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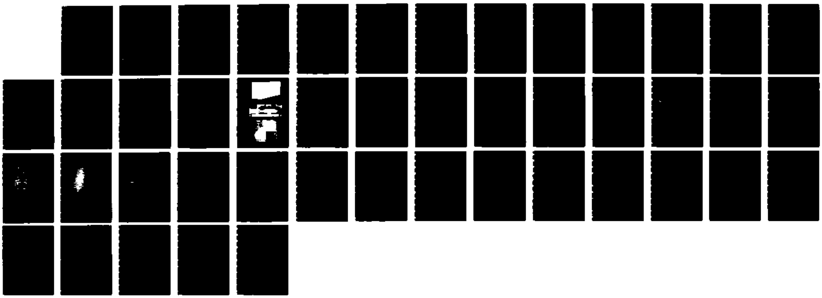

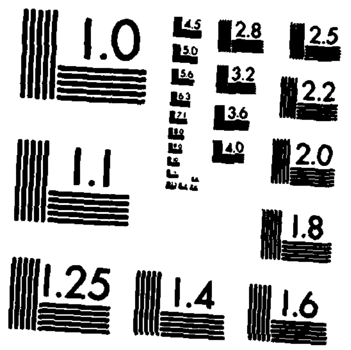

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AFGL-TR-86-0113

ULTRA VIOLET IMAGER SYSTEM

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306 Alexander Street
Princeton, NJ 08540

15 April 1986

Final Report
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AIR FORCE GEOPHYSICS LABORATORY
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
HANSCOM AIR FORCE BASE, MASSACHUSETTS 01731

"This technical report has been reviewed and is approved for publication"

E. J. Stergis
Contract Manager

R. E. Huffman
Branch Chief

FOR THE COMMANDER

Division Director

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Princeton Scientific Instruments, Inc., has developed for the Air Force Geophysical Laboratory, AFGL, an Ultraviolet Imager to measure the spatial distribution of the UV radiation of missiles. An f/2.8, 200 mm focal length Cassigrain telescope optic is followed by a filter wheel containing 5 narrow band UV filters. The optical image is focused onto a 25 mm diameter micro channel plate (MCP) image intensifier having a solar blind Cs_2Te photocathode. Photoelectrons from the photocathode are proximity focused onto the MCP and the MCP output electrons are proximity focused onto a P-20 phosphor. A 17 mm f/0.95 lens relays the 25 mm diameter phosphor image onto a CCD interline transfer type solid state image television camera. The television camera output is recorded by a video 3/4 inch magnetic tape cassett recorder and displayed on a 9 inch television monitor. The UV Imager exposure time can be varied by electronically shuttering the image intensifier from 1 ms to 33 ms, the television camera frame rate. Exposure times, filter wheel position and date are superimposed on the bottom of the video image.

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ULTRAVIOLET IMAGER

Introduction

Under Contract F19628 85C-0118, Princeton Scientific Instruments, Inc., has developed for the Air Force Geophysics Laboratory, AFGL, an Ultraviolet Imager to measure the spatial distribution of the UV radiation of missiles. The UV Imager system is shown schematically in Figure 1. An f/2.8, 200 mm focal length Cassigrain telescope optic is followed by a filter wheel containing 5 narrow band UV filters. The optical image is focused onto a 25 mm diameter micro channel plate (MCP) image intensifier having a solar blind Cs_2Te photocathode. Photoelectrons from the photocathode are proximity focused onto the MCP and the MCP output electrons are proximity focused onto a P-20 phosphor. A 17 mm f/0.95 lens relays the 25 mm diameter phosphor image onto a interline transfer CCD type solid state image television camera. The television camera output is recorded by a 3/4 inch magnetic tape video cassett recorder and displayed on a 9 inch television monitor.

The UV Imager exposure time can be varied by electronically shuttering the image intensifier from 1 ms to 33 ms, the television camera frame rate. Exposure times, filter wheel position and date are superimposed on the bottom of the video raster. Figure 2a, 2b, 2c show a photograph of the completed system. The Head assembly is connected to the Control chassis and video recorder by a 40 ft. cable. The UV Imager development is discussed in detail in the following sections.

System Design

The required spatial resolution of 1/3 meter in a 100 meter field of view dictated that all of the components in the system have good spatial frequency response at 300 lines per picture width in order for the combined system spatial frequency response to be adequate at this spatial frequency.

The Fairchild CCD 3002 television camera has 380 horizontal pixels and an MTF of 75% at this spatial frequency. This is about the best one can do at the standard television rates imposed by the requirement to record data on a standard video casette recorder. To maintain this high video response, the video recorder is a 3/4 inch tape casette recorder, Sony Vo-5800H, with nearly 100% MTF at this spatial frequency. A lens images the phosphor output of the image intensifier onto the CCD. The limiting component in resolving power is the proximity focused image tube. With a 200 mm focal length, 1/3 meter picture elements in the object plane correspond to a spatial frequency of 7.5 cycles per mm in the image plane. The Nye Optical Company Lyman Alpha IA telescope has a MTF of 70% at 7.5 cycles/mm.

The MTF of the proximity focused image tube is made up of the MTF of the phosphor, its fiber optic window, the proximity focus of the MCP output onto the phosphor, the MCP itself and the proximity focus from the photocathode to the MCP. The latter is the dominant MTF, expecially in a tube with an ultraviolet photocathode. The resolution is proportional to $\left(\frac{V}{E_o}\right)^{1/2}/d$. When E_o is the energy of the photoelectron in eV, V is the accelerating voltage between the photocathode and MCP and d is the spacing. The ITT F4112 image tube has a photocathode to MCP spacing "d" of 0.25 mm and operates at a gap voltage V of 180 volts.

UV Telescope

The ultraviolet optics consist of a quartz window followed by a 200 mm F/2.8 Cassigrain type telescope, Lyman Alpha IA manufactured by NYE Optical Company. The spatial frequency response of this telescope is shown in Figure 3. At 7.5 cycles per mm the response is 70%.

Optical Filters & Filter Wheel

The Oriel Model 77255 Multi-Filter Wheel contains 5 filter positions.

The wheel is remotely controlled by a position selection dial on the front panel of the UV Imager Control and Display chasses. Each filter position contains a pair of thin film filters mounted together face to face. The nominal wavelengths are 214, 240, 280, 300 and 330 nm and the actual transmission curves are shown in Figures 4a,b,c,d. Double filters were selected to improve the attenuation outside the passband at long wavelengths.

Micro-Channel Plate Image Tube

The ITT F-4112 channel intensifier tube has a maximum useable aperture of 25 mm. The gain characteristics for the particular tube used in the UV Imager is shown in Figure 5. The MCP operating voltage is set at 700 volts with a resultant gain of 500 electrons per photoelectron. The photocathode, $C_{s2}T_e$, spectral response is shown in Figure 6. The light output per photoelectron is not included in the manufacturer,s test data. However, the efficiency of P-20 phosphors is approximately 1 photon per 16 eV. The MCP to phosphor accelerating voltage is 5000 V. The electrons from the MCP loose about 2500 electron of energy volts in penetrating the aluminum layer covering the phosphor. The net response is about 20 photons from the fiber optic window per incident electron on the phosphor. This corresponds to 10^4 green photons per photoelectron and 10^3 green photons per ultraviolet photon.

The relay lens coupling efficiency is 2 to 3% at full aperture and the CCD quantum efficiency is approximately 20%. This results in 50 signal electrons in the CCD per ultraviolet photoelectron.

Relay Optics

The lens that images the image intensifier output onto the CCD is a KOWA 17 mm, F/0.95 obtained from D. O. Industries, Inc. This lens was selected for its speed and ability to focus at very short distances. The image magnification is adjustable from 1 to 2.5. The theoretical coupling efficiency is:

$$\frac{1}{4F^2\ (1+\frac{1}{m})^2}\ ,$$

where F is the f-number of the line system and m is the ratio of image size to object size. This is the fractional number of photons per pixel, not per unit area.

CCD Camera

The Fairchild CCD camera, Model 3002, employs a Sony interline transfer CCD. The pixels are 23 microns horizontal and 13.4 micron vertical. The image format is 384(H) × 491(V) resulting an 8.8 mm × 6.6 mm image area. The odd lines are read out in 1/60 second field and the even lines on the alternate field. The exposure time for a given field is 1/30 of a second, since the optically sensitive area of the CCD pixel is exposed all the time. Half of each pixel is covered by an opaque strip to cover the vertical shift register that serves to shift the image out to the horizontal shift register and to the on chip amplifier.

