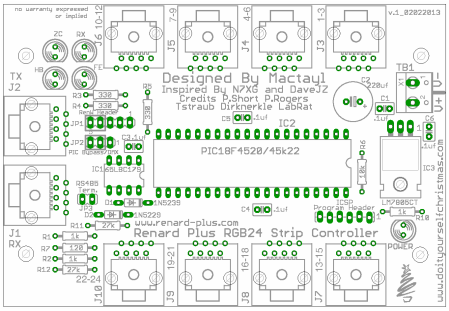
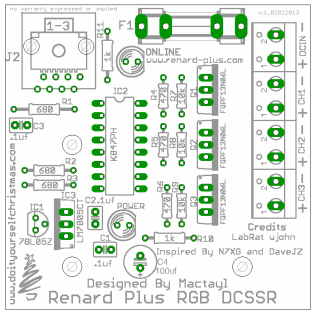
Renard Plus

RGB24 Strip Controller
RGB DCSSR6





January 2013

Version 1.00 Board

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Overview

Renard is the name of a computer-controlled, PIC-based dimmer scheme, and also refers to dimming controllers that people have built based on this scheme. Renard controllers do not have stand-alone show sequencing capabilities, and rely on a separate computer to send it real-time sequences of controller commands.

This design was originally described in the Simple PIC-Based 8-Port Dimmer 'How-To' on the http://computerchristmas.com website in a generic form. Since then various people have designed and built controllers based on this hardware, and there are likely to be coop buys of one or more of these designs. Renard is a DIY hobbyist effort and there is a vast amount of products to select from including the Renard Plus Strip Controller.

Construction

This section covers the construction Renard Plus Strip controller board. It approaches these tasks as a learning exercise for new builders, so that they can develop proficiency and self-confidence. The project itself is quite simple and if you follow the steps you will have a working controller..

Basic Tools

To build this board requires a few basic electronic hand tools. The tools listed below are recommended for anyone building these types of DIY boards.

Soldering Iron

The first is a suitable soldering iron. Anything between 25 and 40 watts is useable, with at least a 1/16-inch wide chisel tip. However, tips that are closer to 1/8-inch will provide better heating of the joint being soldered. While a temperature controlled soldering station is very nice, one can get by nicely with a much more modest solder iron setup. The iron shown in figure 1 is an inexpensive, adjustable 25-40 watt unit, and quite suitable for constructing this type of kit.


Figure 1: Soldering Iron

If you have never soldered any electronic parts, a little practice before starting on your kit might be in order. Go to your local Radio Shack, or other parts store, and buy a few small resistors and capacitors. If they have any sort of perforated PC board material available, get some of that too. You can practice putting the parts through the holes, bending the leads slightly, and soldering them in. Do not clip off the leads; the parts can be unsoldered and reused for more practice. If you can't find any perforated PC board material, buy a piece of blank PC board material, and drill several holes in it spaced the lead width of the parts you have available, and use that for practice. Another approach might be to take apart an old wireless telephone and remove the existing parts by heating the PC board with a small torch and rapping it on a solid surface to knock them out. Wear eye protection when using this method for parts removal!

Another alternative is the **Elenco Practical Soldering Project Kit** This kit can be purchased from Amazon for less than 10 dollars and has a well written set of instructions on learning to solder.
Soldering a part requires placing the tip of the soldering iron against the component lead and the PC board surface, heating it for a few seconds, and then adding a little bit of solder. If the joint is hot, the solder will flow quickly. Once the solder has flowed, remove the soldering iron and the solder, and let the joint cool. If the job was done correctly, the solder will have flowed smoothly, and the joint will look shiny. Later in this article are many examples of correctly soldered joints.

Solder

Solder plays a key role in electronics construction. The right kind will work well, and is easy to use. The wrong kind can be hellish! A suitable solder for electronics work will contain approximately 37% tin, and 63% lead. Anything around those two values, with a rosin flux core is suitable. Do not use "no lead" solders intended for plumbing; they will not work well. Nor will solders with acid flux cores. Also, stay away from solders with water-soluble (organic) fluxes. While they seem to work well while building, failure to remove all of the flux later will lead to corrosion where the flux remains. This is also true of any acid flux core solders.

The best solders also contain about 2% silver. This improves conductivity of the joint, and keeps it bright looking. Figure 2 shows a small roll of solder containing 2% silver, and readily

available from Radio Shack. Kester also makes a similar product that is available from Mouser and DigiKey.

Figure 2 - Solder available from Radio Shack

Side Cutters (also called Diagonal cutters or “dikes”)

The other basic tool that one needs, especially when soldering a PC board, is a pair of side cutters. A favorite is shown in figure 3. These are made by Xcelite, and are available from Mouser, DigiKey, and others supply sources. These cutters are used to clip off the excess lead length of parts soldered into the PC board.

