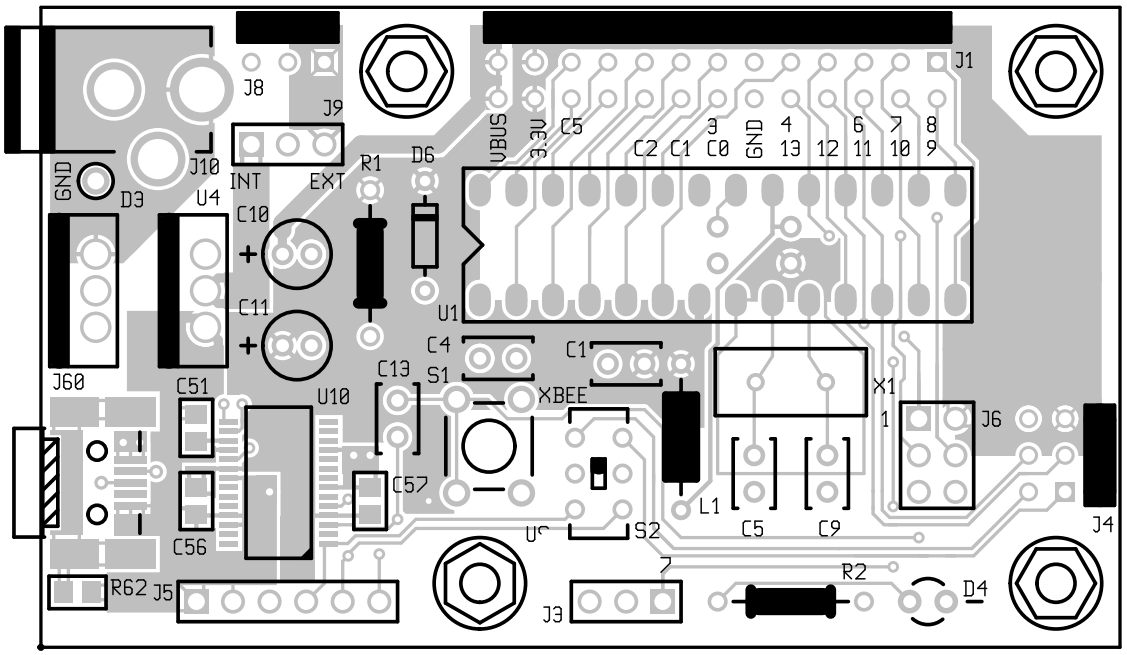


## NB1 Description

The NB1 is a microcontroller development system that is compatible with the Arduino software environment. For system development a variety of peripheral modules are available.

## Features

- Compatible with the Arduino development tools.
- Socketed ATmega168 for easy replacement and upgrade.
- 2.95" x 1.75"
- ATmega168 running at 12MHz with a $V_{CC}$ of 3.3V.
- Side header connector (J4) is wired to two digital lines and the recieve and transmit lines from the UART. A UART enabled device (such as an **X**Bee or a Bluetooth radio) board can be connected to the right side of the NB1.
- I/O connections are wired to a single 26 pin header. Application boards can be mounted parallel using vertical connectors, co-planar using right-angle connectors or remotely using a flexible cable.
- The board can be built with either a USB interface FTDI FT232RL or with a six pin header for use with an FTDI TTL-232R-3V3 cable. The USB interface circuitry includes transient suppression and current limiting resistors.
- ICSP port (3.3V levels)
- A/D reference supply filtered per Atmel specification.
- Reset circuit per Atmel specification (which includes a protection diode and an optional filter capacitor).
- Power supply is jumpered between either an LDO or an external 3.3V supply. The wall adapter and the USB 5V supply are diode or'ed to the LDO input.
- Compatible with all ZB1 peripherals.

# 1 Assembling the NB1

Semiconductors are electrostatic-sensitive devices. Proper ESD handling precautions need to be taken to avoid damage.

The Bill of Materials (BOM) and Component List is in section 6. For full page assembly drawings see Figure 1 (top) and Figure 2 (bottom).

Extra care needs to be taken when soldering the right-angle connector (J1, J8 (opt), J4 (opt)). The outer edge of the connector bodies should not protrude over the edge of the board. After soldering, the connector pins should be parallel to the board.

A DC source with current limiting is useful for testing each section of the NB1 as you build it.

All of the headers supplied with the kit are breakaway headers. The single row headers, J3 (3x1), J5 (6x1), J9 (3x1) may come as individual headers or as strips that need to be broken. Most kits will contain either two 6x1 headers or one 12x1. Break this headers to create J3, J5 and J9.

If you are not building the USB circuit proceed to subsection 1.2.

## 1.1 USB Circuit Assembly

Solder the top side components:

- U10 - FT232RL
- C57, C56, C51
- R62
- J60

Solder the bottom side components:

- U55
- R59
- R58

At this point clean the flux off of the top and bottom side of the board. After the board is cleaned visually inspect the board for solder shorts, opens and cold solder joints. If possible power up U10 with a current limited +3.3V supply by attaching clip leads to the pads of the LDO (U4). +3.3V connected to U4-2 and GND connects to U1-1. The current drawn from the +3.3V supply should not exceed a few milliamperes. If it does then check for solder bridges on U10 and U55.

