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A Universal Dropout Tester for Magnetic Storage Media

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A Universal Dropout Tester for Magnetic Storage Media

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A UNIVERSAL DROPOUT TESTER FOR MAGNETIC STORAGE MEDIA

Sidney B. Geller

This Technical Note describes a signal dropout detection and counting system which was designed to make measurements on 1/2 inch magnetic computer tape, magnetic instrumentation tapes and magnetic cassette tapes as required by existing and potential Federal Specifications. The calibration and operational procedures for the system are described in detail.

Key words: Dropouts, cassette tapes; dropouts, computer magnetic tapes; dropouts, instrumentation magnetic tapes; dropouts, measurement system; magnetic storage media; signal amplitude, dropouts.

1. INTRODUCTION

This Technical Note describes a signal dropout detection and counting system which was designed to make measurements on 1/2 inch magnetic computer tape, magnetic instrumentation tapes and magnetic cassette tapes as required by existing and potential Federal Specifications. The system was developed in the Performance Measurements Laboratory at the NBS Center for Computer Sciences and Technology. It is presently in operation at the GSA - Magnetic Surfaces Laboratory as an integral part of its Quality Products List testing facility for instrumentation tape.

This measurement system is used:

(a) On 1/2 inch magnetic computer tape: to detect and to count the number of signal pulses or pairs of pulses in a reproduced test pulse train (all "1's") whose amplitudes drop below a preset reference level under specified test conditions.

(b) On magnetic instrumentation tape: to detect and to count dropout "windows". A window is the specified length of time that the test sine wave signal reproduced from the tape must fall below a preset drop-out reference level. Each such decrease in signal amplitude which persists for a period of time exactly equal to a "window" length constitutes a dropout. The dropout count continues to mount as long as the test sine wave signal amplitude remains below the reference level. No count is produced by a signal decrease which exists for less time than a full window length under the specified test conditions.

(c) On magnetic tape cassettes: similar to (a) above.

The instrument has been designed so that it can be used as a general instrument in a magnetic media laboratory. For example, it was used in a study of the effects of magnet fields on recorded computer tapes [1][1]. Its flexibility is due to such features as an internal pulse generator which remains under incoming signal control until the signal drops below approximately 1% of the reference (100%) signal level. This generator continues to produce dropout pulses for counting even if the incoming signal has fallen to a zero amplitude. It does this by automatically going into a free-running mode which has been preset to the exact repetition rate as the incoming test signal.

2. FEDERAL SPECIFICATIONS

2.1 Computer Magnetic Tape

The operation of the computer tape measurement section of the dropout system is based upon Interim Federal Specification WT-0051B (March 1969) in which a dropout is defined in three classes:

(a) Class I - 7 Track-800-bits per inch (NRZI)

(b) Class II - 9 Track-800-bits per inch (NRZI)

A dropout(s) in Class I and II occurs when the amplitude of any one of the reproduced pulses falls below 50% of the amplitude of the reference (100%) signal level. Each such occurrence is counted and recorded as an individual dropout.

(c) Class III - 9 track 1600 bits per inch (PE)

A dropout in Class III occurs when the amplitude of any two consecutive reproduced pulses fall below 35% of the amplitude of the reference (100%) signal level. Each such pair of consecutive pulses is counted and recorded as a

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[1] Figures in brackets indicate the literature references on page 19.

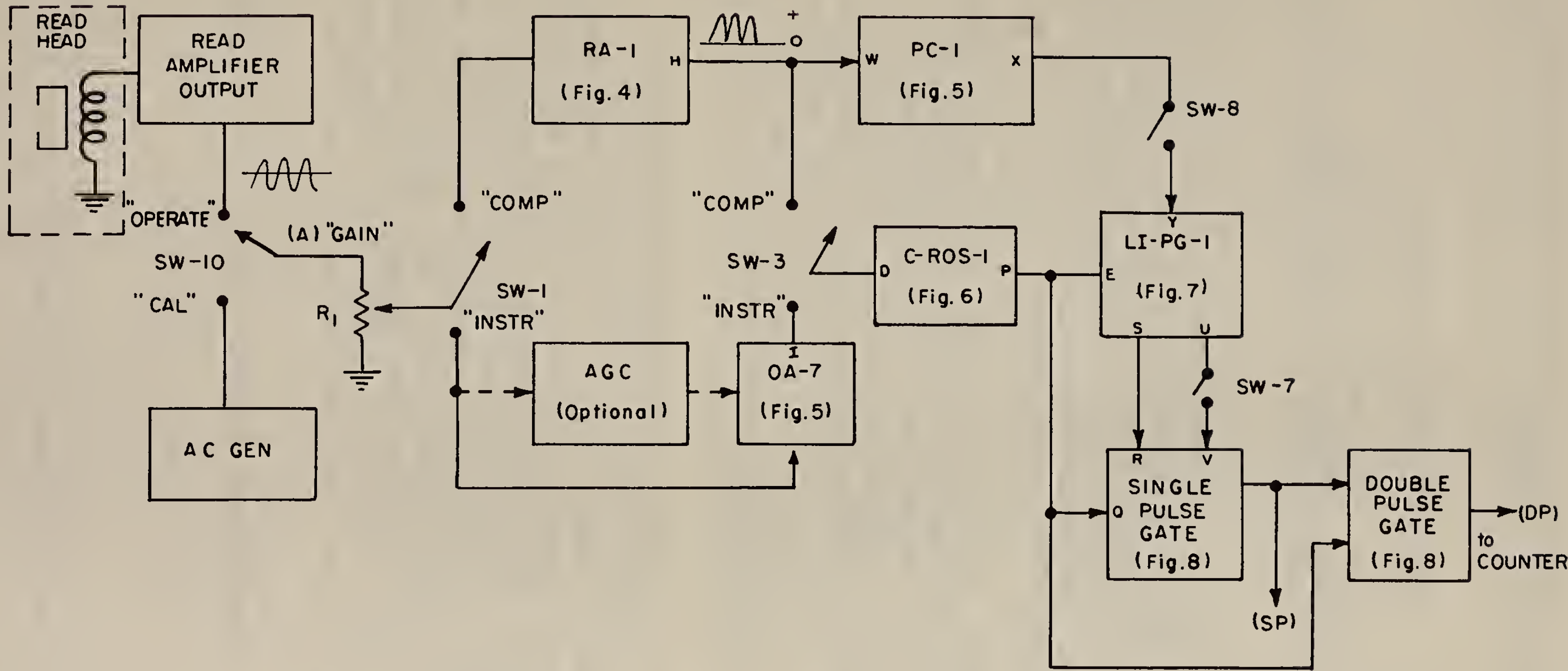

Figure 1. Block diagram of the dropout system.

single dropout. Class III testing can be done with the tape recorded at 3200 frpi (NRZI).

2.2 Instrumentation Magnetic Tape

The design of the instrumentation part of the system is based upon the Interim Federal Specification WT-001553 (December 1970) which defines an instrumentation tape dropout as follows:

(a) A dropout is defined as a 6.0dB (or greater) reduction in output signal amplitude from a reference level for a period of 10 microseconds at the 1.0 mHz recording frequency or for a period of 20 microseconds at the recording frequency of 200 kHz. These periods were referred to as dropout "windows" in section 1b.

(b) Signal losses of 6.0dB (or greater) which extend over a 10 or 20 microsecond period shall result in additional dropout counts for each additional 10 or 20 microseconds during which the signal loss persists. For example, at the 1.0 mHz recording frequency a loss of signal amplitude of 6.0dB for 35 microseconds results in 3 dropout counts. However, a signal loss for 9 microseconds should result in no dropout counts.

2.3 Magnetic Tape Cassettes

At the present time there is no Federal Specification for magnetic tape cassettes, however, the standards which are being written by the industrial committees indicate that the dropout system will also be able to perform with the tape cassettes. To date, successful tests have been made using various cassette transports operating at speeds varying from 4 to 12 inches per second with cassette tapes recorded with pulse trains at 1600 frpi. This resulted in operating frequencies from approximately 3kHz to 10 kHz.