Figure 3 - Side cutters are very useful in clipping off excess lead length

Third Hand Apparatus

Another tool that is very handy to have, but not a necessity, is a "third hand" apparatus of some kind. A commercial version is shown in figure 4. One of these will hold the PC board while parts are being soldered, or hold parts while leads are being attached. One could make the equivalent of this unit with a pair of "pincher" clothespins, a small block of wood, and a bit of fabricating.

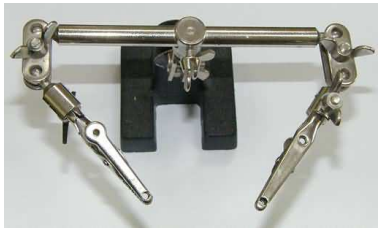


Figure 4: "Third Hand" holds PC board during assembly

Solder Braid

Solder Braid or solder wick is good to have on hand for those occasional mistakes. It is made of a braided copper wire that is impregnated with a rosin flux. If you bridge two solder points when soldering the PCB this can remove the excess solder. This is available Radio Shack, Mouser, DigiKey, and others supply sources

Figure 1 Solder Braid

Needle Nose Pliers

Although though not as vital as the above component, needle nose pliers will be invaluable in forming component leads and in helping straighten bent pins on ICs, This is available Radio Shack, Mouser, DigiKey, and others supply sources.

Figure 6 Needle Nose Pliers

Solder Iron Tip Cleaner

A clean solder iron tip is essential to good solder joints. The tip must be kept clean to ensure the best heat transfer between the iron the part and the solder. The dirt build up on a soldering iron is mostly due to rosin residue. The traditional method of cleaning the tip is with a damp sponge. This will clean off burnt rosin residue on the tip of the iron but will eventually lead to the tip corroding. The item pictured below is a much better method of cleaning the iron and doesn't require any water. Just plunge the tip into the metal mesh and withdraw it and the tip will be clean. This particular cleaner is available from Amazon for about 10 dollars and is well worth the investment.

Figure 7 Hakko Tip Cleaner

Digital Volt Meter (DVM)

This device is used as a diagnostic tool and can be used to troubleshoot as well as test for proper operation. You will need this item when powering the board up for the first time. There will be further instructions later in this manual.

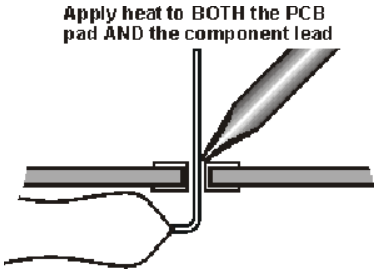
Digital Volt Meter (DVM)

PIC Programmer

The PIC chip on the PCB is used to control all the functions to create blinky flashy. When you order the part from the supplier (Typically Mouser) it will come in un-programmed. You will need a PIC programmer and the software for the board. There are several manufactures out there supplying PIC programmers. The one shown below is made by the original designer of the PIC chip, Microchip. The programming instructions are included later in this manual.

Soldering

Proper positioning of the soldering iron tip and solder are essential in obtaining a well-made soldered joint. The tip must be in contact with both the lead to be soldered and the PC board pad.



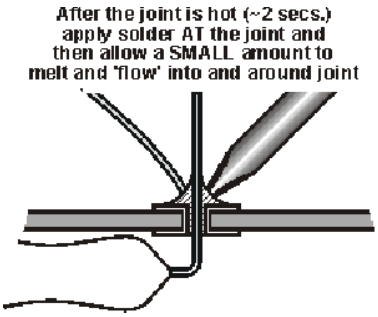
Important!

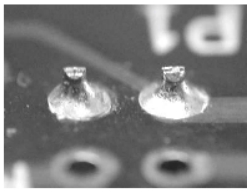
A clean soldering iron tip is essential to heat transfer.

Be aware that it is possible to damage the board and the component if they are heated for too long.

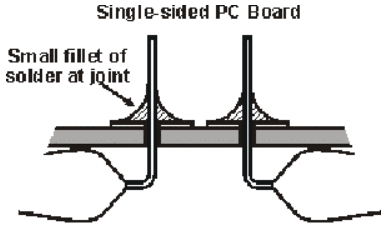
Once the tip has heated the pad and lead apply solder to the **OPPOSITE** side of the joint. The solder should flow evenly around the pad and the lead. Remove the solder iron and give the joint a minute to cool.

DO NOT blow on the joint or move the component as this can cause a poor solder joint (called a cold solder joint). A cold solder joint will not conduct electricity properly and will cause problems during operation.