## 1.2 Bottom Side Components

- F1
- C2, C3

## 1.3 Power Supply Circuit Assembly

Solder the top side components:

- C10, C11

  *C10 and C11 are polarized parts. The long lead is the positive. The short lead is the negative. Make sure that the* **positive** *lead is inserted into positive hole in the PCB*

- U4

  *Be careful to not mixup U4 and D3. U4 is marked* `MC33269T-3.3G` *Make sure that the tab is aligned to the tab marking on the PCB.*

- D3

  *Be careful to not mixup D3 and U4. D3 is marked* `MBR1545CTG` *Make sure that the tab is aligned to the tab marking on the PCB.*

- J9
- J10
- J8 (optional)

  *J8 enables the usage of an external 3.3V power source with the NB1. If you do not need this function then you can omit the installation of J8. J8 is not included in the kit.*

At this point clean the flux off of the top and bottom side of the board. After the board is cleaned visually inspect the board for solder shorts, opens and cold solder joints.

### 1.3.1 Testing the Power Suppy Circuit

If possible apply power through J10 with a current limited +5V supply. The current drawn from the +5V supply should not exceed a few milliamperes. If it does then verify the orientation on C10, C11, D3, U4.

## 1.4 Microcontroller Circuit Assembly

Solder the top side components:

- R1

  *The tolerance of R1 is not critical. Some kits include a 5% resistor others include a 1% resistor. The 5% resistor has four color bands (brown, black, orange, gold). The 1% resistor has five color bands (brown, black, black, red, brown)*

- D1

  *Line the cathode marking on D1 with the cathode marking on the silkscreen*

- C13, C1, C4 (optional).

  *C4 is optional and is not included in the kit. It is meant for applications that require additional filtering of the reset line. Applications that use USB download or ISP programmers like the AVRISPMKII will not require additional filtering. Also, the reset function that uses the /RTS line from the USB interface will not function with C4 installed.*

- L1

  *The value of inductor L1 is not critical. Kits will contain an inductor with a value between 10$\mu$H and 15$\mu$H*

- D4

  *The negative lead of the LED is the short lead. Align the short lead with the negative marking on the PCB.*

- R2

  *The tolerance of R2 is not critical. Some kits include a 5% resistor others include a 1% resistor. The 5% resistor has four color bands (red, red, brown, gold). The 1% resistor has five color bands (red, red, brown, black, brown).*

- J3
- X1, C5, C9
- U1 (socket)
- J6
- J1

  *The J1 that is included with the NB1 Kit is a right angle connector. If your application requires parallel board mounting or a cable connection then replace J3 with a vertical header. A 2x13 receptacle can also be used.*

- J4 (optional).

At this point clean the flux off of the top and bottom side of the board. After the board is cleaned visually inspect the board for solder shorts, opens and cold solder joints. After inserting an ATmega168 into the U1 socket the microcontroller section of the NB1 should be fully functional. If possibly apply power through J10 with a current limited +5V supply. The current drawn should not exceed 10mA (20mA if the J3 jumper is installed in the VCC position).

## 1.5 Electro-mechanical Components

The electro-mechanical components are sensitive to washing. Place all of these last and lightly wash afterwards. If water does get into these components let them dry out before applying power.
Solder the top side components:

- S2
- S1

## 1.6 Mounting Hardware

Space has been provided for four #2 hex standoffs and washers.

## 1.7 Test

Remove the ATmega168 from the antistatic foam and insert it into the U1 socket aligning the notch in the IC package with notch mark indicated on the PCB silkscreen. Be careful to align pins on both sides of the socket prior to pressing the IC into the socket.

The board is now ready to program. To test the programming using the Arduino tools (see section 4).

# 2 IO Connectors

| | | |
|---|---|---|
| J1 | 13x2 header | I/O connections from the ATmega168. See Table 2 |
| J5 | 6x1 header | USB header for an FTDI TTL-232R-3V3 cable. This is only installed if the USB circuit is not populated. |
| J6 | 3x2 header | ICSP header |
| J8 | 3x1 header | External 3.3V regulated voltage input. |
| J9 | 3x1 jumper | Jumper to switch between the external 3.3V input and the on board LDO. |
| J10 | 2.1mm Power Jack | 5V to 15V unregulated DC. The power dissipation in U4 needs to be kept below one watt. |
| J60 | USB Mini-B | |

Table 1: NB1 connectors

## 2.1 J1 Header

| **ATmega168 Pins (Arduino Pins)** | | **J1 Pin** | | **ATmega168 Pins (Arduino Pins)** | |
|---|---|---|---|---|---|
| PB0 (**8**) | 14 | 1 | 2 | PB1 (**9**) | 15 |
| PD7/AIN1 (**7**) | 13 | 3 | 4 | PB2 (**10**) | 16 |
| PD6/AIN0 (**6**) | 12 | 5 | 6 | PB3/MOSI (**11**) | 17 |
| PD5 (**5**) | 11 | 7 | 8 | PB4/MISO (**12**) | 18 |
| PD4 (**4**) | 6 | 9 | 10 | PB5/SCK (**13**) | 19 |
| GND | | 11 | 12 | GND | |
| PD3 (**3**) | 5 | 13 | 14 | PC0/ADC0 (**A0**) | 23 |
| PD2 (**2**) | 4 | 15 | 16 | PC1/ADC1 (**A1**) | 24 |
| PD1 (**1**) | | 17 | 18 | PC2/ADC2 (**A2**) | 25 |
| PD0 (**0**) | | 19 | 20 | PC3/ADC3 (**A3**) | 26 |
| PC5/ADC5/SCL (**A5**) | 28 | 21 | 22 | PC4/ADC4/SDA (**A4**) | 27 |
| +3.3V | | 23 | 24 | +3.3V | |
| VBUS | | 25 | 26 | VBUS | |

