WWVB-Based Video Marker

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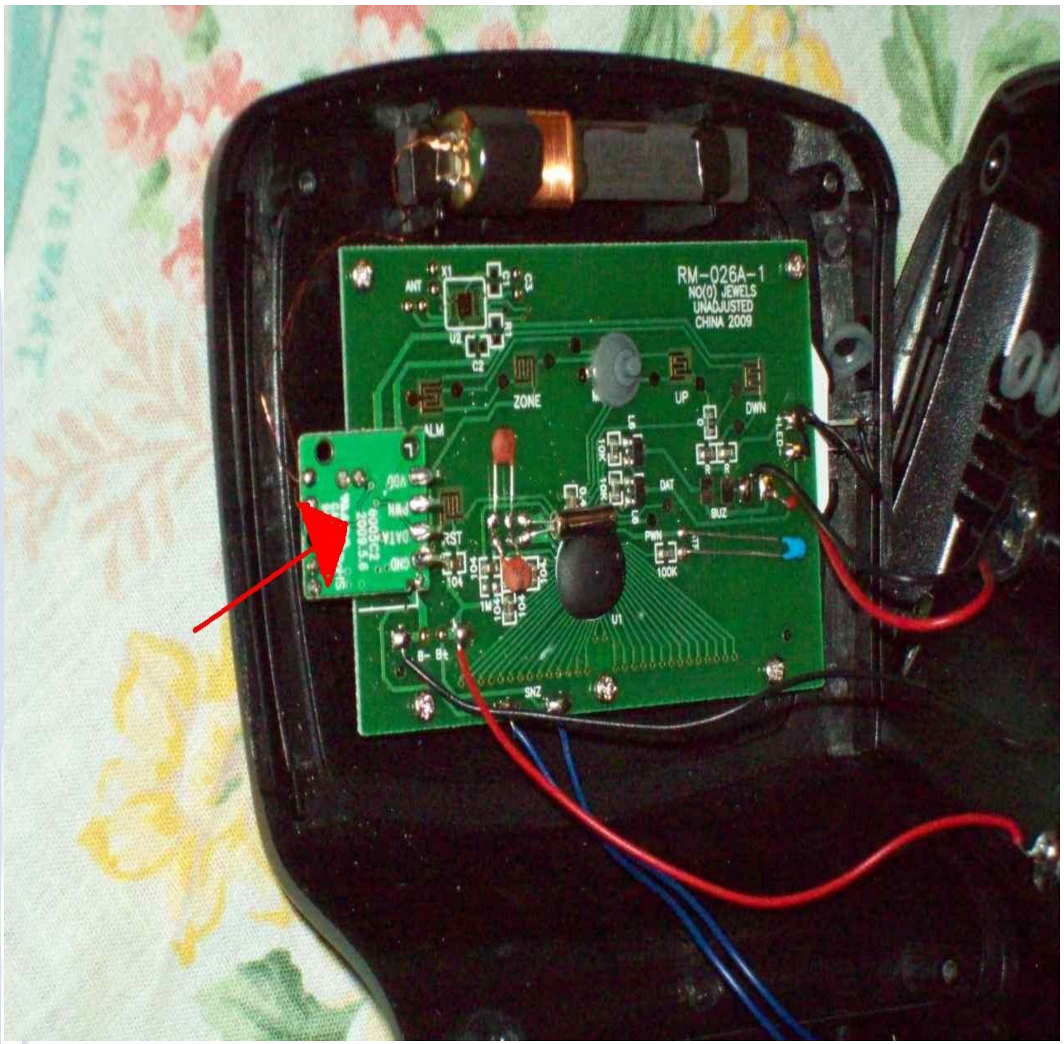
What a WWVB System Needs

- A receiver for WWVB, specifically one that outputs the demodulated time code.
- An interface that generates strobe pulses at the seconds edges of the WWVB time code.
- A free-running 1 Hz, crystal controlled clock that can be synchronized to the (above) strobe pulses.
- A circuit that uses the 1 Hz clock's output pulses to add a marking pattern to the telescope camera's composite video.

