PS-2/RS232 to ASCII Keyboard Adapter Assembly and Operations Guide

By Mike Willegal   **www.willegal.net**   **version 3.0**

CAUTION!!!

Incorrect assembly and interconnecting of this adapter can cause fatal damage to the interface and/or the host computer. Double and triple check your connections before powering on. Pay special attention to the +12 and -12 voltages that are present on many of host computer keyboard sockets. These voltages are not required for operation of this interface and should not be connected. Plugging in the connector backwards when connecting to an Apple 1 will invariably destroy the micro-controller on this adapter and may cause damage to the computer.

Changes Made for Version 3.0

 In addition to disabling control-RST and control-CLR functionality, inserting the CR jumper also causes the SRB output pulse to last until CLR, which becomes an input, is asserted (high).   When the CR jumper is inserted, connecting SRB output directly to CLR input, will result in the normal 125 micro-second pulse. If you connect the SRB output to CLR input with an appropriate resistor (say 10K) and connect the CLR input to ground with an appropriate value capacitor (say .1uF), you create a RC timing circuit which can be used to extend SRB. The aforementioned values will extend strobe to 1 millisecond, but other values can be used to set the timing to a value that you desire. With the CR jumper inserted, the CLR TTL input can also be connected to external logic which can terminate SRB in any arbitrary fashion.

Forward

A number of vintage computers of the 70's and early 80's were designed to support a keyboard with a simple parallel ASCII interface. These keyboards can sometimes be hard to find, the most common source being complete Apple II plus computers. This adapter allows you to connect a slightly more modern PS/2 style keyboard with a 6 pin mini-DIN connector to a vintage computer expecting a parallel ASCII interface. In addition, it provides a RS232 input capability to the same vintage computer. This adapter will not work with Apple IIe or later model Apple computers. Though I haven't tested it, I expect that the adapter will work with other makes of vintage computers that expect keyboard input with a similar parallel ASCII interface. Specifications of the interface are provided in this guide.

In addition, this adapter supports several special functions for Apple 1 and Apple II/II plus computers.

Assembly and testing of these adapters can be done for the user for an additional fee. The purchaser must specify whether the assembled and tested interfaces should be configured for Apple 1 or Apple II/II plus computers. I am unable to build adapters for other computers, because I can not test them.

The power draw of this adapter when connected to a PS/2 keyboard and RS232 interface is nearly beyond the limits of a DIP socket and single AWG28 power supply wire in the ribbon cable. Do not use a ribbon cable longer than necessary. If you are experiencing intermittent operation, try connecting a separate power and ground wire pair between the adapter and the computer.

Chapter 1 – Assemble Components, Tools, and Equipment

1.   Recommended Tools and Equipment

- Quality soldering station - I use a Weller WES51. Whatever you use, I recommend that it has some kind of temperature controlled tip. This will help prevent damage to the PCB when soldering
- Solder - use quality solder - thinner solder is vastly easier to work with than fat solder. The fat stuff sold at hardware stores is not suitable for these sort of electronics projects
- Wire cutters – for trimming component leads and cutting wire to length
- Wire strippers - for stripping ends of jumper wire
- Sharp scissors - for trimming ribbon cable
- Drill press, screw or vice clamp - for assembling plugs to ribbon cable
- Your favorite PCB cleaning agent - Isopropyl Alcohol will dissolve many kinds of soldering resin. Windex will also help with cleaning PCBs
- Ohm meter - to check for good connections and shorts
- Logic probe or oscilloscope – handy if you are having trouble with bring up
- Your host computer schematics or hardware interfacing guide – Direction for connecting to Apple 1 or Apple II/II plus computers are provided in this manual

2.   Additional Components (not included)

- PS/2 keyboard - The type with the smaller mini-DIN 6 connector is required
- RS232 null modem cable - Configuration may vary depending upon specific PC you are connecting your adapter to. Often a DB-9 female to DB-9 female NULL modem cable will work. Pins 2 and 3 are crossed and pins 5 (ground) is connected straight through. Digikey part number AE9879-ND is an example of such a cable.
- PC with terminal software and serial port. Many modern PCs must be connected to RS232 serial interfaces using USB to RS232 converters. Most of these types of converters will work with the DB9-F to DB9-F null modem cable described above

3.   Easy Reconfiguration Option (not included)

WARNING - only try this approach if you have the proper crimper tool

- Header - Digikey part number 609-2434-ND
- One or more shrouds - Digikey part number 609-2391-ND
- Pins - Digikey part number 609-3614-1-ND
- Wire - 22-26 AWG stranded wire

4. Compare Received Components With Parts List

Examine and identify all parts provided with the kit.

