TTL-to-serial Interface for Z100

Clifton Laboratories
Jack Smith K8ZOA

Introduction

This document describes a simple interface between TTL-logic level voltages and RS232 level voltages, intended for use with the Z100 Tuning Aid. As such, it may be useful as a substitute for FTDI's TTL232-R http://www.ftdichip.com/Documents/DataSheets/Modules/DS_TTL232R.pdf module. (The TTL232R adapter is the device for which the Z100 was designed. The TTL232R provides a TTL serial I/O connection at one end, and a USB port at the other, allowing it to be used with a computer not having either a hardware or USB-based serial adapter. The 6-place header connector in the Z100 mates with the TTL232R cable.)

This circuit is based upon the similar design by Elecraft in its W1 digital wattmeter. The modifications relate to the much higher speed used when programming the Z100 via Swordfish's MicroCode loader software, compared with the W1 product.

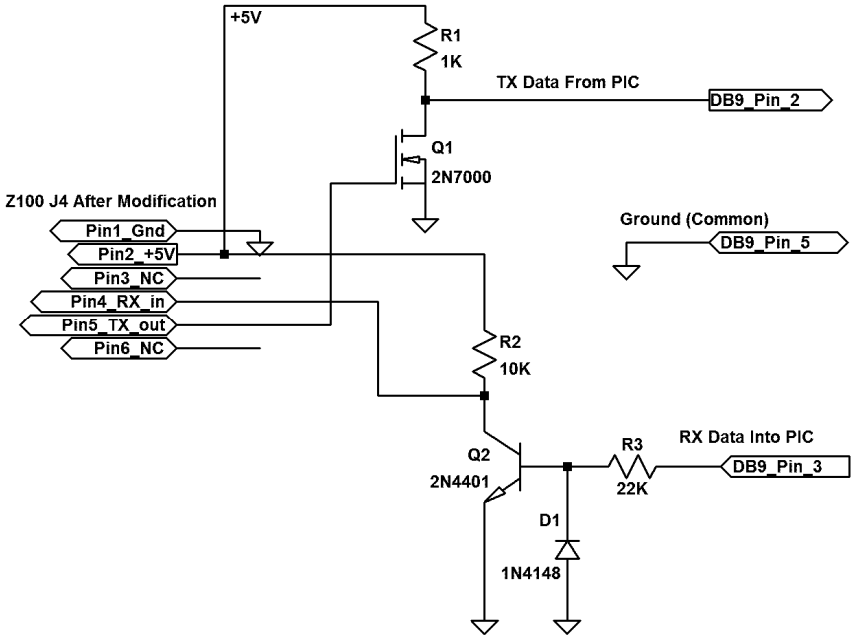
This adapter has been tested with a Keyspan USB-to-serial port adapter, but has not been further tested. While I believe it should work with a standard hardware serial port, I have not tested it with that configuration.

Note that this interface is NOT a PIC programmer. It will work only if the PIC has suitable bootloader firmware, so that the program code may be sent to the bootloader firmware via the PIC's standard serial interface.

The circuit assumes your computer has an RS232 serial port, either a hardware serial port on your computer's motherboard or a card, or a USB-to-serial adapter. It also assumes you have Swordfish's MicroCode loader software installed on your computer. If you have installed Swordfish's compiler (either the free Swordfish SE version or the licensed, for charge, standard Swordfish compiler) the MicroCode loader will be part of the package.

This note does not cover the process of loading new code into the Z100.

Circuit



Theory of Operation

The Z100's 18F2420 PIC has a hardware, 5 V logic-level serial port brought out to J4, a 6-place pin header. In addition to the PIC's transmit-out (pin 5) and receive-in pins (pin 4), the header also has a ground pin (pin 1). As logic level voltages are used, the TX and RX pins are either at 0 or +5 volts.

The RS232 interface, in contrast, is a bi-polar system, with levels of ±15 volts. In addition, the RS232 standard is inverted with respect to logic level; a logic level 0 is asserted on the RS232 line as a positive voltage, whilst a logic level 1 is asserted as a negative voltage.

In fact, most recent PCs play fast and loose with the RS232 standards and most will accept 0 volts as equaling a negative voltage and accept +5 volts as equaling a positive voltage. Hence, the interface need not have a negative supply nor does it need a higher voltage supply than +5V. Note, however, that I said "most" PCs will accept these out-of-specification voltages without a problem. Most is not all and whether this adapter will work with your particular PC is not determinable without trying it.