The Westclox Model 70026 “Atomic Clock” contains a WWVB receiver

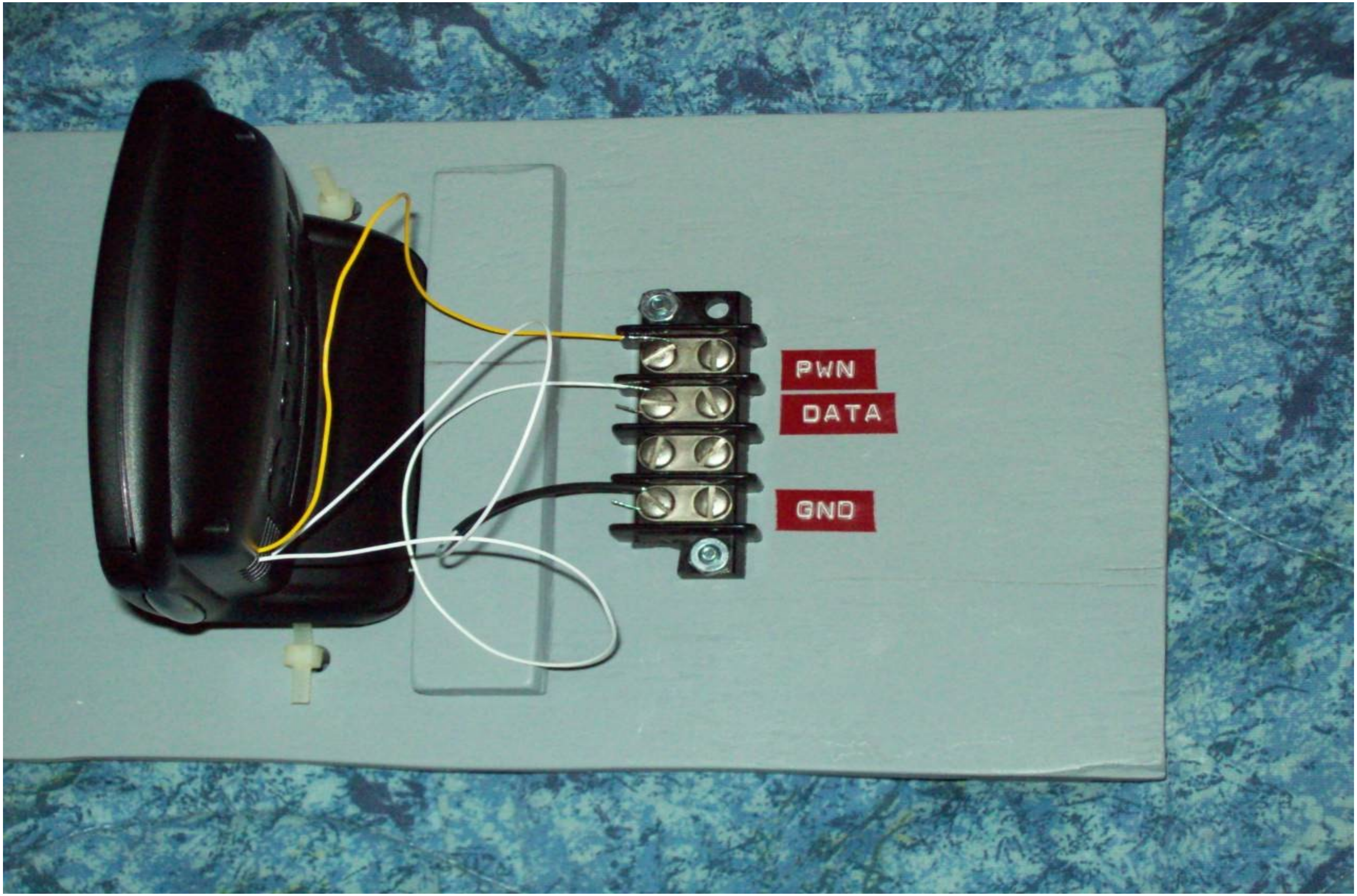
- Cost ~$12 (WalMart)!
- WAVE/DOWN button on the back activates the receiver.
- The demodulated WWVB timecode is available on a test point board inside.
- Other features include a digital time display, with seconds, and a WWVB signal quality indicator

Inside The Clock



- Red arrow marks the test point board, where the necessary signals are found:
- DATA is the demodulated WWVB timecode
- PWN indicates receiver ON/OFF status

Signals externalized

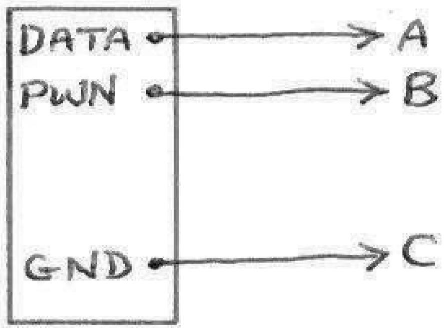


The next three slides show:

- The interface labeling at the receiver end
- The circuit that generates strobe pulses at the WWVB seconds edges, for synchronizing the free-running 1 Hz clock with WWVB
- A photo of the Westclox with the prototype strobe generating interface