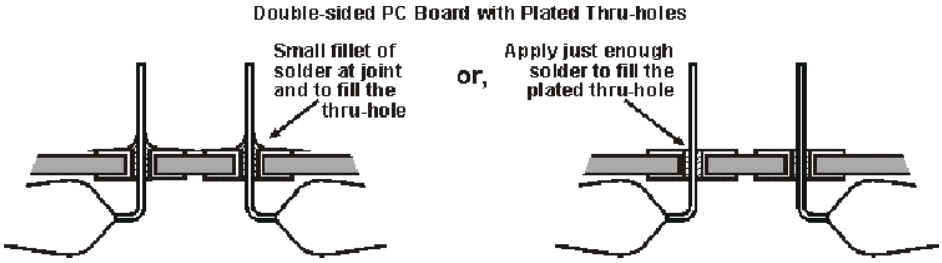




This shows a well-made connection to a single-sided PC board. A small amount of solder has been melted by the heat from the component lead and the PC board pad. A small additional amount of solder has been added to the joint to form a small rising *fillet* around the lead



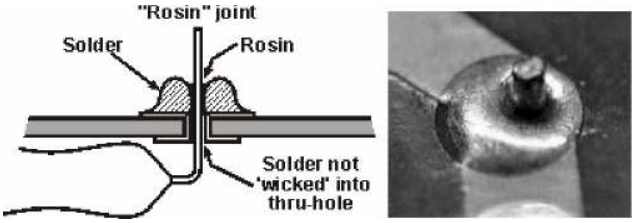
If the PC board was of the plated-thru hole type, capillary action of the lead in the *plated-through hole* has drawn the solder down into the hole. (**left**)



Note that some soldering requirements may dictate that *no fillet* be created when soldering to plated-thru holes. (**right**) In this instance, apply only enough solder to *fill* the plated thru hole. Use of .020" diameter solder greatly enhances your ability to perform this operation. Use of .03" or larger diameter solders will generally cause more solder than required to be applied the instant the solder is applied to the joint.

When soldering plated-thru holed which are to only be filled, apply a small amount of solder and allow your iron to remain a short while longer. This will ensure that the solder is 'wicked' down into the hole. You will be able to *see* the solder as it flows into the hole.

These figures show what can happen if the component lead is not heated along with the PC board pad. A rosin joint will result. The solder flows onto the PC board pad, but since the component lead is not hot enough to melt solder, rosin accumulates around the wire. The solder then forms around the rosin coating on the component lead, and there is no connection. Generally, joints of this type can be corrected by reheating the joint.



Similarly, a poor joint will result if you do not properly strip and tin the enameled wire leads of inductors *before* the lead is inserted into the PC board for soldering. Enamel coating allowed to remain on the inductor lead can create a joint similar to the rosin joint, preventing the lead from being adequately heated by the soldering iron. Such a joint *cannot* normally be restored by reheating. Remove the lead from the PC board, strip it of all enamel and tin it. Then resolder the joint.

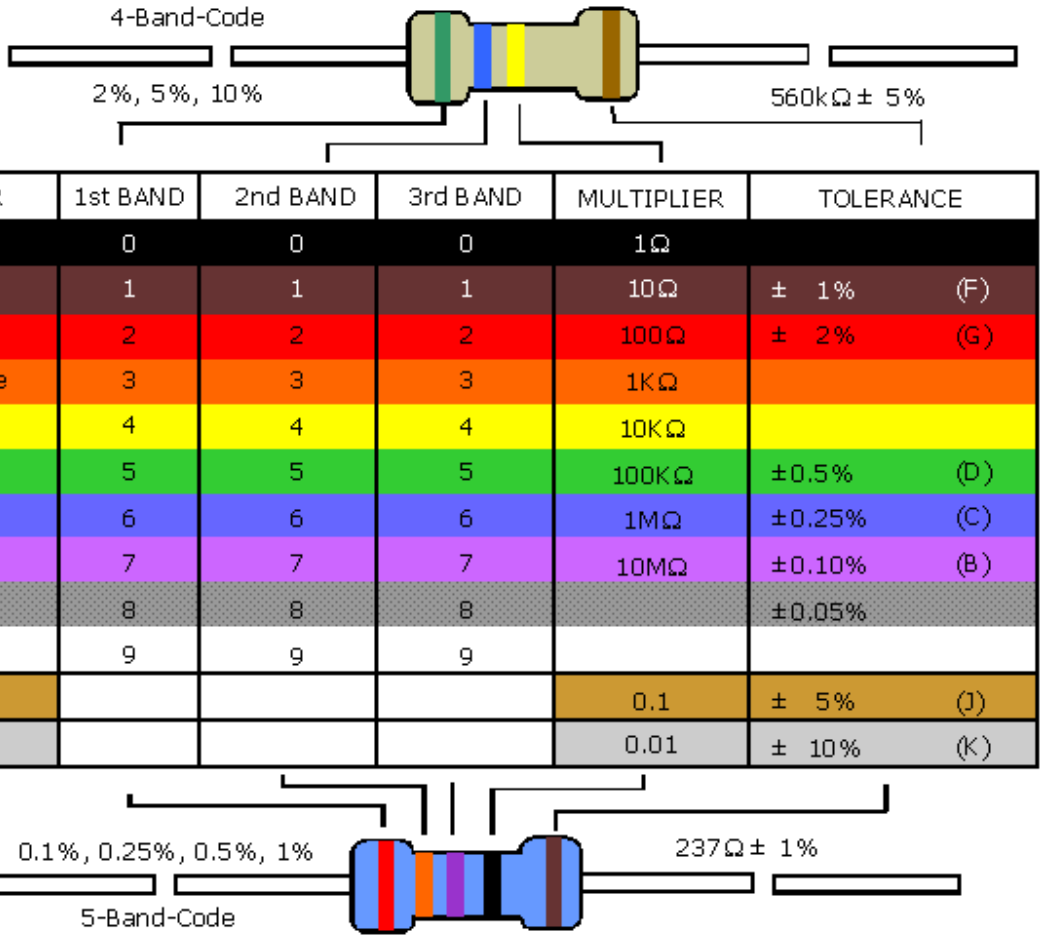
Identifying Components Used in Construction

