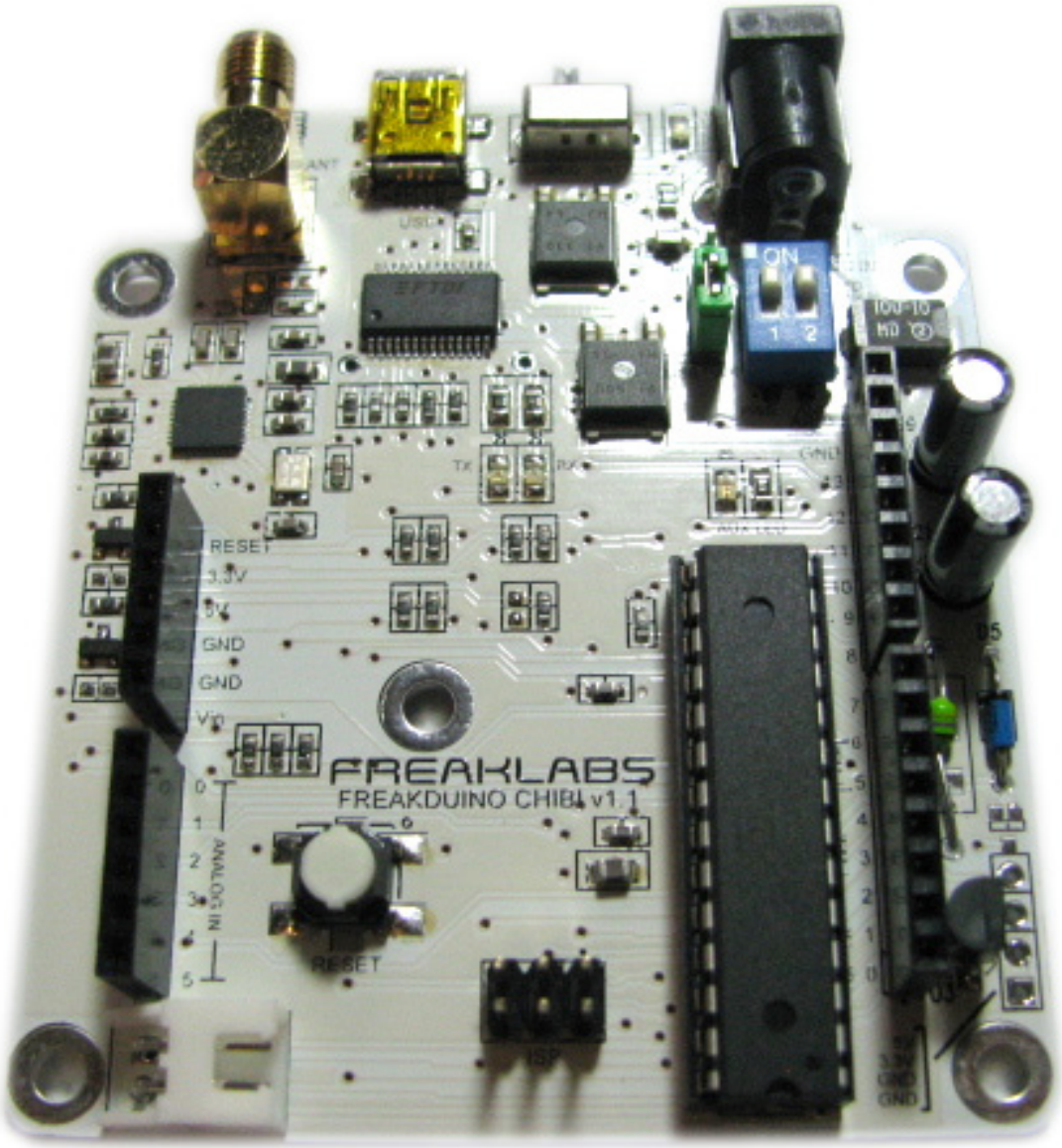
FREAKLABS

FREAKDUINO-CHIBI v1.1
Wireless Arduino-Compatible Prototyping Platform
Datasheet



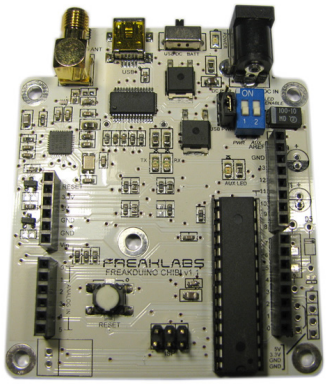
Document Revision History

Date	*Description*
2010-11-01	v1.1A Document creation

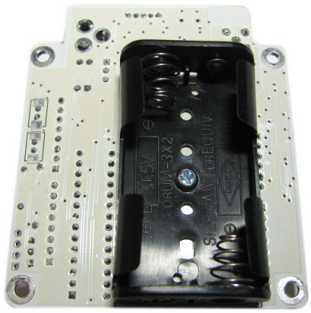
Specifications

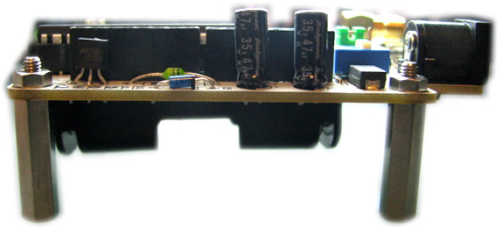
The FreakLabs FREAKDUINO-CHIBI board is designed for rapid prototyping, evaluation, and deployment of custom wireless devices at low cost. It combines the ease-of-use of the Arduino IDE and toolchain, compatibility with a rich assortment of peripherals in the Arduino shield form factor, and an integrated IEEE 802.15.4 wireless radio for inexpensive prototyping and testing of a wireless device.

The base board has all the functionality of an Arduino-based system with wireless communication and is an inexpensive way to start playing with wireless Arduino designs.



It also has optional features such as battery regulation circuitry, a low-cost bottom-mounted battery case, or a ruggedized enclosure with integrated battery case.





This board is designed to introduce people to wireless sensor networking inexpensively and without having to deal with complex toolchains, protocol stacks, and software. It's fully compatible with the Arduino IDE and toolchain which offers a single click compile and download and a rich ecosystem of open source software and tutorials available on the internet. The electrical specifications and connector form factor are also compatible with the original Arduino hardware so that the board can interface with the large assortment of Arduino peripheral shields. The availability

QuicK Specs

MCU: ATMega328P

Memory: 32 kB Flash/2 kB RAM

Communications: 802.15.4 wireless, USB

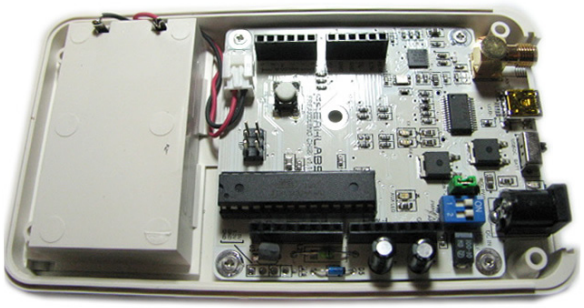
Expansion: Arduino-compatible shield connector

Power: Ext 5VDC, USB, Battery (optional)

Options: Ruggedized enclosure, battery regulation circuit, standalone battery case

of third party peripheral shields and open source software allows this board to be used for many diverse applications.

