DIGWDF Ren-W Universal Assembly Guide

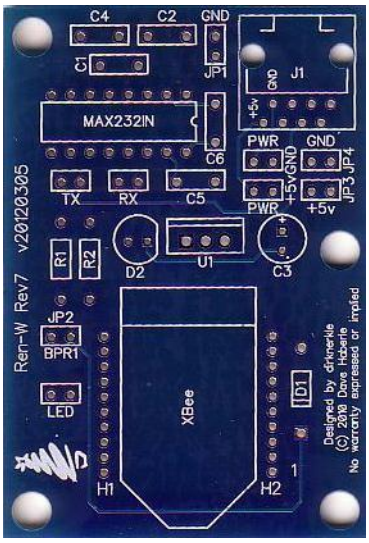
Dirknerkle's Inventorium and Generally Worthless Device Factory

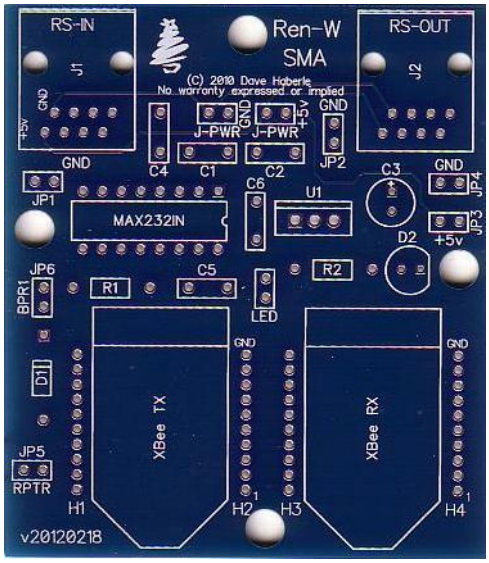
Overview

Before starting, be sure to read through the entire guide to familiarize yourself with the parts and parts locations. In many cases, you may not need to install some parts if those features do not apply to you. As always, careful assembly is very important if you want to have a successful wireless adapter.

Ren-W Board Designs

The Ren-W adapter is available in two configurations, one called the Rev7 and the other the SMA. Aside from the obvious physical differences, the two designs share parts and features, but each has its own special attributes. Both boards can be either a transmit (TX) or receive (RX) unit but the SMA board can serve as both *simultaneously* while the Rev7 board can only operate in TX or RX mode. In situations where a repeater or bridge function is needed, the SMA's simultaneous receive/transmit mode can be very helpful.





Parts Identification/Part Locations

Part	Board location
1uf non polarized capacitor	C1, C2, C4, C5, C6 (Note: the value is 1uf, not .1uf)
100uf electrolytic capacitor	C3
3.3v zener diode	D1
Common LED (any color)	D2
Female XBee sockets	H1, H2, H3, H4
UA78M33 3.3v regulator	U1
33 ohm 1/4 or 1/8 watt resistor	R1
1K ohm ¼ watt resistor	R2
MAX232IN chip (and DIP16 socket)	MAX232IN
RJ45 jack	J1, J2
2-pin headers	JP1, JP2, JP3, JP4, JP5, JP6, TX, RX, LED, PWR, J-PWR
XBee radio module	XBee
Jumper shunts	up to 6 needed (see section "What are the header pins for?")

Consult the DIGWDF Universal BOM for Mouser part numbers – available at the DIGWDF Store.

Step-by-Step Construction

General concepts: It is usually advisable to assemble a circuit board by the height of the parts themselves, starting with the smallest/thinnest parts that are mounted so they lie low right on the board and graduating to the taller and finally the tallest parts such as large capacitors and transformers. In this fashion, you can usually insert several common-height parts into their respective mounting holes, flip the board over and solder them as a group which is more convenient because the parts stay in the holes instead of falling out. In these general construction tips, some items may not be applicable if the board does not require those parts; just skip to the next item on the list. The word "install" implies both mounting and soldering the part to the board and clipping off any extra leads after soldering. Note that many parts are polarized and require that they be installed in a specific orientation on the board. Also, most electrical parts are pretty robust and can withstand some heat, but in general, over-soldering by using too much solder and/or too much heat can create problems and damage either the part or the board itself.

