All Purpose Tester Documentation

Operation and theory:
This device has a rather interesting program structure – it has a different configuration for all of the types of test equipment that it implements. This use of dynamic configuration is very effective because it allows there to be very little external hardware and it allows much of the things that would normally be handled in software to be handled by hardware (such as counters), thus simplifying the programming process.

When the device is powered up, the text, “All Purpose Tester” appears on the screen. Then there is a short routine that waits until the # key on the keypad is pressed. When this key is pressed, the text, “Enter the number” appears on the screen. Then the user enters the number of his/her choice, which corresponds to a certain test device. There is text to the right of the keypad on the project case that lists the numbers and what test device they correspond to (see picture below). This type of user interface was chosen for this part of the system, because it would allow the user to get to the part that they wanted quickly as opposed to slowly scrolling through a list.

After this, the user plugs the test cables into the appropriate jack. And connects the thing to be measured or tested. For the voltmeter, cables are plugged into the A and GND jacks. For the ampmeter, cables are plugged into the B and GND jacks. For the capacitance meter, continuity test, frequency counter, ohmmeter, and logic probe, cables are plugged into the C and GND jacks. For the function generator, cables are plugged into the F and GND jacks. The internal temperature meter does not require any cables plugged in since it uses the internal FlashTemp user module.
If the user selects the amp meter as their choice (#1), the base configuration is unloaded and the configuration for the amp meter is loaded. Then a new screen pops up that shows the value of the input current in amps with 3 digits to the right of the decimal place and one to the left, which is updated approximately 7 times per second. This update rate was chosen because it provides the 12-bit incremental ADC with optimum rejection to noise from 50 and 60 HZ power lines. When the user presses the * button, the device will go back to the menu screen and the configuration for the amp meter will be unloaded and the base configuration will be reloaded.

If the user selects the continuity tester as their choice (#3), then the base configuration is unloaded and the configuration for the continuity tester is loaded. Then the text, “Continuity Tester” is displayed on the LCD display. If the probes are connected by a resistance less than approximately 11000 ohms, then a tone will be sounded from a piezo speaker. This is accomplished by connecting the enable input of one 8-bit pulse width modulation (PWM) module to one of the probes, connecting +5v to the other probe, and by connecting the output of the PWM module to the piezo speaker. When the * button is pressed by the user, this configuration is unloaded and the base configuration is reloaded.

If the DC voltmeter is selected by the user (#4), then the base configuration is unloaded and the configuration for the DC voltmeter is loaded. Then the relay that turns on or off the bottom part of the resistor voltage divider is turned on. The input voltage is then displayed on the LCD display with 2 places to the left of the decimal point and 3 to the
right, and for the same reason as explained in the Amp Meter section, the update rate is approximately 7 times per second. After the input voltage is divided by 8 through the voltage divider, it is buffered with an internal programmable gain amplifier (PGA) so it can be passed to the 12 bit incremental analog to digital converter. Then the value of the ADC is multiplied by 1250, then that number is added to 512, and finally, it is divided by 1024 then multiplied by 8 (it is multiplied by 8 to get the true value of the voltage since it was divided by 8 through the voltage divider) this is accomplished by shifting it right 7 times. These numbers were chosen because 1250/1024 is equal to 2500/2048, where 2500 is the maximum input voltage in millivolts (relative to AGND, in which in this case is VCC/2) and 2048 is the unsigned range of the ADC. The number 512 is half of the denominator, which is equal to .5, so adding it to the result of the multiplication in the numerator makes the result be rounded instead of truncated to the nearest millivolt. Next, my “BinaryToBCD” routine, which is shown at the bottom of this paper, converts this value to BCD so it can be displayed on the LCD display. Finally, when the user presses the * button, the DC voltmeter configuration is unloaded and the base configuration is reloaded.

If the user selects the frequency counter (#5), then the base configuration is unloaded and the frequency counter configuration is loaded. Then the value of the digital input frequency is displayed on-screen. To measure the frequency, a counter counts how many input pulses there are in a set period of time. Finally, when the user presses the * button, the frequency counter configuration is unloaded and the base configuration is reloaded.

If the user selects the internal temperature (#6), then the base configuration is unloaded and the internal temperature configuration is loaded. Next, the current temperature is displayed in Celsius and updated approximately 13 times per second. The temperature measurement is not really accurate, but I find that it often is ± 5, rather than the ± 20 as stated in the data sheet for that user module. In the software, after the value is received it is converted to BCD and displayed on the LCD display. When the user presses the * button, the temperature measurement configuration is unloaded and the base configuration is reloaded.

When the user presses the 7 button, the configuration for the logic probe is loaded and the base configuration is unloaded. Then whether the input is high, low, or pulsed is displayed on the LCD display. When the user presses the * button, the frequency counter configuration is unloaded and the base configuration is reloaded.