BNL 6439

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Servo Stabilized RF Vernier Time-of-Flight Analyzer

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The analyzer can be operated either internally or externally gated. In the "Int." mode all input signals are processed unless they arrive when the analyzer is busy with a preceding signal. In this mode the Reset Univibrator (T32-33) is inoperative. In the "Ext." mode, operation is the same as in the "Int." mode except that if the External Gate Univibrator (T23-24) is not triggered during the 12.5 µsec period of the Settle Univibrator (T20-21) the Reset Univibrator is triggered, resetting the Local Oscillator Control FF (T4-5), the steering FF (T60-61), the 10 ma TD discriminator and the entire Data Scaler.

The 10 ma germanium TD discriminator is quiescently biased to 6.5 ma in its low voltage state. An input signal current of 3.5 ma or more (0.7 volts into the 200Ω input impedance of the limiter) triggers the TD to its high voltage state. This triggers the Local Osc. Control FF (T4-5) through amplifier (T2), permitting Local Oscillator (T9-10) to oscillate at a preset frequency between 10 and 20 mc. The Local Oscillator signal is buffered by T11,12,13 and presented to Gate (T58). Because Steering FF (T60-61) is in its "0" state, T58 passes the Local Oscillator signal through a 20 ma GaAs TD discriminator to the Data Scaler. The Local Oscillator signal is further buffered by T14 and mixed in the Bridge Modulator with the reference RF signal from the Cyclotron. The reference RF should have an RMS amplitude of 1 to 2 volts.

Facsimile Price $ 6.60
Microfilm Price $ 2.24

Available from the
Office of Technical Services
Department of Commerce
Washington 25, D. C.

The low frequency beat note from the Bridge Modulator is squared up by Schmitt Trigger T15-16 and passed to the Beat Zero Univibrator (T18-19) which generates 0.7 μsec signals each time the beat note passes through zero from positive to negative. The trailing edge of the Beat Zero Univibrator is employed to terminate the time-of-flight measurement and to control the servo measurement. However these functions are inhibited for the first 12.5 μsec to allow the beat note to achieve an equilibrium amplitude and to permit the Beat Zero Univibrator to attain an equilibrium period. The Settle Univibrator (T20-21) is triggered by the first transition of the Local Oscillator Control FF (T4-5). Its 12.5 μsec output is mixed in "And" Circuit T38-39 with the output of the Beat Zero Univibrator. Those outputs from the Beat Zero Univibrator which occur during the period of the Settle Univibrator cause the Inhibit Univibrator (T41-42) to be triggered. The Inhibit Univibrators period (1.2 μsec) is longer than the Beat Zero Univibrator period (0.8 μsec) and shorter than the minimum period of the beat note (12.8 μsec for 20 Mc reference). It reverse-biases a diode gate, preventing the trailing edge of the Beat Zero Univibrator waveform from triggering the Steering FF (T60-61). The trailing edge of the first Beat Zero Univibrator signal occurring after the Settle Univibrator recovers, triggers the Steering FF to the "1" state. This disconnects the Local Oscillator Signal from the Data Scaler and directs it to the servo Scaler. The Data Scaler now contains a count which is a digital measure of the time of arrival of of the input signal with respect to the phase of the reference RF. This count may have any integral value from 0 to 255. However, the number of Local Oscillator pulses actually tallied may be considerably greater than 255 because of the turnoff inhibition imposed during the period of the Settle Univibrator. The effect of imposing this waiting period and discarding the Data Scaler carry pulses is merely to shift the effective zero phase of the reference RF. Of course, changing the period of the Settle Univibrator (and the Beat Zero Univibrator as well) will change the effective zero phase. It is expected however that these periods will not drift enough to affect the system resolution.