| PART	DESCRIPTION	QUANTITY	PRESENT
MAX202CPE	RS232 Transceiver 16 pin DIP package (not socketed)	1	
.1uF capacitors	Used with RS232 transceiver	5	
47uF capacitor	Power supply smoothing	1	
DB9 male connector	RS232 connector	1	
din6	PS/2 keyboard connector	1	
16 pin socket	for keyboard to host ribbon cable connection	1	
20 pin socket	for AVR microcontroller	1	
Attiny2313	preprogrammed and calibrated microcontroller 20 pin DIP package	1	
1' ribbon cable	keyboard to motherboard connection (cut to length)	1	
ribbon cable headers	connect to ribbon cable ends after cutting ribbon cable to length	2	
PCB	printed circuit board	1	
1N914 diode	for Apple 1 clear function	1	
2 pin KK style headers	configuration headers 6 pin header provided (you break apart into 3, 2 pin headers)	3	
shunts	configuration jumpers	3	
3' jumper wire	for jumpering from microcontroller to keyboard header	1	
PARTS COUNT		24	
COUNT OF TYPES		15	

Chapter 2 – Solder In Components

1. Overview

The key thing here is to check orientation and make sure that you don't put the sockets or MAX202 chip in wrong. Make sure that the parts are oriented correctly with pin 1 of the socket or chip near the bottom of the PCB.
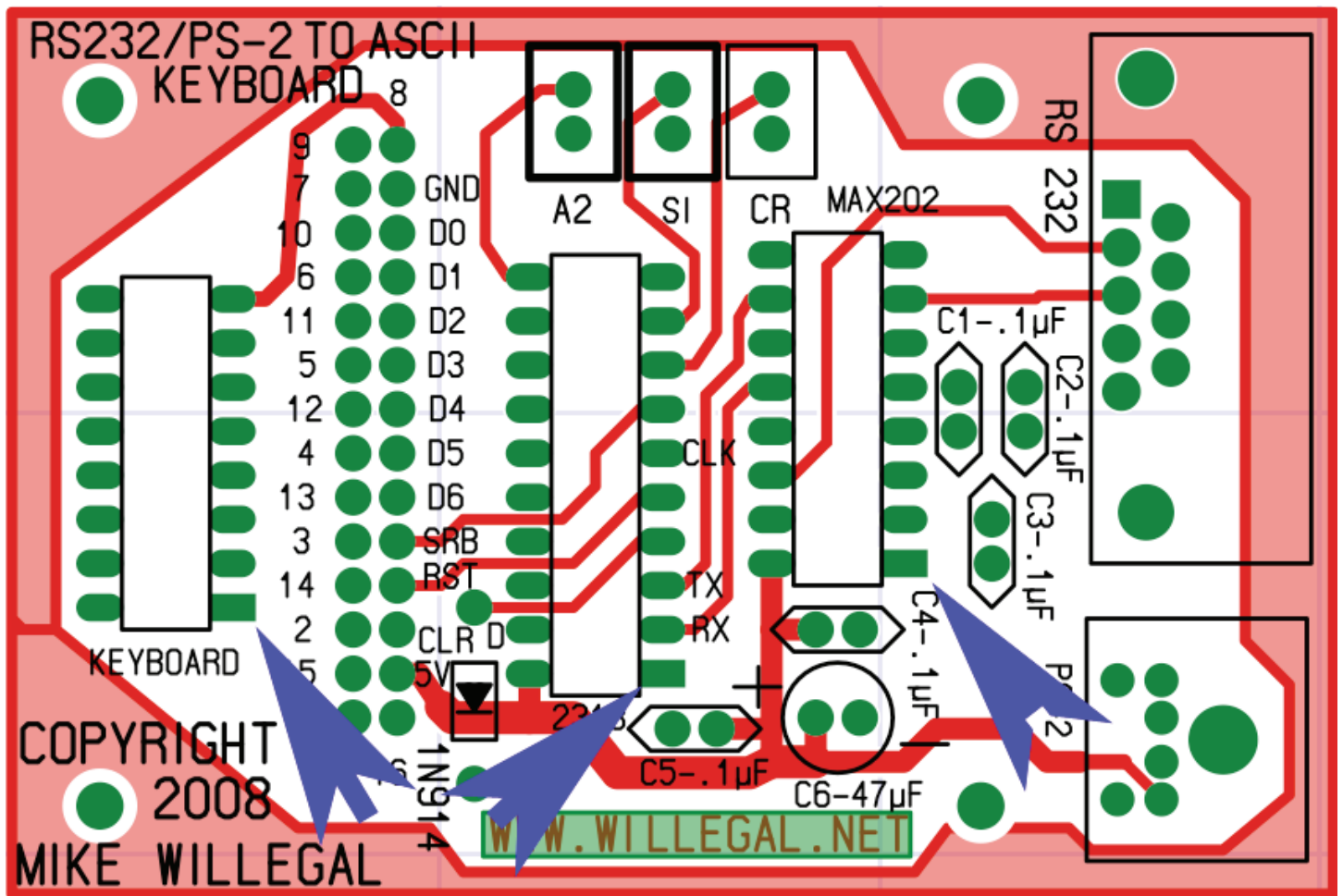
Make sure the socket or chip is fully seated. I accomplish this by resting the socket upside down on a small object with the board on top. The weight of the board should keep the socket or chip completely seated. Then tack down a couple of corner pins and recheck orientation and seating. Then finish soldering the rest of the pins.

