ANDREW LYNCH HARDWARE TEST FUNCTIONS

There are a series of hardware test routines written to quickly test all of the multi-function chips, the addressing of all hardware devices, the input and output functions through the UART and PIO chips, and the debug monitor. All of these test suites require that the basic CPU, memory, and addressing functions work properly. Andrew developed a set of such test routines which are useful across a wide range of circuit board debug and evaluation situations.

With the caveat that the basic processor function has to be working properly, this test suit is an excellent way to automate the sequential test of circuits and proper chip function. These ROM code modules automate the necessary task of confirming that each processor subsystem works and configures as expected. A Test ROM should be part of every CPU board start-up effort.

The test functions developed in Folder “Test Hardware” come in several steps. Each test step requires that there be some hardware test fixtures to display the expected results. For example, a terminal device is necessary to observe or input text data, a bank of LEDs with clip leads is necessary to test proper addressing of functional chips or correct setting of port outputs, and a bank of pull-up leads provides switchable bit states for parallel input testing (prototype circuit suggestions are listed in a later section). The test steps are as follows:

1. Test #1 provides a set of instructions which confirm that the cpu is running, that critical ROM/RAM memory addressing works, and that there is sufficient CPU processor function to enable in-system testing with a monitor. If this level of functionality is not working, an ohm-meter tracing of address and data bus lines is in order.

2. Test #2 provides testing of key peripheral devices starting with the UART and PIO chips, and including any other ports, registers, or programmable function chips (timers, disk controllers, network controllers).

3. Test #3 provides the installation of a Monitor which provides tools to read/write/modify memory and ports, load commands and code from the terminal, sequence configuration instructions for complex chips, and

communication with peripheral devices. The monitor provides easy functions to exercise complex circuits and confirm that circuits perform as expected in all possible situations. A monitor will not always insure that time and sequencing criteria are correct in all cases (i.e. wait states and logic delay testing still requires a logic analyzer or scope).

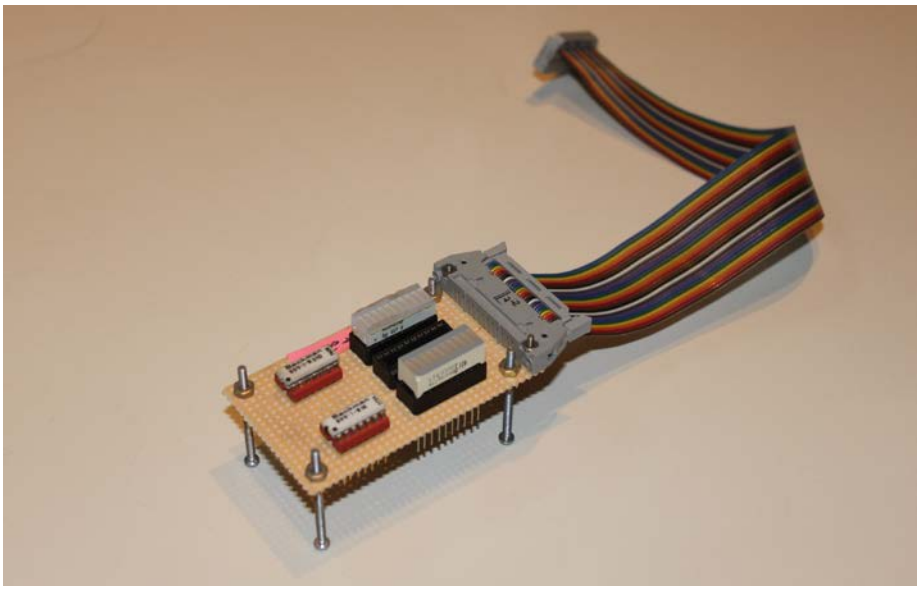
Integral to this step is the presence of the test hardware and the routines to configure and exercise all of the design complexity of the logic on the PCB or the functionality of the programmable chips.

Test hardware is pretty simple and unexciting, but is necessary to confirm that circuits actually perform as expected. The high end of these test fixtures is a logic analyzer or oscilloscope, and the bottom end is a suite of LED indicators with clip leads. Build the LED test fixtures first, and the need for expensive test equipment may never materialize.