Data Acquisition

The Sony VO-5800H, 3/4 inch video tape recorder is the primary data acquisition component of the system. In testing the system and evaluating its performance the video signal was also captured, using a "frame grabber" board resident in an IBM-XT microcomputer. Individual frames are digitized at 512 pixels per line and displayed on a monitor. Software allows horizontal and vertical intensity plots of the video to be superimposed on the image and plotted out on the computer's printer. These plots are used in this final report to document the system performance.

Exposure Control

The image tube photocathode to MCP voltage can be turned on and off to act as an electronic shutter. This electronic shutter is synchronized with the CCD camera frame rate such that the exposure begins at the start of each frame. The exposure time is manually selected by thumb wheel switches on the front panel of the control chassis. Beyond 16 ms the image tube is on all the time and the exposure time is 1/30 second, set by the CCD camera readout rate. The exposure time can also be made automatic by a front panel switch that connects the exposure control to an automatic gain control circuit available in the Fairchild CCD camera. However, the CCD AGC circuit senses the video signal over a large area of the image and therefore it is ineffective in controlling the exposure on small bright areas against a dark background.

UV Test Pattern

The ultraviolet test pattern used to measure the system performance consisted of a metal aperature plate illuminated by a UV lamp. The aperture plate had 4 slots 1/4 inch wide on half inch centers. The UV test pattern was located 750 inches from the camera such that the 0.25 inch apertures corresponded to 1/3 meter at 1000 meters, the limiting resolving power required by the system specification.

During tests it was found that the UV lamp was flickering at the power line frequency such that the exposure depended on the phase of the power line relative to the CCD camera frame cycle and the electronic shutter pulse that was synchronized with this frame cycle. Powering the UV lamp from a DC power supply eliminated the problem.

System Tests

CCD Camera Plus Telescope - The telescope was mounted directly to the CCD camera in order to assess the telescope performance without the U.V. filters, image tube and relay lens. A test pattern with 0.11 inch wide bars and 0.22 inch wide pitch was used. Figure 7a shows an intensity plot through an image of this pattern. The actual intensity values are also included.

The peak to peak modulation is approximately 40 counts while the background peak to peak noise is typically 4 or 5 counts. This test was repeated with the 0.25 inch wide bare test patterns and these data are shown in Figure 7b. The peak to peak modulation is approximately 75 counts. Figure 7c shows the impulse response to a single bar 0.12 inches wide, 750 inches away. The peak is 78 counts and the full width at half maximum is 3 samples wide which cooresponds to 2 CCD pixels or 46 microns in the image plane. This width is broadened somewhat by the fact that the two peak values are nearly equal implying that the image of the bar is nearly centered on a pair of pixels. The actual width of the single bar is probably only one pixel wide at half maximum.

CCD Camera Plus Relay Lens - To assess the quality of the relay lens it was used with the CCD camera to image a grating positioned at approximately the same distance as the image tubes output for plate. These data are shown in Figure 8a.

Figure 8a is the response to a grating with a pitch of 100 line pairs per inch and shows that the focus is fairly flat across the field. Figure 8b showns the response to a 250 line pairs per inch pattern and one notes a modulation due to "beat" between the video digitizing, CCD pixel sampling and the test pattern. There is also falloff in focus at the edges of the field.

The overall system response to 0.25 inch wide bars on a 0.5 inch center is shown in Figure 9a. The filter was #2, 2410Å and the distance was 750 inches. The 4 bars in the pattern produce a modulation of that is well above the background noise. The response to a single 0.25 inch bar is shown in Figure 9b. In this particular the single bar appears to be centered on one pixel and the full width at half maximum is about 3 samples wide.

Head Assembly and Disassembly

Figure 2b is a photograph of the camera head with the side cover removed. All of the imaging components are mounted on an optical bench type rail. The high voltage power supply is mounted separately to the top of the enclosure near the image intensifier.

The filter wheel housing serves as the mount for the telescope and the image tube. To remove the image tube from the filter wheel, loosen three set screws in the aluminum cup holding the image tube. These set screws engage a flange on the filter wheel. To remove the telescope from the filter wheel loosen three set screws, accessable through holes in the sides of the filter wheel.

To minimize light leaks around the filters, the telescope barrel is closely fitted into the front plate of the enclosure. The first step in removing the telescope is to move the telescope back from the front plate by moving the filter wheel-telescope-image tube assembly. This is done by first loosening the carriers clamp to the rail and sliding the whole assembly back. This also requires dismounting the electrical connector strip mounted on the top plate of the enclosure.

Access to the filters in the filter wheel is from the telescope side of the wheel and requires a spanner tool to unscrew a ring nut holding the filters in place. To remove the filter wheel from the rail, remove the front screw holding the rail to the bottom of the enclosure. This allows the rail to be swung to the side so that the filter wheel is outside the enclosure and can be lifted clear of the rail.

The image tube is a snug fit into its aluminum mounting cup and can be removed by gently pushing it out.

Focusing

The relay lens can be focused on the surface of the fiber optic window by shining light onto the window and moving the lens focus ring or the CCD camera carriage. The telescope is focused by screwing the secondary mirror spider in and out of the threaded barrel of the telescope. This spider is accessable after removal of the quartz window on the front of the housing.

Control and Display Chassis

The Control and Display chassis has the following sections: 5 volt power supply for the video camera and MCP high voltage supply, control board for the filter wheel, exposure interface board, a video formatter which superimposes time and date, filter position and exposure information onto the camera video, and a video monitor display.

In addition a high quality Sony video tape recorder is provided to record the data for later processing. Refer to the Sony operational manual for details.

A thumb wheel switch selects the desired exposure in manual operation, from 0 to 39 milliseconds. The auto/manual switch is used to select automatic or manual operation. Automatic exposure can vary from 0 to 16 miliseconds.

Camera power switch actually controls the power to the image tube high voltage supply. Power is on to the camera unless main power is turned off.

To set time and date see the video formatter manual.

The filter position switch is used to select different filter positions. The positions have the following filters:

position 1 - no filter

position 2 - 2410Å

position 3 - 2795Å

position 4 - 3000Å

position 5 - 3260Å

The LED comes on when the filter wheel is in one of the 5 positions.

The power switch for the system is located on the rear of the control chassis on the power strip.

The switch for automatic gain control of the video camera is located on the power supply and is normally in the off position.

Vertical drive is also available from the video camera for use with an oscilloscope as a sync.

Intrepreting the Formatted Characters

The first six characters are time and date. The next 2 characters are the exposure time in milliseconds from 0 to 39. The next character is the filter position. The final 2 characters are the digitized AGC voltage. The value can be 0 to 63. Each count is equal to 80 millivolts of AGC voltage. A sixth character is available and presently unused.

Operating the System

This system is easy to use, however, there are certain precautions to follow when using the system. First: do not expose the MCP for long periods of time. This can shorten the life of the tube. Avoid dropping or shocks to the equipment.

To set up the system, connect the cable between the Head and Control Electronics. Connect the power plug of the Control Electronics to 120vAC, 100watts. Set up the VCR tape recorder on top of the control electronics and plug power into control electronics power strip. Connect the BNC cable from the video formatter output to the VCR video Input #1. Connect the BNC from the monitor input to the VCR video output. Turn the Control Electrons power strip on. Turn on the VCR. Load a tape into the VCR (see Sony manual for details). Press record, play, pause, simultaneously. The monitor should now have 11 BCD digits across the bottom. Set the time and date (refer to the formatter manual). Select desired filter wheel position by turning filter knob. Turn on the camera power switch which turns power on the ITT MCP power supply. Remove quartz window on camera head by removing the allen head screws to adjust focus of elescope. Hit pause button when data is to be recorded.

Figures

Figure 1. Schematic Diagram of UV Imager System.

Figure 2a. UV Image Head Assembly.

Figure 2b. UV Image Head showing internal components.

Figure 2c. UV Image Control Chasis and Sony Video Tape Recorder.

Figure 3. NYE Lyma ALpha Telescope spatial frequency response.

Figure 4a. Filter #1

Figure 4b. Filter #2

Figure 4c. Filter #3

Figure 4d. Filter #4

Figure 4e. Filter $5

Figure 5. ITT MCP Intensifier Gain.