Enhancements were also added to this board to increase functionality. The addition of an integrated wireless radio based on the 802.15.4 protocol (same radio protocol as the XBee) allows for wireless control of devices or wireless sensor data collection. Battery circuitry was added so that it could function as a true wireless node without any external power cables. The board is also fitted to a ruggedized enclosure so that the design can be transported safely or deployed in remote settings without worrying about damaging the circuit.



Radio

The main addition to this board is the integrated wireless radio. The radio is based on the 802.15.4 wireless protocol and is the same protocol used by XBee modules and Zigbee devices. The radio operates at 2.4 GHz and comes with an RP-SMA antenna connector which is a standard antenna connector commonly found on Wi-Fi routers. An external antenna was chosen over other options such as a chip antenna or printed antenna because of the improved range and variety of available antennas.

The radio driver software and protocol stack are fully open source and available as an Arduino library. The protocol stack is simplified to three main library functions to make wireless communications as simple as possible. Those functions are: init, send, and receive. This makes it easy to use the radio as a simple extension of a serial port or to set up a peer-to-peer star network where each device can talk with any other device within listening range.

There are also many benefits to using 802.15.4 for communications. At 2.4 GHz, the antennas used are the same as those used for Wi-Fi. Hence there are a large variety of antennas in different sizes, shapes, and power. Omnidirectional antennas such as the standard whip antennas on Wi-Fi routers give moderate range and allow transmission from all directions. Directional antennas can also be used for greatly improved range if the direction of communications is fixed.

Some other benefits of using 802.15.4 is robustness such as automatic acknowledge and retries

and functionality such as auto-discard of frames that don't match the particular network address or node address.

Also, since it's possible to talk directly to the radio, it also allows for more flexibility for advanced users such as a direct readout of the signal strength (RSSI), changing transmission thresholds (CCA), number of retries, or whatever else is available in the radio's registers.

Power

There are three options to provide power to the board. The most common is via the USB, however the board can also be powered via an external adapter connected to the DC jack. This is especially useful when more power is needed than can be provided by the USB. Finally, when no external power is available, the board can also be battery powered.

The USB connector provides up to 500 mA of current at 5V and can directly power the board for most applications. It's convenient when the device is connected to a PC since the USB to serial converter also allows for communications with the PC.

For designs with higher current requirements, such as driving motors or high power LEDs, an external DC adapter can be used. The adapter should be a minimum of 6V and a maximum of 10V.

> **Note:** The power input is determined by the position of the jumper below the DC input jack. The markings on the jumper indicate whether the USB or DC input is being used.

The board also has two separate connectors for batteries. One of the connectors allows a battery case to be mounted on the bottom side of the board. This is convenient since the battery case is directly mounted to the board and allows for battery operation in tight spaces.

The other connector is located near the bottom of the board and is a 2-wire connector that features mating and polarization. It's technically called a JST XH series connector and was chosen to allow easy attachment of external battery cables without worrying about reversing the positive and negative connections. It also makes connecting and disconnecting the battery case of the enclosure to the board much easier.

There is also a battery regulation circuit on the board. The reason this is needed is because the battery voltage varies based on the battery type and amount of charge left. The voltage regulation allows any type of battery to be connected to the board as long as the battery voltage is below 6V and will generate a stable 5V output. The battery regulation circuit has a maximum current output of 200 mA. This is fine for most devices, however devices like motors and high power LEDs (1W or greater) may exceed the maximum current output.

There is a power switch on the board that selects between external line power (via USB or DC jack depending on the jumper) or battery power. The switch can also be used as an OFF switch if either line power or battery power is not present.

There is also a 2-pin DIP switch on the board that enables or disables the power LED and the auxiliary LED. If the board is externally powered, then it's fine to enable both LEDs, but when the board is battery powered, the LEDs will cause the battery to drain much faster. The DIP switch allows the user to easily disable the LEDs during battery operation.

Connectors, Jumpers and Switches

The board contains a number of connectors, jumpers, and switches:

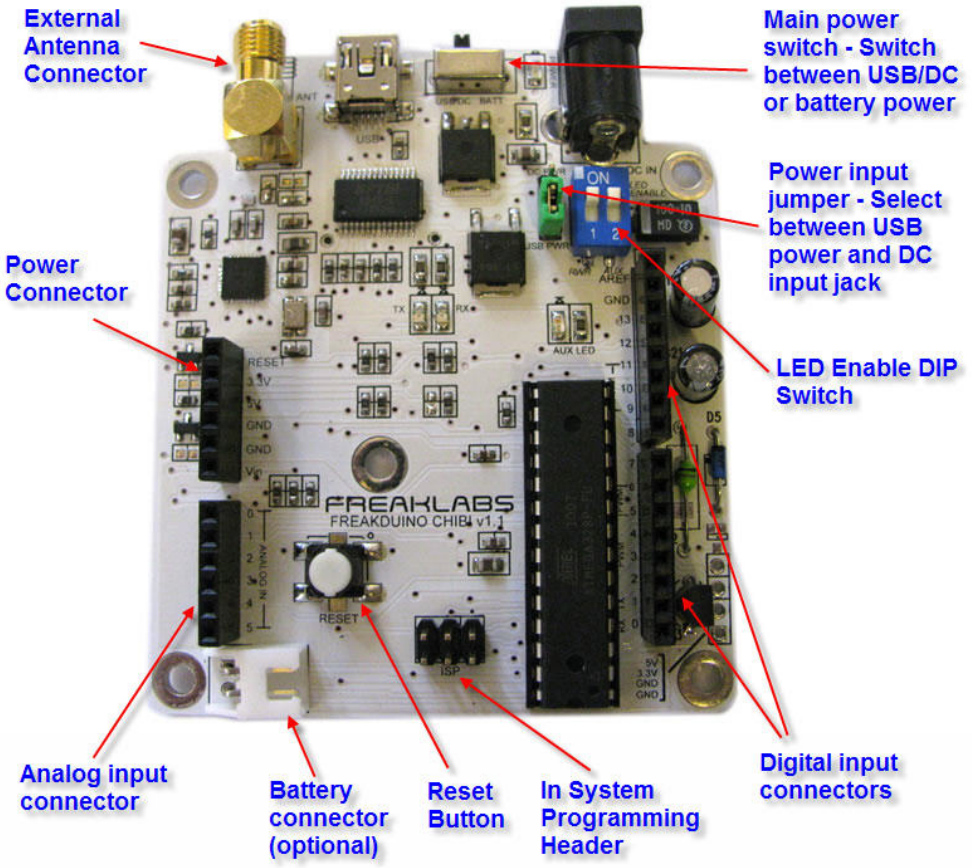
1. **Power Input Jumper.** The power input jumper is used to select between using the external DC jack or the USB to power the board.

2. **Main Power Switch.** The main power switch toggles between using line power or battery power. When no battery is connected, this would also serve as the OFF position. The opposite is true when no line power is attached.

3. **LED Enable Switch.** The LED enable DIP switch is used to enable or disable the main power LED and auxiliary LED. LEDs may consume unecessary power during battery operation so the DIP switch allows the user to enable/disable them when needed.

4. **External Antenna Connector.** The external antenna connector is an RP-SMA connector that attaches to a compatible antenna.

5. **Battery Connector.** The battery connector is optionally installed and comes with the battery boost kit.

