Reclaiming Surplus Test Equipment

by Dennis L Feucht

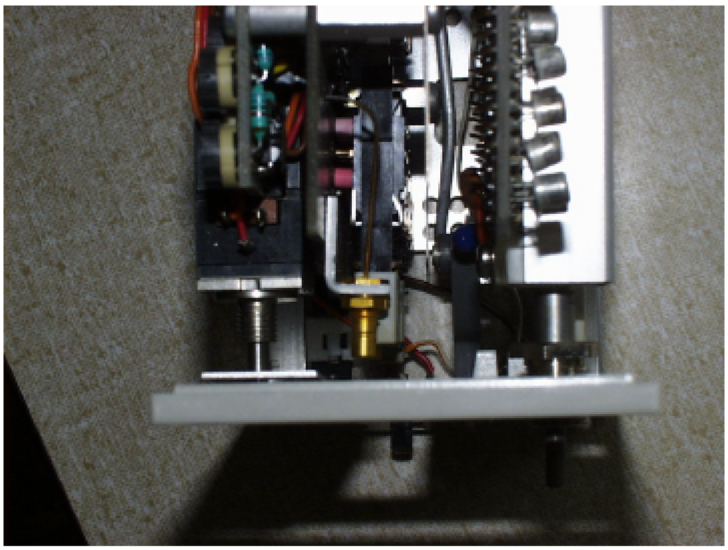
Laboratory-quality personal electronics is affordable as aging but quite functional test instruments. They are increasingly available through surplus electronics dealers and Web auctions. E-bay http://www.e-bay.com has extensive trading in used electronics laboratory equipment. The reduction of trade barriers brought about by Web auctions has allowed many sources to divest their surplus equipment inexpensively. The result is a buyer's market.

These older instruments have some advantages not found in newer equipment that make them worth salvaging. First, because they are free of custom-programmed parts, they are completely (a) knowable, and (b) repairable. Their service manuals divulge all essential technical details. Before about 1980, it was assumed that the customer would want to have technical knowledge of a purchased instrument for maintenance and repair. It was also a time when field repair of electronics was eased by the inclusion of IC sockets. These instruments are of a low enough complexity that complete understanding of the entire instrument takes only a modest amount of effort.

One such unit is the DC505A counter/timer of the Tektronix TM500 line of plug-in instruments that were first introduced to the market around 1970. This article uses the DC505A as an example of the kinds of problems that are typically encountered in refurbishing older test equipment. They are usually surmountable and the effort can be more than rewarded by the functionality achieved at surplus prices.

The Tek DC505A Counter/Timer

The DC505A has two channels, can count up to 225 MHz and measure frequency, period, pulse width, frequency ratio, and time between the transitions of two signals. It can also count events during a gate pulse. A DC505A in good working order can be found for less than $200 in Web auctions, or on the surplus equipment market. A TM500 mainframe (such as a one-slot TM501) completes the instrument.



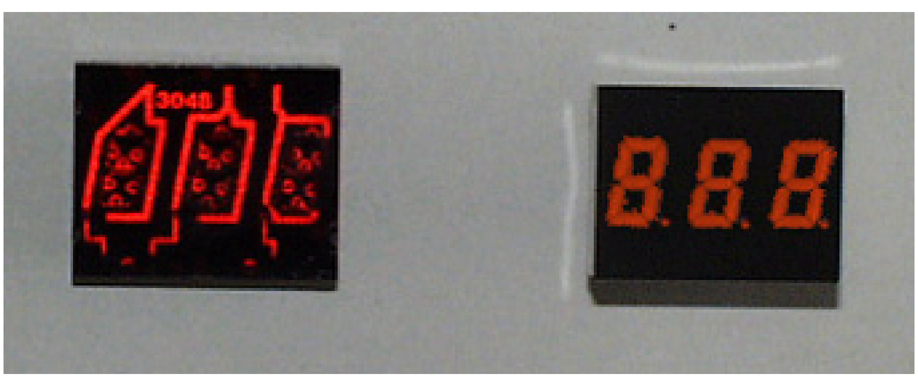
As a one-slot TM500 instrument, the front-panel is crowded with knobs, push-buttons, and BNC connectors. These instruments were designed at a time when integrated circuits (ICs) were at the medium-scale integration (MSI) level. Digital circuits were of TTL logic. Instead of using EPROMs (no less a microcontroller) for front-panel display logic, a matrix of discrete transistors was used instead, as seen protruding from the rightmost board in the following top-front view of a partially-disassembled DC505A.

The rapid rate of integration with ICs encouraged TM500 system architects to opt for smaller instruments, with an inter-instrument level of integration as a shared power supply in the mainframe. Tektronix had success with its novel oscilloscope plug-in concept which increased measurement versatility by allowing multiple subsystems to be used in the oscilloscope mainframe. TM500 extended the plug-in concept to instruments. This resulted in a single power cord, and Tek ads featured the advantage of an uncluttered bench. But alas, the standalone, plug-per-instrument products of HP and others prevailed in the end. Human fingers were not miniaturizing along with instrument front-panels. Low-cost, high-density switching converters also largely negated the shared supply advantage.

