NAVAL AIR DEVELOPMENT CENTER

WARMINSTER, PA. 18974

REPORT NO. NADC-73030-20 11 MAY 1973

TELEVISION CAMERA TUBE LAG TESTER

PHASE REPORT

NAVELECSYSCOM

PROJECT ORDER NO. PO 3-3009

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DEPARTMENT OF THE NAVY
NAVAL AIR DEVELOPMENT CENTER
WARMINSTER, PA. 18974

Aero-Electronic Technology Department

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A unit has been developed to provide a more versatile, convenient and inexpensive method of testing lag response in tv camera tubes. Lag is measured by exposing the tube to a step transition in irradiance and measuring the resultant transient response. The irradiance is provided by a 4 x 4 array of gallium arsenide phosphide LED continually recycled on and off by a digital logic circuit. Controlling the on and off period permits the unit to be used in evaluating tubes which exhibit a wide range of lag response. A high degree of measurement accuracy is possible by use of a synchronizing trigger allowing for the observation of a single line of video. Details of the logic circuit operation, circuit diagrams, timing waveforms and a complete description of the operation controls are presented.

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S U M M A R Y

INTRODUCTION

Low light level tv camera tubes exhibit a smearing of image detail when viewing a scene in motion relative to the camera's field of view. Image persistence, commonly called lag, is the main cause of this type of image degradation. Thus, lag is an important characteristic to evaluate when assessing a camera tube's performance. Image retention can be quantitatively determined in the laboratory by exposing the sensor to a step transition of light and measuring the resultant transient response.

Lag is a multiparameter phenomenon often described with one number - the percentage of signal remaining 50 milliseconds after the light input has been removed. However, to more completely characterize the tube's response, lag should be measured as a function of dark current, signal current level, and position on the raster. Hysteresis effects and the overload recovery of the tube also bear investigation. Inherently, the equipment needed to perform such measurements should provide versatility for controlling the test conditions, be easy to setup and operate, and provide for speedy and accurate data collection. These requirements demand that the equipment independently control the phase, amplitude and period of square wave of light intensity and provide a synchronizing trigger output. There is no known commercially available equipment capable of meeting these demands.

The NAVAIRDEVCEN has improved and updated its existing lag measurement capabilities by developing a pulsed LED lag tester that performs a comprehensive evaluation of lag response of tv camera tubes.

RESULTS

The following is a summary of the characteristics of the lag test unit.

Input requirements	115 vac Vertical drive (negative, 3 to 7 v amplitude) Horizontal drive (negative, 3 to 7 v amplitude)
Power requirements	Logic supply: 5 v at 600 milliampere Driver supply: 5 v at 525 milliampere
LED array output	Brightness on opal glass is 2 foot-lamberts at 500 milliampere Peak wavelength: 0.66 microns Optical Bandwidth = 0.64 microns

	Rise time = 0.5 microsecond Fall time = 1.5 microsecond
Trigger output	Positive pulse, 0 to +4 v Pulse width = 20 microsecond
Variable parameters	Light on period, light off period independently adjustable from 1 to 99 tv frames. Delay of light cycle adjustable from 1 to 999 horizontal lines. Trigger output delay adjustable from 1 to 99 tv fields.

CONCLUSION

The pulsed lag tester has proven to be a simple and convenient unit to operate requiring minimal setup and data collection time. A wide variety of operating conditions have been achieved, thus permitting a comprehensive and precise evaluation of lag response. Compactness and low cost of the unit is made possible by the utilization of IC and LED.

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B A C K G R O U N D

BASIC PHYSICAL NATURE OF LAG

The lag response of a typical tv camera tube depends on the characteristics of the storage target and reading beam. The scanned surface of the target is charged down to cathode potential by the reading beam. A charge pattern is formed when optically generated carriers neutralize the charge stored in the target with the amount of discharge being proportioned to the light intensity of the scene. The reading beam interrogates the target to reestablish the charged condition, thus erasing the charge pattern. During the scanning operation, the video signal is developed in accordance with the amount of current needed to recharge the capacitor.

If the scene illumination is removed, an image is retained for a number of fields with each succeeding field containing a decreasing amount of residual signal. The residual signal remaining after each succeeding field is the transient response (lag) and is dependent upon such tube parameters as the beam characteristics, target capacitance and level of stored signal.

A smearing of detail occurs when the scene is moving, resulting in a loss of dynamic resolution and a deterioration of image quality. Frame to frame image retention and the fact that the scene is integrated for a finite frame time are two reasons for this degradation.

INSTRUMENTATION REQUIREMENTS

The equipment used in the past for transient response measurement has been bulky, cumbersome and somewhat unreliable for extracting accurate data. Fluorescent sources are characteristically laggy themselves, and thereby affect the accuracy of the measurement. Methods of mechanical shuttering of the light have proven to be unsatisfactory because manual recycling was necessary.

The use of LED and IC have made current lag test equipment convenient, compact and more reliable. The fast rise and fall time of the LED has alleviated the problem of a laggy light source and the IC make automatic recycling convenient.

The improvement in equipment hardware has not been correspondingly matched by a refinement of the measurement technique. Currently, the data is obtained from oscilloscope video waveform presentations of the tube transient response covering many fields or from one selected field. The accuracy of the data is limited by the effects that preamplifier noise, 60 Hz hum, shading and shifting clamp levels have on the video waveforms. The technique of viewing any desired horizontal line within any field would eliminate these effects. A synchronizing trigger from the test unit allows this technique to be employed.

Normally, camera tube lag is simply measured as the percentage of signal remaining from a selected operating steady-state signal level 50 milliseconds after the light has been extinguished. However, a one number description cannot completely describe a multiparameter function. Transient response should be measured in a more complete manner to better assess a tube's lag performance.

To perform a comprehensive measurement of lag, the test equipment must have the versatility to handle various test conditions. The requirements for the equipment should include the following:

1. An independently adjustable control of on and off periods of light is necessary. In particular, long periods are needed to check for hysteresis and to measure overload recovery.

2. A method is needed for measuring lag as a function of position on the raster.

3. A means of triggering the oscilloscope is required in order to present stable, repetitive waveforms. This would also permit the selection of one horizontal line for viewing, thereby obtaining a high degree of accuracy in measuring the data.

4. A capability of presenting the total buildup and decay lag response is necessary.

5. A control to adjust photocathode illumination is required to obtain different signal output levels over the normal operating range of the tube.

OPERATING CONTROLS

The following sections describe the functions and interaction of the front panel controls shown in figure 1.

Thumbwheel Switch - Thumbwheel switches control the logic counting circuits. The decimal numbers shown on the dials are transformed into a binary code to set the internal logic for the proper counts.

Inputs - Negative vertical and horizontal drives (V_D and H_D, respectively) are needed for proper operation. Positive V_D, H_D pulses can be used if the input inverters are bypassed. The high impedance of the logic input circuits do not load the drive lines.

PULSED/CONT - The PULSED/CONT switch determines the operating mode of the LED array. In the PULSED position, a logic pulse train is fed to the LED driver stage to cycle the array into on and off periods. In the CONT

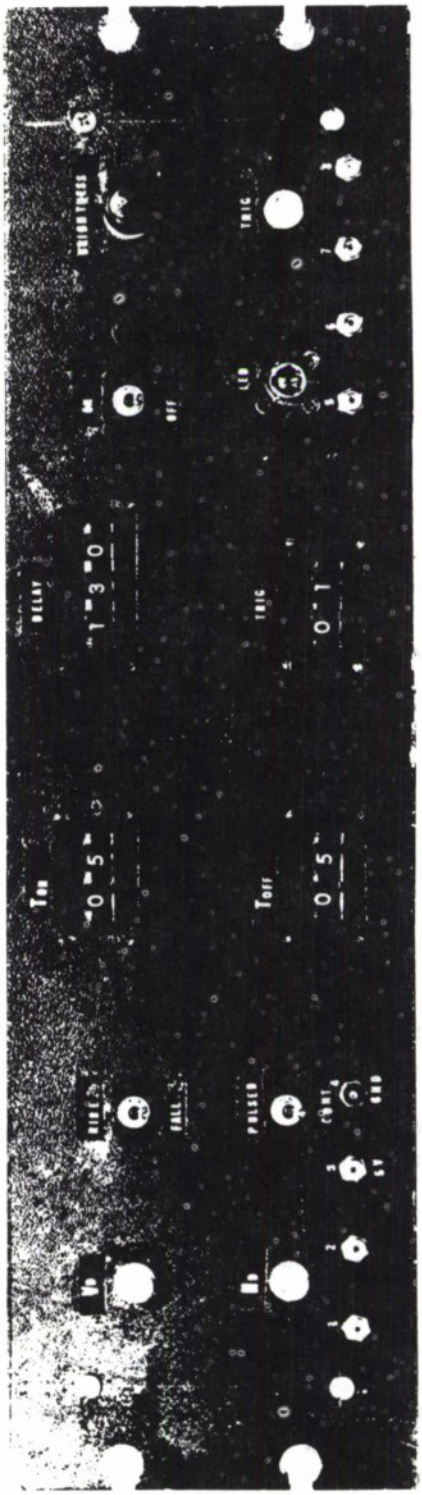

FIGURE 1 - Pulsed LED Lag Tester

position, the pulse train to the driver circuit is discontinued and the LED remain in a continuously on condition.