3. MEASUREMENT SYSTEM THEORY AND DESIGN.

3.1 Circuit Description.

Figure 1 shows a block diagram of the entire dropout measurement system with some of the switches that are used when changing from the instrumentation "INSTR" measurement mode to the computer "COMP" mode. Enclosed in each block is the figure number of the circuit diagram which corresponds to that block. Figures 2, 3 and 9 show typical signals which appear at various points in the system for computer and instrumentation tests respectively.

3.1.1 Computer Tape Measurement Section

(a) The test signal from the computer tape transport read channel amplifier is fed into the measurement system via the "GAIN" control R_1 (figs. 1 and 4). R_1 feeds the signal simultaneously into amplifiers OA-1 and OA-2 of the rectifying amplifier RA-1 (fig. 4) via switch SW-1. The signal is inverted and clipped and the output from OA-2 is reinverted by OA-3. The outputs OA-1 and OA-3 are summed by amplifier OA-4 which produces a full-wave rectified version of the input test signal. The system is calibrated so that a 1.0 volt peak-to-peak input signal from R_1 is adjusted by R_9 for a 6.0 volt base-to-peak rectified output signal from OA-4. This is the nominal 100% signal level for the system (fig. 2b).

(b) The "PULSE ADJUST" control R_2 in the feedback loop of OA-3 can be adjusted for the following 2 test modes:

1. The output pulses from OA-4 (point H) are made equal in amplitude even if the positive and negative test signal peak amplitudes are unequal at the input to R_1.

2. The relative amplitudes of the pulses at the outputs of OA-4 are adjusted to be the same as they appeared at the input to R_1. This is the usual test mode.

(c) The output from OA-4 (fig. 2b) is now injected both into the pulse control circuit PC-1 (fig. 5) and into the comparator - retriggerable one-shot circuit C-ROS-1 via SW-3 (fig. 6). The output from PC-1 controls the repetition rate of the pulses which are produced by the pulse generator LI-PG-1 (fig. 7). This control action is described in section 3.1.1.f2.

C-ROS-1 is the threshold setting and sensing circuit: it detects when the test signal amplitude has fallen below its preset dropout signal level. For example, when the 100% signal level at the output of OA-4 is set for 6.0 volts base-to-peak then for Class I and II testing a drop-out occurs when the input to comparator C-1 falls below 3.0 volts base-to-peak and for Class III testing a dropout occurs when the C-1 input falls below 2.1 volts base-to-peak.

(d) The threshold of comparator C-1 is adjusted with the "COMP ADJUST" control R_3 so that it switches its output state towards ground whenever any portion of the input test signal from OA-4 exceeds that threshold. Figures 2b and 2c show these signal relationships. Note that the outputs of C-1 are either a positive voltage level (dropout) or a negative going pulse train (no dropout). C-1 is able to make these decisions on a pulse by pulse basis at all of the specified test frequencies.

(e) The output from C-1 is injected into the retriggerable one-shot ROS-1 via diode D_4 (fig. 6). The "ROS-ADJUST"potentiometer R_4 sets the cycle time of ROS-1 into the correct relationship with the driving pulse train from C-1. When this pulse train appears at the ROS-1 input then its output remains in the ground state (fig. 2d). However, when the C-1 output pulse train ceases due to a dropout(s) then ROS-1 senses the absence of the next expected incoming pulse(s) and can be adjusted to switch its output level to approximately + 2.50 volts dc until the pulses reappear. ROS-1 can switch states in response to the absence of alternate pulses in the negative going input train, from C-1 as shown in figure 9c, d and e.

(f) The output voltage levels from ROS-1 are now used to control the operation of the linear integrator, pulse generator system LI-PG-1 (fig. 7) which operates in 2 modes as follows:

(1) Free-running mode (switch SW-8 "open"):

The linear integrator stage OA-6 which is driven by the T_1-T_2 circuit begins to produce a negative going voltage ramp V_{CR} across the capacitor(s) C_R in response to a positive voltage from ROS-1 (fig. 3d). This occurs during a dropout event. The voltage ramp which drives comparator C-2 continues to grow in amplitude until it reaches the preset negative C-2 triggering level and causes the output to switch from ground to a positive voltage level. This positive voltage is fed into the T_5-T_6 current switch which is located in the (OA-6)-(C-2) feedback loop. The collector of T_5 becomes negative and drives the gate transistor T_4 into conduction. T_4 now discharges the ramp capacitor(s) C_R back towards ground. This in turn causes C-2 to switch its output voltage back towards ground which causes the collector of T_5 to return to its quiescent positive voltage state. The result of this regenerative feedback action between OA-6 and C-2 has produced a pulse with a width of approximately 0.40 microseconds at the outputs of both comparator C-2 (point S and the single pulse gate (SP) output (fig. 8). The rate at which these pulses are generated depends upon:

(a) The linear-integrator time constants as set by the (total) ramp capacitance C_R and the "LI-TRIM" control R_5 and

(b) The comparator C-2 triggering level as set by the "FREQ ADJUST" control R_6. Variations in C_R and R_5 alter the slope of the linear voltage ramp V_{CR} and thereby alter the length of time which is required to reach the C-2 trigger point. This varies the pulse regeneration rate and can be made to coincide with the pulse rate of the incoming test signal from OA-4. The separation between the pulses can also be adjusted to be equal to one window length for use in instrumentation tape testing.

The pulse generator system LI-PG-1 will continue to produce a pulse train so long as ROS-1 remains at its positive (dropout) voltage level. At the instant that the dropouts terminate then ROS-1 returns to its ground state and T_2 applies a negative voltage into the base of T_3 which discharges C_R. V_{CR} remains near zero potential until the next dropout appears.

(2) Controlled generator mode (figs. 5 and 7):

When the amplitude of the computer tape test signal out of OA-4 is greater than approximately 1% of its nomial 6.0 volt (100%) level then the frequency of the LI-PG-1 pulse generator is controlled by the test signal. This is done as follows: the signal from OA-4 is inverted and shifted by OA-5 (fig. 5). The rectification of the input signal in RA-1 has produced sharp cusps at the signal crossover points (fig. 2b). When these cusps are inverted and level shifted by OA-5 and the "C-2 Control" potentiometer R_7 then sharp positive output control pulses are produced as shown in figure 2f. These pulses are injected into comparator C-2 at point Y, figure 7 and override the control of the ramp voltage V_{CR}. This causes C-2 to trigger the regenerative cycle at the rate of the incoming test signal. This pulse control is retained until the test signal falls to less than 1% of its nominal level. When this occurs LI-PG-1 returns to its free-running mode and continues to produce pulses at the preset rate. This assures a dropout count even with a complete loss of signal which is often caused by a defective tape surface area.

(g) The output pulses from comparator C-2 (point S) and ROS-1 (point P) are fed into the series T_7-T_8 "AND" gate (fig. 8). The output from transistor T_2 is differentiated and also fed into the gate. This differentiated pulse is produced from the leading edge of the pulse on the collector of T_2 which is produced at the onset of the dropout interval. It is always counted as the first dropout pulse in a string of dropout pulses (fig. 2g). All of the remaining pulses are produced by the action of LI-PG-1 as described in section 3.1.1f.

For Class I and II computer tapes the output from point SP (fig. 2g and 8) is fed to a counter unit (see section 5) which records the total number of dropouts that are measured on a test tape. For Class III tape testing each two successive dropouts are given single counts. This is accomplished with the binary "toggle" circuit TG-1 and the T_{10}-T_{11} "AND" gate. The output appears at point DP (figs. 2h and 8) and is fed to the counter unit.

3.1.2 Instrumentation Tape Measurement Section

As defined in section 2.2 an instrumentation tape dropout does not consist of individual pulse counts; instead it consists of time interval counts or "window" counts. In addition no count must appear if a dropout interval persists for less than a full window length in duration.

(a) The use of an AGC input circuit as shown in figure 1 is optional. One such device is used in the GSA-Magnetic Surfaces Laboratory dropout model [2]. When an AGC circuit is not used in the signal path, then R_1 attenuates the input signal level to 1.0 volt peak-to-peak at point T (fig. 1). It is then fed directly to the input of OA-7. If an AGC circuit is used it is adjusted to provide an unmodulated 1.0 volt peak-to-peak output signal.