There are many different types of components used in construction of this board. Below is a list of the types of components and how to identify them.

Resistors

Resistors are small tubular shaped components with wire leads coming out each end. Resistors will have different values depending on where they are used in the circuit. The values are defined by a color code marked on the resistors. The table below can be used as a reference to determine the resistor value.

Resistor Color Code



COLOR	1st BAND	2nd BAND	3rd BAND	MULTIPLIER	TOLERANCE	
Black	0	0	0	1Ω		
Brown	1	1	1	10Ω	± 1%	(F)
Red	2	2	2	100Ω	± 2%	(G)
Orange	3	3	3	1KΩ		
Yellow	4	4	4	10KΩ		
Green	5	5	5	100KΩ	±0.5%	(D)
Blue	6	6	6	1MΩ	±0.25%	(C)
Violet	7	7	7	10MΩ	±0.10%	(B)
Grey	8	8	8		±0.05%	
White	9	9	9			
Gold				0.1	± 5%	(J)
Silver				0.01	± 10%	(K)

Capacitors

Capacitors come in various forms and makes. The ones in this kit include electrolytic and MLCC (multilayer ceramic capacitor. These are radial style which means both leads come out the same end of the component.

The electrolytic caps are polarized, which means that have to be installed in the correct orientation. The side of the cap will have a minus sign and must be installed in the board with the unmarked side in the hole with the plus indication on the board. The cap will be labeled with the value and voltage rating.

Electrolytic Capacitor

The MLCC caps will simply have a number on it. For example 102 this stands for a 1000pf capacitor. The 10 is the first 2 numbers of the value and the 2 represents the number of following zeros. Thus 10 with 2 zeros equals 1000.

Radial MLCC Capacitor (value 47000pf)

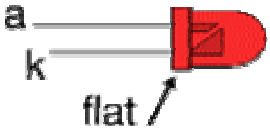
Diodes

Both conventional diodes and light emitting diodes are used in this project.

Conventional diodes are similar in shape to resistors small tubular shaped components with wire leads coming out each end. Diodes are polarized and must be installed in the correct direction. The diode will have a stripe on one end and this must be oriented to the stripe on the printed circuit board. Failure to do so will damage the diode and possibly other components when power is applied.

Conventional Diode

Light Emitting Diodes or LEDs are diodes that emit light. These diodes are typically radial in design and look like small light bulbs. As with all diodes LEDs must be oriented properly. Typically the diode will have a flat side cut into the plastic bulb indicating its polarity. This flat will be indicated on the PCB.

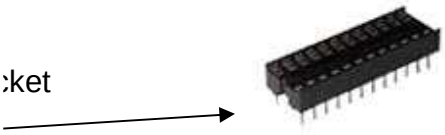


Light Emitting Diode

Integrated Circuits

There are several different types of ICs used in this project. ICs also require proper orientation when installing them on the PCB. They are usually marked with either a notch or a dot at the end nearest pin one. In addition to orientation it is important to remember that ICs are sensitive to heat and are easily damaged. Limiting the time your soldering iron is used to solder the connections reduces the likelihood that the part will be damaged. In this kit it is recommended that sockets be used for the ICs so they can be easily replaced in the event of a failure.

Pin 1 of the IC socket is on the end, closest to the notch.