Table 2: J1 Pinout

# 3 Electrical Hints

## 3.1 Power Supply

The NB1 can be powered by a wall adapter, the USB port or an external regulated 3.3V supply. The wall adapter and the USB port are diode or'ed and are connected to the input of a LDO regulator (U4). Jumper J9 selects between the two power sources – INT is the LDO regulator (U4), EXT is the power source connected to J8.


Power Jumper in the Internal Position


Power Jumper in the External Position

It is critcal to keep the power dissipation in the LDO regulator (U4), to less than one watt. The voltage drop across U4 is

$$V_{drop} = V_{in} - 0.5V$$

where $V_{in}$ is the greater of the wall adapter voltage or +5V (USB 5V supply). The power dissipated in U4 is given by

$$P_{diss} = V_{drop} \cdot I_{system}$$

where $I_{system}$ is the load of the NB1 plus its peripheral circuitry.

## 3.2 Powering from the USB Port

The intial startup load of a device connected to the USB port must not exceed 10$\mu$F in parallel with 44Ω ((USB-IF, 2000a)). Peripheral circuitry attached to the NB1 may produce a system load that exceeds the specification.

## 3.3 $V_{BUS}$

$V_{BUS}$ is the unregulated voltage at the cathode of the or'ing diode (D3). Applications that require current beyond the current rating of the LDO regulator (U4) should use $V_{BUS}$. Since the only volage drop between the input power source and $V_{BUS}$ is the $V_f$ of the or'ing diode (D3) it is more efficient to use $V_{BUS}$ rather than the +3.3V supply as an input voltage for other power conversions.

## 3.4 Debug LED

The debug LED, D4, can be connected to the +3.3V supply or to U1 pin 13 (PD7) of the ATmega168. U1 pin 13 corresponds to Arduino pin "7".


LED jumper in the VCC position


LED jumper in the Pin 7 position

# 4 Application Hints

## 4.1 Downloading a program to the NB1

1. Place switch S2 in the USB position.
2. The NB1 is ready for download. It may be necessary to press the reset button prior to starting the download.

## 4.2 Downloading a bootloader

The NB1 is powered from 3.3V. Any device that connects to the NB1 needs to output 3.3V TTL levels. The Atmel `AVRATAVRISPMKII` and Ladyada USBtiny are compatible with the NB1.

To use the Ladyada USBtiny remove the USBtiny jumper, JP3, and plug the USBtiny cable into the NB1 ICSP header. With JP3 removed the USBtiny output buffer (IC2) is powered by the $V_{cc}$ from the NB1 (3.3V). The USBtiny output buffer (IC2) is a `74AHC125` which will tolerate 5V levels when powered from a 3.3V supply.

# 5 Programming the NB1

The NB1 can be programmed using the Arduino tools (version `0011` or more recent). Kits contain either an ATmega168 or ATmega328 ATmega168. From the `Tools->Board` menu select one of the following –

**ATmega168** `Arduino NG or older w/ ATmega168`

**ATmega328** `Arduino Deicimila w/ ATmega328`

To download a program the UART switch S2 must be in the USB position.

The NB1 uses a 12MHz XTAL. The Arduino tools are setup for boards with a 16MHz XTAL. If you do not change the tool setup you will need to adjust the baud rate of the serial port. For example – to get a baudrate of 9600 it is necessary to run the command:

```
Serial.begin(12800)
```

This baudrate setting value comes from the following equation:

$$\text{baud rate setting} = \frac{16\text{MHz}}{12\text{MHz}} \cdot 9600$$

## References

USB-IF, I. (2000a, April 27). Universal Serial Bus Specification. 171-177.
USB-IF, I. (2000b, April 27). Universal Serial Bus Specification.