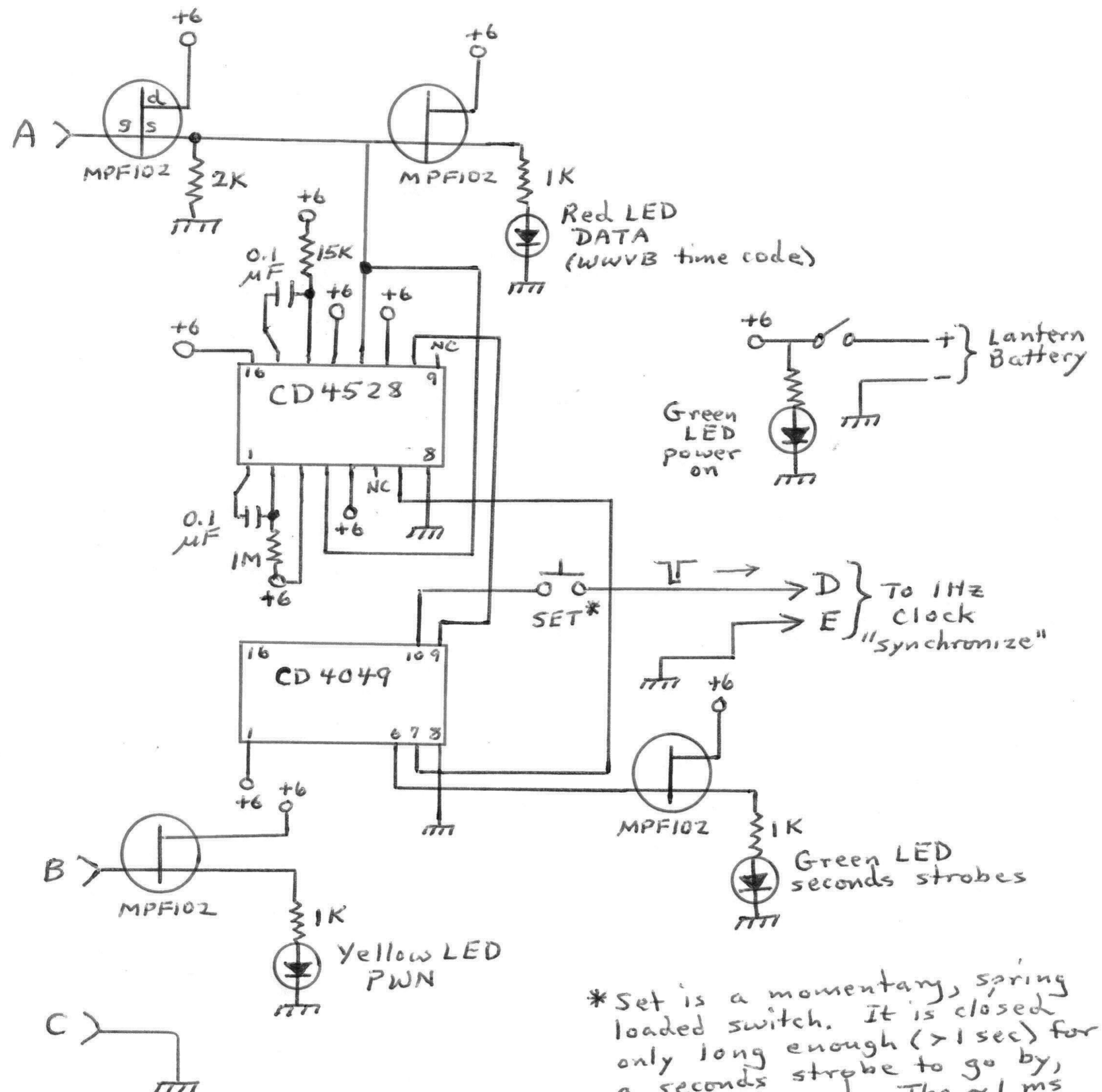
Inside the Westclox 70026

(the small test points board)



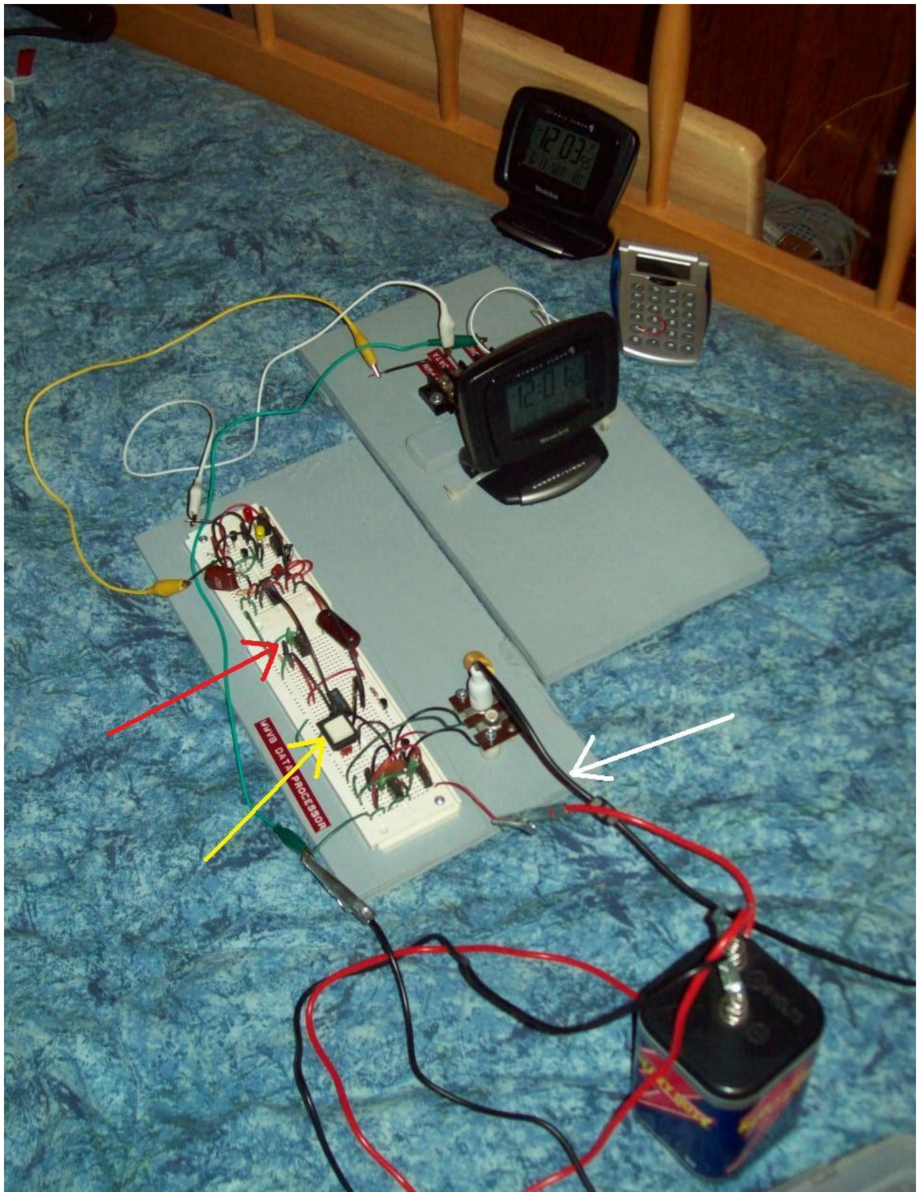
The clock's time display (LCD) is used for voice marking of hours, minutes and seconds when shortwave radio is not reliable.