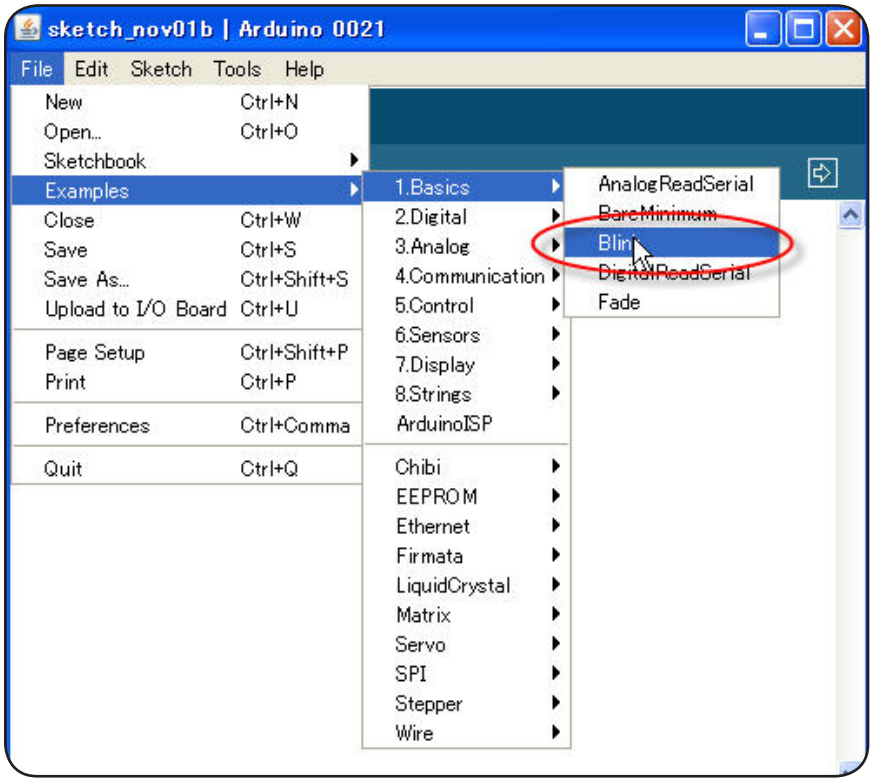


Uploading Code

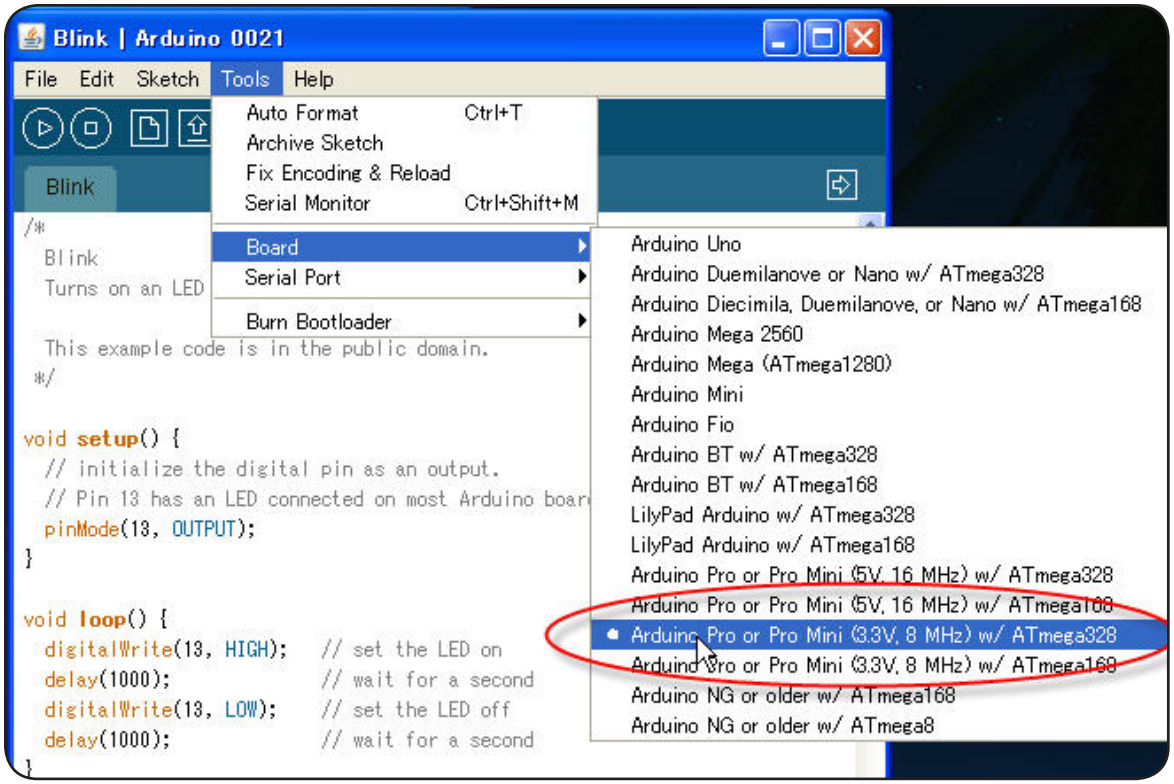
Compiling and uploading user code into the Freakduino board is very simple:

1. **Download the Arduino IDE.** The first thing you need to do is get the Arduino IDE and install it. It can be found at the Arduino site.

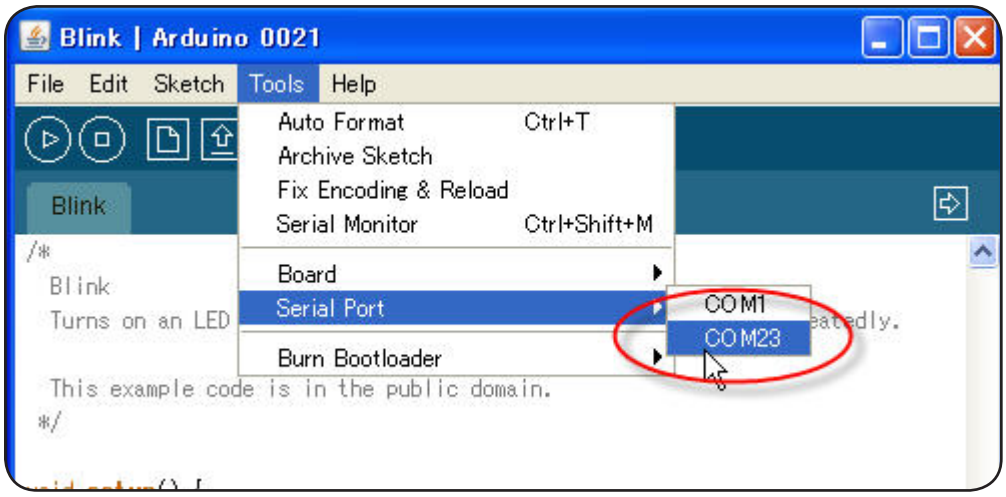
2. **Open the IDE and add code.** We're going to take a shortcut and open up one of the default examples that comes with the Arduino software. Go to the "File/Examples/Basics" menu and select "Blink".



