K4HJU

Amateur Radio
Woodcreek, Texas

JRS Frequency Counter 1972 Restoration/ Rejuvenation

Rev 1.00
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K4HJU
1/29/2018

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1. Introduction

In 1972 I began the design of a battery operated frequency counter as a lunch hour project at Bell Labs. At the time we were doing field work developing a test set for "outside - in" fault location in buried telephone cables. This required measurements in the field and we didn't have a suitable battery operated frequency counter. I made a deal with my supervisor that I would design such a counter on my lunch hour and I would get to keep my prototype and one of the production models. I enjoyed the design and development. Fortunately or unfortunately, just as we were finishing the project HP released their 5380 series battery operated frequency counters. At that time we (Jerome Parker and I) had completed the design and built a few models. Since then this frequency counter has been my "go-to" frequency counter in the lab. I have five other more modern frequency counters in lab and this counter is still my "go-to" counter for most things.

Recently, it failed and I went in to it to repair it. I found that a transistor in the front end had failed and I replaced it; however in the process I had inadvertently broken something else. Although, I had near current schematics that fault was very difficult to locate. Jerry (Jerome) the mechanical engineer had decided to use "cordwood" construction for the modules similar to that used in the Sprint/Spartan missile guidance sets we had been working on previously. With integrated circuits, cordwood construction is a nightmare from a construction and maintenance point of view. With that and the fact, although I had schematics that reflected my breadboard and the essence of the final design, I did not have the wiring layout.

First, let's look at what I did have. I had my breadboard prototype counter and one "production" counter. The breadboard counter was built using wire-wrap construction and was rather bulky and the wiring a bit "hairy".

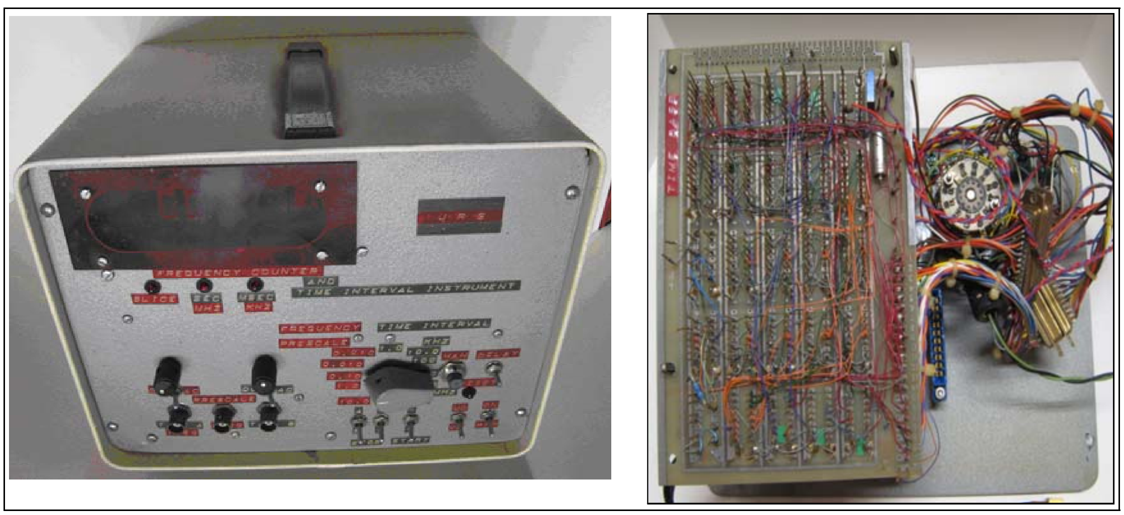

Figure 1-1 Breadboard Frequency Counter

It is interesting to compare the breadboard with the "production" model shown below.