Westclox 70026 Interface



* Set is a momentary, spring loaded switch. It is closed only long enough (>1 sec) for a seconds strobe to go by, then released. The ~1 ms negative going strobe synchronizes the 1 Hz clock with WWVB.

WWVB Interface on a Prototyping Board



*Red arrow: the green LED strobes seconds. Extra strobes (>1 Hz) indicates a poor signal.

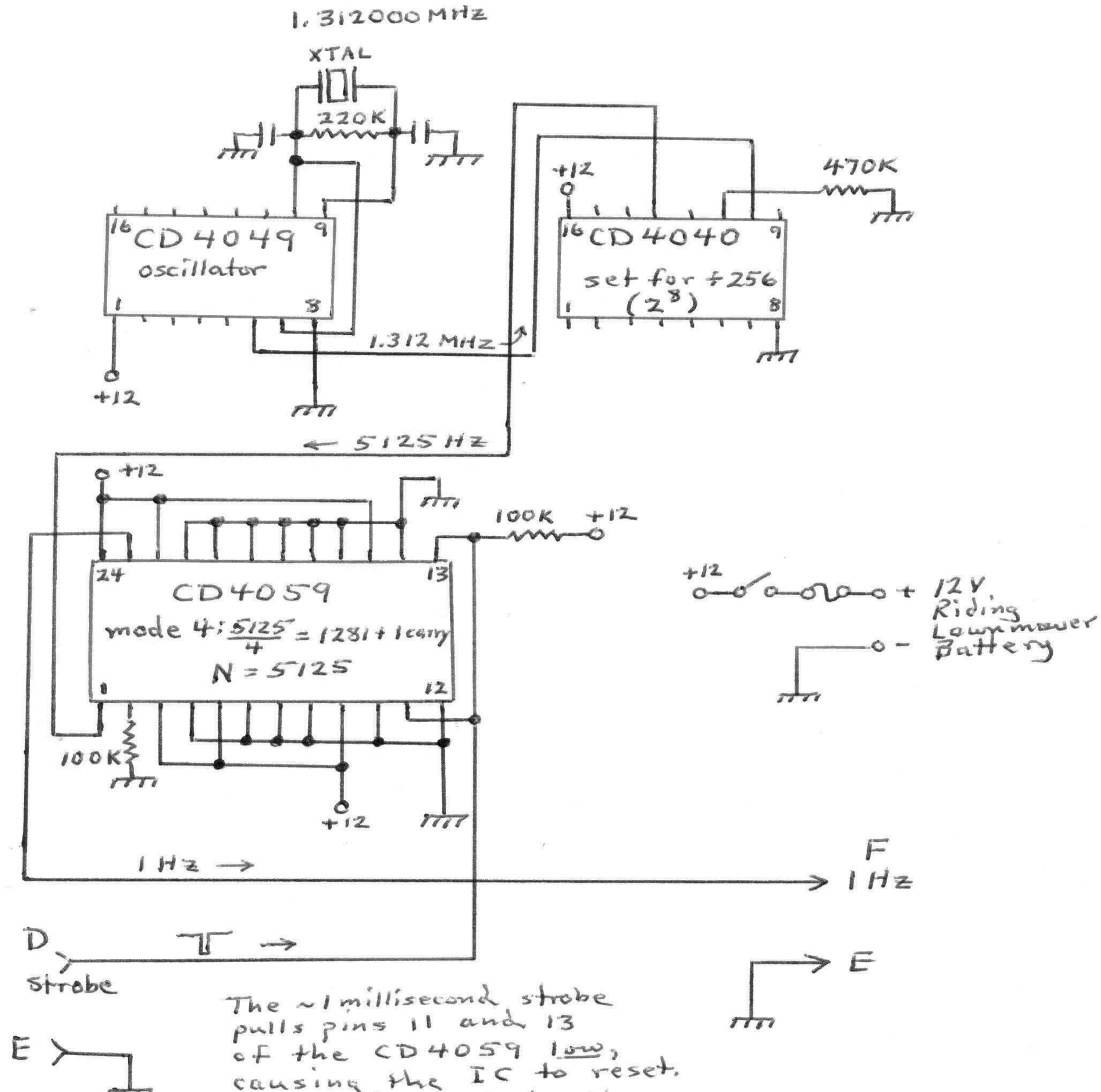
*Yellow arrow: spring loaded switch applies sync strobes to the 1 Hz clock.