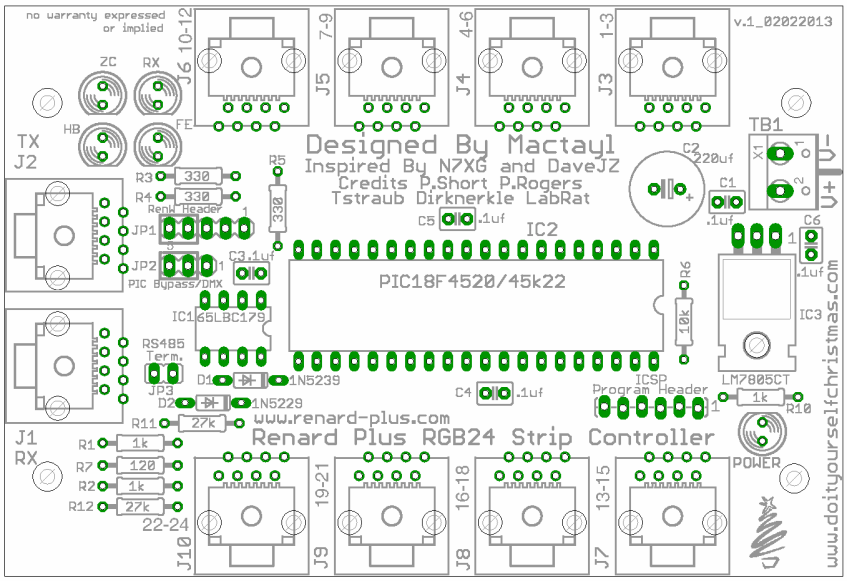


8 Pin IC (Note notch on left side of chip indicating the end with pin one.)

Controller Board Assembly

The Renard Plus RGB24 Strip Controller is a simple device to assemble and test. It is easiest if you build the units by inserting the various components from smallest to tallest .

1. Begin by inspecting the PCBs to look for any defects such as cracks or breaks. The holes on the board should be open on both sides. Then inspect and sort out the various parts for the board.



Install the resistors

☐ Install the 1K (brown-black-red) ohm resistors at locations R1, R2,. Solder and clip the leads.

☐ Install the 330 (orange-orange-brown) ohm resistors at locations R4, R5. Solder and clip the leads.

☐ Install the 120 (brown-red-brown) ohm resistor at location R7. Solder and clip the leads.

☐ Install the 27K (brown-red-brown)ohm resistors at locations R11,R12. Solder and clip the leads.

Install the diodes

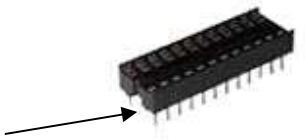
☐ Install the 1N5239 diode at location D1. The diode is polarized and it can only go one way. The end with the band (cathode) goes towards the left side of the board. Solder and clip the leads.

☐ Install the 1N5229 diode at location D2. The diode is polarized and it can only go one way. The end with the band (cathode) goes towards the left side of the board. Solder and clip the leads.

Install IC sockets and Bridge Rectifier

Even though these parts are optional we strongly recommend that sockets be used on all of the IC's. Pin 1 of the IC aligns to the square solder pad on the PCB.

Pin 1 of the IC socket is on the end, closest to the notch.



☐ Install the 8 pin socket at location IC1. Make sure the notched or dimpled end is lined up with the notched end of the silk screen board outline. The notch on the socket should face the right side of the board. Solder one pin and make sure the socket is firmly seated before continuing to solder the remaining pins. Solder all pins.

☐ Install the 40 pin socket at location IC2. Make sure the notched or dimpled end is lined up with the notched end of the silk screen board outline. The notch on the socket should face the right side of the board. Solder one pin and make sure the socket is firmly seated before continuing to solder the remaining pins. Solder all pins.

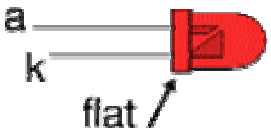
Install the capacitors

☐ Install the 220uf Electrolytic Capacitor at location C2 which is polarized. Be sure that the (+) lead is installed in the hole marked with a “+” symbol. The (+) lead is usually longer than the (-) lead, and the (-) lead is identified by a black stripe on the capacitor. Solder and clip the leads.

☐ Install the 0.1uf Ceramic Capacitors (marked 104) at locations C3, C4, C5. Solder and clip the leads.

Install the light emitting diodes

LED’s (light emitting diodes) must be installed according to the silk screen pattern on the board. In looking at an LED you will notice a flat spot on one side of the LED:



☐ Install the Red LEDs at the locations marked Power, HB, ZC. The LED is polarized. There is a flat side (cathode) that has a short lead and it faces towards the right side of the board. Solder and clip the leads.

☐ Install the Yellow LED at the location marked FE. The LED is polarized. There is a flat side (cathode) that has a short lead and it faces towards the right side of the board. Solder and clip the leads.

☐ Install the Green LED at the location marked TX. The LED is polarized. There is a flat side (cathode) that has a short lead and it faces towards the right side of the board. Solder and clip the leads.

Install Misc. Parts (group 1)

You may have purchased either a single 16 pin header or headers cut according to the board specifications. When installing headers the short side of the header is installed into the board.

☐ Install the 5 pin header at location JP1 (RENW header). Solder

☐ Install the 3 pin header at location JP2 (PIC bypass). Solder.

☐ Install the 2 pin header at location JP3 (RS485 Term). Solder.

☐ Install the 6 pin header at location ICSP (PIC programming header). Solder.

☐ Install the 5v linear regulator at location IC3 forming the leads as indicated below. Fold the pins over the shaft of a small screwdriver to create smooth bends. After inserting the leads into the proper holes, secure the IC with a 4-40 screw, #4 lock washer, and a 4-40 nut. Solder

☐ Install the RJ45 jacks at locations J1-10. Gently align the eight wires with the matching holes and snap the connector to the board. Solder.