Take your time and enjoy the process, double checking orientation of devices as you go. The blue arrows indicate places to pay attention to orientation when placing components.
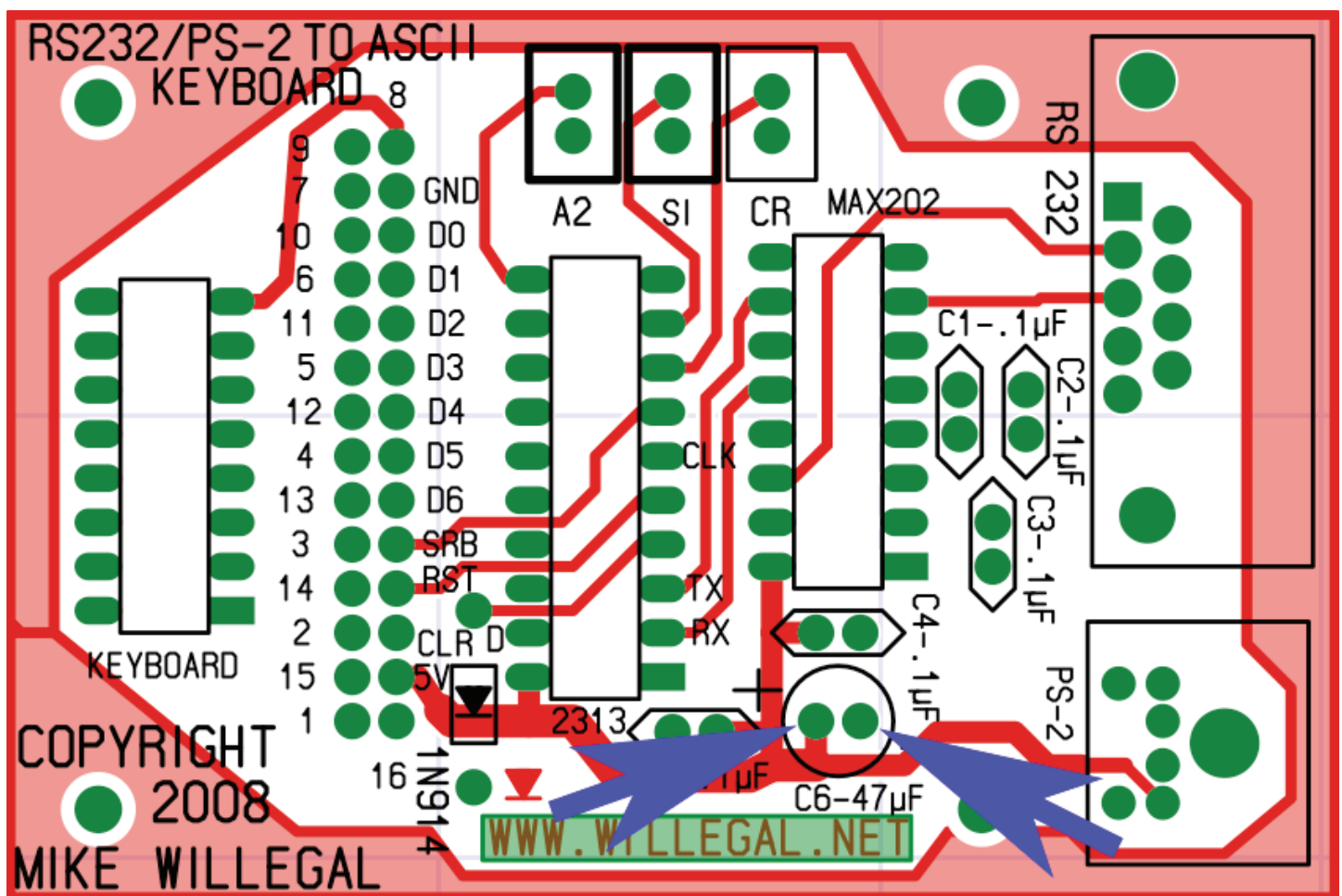

2. Check for Power and Ground Shorts on PCB

Easiest way to do this is to use an ohm-meter to make sure that there is no connection between power and ground. A convenient place to use, is the positive and negative pins of electrolytic capacitor location (blue arrows above).