# 6 Assembly Documentation and Schematics

Table 3: Bill of Materials

**Schematic:** nb1_r1.sch Mon Aug 3 15:39:02 2009
**BOM:** nb1_r1.bom Tue Sep 15 10:17:46 2009

| Qty | Reference | Value | Footprint | Mfg PN |
|---|---|---|---|---|
| 5 | C1, C2, C3, C4, C13 | 0.1u | CAPR-254P-318W-508L-660.. | Kemet C320C104K5R5TA |
| 2 | C5, C9 | 20p | CAPR-254P-318W-508L-660.. | Xicon 140-100N2-200J-RC |
| 2 | C10, C11 | 10uF | CAPPR-200P-500D.. | Nichicon UPW1E100MDD |
| 3 | C51, C56, C57 | 0.1u | 0805 | Kemet C0805C104K5RACTU |
| 1 | D3 | | TO220-3N | On-Semi MBR1545CTG |
| 1 | D4 | | LED-254P-320D.. | Kingbright WP7104LGD |
| 1 | D6 | | DO-35.fp | Fairchild 1N4148TA |
| 1 | F1 | | 1812 | Littelfuse 1812L050PR |
| 1 | J1 | | CON_HDR_RA-254P-13C-2R.. | Amp 1-103149-3 |
| 2 | J3, J9 | | CON_HDR-254P-3C-1R-3N.. | Harwin M20-9990345 |
| 1 | J4 | | CON_HDR_RA-254P-3C-2R-6.. | Harwin M20-9990645 |
| 1 | J5 | | CON_HDR-254P-6C-1R-6N.. | Harwin M20-9990645 |
| 1 | J6 | | CON_HDR-254P-3C-2R-6N.. | FCI 69192-406HLF |
| 1 | J8 | | CON_HDR_RA-254P-3C-1R-3.. | Tyco 5-103765-3 |
| 1 | J10 | | CON__CUI_PJ-202AH.fp | CUI PJ-202AH |
| 1 | J60 | | CON_USB_MINI_B.. | Molex 67503-1020 |
| 1 | L1 | 10uH | IND-1016P-635L-241D.. | Bourns 78F100J-RC |
| 1 | R1 | 10K | RES-1016P-630L-240D.. | Yageo MFR-25FBF-10K0 |
| 1 | R2 | 220 | RES-1016P-630L-240D.. | Yageo MFR-25FBF-221R |
| 1 | R58 | 10K | 0805 | Yageo 9C08052A1002FKHFT |
| 1 | R59 | 4.7K | 0805 | Rohm MCR10EZHF4701 |
| 1 | R62 | 33K | 0805 | Yageo 9C08052A3302FKHFT |
| 1 | S1 | | SW.. | Panasonic EVQ-PAE04M |
| 1 | S2 | | SW__CK_JS202011CQN.fp | CK JS202011CQN |
| 1 | U1 | | DIP-28-300 | Atmel ATmega168-20PU |
| 1 | U4 | | TO220-3N | On-Semi MC33269T-3.3G |
| 1 | U10 | | SSOP-65P-780L1-28N.. | FTDI FT232RL |
| 1 | U55 | | SOT23-95P-280L1-6N.. | TI SN65220DBV |
| 1 | X1 | 12MHz | XTAL_HC-49US | ECS ECS-120-20-4X |

Table 4: Component List

**Schematic:** nb1_r1.sch Mon Aug 3 15:39:02 2009
**BOM:** nb1_r1.bom Tue Sep 15 10:17:46 2009

| Reference | Value | Footprint | Mfg PN |
|---|---|---|---|
| C1 | 0.1u | CAPR-254P-318W-508L-660H.. | Kemet C320C104K5R5TA |
| C2 | 0.1u | CAPR-254P-318W-508L-660H.. | Kemet C320C104K5R5TA |
| C3 | 0.1u | CAPR-254P-318W-508L-660H.. | Kemet C320C104K5R5TA |
| C4 | 0.1u | CAPR-254P-318W-508L-660H.. | Kemet C320C104K5R5TA |
| C5 | 20p | CAPR-254P-318W-508L-660H.. | Xicon 140-100N2-200J-RC |
| C9 | 20p | CAPR-254P-318W-508L-660H.. | Xicon 140-100N2-200J-RC |
| C10 | 10uF | CAPPR-200P-500D.. | Nichicon UPW1E100MDD |
| C11 | 10uF | CAPPR-200P-500D.. | Nichicon UPW1E100MDD |
| C13 | 0.1u | CAPR-254P-318W-508L-660H.. | Kemet C320C104K5R5TA |
| C51 | 0.1u | 0805 | Kemet C0805C104K5RACTU |
| C56 | 0.1u | 0805 | Kemet C0805C104K5RACTU |
| C57 | 0.1u | 0805 | Kemet C0805C104K5RACTU |
| D3 | | TO220-3N | On-Semi MBR1545CTG |
| D4 | | LED-254P-320D__Kingbright_3mm.fp | Kingbright WP7104LGD |
| D6 | | DO-35.fp | Fairchild 1N4148TA |
| F1 | | 1812 | Littelfuse 1812L050PR |
| J1 | | CON_HDR_RA-254P-13C-2R-26N.. | Amp 1-103149-3 |
| J3 | | CON_HDR-254P-3C-1R-3N.. | Harwin M20-9990345 |
| J4 | | CON_HDR_RA-254P-3C-2R-6N.. | Harwin M20-9990645 |
| J5 | | CON_HDR-254P-6C-1R-6N.. | Harwin M20-9990645 |
| J6 | | CON_HDR-254P-3C-2R-6N.. | FCI 69192-406HLF |
| J8 | | CON_HDR_RA-254P-3C-1R-3N.. | Tyco 5-103765-3 |
| J9 | | CON_HDR-254P-3C-1R-3N.. | Harwin M20-9990345 |
| J10 | | CON__CUI_PJ-202AH.fp | CUI PJ-202AH |
| J60 | | CON_USB_MINI_B__Molex_67503-1020 | Molex 67503-1020 |
| L1 | 10uH | IND-1016P-635L-241D.. | Bourns 78F100J-RC |
| R1 | 10K | RES-1016P-630L-240D.. | Yageo MFR-25FBF-10K0 |
| R2 | 220 | RES-1016P-630L-240D.. | Yageo MFR-25FBF-221R |
| R58 | 10K | 0805 | Yageo 9C08052A1002FKHFT |
| R59 | 4.7K | 0805 | Rohm MCR10EZHF4701 |
| R62 | 33K | 0805 | Yageo 9C08052A3302FKHFT |
| S1 | | SW__Panasonic_EVQPA_Series | Panasonic EVQ-PAE04M |
| S2 | | SW__CK_JS202011CQN.fp | CK JS202011CQN |
| U1 | | DIP-28-300 | Atmel ATmega168-20PU |
| U4 | | TO220-3N | On-Semi MC33269T-3.3G |
| U10 | | SSOP-65P-780L1-28N.. | FTDI FT232RL |
| U55 | | SOT23-95P-280L1-6N__LTC_S6_Package | TI SN65220DBV |
| X1 | 12MHz | XTAL_HC-49US | ECS ECS-120-20-4X |

