD Sockets
GND Sockets
Digital to Analog DA0, DA1
Analog to Digital AD0..AD3

(6) Stereo Output Jack, 1/8"

(7) MicroSD Socket

(9) Power Switch
with green LED
indicator lights for
settings 1 & 2
0 – Off
1 – System on
2 – System + servo on

(10) Reset Button

(12) Digital to Analog Lights
Yellow LEDs vary in
brightness with duty
modulated digital to analog
output voltage

(8) XBee
Digital RF Module Socket

(11) Analog to Digital Converter
10 bit I2C analog to
digital converter

(a) Labeled power pads

(b) SOIC IC land pattern

(c) Outer pads alternate
between I/O pin and SOIC
and MSOP pad connections

(d) Labeled ground pads

(b) MSOP IC land pattern

(21) Surface-mount Pads (Rev A only)

32900 Rev A

Propeller™ Board of Education®

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Limited Lifetime Warranty

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Open Hardware

Need tech support?
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(24) Product Resource Page

(23) Rubber Foot Outline

(22) XBee, MicroSD Aux Access (Rev A only)

(1) External Power Inputs
The 9 V battery clip and 2.1 mm center-positive jack are two of the Propeller BOE's three power input options. The board will accept 4 VDC to 16 VDC from either of these inputs. These input ports are useful for robots and other remote applications where the application continues to run when it's not connected to, and drawing power from, its USB programming port (the third option, see (5)).

(2) Multicore Propeller Microcontroller System
- 64 KB I2C EEPROM for non-volatile program and data storage.
- 8 core Propeller microcontroller
- 3.3 V, 460 mA voltage regulator
- 5.00 MHz crystal oscillator

The Propeller provides the EEPROM's I2C clock through I/O pin P28, and communicates with its I2C data line through I/O pin P29. The Propeller microcontroller can multiply the 5.0 MHz crystal oscillator signal by up to 16 for a system clock frequency of 80 MHz.

(3) VGA Video Output Port
This is a convenient port for Propeller microcontroller applications that display data and graphics on devices with VGA inputs, such as certain computer monitors and televisions. Signals are applied to the VGA driver circuits by running jumper wires from Propeller I/O pin sockets (15) to VGA inputs on the 2x10 socket (18).

(4) Electret Microphone
This microphone is connected to Propeller I/O pins 20 and 21 through a sigma-delta circuit (a low-pass RC filter with negative feedback).. Propeller applications can use the RC circuit to measure the microphone's voltage output with sigma analog to digital conversion. This is useful for basic sound recording and analysis.

(5) USB Port
In addition to loading programs from the PC into the Propeller microcontroller, the USB port can also be used for serial over USB communication with a terminal, as a conduit for debugging software, and as a 5 V power input. For power, the USB Port is input current limited to between 450 mA and 500 mA. This prevents any unexpected responses from USB 2.0 ports to current draws from motors, wiring mistakes, etc.

(6) Stereo Output Jack
This 1/8" jack is useful for speech synthesis, music, and other audio applications. I/O pins P26 (right channel) and P27 (left channel) are hardwired to the low-pass filter, amplifier and coupling capacitor circuits that can drive headphones, ear-buds, speakers with built-in amplifiers, or line level inputs.

(7) MicroSD Socket
This socket is useful for applications that use a microSD card. With common sizes of 1 to 32 GB, these cards are great for applications where there is more data than can conveniently be stored in the Propeller chip's 32 KB of RAM or the board's 64 KB EEPROM. Examples include:
- Extended memory model (XMM) C language programs
- Multiple Spin program application images that can be boot-loaded
- Large lookup tables
- Record and playback of audio files
- Datalogging

This socket is hardwired to I/O pins: P22 - DO (data out); P23 - CLK (clock); P24 - DI/CD (data in and card detect); P25 - /CS (active low chip select).

(8) XBee Digital RF Module Socket

This socket accommodates most XBee wireless modules and is useful for applications where the Propeller Board of Education is part of an XBee wireless network. Possible applications include robot team sports, remote data logging, and wireless message exchange with computer that has an XBee connected (XBee module + adapter or compatible USB XStick). *NOTE: This socket does not support XBee Wi-Fi.*

(9) Power Switch

This 3-position switch can select between system power off (position-0), system power on (position-1), and system power + servo power on (position-2); see Servo Ports (17) for more details.

(10) Reset Button

Provides a mechanical means of restarting the Propeller microcontroller's program. Press and hold to keep the microcontroller in reset, press and release to reset and allow the Propeller to load the program in EEPROM.