RS232/PS-2 TO ASCII KEYBOARD

8 9 7 10 6 11 5 12 4 13 3 14 2 5

GND D0 D1 D2 D3 D4 D5 D6 SRB RST CLR D 5V

A2 SI CR MAX202

RS 232

C1-.1µF C2-.1µF C3-.1µF C4-.1µF

CLK

TX
RX

KEYBOARD

231

C5-.1µF C6-47µF

1N914

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PS 2

PART	DESCRIPTION	QUANTITY	COMPLETE
MAX202CPE	Pin 1 has square pad on top side of board (pin 1 toward www.willegal.net). This chip is not socketed because I have never had one fail or reason to remove one from it's socket. If you have an extra 16 pin socket, and prefer having socketed parts on your adapter, putting a socket here will not have adverse affects on operation.	1	
.1uF capacitors	Orientation not important	5	
DB9 male connector	RS232 connector facing edge of board	1	
din6	PS/2 connector facing edge of board. Fill in big hole with solder in order to make connector more stable	1	
20 pin socket	For AVR microcontroller - Pin 1 has square pad on top side of board (pin 1 toward www.willegal.net)	1	
16 pin socket	For keyboard to host ribbon cable connection - Pin 1 has square pad on top side of board (pin 1 toward www.willegal.net)	1	
2 pin KK style headers	2 pin configuration headers labelled A2, SI and CR	3	
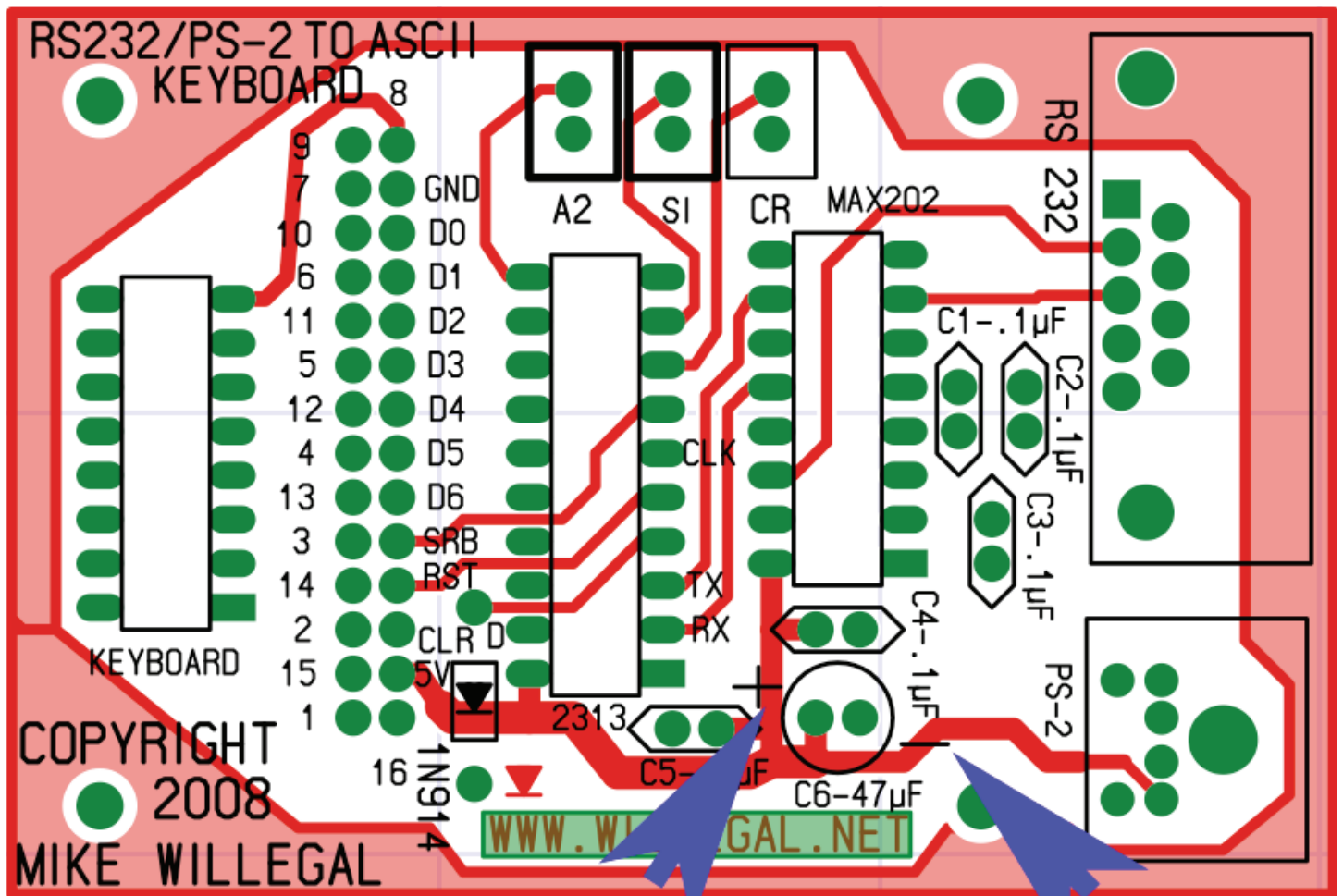
3. Electrolytic Capacitor

Orientation is critical. Double check this work. Incorrect insertion can result in fire!

PART	DESCRIPTION	QUANTITY	COMPLETE
47uF capacitor	Orient * and - leads to match + and - signs on silk screen. **Failure to do so may result in damage to the adapter and connected equipment and possibility of fire.**	5	