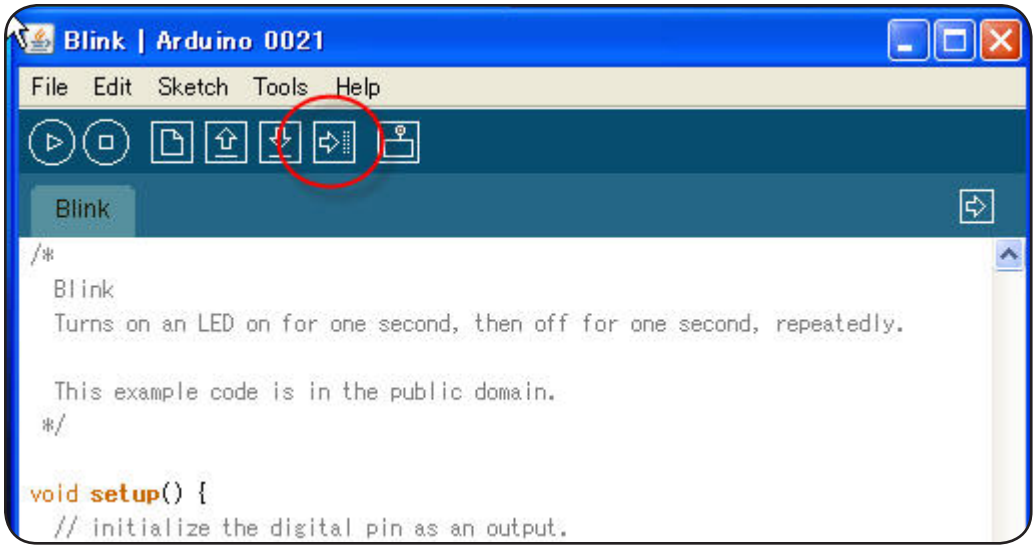
3. **Select the board.** Go to the "Tools/Board" menu and select "Arduino Pro or Pro Mini (3.3V, 8 MHz) w/ATMega328". Don't worry that it specifies 3.3 volts. We actually run at 5V but the main thing is to get the clock frequency and chip correct. In the case of the Freakduino, it uses an ATMega328 running at 8MHz.



4. **Select the serial port.** Plug the USB connector into the Freakduino board and select the serial port that it's connected to.



5. **Click on the "Upload" icon.** The code should compile and start uploading. You'll also see the serial port's TX and RX LEDs blinking on the Freakduino board.



Congratulations! You just uploaded your code to the Freakduino board. You should now be the proud owner of a blinking LED :)

Compatibility

The FREAKDUINO-CHIBI board is essentially an Arduino-based system and a shield integrated together. This means that the peripheral will require using some dedicated pins for the wireless functionality.

Two pins on the analog input connector are not available for use except for standard digital I/O. These are pins Analog 2 and Analog 3. Analog 2 controls the sleep mode and Analog 3 controls the chip select for communications between the microcontroller and radio IC. If the wireless functionality is not used, these pins are available as standard digital I/O but not as analog inputs. If possible, its best to avoid using these pins.

If the wireless functionality is being used, the SPI bus is also required to communicate with the radio. That means that digital pins 10-12 (PB3 to PB5 or MOSI, MISO, and SCLK) will be dedicated SPI pins.

If there is any question about compatibility with a particular shield, please post to the FreakLabs forums or email *support@freaklabsstore.com*.