With the steering of the Local Oscillator signals to the Servo Scaler, the servo-stabilizing part of the cycle begins, after which the information will be transferred from the Data Scaler to an external memory. Let us assume that the Servo Scaler has been left by the preceding measurements in a state suitable for establishing the beat note period approximately equal to 256 times the Local Oscillator period. When the Steering FF switches to the "1" state the Servo Scaler begins counting Local Oscillator cycles. The trailing edge of the next Beat Zero Univibrator output passes through a diode gate which has been switched by Steering FF and T50, and resets Local Oscillator Control FF through Inverter T7. This terminates the train of Local Oscillator pulses to the Servo Scaler exactly one beat note period after it began and leaves the servo Scaler with approximately 256 counts more than previously. Since its capacity is 4096 counts, a subsequent addition of 3840 counts (15 x 256) will return it to a state that differs from its original state by the amount by which the number of counts from the Local Oscillator differed from 256.

The same signal that reset the Local Oscillator Control FF also resets the Steering FF through Inverter T43. As the Steering FF returns to its "0" state, it triggers a 20 μsec univibrator (T64-65) whose leading edge initiates a train of four 2.5 μsec univibrator pulses in sequence. These signals serve to complement the 9th, 10th, 11th and 12th stages of the Servo Scaler, thus adding the required 3840 counts. The trailing edge of the last univibrator waveform initiates the transfer of the contents of the Servo Scaler to the Servo Register. If the beat note period had the desired duration the contents of the register would have been unaltered. If it were too long the register count would have been increased, and if it were too short the count would have been decreased. The state of the Servo Register determines the analogue output from the Digital-to-Analogue converter which controls the frequency of the Local Oscillator so that the proper beat note period is maintained.

The first 9 stages of the D-to-A converter have a conventional ladder attenuator configuration. In order that resistor tolerances and uncertainties in transistor saturation voltage shall not lead to errors greater than a least-count of 1 part in 4096, the last three stages of the D-to-A converter employ a logical gating circuit which gives equal weight to 7 resistors instead of graduated weight to 3 resistors, so that 0.1% resistors can be employed without the error exceeding 1 part in 4096.

The count information in the Data Scaler can be transferred to the Address Scaler of any of a number of commercial Pulse Height Analyzers. Those analyzers which have a "live" display require a reset signal to the Address Scaler before new information is entered.

This signal is supplied by the External Reset Univibrator (T35-36) when the Steering FF is triggered to the "1" state at the beginning of the servo-stabilizing cycle. It is not required by the Nuclear Data Model ND-100 Pulse Height Analyzer.

The same signal that resets the Steering FF to the "0" state triggers the LF Oscillator Long Period Univibrator (LPU) (T44-45). This initiates a train of 2 Mc pulses which are fed to both the Data Scaler and the Address Scaler of the Pulse Height Analyzer. The "carry" signal from the last stage of the Data Scaler resets the LF Oscillator LPU, leaving the Data Scaler reset to zero and the 256 complement of the data count in the Address Scaler. The 2 Mc pulse train primes a diode pump holdoff circuit which triggers Store Univibrator (T52-53) shortly after the end of the pulse train. This is used to initiate the storage program in the Pulse Height Analyzer.