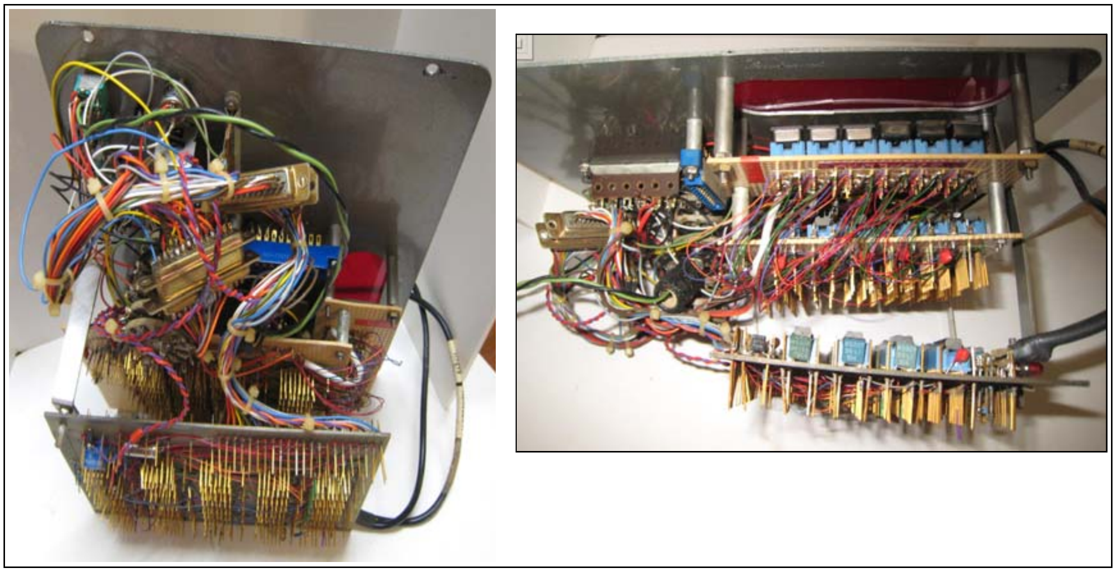

Figure 1-2 More Interior Detail

One interesting aspect of digging this out is that the original batteries were in the unit. There were eight D cell Ni Cads, The contacts on the original battery holders were not working well so I found some more modern battery holders.

Figure 1-3 D Cell Ni Cad Batteries

The really interesting thing is that when I attempted to charge the batteries, they took the charge and held it. I consider this phenomenal for 46 year old Ni Cads. They have a date stamp of 52nd week of 1971.

The "production" counter is a bit more compact, although the wiring, to me, is a real mess.

Figure 1-4 "Production Counter"

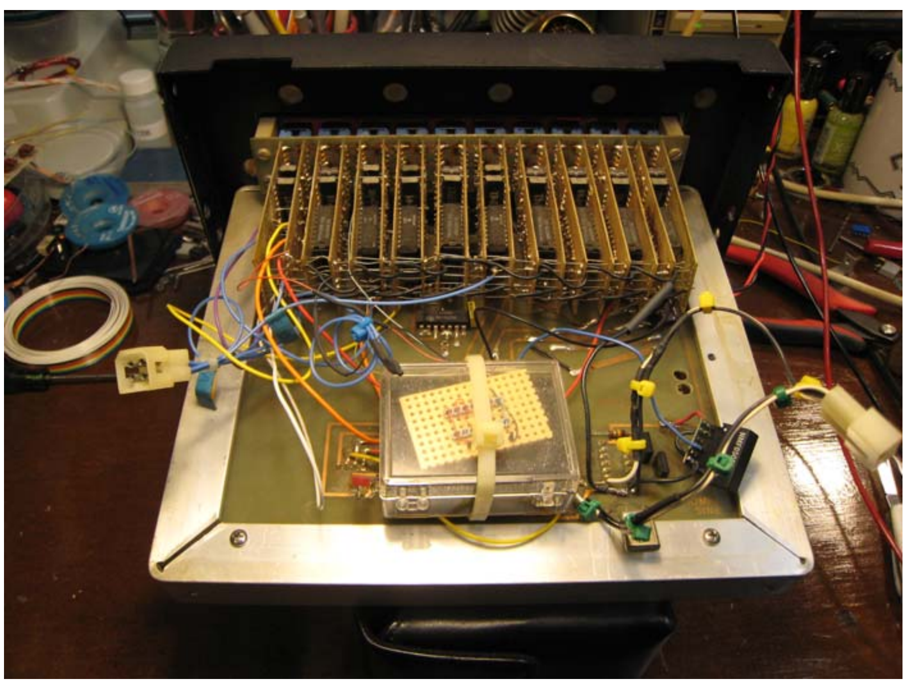

Figure 1-5 Top side of Counter

Figure 1-5 shows the top side of the counter with the display modules. In addition there is the plastic box containing a previous "fix" to one of the display modules.