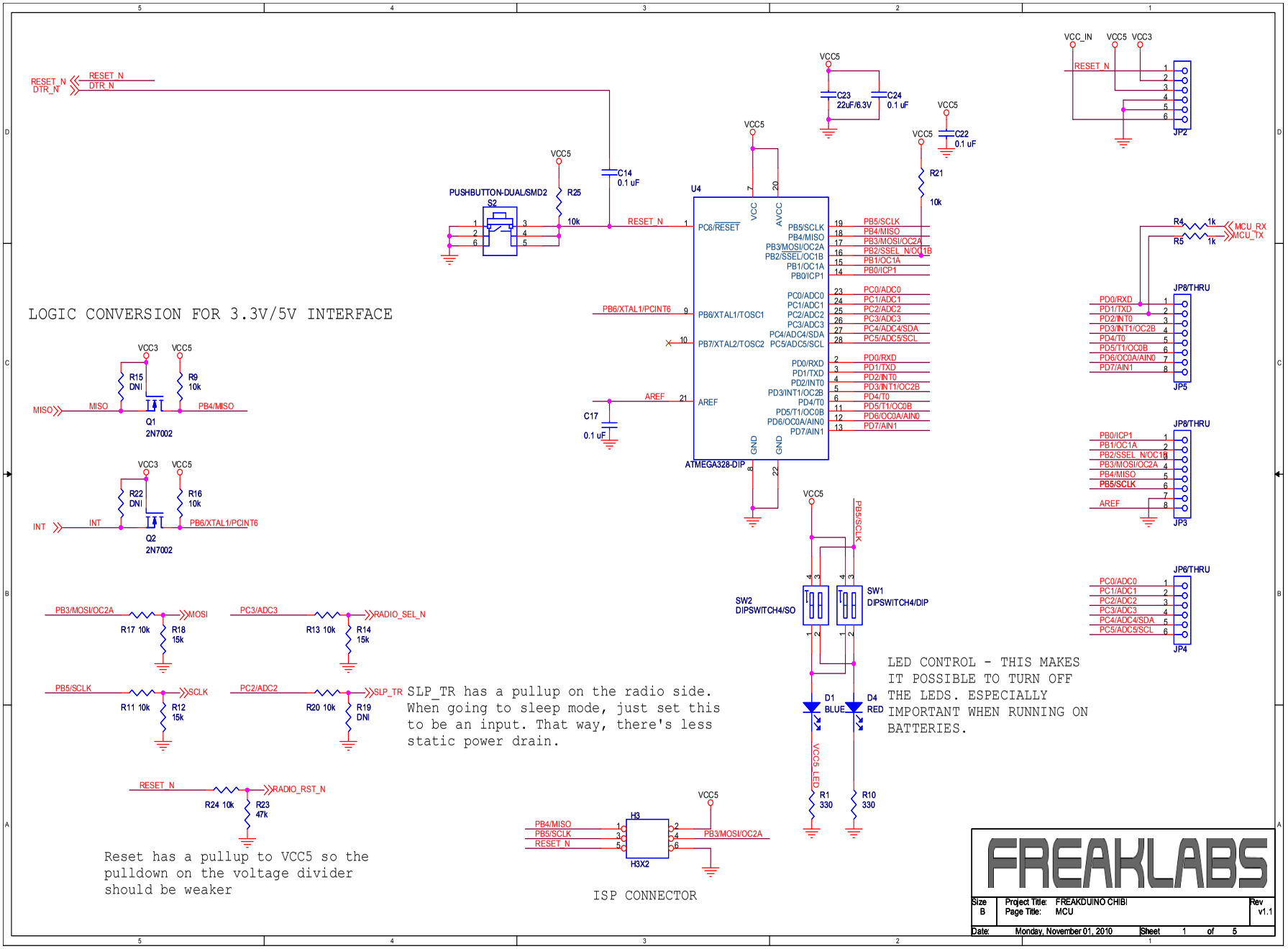
License

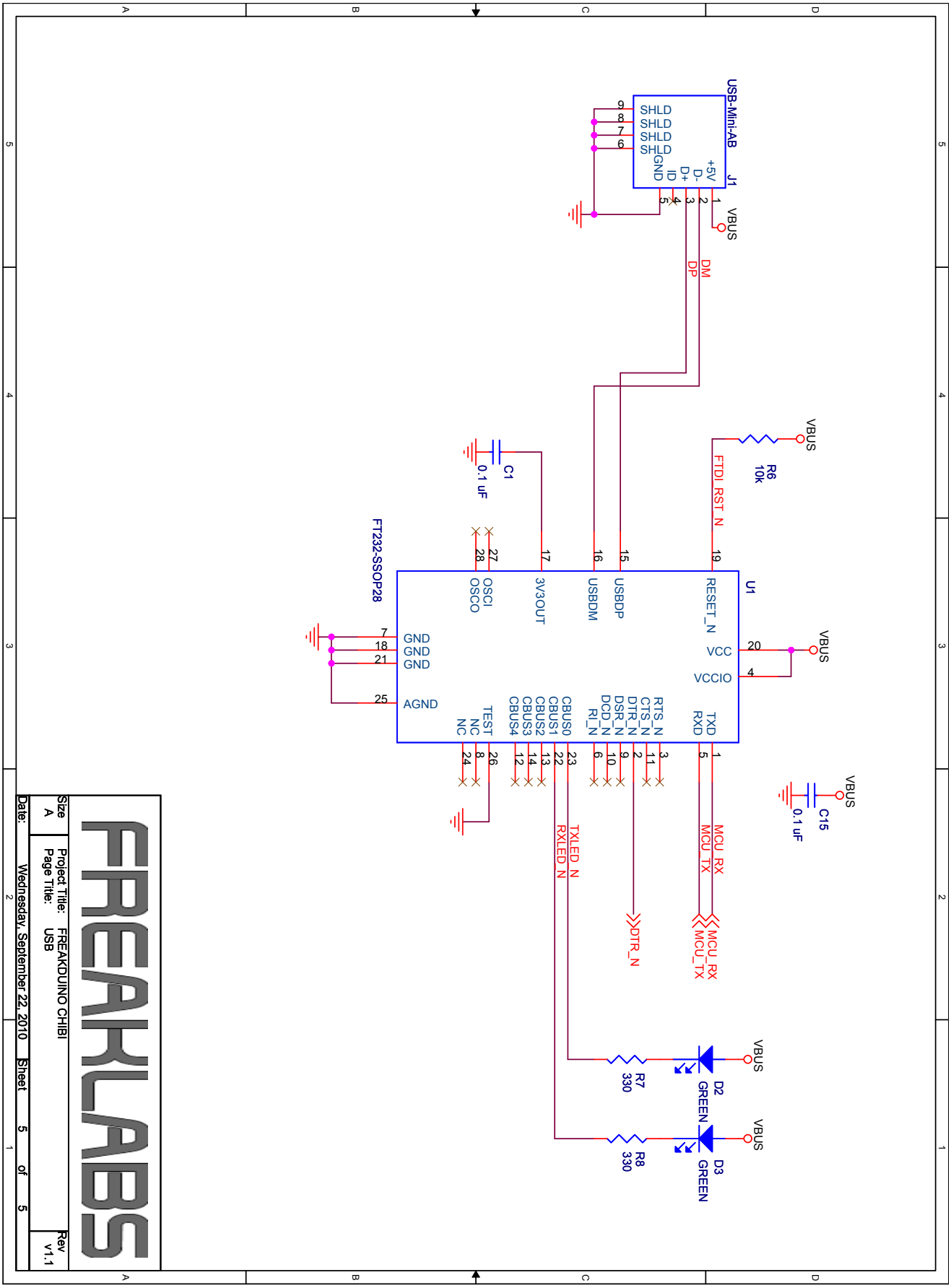
Disclaimer

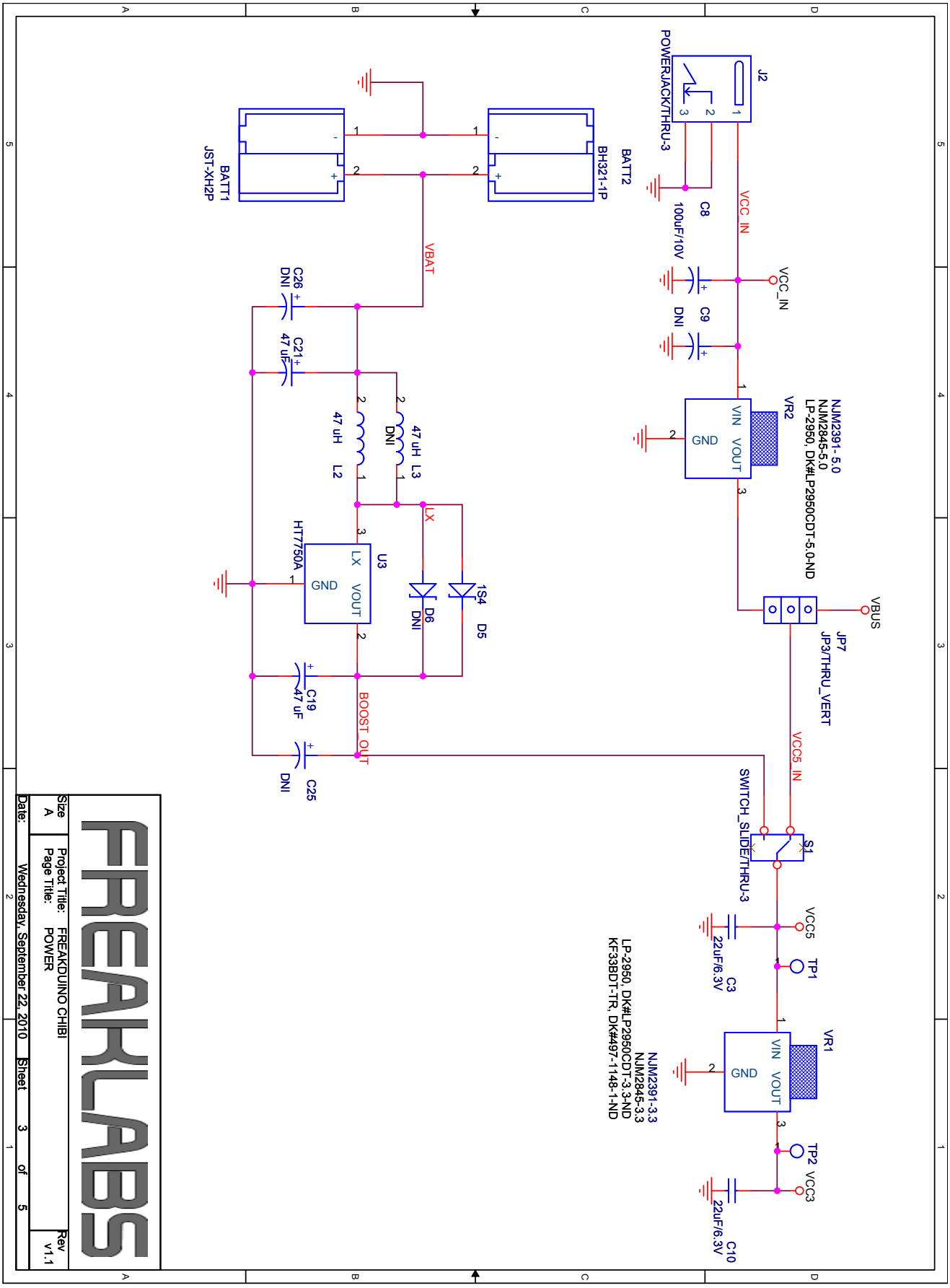
The FREAKDUINO-CHIBI board is NOT FCC approved. It is designed to comply with FCC Part 15 rules. However this board is not in a finished product form and is only intended for experimental and research/development purposes. If you wish to use this board in an actual product, you will need to attain certification with the appropriate local regulatory body for the complete system. Additionally, please use the wireless equipment in a responsible manner with regard for others and your surroundings.