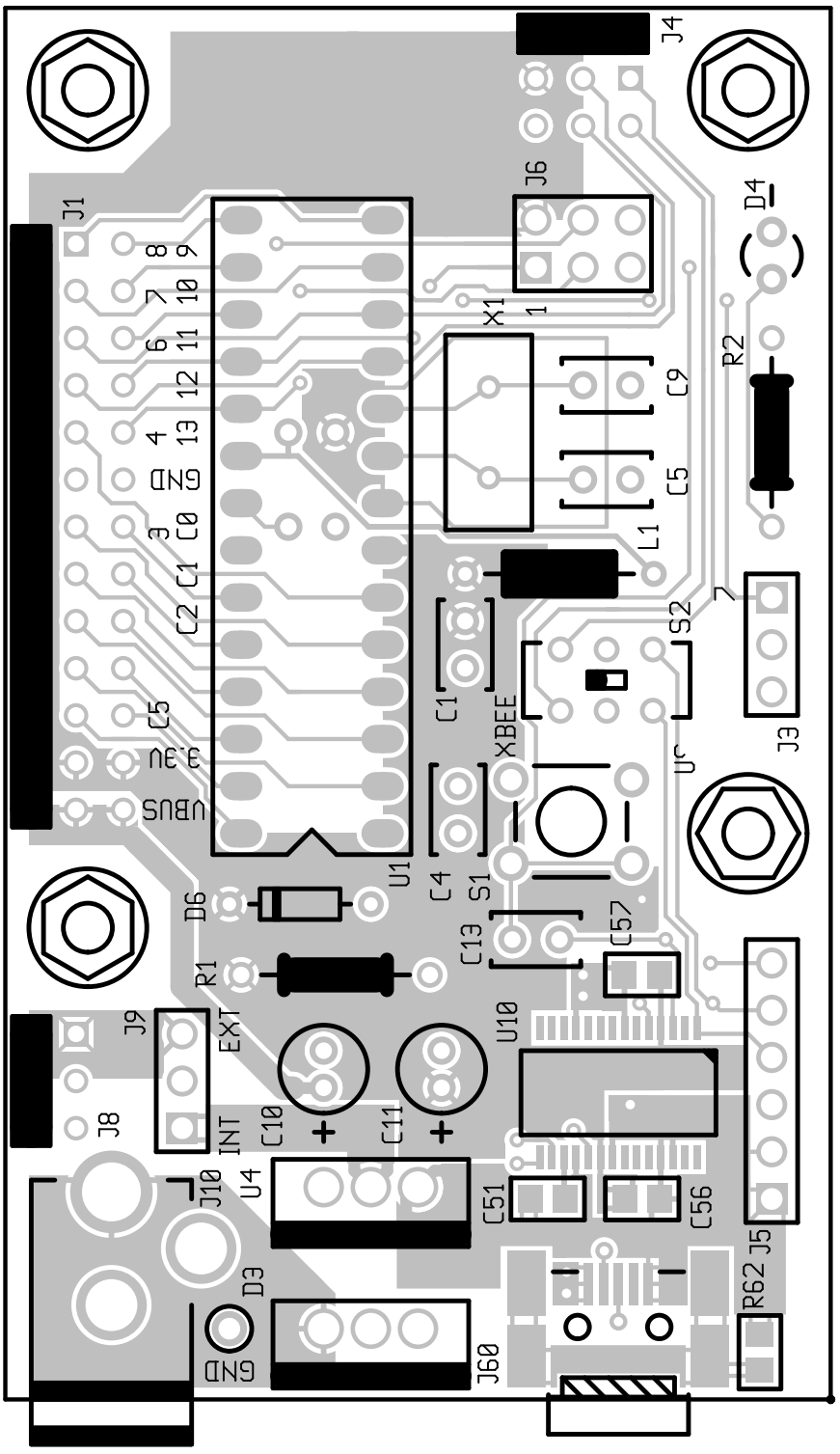


Figure 1: NB1 Top Side Assembly Drawing (Rev 1)

