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VLB DELAY II, III

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Introduction

The VLB Delay Units II and III allow the difference between VLB Control timing signals and Loran-C timing signals to be measured. Delay unit period switches allow Loran-C chains of periods other than 100 millisec to be used. The delay unit is also useful in measuring the time difference between the VLB Control timing signals and another time reference such as a portable clock. Since the delay unit provides repetitive pulses with a 100 millisec period, the portable clock should be used to sync the scope while observing the single pulse from the delay unit. The delay unit resolution is 25 μsec. A scope with a sweep error of less than 4% provides a maximum error of 1 μsec.

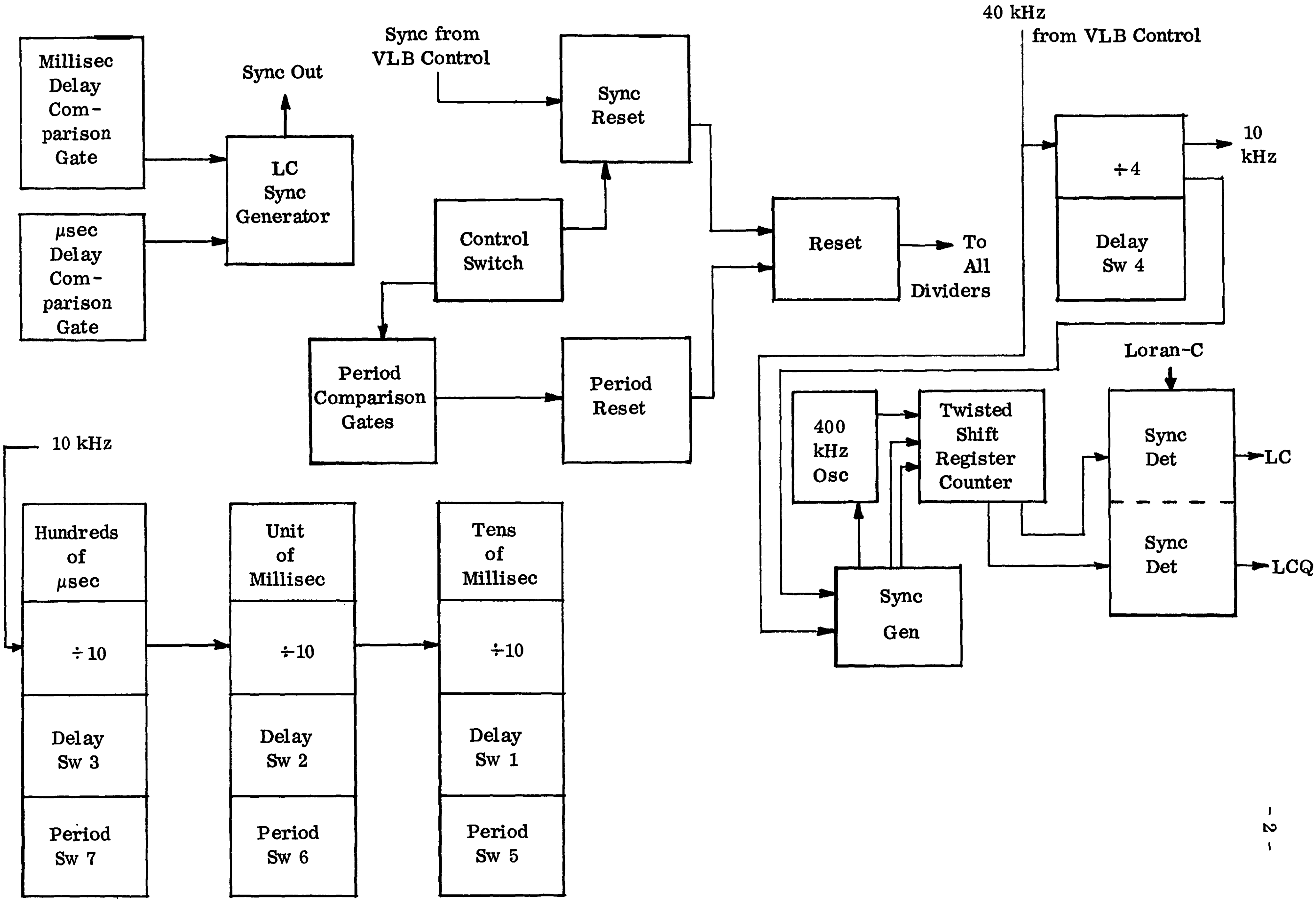
Block Diagram

The block diagram is shown on the next page. The layout is similar to the logic drawing S2. 500-5 (see end of report).