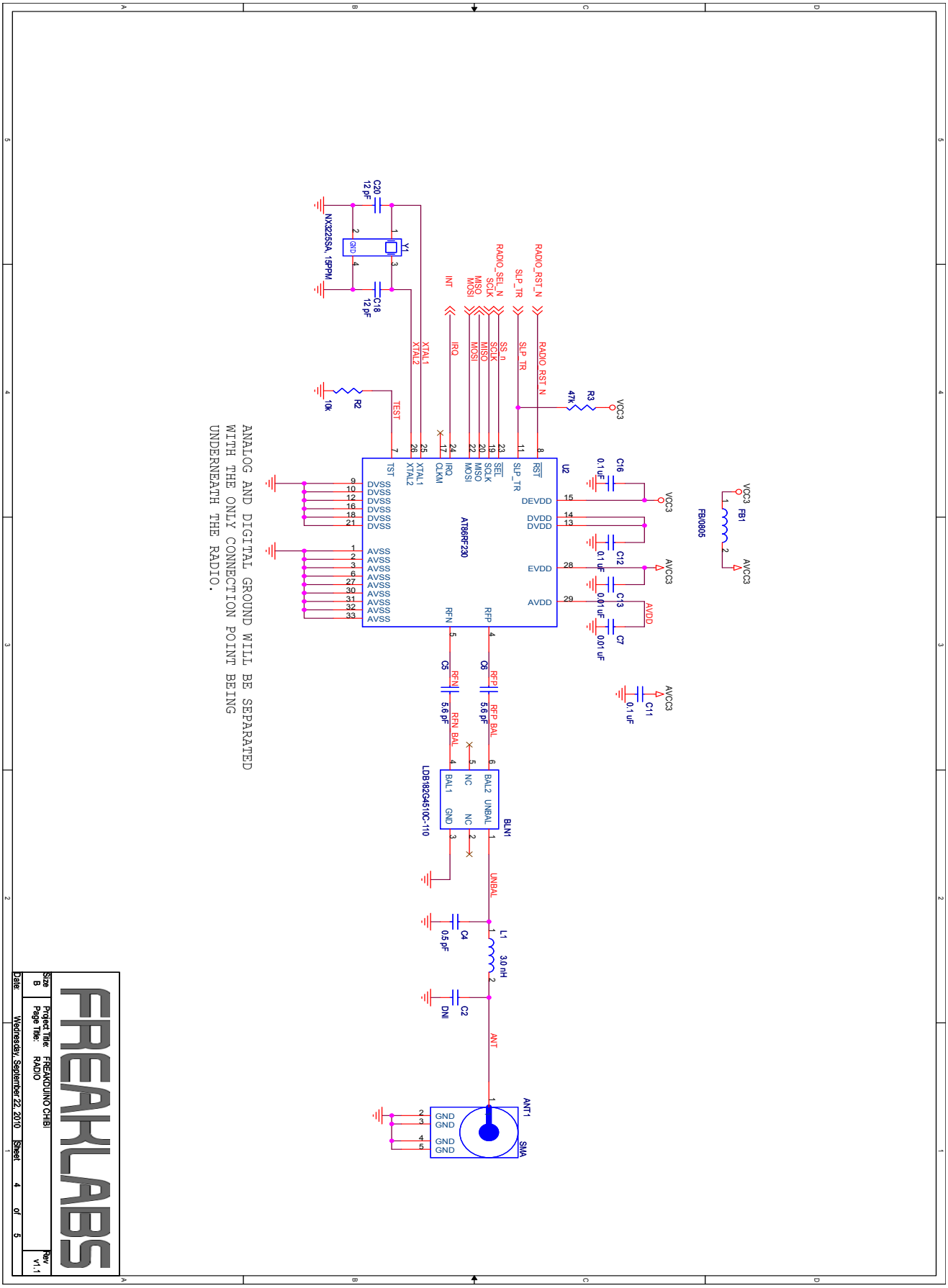
Schematics

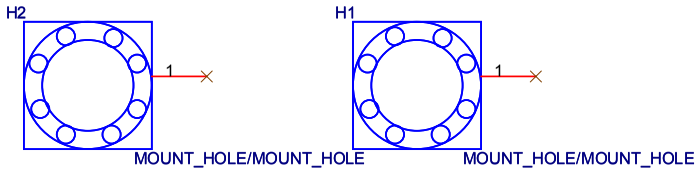
Schematics can be found on the following page:

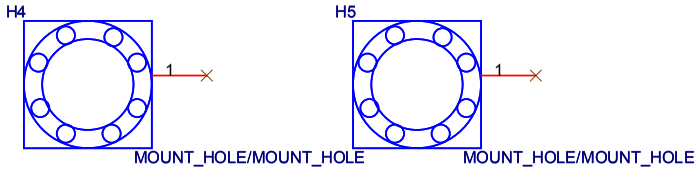

LOGIC CONVERSION FOR 3.3V/5V INTERFACE
ATMEGA328-DIP
U4
PUSHBUTTON-DUAL/SMD2
S2
C14 0.1 uF
C23 22uF/6.3V
C24 0.1 uF
C22 0.1 uF
R21 10k
R25 10k
C17 0.1 uF
JP2
JP8/THRU
JP5
JP3
JP4
R4 1k
R5 1k
MCU_RX
MCU_TX
R15 DNI
R9 10k
Q1 2N7002
R22 DNI
R16 10k
Q2 2N7002
SW1 DIPSWITCH4/DIP
SW2 DIPSWITCH4/SO
D1 BLUE
D4 RED
R1 330
R10 330
VCC5_LED
R17 10k
R18 15k
R13 10k
R14 15k
R11 10k
R12 15k
R20 10k
R19 DNI
R24 10k
R23 47k
H3
H3X2
SLP_TR has a pullup on the radio side. When going to sleep mode, just set this to be an input. That way, there's less static power drain.
LED CONTROL - THIS MAKES IT POSSIBLE TO TURN OFF THE LEDS. ESPECIALLY IMPORTANT WHEN RUNNING ON BATTERIES.
Reset has a pullup to VCC5 so the pulldown on the voltage divider should be weaker
ISP CONNECTOR
FREAKLABS
Project Title: FREAKDUINO CHIBI
Page Title: MCU
Rev v1.1
Size B
Date: Monday, November 01, 2010
Sheet 1 of 5


USB-Mini-AB
J1
SHLD
SHLD
SHLD
SHLD
GND
ID
D+
D-
+5V
VBUS
DM
DP
FT232-SSOP28
U1
GND
GND
GND
AGND
TEST
NC
NC
OSCI
OSCO
3V3OUT
USBDM
USBDP
RESET_N
VCC
VCCIO
TXD
RXD
RTS_N
CTS_N
DTR_N
DSR_N
DCD_N
RI_N
CBUS0
CBUS1
CBUS2
CBUS3
CBUS4
FTDI_RST_N
R6
10k
C1
0.1 uF
C15
0.1 uF
R7
330
R8
330
D2
GREEN
D3
GREEN
MCU_RX
MCU_TX
DTR_N
TXLED_N
RXLED_N
FREAKLABS
Project Title: FREAKDUINO CHIBI
Page Title: USB
Size A
Rev v1.1
Date: Wednesday, September 22, 2010
Sheet 5 of 5