RS232/PS-2 TO ASCII KEYBOARD
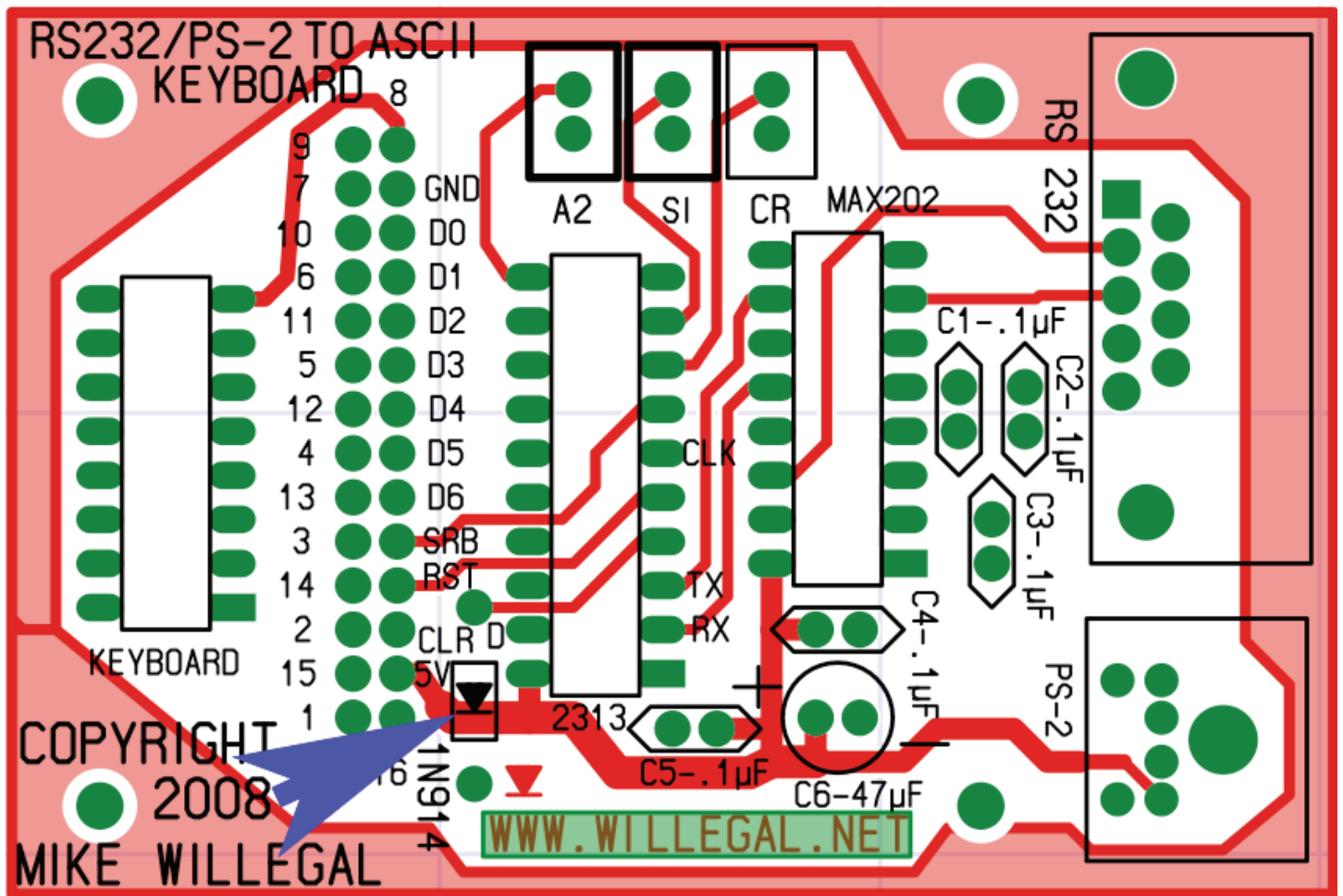
4.   Diode

This diode is only required if using the adapter with an Apple 1. Chapter 3 has a description of the clear function that is associated with this diode.

A   K

silk
screen
orientation

The diode must be oriented correctly. There are two ends, anode and cathode. Be sure that orientation matches the silk screen.

PART	DESCRIPTION	QUANTITY	COMPLETE
1N914 diode	for Apple 1 clear screen function - not needed for Apple 2 or other applications - orientation is important	1	