*White arrow: the strobe cable to the 1 Hz clock

The next three slides show:

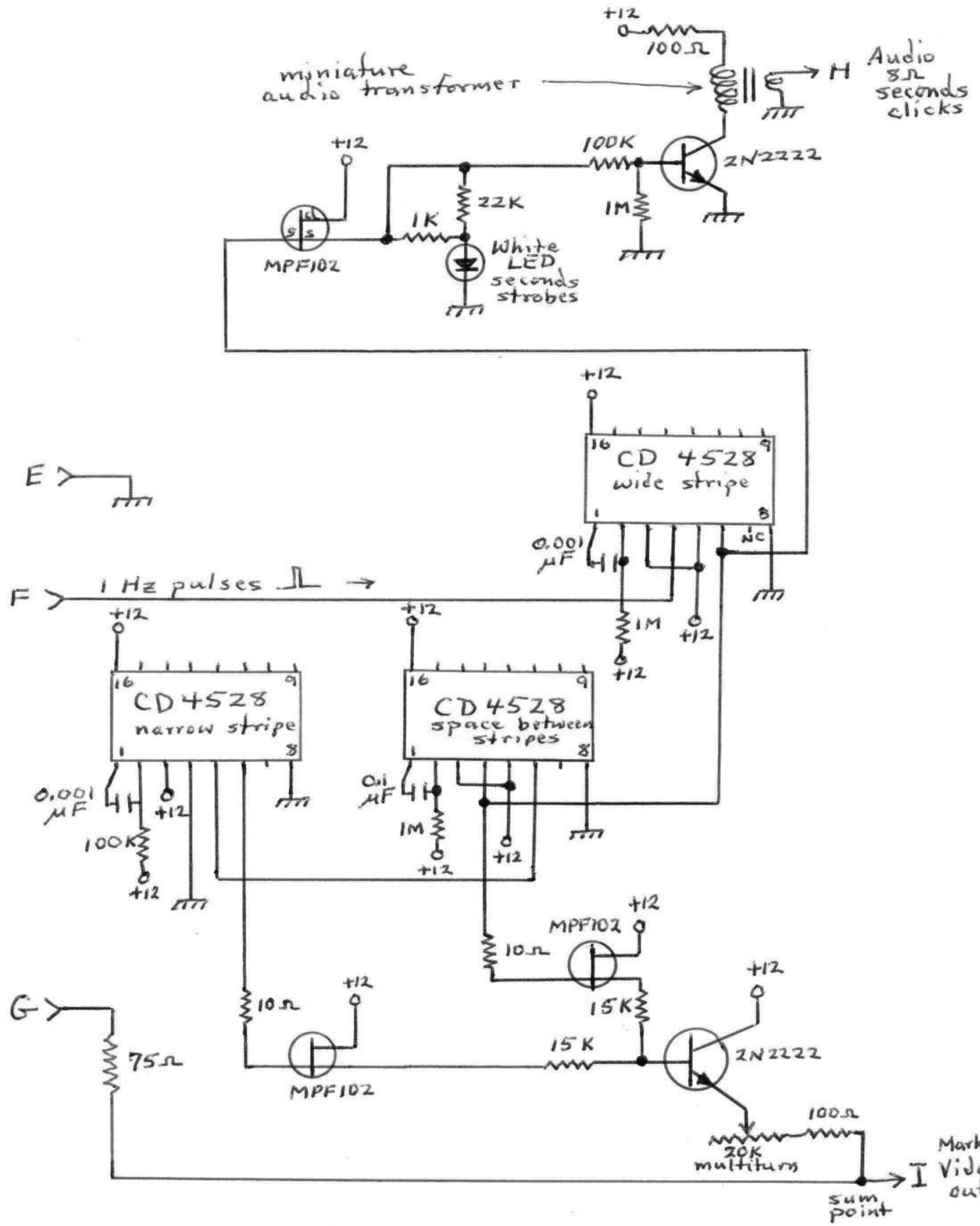
*The 1 Hz crystal controlled clock circuit
*The video/audio marking circuit (The device not only marks two stripes across a video interlace field but also sends seconds clicks to the DVD's audio input)
*A photo of the 1 Hz clock and video/audio marking circuits