BRIGHTNESS - The BRIGHTNESS control is used to adjust the LED irradiance level for both pulsed and continuous operation. An open position on the control allows the array to be extinguished without effecting other operations.

RISE/FALL - The RISE/FALL switch permits measurements of buildup or decay lag. The position of this control determines if the trigger to synchronize the oscilloscope occurs during the LED on or off period. In the RISE mode, the TRIG output occurs when the array is on, thus buildup lag can be measured. If FALL is selected, the TRIG output occurs during the light off period and decay lag can be measured.

T_{ON}/T_{OFF} - The number of frames (1 to 99) the LED array is pulsed 'on' or turned 'off' is determined by the setting of the T_{ON}/T_{OFF} dials. Each control is functionally independent of the other and any combination of T_{ON}/T_{OFF} periods can be accomplished.

A condition of '00' for either function results in an'on' or 'off' period equal to one frame.

DELAY - The start of the light cycle can be positioned anywhere in the field by the DELAY control. The dial figures correspond to the number of horizontal lines counted before the light cycle starts. Improper test results will occur if the number dialed is greater than the number of horizontal lines contained within one field. For example, 262 is the maximum number that should be dialed for the 525 line, interlaced mode of scanning.

TRIG - A positive 4 v trigger pulse, used to synchronize the oscilloscope, is available at the TRIG connector. The TRIG thumbwheel indicates the field number in which the trigger occurs during the 'on' or 'off' period and its position within the field is dictated by the DELAY control. An output exists only once during the 'on' period for the RISE position or the 'off' period for the FALL position. The '01' setting corresponds to the field in which the light transition takes place. This field is often designated the initial or 'zeroeth' field. If this convention is used, the field number is determined by subtracting one from the dial setting. A trigger is not generated for a dial setting of '00'. A TRIG output can occur for a field number that is greater than the number of fields dialed on T_{ON}/T_{OFF}. For example, if T_{OFF} = 05 and FALL are selected, the light pulse will remain off for 10 tv fields. If the TRIG dial is set for any number from 01 to 10, a trigger will occur during the 'off' time of the light source. However, if a number greater than 10 is selected for the TRIG setting, a trigger output will result during the 'on' time of the light source, thereby allowing a field that occurs in the'on' time instead

of the 'off' time to be presented on the oscilloscope. To prevent this situation, the TRIG setting limit should be

$$TRIG \leq 2T_{ON} \text{ or } 2T_{OFF}.$$

LED - The LED array is connected to the driver stage of the unit via the LED two pin Burndy connector.

TEST POINTS - Test points are located on the front panel to enable quick and easy fault isolation. The various signals available at the test points are listed below. Waveforms can be found in the section CIRCUIT THEORY.

TP1 - Output of DELAY counter gating flip-flop
TP2 - DELAY circuit output
TP3 - Logic power supply (5 v)
TP4 - Ground
TP5 - Input to TRIG circuit from T_{ON}/T_{OFF} stage
TP6 - LED array drive pulses
TP7 - TRIG output
TP8 - Blank

C I R C U I T T H E O R Y

GENERAL

Figure 2 is a block diagram of the logic circuits showing the basic interaction between the stages.

The DELAY circuit provides the main timing pulses for the unit. The vertical drive input initiates gating to allow the programmable counters to count the number of horizontal drive pulses as determined by the DELAY setting. Once the proper count has been reached, an output pulse is produced. This pulse ceases counting operations until the next vertical drive input, at which time the process repeats itself. Thus, only one output pulse is produced per field and can be made to occur on any horizontal line within the field.

The T_{ON}/T_{OFF} circuit consists of two sets of counters. The DELAY input is first transformed from a field repetition rate to a frame rate with pulses one field wide. These pulses are simultaneously counted by the T_{ON}/T_{OFF} counter. When one counter has finished its operation, it produces a pulse that causes itself to be gated 'off' and the other counter to be gated 'on'. The counter outputs also create a pulse train that ultimately drives the LED array. The high level condition of the output corresponds to LED 'on' periods while the opposite is true for the low level portion of the cycle.

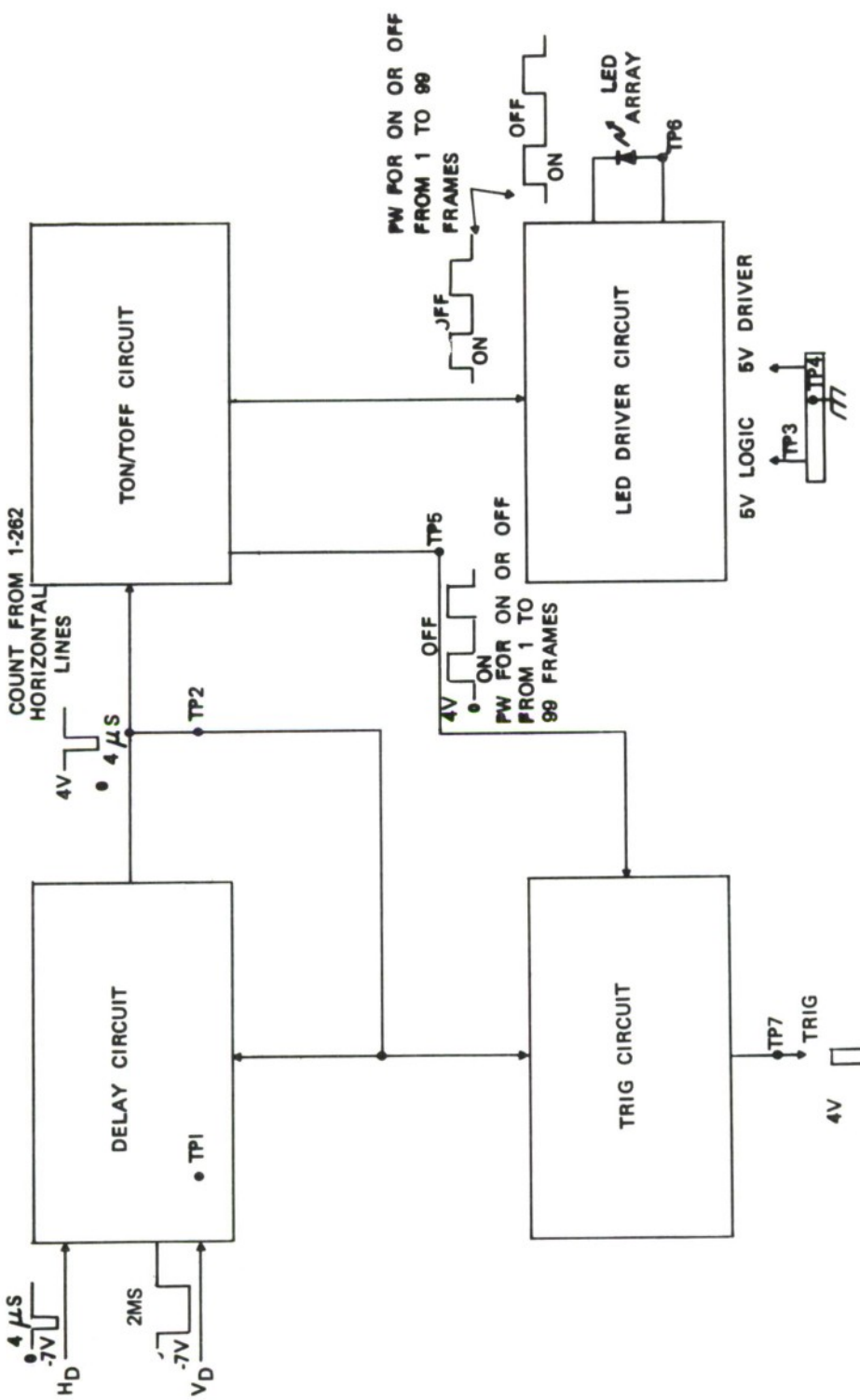

FIGURE 2 - Circuit Block Diagram

The TRIG circuit operates in the same manner as the DELAY circuit. The leading edge of the T_{ON}/T_{OFF} input initiates counter on gating to count the DELAY pulses as determined by the TRIG control. The TRIG pulse, therefore, occurs only once during either the T_{ON}/T_{OFF} period.

The driver stage receives the T_{ON}/T_{OFF} pulse train and correspondingly cycles the LED array. This stage acts as a buffer between the high power requirements of the array and the low power logic.

DELAY CIRCUIT THEORY

The schematic and timing waveforms of the DELAY circuit are shown in figures 3 and 4, respectively. The IC operate on positive logic, thus the negative vertical and horizontal drives are ac coupled at the input. The inverters then transform the inputs into positive logic pulses. The input decoupling networks were designed to preserve the input waveshape and to prevent loading effects on the inverters or drive inputs.