(b) OA-7 (fig. 5 amplifies the AGC or R_1 output signal to 6.0 volts peak-to-peak (fig. 3a). 3.0 volts base-to-peak is the 100% signal level for the system while +1.5 volts base-to-peak is the dropout threshold for the instrumentation tape measurements.

(c) The signal output from amplifier OA-7 is fed into the C-1 comparator circuit which has been adjusted to switch its output state when the input signal amplitude passes through +1.50 volts (fig. 3b). The operation of C-1 and ROS-1 is identical to that described in sections 3.1.1d and e; their outputs are shown in figures 3b and c.

(d) The pulse generator system LI-PG-1 is controlled by the output from ROS-1 in the same manner as described in section 3.1.1f1. LI-PG-1 is operated in the free-running mode for instrumentation tape dropout measurements and is adjusted with C_R, R_5 and R_6 to produce pulses which are spaced one window length apart. The signal control pulses from PC-1 (point X) are switched out of the C-2 circuit with switch SW-8 in this operating mode.

(e) The pulses from C-2 (point S) and ROS-1 (point P) are fed into the T_7-T_8 "AND" gate (points R and Q, fig. 8). For instrumentation tape measurements the differentiated signal into point V, figure 8 is switched out by SW-7. Therefore the first dropout pulse will not appear at point SP before the end of the first "window" interval. This occurs 10 μs after C-ROS-1 detects the beginning of the dropout interval in 1.0 mHz testing; or after 20 μs in the case of 200 kHz testing. The output from point SP is fed into a counter device which records the total number of dropouts over the length of tape which is being measured.

Note that in figures 3d and e that when LI-PG-1 was set for a 10 μs pulse spacing (window) that no SP output was obtained from the T_7-T_8 gate for the 4 μs dropout interval immediately following the second dropout pulse in the 24 μs dropout interval: V_{CR} has been returned to the ground state by transistor T_3 (fig. 7) before C-2 was triggered for an additional pulse at SP.

Experiments were performed with LI-PG-1 operating in the controlled frequency mode at the 1.0 mHz rate. A divide-by-ten integrated circuit was used to produce the 10 μs windows. Additional development is required for this approach.

4. SYSTEM CALIBRATION AND OPERATION

4.1 Calibration Method

4.1.1 Calibration of the Computer Tape Measurement Section

Table 1 gives the initial settings for the "FREQ ADJUST" control R_6 and switches SW-4, SW-5 and SW-6 at the various operating densities. The "LI-TRIM" control R_5 is set to approximately 1500 Ω (3.25 turns: CW). Set switch SW-1 into "COMP" (fig. 1).

After these settings are made proceed as follows:

(a) Connect an ac sine wave generator* to the input point A (fig. 1). Switch SW-10 into "CAL" position.

(b) Connect the counter unit* to point SP (fig. 8).

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*These instruments are listed in section 5.0.

TABLE 1. Adjustments for different operating densities

Densities	Spacing(μs) (Point SP)	Frequency (kHz) (Point SP)	AC Generator Frequency (kHz)	"FREQ-ADJUST" R6 (Fig.7)	SW-4 (Fig.6)	SW-5 (Fig.7)	SW-6 (Fig.7)
3200 frpi (112.5 ips)[c]	~2.78	360	180	4T:CW[a]	open	open	open
800 frpi (112.5 ips)	11.1	90	45	1.75T:CW	closed[b]	open	closed
1600 frpi (Cassette: 12 ips)	50	20	10	3.5T:CW	closed	closed	closed
1600 frpi (Cassette: 6 ips)	100	10	5	2T:CW	closed	closed	closed
1.0 mHz Instrumentation Tape	10 (window)	100	1000 (modulated)	1.5T:CW	open	open	open
200 kHz Instrumentation Tape	20 (window)	50	200 (modulated)	3.6T:CW	closed	closed	open

a - This reads "4 turns clockwise from full counterclockwise".
b - Closed switch adds the parallel capacitance shown in the figure.
c - ips is the "inches per second" transport speed.

(c) Connect an oscilloscope to point SP (fig. 8).

(d) Set the ac generator output to approximately 3.0 volts peak-to-peak at the operating frequency given in Table 1. Reduce the ac input signal to zero by turning the "GAIN" control R_1 fully counterclockwise. Now adjust the free-running pulse repetition rate from LI-PG-1 with the "FREQ-ADJUST" control R_6: check the pulse spacing and the counter frequency at point SP using Table 1. For example, if the test is to be made on a computer tape which has been recorded at 3200 frpi at 112.5 ips then the pulse spacing at point SP is set to 2.78 μs and the counter (in the "Frequency" position) should read 360 kHz due to the rectifying action of RA-1 (fig. 2b).

Note: If the tape has been recorded at densities which vary slightly from the tabulated values, then the free-running pulse rate as well as the ac generator frequency should be set equal to the recorded frequency.

(e) After the free-running pulse rate has been set, adjust R_1 so that the signal amplitude at the center tap is 1.0 volt peak-to-peak at point T (fig. 4).

(f) Adjust the "PULSE ADJUST" control R_2 and the OA-4 gain control R_9 (fig. 4) until the rectified output from OA-4 (point H) has equal amplitude peaks whose values are 6.0 volts base-to-peak as shown in the first 4 pulses of figure 2b. With this adjustment the relative amplitudes of the actual signal peaks as read from the tapes will remain as they appear at the system input. This is the usual test procedure.

(g) Adjust the "C-2 CONTROL" R_7 and R_{12} in PC-1 (fig. 5) until the pulses at the OA-5 output (point X) are approximately 1.0 volt peak-to-peak (fig. 2f). Close switch SW-8: this applies these PC-1 control pulses to comparator C-2 in LI-PG-1 (fig. 7).

(h) Adjust the comparator C-1 (fig. 6) dropout threshold level as follows:

(1) Reduce the signal from OA-4 with "GAIN" control R_1 to:

(a) 3.0 volts base-to-peak: this is the 50% level in Class I and II computer tape testing.

(b) 2.1 volts base-to-peak: this is the 35% level used in Class III computer tape testing.

(2) Now adjust the "COMP-ADJUST" control R_3 (fig. 6) until an unsteady negative going pulse train appears at the output of C-1 (point TP-1). Increase the signal amplitude slightly with R_1 and note if the pulse train becomes steady. Readjust R_3 and R_1 until C-1 just produces the pulse train when it is triggered with a 3.0 volt (or 2.1 volt) base-to-peak input signal. Figure 9b shows the output from C-1 when the OA-4 signal amplitude is slightly greater than the 50% (or 35%) threshold level.

(i) Adjust the retriggerable-one-shot ROS-1 as follows:

(1) Close the "SET ROS" switch SW-2 in RA-1 (fig. 4). This produces the pulse pattern shown in figure 9c. Adjust the "GAIN" control R_1 until the peak amplitude of the smaller of the two pulses is slightly less than 50% (or 35%) - the other pulse will be greater than 50% (or 35%) as shown in the figure. The output from comparator C-1 (point TP-1) will now appear as shown in figure 9d as alternate C-1 output pulses.

(2) Place a scope probe at the output of ROS-1 (point P) and set ROS-1 with the "ROS-ADJUST" control R_4 as follows:

(a) Figure 9e shows the ROS-1 output pulses as they approach the correct adjustment. The SP output from the T_7-T_8 gate consists of pulse pairs (fig. 9f).

(b) Continue adjusting R_4 so that the leading edge of each ROS-1 pulse moves to the right (fig. 9g) until each SP pulse on the left merges with the one on the right as shown in figure 9h. Now, for example at 800 frpi the counter should read 45kHz because every alternate pulse in the 90kHz pulse train is a dropout.

(c) Reduce the input signal amplitude with the "GAIN" control R_1 until both peaks are below 50% (35%) in amplitude: the counter should read 90kHz. Reduce the input signal amplitude to zero: the free-running counter should continue to read 90kHz.