☐ Install the 2 position terminal strip location TB1. The side where the wires enter under the screw should face the top of the board.

☐ Install the shunts on the headers according to the Header Settings listed below.

Initial Testing / Final Assembly

At this point you have completed the assembly of the board and you should gently clean the board of any residue and inspect for solder bridges. What you are looking for are any solder bridges especially around the IC's and other closely spaced parts.

If you have any of the IC's (IC1, IC2) installed – remove them now.

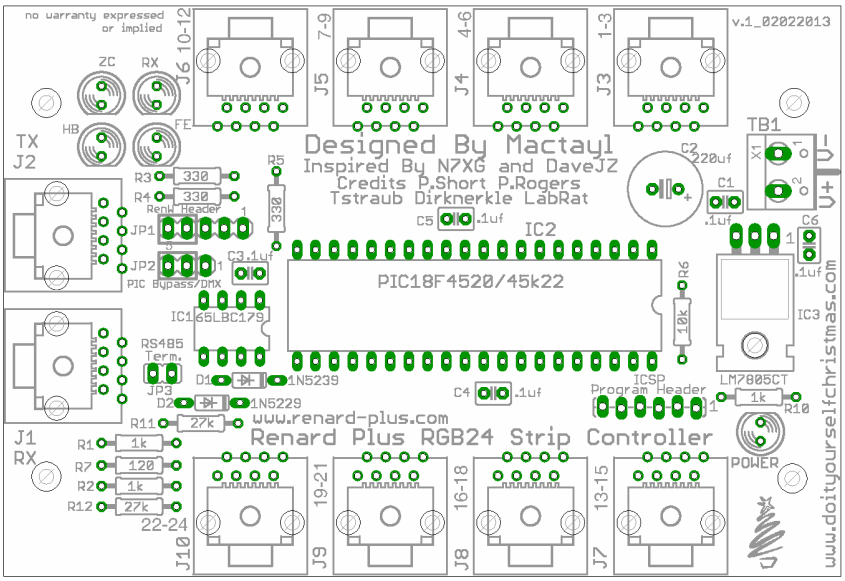
Connect your 9-12vdc power supply to the P1 terminal strip noting the polairity V+ and V-. It supplies power to controller portion of the board.

Turn on your power supply and verify the power LED lights up.

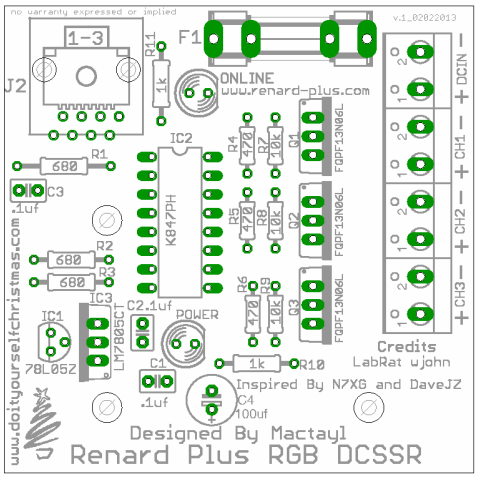
Install the ICs:

☐ Install the PIC18F4520 in the 40 pin socket at location IC2. The IC is polarized. Gently install the IC so that the notch faces towards the right matching the socket and the silkscreen.

☐ Install the SN65LBC179P in the 8 pin socket at location IC1. The IC is polarized. Gently install the IC so that the notch faces towards the right matching the socket and the silkscreen.



DCSSR6 Board Assembly



Install parts – Group 1

☐ Install the 1K (brown-black-red) ohm resistors at locations R10, R11. Solder and clip the leads.

☐ Install the 470 (yellow-violet-brown) ohm resistors at locations R4, R5, R6. Solder and clip the leads.

☐ Install the 680 (blue-gary-brown) ohm resistors at locations RR1, R2, R3. Solder and clip the leads.

☐ Install the 10K (brown-black-orange) ohm resistors at locations R7, R8, R9. Solder and clip the leads.

☐ Install the 0.1uf Ceramic Capacitors (marked 104) at locations C3, C4. Solder and clip the leads

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☐ Install the 100uf Electrolytic Capacitor at location C4 which is polarized. Be sure that the (+) lead is installed in the hole marked with a “+” symbol. The (+) lead is

usually longer than the (-) lead, and the (-) lead is identified by a black stripe on the capacitor. Solder and clip the leads.

☐ Install the 16 pin socket at location IC2. (***see instructions above***) Make sure the notched or dimpled end is lined up with the notched end of the silk screen board outline. The notch on the socket should face the right side of the board. Solder one pin and make sure the socket is firmly seated before continuing to solder the remaining pins. Solder all pins.

☐ Install the Red LEDs at the location marked Power. The LED is polarized. There is a flat side (cathode) that has a short lead and it faces towards the right side of the board. Solder and clip the leads.