The waveform in figure 4c shows the gating flip-flop output going to a '1' state when triggered by the trailing edge of the vertical input and remaining in this condition until the S_1, C_2 inputs change.

This high level signal on the counter $\overline{PE}$ terminal enables the counters to count the horizontal drive pulses present at the gate input. The counter output pulse occurs when the counter has reached the number programmed on the front panel thumbwheels. The output pulse width of the MC4016 equals the pulse width of the input pulse. With the counters connected as shown in figure 3, the count can be extended to 999. However, as discussed in "OPERATING CONTROLS - DELAY" erroneous triggering operations will occur for a count that is greater than the number of horizontal lines contained within a field.

The present inputs (P_0 to P_3) requires either a high voltage (5 v) or a low voltage (ground) input for the MC4016's to properly count. Inverters are used to achieve these requirements.

A BCD (binary coded decimal) code, determined by the thumbwheel outputs, is fed to the P_0 to P_3 terminals. The $\overline{MR}$ counter terminals require a 5 v level to prevent spurious gating and counting operation. Once a counter output is obtained, it is fed to a monostable multivibrator to set the gating flip-flop in a '0' logic state. This low voltage condition disables the counters until the next vertical drive input. The multivibrator was necessary for stable gating operation. It was found that pulses greater than 10 microseconds in width were required on the S_1, C_2 inputs to properly change the gating flip-flop's output state. The one-shot output is 16 microsecond wide.

As seen from figure 4d, the DELAY circuit allows one output pulse per field that can be positioned anywhere within a field.

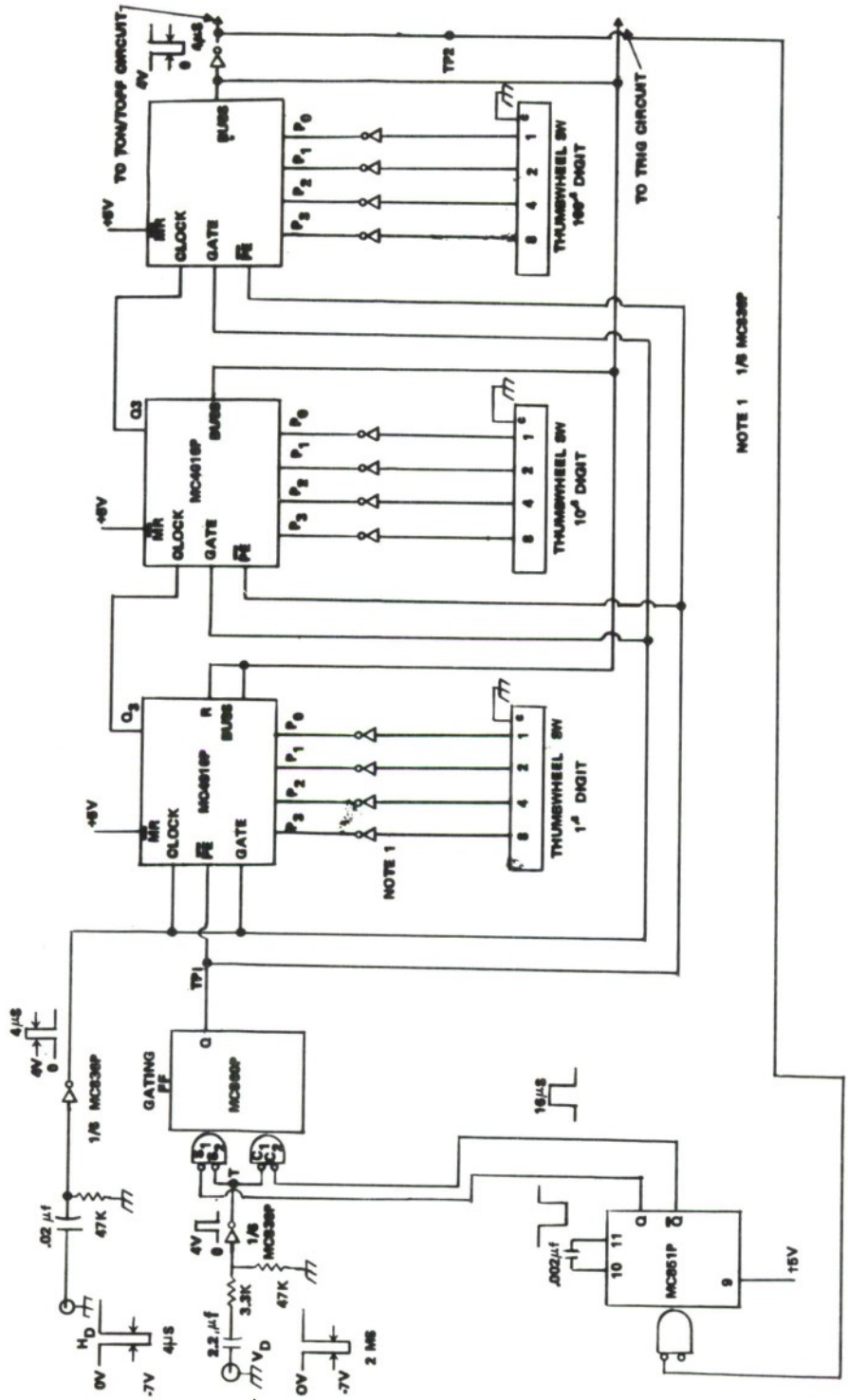

FIGURE 3 - DELAY Circuit Schematic

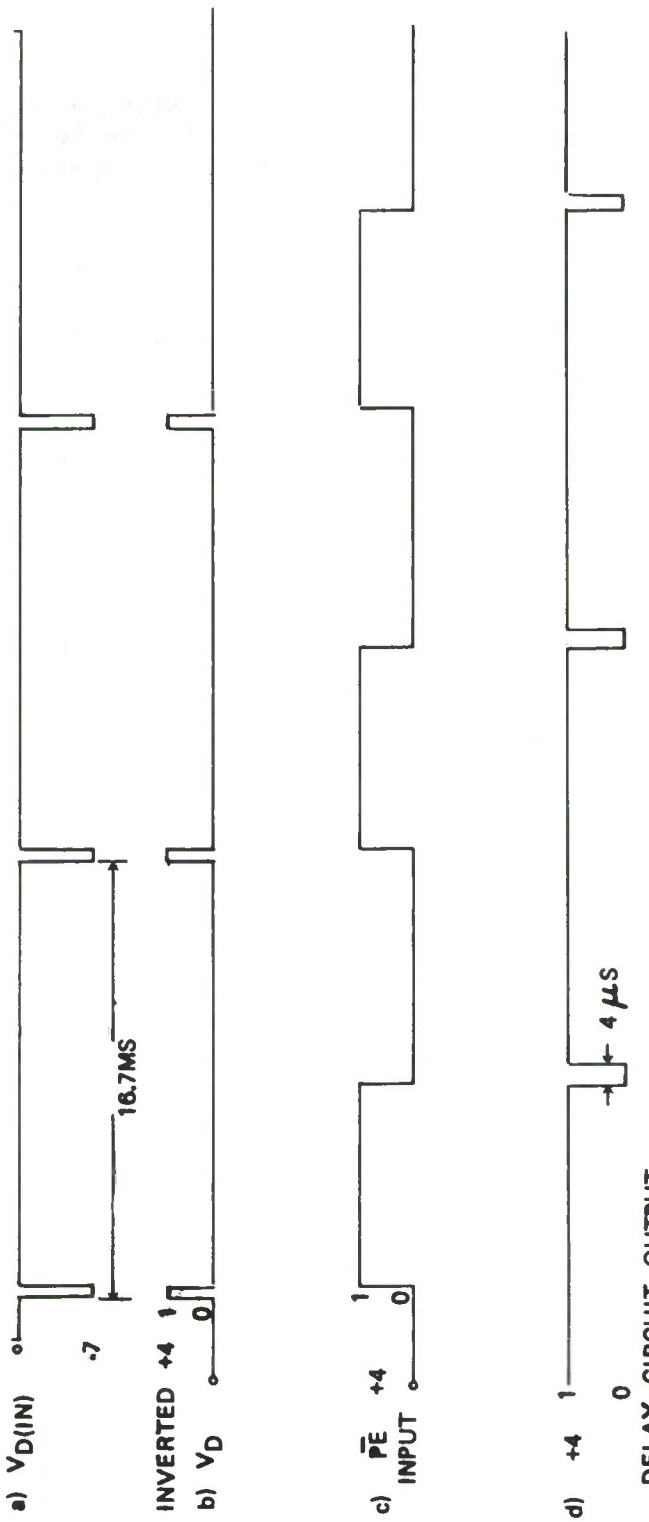

FIGURE 4 - DELAY Circuit Waveforms

T_{ON}/T_{OFF} CIRCUIT THEORY

The T_{ON}/T_{OFF} circuit as shown in figure 5 uses the DELAY output to trigger a flip-flop to produce the necessary timing pulses (see figure 6). The flip-flop output is a pulse train consisting of pulses one field wide occurring at a frame rate as indicated in figure 6c. This pulse train is sent to the counter stages and to a steering flip-flop that decides which counter circuit is to be gated 'on' or 'off'.