Chapter 3 – Wiring Jumper Area

This adapter has a flexible jumper area that is used to connect a 16 pin keyboard ribbon cable header to the microcontroller that is the brains of the adapter. This jumper area contains 2 rows of pins. The connections can be made by direct jumper, wire wrap or through a removable header.
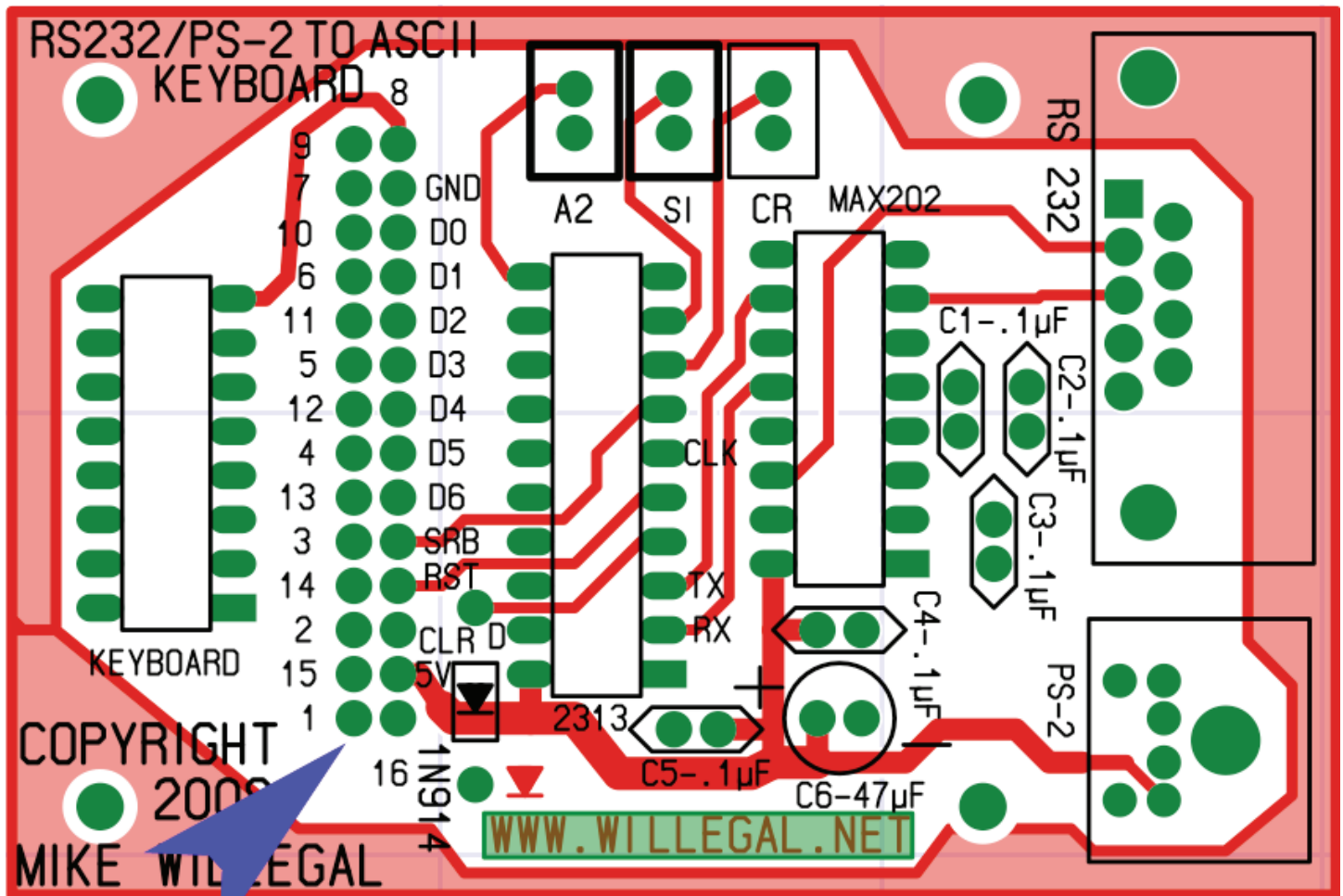
Wire is provided with the kit for direct jumpering.

When doing direct wire jumpering, cut wires to length to provide a neater appearance. Wires should be stripped at one end and soldered to the adapter at that end before cutting to length, stripping and soldering the other end.

If you want make the connections via wire wrap or a removable header, you must provide the additional components required.

If you have access to the correct crimper tool, you can make a removable header. Be sure that you use a keyed shroud and header that will prevent you from plugging the header in wrong and causing damage to the adapter or computer. Suggested shroud and header parts are listed in chapter 1. Trying this approach without using the proper crimper tool is likely to end in fustration.

Wire wrapping involves adding a 28 pin 2 row KK style header to the board and using a wire wrap tool and wire to make the connection.

In all cases the connections remain the same.

1.   Adapter Interface Details

The connection area consists of locations for 28 pins in 2 rows of 14 each row. 16 of the pins connect directly to the 16 pin DIP header labeled "KEYBOARD".   These pins are labelled 1 through 16 and connect directly to the same numbered pin on the 16 pins DIP header. 12 of the pins connect to the microcontroller and are described in the table below.