1 Hz Clock Circuit

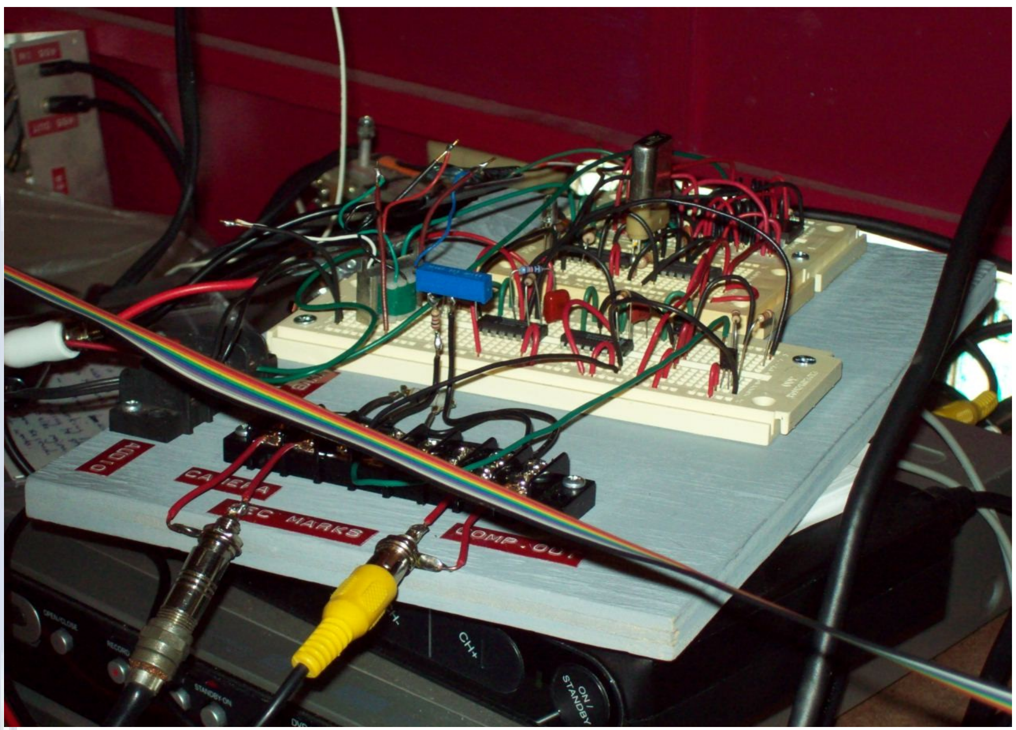


The ~1 millisecond strobe pulls pins 11 and 13 of the CD4059 low, causing the IC to reset. Having done that the narrow 1 Hz pulses at output F occur simultaneously with WWVB's seconds edges.