The counting operating is similar in principle to the method employed in the DELAY circuit. The steering flip-flop enables one counter stage while disabling the other counter. When the active counter reaches its programmed count, the trailing edge of the output pulse causes the flip-flop to change state.

The two counter circuits now change their operating conditions with the previously enabled counter being disabled and vice versa. Once an output occurs in this mode of operation, the cycle is repeated. The T_{ON}/T_{OFF} counter outputs to the steering flip-flop are indicated in figures 6d, e. The final outputs of the T_{ON}/T_{OFF} stage to other unit circuits are taken from the gating terminals of the steering flip-flop. One of these outputs is shown in figure 6f. Figure 6f indicates that the 'on' and 'off' transitions of the pulses occur at the same relative position within their respective scanning fields. The length of the '1' and '0' states of the output can be varied from 1 to 99 frames.

The output inverter provides isolation between the logic and driver circuits and accomplishes the proper phase reversal of the output. The other output is sent to the RISE/FALL front panel switch and then to the TRIG circuit.

TRIG CIRCUIT THEORY

With a few exceptions, the TRIG circuit shown in figure 7 operates in the same manner as the DELAY stage. However, a critical timing situation exists within this circuit. The leading edge ('1' to '0') of the T_{ON}/T_{OFF} pulses initiates the counter gating via the gating flip-flop, thereby allowing the count of incoming DELAY pulses. The waveforms are presented in figure 8. Ideally, for proper counting operations, the leading edge of the two inputs (figure 8b, c) should coincide as depicted in the expanded view of the pulses in figure 8c. However, a time delay of a few microseconds is associated with the T_{ON}/T_{OFF} pulse causing its leading edge to occur after the beginning of the DELAY pulse as shown in figure 8e by the dotted lines. This situation, if uncorrected, would result in the counter not properly starting its count with the DELAY pulse that concides with the T_{ON}/T_{OFF} pulse transition. The MC4016 triggers on the '0' to '1' transition of the DELAY pulse and would start its count with the next pulse after the T_{ON}/T_{OFF} pulse transition. Hence, the output would occur in the wrong field in relation to the TRIG dial number.