D0-D6	Data bits 0 – 6	TTL ASCII data output from micro-controller. Least significant bit is D0, most significant is D6. Data is high true. Most common microcomputers (including Apple) expect high true data from an ASCII keyboard. If your computer requires low true data, add inverters on the data lines between the PS/2 adapter and your computer.
5V	+5 Volt Supply	Connect to +5 Volt pin on keyboard header. Provides power to micro-controller, RS232 interface and keyboard. PS/2 spec says keyboards are allowed to draw up to 300 milliamps of current. The micro controller and RS232 driver can draw up to an additional 15 milliamps of power. This can stretch the capability of a 28 AWG wire in a ribbon cable and DIP socket. For reliable operation, keep the length of the ribbon cable reasonably short. If you suffer from intermittent operation, try adding separate power and ground wires from the adapter to the host computer.
GND	Ground	Connect to ground pin on keyboard header
SRB	Strobe (output from adapter)	TTL output from micro-controller. Generates 125 micro-second positive going pulse .75 micro-seconds after data is presented to D0-D6. Any host that accepts parallel keyboard data and responds to a positive or negative edge triggered strobe should work with this adapter. In addition to disabling control-RST and control-CLR functionality, inserting the CR jumper also causes the SRB output pulse to last until the CLR input, is asserted (high) with a minimum pulse width of 125 micro-seconds. When the CR jumper is inserted, connecting SRB output directly to CLR input, will result in the minimum 125 micro-second pulse. If you connect the SRB output to CLR input with an appropriate resistor (say 10K) and connect the CLR input to ground with an appropriate value capacitor (say .1uF), you create a RC timing circuit which can be used to extend SRB. The aforementioned values will extend strobe to 1 millisecond. CLR can also be connected to external logic which can terminate SRB in any arbitrary fashion. IMPORTANT: If the CR jumper is in place, and the CLR input is not asserted (made high) after sending a character, the adapter will stop inputing data, until the CLR input is asserted.
RST	Low true reset signal	TTL output from micro-controller. Reset is a asserted as a low going pulse lasting approximately 1.25 milliseconds. The PS/2 adapter can be configured to automatically assert reset after the adapter is powered up and initialized. To enable this feature, the jumper labelled "SI" at the edge of the board should have a shunt inserted. Reset will also be asserted when a control-alt-del sequence is typed on a PS/2 keyboard and optionally if a control-R, control-S, control-T sequence is detected on either the RS232 interface or keyboard. The optional control-R, control-S, control-T sequence can be disabled by inserting the CR jumper shunt on the adapter.
CLR	High true clear screen signal	TTL output with diode "OR" function. The signal is a high going pulse approximately 40 milliseconds long. This is specifically added to allow clearing the screen on Apple 1 computers. The diode can be replaced with a jumper wire for other applications that may have need for a user controlled high going TTL level pulse. The PS/2 adapter can be configured to automatically assert clear after the adapter is powered up and initialized. To enable this feature, the jumper labelled "SI" at the edge of the board should have a shunt inserted. It will also be asserted if a control-C, control-L, control-R sequence is detected on either the RS232 interface or keyboard. This optional control-C, control-L, control-R sequence can be disabled by inserting the CR jumper shunt on the adapter. When the CR jumper is inserted, CLR becomes an input and is used to terminate the SRB output. See the SRB signal for details.

Apple II Example:

The Apple II and II plus keyboard socket has the following pinout. Double check your connections with an ohm meter prior to powering up. Incorrect connections, especially to the -12 volt pin can damage your adapter or the host computer. Be sure to check for shorts between adjacent connections. Later Apple computers like the IIe use different technology for keyboard interfacing and are not compatible with this adapter. See the following page for the Apple 1 configuration, which is not compatible with the II/II plus. The following jumper connections should be made for the Apple II/II plus computers. Install the A2 shunt to enable arrow mapping capability. Other shunts should not be installed.

AII or AII Plus DIP SOCKET PIN NUMBER	MICROPROCESSOR CONNECTION	COMPLETE	CHECKED
1	5V		
2	SRB		
3	RST		
4	no connection		
5	D5		
6	D4		
7	D6		
8	GND		
9	no connection		
10	D2		
11	D3		
12	D0		
13	D1		
14	no connection		
15	no connection*		
16	no connection		

* - 12 volts is on this pin on the computer's 16 pin keyboard socket - connecting this pin will most likely damage the adapter and possibly the computer

Apple 1 Example:

The Apple 1 keyboard socket has the following pinout. Double check your connections with an ohm meter prior to powering up. Incorrect connections, especially to the +12 or -12 voltages can damage your adapter or the host computer. Be sure to check for shorts between adjacent connections. Add the SI shunt for automatic reset and clear after power up. In original Apple 1's, it was a manual process, so leave the SI jumper disconnected for authentic behavior. The following jumper connections should be made for the Apple 1.

A1 DIP SOCKET PIN NUMBER	MICROPROCESSOR CONNECTION	COMPLETE	CHECKED
1	RST		
2	D3		
3	D2		
4	D1		
5	D0		
6	D4		
7	D5		
8	D6		
9	GND		
10	no connection*		
11	no connection**		
12	CLR		
13	no connection		
14	SRB		
15	5V***		
16	5V		

* +12 volts is on this pin on the computer's 16 pin keyboard socket - connecting this pin will most likely damage the adapter and possibly the computer

** - 12 volts is on this pin on the computer's 16 pin keyboard socket - connecting this pin will most likely damage the adapter and possibly the computer

*** this pin is a provision for an 8th input data bit, but is normally connected the +5 volts. There is only 1 hole for +5 volts and two wires going to it. I recommend connecting pin 16 to 5 volts with a bare wire and soldering pin 15 to the bare wire going between pin 16 and 5 volts.

2.   Clean PCB of Rosin and By-products of Soldering

Once soldering is complete, clean the back of PCB of excess flux and rosin. 90% or higher isopropyl alcohol. IPA will dissolve soldering resin. Spray it on the back of the board and lightly scrub with a very soft brush that will not scratch the surface of the PCB. Soak up the IPA and contaminates with a clean soft cloth before it evaporates in order to remove the by products of soldering. Let dry overnight. Position a fan to blow over the board to make sure that all remaining moisture evaporates.

 I have also discovered that "Windex" window cleaner can help remove the by-products from the soldering job. Removing contaminates is important as many kinds of rosins are corrosive.

3.   Check Board for Solder Bridges and Cold Solder Joints

While the board is drying, you should carefully check your work for bad solder joints and solder bridges.

4.   Insert Microcontroller

Pin 1 is toward WWW.WILLEGAL.NET etched in copper layer.