1. As you perform each installation step, take a pencil and check it off. This will ensure you haven't missed anything.
2. Install resistors first. Resistors do not have a polarity, but it's the best technique to install them all the same way, reading the colored stripe values from left-to-right.
    a. Note: R1 is only required if the board will be used in a transmit mode; it is not necessary in receive mode.
    b. R2 is optional and required only if you intend to install the status LED on the board (step 7).
3. Install the 3.3v zener diode. This is a polarized part; take care to install it matching the band on the diode with the band on the board marking. Zener diodes are a bit heat-sensitive.
    a. Note: the zener diode is only necessary if the board will be used in a transmit mode; it is not necessary if the board will only be in receive mode. The zener helps limit potentially damaging input voltage to the XBee radio, which tends to lock up if more than 3.3vdc touches any of its pins.
4. Install the XBee female sockets. They have a very low profile. Don't use too much solder as it may flow into the header holes too far and prevent plugging the XBee securely into the sockets.
    a. Note: On the SMA board, H1 and H2 are not necessary unless the board will be used in either transmit or repeater mode. These are not necessary if the board will be in receive mode only.
5. Install the DIP-16 socket for the MAX232IN chip. Take care to orient the notch on the socket with the marking on the board. Note: The DIP socket is optional; some users solder IC chips directly to the board, which is fine. If you do, solder the MAX232IN chip in place of the DIP socket and understand that it is heat-sensitive.
6. Install the 1uf capacitors. These are non-polarized. All of the capacitors are necessary.
    a. Note that the value of these capacitors is *not* .1uf
7. Install the LED.
    a. Note: The LED is optional and if installed, also requires the R2 resistor.
8. Install the C3 100uf electrolytic capacitor. This is a polarized part and marked with a stripe on the NEGATIVE side. The board is marked with a + for the capacitor's + lead in the square hole.
9. Install the 2-pin headers at their respective locations. What these do is later highlighted in the section "What are all the header pins for?"
10. Install the UA78M33 3.3v regulator. This is a polarized part; be sure to install it so that the metal tab matches the marking on the board.

11. Install the RJ45 jacks.
12. Check all solder joints to ensure they are clean and neat.
13. Install the MAX232IN chip into its socket. Be sure to orient the notch on the chip so that it matches the notch on the DIP socket and markings on the board.
14. Install the XBee module in the XBee sockets. Be sure to orient the XBee to match the marking on the board.
    a. SMA board: install the XBee in the RX side of the board for a receiver; the TX side of the board if it is either a transmitter or a "repeater."
    b. SMA board: if the board is a repeater, connect a jumper shunt at the JP5 header (RPTR).
    c. Rev7: connect a jumper shunt at the RX header if it is a receiver; or the TX header if it is a transmitter. Do not connect shunts on both RX and TX simultaneously.
15. Construction is complete. Before applying power to the board, read the section entitled "What are all the header pins for?"

What are all the Header Pins For?