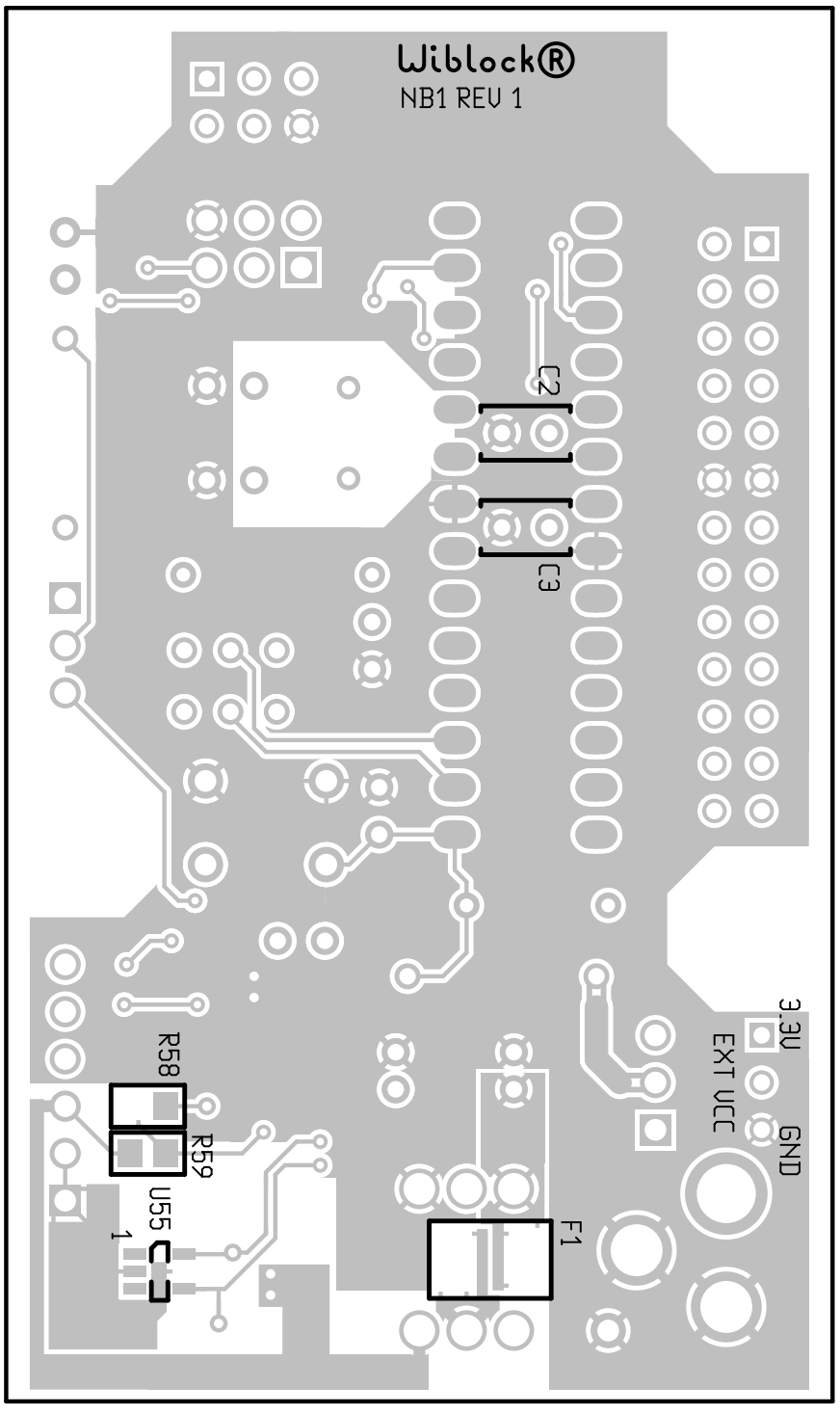


Figure 2: NB1 Bottom Side Assembly Drawing (Rev 1)