Video and Audio Marking Circuit



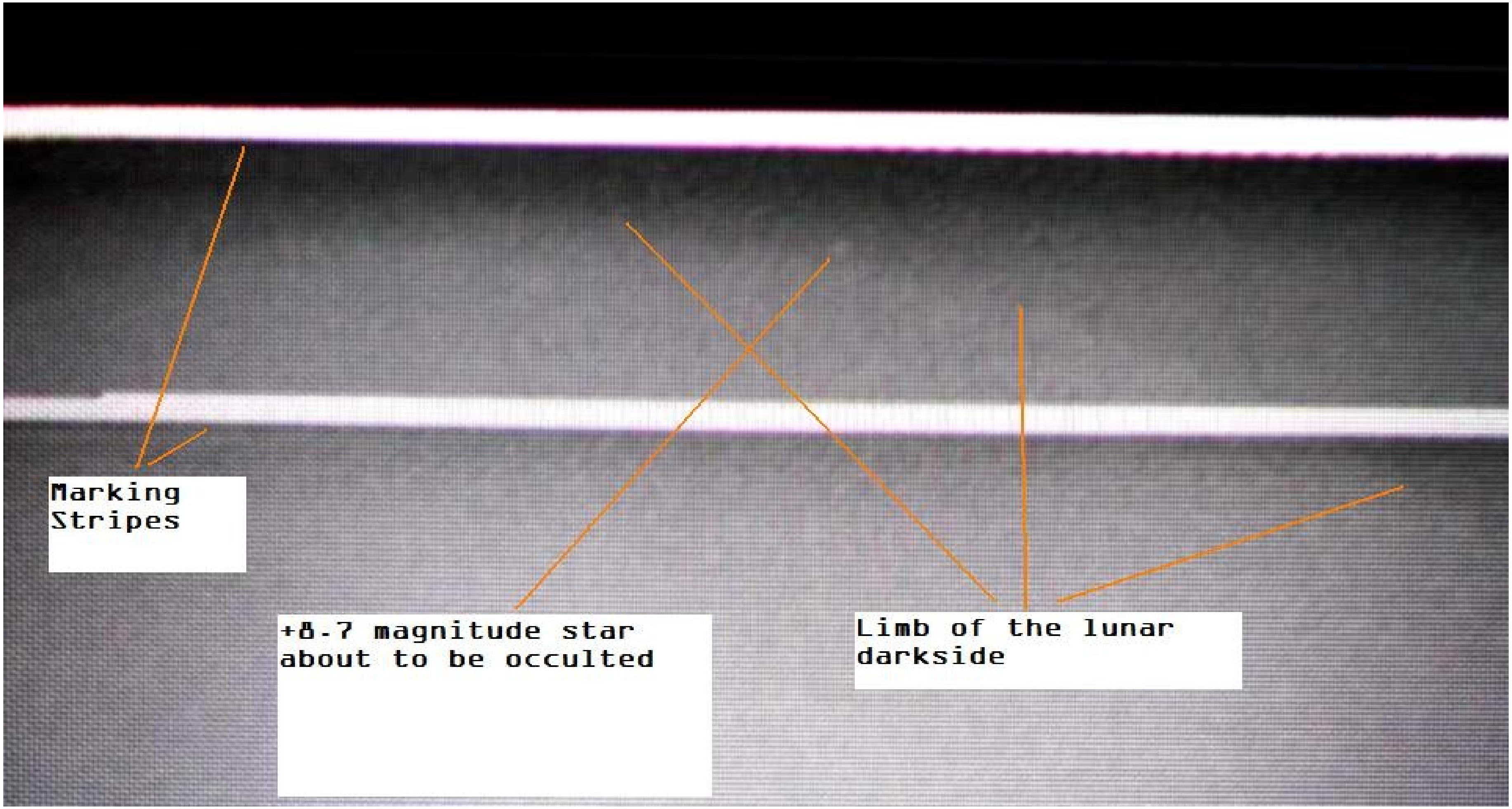
1 Hz clock and video/audio marker



- In the foreground, video in (left, silver) and marked video out (right, yellow)
- The crystal is not exact for 1 Hz, and a clock offset and drift correction factor has to be applied.
- I see ~$50 in proto-typing boards. Com-ponents are cheaper.

What a marked video field looks like:

The two horizontal stripes *almost* straddle the blanking period between scans. One field is thus always marked. The lower stripe is narrower. The stripes move upward.

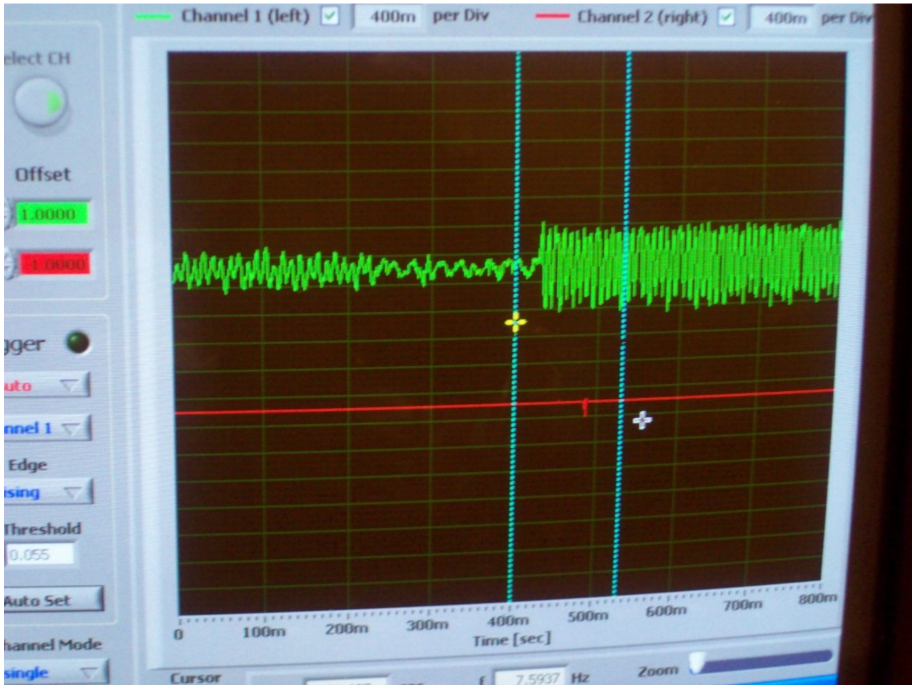


How To Use It

*Synchronize the 1 Hz clock to an exact minute, i.e., watch the Westclox display, hold the sync switch down for a second or two coming up on the even minute, then when the strobe for the exact minute goes by (judged by the green LED), release the switch. Record that time in hours and minutes. The display is accurate.