☐ Install the Green LED at the location marked Online. The LED is polarized. There is a flat side (cathode) that has a short lead and it faces towards the right side of the board. Solder and clip the leads.

☐ Install fuse holder at location F1. The clips have dimples on one side of then and these must be facing towards the sides of the board and not the center. Solder.

☐ Install the RJ45 jack at locations J2. Gently align the eight wires with the matching holes and snap the connector to the board. Solder all pins

.

☐ Install 4 terminal blocks at locations CH3, CH2, CH1, and DCIN. Before installing in board the 4 terminal blocks must be locked together. ***The terminal blocks must be oriented facing outward.***

Install Parts Group 2:

☐ Install the K847PH optocoupler into socket at location location IC2. The IC is polarized. Gently install the IC so that the notch lines up with notch in the 16 pin socket

☐ The DCSSR6 may either built for low current or high current strips. Either and **NOT BOTH** the LM78L05 (low current) may be installed at location IC1 **OR** the LM7805CT (high current) may be installed at location IC3. If installing the LM78L05 the flat side if the IC should be pointing to the side of the board. If installing the LM7805 then the tab side should be installed toward the side of the board. Solder and clip leads.

☐ Install the FQPF13N06L power fet's at location Q1, Q2, Q3. The fets whould be installed with the tabs facing the terminal blocks. Solder and clip the leads

☐ Install fuse at location F1. The fuse does not get solderded.

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Final Steps

Programming the PIC

Programming the PIC can be done with the PIC chip plugged into a PIC programmer such as the PICStart from MicroChip or onboard using a programmer like a PicketIII. Programming PIC's using standard assembled is written up in our PIC Programming Manual.

Jumper Settings / Headers

JP1 XBee Header

This header can be used to connect a XBee Wireless module directly to the Renard Plus Strip using a Xbee Snap-in board or indirectly using 3 wires to a board such as the REN-W. If you are not using XBee Wireless then you must jumper pins 4/5 using a shunt jumper. The following are the pinouts for the Xbee header:

1 = +5VDC
2 = N/C
3 = GND
4 = RX from 485 chip
5 = RX in to PIC

JP2 PIC Bypass

If you are using Start Address Programming, you can use the PIC bypass to allow the data to flow thru the Renard Plus Strip without the usual Renard "address eating". If you use a jumper across pins 1/2 then the data stream that comes into the device goes out exactly as it came in with no addresses consumed by the Renard Plus 32. The default position is a jumper across pins 2/3.

Pin Layout
1 = Data In From RS485 IC
2 = Data Out to RS485 IC
3 = Data Out from PIC

JP3 RS485 Terminator

Programming (ICSP Header)

This header allows the PIC to be programmed while the PIC is installed on the board

The following are the pin-outs for this header:

Pin 1 = MCLR
Pin 2 = +5 volts
Pin 3 = GND
Pin 4 = PGD
Pin 5 = PGC
Pin 6 = PGM/RB5

Final Testing

The Renard Plus Strip Controller has 3 diagnostic LED status lights:

Diagnostic LED Status Lights

 RX	**RX** – Active when sequence is running
FE	**FE** – Will blink every few seconds to indicate the microprocessor is active
 PWR	**Power, HB, and ZC** - Will be on when power is applied

For normal operation you should have the power LED lighted and the status LED blinking every few seconds (the PIC must be programmed). If you are running a sequence you will also see the RX LED flashing as well.

The data wiring of the Renard Plus Strip Controller is the same as other Renard boards. Standard CAT5 cables can be used to inter connect other controllers

Connect the Renard Plus Strip to your PC using a standard CAT5 cable from the controller to a RS485 connection on your PC.

Program a Vixen sequence to turn on/off each of the channels on the controller. We would suggest that each channel is turned on for 4 or 5 seconds.

Connect a DCSSR board to each of the channels J3-J10 using CAT5 cable and connect lights to the SSR boards. Once that is complete you should run your test sequence to verify that all of the channels are working correctly.

Connecting the Renard to your PC

This board contains 2 RJ45 connectors that are used to receive data and pass data to the next controller.

J1 RX	RS485 incoming data from either a RS485 converter or another controller
J2 TX	RS485 outgoing data to next controller

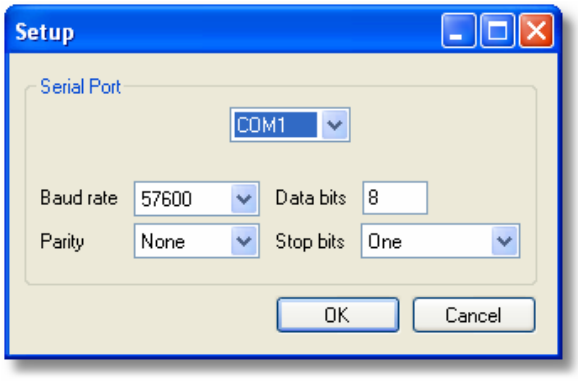
There are many options to connect your computer to the Simple Renard 32. Below is a picture of the Hexim HXSP-2018F USB to RS485 adapter:

When selecting an adapter look for ones that have an easy to use screw terminal like this one.