(3) Check the DP count at the output of T_{10} (fig. 8): this should be exactly one-half of the SP count.

The system is now calibrated for making computer tape dropout measurements according to Interim Federal Specifications WT-0051B (March 1969). These same calibration techniques are used for setting up the system for digital cassette dropout testing.

4.1.2 Calibration of the Instrumentation Tape Measurement Section

Table 1 gives the initial settings for the "FREQ-ADJUST" control R_6 and switches SW-4, SW-5 and SW-6. Switch SW-8 in the PC-1 circuit (fig. 5) is opened since LI-PG-1 operates only in the free-running mode for instrumentation tape testing. Set the "LI-TRIM" control R_5 to approximately 1500Ω (3.25 turns: CW).

The calibration proceeds as follows:

(a) Connect an ac sine wave* generator to the system input (point A, fig. 1). Switch SW-10 is in the "CAL" position.

(b) Connect the counter unit* to point SP (fig. 8).

(c) Connect an oscilloscope to point SP (fig. 8).

(d) Switch SW-1 is set into the "INSTR" position:

The ac signal can be either:

(1) Attenuated by the "GAIN" control R_1 to 1.0 volt peak-to-peak and then fed directly into OA-7, or

(2) Fed into an AGC amplifier (optional) whose output is adjusted for a steady state output level of 1.0 volt peak-to-peak. This AGC output signal is then fed directly into OA-7 (fig. 1). An AGC amplifier is employed in the GSA-Magnetic Surfaces Laboratory model [2].

(e) Adjust the gain of OA-7 with potentiometer R_{11} for a signal output of 6.0 volts peak-to-peak at point I (fig. 3a and 5). Switch SW-9 is open during this adjustment.

(f) Switch SW-9 is now closed and potentiometer R_{10} (fig. 5) is adjusted so that the output voltage at point I is reduced to 3.0 volts peak-to-peak. In this way, the 50% level of any input signal can be obtained by activating SW-9.

(g) The C-1 threshold level and ROS-1 are adjusted as follows:

Method I: (1) The dropout threshold is adjusted by the "COMP-ADJUST" control R_3 (fig. 6) in the same manner as described in section 4.1.1h with the exception that the 50%

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*These instruments are listed in section 5.0.

level is set for +1.5 volts base-to-peak. If control R_1 feeds OA-7 directly then the input signal can be varied by R_1 about the dropout level. If an AGC amplifier is used then the 50% level can be set by activating switch SW-9.

(2) The adjustment of ROS-1 proceeds as follows:

(a) Set the ac sine wave generator frequency to exactly one half of the test frequency, i.e., 500kHz for the 1.0mHz test frequency and 100kHz for the 200kHz test frequency.

(b) Set switch SW-1 into the "COMP" position. The input signal is now rectified by RA-1 so that the positive peak pulse spacing is corrected to 1.0μs and 5.0μs for the 1.0mHz and 200kHz test frequencies respectively.

(c) Close the "SET ROS" switch SW-2 (fig. 4). This produces the pulse pattern shown in figure 9c. Adjust R_1 so that each smaller peak lies below the 50% level (i.e. below +1.5 volts).

(d) Set the "ROS-ADJUST" control R_4 so that the output signal from ROS-1 (point P) is adjusted to switch at the peak of each dropout pulse as shown in figure 9e. The ROS-1 output signal returns to ground when the input pulse amplitude goes above the 50% level.

(e) Note: The threshold of comparator C-1 can also be set using an actual tape signal by activating switch SW-9 as described in section 4.1.2f and adjusting the "COMP-ADJUST" control R_3 to achieve an unsteady pulse train at the C-1 output point TP-1.

Method II: (1) C-ROS-1 can also be adjusted through the use of a sine wave generator which is capable of being modulated* by a signal which produces an envelope that goes above and below the 50% level (fig. 3a). The modulated sine wave frequency is set equal to the test frequency and the modulated signal is passed either through an AGC circuit or directly through OA-7. C-1 and ROS-1 are then adjusted as described in sections 4.1.1 and 4.1.2. The C-1 adjustments are made so that the negative pulse train stops with the first modulated peak which falls below the 50% level (figs. 3a and 3b). The ROS-1 adjustment is made so that it switches on that same peak and returns to ground with the first peak that exceeds the 50% amplitude level (fig. 3c).

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*These instruments are listed in section 5.0.

TABLE 2. Switch settings

Switch No.	Computer Tapes	Instrumentation Tape	Figure No.
SW-1	"Comp"	"Instr"	4
SW-2	Open	Open	4
SW-3	"Comp"	"Instr"	6
SW-4	Table 1	Table 1	6
SW-5	Table 1	Table 1	7
SW-6	Table 1	Table 1	7
SW-7	Closed	Open	8
SW-8	Closed	Open	5
SW-9	Open	Open	5
SW-10	"Operate"	"Operate"	1

(h) Reduce the input signal to zero amplitude with "GAIN" control R_1. This sets the pulse generator circuit LI-PG-1 into the free-running mode. Now set the pulse rate as described in section 4.1.1d. For example, as indicated in Table 1; at the 1.0 mHz test frequency the pulse spacing is set to 10 μs and the counter should read a frequency of 100 kHz.

The calibration is completed for instrumentation tape dropout testing according to the Interim Federal Specification WT-001553 (December 1970).

4.2 Operation of the Measurement System

4.2.1 Operation of the Computer Tape Testing System

(a) The switches in the system should be set according to Tables 1 and 2. Note that switches SW-4, SW-5 and SW-6 are set according to Table 1 at the various densities and machine speeds.

(b) Make the following connections:

(1) Read amplifier output into SW-10 (fig. 1).

(2) Counter unit and oscilloscope to point SP (fig. 8).

(3) Oscilloscope on point H (fig. 4).

(c) Start the tape transport and adjust the read amplifier signal output level for approximately 3.0 volts peak-to-peak from the test tape.

(d) Set the pulse counter into the "FREQUENCY" position. Reduce the signal output from OA-4 (point H) with the "GAIN" control R_1 to slightly less than 3.0 volts or 2.1 volts base-to-peak according to the test mode and measure the dropout count at point SP.

(e) Turn R_1 fully counterclockwise and adjust the "FREQ ADJUST" control R_6 to produce the same frequency count at SP as in (d) above. The free-running frequency is now equal to the test frequency. The ccunt at point DP (fig. 8) should now be equal to one-half of the SP count.

(f) Readjust R_1 until the signal output from OA-4 (point H) is 6.0 volts base-to-peak (100% level).

(g) (1) Rewind the tape back to the beginning.

(2) Set the counter unit into the "COUNT" position.

(3) Start the tape transport.

(4) Zero and start the counter unit. The system is in operation.

Note: During normal operating procedures, the calibration of the unit can be quickly checked with the actual tape signal input. For example, the "SET ROS" switch SW-2 can be closed and the input signal reduced with R_1 as described in section 4.1.1i.

4.2.2 Operation of the Instrumentation Tape Testing System

(a) The switches in the system should be set according to Tables 1 and 2. Note that switches SW-4, SW-5 and SW-6 are set according to Table 1 at the various densities.

(b) Make the following connections:

(1) Read amplifier output into SW-10 (fig. 1).

(2) Counter unit and oscilloscope to point SP (fig. 8).

(3) Oscilloscope on point I (fig. 5).

(c) Turn the "GAIN" control R_1 fully counterclockwise and adjust the free-running frequency from LI-PG-1 at point SP to produce the "window" pulse spacing as given in Table 1.

(d) Start the tape transport and adjust R_1 until the signal amplitude at point I (fig. 5) is 6.0 volts peak-to-peak. If an AGC amplifier is used, adjust R_1 until the normal input signal level for that amplifier is achieved.

(e) (1) Rewind the tape to the beginning.

(2) Set the counter unit into the "COUNT" position.

(3) Start the transport and permit it to get up to speed.

(4) Zero and start the counter unit. The system is in operation.