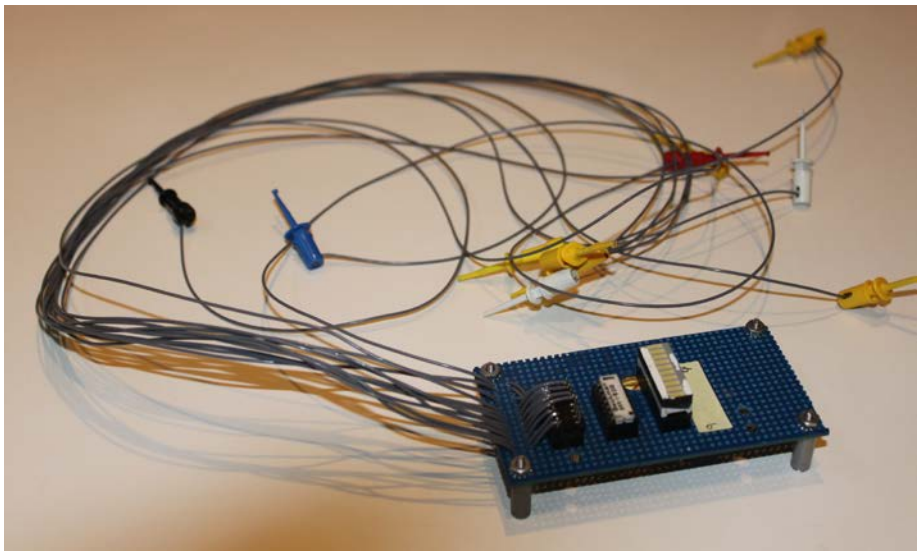
Put a header on each board and make the clip lead cable from ribbon cable so that you can use a header plug to put the clip leads on any of the test fixtures. All of these test fixtures can be wire wrapped or point to point wired and/or soldered. Neat and robust are good while pretty is not a criteria.

1. LED Register (Fig 1 & 2). A LED register is comprised of a 10 lED block, a 20 pin dip 1K resistor package connecting the + pins to a +5(3.3) volt source, and a set of miniature clip leads to the negative side of the LEDS. When the clip lead test point goes low (and most circuits are negative or low true), the led will light. This is the best circuit format because the test points are normally low true, and because logic chips are much better at sinking current rather than sourcing current.

   A cable header on the board allows cable or clip leads to be attached when needed and used elsewhere. The cable header can be configured to match the cable headers on the external IO cable.