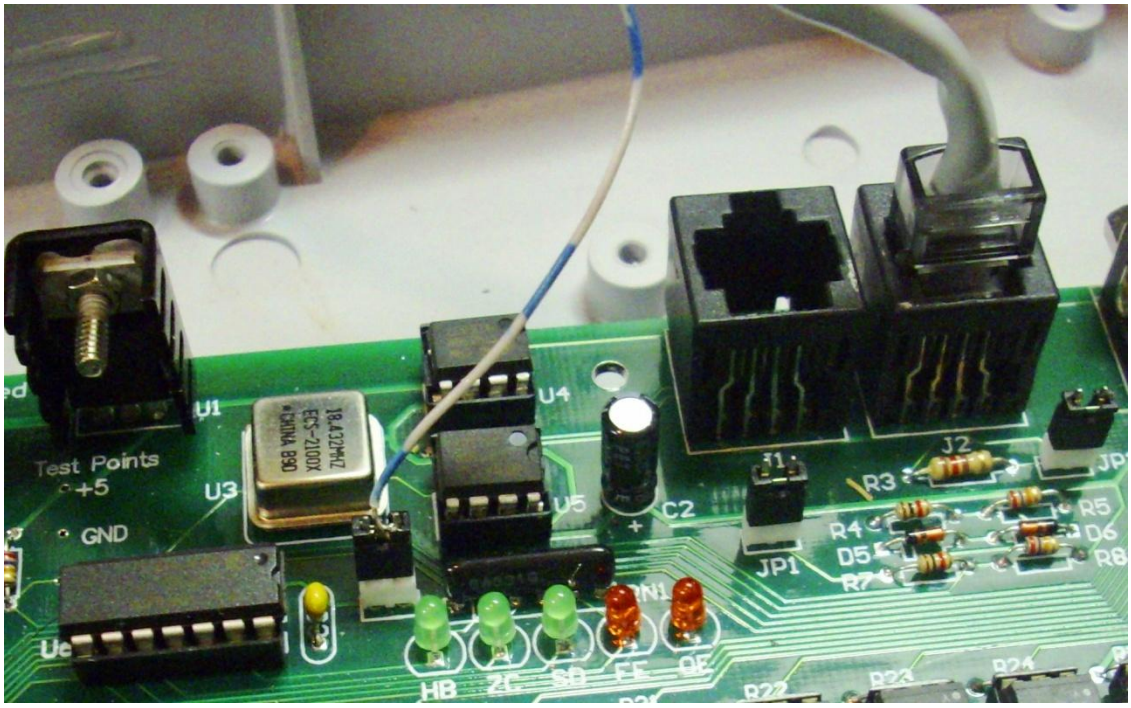
Pay close attention as some pins marked on the Rev7 board do NOT coincide with pins on the SMA board.

SMA BOARD	REV7 BOARD
JP1: An alternate input point for a RS485- signal. The right pin is GND while the left pin is the same as pin4 of the RJ45 jack. Never connect a jumper shunt across this header.	**JP1:** An alternate input point for an RS485- signal. The top pin is GND while the bottom pin is the same as pin4 of the RJ45 jack. Never connect a jumper shunt across this header.
JP2: An alternate output point for the RS485 signal from the SMA to the controller. The top pin is GND while the bottom pin is the same as pin5 of the RJ45 jack. Never connect a jumper shunt across this header.	**JP2:** (Also marked BPR1) Bypass resistor #1. In transmit mode, if the voltage of the RS485 input signal is low, connecting this to bypass the 33ohm resistor will make the Rev7 more sensitive to a lower voltage signal. Normally this should not be jumpered.
JP3: +5vdc. Connect either pin to +5vdc power on the controller. NEVER connect a shunt jumper from JP3 to JP4!	**JP3:** +5vdc. Connect either pin to +5vdc power on the controller. NEVER connect a shunt jumper from JP3 to JP4!
JP4: GND. This is an alternate ground connection to the controller. GND is normally made automatically when the RJ45 cable is plugged into the jack. NEVER connect a shunt jumper from JP3 to JP4!	**JP4:** GND. This is an alternate ground connection to the controller. GND is normally made automatically when the RJ45 cable is plugged into the jack. NEVER connect a shunt jumper from JP3 to JP4!
JP5: (Also marked RPTR). This enables the e-mode repeater with the XBee radio in the TX position and a cat5 cable connecting the controller's overflow channel data to the RS-IN (J1) RJ45 jack. If TWO XBee radios are in use on the board, do not connect the JP5 jumper.	**PWR-GND:** The Rev7 can be powered through the cat5 cable with GND on pin 7 of the RJ45 jack and +5vdc on pin 8. Connecting PWR-GND connects pin 7 of the RJ45 to JP4. Normally PWR-GND is not connected. NEVER connect a shunt jumper from PWR-GND to PWR-+5v!
JP6: (Also marked BPR1) Bypass resistor #1. In transmit mode, if the voltage of the RS485 input signal is low, connecting this to bypass the 33ohm resistor will make the SMA more sensitive to a lower voltage signal. Normally this should not be jumpered.	**PWR-+5v:** The Rev7 can be powered through the cat5 cable with +5v on pin 8 of the RJ45 jack and GND on pin 7. Connecting PWR-+5v connects RJ45 pin 8 to JP3. Normally PWR-+5v is not connected. NEVER connect a shunt jumper from PWR-+5v to PWR-GND!
J-PWR-GND: The SMA can be powered through the cat5 cable with GND on pin 7 of either RJ45 jack and +5vdc on pin 8. Connecting J-PWR-GND connects pin 7 of either RJ45 to JP4. Normally J-PWR-GND is not connected. NEVER connect a shunt jumper from J-PWR-GND to J-PWR-+5v!	**TX:** this enables the transmit mode of the Rev7 board, taking RS485-serial data from the input via pin 4 of the RJ45 jack. Never connect TX and RX simultaneously. The MAX232IN chip inverts this signal before feeding it to the XBee radio on XBee pin #3.
J-PWR-+5v: The SMA can be powered through the cat5 cable with +5v on pin 8 of the RJ45 jack and GND on pin 7. Connecting J-PWR-+5v connects either RJ45 pin 8 to JP3. Normally J-PWR-+5v is not connected. NEVER connect a shunt jumper from J-PWR-+5v to J-PWR-GND!	**RX:** this enables the receive mode of the Rev7 board, sending the +v serial output data to the controller via pin 5 of the RJ45 jack. Never connect RX and TX simultaneously. You may have to experiment whether your controller works better in RS232 or RS485 mode and whether RS485 termination is needed.
LED: connecting a shunt jumper on this turns on the D2 status LED. Disconnecting it can save a few milliamps of current draw on the power source and turn off the LED.	**LED:** connecting a shunt jumper on this turns on the D2 status LED. Disconnecting it can save a few milliamps of current draw on the power source and turn off the LED.