(11) Digital to Analog Converter

Propeller applications can use this 10-bit analog to digital converter (ADC) to monitor analog inputs labeled A0, A1, A2, and A3 on (13). This ADC was chosen because it can share the I2C bus with the board's 64 KB external EEPROM memory, which keeps more I/O pins available for general purpose use. With a 400 kHz clock (Fast I2C), it supports sampling rates up to 25 kHz and supports common low bandwidth measurements like DC and 3 phase signals. This ADC has a 5.0 V reference, so it reports voltage measurements in units of 1024ths of 5 V.

(12) Digital to Analog Indicator Lights

Yellow LEDs vary in brightness with duty modulated digital to analog signals. These lights are primarily a visual indicator of the output voltage at DA sockets (13), but they also indicate stereo output jack (6) signal activity.

(13) GND, DA, AD Sockets

- GND Sockets – common ground for the system
- Digital to Analog DA0, DA1
    - Output voltage range: 0 to 3.3 V
    - DA0 is the digital to analog voltage from P26 after it has passed through a low-pass filter and buffer amplifier (but before it has passed through the coupling capacitor to the stereo output jack's right speaker channel).
    - DA1 is the same as DA0, but the duty modulated signal is provided by P27.
- Analog to Digital AD0..AD3
    - Input voltage range: 0 to 5 V

(14) Breadboard

Solderless breadboard with 0.1" pin spacing for circuit prototyping. This breadboard has 34 5-socket rows arranged in 2 columns. The columns are separated by a valley in the middle.

(15) Propeller I/O P0..P15

Socket access to P0..P15, conveniently located to the left of the breadboard (14) and close to the 2x10 socket header (18). Jumper wires can be used to connect these I/O pins to circuits on the breadboard, or to the 2x10 socket header's VGA, XBee, Propeller, and serial over USB features.

(16) + Supply Sockets

The positive 3.3 V and 5 V supply sockets are positioned along the top of the breadboard, making it convenient to jumper supply voltage to circuits built onto the breadboard.

(17) Servo Ports
These ports are convenient for connecting servos and other peripherals, such as the PING))) Ultrasonic Distance Sensor and Parallax Serial LCD. Each servo port has a label printed above it indicating which I/O pin will communicate with the peripheral. Labels indicating the GND (ground), PWR (power) and SIG (signal) pins for each port are along the right.

Each pair of servo ports has power selection pins with a jumper shunt to its immediate left. Each pair of ports can be set to 5 V by placing the jumper over the pair of pins closer to the 5V label, or to unregulated input voltage from the external power inputs by placing it over the pair of pins closer to the VIN label.

When the jumper for a given pair of ports is set to 5 V, that pair of ports will receive regulated 5 V power whenever the Power Switch (9) is set to 2. If the jumper for a pair of servo ports is set to VIN, that pair of servo ports will receive power so long as a power source is connected to either the 9 V battery clip or the 2.1 mm barrel jack and the power switch is set to 2.

(18) 2x10 Socket Access—J5 Header
The J5 header is just to the left of the Propeller I/O P0..P15 header (14) making it convenient to connect Propeller I/O pins to built-in LEDs, VGA, XBee, and serial-over-USB flow control signals, as well as certain Propeller chip inputs. See the J5 Header table on page 8 for more information on each socket.

VGA Sockets
The VGA sockets are connected to active-high, color-coded LEDs and buffered inputs that drive the VGA Video Output Port (3) channels. The inputs labeled R1 and R0 are red channel inputs and drive red indicator LEDs. G1 and G0 are green inputs and have green indicator LEDs, and the B1 and B0 are blue inputs and have blue indicator LEDs. The horizontal and vertical channel inputs are labeled H and V, and have yellow indicator LEDs.

XBee Sockets
The XBee DO and DI sockets connect to DO and DI sockets on the XBee Digital RF Module Socket headers (8). Signals applied to these sockets also drive active low LEDs. The DO socket LED is color-coded blue, and the DI socket LED is color-coded red.

XBee sockets labeled /RTS, ASOC, /CTS, /DTR, /SSI, /RST are connected to sockets of the same name on the XBee Digital RF Module Socket's headers (8). As with all the sockets along the left side of the J5 Header, they do not drive any LEDs. For more information on these signal lines and their functions, download the XBee reference manual from www.digi.com.

Propeller Sockets
Most of the socket labels have lines connecting them to categories like VGA, XBee, and Serial over USB (next to the USB trident). There are two sockets, labeled /RST and XI, that do not have lines connecting them to category labels. These provide connections to the Propeller chip's active-low reset (/RST) and external clock input (XI) pins. A low signal sent to the /RST line will hold the Propeller chip in reset state, just like holding down the reset button, and releasing the input to high after a low signal allows the program to load from EEPROM. The Propeller will also drive this signal low if a brown-out condition is detected. The XI input is for applications that need to make use of a clock signal other than the Propeller chip's internal oscillator or the Propeller Board of Education's 5 MHz crystal oscillator. This socket makes it convenient to supply the Propeller chip with a clock signal from an external source with an active output for any application that might require a custom system clock frequency.