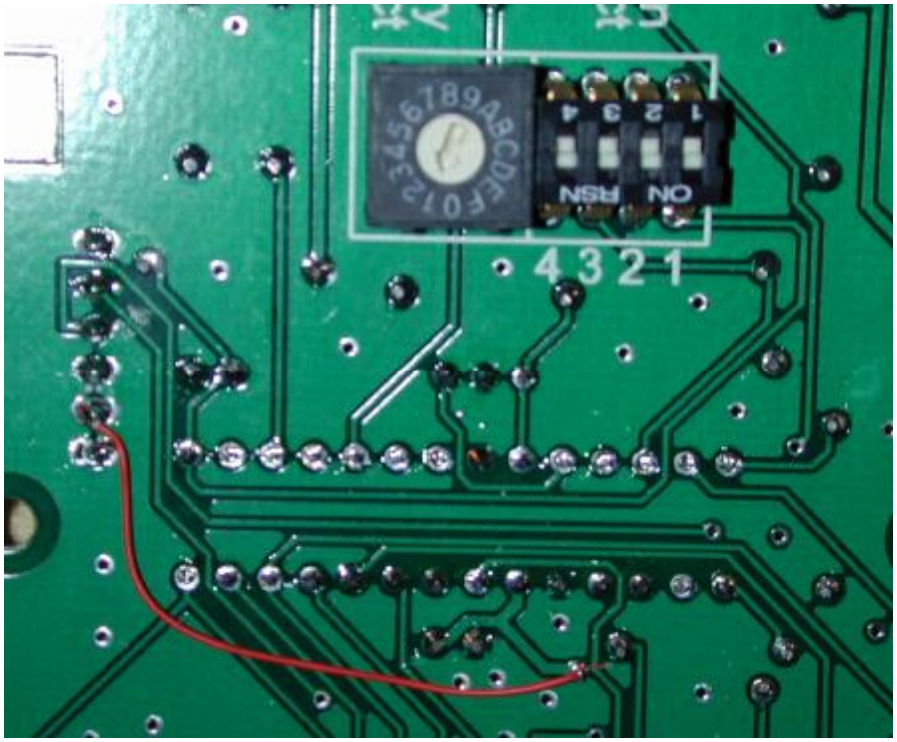
A logic high on the PIC's TX pin takes Q1's drain low and outputs approximately 0 volts into the DB9's Pin 2. Likewise, when the TX pin is low, Q1 is shut off and the DB9, Pin 2 rises to +5 V. Thus, Q2 provides both voltage translation and inversion.

Likewise, a positive voltage on the PC's TX line (DB9, Pin 3) saturates Q2, dropping its collector near 0, representing a logic low, which is read by the PIC's RX pin as a logical 0. A negative voltage from the PC's TX line turns Q2 off, thus placing +5 V on Q2's collector and into the PIC's RX pin. R3 provides current limiting to the PC's TX output and to Q2's base. Diode D1 prevents Q2's base-emitter junction from being damaged by reverse bias when the PC's TX output is negative.

Modification to Z100

To make the module a plug-in device, it is necessary to modify the Z100 to bring out +5V to J4, Pin 2. FTDI's TTL232R USB-logic adapter uses Pin 2 as an input, so this modification will not prevent you from using the FTDI adapter should you so decide in the future. However, using any other pin than J4, pin 2 as the +5V source will render J4 incompatible with the TTL232R. Indeed, damage to the TTL232R may be caused if you use any pin other than 2 for the +5V source.

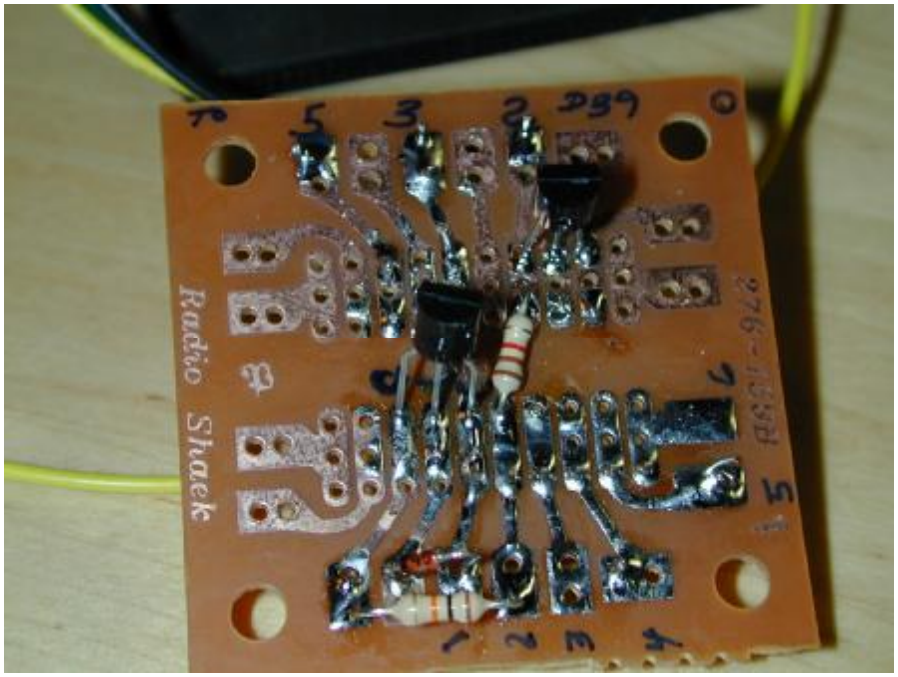
Use a short length of #30 wire to connect J4, pin 2 to the Z100's +5V supply. There's a convenient via pad that may be used for this purpose as shown in the photo below. After making the connection, check that J4, Pin 2 has +5V when the Z100 is powered.