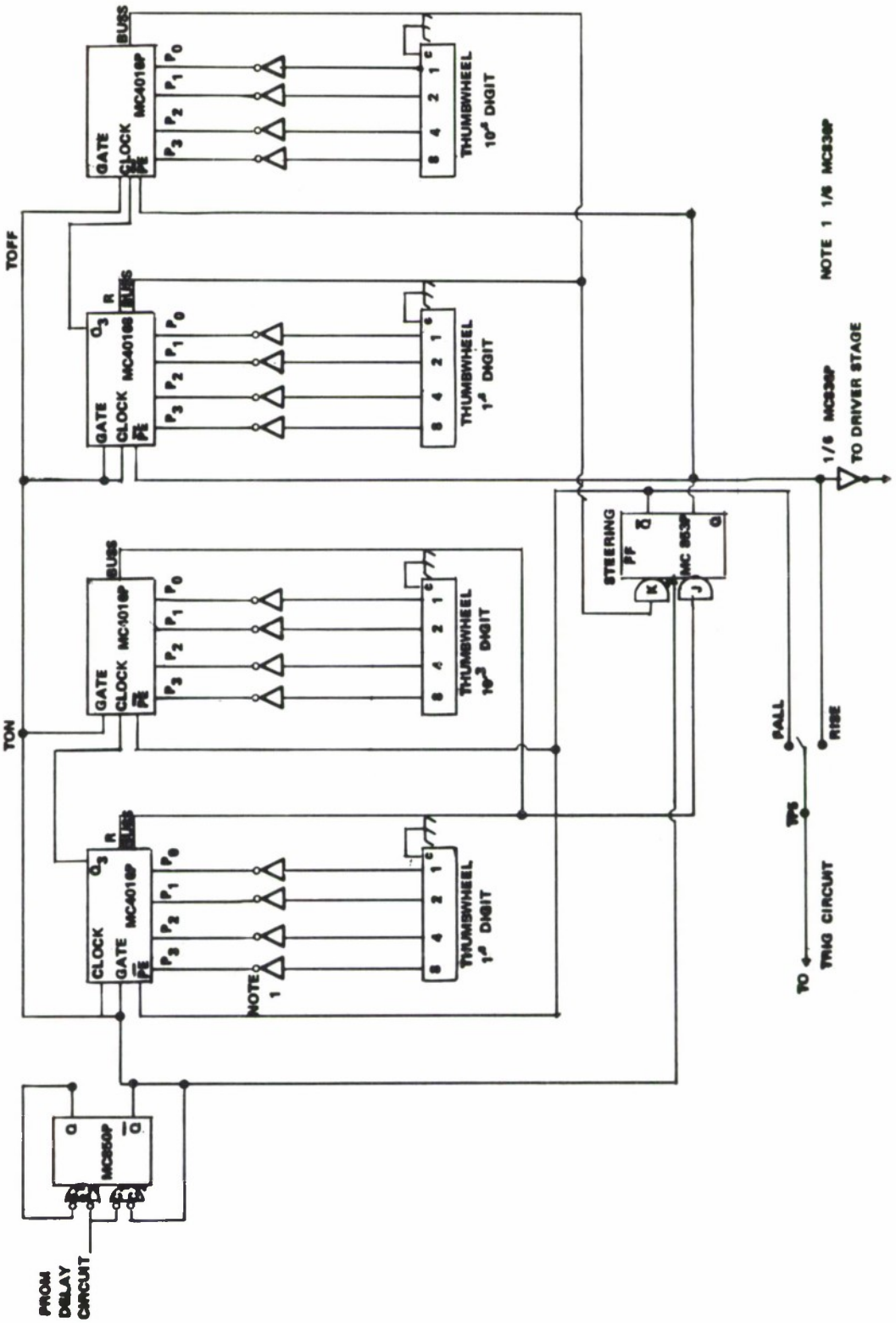

FIGURE 5 - T_{ON}/T_{OFF} Circuit Schematic

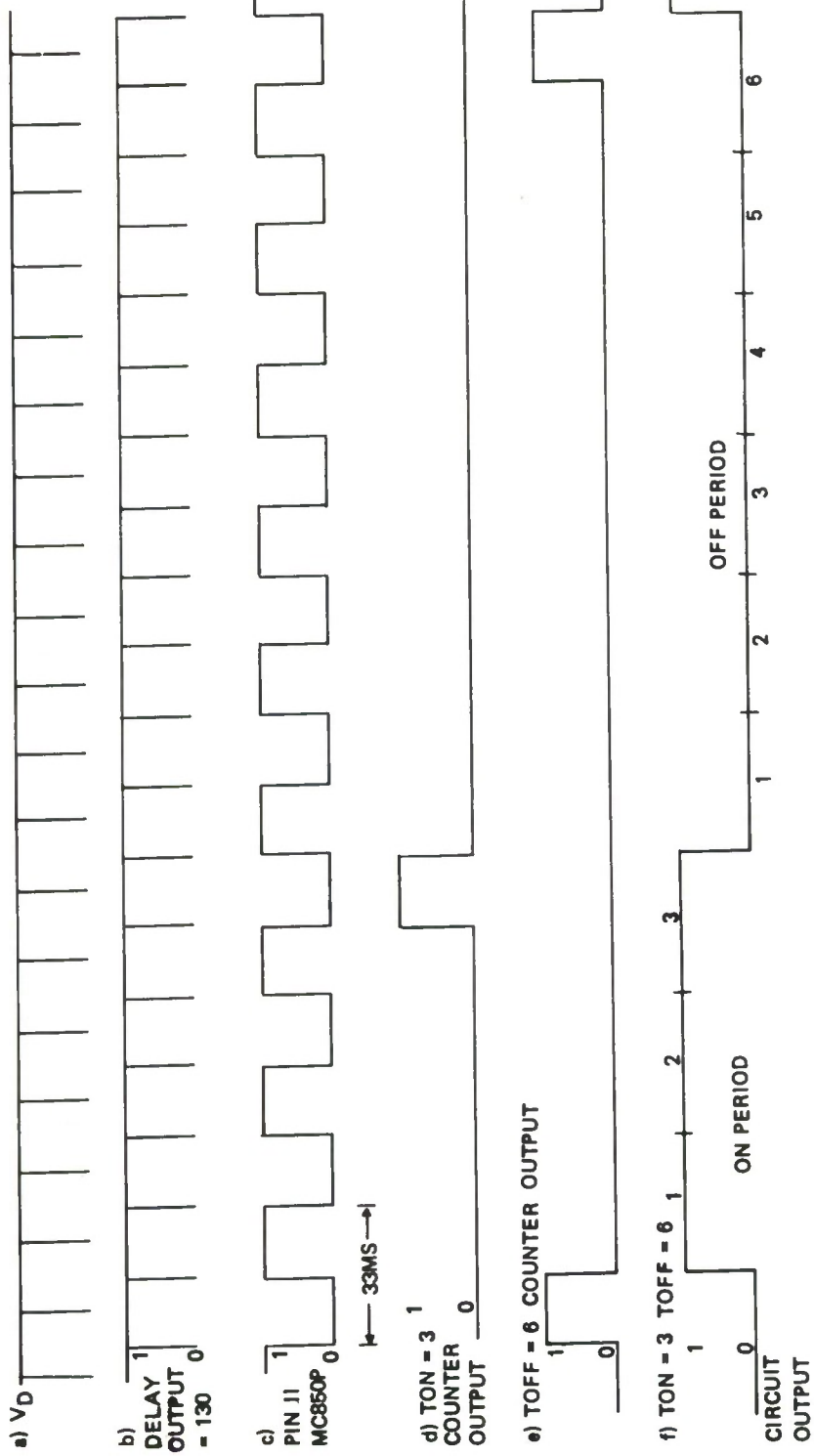

FIGURE 6 - T_{ON}/T_{OFF} Circuit Waveforms

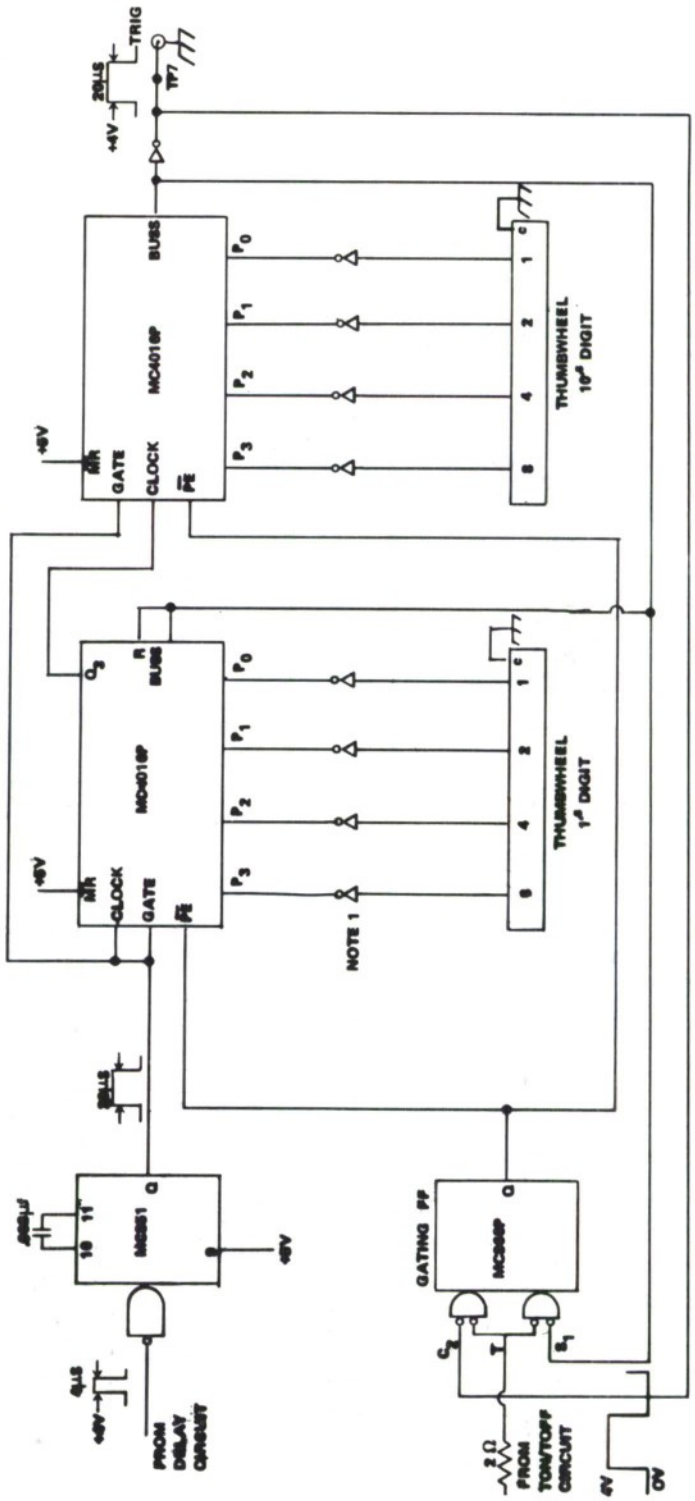

FIGURE 7 - TRIG Circuit Schematic

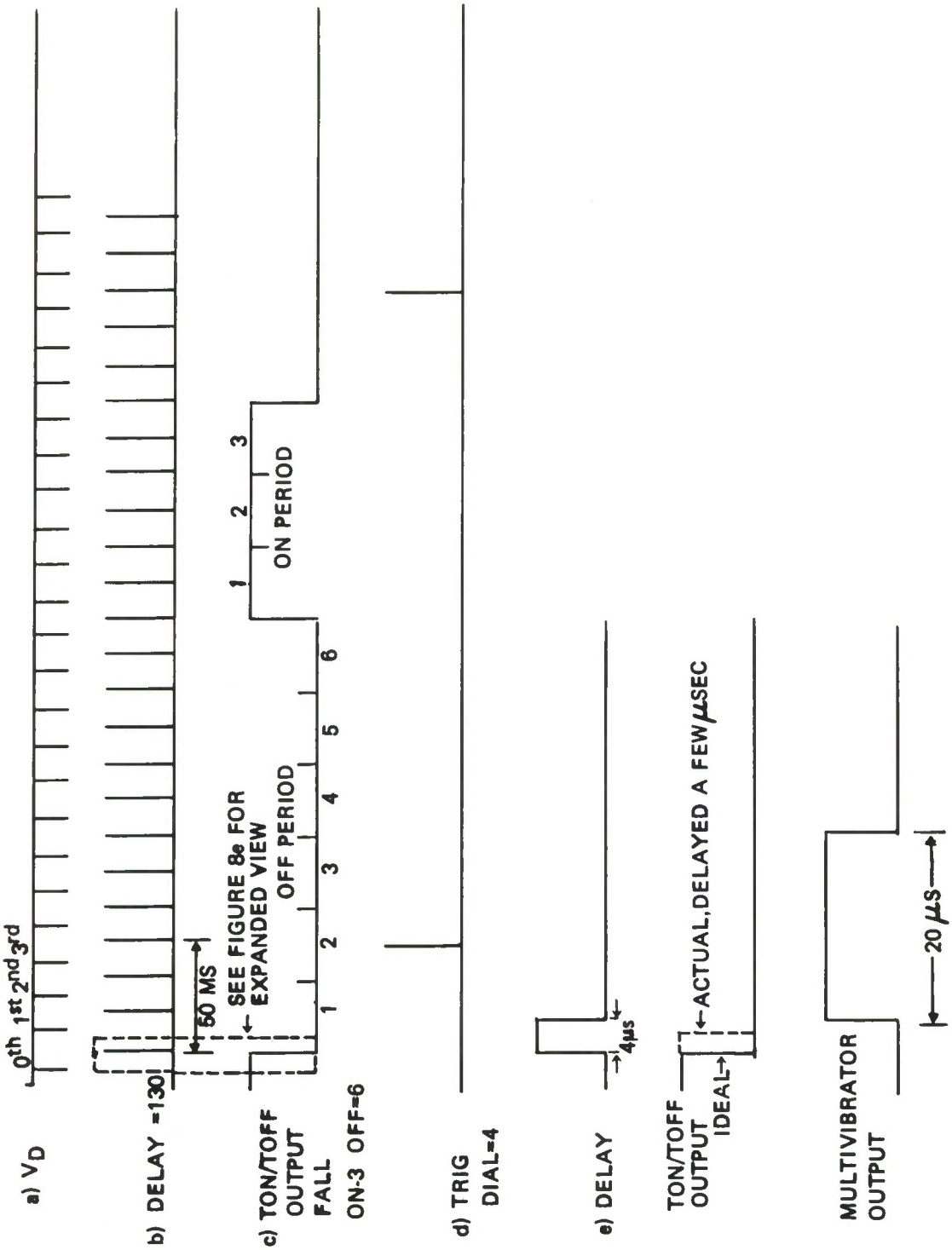

FIGURE 8 - TRIG Circuit Waveforms

For example, if the TRIG dial is set at 04, the TRIG pulse would occur in the second field instead of the third field (see figure 8a, d). To remedy this problem, a monostable multivibrator was used in the DELAY input line. The trailing edge of the DELAY pulse triggers the one-shot. As shown in figure 8e, the multibibrator output occurs after the start of the T_{ON}/T_{OFF} pulse and can be properly counted by the circuit.