Figure 6. TTT MCP Tube Spectral Response.

Figure 7a. Video line across 0.12"wide bars, 0.25" pitch using CCD camera plus telescope.

Figure 7b. Video line across 0.25" wide bars, 0.5" pitch using CCD camera plus telescope.

Figure 7c. Video line across single 0.12" wide bar using CCD camera and telescope.

Figure 8a. Video line across a test pattern having 100 line pairs per inch using the CCD camera and 17mm, f/0.95 relay lens.

Figure 8b. Video line across a 250 line pairs per inch for pattern using the CCD camera and 17mm, f/0.95 relay lens.

Figure 9a. Video line across the image of 4 bars, 0.25 inch wide on 0.5 inch centers using the complete system, filter position 2, 2410Å. Distance 750 inches.

Figure 9b. Video line across single 0.25 inch wide bar. Conditions same as 9a.

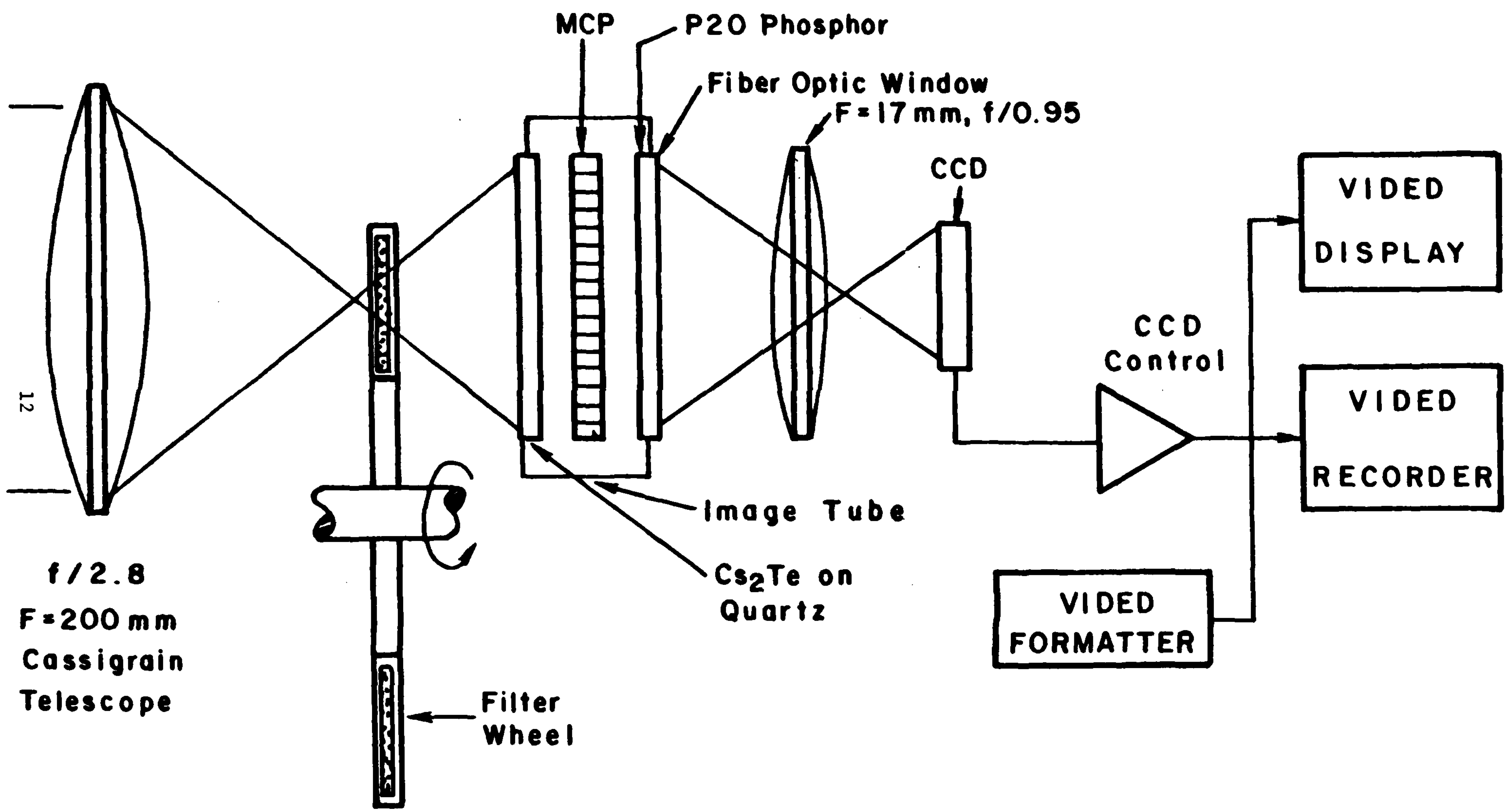

Figure 1. Schematic Diagram of UV Imager System.