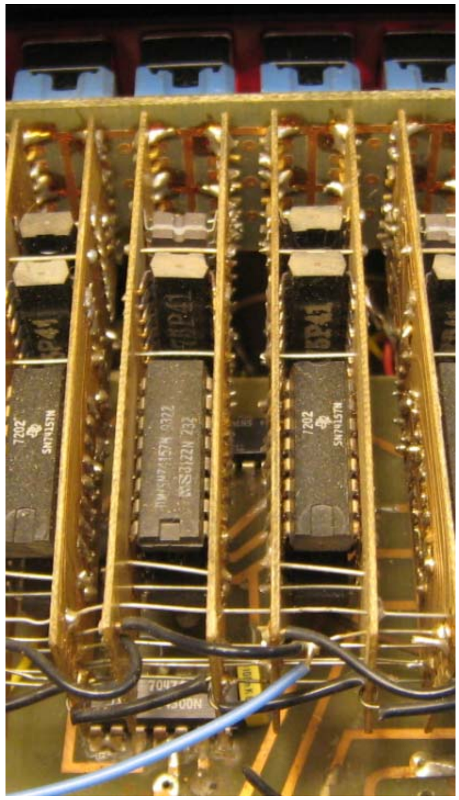

Figure 1-6 Display module cordwood construction

Figure 1-6 shows the cordwood construction of the display modules. Maintenance of this construction nearly impossible. In this construction the IC pins are bent outward from the chip and the leads are aligned and fed through PCBs on both sides. This is a very, very tedious alignment problem. In addition, there is no way to replace an IC if it fails or there is an error. How Jerry actually constructed these modules remains a mystery to me. To date only one chip in one module has failed and I was able to jumper around that with an external circuit.

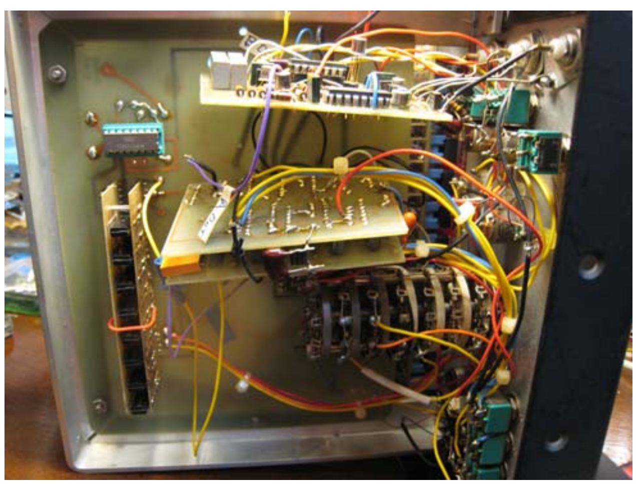

Figure 1-7 Bottom view of counter

Figure 1-7 shows the bottom view of the counter. With no wiring diagram for the modules or the chassis, maintenance is very difficult, particularly with the modules in place.

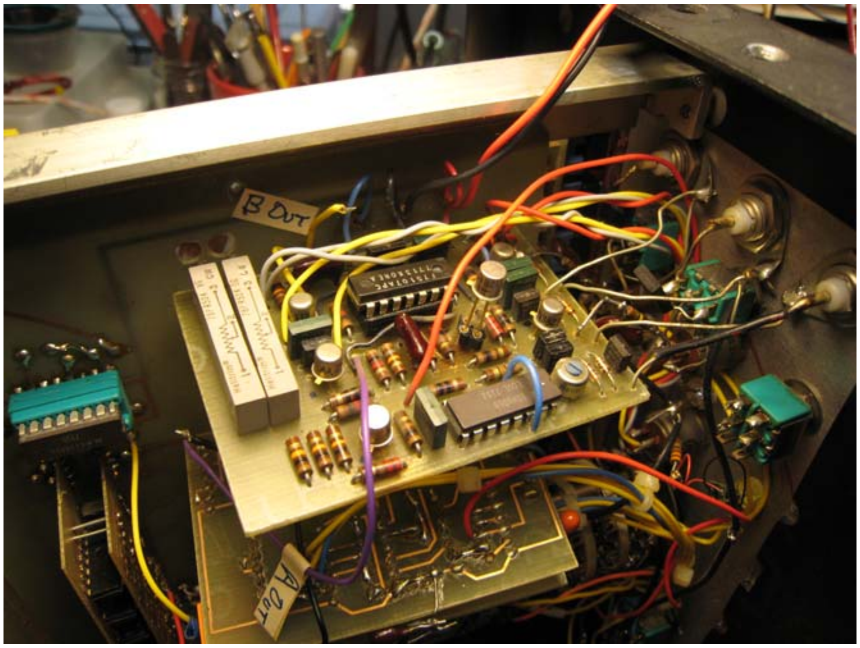

Figure 1-8 Example of wiring

As I was recovering from a serious illness and had some time on my hands, I decided to rebuild the counter and clean up the wiring.