Powering the Ren-W Board

The Ren-W pirates power from the controller to which its connected or, if it's a transmitter that is not connected to a controller, from an alternate power source. When a cat5 cable connects the Ren-W to a controller, the ground connection is automatically made via the cat5 cable, and all that remains is to tap +5vdc power from some location on the controller, and connect that to the Ren-W's JP3 header. Alternately, +5v can be delivered to the Ren-W via pin 8 of the cat5 cable although in most cases, this requires some modification to the controller board itself. Pin 7 of the Ren-W's RJ45 jack can also be enabled as a ground connection.

In the example below using an SS24 controller, an additional wire has been soldered to a shunt jumper and the jumper simply plugged into the JP3 header of the SS24, which provides power to the controller's on-board diagnostic LEDs (all SS controllers have the JP3 header). Another shunt jumper is soldered to the other end of the wire that is then plugged into the Ren-W's JP3 header (+5v). Remember, the ground connection happens automatically when the cat5 cable is plugged into the Ren-W.



All Renard controllers have some location on the controller board where +5vdc is available; some may have a jumper such as the SS controllers do; others may have a test point or other convenient place.

The lion's share of the Ren-W's current draw is done by the XBee radio itself. In receive mode, an XBee Pro radio should be in the 55ma range and in full transmit mode, the draw is upwards of 250ma.

Repeater/Bridge Modes (SMA only)

Having two locations for the XBee radio on the same board, the SMA can serve as not only a receiver, but as a retransmitter (i.e. "repeater") in two different ways. Be forewarned – this is pretty technical, advanced stuff and understand that there also may be a 2 to 6ms delay in performance when a repeater mechanism is used.

E-Mode Repeater: E-Mode stands for "econo mode" where one XBee radio performs both the receiving and transmitting functions. Typically this is used to daisy-chain one radio to the next, much like connecting one Renard controller to the next one in line. To enable this mode, do the following:

1. Configure the "to" XBee radio with an unique 16-bit source address. The "to" XBee is the radio that is connected to the controller that is NEXT in line to get the data after the retransmitting unit sends it. If you don't know what a source address is, consult the XBee technical documentation – DIGWDF is not offering classes. As mentioned above, this is pretty advanced stuff. Write the 16-bit source address down.
2. Set the "to" controller aside for now.
3. Configure the "repeater" (sending) XBee radio to transmit to the destination address that was configured in the "to" Xbee radio. Use the DH address (Destination High) for this value.
4. At the unit to serve as the repeater, place the reconfigured XBee radio module in the TX side of the SMA board
5. Connect a shunt-jumper at the JP5 (RPTR) header
6. Connect a cat5 cable from J2 to the controllers serial input (normal connection)
7. Connect a cat5 cable from the controller's overflow channel output (i.e. "daisy chain") to the SMA's J1 RJ45 jack.
8. Make sure the sequence has at least as many channels as are necessary for both controllers.
9. Because the "to" XBee has a 16-bit source address, it will no longer respond to a global broadcast; it will only respond to transmissions that are specifically for its address.

How it works: Using a 48-channel example and two SS24 controllers, the first Ren-W receives the data and sends all 48 channels to its controller. The first SS24 uses up 24 of the channels and passes the remaining channels out it data-out RJ45, which goes back into the Ren-W's input. The Ren-W then transmits the data to it's "destination address." The second Ren-W, having an XBee that has the correct address that the first XBee is sending to will accept the data, so the second Ren-W receives the data and sends it to its controller.

Normal Repeater Mode: this is the most expensive way to use the Ren-W as it requires two XBee radios – one in the TX side and one in the RX side of the SMA board. Its operation is almost identical to the e-mode except that the JP5 (RPTR) header is left unconnected. Other considerations:

- You still use the XBee addressing setup as outlined for the e-mode repeater
- You may need extra electrical power insofar as two XBee radios will draw a lot more current from the controller than only one.

Bridge Repeater: This is almost identical to the normal repeater mode, although the bridge mode essentially connects two different XBee networks. You might use the bridge mode when you need to position the main transmitter in the midst of a large display (for good signal connectivity to all parts of the display) yet your control computer cannot be located where the main transmitter is.

- Set all the XBee radios in the display to the same channel and PANID. You do NOT use special addressing.
- Set the XBee in the TX side of the SMA to use the same channel and PANID as the display.
- Set the XBee in the RX side of the SMA to use a different channel and PANID than the display.
- Connect a short cat5 cable from the SMA's J2 jack into the J1 jack, essentially telling the SMA to feed its output back into itself.
- Power this unit with a good 5vdc power supply that can provide ample current, because it's going to be working pretty hard. This is now the central "main" transmitter.
- Set the control computer's XBee to use the same channel and PANID of the SMA's RX XBee.
- Consider using XBee radios that have external antennae for this application.

Troubleshooting

Getting into the world of wireless controllers opens a whole new set of possibilities as well as challenges. It is inherently much more complex than connecting a cat5 wire from point A to point B. But a properly assembled Ren-W adapter with a properly configured XBee radio setup will normally work first time, every time. When it doesn't work, experience has shown that the solution turns out to be something very simple such as the XBee radios not configured properly or a cable plugged into the wrong RJ45 jack. However, here are some solutions to a few common issues that have arisen.

- Board doesn't power up.
    - Check all solder points to ensure there are no shorts and joints are shiny and bright.
    - Temporarily remove ALL jumpers from the board
    - Make sure MAX232IN chip is in the socket properly; the notch should point toward the C6 capacitor.
    - Make sure the 3.3v zener diode is installed in the proper orientation:
        - Rev7 board: the stripe is toward XBee pin #1.
        - SMA board: the stripe is toward the JP6 header.
    - Electrolytic capacitor C3 is installed in the proper orientation:
        - Rev7 board: the stripe is on the side closer to the XBee
        - SMA board: the stripe is toward the LED (D2).
    - Determine whether the board is getting 5vdc power (test across JP3 to JP4)
    - Determine whether the XBee is getting 3.3vdc power (test across XBee pins 1 and 10)
    - Determine whether the MAX232IN chip is getting 5vdc power (test across pins 15 and 16)
    - Connect the LED jumper; LED should light.