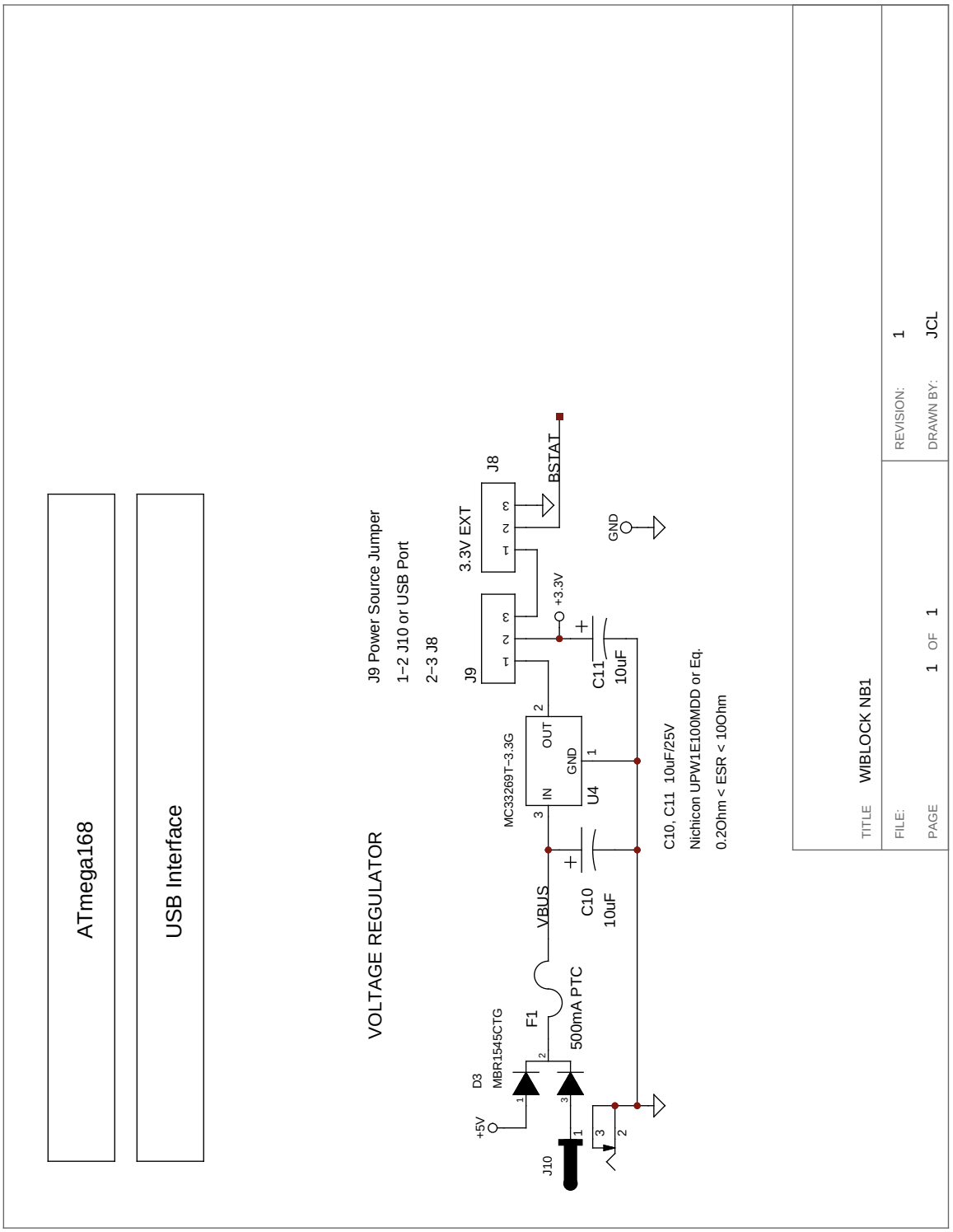


Figure 3: NB1 Top Schematic (Rev 1)