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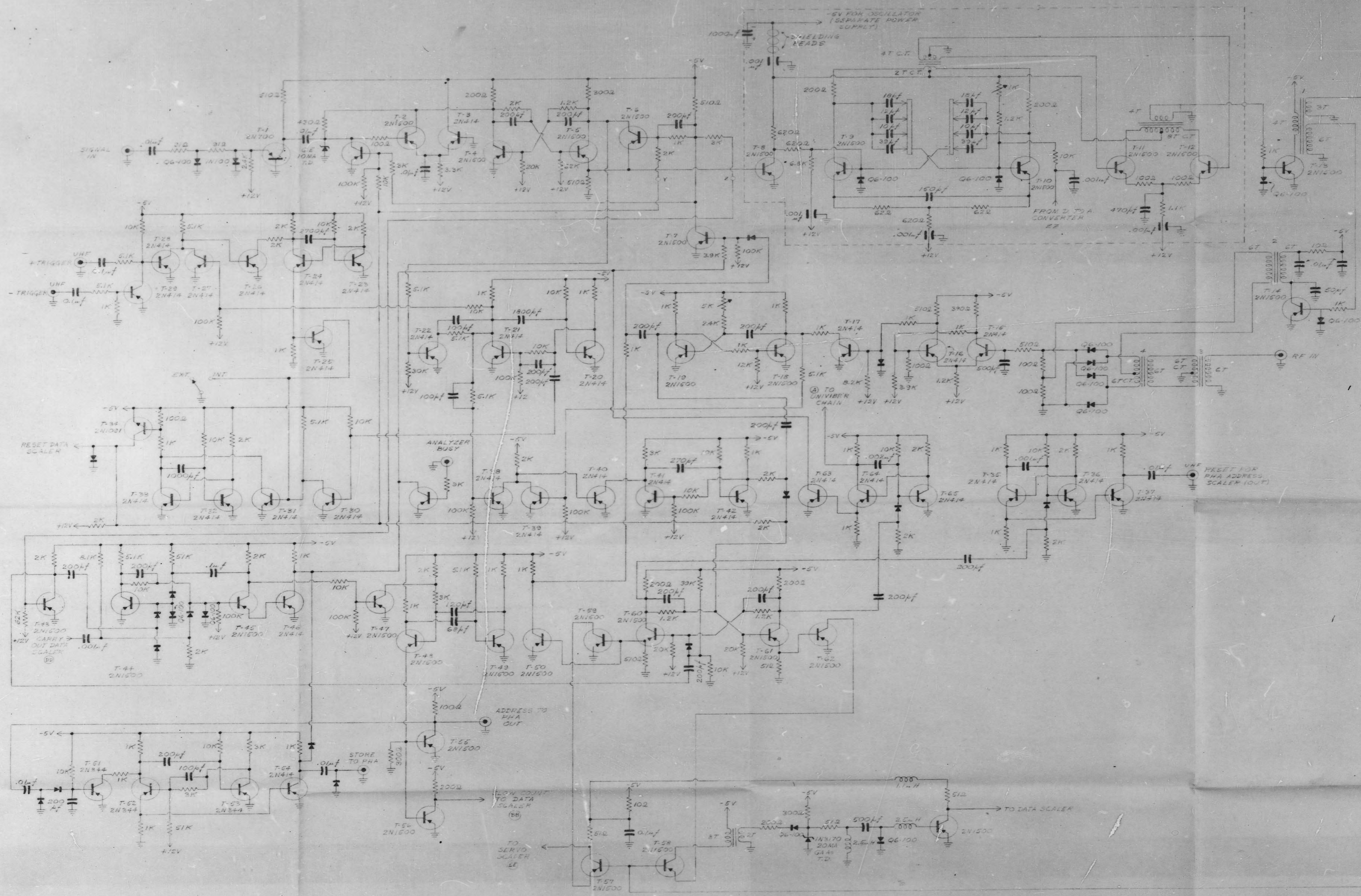
UPTON, N.Y.

R.F. VERNIER TIME OF FLIGHT ANALYZER
BLOCK DIAGRAM

MATERIAL SPEC.	SIZE	WEIGHT	FINISH
4-30-62 (DATE)	Jo. (DRAWN BY)	[illegible] (CHECKED BY)	(APPROVED BY)

DRAWING NUMBER: IH-141-3-4 REV. A



ITEM	NO.	USED ON DWG. NO.	NO. REQD.

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R.F. VERNIER TIME OF FLIGHT ANALYZER - SCHEMATIC

DATE	DRAWN BY	CHECKED BY	APPROVED BY	SCALE	DRAWING NUMBER	REV.
5-8-62					IH-141-1-5	A

ALL DIODES ARE INTERNATIONAL DIODE CORP. # Q6-100

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R.F. VERNIER TIME OF FLIGHT ANALYZER SCHEMATIC

DATE	DRAWN BY	CHECKED BY	APPROVED BY	SCALE	DRAWING NUMBER	REV.
6-8-62	J.C.	[signature]			IH-141-2-5	A