Fig. 2a UV Image Head Assembly

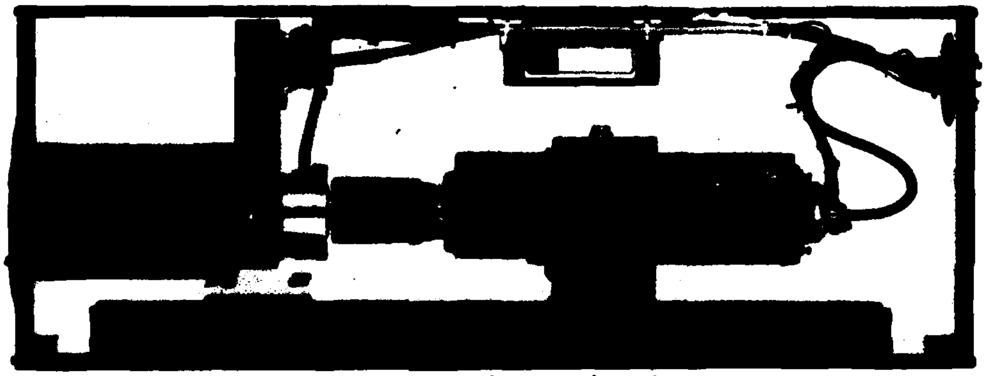

Fig. 2b UV Image Head showing
internal components

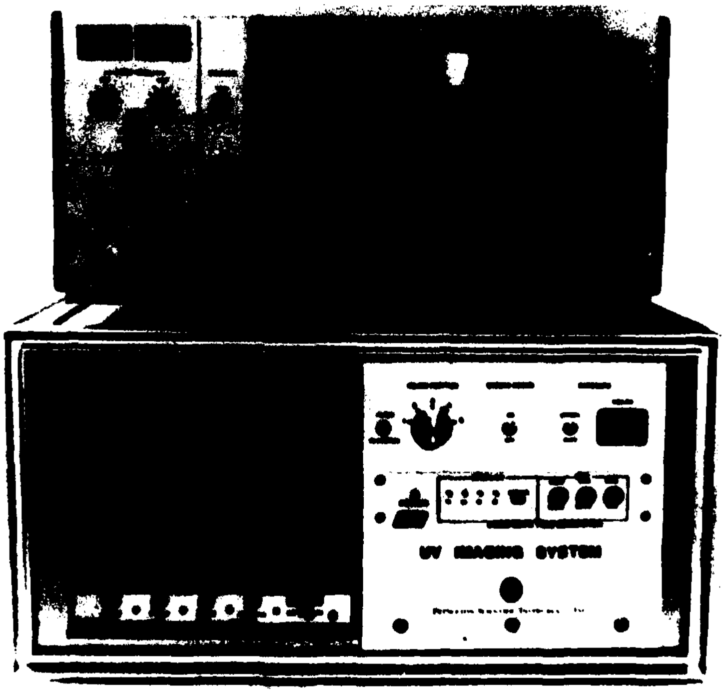

Fig. 2c UV Image Control Chassis
and Video Tape Recorder

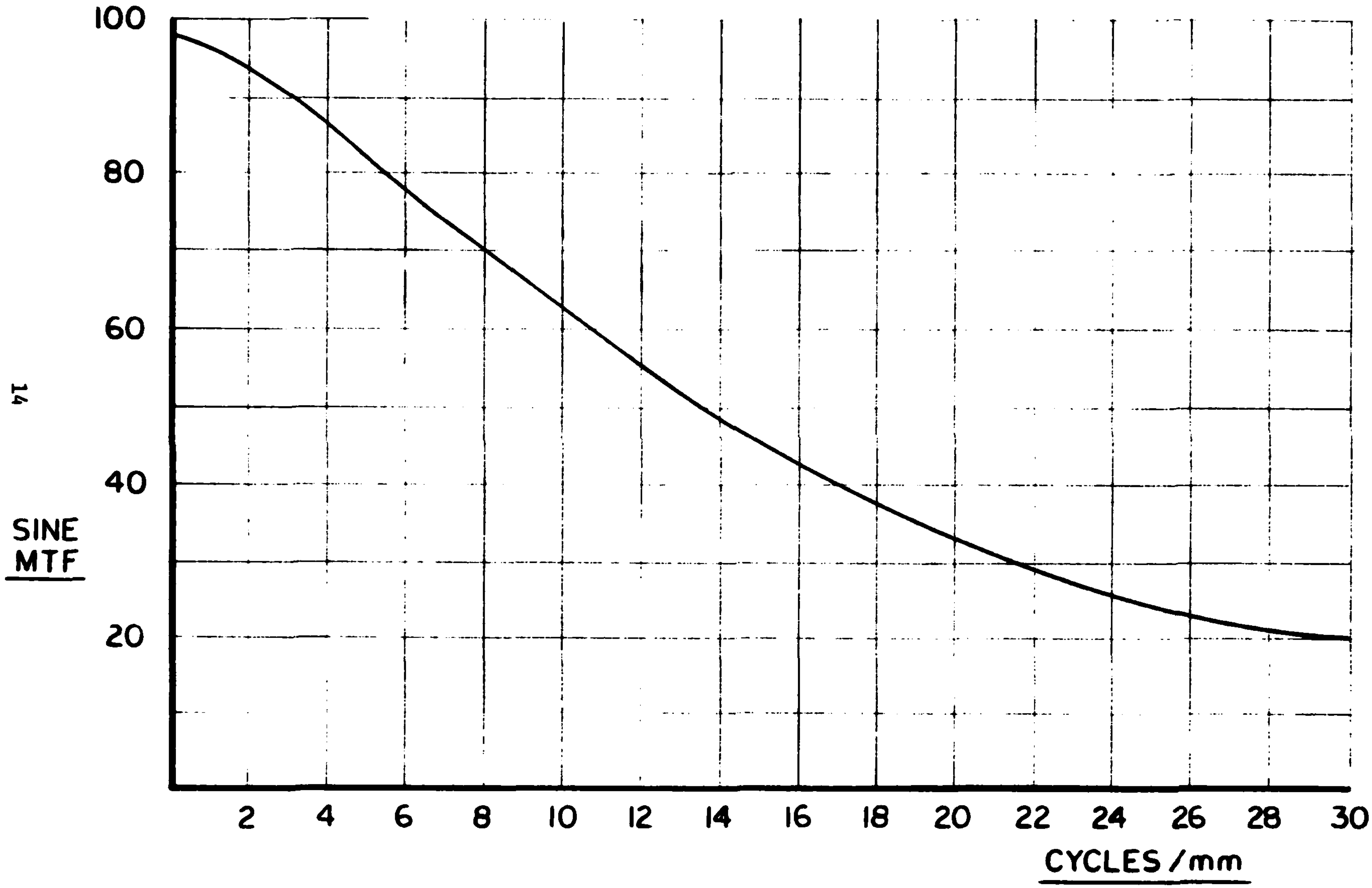

FIGURE 3. NYE LYMA ALFA TELESCOPE SPATIAL FREQUENCE RESPONSE.