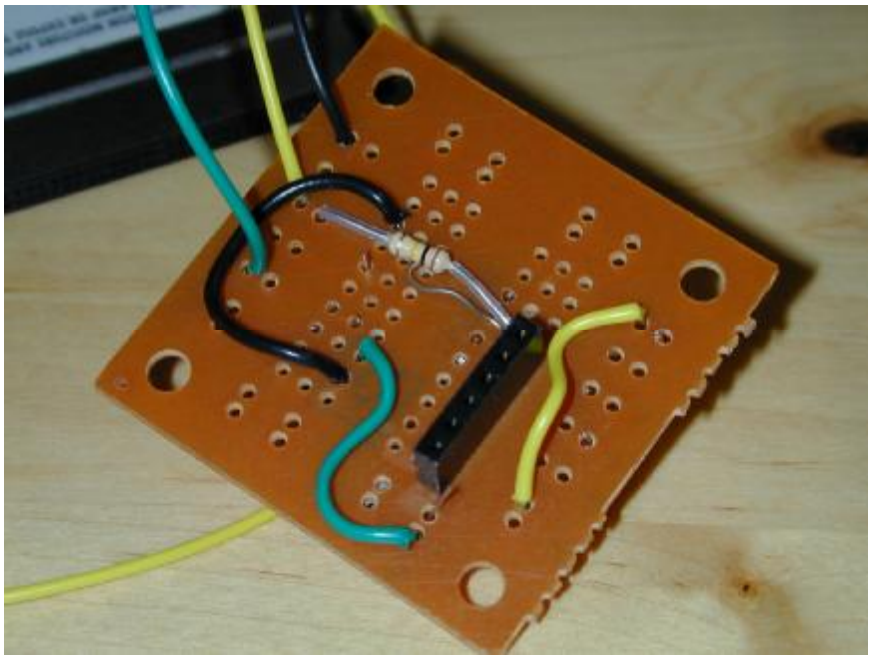


Building the Adapter

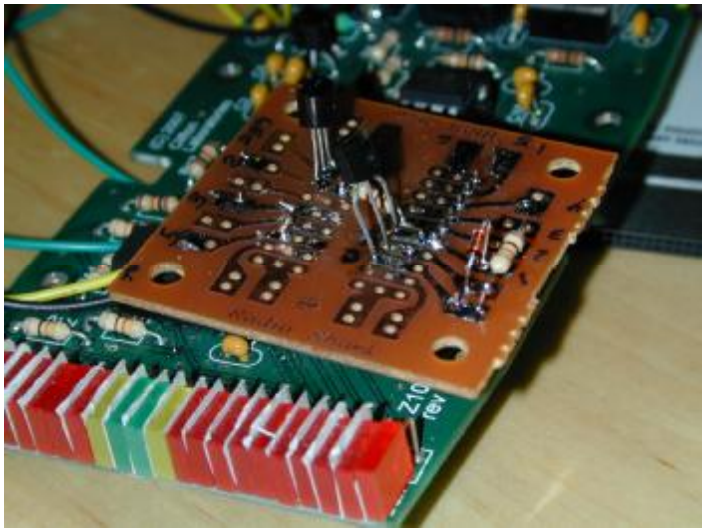
To make the adapter as easy as possible to build, I've tried to use Radio Shack parts wherever possible. Feel free to substitute, as the parts are not particularly critical.

The adapter is built upon one-half of a Radio Shack 276-1588 prototyping board. The numbers I've written onto the prototyping board are (at the top) the DB9 pins and at the bottom and right, the pin numbers from the Z100's J4.





On the bottom of the prototype board (normally this is considered to be the top of the prototyping board, but I generally build on the copper side, permitting quasi-surface mounting of conventional through-hole parts, in addition to normal mounting) install the 6-pin female header. If you follow the orientation in the photos above, the prototype board will fit into the Z100 when the top is removed, but it is not necessary to take the Z100's PCB out of the enclosure's lower half. This is a significant plus, so make sure that your configuration does not require removing the Z100's PCB.



The above photo shows the completed adapter plugged into the Z100 PCB. This is an early Z100 board that I use for experimentation.

The three DB9 wires go to a female DB9 connector. Watch your wiring—don't get the DB9's pins wrong.