Serial over USB Sockets
Propeller I/O pin P30 is connected to the PC's Rx input signal, and P31 is connected to the PC's Tx output signal for asynchronous serial communication without flow control. For flow control, simply run jumper

wires between the I/O pins of your choice to the /CTS (clear to send) and /RTS (request to send) sockets. You will also need to either write or download and use an object or library that supports serial flow control.

(19) Switching Regulator
The Propeller Board of Education features a SEPIC (single-ended primary inductor converter) switching capable of delivering regulated 5 V to the system with output currents up to 3 A and input voltages ranging anywhere from 4 to 16 VDC.

(20) VGA LEDs and XBee LEDs
As mentioned in the (18) 2x10 Socket Access section, the each VGA input has a color-coded LED:
- R1, R0 (red)
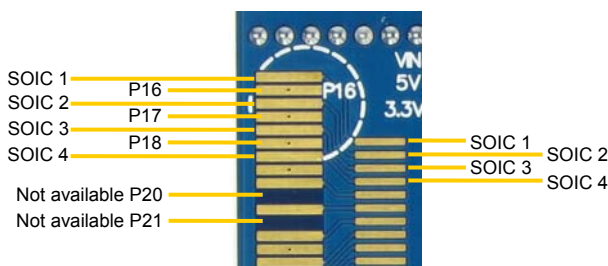- G1, G0 (green)
- B1, B0 (blue)
- H, V (yellow)

These LEDs will emit light regardless of whether or not the VGA Video Output Port is connected to a monitor. So, in addition to indicating VGA signal activity (when connected) these LEDs can be used as indicator lights for non-VGA projects.

The Blue XBee DO and red XBee DI indicator LEDs are useful for monitoring signal activity between the Propeller chip and XBee module, but can also be used as indicator LEDs for non-XBee projects. These two LEDs are active-low, so keep in mind that they require a low (GND = 0 V) signal to turn on and a high (3.3 V) signal to turn off.

(21) Surface-mount pads (Rev A boards only)
The surface-mount pads provide a convenient means for incorporating surface mount chips into Propeller BOE projects. The SOIC (small-outline integrated circuit) land pattern (21b) has pads that can accommodate both narrow and wide SOIC chips. With 20 pads, it can accommodate a 20-pin part, a single 16-pin part, or even a pair of 8-pin parts. The MSOP (mini small outline package) land pattern (21e) has 16 pads, and provides similar flexibility for the smaller MSOP parts, but be aware that the column of pads on the land pattern's right side are not connected to their corresponding outer pads.

The outer surface-mount pads (21c) along left and right sides alternate between I/O pin connections and SOIC/MSOP pad connections.

(22) XBee, MicroSD Aux Access (Rev A boards only)
Pads on the back of the board underneath the XBee Socket provide connections to individual header sockets that are not available through the 2x10 access header, as well as microSD card connections that are not already hard wired to the Propeller chip.
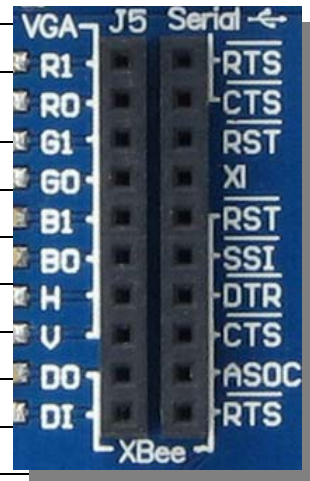- XBee: IO0..IO4, VREF, DO8 and PWM1
- MicroSD: DAT1, DAT2
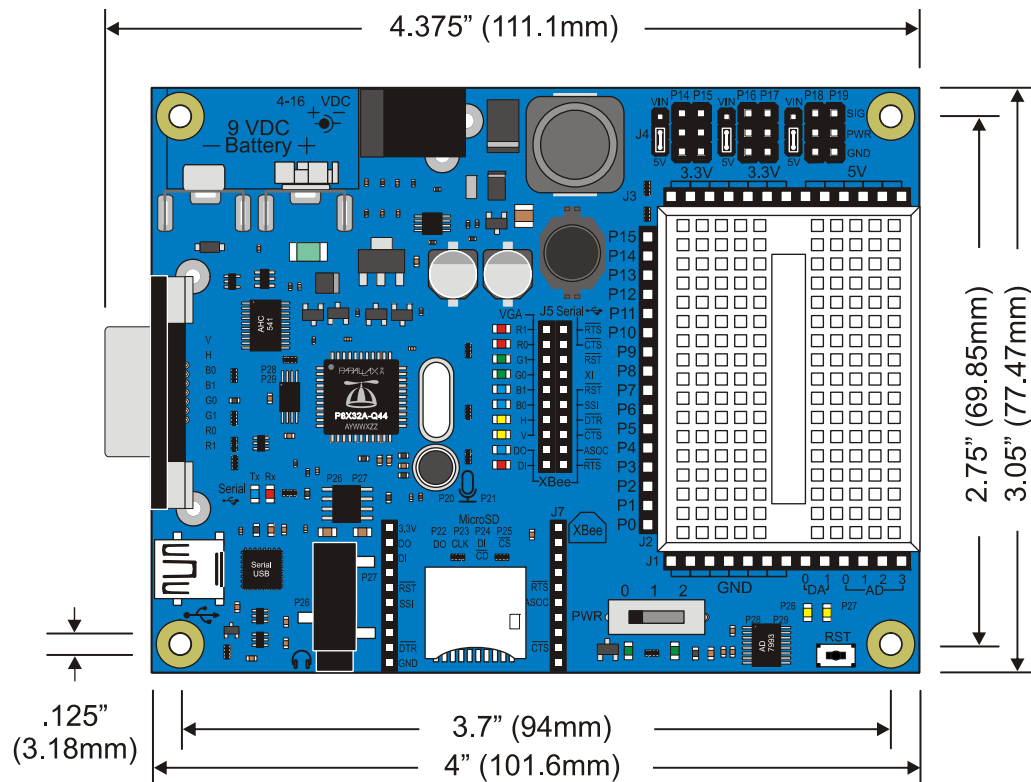
Propeller I/O Pin Assignments