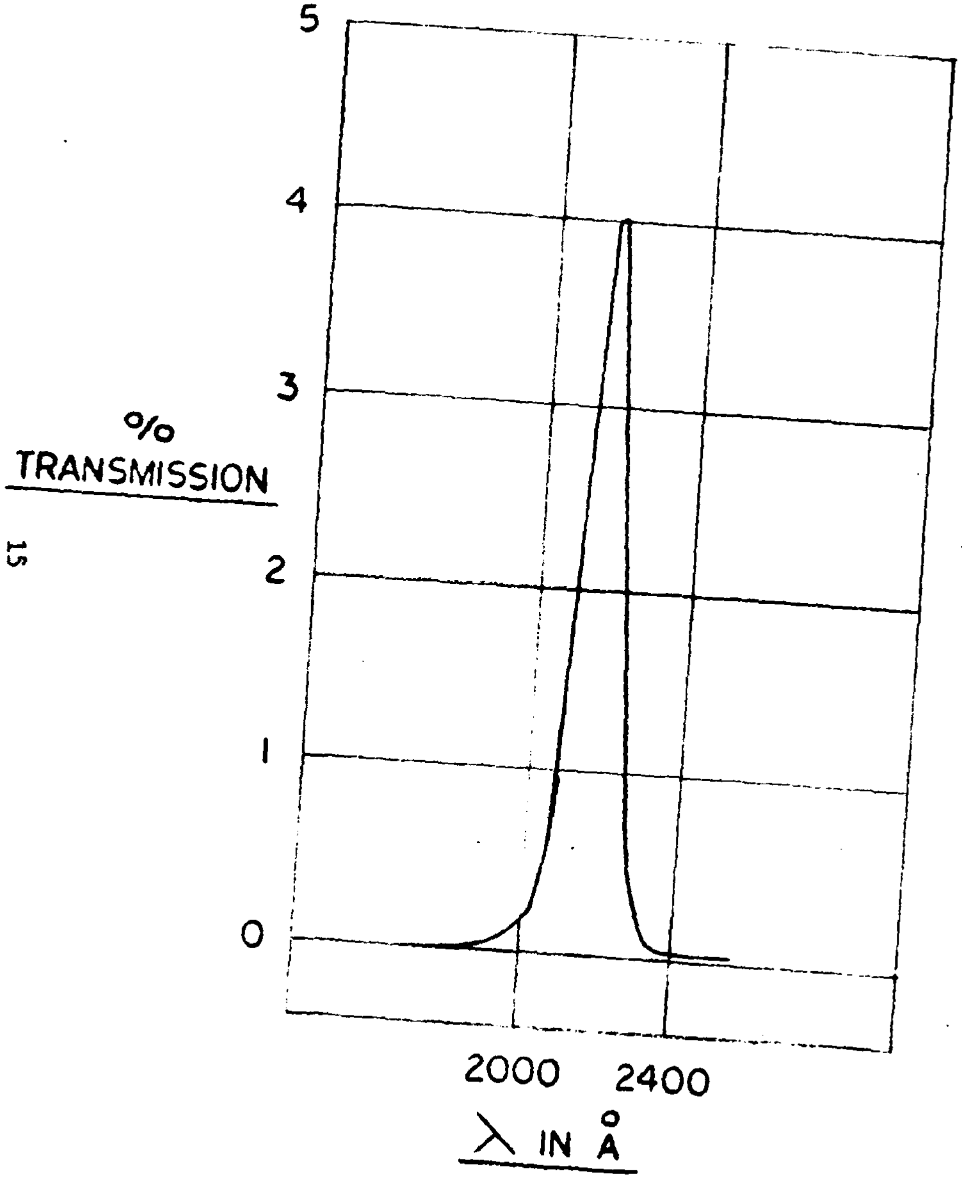

FIGURE 4A. FILTER # 1

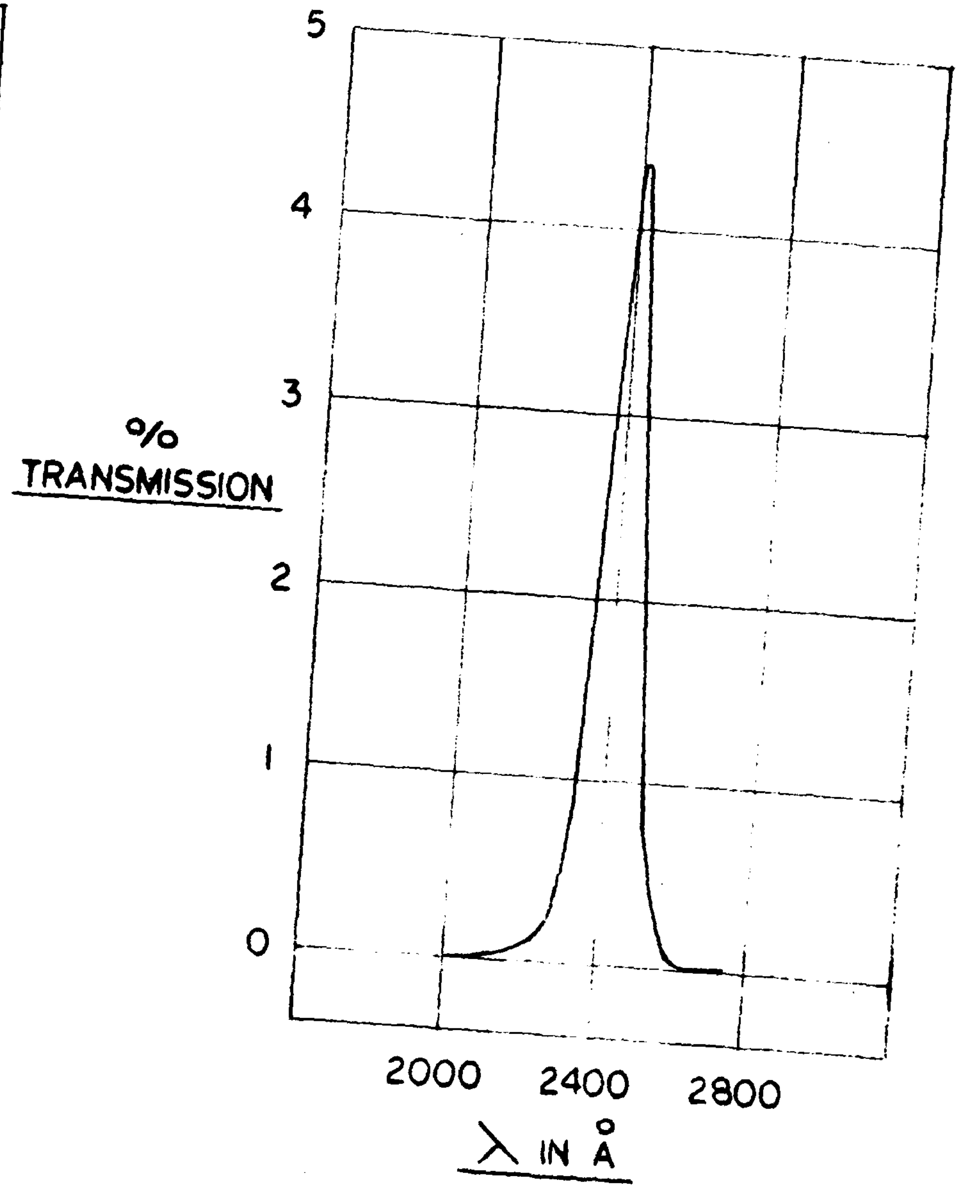

FIGURE 4B. FILTER # 2

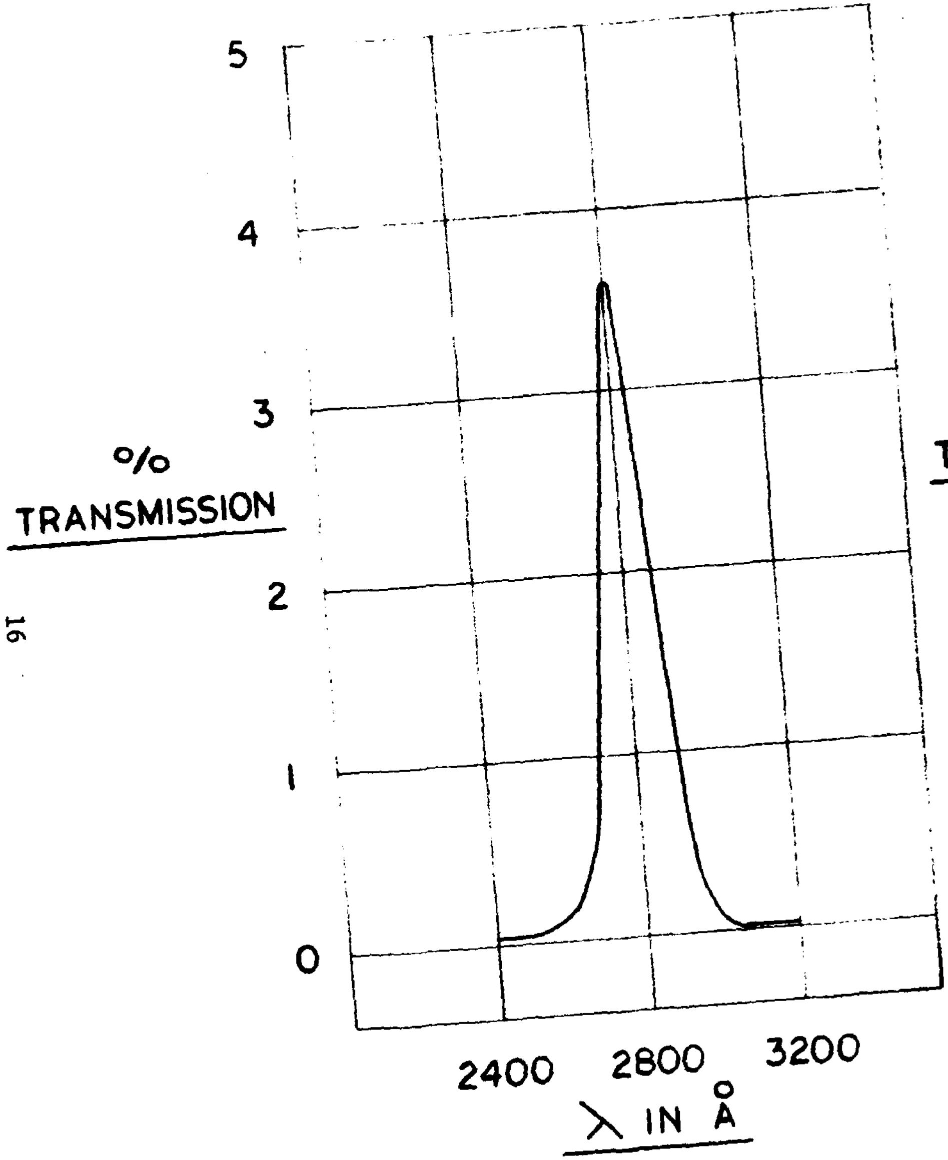

FIGURE 4C. FILTER # 3

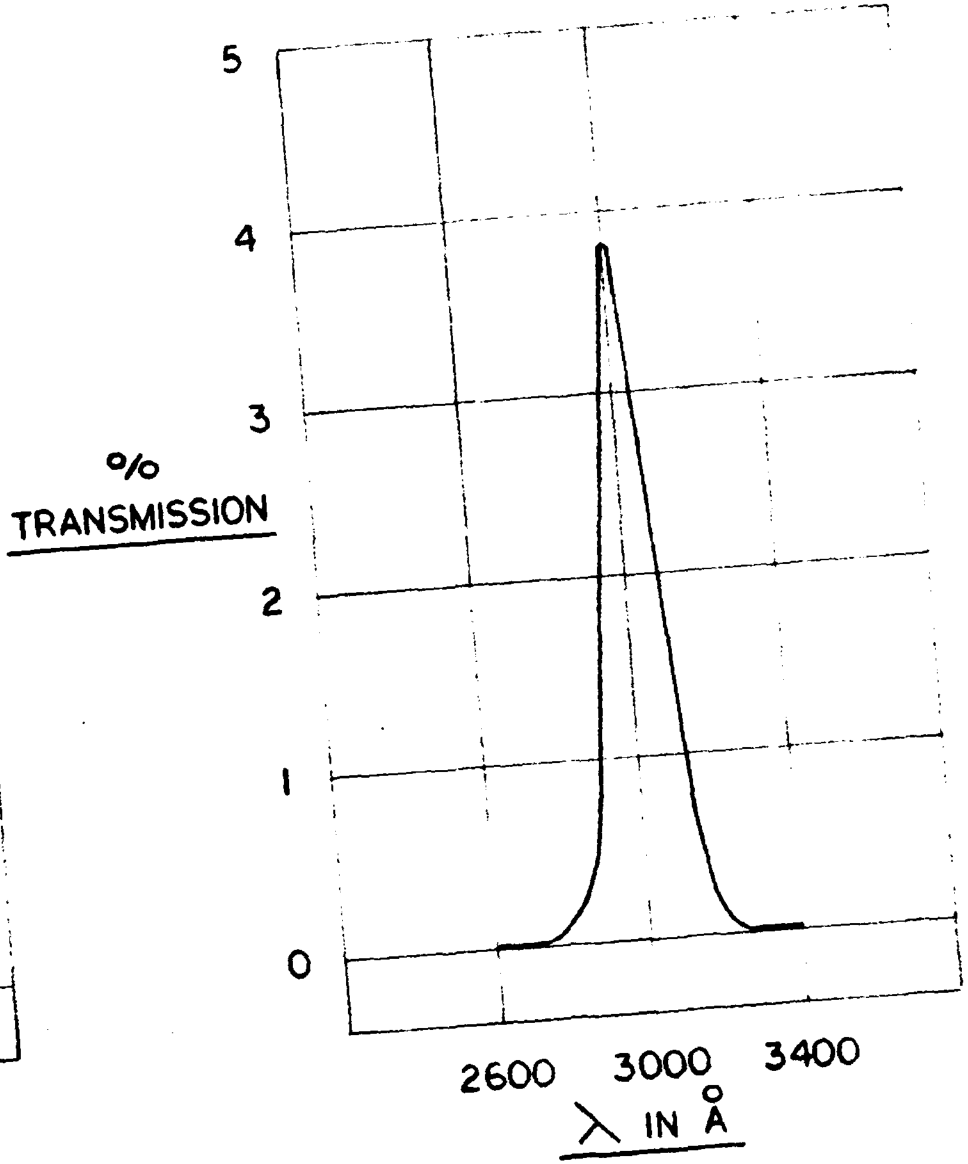

FIGURE 4D. FILTER # 4