The multivibrator output was adjusted for a 20 microsecond pulse width for two reasons:

1. The pulse width alleviates the problem associated with the S_1, C_2 inputs of the gating flip-flop as discussed in "CIRCUIT THEORY, GENERAL."

2. The TRIG output is easier to view when troubleshooting.

The output inverter is used to isolate the logic circuits from the scope trigger input. A two ohm isolation resistor was necessary in the toggle input line of the gating flip-flop to prevent spurious operation.

DRIVER AND LED STAGE

Figure 9 is a schematic of the driver and LED circuit. Transistor Q1 is used for isolation with R_2 reducing the input pulse amplitude to prevent base to emitter breakdown of Q1. The Darlington pair of Q2 and Q3 provides ample signal gain for Q4 to pulse the LED array. The array can draw more than 800 milliamperes but Q4 can be damaged at currents above 600 milliamperes. To limit the LED current to a maximum of 525 milliamperes, R8 was inserted in series with the base of Q4.

The BRIGHTNESS potentiometer (R9) is a 50 ohm, 25 watt resistor used to control the array current and hence, the brightness. When R9 is in the open position, the LED are disabled.

The pulse train input is discontinued for the CONT position of S1. The bias conditions keep Q4 conducting to maintain the same array intensity as was present in the PULSED mode.

The array consists of a 4 x 4 matrix of GaAsP LED. These are red light sources emitting radiation in the 0.63 to 0.69 microns spectral region with each diode having a maximum current rating of 50 milliamperes. With the array inserted behind an opal glass, the brightness was measured as a function of the LED current. The results are presented in figure 10.

POWER SUPPLIES

The power distribution is shown in figure 11. Two 5 v, 1 ampere pcb power supplies were used because the driver/LED stage requires 525 milliamperes and the logic circuits draw 600 milliamperes. The separate supplies further prevent any interaction between the logic and driver stages.