Improvising Replacement Parts

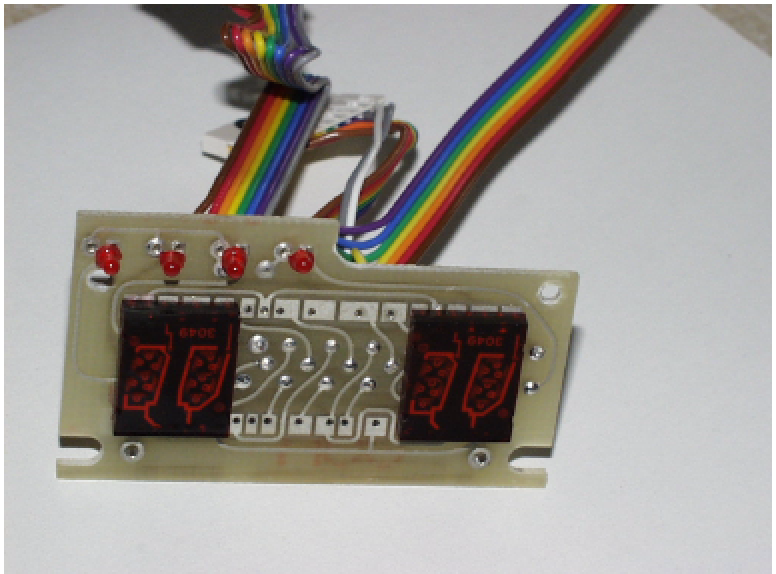
One of the problems in owning older equipment is finding replacement parts. In particular, the 7-digit LED display of the DC505A consists of two 2-digit, 7-segment displays and a 3-digit display. These LED modules were originally manufactured by Litronix, a spin-off of the early LED manufacturer, Monsanto. Litronix was acquired by Siemens, which spun off its optoelectronics as Infineon. A search of the Infineon website produced no trace of the failed DL-883A display failed. The failure, with no replacement part found, was turned into an opportunity to improve the original equipment.

The DC505A to be refurbished had lost segments in the middle, 3-digit module. It is shown below (left) along with the three-digit display chosen to replace it (right).

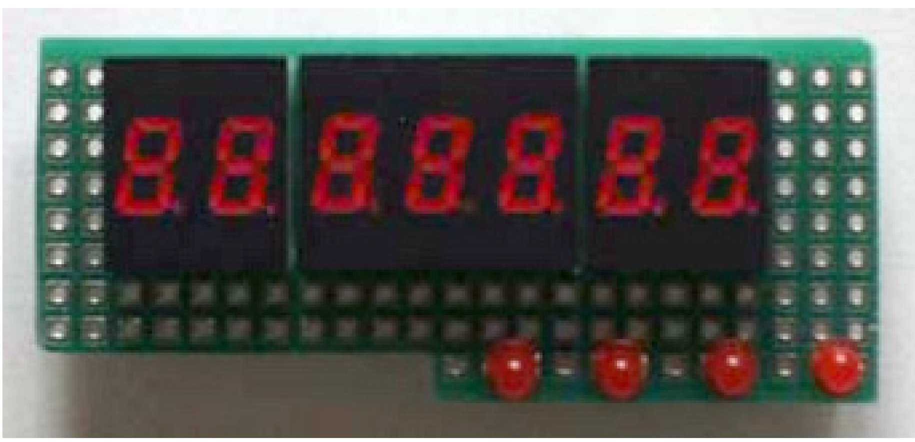


Early LED displays were single LEDs mounted in a 7-segment pattern, with three or four LEDs forming each segment. No light diffusion was used, and the result was high-intensity points of red light glaring back at the viewer. Newer LED displays usually have light diffusers. In the search for a suitable replacement, surprisingly few miniature multi-character displays were found to be available. Only one manufacturer produces a line of displays that would fit in the cramped space of the DC505A: Rohm, a leading Japanese display manufacturer.

The display board with the faulty module removed is shown below. The original intent was to replace it with the newer one, which had the small dimensions required to fit the vacated space of the old module.