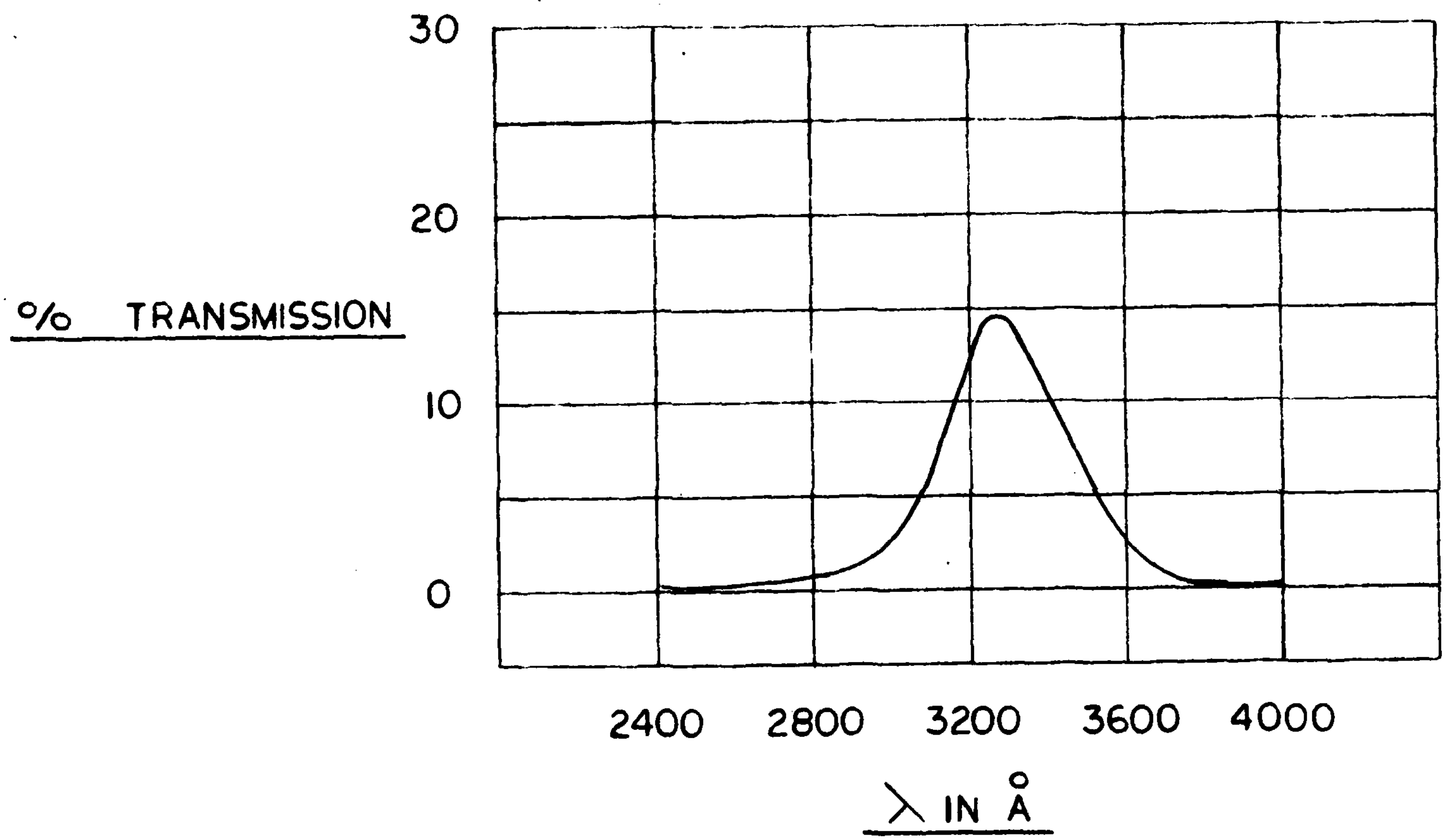

FIGURE 4E. FILTER # 5

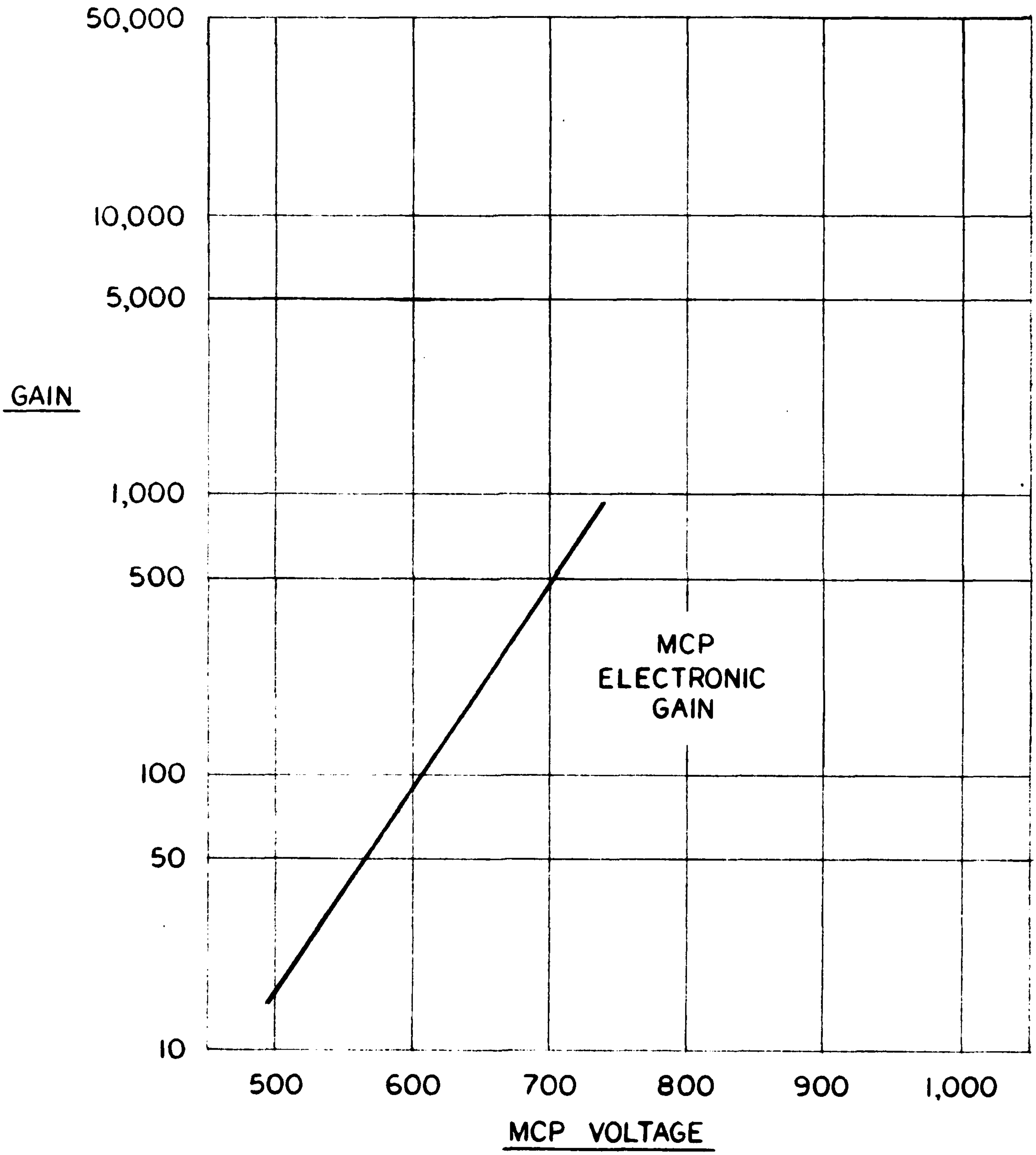

FIGURE 5. ITT MCP INTENSIFIER GAIN

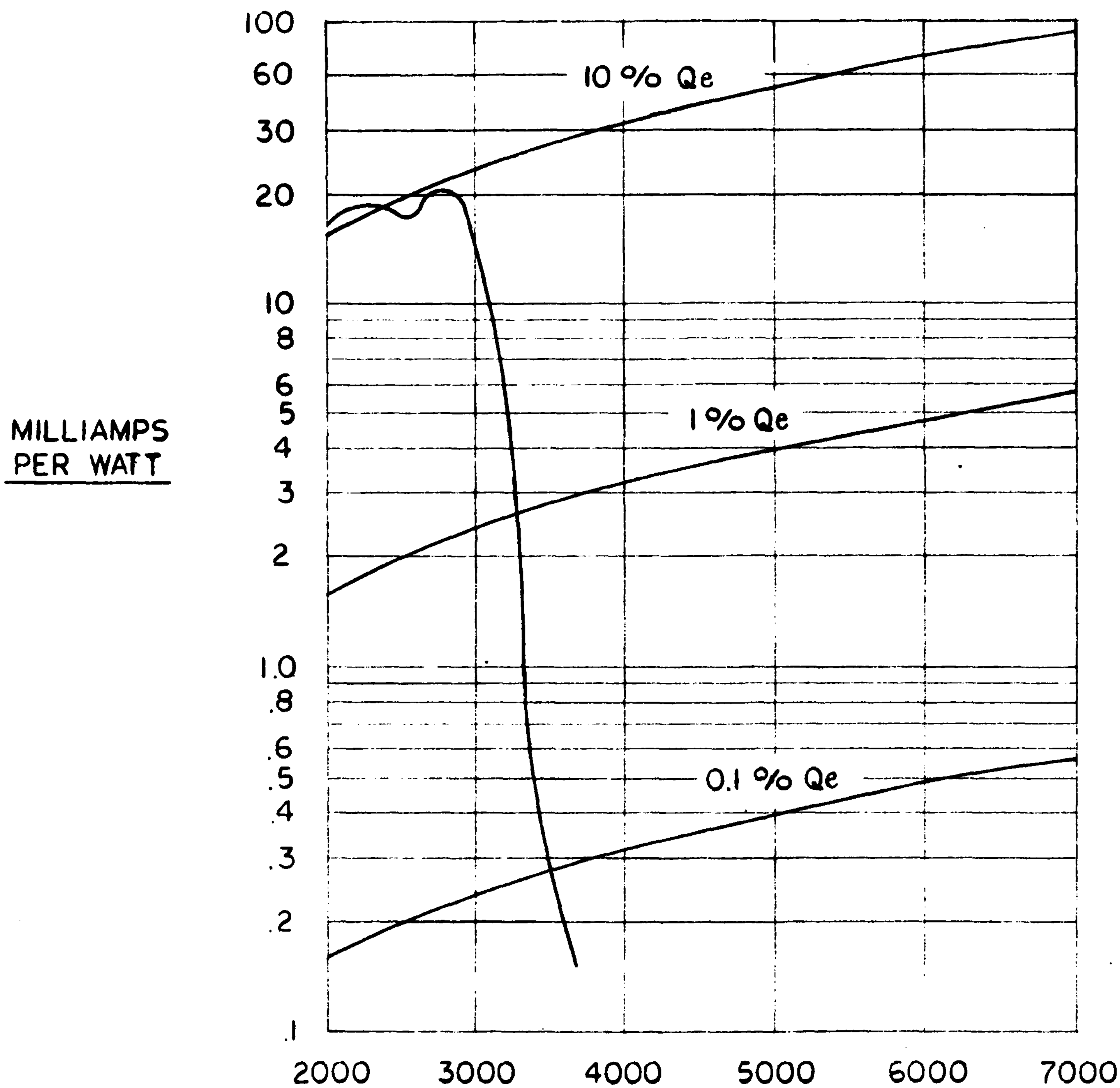

FIGURE 6.

TTT MCP TUBE SPECTRAL RESPONSE.

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