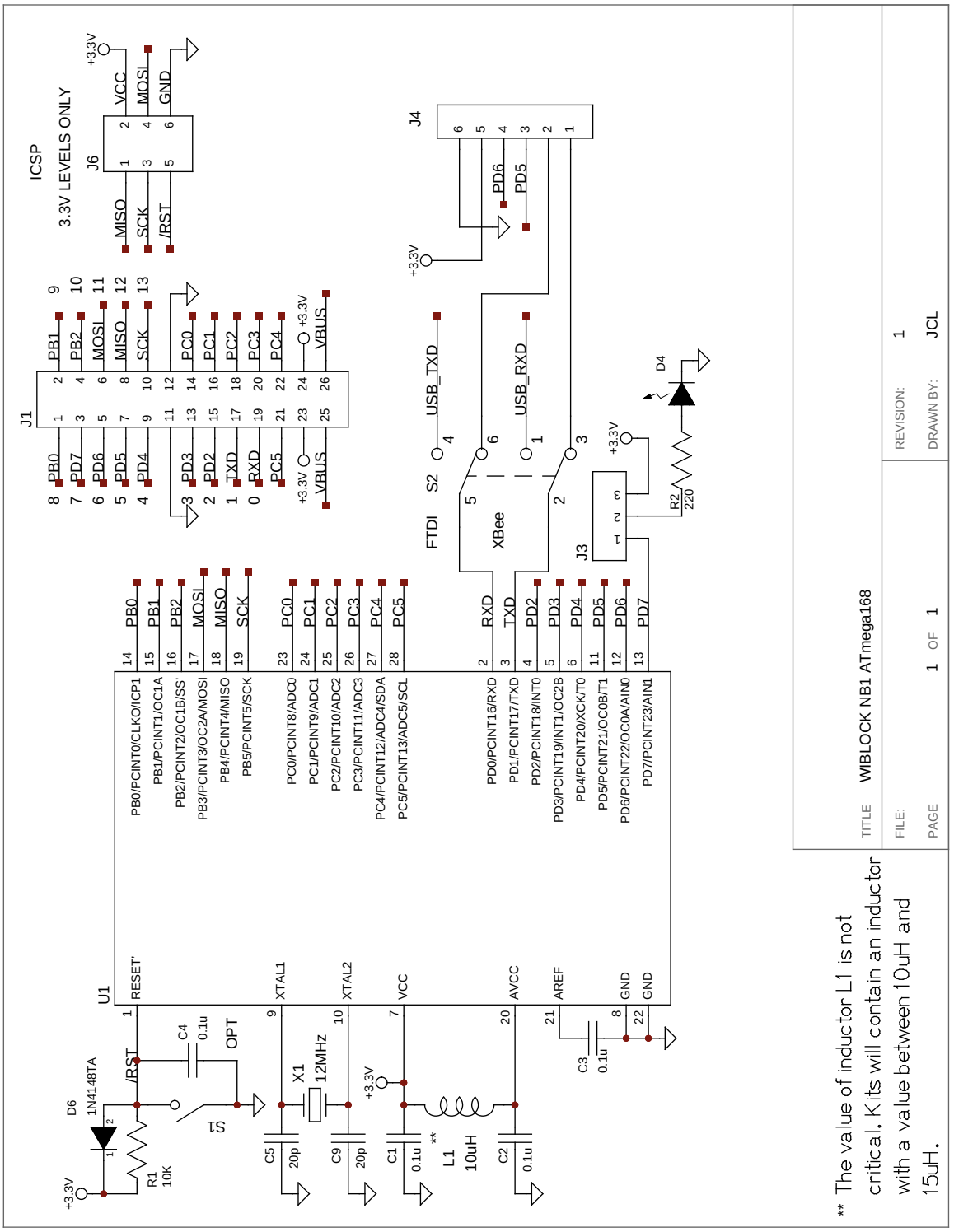


Figure 4: NB1 Microcontroller (Rev 1)

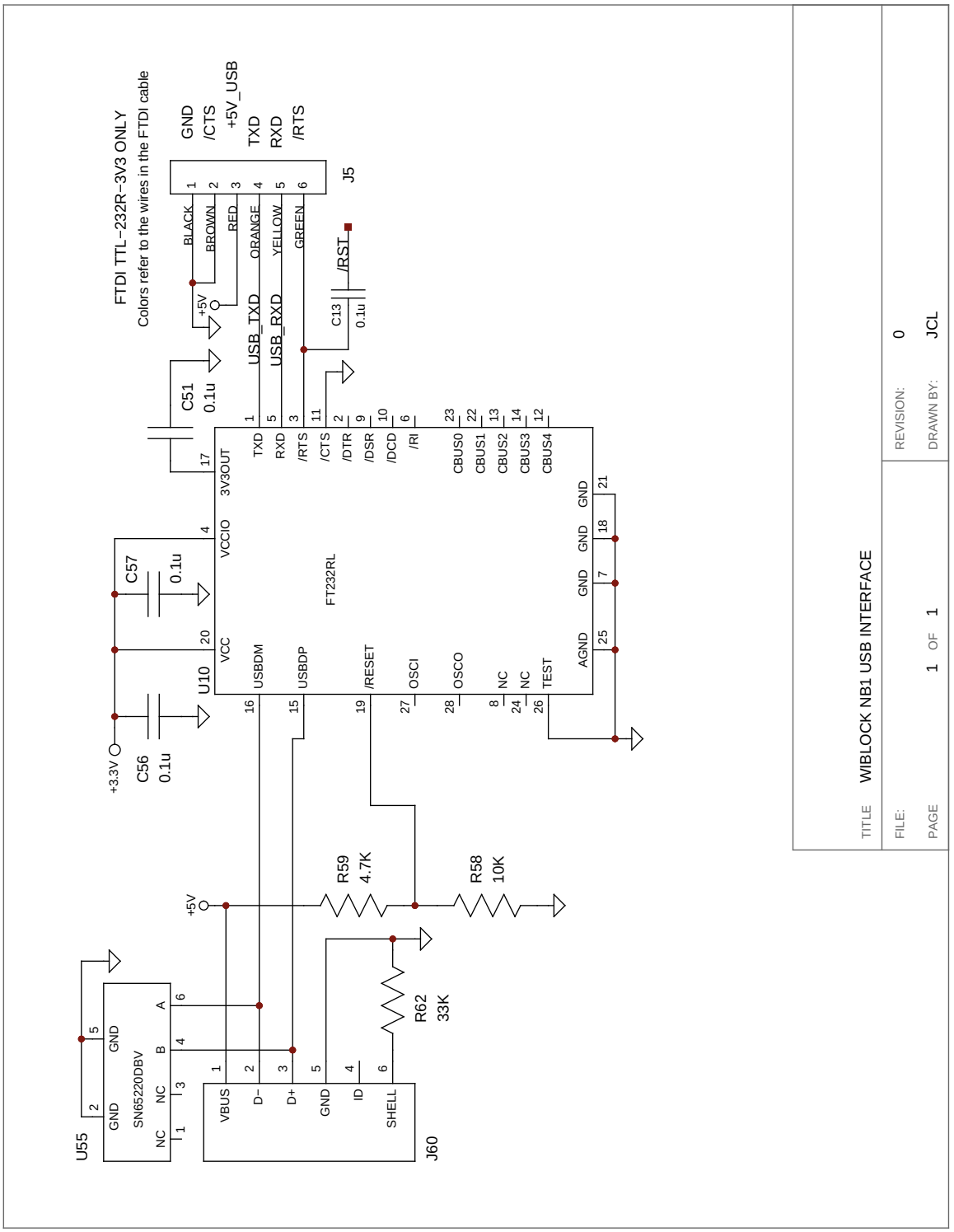


Figure 5: NB1 USB Interface (Rev 1)