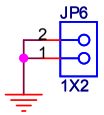

J2
POWERJACK/THRU-3
C8
100uF/10V
VCC_IN
C9
DNI
VCC_IN
VR2
NJM2391-5.0
NJM2845-5.0
LP-2950, DK#LP2950CDT-5.0-ND
VIN
VOUT
GND
JP7
JP3/THRU_VERT
VBUS
VCC5 IN
SWITCH_SLIDE/THRU-3
S1
VCC5
C3
22uF/6.3V
TP1
VR1
NJM2391-3.3
NJM2845-3.3
LP-2950, DK#LP2950CDT-3.3-ND
KF33BDT-TR, DK#497-1148-1-ND
TP2
VCC3
C10
22uF/6.3V
BATT2
BH321-1P
BATT1
JST-XH2P
VBAT
C26
DNI
C21
47 uF
47 uH
L2
47 uH
DNI
L3
LX
U3
HT7750A
GND
LX
VOUT
D6
DNI
1S4
D5
C19
47 uF
BOOST_OUT
C25
DNI
FREAKLABS
Size
A
Project Title:
FREAKDUINO CHIBI
Page Title:
POWER
Rev
v1.1
Date:
Wednesday, September 22, 2010
Sheet
3
of
5


ANALOG AND DIGITAL GROUND WILL BE SEPARATED
WITH THE ONLY CONNECTION POINT BEING
UNDERNEATH THE RADIO.
FREAKLABS
Project Title: FREAKDUINO CHIBI
Page Title: RADIO
Size: B
Date: Wednesday, September 22, 2010
Sheet 4 of 5
Rev: v1.1
AT86RF230
LDB182G4510C-110
NX3225SA, 16PPM
FB/0805
ANT1
SMA





GND TESTPOINTS FOR DEBUGGING



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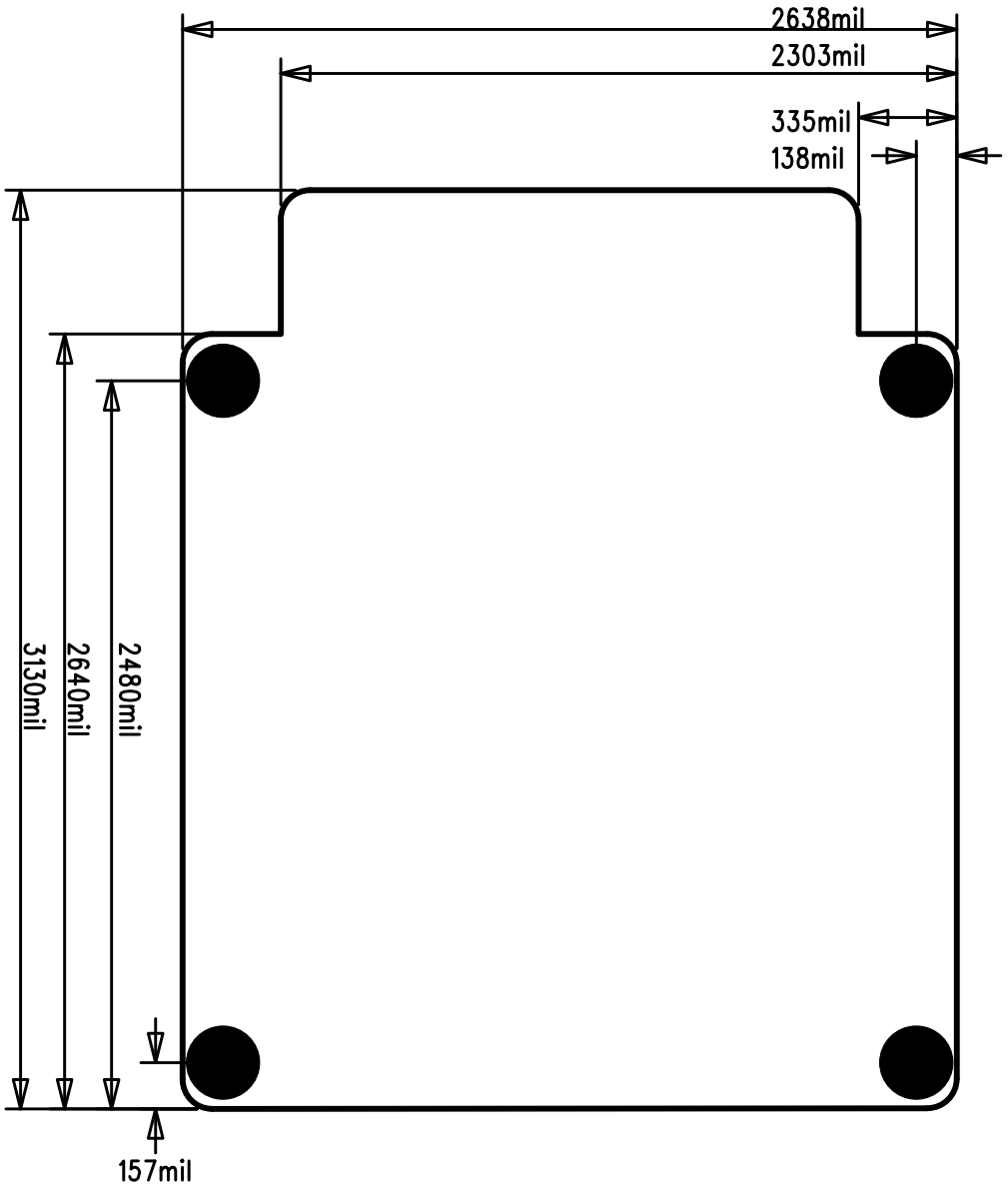
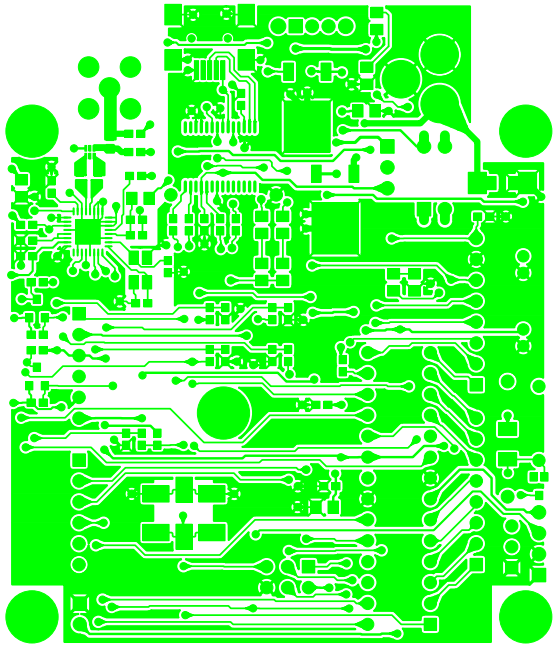
Size	Project Title:	Rev
A	FREAKDUINO CHIBI	v1.1
	Page Title: RESET/MISC	
Date: Sunday, September 05, 2010	Sheet 2 of 5	