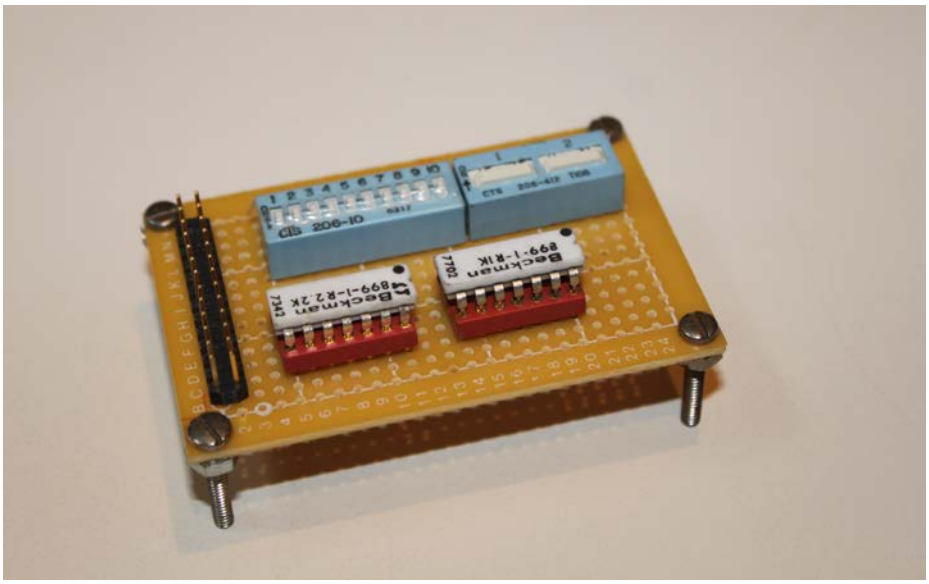


Indicator LEDs with cable headers to circuit IO

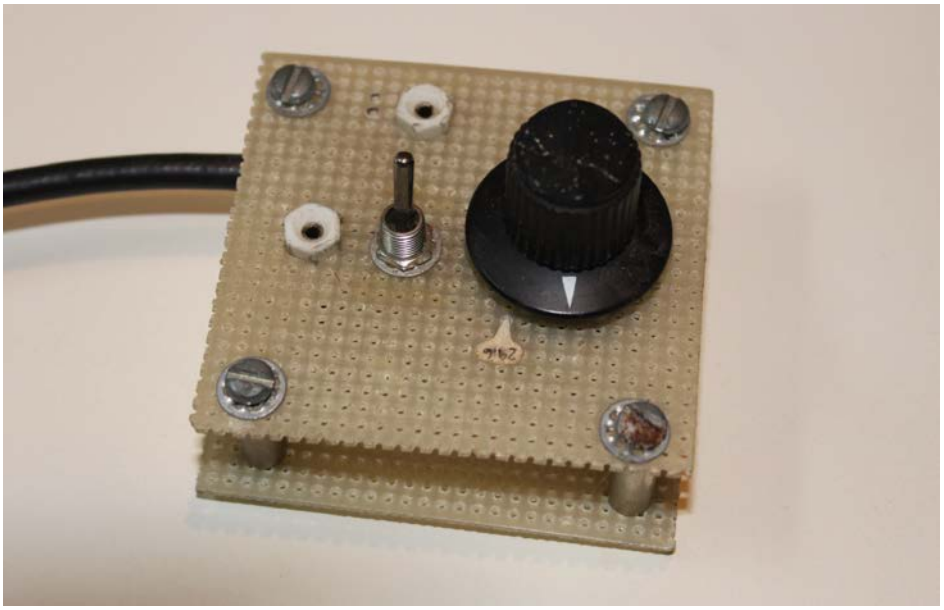


Indicator LEDs with detachable clip leads to circuit

2. Switch Register (Fig 3). The best way to provide high and low inputs to an IO register is a second LED register (as above), but with a dip switch to ground on the negative side of the LEDs. In this configuration, the test clip leads will be pulled low (LED ON) in each bit position where the switch is closed. A set of resistors in series with each of the test clips will limit the current allowed in the test circuit chip interface. This one was made without the LED array.

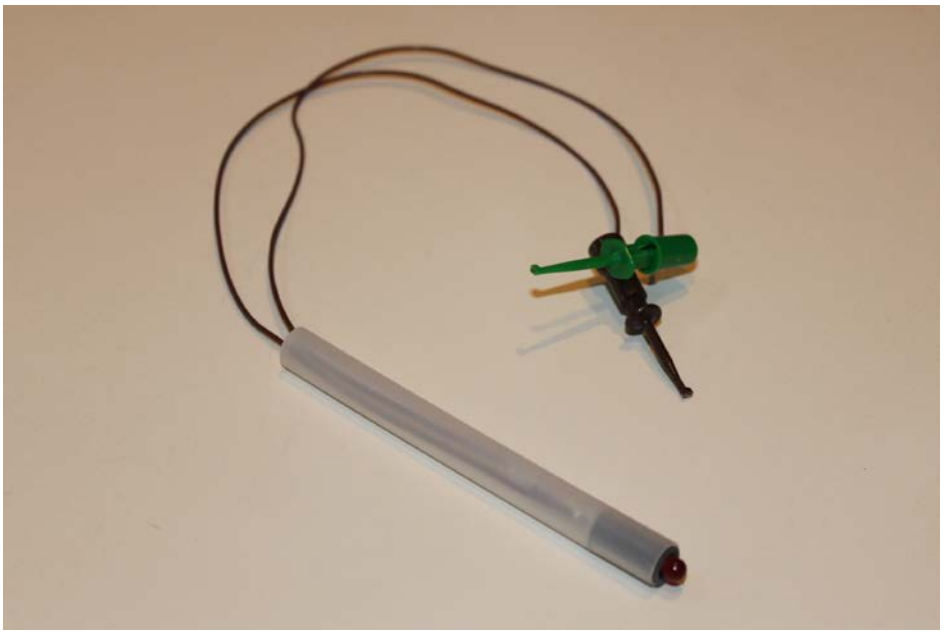


3. Analog Test. Many digital systems have a need to measure analog voltages through an A/D chip, which can best be tested by a set of voltages. Such a voltage test source can be constructed from the PCB power supply, through a series string of resistors with a rotary switch or pot to dial in the voltage desired. Put a 1K series current limiting resistor in the line between the source and the ADC input.