5. COMPONENT LIST

The mention of specific equipments or components in any portion of publication is not to be construed as an endorsement of these items by NBS to the exclusion of other equivalent devices. There is considerable latitude in the choice of semi-conductor components, potentiometers, recording, reproducing and measuring devices. The following is a tabulation of some of the devices that are used in the NBS dropout measuring system:

Transistors	T(Numbers in Figures)	Type
2N3646	1,7-11	NPN Switching
2N3638	2-6	PNP Switching

Diodes	D(Numbers in Figures)	Type
1N276	1,2,3,13	Ge Switch
1N916	4,5-8,9-12	Si Switch
1N751A	D_Z	Zener

Amplifiers	(Numbers in Figures)	Type
PP45U	OA-1-to OA-7	Operational Amplifier (Solid State)

Integrated Circuits	Numbers in Figures	Type
MC1710CG	C-1,C-2	Comparator
SN7472N	TG-1	J-K flip-flop (Toggle)
MC9601	ROS-1	Retriggerable one-shot

Instruments	Model	Manufacturer
Counter unit	CMC 600A	Computer Measurements
Sine wave generator	1202	Donner Scientific Co
Modulated sine wave generator	606A	Hewlett-Packard
Data generator	Datapulse 201	Systron-Donner Co.

6. REFERENCES

[1] Geller, S.B., The Effects of Magnetic Fields on Magnetic Storage Media Used in Computers; NBS Technical Note 735, July 1972.

[2] NSA, XR-3-80A Magnetic Tape Analyzer System, Manual IB-5 (March 1966).

The assistance of George A. Wilson of GSA with the construction and testing of the GSA-MSL dropout unit and the assistance of Amory W. Ericson with the construction and testing of the NBS unit is gratefully acknowledged. The efforts of John A. Warme in the preparation of the illustrations and drawings in this NBS publication is gratefully acknowledged.

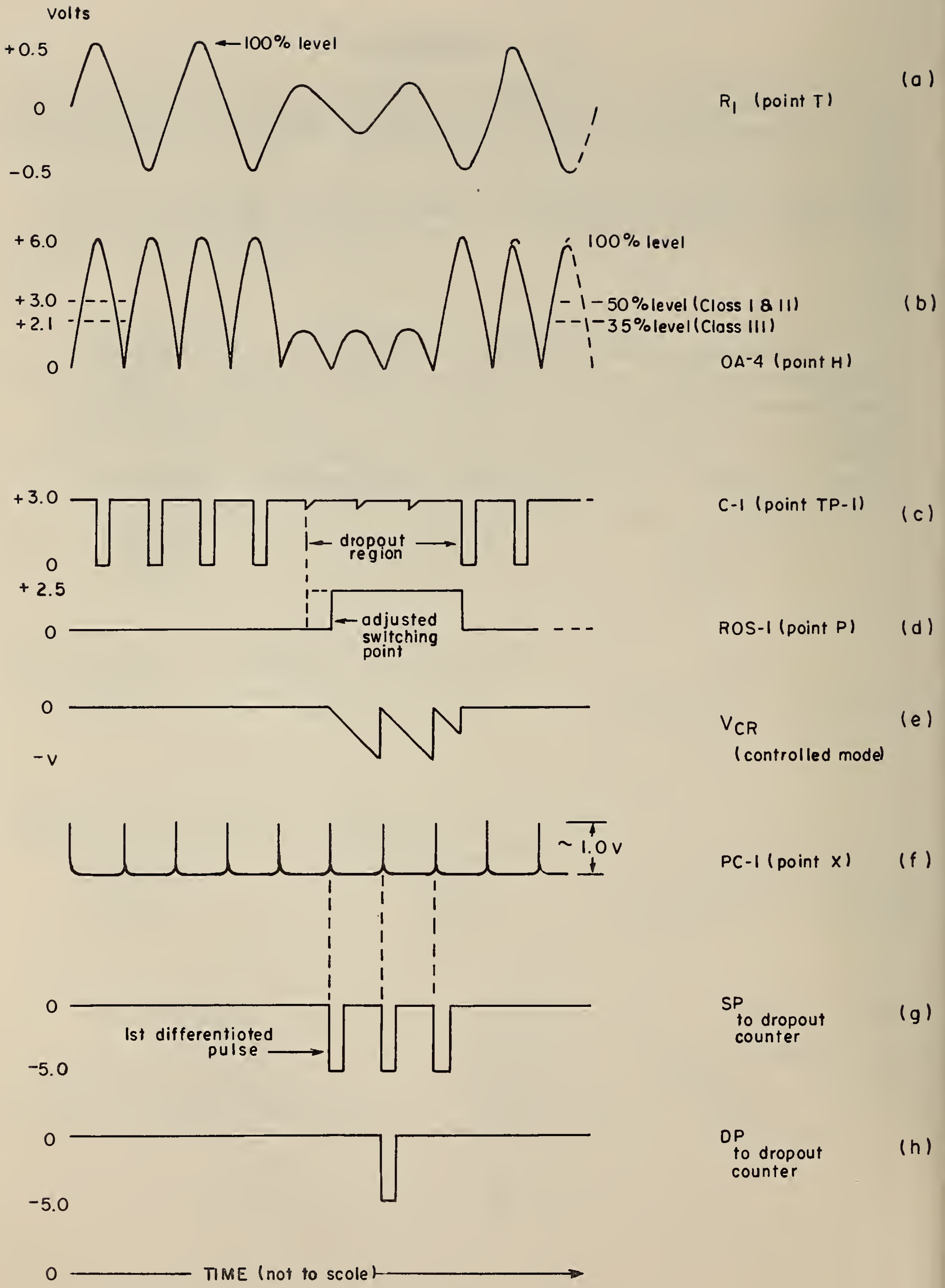

Figure 2. Signal waveforms in computer tape measurements.