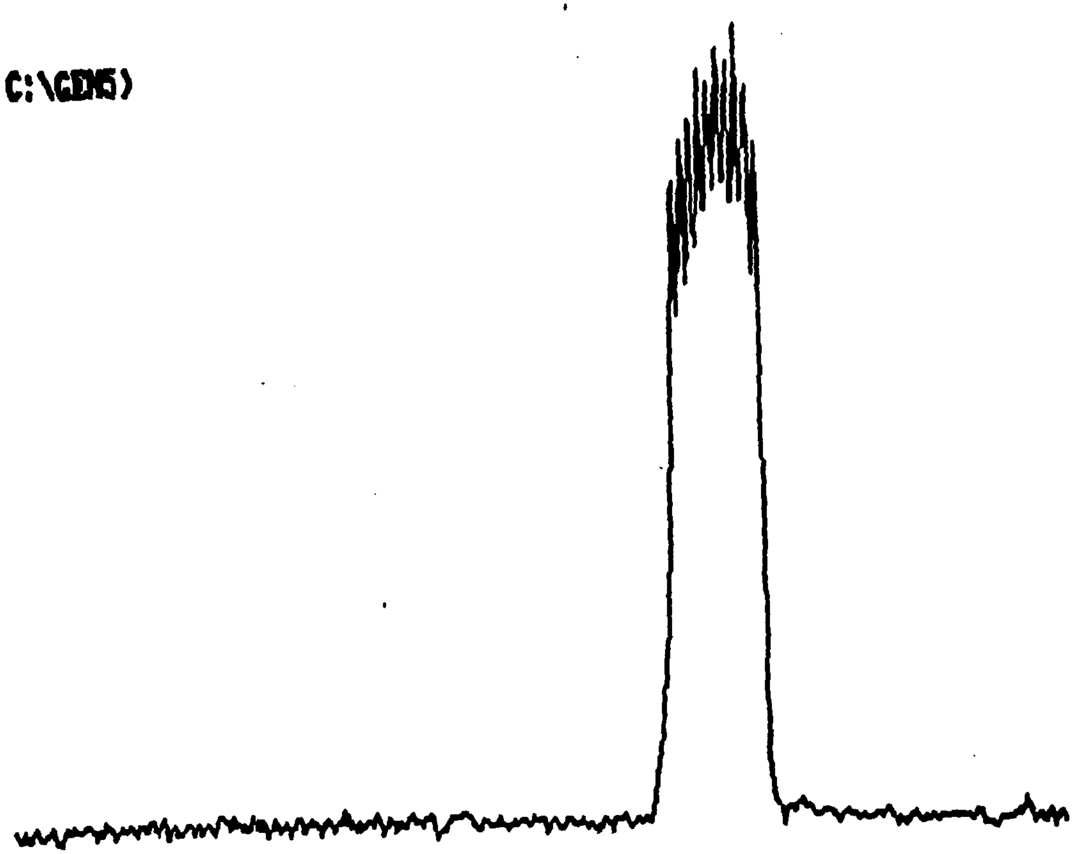

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22	20	20	20	20	19	18	18	18	18	19	19
19	19	19	18	18	17	16	17	18	16	19	18

Figure 7a. Video line across 0.12"wide bars, 0.25" pitch using CCD camera plus telescope.