Chapter 4 – The Cables and Plugging It In

1.   The Ribbon Cable

The ribbon cable and connectors are not preasembled. This allows the adapter owner to assemble the cable into the best configuration for his application. Because of possible issues with power drop over the length of a longer cable, it is recommended that ribbon cable length be kept to 1 foot or less, If a longer ribbon cable is needed, separate provisions may have to be made for supplying +5 volts and ground to the adapter.

Cut the ribbon cable to length with a sharp scissors. Before pressing the cable into place, it is recommended that the connector is plugged into a spare socket. This will help protect the pins from damage. The best way to press the cable into place, is to use a press. A drill press can easily be adapted for the job. If a drill press is not available, a screw clamp would make the next best tool for the job. Make sure you work out the best orientation of plugs before pressing into place and make sure that the marked pin 1 side of the cable is at pin 1 of the connector at both ends. A sure way to damage your adapter is to plug it in backwards. Having the markings on the cable and plugs match actual pin 1 will help prevent you from making mistakes.

2.   RS232 Interface

This cable is not provided. The pinout of the RS232 DB-9 male connector is as follows. A suggestion for a ready made cable that will work with some commonly available USB to RS232 adapters is listed in chapter 1.

PIN	DESCRIPTION
2	RX data
3	TX data
4	Always asserted - can be used as DTR
5	Ground

The RS232 interface is configured to run at 9600 baud, 7 data bits, even parity, with one stop bit. Configure you PC's terminal software to this configuration.   The baud rate is generated using the microcontrollers internal RC-oscillator. This oscillator is configured to operated at nominal baud rate at room temperature. I have not experienced this, but it is possible that at extremely hot or cold temperatures, that the oscillator will drift. This drift may cause the baud rate change to a speed that is beyond the capability of RS232 protocol to correctly transmit and receive data. Returning the system to room temperature should resolve the issue. If you encounter this issue, record the temperature at which you experienced the problem and let me know about it.

3.   Plugging It In and Powering It Up

Power off your computer before plugging in the adapter. Make sure pin 1 of the ribbon cable is connected correctly to the computer and adapter. It is easy to accidentally offset DIP plugs, so make sure pin 1 of the plug is in the pin 1 position of the socket. Connect the PS/2 keyboard and/or the RS232 interface to your adapter.

When you power up, you should see the LED indicators of you keyboard blink as it runs it's power on self test. If the adapter doesn't immediately establish good communication with the keyboard, the adapter will reset the keyboard and this self test will be repeated.   After a blink or two, the num lock and caps lock lights should remain on, with the other light off.   With the SI jumper in place, the adapter will autmoatically reset your computer, and in the case of an Apple 1, it will clear the screen. If the SI jumper is not in place, you may need to manaully reset it(control-alt-delete) and in the case of an Apple 1, clear screen (control-C, control-L, control-R). At this point, if all is well, you should be able enter data into your computer using the PS/2 keyboard or RS232 interface. Either the PS/2 or RS232 or both interfaces can be connected and used at any given time.

Chapter 5 - Special Features

1. PS/2 Keyboard

KEY SEQUENCE	DESCRIPTION
Control-ALT-DEL	Asserts reset
Caps-lock	Toggles between upper and lower case input
Num-lock	Num lock is always on - cursor controls on keypad can not be enabled
Arrow keys	If A2 shunt is in place, arrow keys will cause Apple 2, esc-x cursor control sequences to be sent when arrow keys are pressed
Control-R Control-S Control-T	If CR shunt is not in place, pressing these keys, sequentially, will cause reset to be asserted
Control-C Control-L Control-R	If CR shunt is not in place, pressing these keys sequentially will cause clear to be asserted. This is intended to clear the screen of an Apple 1 computer

2. RS232 Interface

The RS232 interface is a write only interface. Characters output by the vintage computer cannot be captured by the RS232 interface. However, if both a PS/2 keyboard and RS232 interface are connected, any data input to a vintage computer with the PS/2 keyboard will be automatically echoed to the RS232 interface.

KEY SEQUENCE	DESCRIPTION
Control-R Control-S Control-T	If CR shunt is not in place, pressing these keys, sequentially, will cause reset to be asserted
Control-C Control-L Control-R	If CR shunt is not in place, pressing these keys, sequentially, will cause clear to be asserted. This is intended to clear the screen of an Apple 1 computer

With the right terminal software on a PC, commands and programs can be automatically loaded into a vintage computer using this write only interface. Typically the text to be entered, is put into a file on the modern PC. The format will often be a series of monitor commands that write memory.   These files are sent to the vintage computer using the terminal software's send file command.

Some vintage computers, such as the Apple 1, have a very limited rate at which they can accept monitor input. In these cases, to prevent overruns, the terminal software must be configured to delay between characters and lines.   The exact delays required for reliable data transfer depend upon capabilities of the specific vintage computer. I have found that the Apple 1 monitor accepts data reliably with a 20 millisecond per character delay and a 200 millisecond end of line delay.

Chapter 7 – Troubleshooting and Help

A good job of soldering the components into place should eliminate most if not all trouble. First step, in case of trouble, should be to check for bad solder joints or bridges.

Refer to my Apple II repair page at www.willegal.net for some general troubleshooting hints.

Feel free to send email to: mike@willegal.net if you run into difficulties.