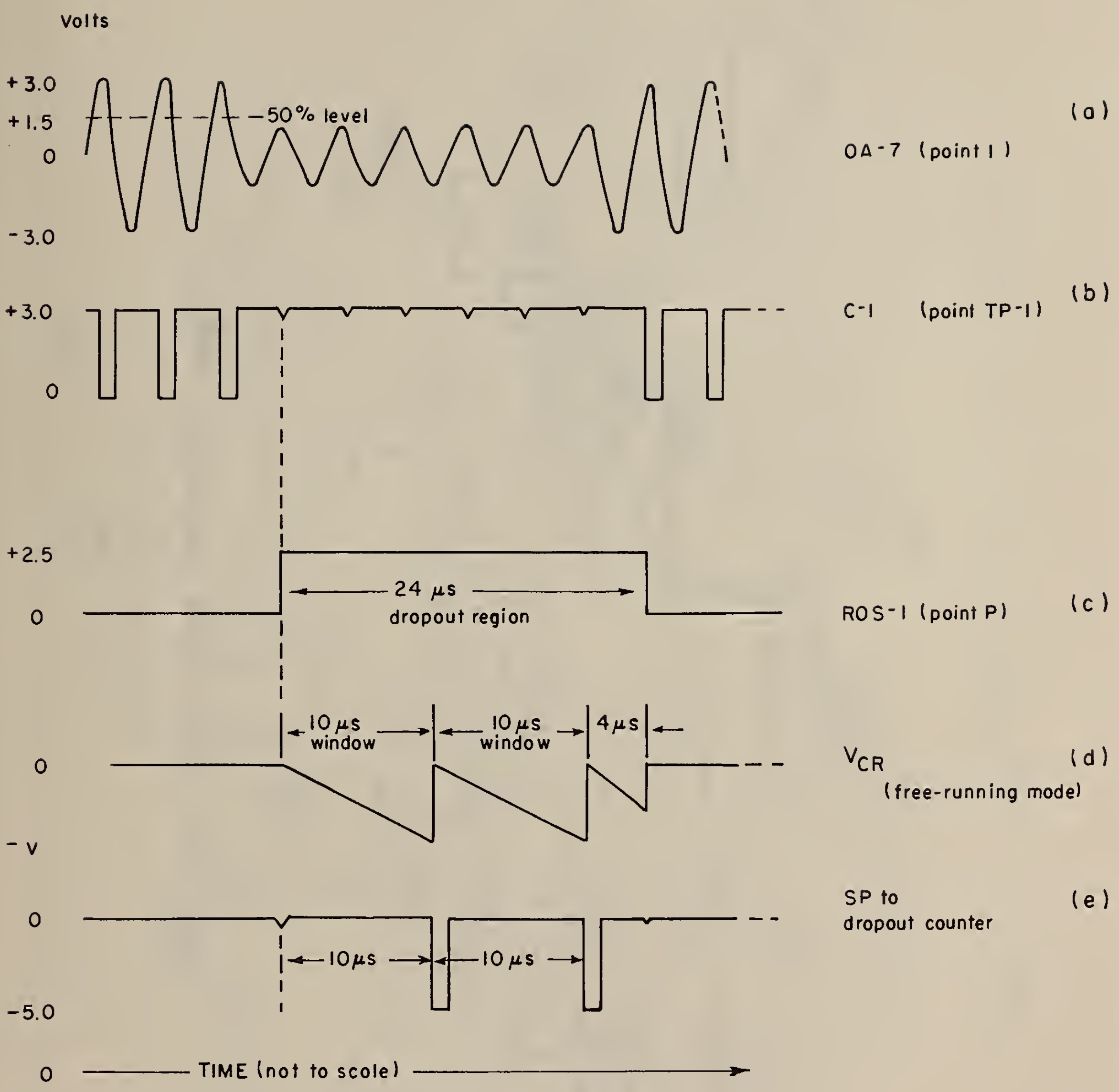

Figure 3. Signal waveforms in instrumentation tape measurements.

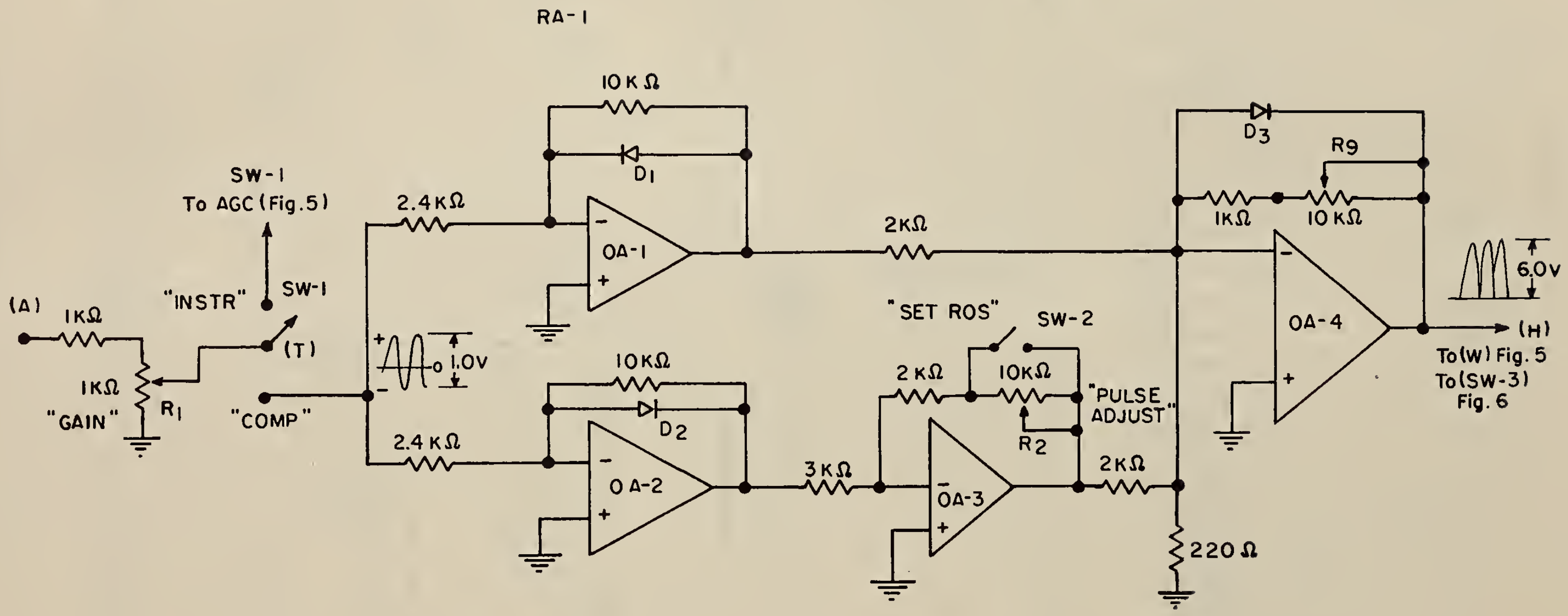

Figure 4. Rectifying amplifier circuit, RA-1.

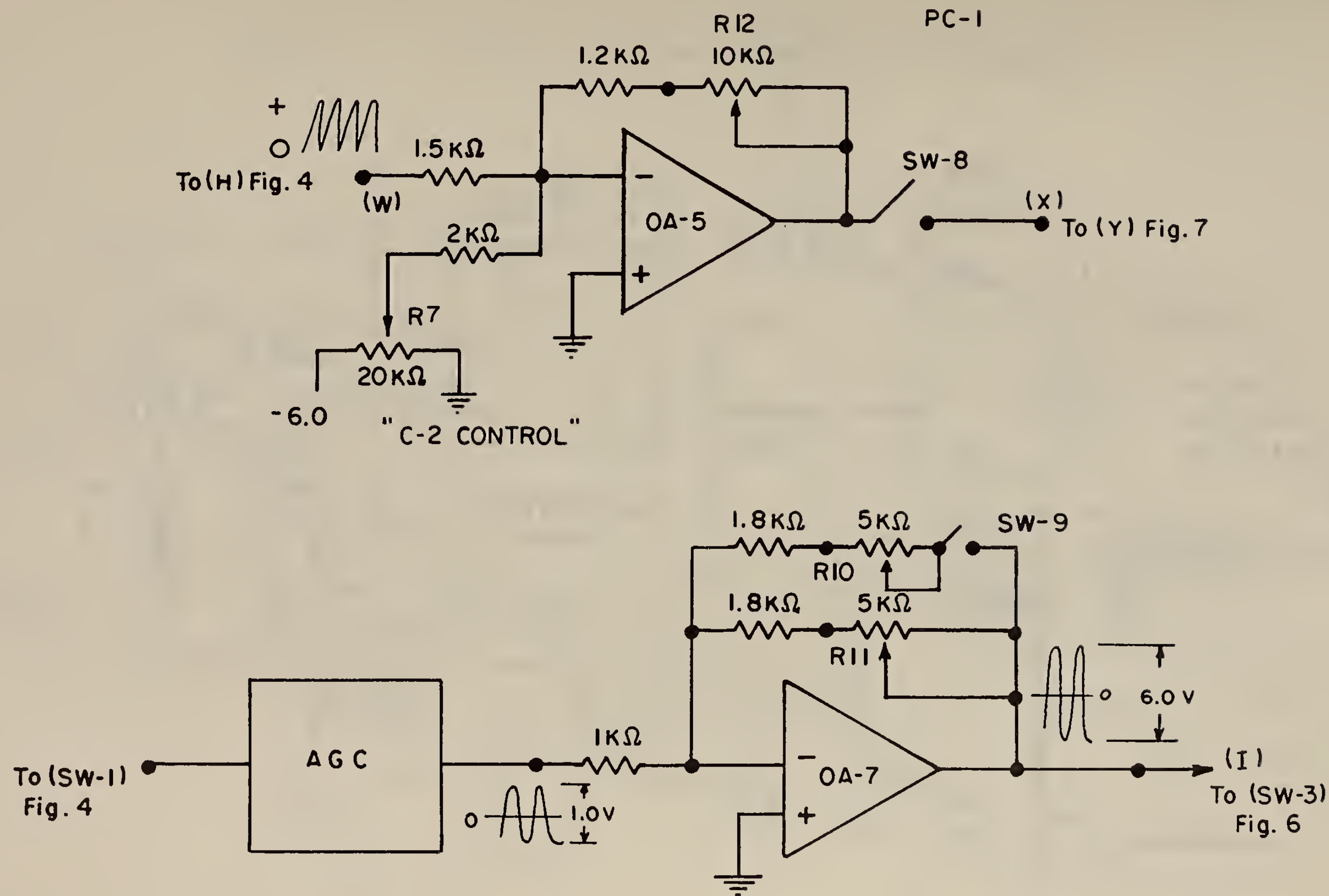

Figure 5. Pulse control PC-1 and OA-7 circuits.