I/0 Pin	Function
P0–P15	General-purpose I/O brought alongside breadboard to J2 header
P14–P19	3-pin header signal pins (J4 header, not marked on Rev A, this is the servo port header above the breadboard)
P20	Microphone sigma-delta input
P21	Microphone sigma-delta feedback
P22	MicroSD card DO (data out)
P23	MicroSD card CLK (clock)
P24	MicroSD card DI (data in)
P25	MicroSD card /CS (active-low chip select)
P26..P27	P26..P27: Duty modulated D/A converter signals go to: – Logic buffered yellow LED circuits below DA0 and DA1 sockets for brightness control – Low-pass filter + op amp buffer with outputs ranging from 0 to 3.3 V: o To DA0 and DA1 analog outputs on J1 o Through coupling capacitor to stereo outputs
P28..P29	P28 = I2C CLOCK, P29 = I2C DATA – To 64 KB EEPROM for non volatile program and data storage – To 10-Bit A/D converter for measurement of voltages at AD0..AD3 sockets
P30	Propeller programming Rx (transmits signal received by FTDI USB to serial converter's Rx line)
P31	Propeller programming/debugging Tx (receives signal transmitted by FTDI USB to serial converter's Tx line)

J5 Header

Group	Label	Description
VGA	R1	Red 1 signal to red LED and buffer input Buffer output to 470 Ω to VGA socket pin 1
	R0	Red 0 signal to red LED and buffer input Buffer output to 240 Ω to VGA socket pin 1
	G1	Red 1 signal to green LED and buffer input Buffer output to 470 Ω to VGA socket pin 2
	G0	Red 0 signal to green LED and buffer input Buffer output to 240 Ω to VGA socket pin 2
	B1	Red 1 signal to blue LED and buffer input Buffer output to 470 Ω to VGA socket pin 3
	B0	Red 0 signal to blue LED and buffer input Buffer output to 240 Ω to VGA socket pin 3
	H	Horizontal sync signal to yellow LED and buffer input Buffer output to 240 Ω to VGA socket pin 13
	V	Vertical sync signal to yellow LED and buffer input Buffer output to 240 Ω to VGA socket pin 14
XBee	DO	Pin 2 DOUT (UART transmitter output)
	DI	Pin 3 defaults to DIN (UART receiver input) and configurable to /CONFIG
	/RTS	Pin 16 /RTS, AD6, DIO6
	ASOC	Pin 15 Associate, AD5, DIO5
	/CTS	Pin 12 CTS, DIO7
	/DTR	Pin 9 DTR, SLEEP_RQ, DI8
	SSI	Pin 6 PWM0, RSSI
	/RST	Pin 5 Reset
Propeller	XI	Optional external clock signal input
	/RST	To active-low Propeller reset signal
Serial USB	/CTS	Clear to send for optional serial over USB flow control
	/RTS	Request to send for optional serial over USB flow control

Dimensions

4.375" (111.1mm)

2.75" (69.85mm)
3.05" (77.47mm)

.125" (3.18mm)

3.7" (94mm)
4" (101.6mm)

Resources and Downloads

- **Getting Started guide, application examples and tutorials:**
  learn.parallax.com/PropellerBOE
- **Schematics and other open hardware design files:**
  www.parallax.com/PropBOE -> Downloads & Resources