- Ren-W powers up but controller doesn't respond
    - Controller set in wrong mode (RS232) or may or may not be RS485 terminated.
    - Cable from the Ren-W to the controller is bad
    - Controller and XBee radio not set to same baud rate
    - Receiving XBee not set to exactly the same parameters as transmitting XBee
    - Vixen plug-in not set to proper COM port for the transmitter, or to wrong com settings
    - Channels not active in Vixen plugin
    - Start address firmware in controller outside of active channel range
    - Cat5 cables plugged into wrong jacks on controller
    - Ren-W connected to controller as receiver but XBee radio is in wrong mode (TX vs RX) or XBee is in wrong position (SMA board only)
    - Lights plugged into controller are bad or blown fuse
    - Controller or SSR has bad triac
    - Bad cat5 connection cable to the SSR or SSR not powered on

When all else fails, you can always send your Ren-W units (with the XBees) to DIGWDF and we'll be glad to review them for you and fix whatever seems to be the problem – you pay shipping both ways. However, before you contact us and go to the trouble to ship your gear, understand that the top three problems historically have been:

(1) The user has not configured the XBee radios properly;
(2) The user's computer (Vixen or otherwise) isn't set up properly to talk to the XBee radio transmitter;
(3) The controller's start address has not been configured properly (or at all).

These are problems the user can and should be able to fix with just normally careful attention to detail.

XBee Communication Settings

The following XBee settings have been proven to be very efficient and are HIGHLY suggested. If you deviate from the settings presented here, you're on your own.

- XBee firmware version: **10E6 or later**
- MAC Mode: **1 - 802.15.4 NO ACKS**
- Interface Data Rate: **6 – 56700**
- Parity: **0 – No Parity**
- Packetization timeout: **0**
- Channel: **17**
- PANID: your choice, the default is 3332

In cases where you have one controller or a block of controllers that together total more than 55 channels connected to the same Ren-W, use all the above settings plus the following instead:

- Parity: **3 – Mark Parity**
- Set the computer's output (Vixen Plugin) to use Mark Parity and 2 stop bits

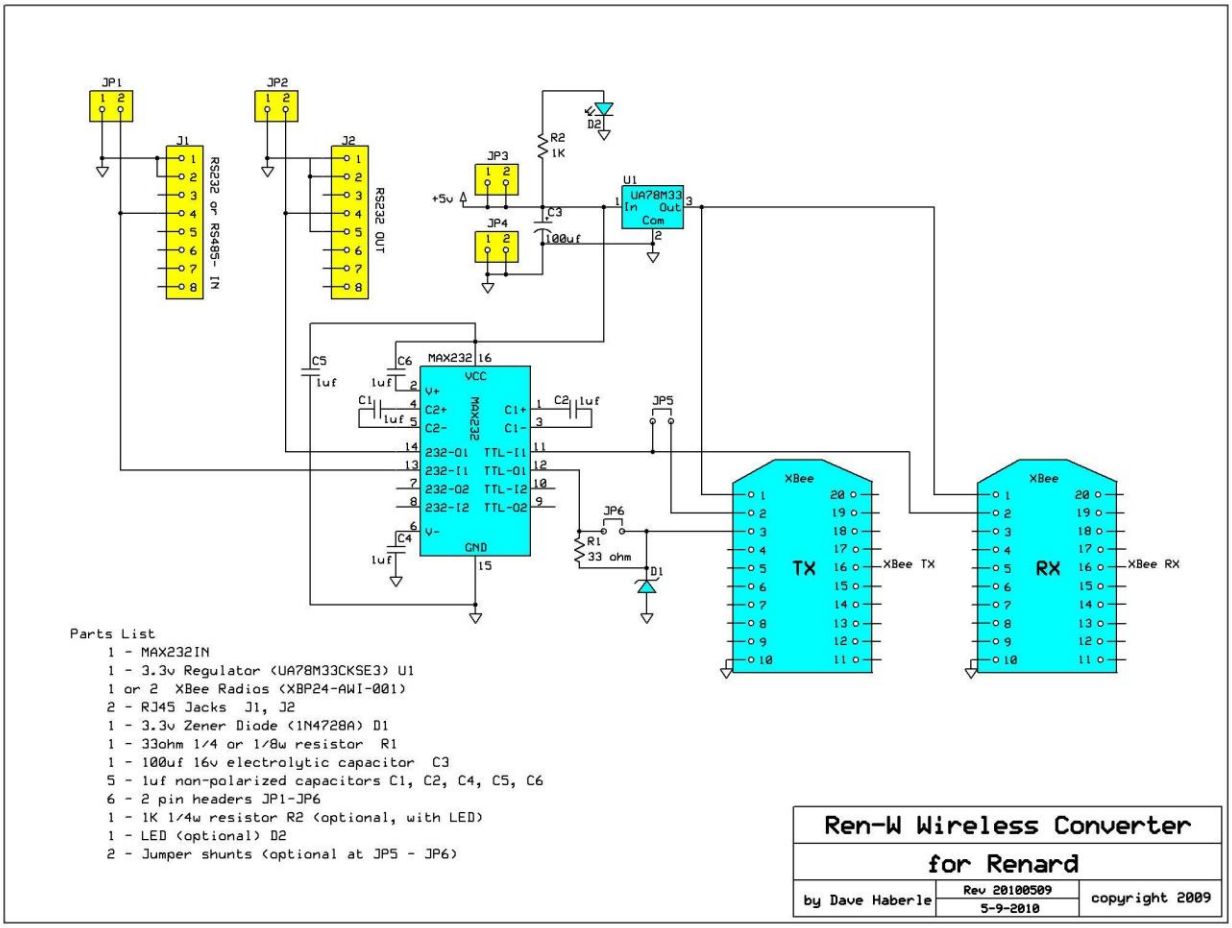
Why is this special change necessary? The XBee radio's internal clock runs slightly faster than the 57600 baud that the PIC16F688 chips are running and the extra parity and stop bits effectively slows it down just enough so that the multiple PICs that are processing the data aren't overrun with data. When a data overrun occurs, it shows up as misfires in the display.