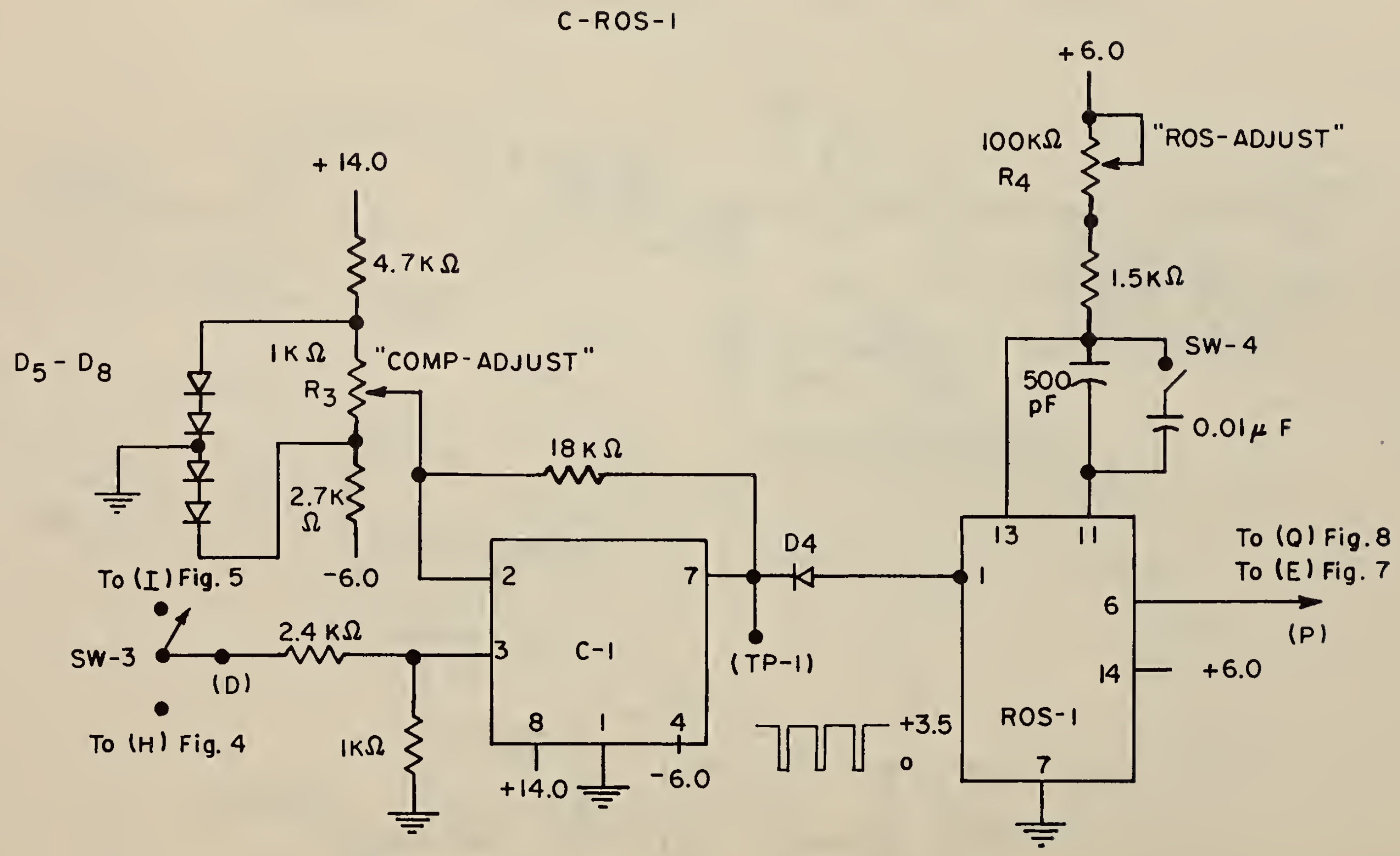

Figure 6. C-ROS-1 threshold detection circuits.

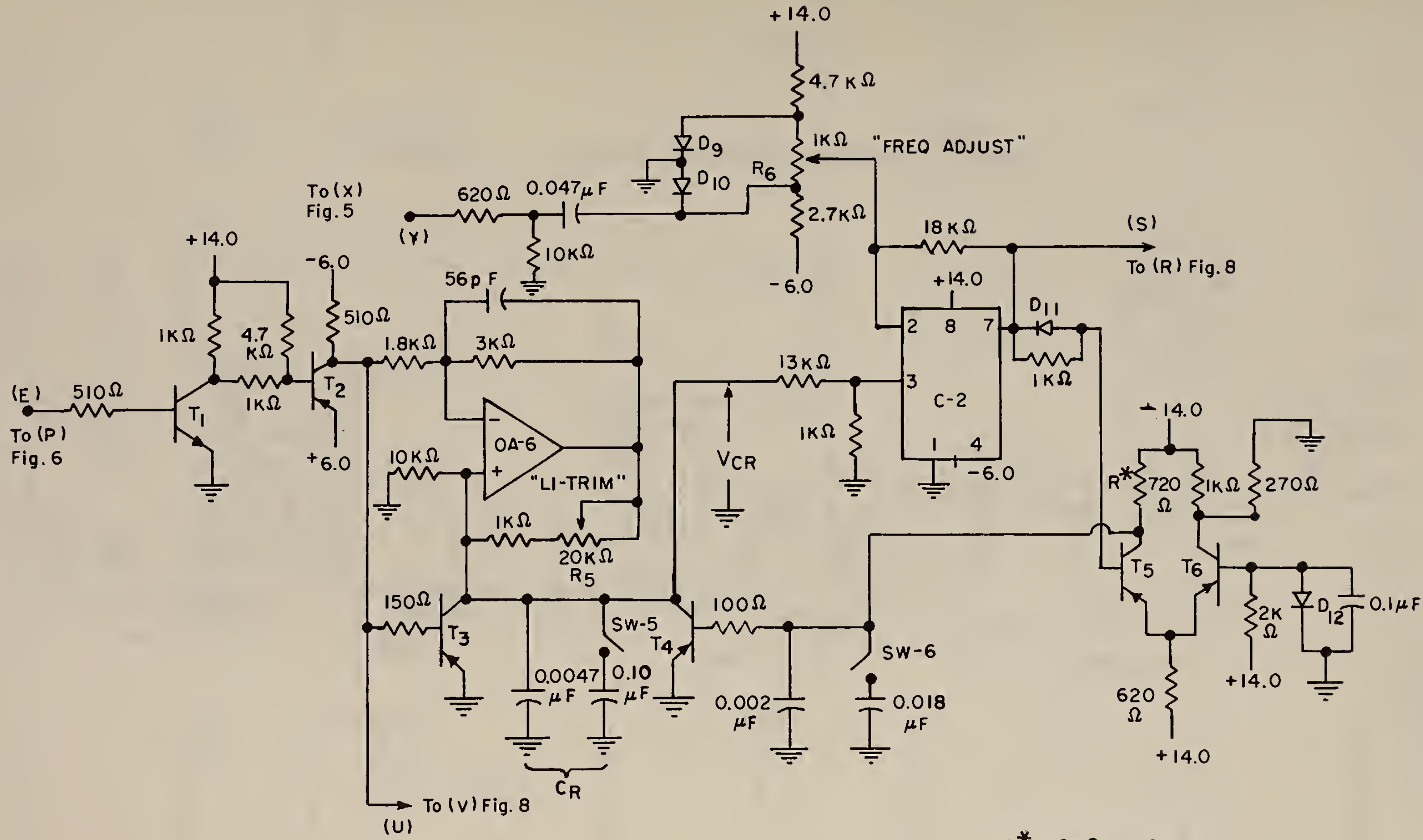

Figure 7. LI-PG-1 pulse generator system.