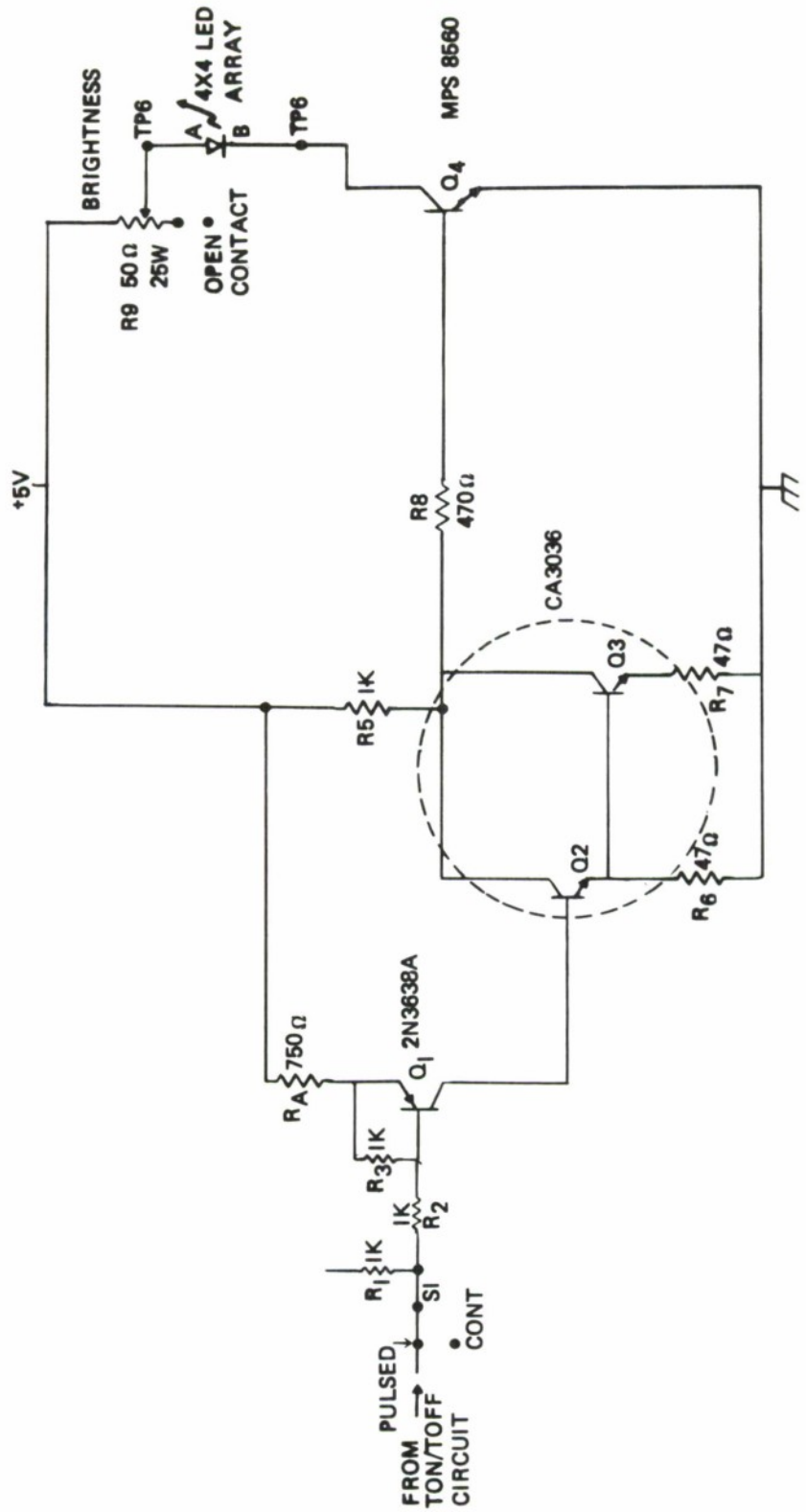

FIGURE 9 - Driver and LED Circuit Schematic

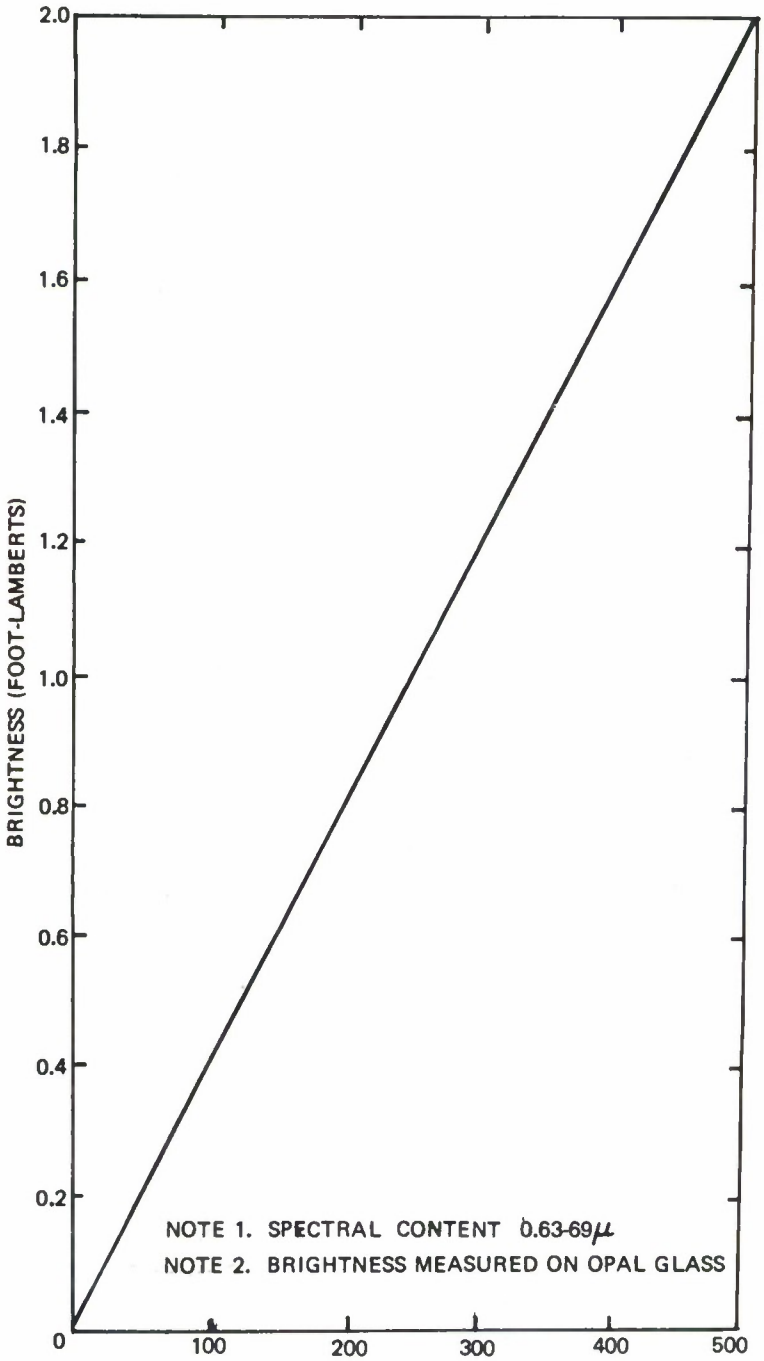

FIGURE 10 - LED Array Brightness Versus Current

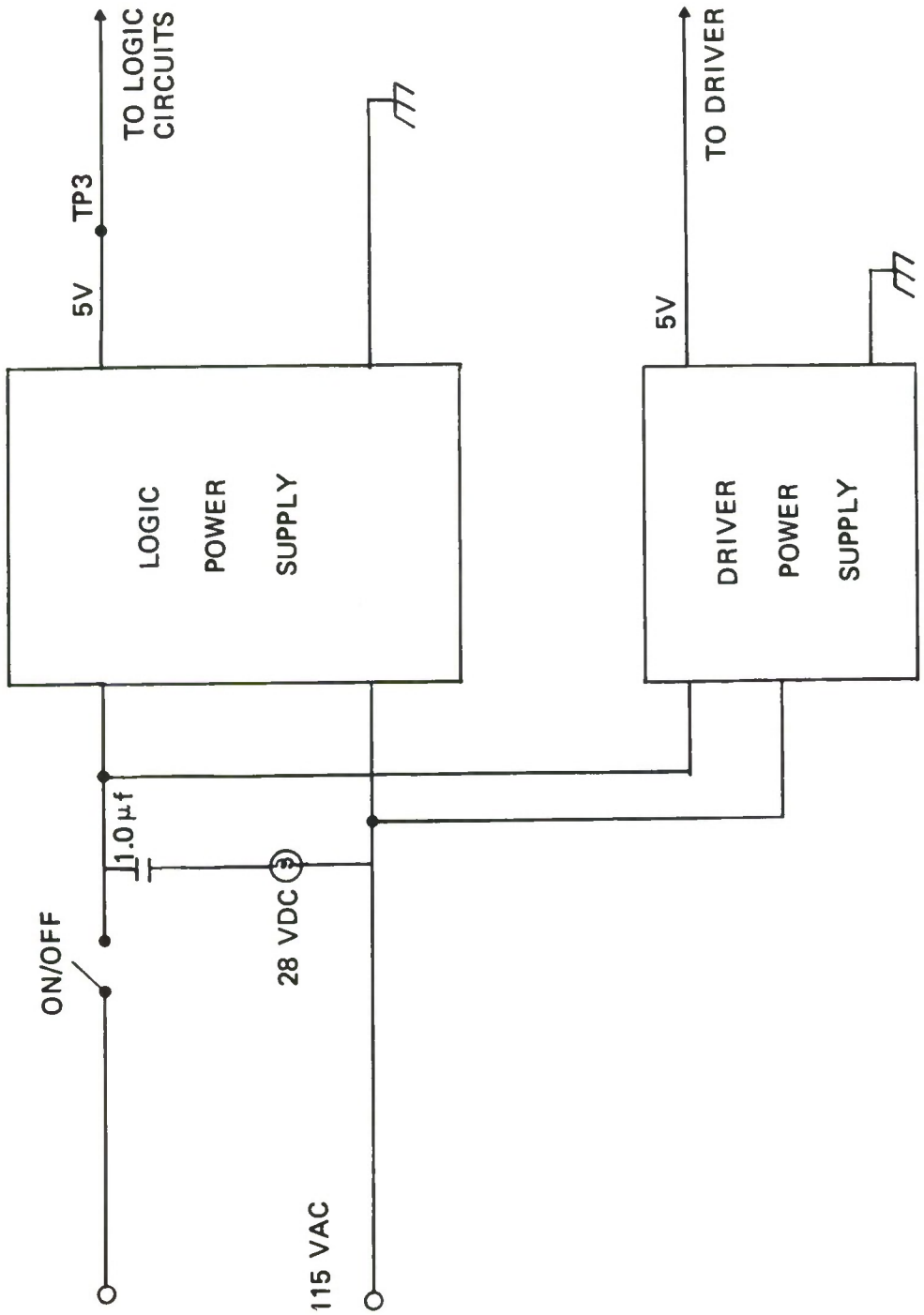

FIGURE 11 - Power Diagram

The indicator light is a 28 vdc bulb in series with a capacitor across the ac input line.

D I S C U S S I O N

The lag tester was designed to be a convenient and versatile unit capable of providing an accurate and comprehensive means for evaluating television camera tube lag characteristics. Measurements conducted using the lag tester have shown that the unit meets or exceeds design expectations.

One of the unit features immediately apparent during the tests was the simplicity of operation. Initial set up required a few minutes and all controls could be quickly changed, thus a complete set of lag response data was taken within a short time. The result is a reduction in testing time over previous methods.

A wide range of test conditions are easily handled by the lag tester. This versatility has been accomplished by the unit's ability to adjust the LED irradiance, by controlling the 'on' and 'off' periods of the light source and by being able to view any portion of the buildup or decay response.

As an experiment, the lag of a SIT (silicon intensified target) tube was measured at different areas of the raster. The results showed lag being significantly greater at the edges than at the center of the raster, due to the poor beam landing characteristics at the edge of the target. This behaviour is not exhibited by all tubes. However, the unique capability necessary to perform this type of measurement has been demonstrated by the lag tester.

The most important feature of the unit is its ability to present a stable, repetitive waveform of one line of video. Thus, the accuracy of the measurement is enhanced because the exact line being viewed within a field is easily determined, the measurement is repeatable and the waveforms are relatively free of undesirable effects.

The unit is small in size, consisting of three pcb for the logic circuits and two pcb power supplies. The boards are mounted on a panel for easy rack mounting. A further reduction in the unit size, the number of logic components, and power requirements can be accomplished by the following steps:

1. Utilize a complementary input to the counter parallel preset terminals (P_0 to P_3) to eliminate the inverter currently employed.

2. Use dual pulse triggered binary IC to reduce the number of flip-flop hardware.

3. Use one power supply capable of handling the reduced logic power requirements accomplished by steps 1 and 2.

If these steps are followed, the number of logic circuits can be reduced from 24 to about 14 without a scarifice in performance. The result would be a more compact, lower cost, high performance lag tester.

A P P E N D I X A

MEASUREMENT PROCEDURE

- -

This appendix contains the test procedure necessary to perform lag measurements utilizing the laboratory facilities of the NAVAIRDEVCEN.

EQUIPMENT SETUP

The basic test setup currently employed at the NAVAIRDEVCEN to evaluate lag characteristics is shown in figure A-1. The LED array is placed behind an opal diffuse glass plate to provide uniform illumination over the face of the tube. To set the raster format and tube focus, a test pattern is placed in front of the opal glass with the lag tester turned on for CONT operation. The tube controls are adjusted to achieve the desired conditions. The pattern is then replaced with a glass lantern slide covered with black tape, except for a vertical strip down the middle. This pattern facilitates the viewing of the signal transient on any line in the field as designated on the DELAY control. A one MHz low pass filter reduces wideband system noise, thus allowing a well-defined video pulse to be presented.

TEST PROCEDURE

The test procedure presented incorporates the basic measurement techniques needed to perform any aspect of lag testing.

The test method used to measure lag 50 milliseconds after the light source has been extinguished is as follows:

1. Set up equipment as shown in figure A-1.

2. Set the scope controls as follows:

HORIZONTAL DISPLAY	'A,' Normal
TRIGGERING	
MODE	TRIG
SLOPE	+
COUPLING	DC
SOURCE	EXT
TRIGGERING LEVEL	mid-range

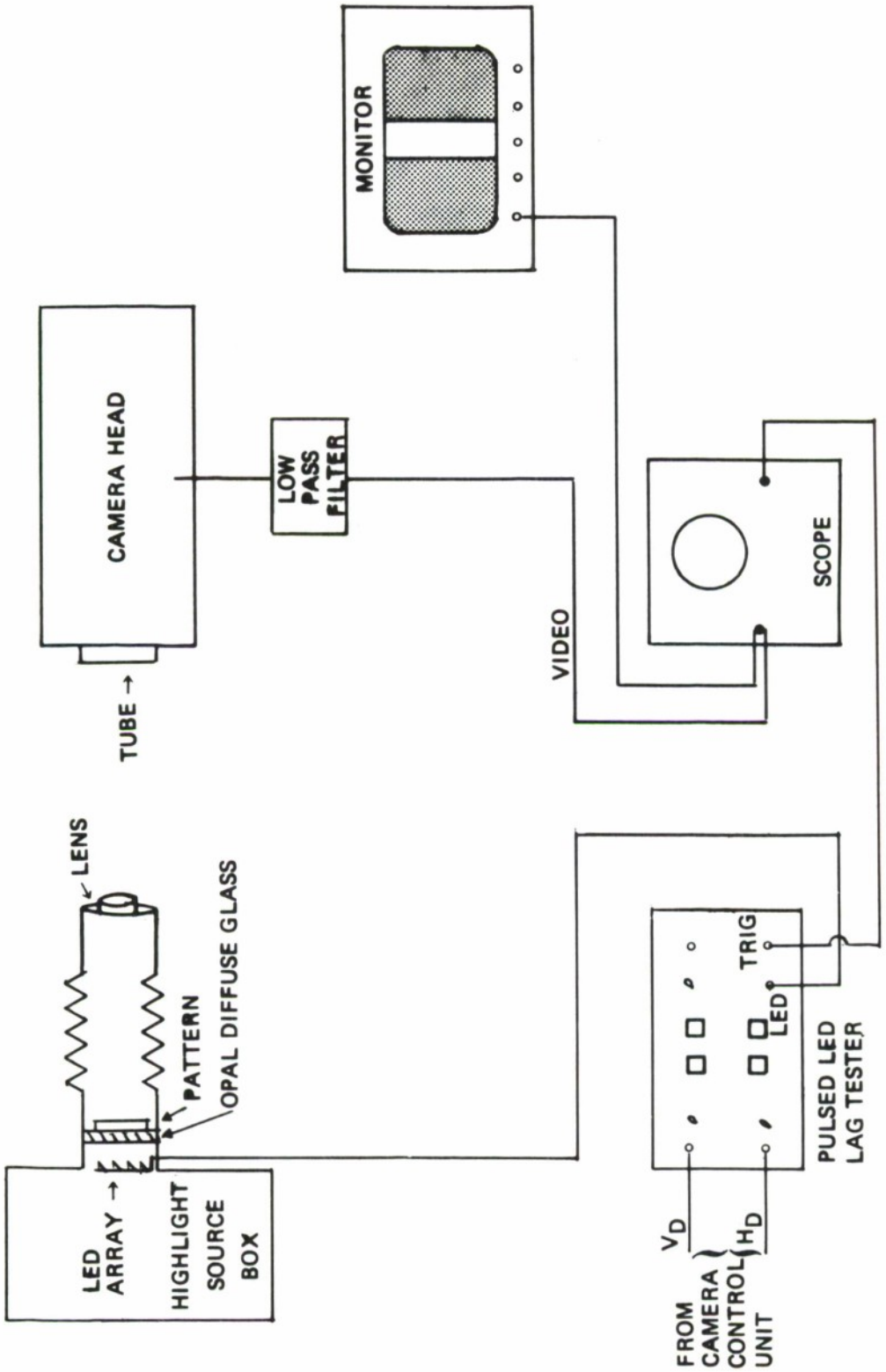

FIGURE A-1 - Lag Measurement Test Setup

3. Set the lag tester and scope controls as follows:

a.	RISE/FALL	FALL
b.	DELAY	130
c.	TRIG	01
d.	PULSED/CONT	CONT
e.	BRIGHTNESS	Adjust control to obtain the desired tube signal current level. This amplitude represents a 100 percent signal reference.
f.	PULSED/CONT	PULSED
g.	'A' time base	Adjust to view composite buildup and decay as shown in figure A-2.
h.	T_{ON}/T_{OFF}	Set for a sufficient number of frames for the tube output to reach steady-state conditions.
i.	'A' time base	Adjust to view one horizontal line.
j.	TRIG	Set at 04. Measure signal amplitude and compare with the amplitude from step 3e. This gives the percentage of residual signal (decay lag) 50 milliseconds after the light transition.

4. If the TRIG thumbwheels are sequentially dialed starting with 01, the resultant video display on the oscilloscope appears as shown in figure A-3. These waveforms are the expanded view of the output in figure A-2 as represented by the dotted lines.

Similarly, other aspects of lag can be investigated, such as the following:

1. Composite buildup and decay lag
2. Lag as a function of output signal current level and dark current
3. Lag as a function of position on the raster
4. Lag as a function of long T_{ON}/T_{OFF} periods (hysteresis)
5. Overload recovery of the tube

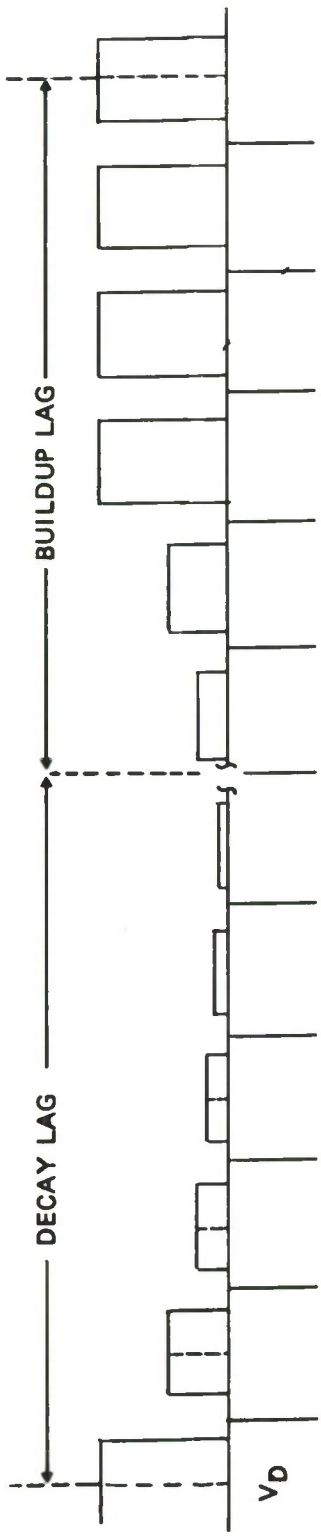

FIGURE A-2 - Simplified Scope Presentation of Composite Lag

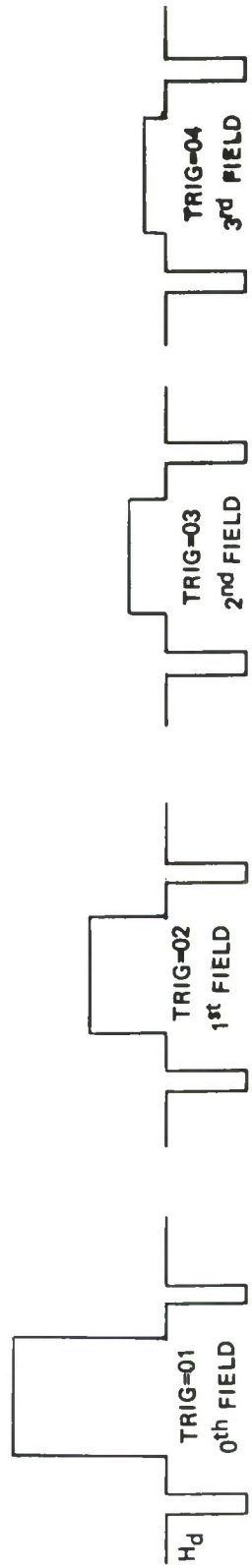

FIGURE A-3 - Simplified Decay Lag Waveforms

P A R T S L I S T

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MC836P	Hexinverter	8	Motorola Semiconductor Products, Inc
MC4016P	Programmable 'N' Modulo Counter	9	Motorola Semiconductor Products, Inc
MC860P	Dual Pulse Triggered Binary	2	Motorola Semiconductor Products, Inc
MC851P	Monostable Multivibrator	2	Motorola Semiconductor, Products, Inc
MC850P	Pulse Triggered Binary	1	Motorola Semiconductor Products, Inc
MC853P	Dual J-K Flip-flop	1	Motorola Semiconductor Products, Inc
MPS8560	Transistor	1	Motorola Semiconductor Products, Inc
2N3638A	Transistor	1	National Semiconductor Corp
CA3036	Dual Darlington Array	1	Radio Corporation of America
BT06E 8-2P	Connector	2	Burndy Corp
BT02E 8-2S	Connector	2	Burndy Corp
FLV100	LED	16	Fairchild Camera and Instrument Corp
T20-02A	Binary Coded Decimal Thumbwheel Switch	9	Cherry Electrical Products Corp
AN3155-25-50	Rheostat-Aircraft Power	1	Clarostat Mfg Co, Inc
CP-5X	5 v Power Supply	2	Power/Mate Corp

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13. ABSTRACT

A unit has been developed to provide a more versatile, convenient and inexpensive method of testing lag response in tv camera tubes. Lag is measured by exposing the tube to a step transition in irradiance and measuring the resultant transient response. The irradiance is provided by a 4 x 4 array of gallium arsenide phosphide LED continually recycled on and off by a digital logic circuit. Controlling the on and off period permits the unit to be used in evaluating tubes which exhibit a wide range of lag response. A high degree of measurement accuracy is possible by use of a synchronizing trigger allowing for the observation of a single line of video. Details of the logic circuit operation, circuit diagrams, timing waveforms and a complete description of the operation controls are presented.

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