2. Design

The original design is done with 7400 series TTL logic chips, therefore very power hungry. Therefore, it has not been batter operated in many years.

3. Rebuild

I decided to rebuild the counter using the old cordwood modules. I added sockets to the modules on the main chassis. To determine the wiring required reverse engineering the counter. I created schematics of the modules and the wiring. I then took it apart and began the rebuild, connectorizing every separate assembly. I removed the crystal oscillator circuit and replaced it with a high stability oven controlled crystal oscillator.

The original design used a high speed decade counter for the first stage employing 74S00 series logic. I replaced this with a decade counter employing 74HCxx series logic..

Insulation displacement wiring was used to interconnect the circuits on the mother board.

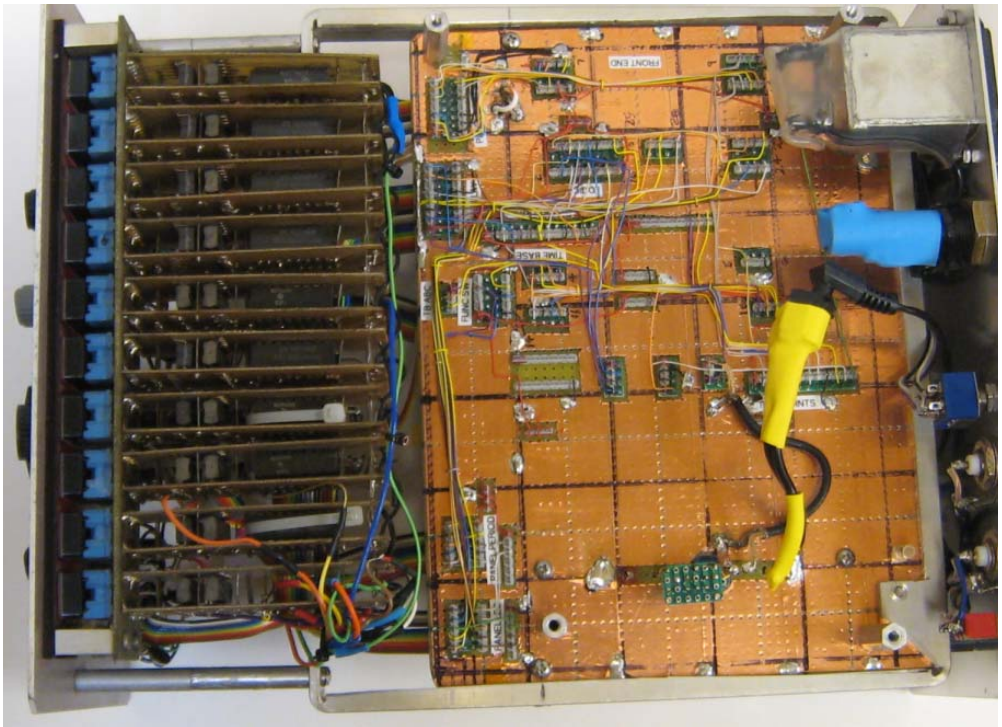

Figure 3-1 Top view of Rejuvenated Counter

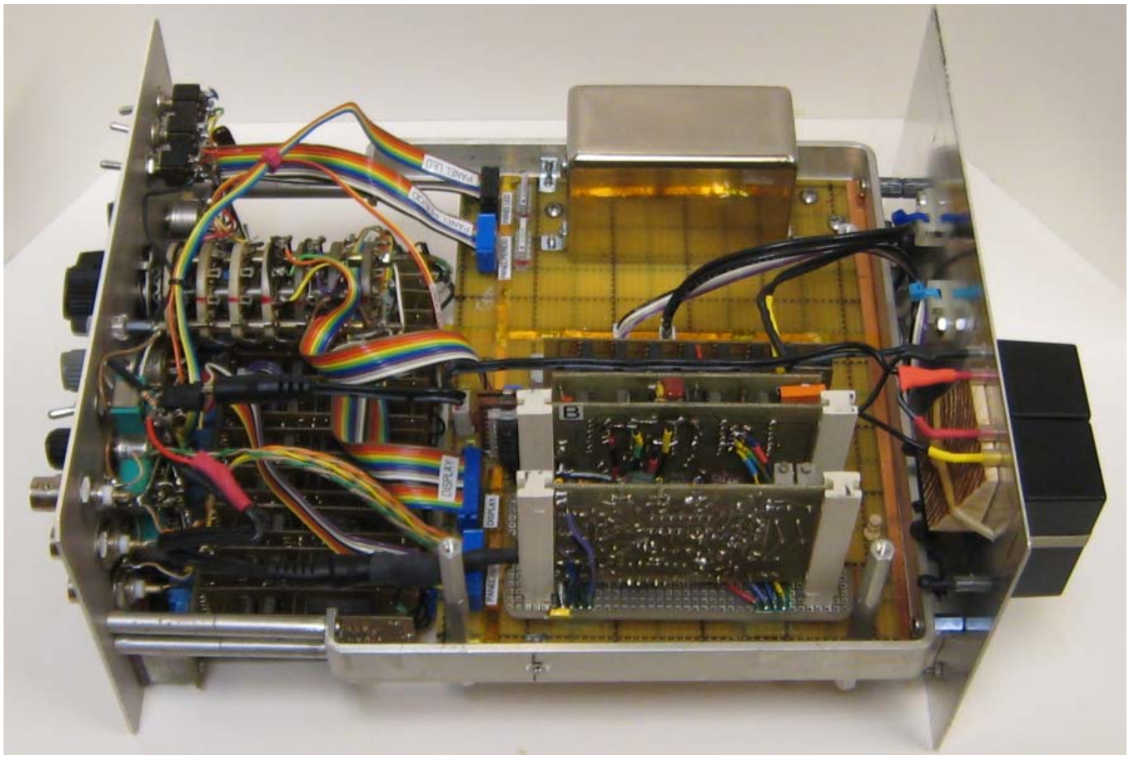

Figure 3-2 Bottom view of Rejuvenated Counter

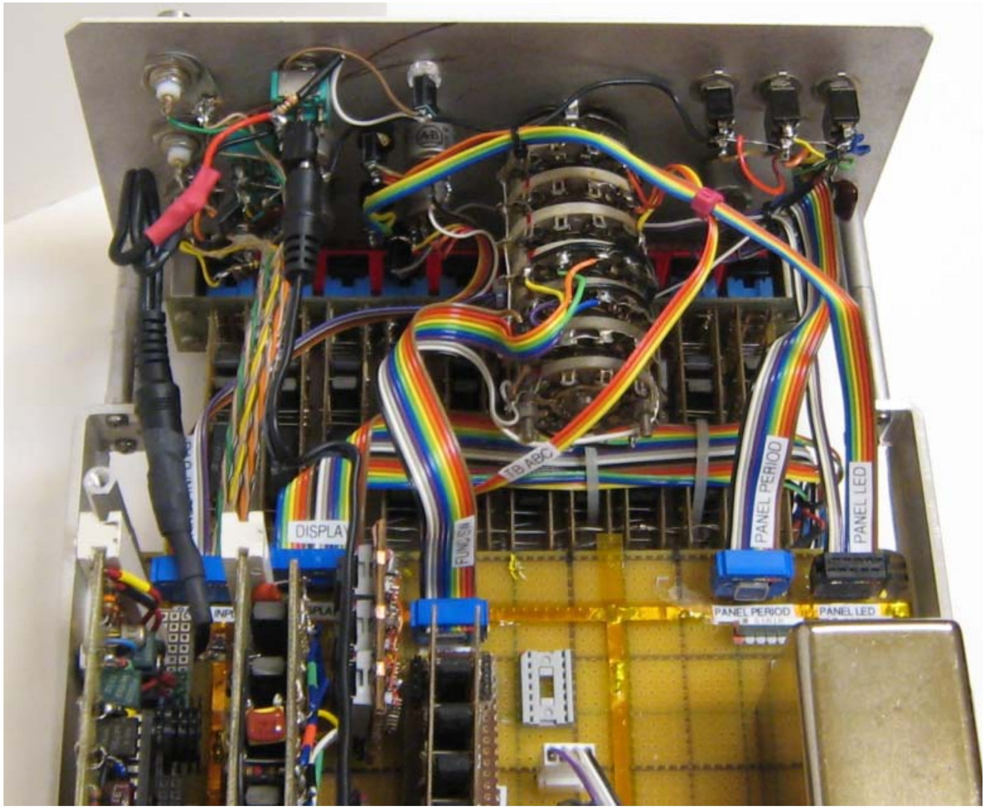

Figure 3-3 Front Panel wiring

Figure 3-4 The Rejuvenated Counter in It's New Case

4. References

- J. R. Satterwhite, "A Battery-Operated Digital Frequency Counter and Time Interval Instrument", October 18, 1972, Bell Laboratories Memorandum for File

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