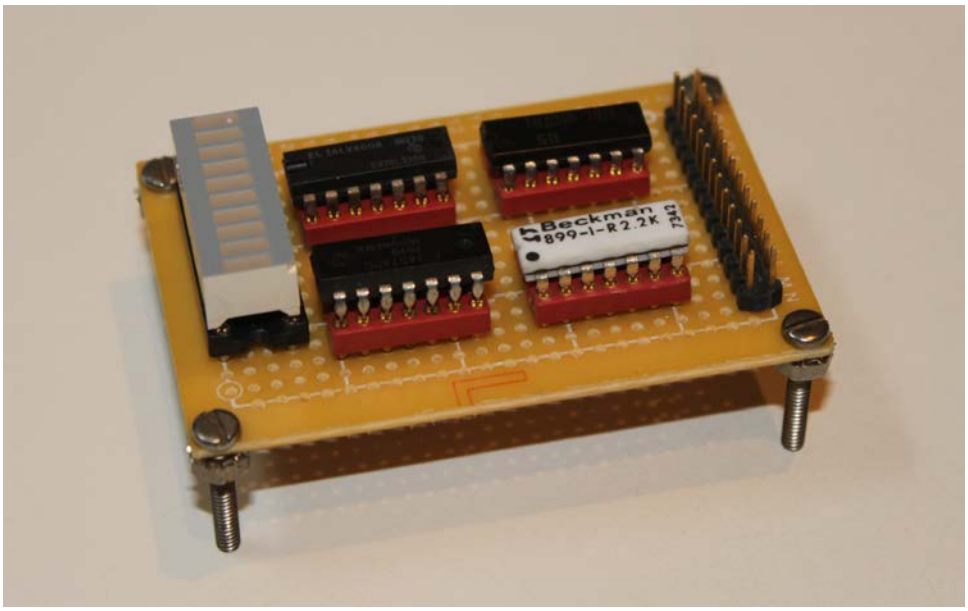
Analog Voltage available from a Pot across VCC

4. A single chip select line or output pin on a line decoder (74LS138) can be checked with a single LED probe or clip lead indicator device.



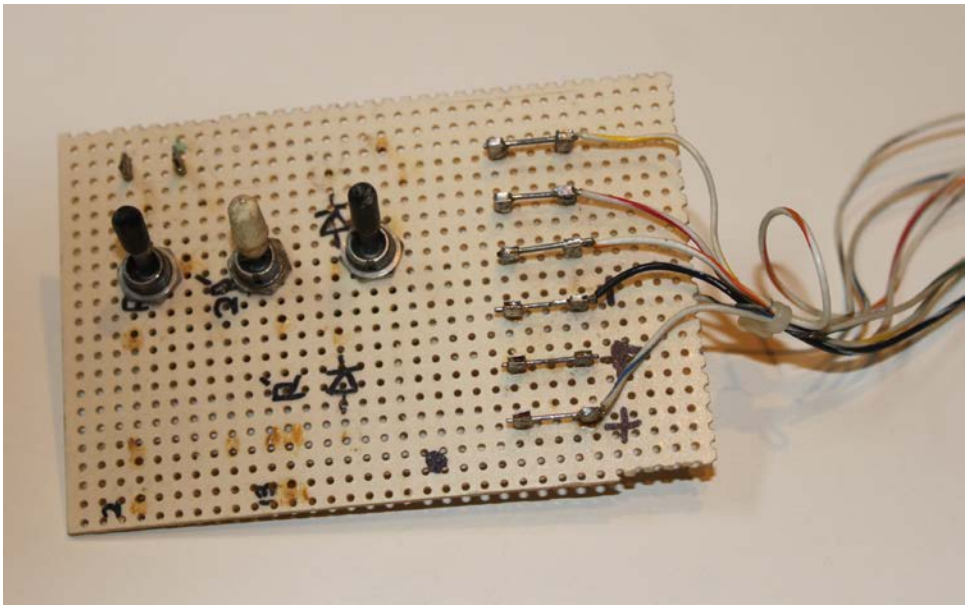
5. Test Power Supply. Current generation chips may be powered by 5.0 volts, 3.3 volts, 2.2 volts, or other voltages. There are integrated circuit regulator devices for each of these voltages which can be combined with a single wall-plug power supply to provide each of these voltages. Output clip leads are provided for each voltage and ground. Negative supplies can be built as well.

6. Pulse or Edge Detection. It is often useful to detect and indicate that a high or low going edge was seen on a signal line. In other cases it is useful to know that a full pulse (high or low going) was seen on a signal line. Alternately, it is useful to know if a signal or two took place at the same clocked moment. All of these signals can be captured with flip-flops in various configurations. Logic Analyzers serve this function at the high end, but there are other less elegant alternatives:



Pulse Detector using Flip-Flops, LEDs, and Clip Leads

Here is an oldie which provides a place for series current limit resistors. As is evident, it is not necessary for test or indicator tools to be pretty:



Firmware Development of test codes can be based on the basic source files developed or collected by Andrew for his initial test work. All of the basic kinds of code are available in this directory (or lots of places on the WEB), and support for other programmable chips could be developed.