Computer Setup

VIXEN Settings the Simple Renard 32 Combo requires the Renard Dimmer [Vixen 1.1.*] or Renard Dimmer (modified) [Vixen 2.*] Plug-In.

Renard Dimmer Plug-In Settings:

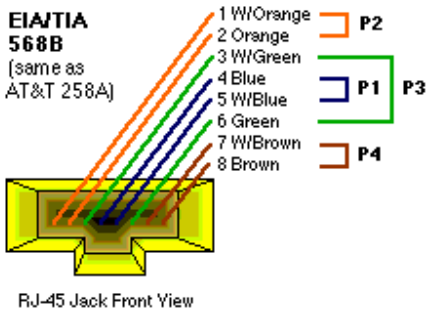


If you are using Xbees the baud rate must be 57600.

RJ45 Wiring

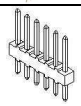
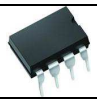
A standard RJ 45 networking cable can be used to connect the Renard to your SSRs. Just check and make sure that the pins on one end of the cable connect to the same pin on the other end of the cable.

Here is an example of a data cable wired to the EIA-568B standard. There are eight pins, numbered from left to right, looking at the jack. While you only need six wires in your in SSR interface cable, it is just easier to wire up all eight as per the cabling standard.



EIA-568B RJ45 Socket

RGB24 Strip Parts List

Picture	Designators	Description	Qty	Mouser P/N
	R1, R2, R10	1k ohm resistor ¼ watt	3	571-1k-RC
	R3, R4, R5	330 ohm resistor 1/4 watt	3	571-330-RC
	R7	120 ohm resistor 1/4 watt	1	571-120-RC
	R11, R12	27k ohm resistor 1/4 watt	2	571-27k-RC
	D2	1N5229 (4.3v) zener diode	1	78-1N5229B
	D1	1N5239 (9.1v) zener diode	1	78-1N5239B
	C2	220uf 25V Electrolytic Cap	1	647-UVZ1E221MPD
	C1, C3, C4, C5, C6	.1uf cap	5	81-RPEF51104Z2S2A03A
	TB1	Tyco Terminal Block vertical	1	571-7969492
	J1-J10	Modular Jacks 8 PCB TOP ENTRY	10	571-5556416-1
		IC Sockets 6P ECONOMY TIN (Optional)	1	571-1-390261-1
		8 pin IC socket (optional)	1	517-4808-3004-CP
	IC1	IC & Component Sockets 40P	1	571-1-390261-9
		16 pin header cut to fit: ICSP, JP2 PIC Bypass, JP1 RenW, JP3 RS485 term.	1	571-16404526
		Shunts for Xbee header and Bypass	3	737-MSC-G
	IC4	LM7805CT voltage regulator	1	512-LM7805CT
	IC2	65LBC179	1	595-SN65LBC179P

	IC3	H11AA1	1	782-H11AA1
	IC1	PIC Microcontrollers (MCU) PIC18F4520 or 4620 and 4525	1	579-PIC18F4520-I/P
	Status	yellow 5 MM LED	1	78-TLHY5405
	Power, HB, ZC	Red 5 MM LED	3	78-TLHR5401
	RX	Green 5 MM LED	1	78-TLHG5401

DCSSR Parts List

Picture	Designators	Description	Qty	Mouser P/N
	R10, R11	1k ohm resistor 1 / 4 watt	2	571-1k-RC
	R4, R5, R6	470 ohm resistor 1 / 4 watt	3	571-470-RC
	R1, R2, R3	680 ohm resistor 1 / 4 watt	3	571-680-RC
	R7, R8, R9	19K ohm resistor 1 / 4 watt	3	291-10k-RC
	C4	100uf 35V Electrolytic Cap	1	647-UVR1V101MED1TA
	C1, C3	.1uf cap	2	81-RPEF51104Z2S2A03A
	DCIN, CH1, CH2, CH3	Tyco Terminal Block vertical	4	571-7969492
	J2	Modular Jacks 8 PCB TOP ENTRY	1	571-5556416-1
	IC2	16 pin IC socket (optional)	1	571-390261-4
	IC1	Low Current 5 volt vreg	1	512-LM78L05ACZX
	IC2	K847PH optocoupler	3	512-K847PH
	IC3	LM7805CT voltage regulator	1	512-LM7805CT

	Q1, Q2, Q3	Power Fet	3	512-FQPF13N06L
	Power	Red 5 MM LED	3	78-TLHR5401
	Online	Green 5 MM LED	1	78-TLHG5401
	F1	Fuse Holder	2	576-05200001N
	F1	Fuse 10amp fast acting	1	504-GMA-10

Parts Placement Diagram