The delay unit consists of a counter with a period of 100 millisec (EAST COAST) or with a period 0. 1 millisec longer than that which is set on the period switches (OTHER). When the period control switch is set to EAST COAST, the next 40 kHz pulse after the negative edge of the sync pulse resets the counter to zero. When the period control switch is set to OTHER, the next 40 kHz pulse after agreement between the period switches and the counter resets the counter to zero. Sync pulses are inhibited from resetting the counter except when the SYNC ENABLE switch is pushed.

An LC sync pattern of eight pulses is started after the counter and delay switches agree. Only one pulse (useful in portable clock comparison) is generated if the sync switch is moved from LC to SINGLE.

The Loran-C synchronous detector schematic (S2. 500-6) is included at the end of the report. This card allows Loran signals of poor signal-to-noise ratio to be used for timing. Also, the obvious indication of phase changes makes the weaker ground wave or first hop sky wave signal more easily observed in the presence of stronger, higher order hop signals.



BLOCK DIAGRAM — VLB DELAY II, III

The detector card consists of two synchronous detectors driving operational amplifier filters. The filter produces a delay (same sign as receiver delay) of $\approx 25\ \mu$sec. The synchronous detector shunt FET switches are driven by in-phase and quadrature signals from a twisted shift register counter. Since neither 100 kHz nor 400 kHz are available from the VLB CONTROL, an oscillator at 400 kHz was locked to the 40 kHz (P1) signal. The counter is synchronized to the 20 kHz (F10) signal.

Operation

The most important point to remember is that the DELAY UNIT was constructed as simple and cheap as possible. The following, confusing factors must be taken into account:

1) A minimum delay must be added to the reading of the delay switches ($\approx 41\ \mu$sec for D.U. III).

2) When used with VLB CONTROL II, the minimum delay for LCR sync is different than for $\overline{\text{0.8 second}}$ and $\overline{\text{10 sec}}$ sync. Also note that LCR is delayed from $\overline{\text{0.8 sec}}$ and $\overline{\text{10 sec}}$ by 5,490 microseconds. Therefore, it is not recommended that LCR be used as a sync input to the VLB DELAY UNIT II.

3) When using a non-East Coast (OTHER) chain, the sync enable may be depressed at any time before the correct sync pulse, but must be released after the desired sync pulse and before the next sync.

4) The period switches must be set to 0.1 millisec less than the chain period.

5) Antenna delays, receiver delays, and Loran-C detector delays must be subtracted from Delay Unit reading or added to the propagation delay and emission delay.

Loran-C Introduction

The East Coast Loran-C chain operates with a period of 100 millisec. During the 100 millisec period each station in the chain will transmit at its assigned time. The first pulse of the master (Cape Fear, N. C.) begins at [0 sec UTC + (N x 0. 1 sec)]. Seven pulses follow at 1 millisec intervals. A ninth pulse follows at 2 millisec intervals to denote that this is a master station (slaves transmit only eight pulses). Preceding the UTC second by 2 millisec is the beginning of an additional pulse (only at Cape Fear). The following table of data from the U. S. Naval Observatory is included, but this data may change at any time:

Transmitter Designation, Coordinates, and Emission Delay

Des.	Location	Latitude	Longitude	Emission Delay (1)
M	Cape Fear, North Carolina	+34° 03. 8'	77° 54. 8' W	
W	Jupiter, Florida	+27° 02. 0'	80° 06. 9' W	13, 695. 5 μs
X	Cape Race, Newfoundland	+46° 46. 5'	53° 10. 5' W	36, 389. 6 μs
Y	Nantucket, Massachusetts	+41° 15. 2'	69° 58. 7' W	52, 542. 5 μs
Z	Dana, Indiana	+29° 51. 1'	87° 29. 2' W	68, 564. 2 μs
T	Wildwood, New Jersey (2)	+38° 57. 0'	74° 52. 0' W	84, 028. 7 μs

Notes: (1) With respect to Cape Fear (UTC).
(2) For testing only.

Users of precise time from Loran-C may request propagation time delays from Loran-C stations to their receiving antennas from the Superintendent
U. S. Naval Observatory
Attention: Time Service Division
Washington, D. C. 20390