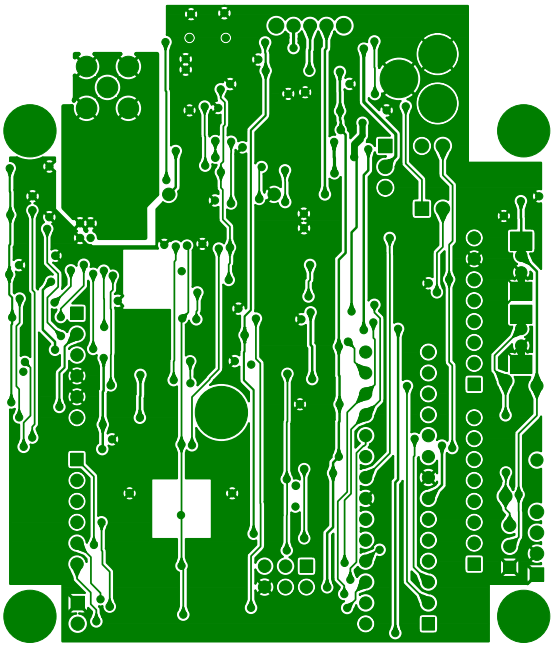
PCB Layout

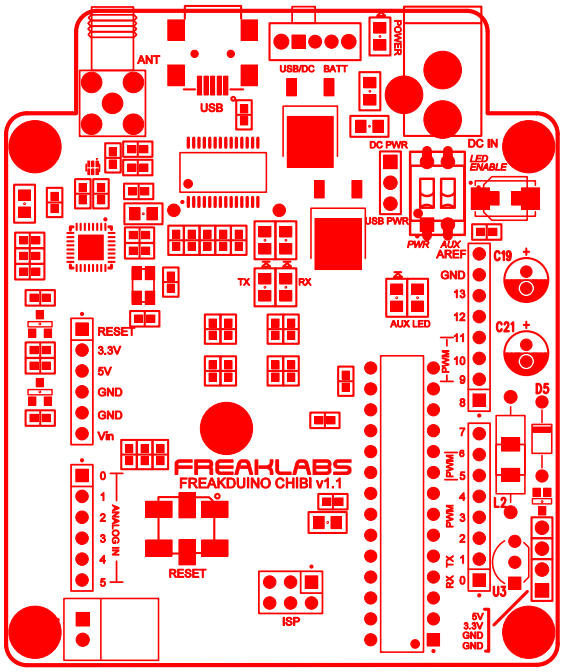
PCB layout file order:

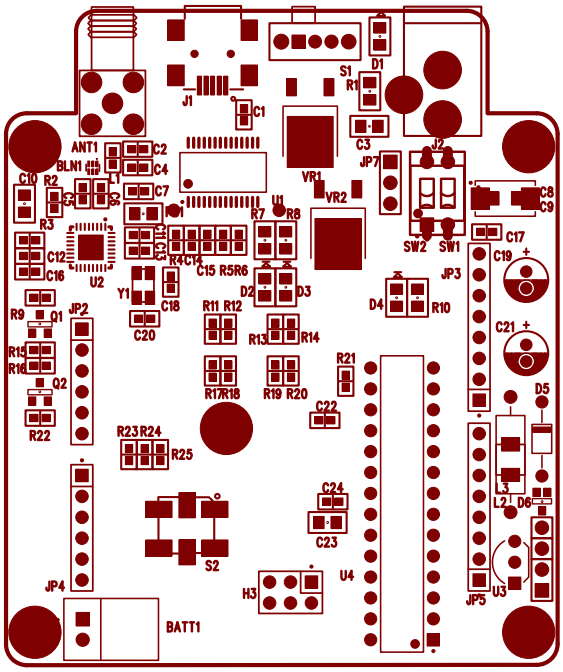
1. *Mechanical Dimensions*
2. *Top Layer*
3. *Bottom Layer*
4. *Assembly Drawing - Silkscreen View*
5. *Assembly drawing - Reference Designator View*








ANT
USB
USB/DC
BATT
POWER
DC PWR
DC IN
LED ENABLE
USB PWR
PWR
AUX
AREF
TX
RX
AUX LED
RESET
3.3V
5V
GND
GND
Vin
ANALOG IN
FREAKLABS
FREAKDUINO CHIBI v1.1
RESET
ISP
PWM
GND
13
12
11
10
9
8
7
6
5
4
3
2
1
0
RX TX
5V
3.3V
GND
GND
C19
C21
D5
L2
U3


J1
S1
D1
R1
C1
C3
JP7
VR1
VR2
U1
R7
R8
SW2
SW1
C17
C19
JP3
C8
C9
ANT1
BLN1
C2
C4
L1
C7
C10
R2
R3
C12
C16
U2
Y1
C18
C20
R4
C14
C15
R5
R6
D2
D3
R11
R12
R13
R14
D4
R10
C21
D5
L3
D6
L2
U3
JP5
R9
Q1
JP2
R15
R16
Q2
R22
R17
R18
R19
R20
R21
C22
R23
R24
R25
S2
C24
C23
H3
U4
JP4
BATT1

Bill of Materials

Quantity	*Reference*	*Manufacturer*	*Part Number*	*Description*
1	ANT1	ChangHong	SMA-02-113-TGG	RP-SMA Connector
1	BATT1	JST	JST-XH2P	2-pin mated, polarized connector, male
1	BATT2	COMF	BH321-1P	2-AA battery case
1	BLN1	Murata	LDB 182G4510C-110	100 ohm diff/50 ohm single ended, 2.4 GHz, balun
9	C1,C11,C12,C14, C15,C16, C17,C22, C24	Various		0.1uF/50V, 0603
3	C3,C10,C23	Various		22uF/6.3V, 0805, MLCC
1	C4	Taiyo Yuden	UVK-105CH0R5BW-F	0.5 pF/50V, 0402, high freq
2	C5,C6	Taiyo Yuden	UMK105C-G5R6DW-F	5.6 pF/50V, 0402, high freq
2	C7,C13	Various		0.01 uF/50V, 0603
1	C8	Various		100 uF/10V, Case-D, Tantalum
2	C18,C20	Various		12 pF/50V, 0603
2	C19,C21	Various		100 uF/10V, Case-D, Tantalum
1	D1	Various		Blue LED, 0805
2	D2,D3	Various		Green LED, 0805
1	D4	Various		Red LED, 0805
1	D5	Various		Schottky diode, 200 mA
1	FB1	Various		Ferrite Bead, 0805
1	H3	Various		3x2 Straight male header, 0.100”
2	JP3,JP5	Various		1x8 Straight female header, 0.100”
1	JP4, JP2	Various		1x6 Straight female header, 0.100”
1	JP7	Various		1x3 Straight male header, 0.100”

Quantity	Reference	Manufacturer	Part Number	Description
1	J1	4UCON	09558	USB Mini-AB connector
1	J2	4UCON	05537	DC Power Jack, 2.0 mm center conductor
1	L1	Abracon	ATFC-0402-3N0-BT	3.0 nH, 0402, high freq
2	L2,L3	Various		47 uH inductor, 200 mA
2	Q1,Q2	Diodes, Inc	2N7002	N-channel enhancement FET
4	R1,R7,R8,R10	Various		330 ohms, 0805
14	R2, R6, R9, R11, R13, R16, R17, R20, R21, R24, R25	Various		10 kohms, 0603
3	R12, R14, R18	Various		15 kohms, 0805
2	R3,R23	Various		47 kohms, 0603
2	R4,R5	Various		1 kohms, 0603
1	SW1	Various		2-input DIP switch
1	S1	See-Plus	SK-12D01-VG2	Right angle slide switch
1	S2	Various		SMD SPST Tactile Switch/Pushbutton
1	U1	FTDI	FT232RL	USB to Serial Converter
1	U2	Atmel	AT86RF230	2.4 GHz, 802.15.4 radio
1	U3	Holtek	HT7750A	5V Boost Converter
1	U4	Atmel	ATMEGA328P	AVR Microcontroller
1	VR1	NJRC	NJM2391-3.3	3.3V Regulator
1	VR2	NJRC	NJM2391- 5.0	5.0V Regulator
1	Y1	NDK	NX3225SA	16 MHz crystal, 15 ppm