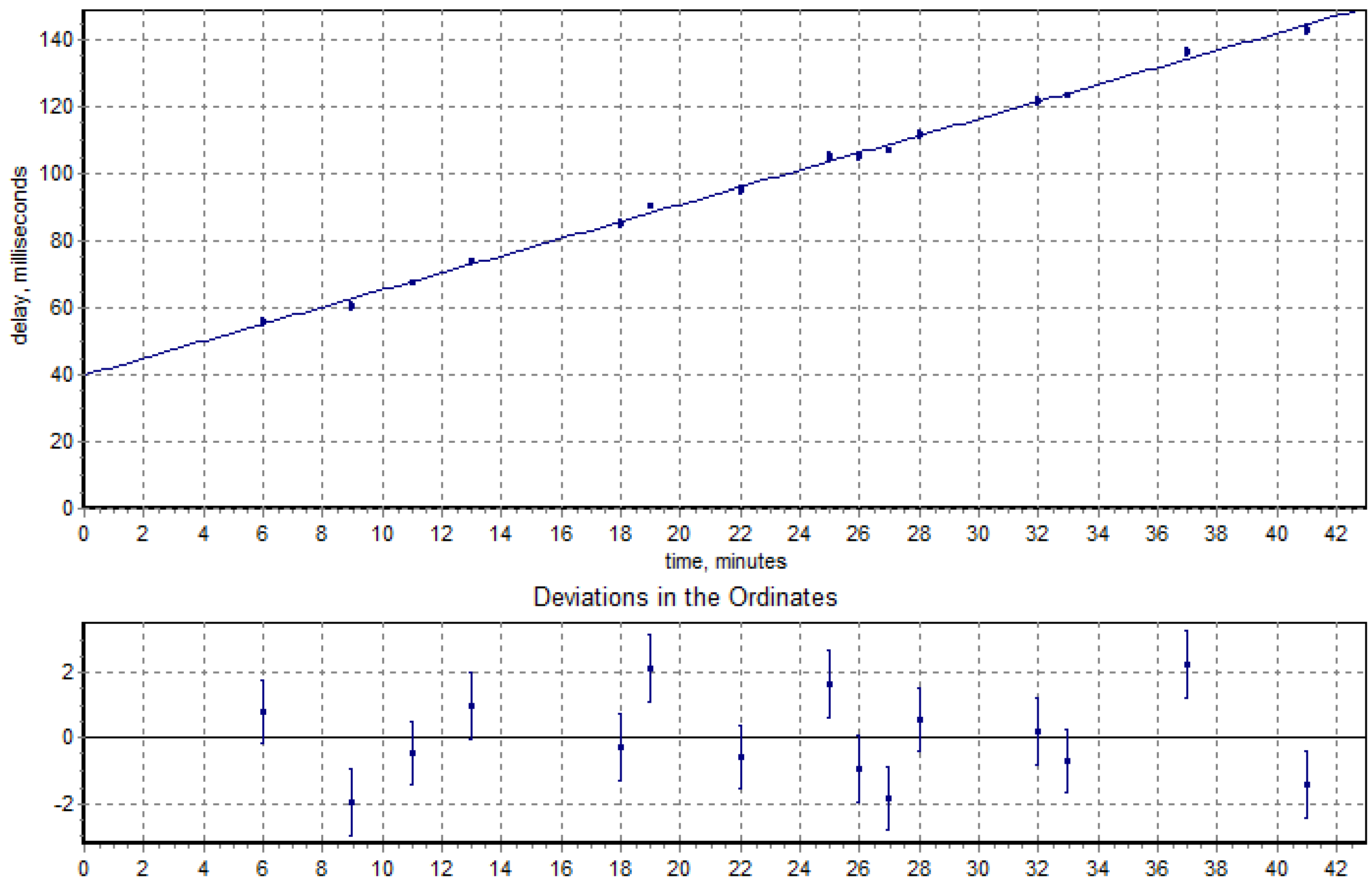
*At the next even minute log the DVD recorder's elapsed time using the recorder's "DISPLAY" feature (I also start a stopwatch at that point). That gives you reference to a *relative* time logging scale for hours, minutes and seconds. You get 60^{th} second time resolution (~17 ms) between seconds by forward-counting fields from a marked field to *an event* and applying the clock's *correction factor* (see ahead).

1 Hz Clock Correction Factor



- Sync strobe is broad and the 1 Hz clock resets on the trailing edge of the strobe, with about 40 ms delay.
- The photo shows a two channel scope display: (green, WWV's even minute tone); (red) a narrow seconds strobe *from* the 1 Hz clock. Use cursors to measure ΔT in ms (from leading edge of the WWV tone to the 1 Hz clock pulse.

Least Squares Analysis of the Starting Offset and Drift Rate After Synchronization



My 1 Hz clock is slow. Least squares analysis of its drift rate and sync time offset fits a linear equation:

$\Delta T = a \times T(\text{lapsed}) + b$

Where: a = 2.554 plus or minus 0.256 ms/min

(17ms divided by 0.256 ms/min = 66 minutes)

And: b = 39.89 plus or minus 2.58 ms (<17 ms)

T(lapsed) is the time from clock synchronization to the measured event, and ΔT is the correction factor to add to the apparent time.

Where to from here?

1. A large tuned loop antenna with a feedline connecting it to a small loop around the Westclox might improve its day reception of WWVB, but it might also amplify T-storm noise and not lead to improvement. Even so, I should try it.

2. Reception of WWV 5 and 10 MHz (Kenwood R-2000) has not been good for *months*. There needs to be more data for ΔT vs. T(lapsed) at different crystal temperatures and differing WWVB signal strengths, to assess for reliability.

3. I need to find a way to separate the top and bottom fields of a single frame, using the DVD+R recorder. I'm having no luck ripping recordings for VirtualDub. I'm going to try out a hand-held, stroboscope-type viewer based on a 60 Hz synchronous motor and an appropriately slotted disk. I'm desperate! JW