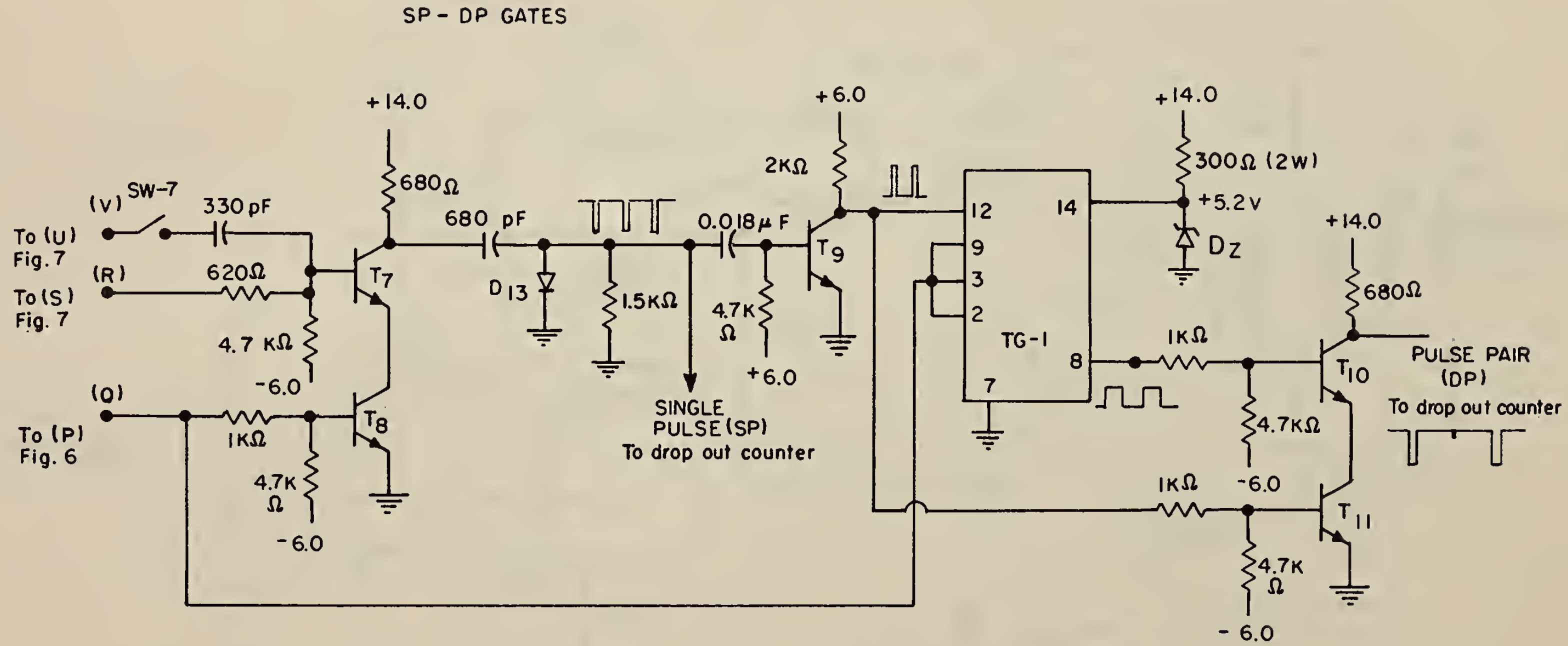

Figure 8. SP-DP dropout counting gates.

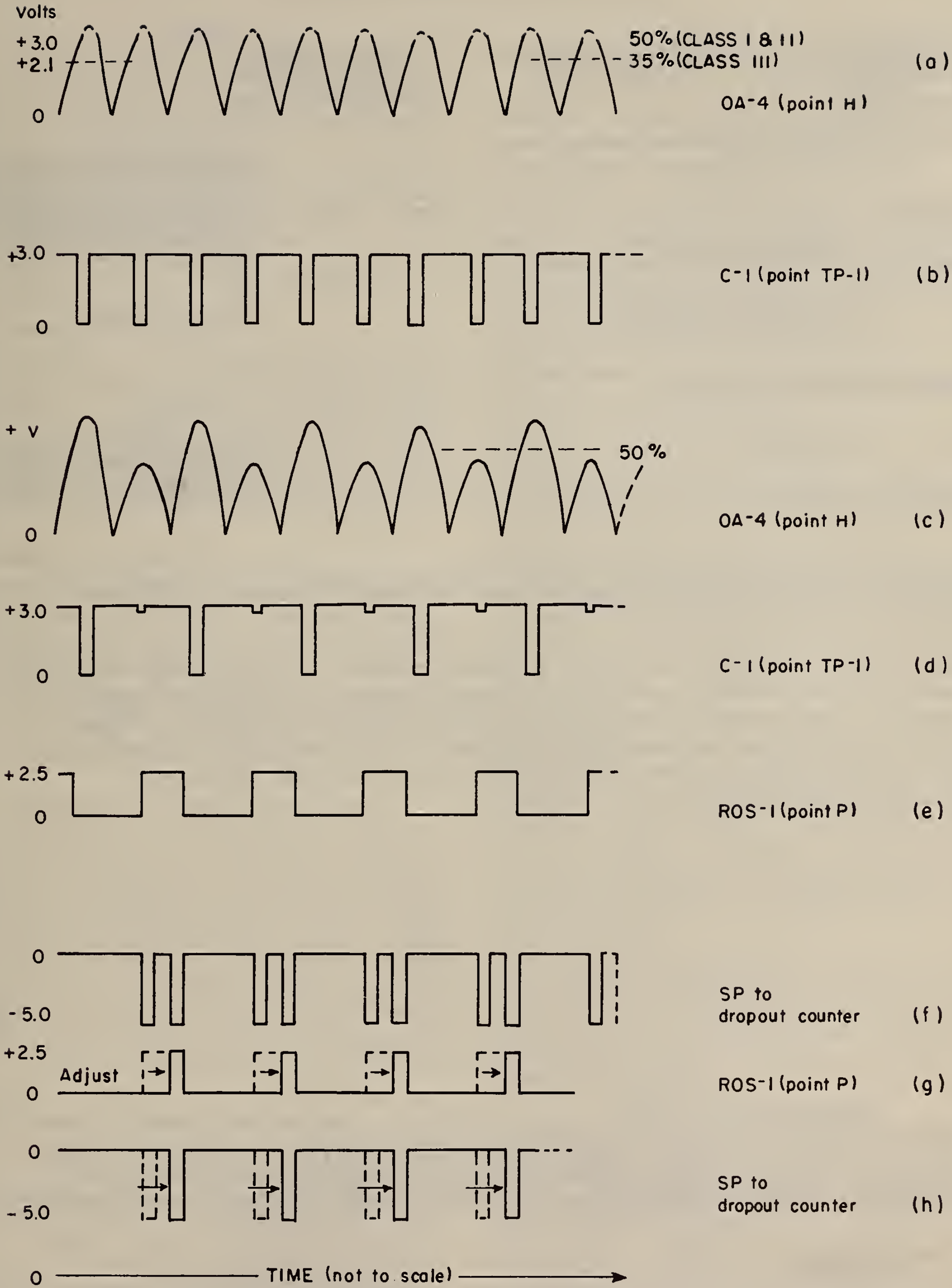

Figure 9. Signal waveforms in system calibration.

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15. SUPPLEMENTARY NOTES

16. ABSTRACT (A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)

This Technical Note describes a signal dropout detection and counting system which was designed to make measurements on 1/2 inch magnetic computer tape, magnetic instrumentation tapes and magnetic cassette tapes as required by existing and potential Federal Specifications. The calibration and operational procedures for the system are described in detail.

17. KEY WORDS (Alphabetical order, separated by semicolons) Dropouts, cassette tapes; dropouts, computer magnetic tapes; dropouts, instrumentation magnetic tapes; dropouts, measurement system; magnetic storage media; signal amplitude, dropouts.

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