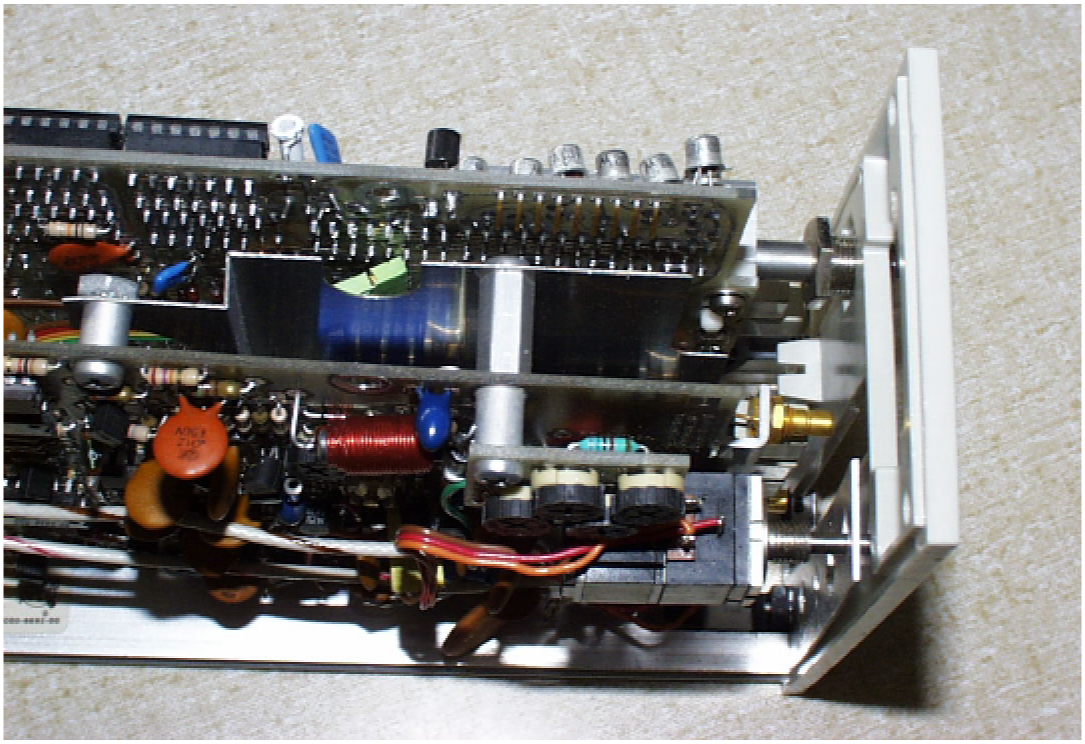


But the inability to retrofit the new module, with its different pinout, led to abandonment of the entire display board in favor of a customized retrofit, shown below, using all-new LED modules.



Repair or Redesign?

Disassembly of the DC505A front-panel to access the display board is entirely nontrivial. The following photograph, showing the inside of the front-panel from a different view than the previous instrument photo, suggests why. The instrument has to be almost entirely disassembled to access the display board.



After this tedious exercise was completed, the motivation to repackage (rather than reassemble) the DC505A was immense, and of this writing, the unit has not been reassembled in its original form, nor is it likely to be. Although this is an extreme example, be prepared to encounter such a dilemma *before* you tear too deeply into an instrument. Have a contingency plan in case the unit cannot be repaired (or refurbished) according to the original design!

Simplifying Design

Another opportunity when refurbishing older equipment is to take advantage of microcontroller (?C) technology. What often fails on this era of instruments are front-panel electromechanics. Front-panel controls directly actuate switches or pots located where signals are routed or processed. The mechanical and wiring constraints of having to couple this circuitry to the front-panel for user access was an inconvenient aspect of instrument design, used substantial space, and limited instrument layout and configurability.

During the 1970s, the concept of *cold-switching*, of separating signal paths in circuits from the user interface was known, but complete microcomputers in a single IC were not yet available. The high-frequency and low-amplitude waveform processing typically found in instruments make it especially beneficial. "Hot" waveforms are switched using relays, solid-state analog switch ICs, IC potentiometers, or transistors. Front-panel controls reduce to a display with membrane push-button switches and a possible digital rotary encoder, all interfaced to the microcontroller. By placing the front-panel components on a single board with a microcontroller, the entire user interface reduces to a separable module with a low-count multi-conductor cable connecting it to the instrument.

At a more ambitious level of retrofitting, instruments such as the DC505A can be made to cold-switch. This simplifies some instruments substantially. The DC505A rotary cam switches, invented by Tektronix co-founder Howard Vollum, consist of a row of in-line SPST board-mount cantilever switches, each actuated by a protruding strip of plastic, or *cam* on a drum. The drum was machined with the multiple cam tracks distributed along its length, one track per switch. When the drum was turned through its detented switch positions, where cams appeared at the required track positions, they would depress the board-mount switches. Cam switches, as they are called, take up so much board space that cold-switch retrofitting is not usually space-limited, especially if surface-mount ICs are used on floater boards. Numerous components in the DC505A are used to do what a few lines of software in a microcontroller could replace. The core circuitry -- especially the analog -- could be retained, with an all-new, expanded front-panel in a larger enclosure.

Several of the Tek TM500 instruments could be repackaged with cold-switching and a substantially reduced parts count. (Someone might even start a modest business upgrading surplus instruments.) By using a desktop computer as the user interface, a major strand of instrument development has eliminated that redundancy, and plug-in board instruments have emerged. Retrofits can follow this approach somewhat by scavenging the desirable (usually analog) circuitry from surplus instruments for building computer-based instruments.

Closure

Many older instruments can be refurbished or become the foundation for partial redesign projects. Using newer parts and some microcontroller programming to replace vast amounts of discrete implementation, a hybrid design can emerge that retains the analog measurement core while simplifying the user interface. Repackaging is not always necessary, especially when the front-panel has the room to accommodate changes. The result may not have the attractive appearance of the original (when new) but the combination of low price and "command of ownership" can make it worthwhile. Such an instrument is bound to remain on your bench for some time to come. If it breaks, repair will likely be quick and easy since you previously invested in its future through the effort expended in redesign.

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