If using Ren-W Repeaters: the Mark parity and 2 stop bits settings break down when using Ren-W repeaters because the Renard firmware strips out the extra bits. The data coming out of the last PIC on a controller no longer has the extra bits and no longer matches the XBee settings. The result is quite unsatisfying. If you must use repeaters, stick to the 0 - No parity setting and don't daisy chain more than 48 channels. Instead of daisy chaining, use Renard Start Address firmware and install a Ren-W at each controller.

Renard Start Address Firmware

Ren-W and start address firmware are a match made in heaven. Using the two together absolutely solves virtually all communication settings problems and opens doors that are extremely difficult if not impossible to do in a wired setting. Information about start address firmware is in the Wiki at www.diychristmas.com or www.doityourselfchristmas.com

Ren-W Schematic



Ren-W Parts Substitutions

- **Resistors:** either 1/8 or 1/4 watt resistors are acceptable
- **Capacitors:** Ren-W carries low voltage only, and capacitors rated at least 10vdc should be OK. Electrolytic capacitors may be used in place of the non-polarized versions; observe the appropriate polarity as shown in the schematic if using all electrolytics. **100uf capacitor:** this serves as a slight voltage moderator in case the controller's own draw causes the Ren-W to be a bit starved. A higher value can certainly be used; a lower value is not suggested.
- **LED:** any general-purpose red or green LED should work fine. The 1K current limiting resistor can be replaced with anything between 330 - 1200 ohms, depending on how bright you want the LED to be. A higher value also helps limit the current drawn from the power source.
- **MAX232IN** – most any of the 16-pin MAX232 ICs can be used although pay attention to their suggested operating temperature ranges. The IN version specs down to -40F/-40C and is probably the best overall choice, but if you don't have to worry about freezing temperatures, you can often save some money with a different chip.
- **XBee radios**: the Series-1, XBee Pro radio is our radio of choice. The regular XBee radio is okay for very short ranges, but the Pro version not only has more transmitting power, but a vastly more sensitive receiver. Some users have gotten Series-2 XBees to work, but Series-2 are not compatible with series-1 as they do not communicate with one another. Bottom line: pay attention to which XBees that you purchase.