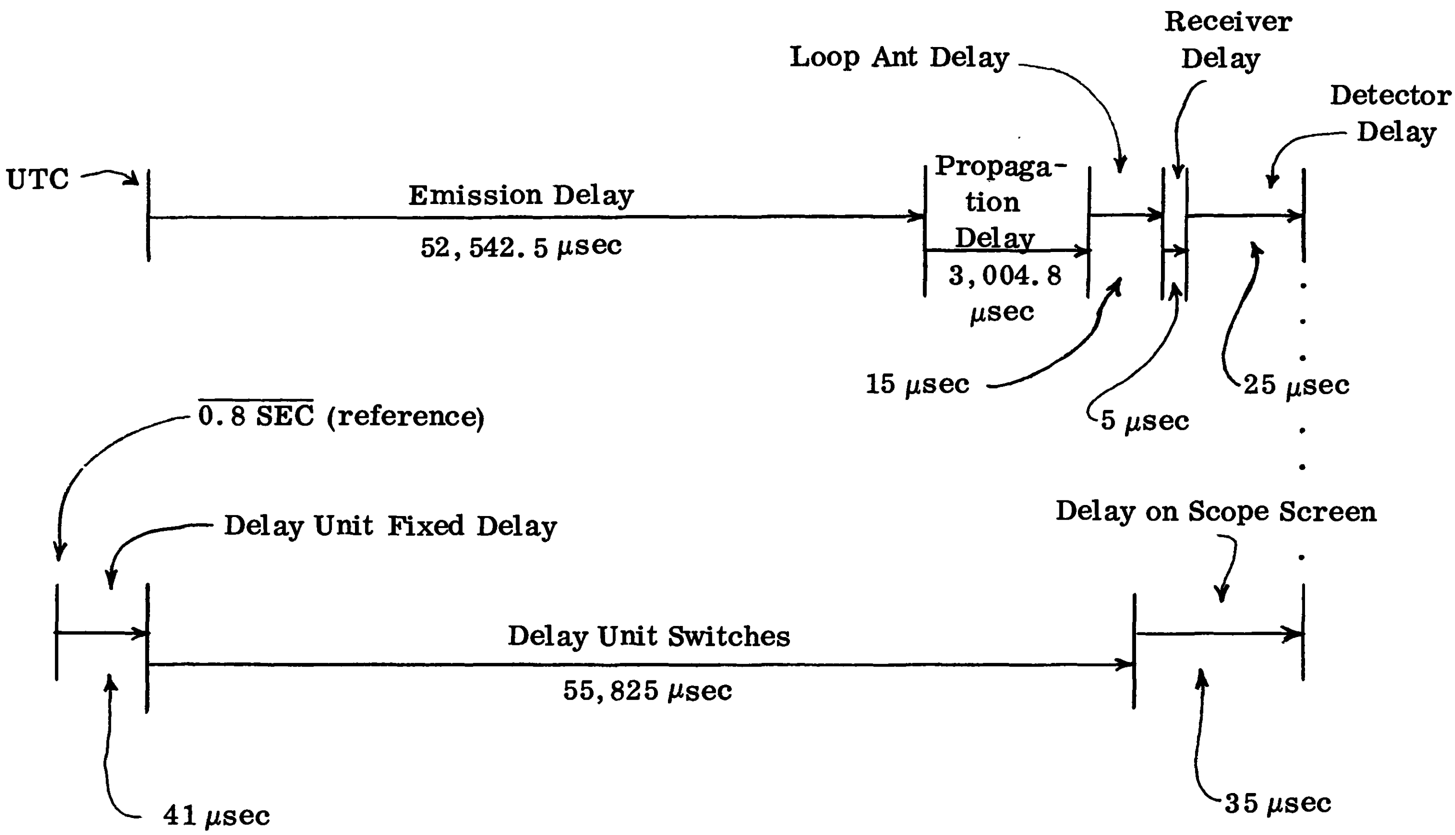
Requests must include the latitude and longitude of the receiving antennas.

Other Loran-C chains operate in a similar manner except that the peculiar period causes the master to transmit at different times relative to the UTC second. At the present time one of these chains (Central Pacific) is synchronized to the UTC second. The North Atlanaic chain is scheduled to be synchronized to UTC in 1968. At present the North Atlantic has a period of 79.3 millisec. Every 13 minutes and 13 seconds the master (Anglssoq, Greenland) transmits approximately synchronous with a UTC second. This chain may be used for time synchronization across the Atlantic by measuring the timing of the Newfoundland station as it transmits in both the East Coast and the North Atlantic chains (North Atlantic takes precedence). This technique should allow the North Atlantic to be calibrated to 1 μsec accuracy, since the propagation delay should cancel out.

Note: The period switches must be set for 79.2 millisec (0.1 less than the actual period).

An example of a time check using the Nantucket station is shown on the next page.

A memo will be prepared before each VLB run to explain the latest timing techniques. Problems experienced in past runs will be carefully explained to reduce the possibility of error in future experiments.



52542. 5	41
3004. 8	55825
25. 0	35
5. 0	55881
30. 0	-55607. 3
55607. 3	273. 7 μsec

The $\overline{0.8\ \text{SEC}}$ reference signal from the VLB CONTROL is 273. 7 ± 25 μsec earlier than UTC.