CRT

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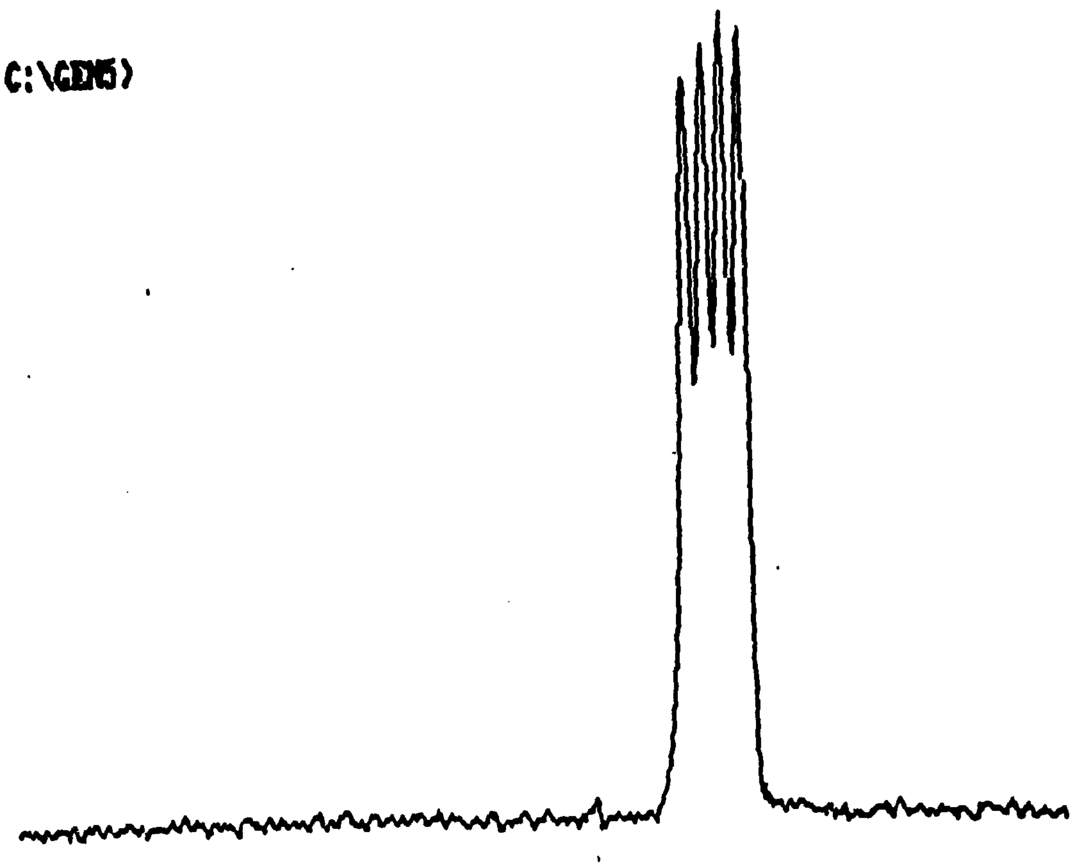

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Figure 7b. Video line across 0.25" wide bars, 0.5" pitch using CCD camera plus telescope.

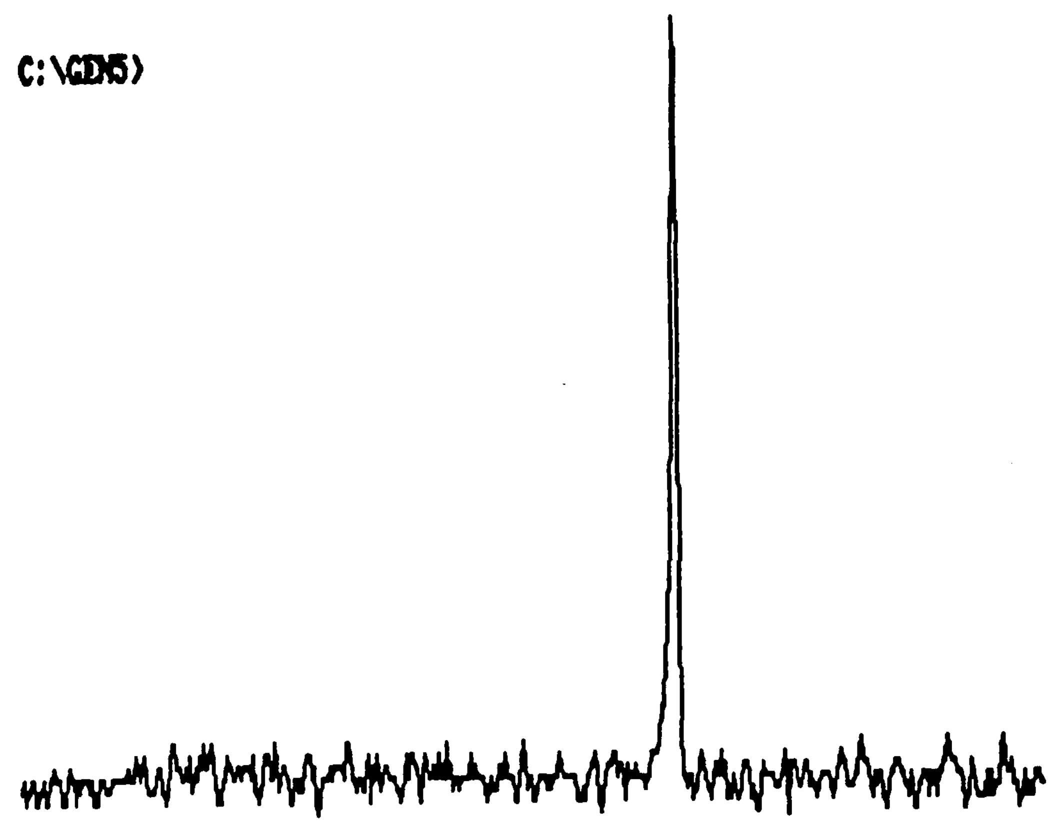

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Figure 7c. Video line across single 0.12" wide bar using CCD camera and telescope.

31	30	36	42	42	38	31	29	34	41	44	39
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40	54	47	26	19	22	44	56	52	32	20	25
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30	40	54	53	33	21	21	41	60	56	34	14
16	29	48	62	52	20	13	26	42	50	49	31
19	10	35	40	50	42	25	18	29	52	50	51
31	24	23	40	52	53	43	21	20	31	50	55
51	33	20	22	30	64	57	39	23	21	36	53
56	43	28	22	24	46	50	51	33	25	22	39
53	57	44	26	20	24	47	54	51	34	27	24
36	53	53	43	25	21	29	42	55	50	38	24
25	31	50	57	43	29	10	29	39	54	47	36
26	24	36	50	56	42	23	18	25	42	52	52
36	21	21	34	52	55	42	25	24	27	43	50
50	34	23	23	29	47	53	45	30	24	27	39
50	49	30	23	26	32	46	51	42	32	26	29
40	49	40	42	26	23	33	49	53	41	33	26
27	41	50	50	36	26	25	32	45	50	43	31
25	25	30	52	53	30	22	23	34	45	40	45
34	25	27	40	55	49	30	20	25	27	40	53
49	32	24	26	38	48	49	42	27	24	30	41
51	45	33	22	21	32	44	50	42	33	24	30
40	46	40	34	25	23	36	48	51	42	25	21
27	40	40	49	31	21	24	32	46	49	42	24
21	26	42	55	50	34	21	23	30	40	52	43
26	19	24	40	57	49	36	24	22	31	50	53
40	25	10	27	30	50	46	34	27	21	35	47
52	41	25	16	24	45	52	52	33	19	21	32
50	52	41	25	20	27	40	57	45	26	16	20
28	53	55	37	19	15	35	44	53	44	29	17
20	42	52	50	31	19	20	31	47	53	46	25
17	20	46	51	40	31	21	19	26	40	55	43
22	17	32	44	50	43	29	20	20	36	40	49
28	20	10	34	47	52	43	24	20	22	42	50
45	31	20	29	40	40	46	36	24	19	30	46
50	37	24	19	27	42	47	46	34	23	22	39

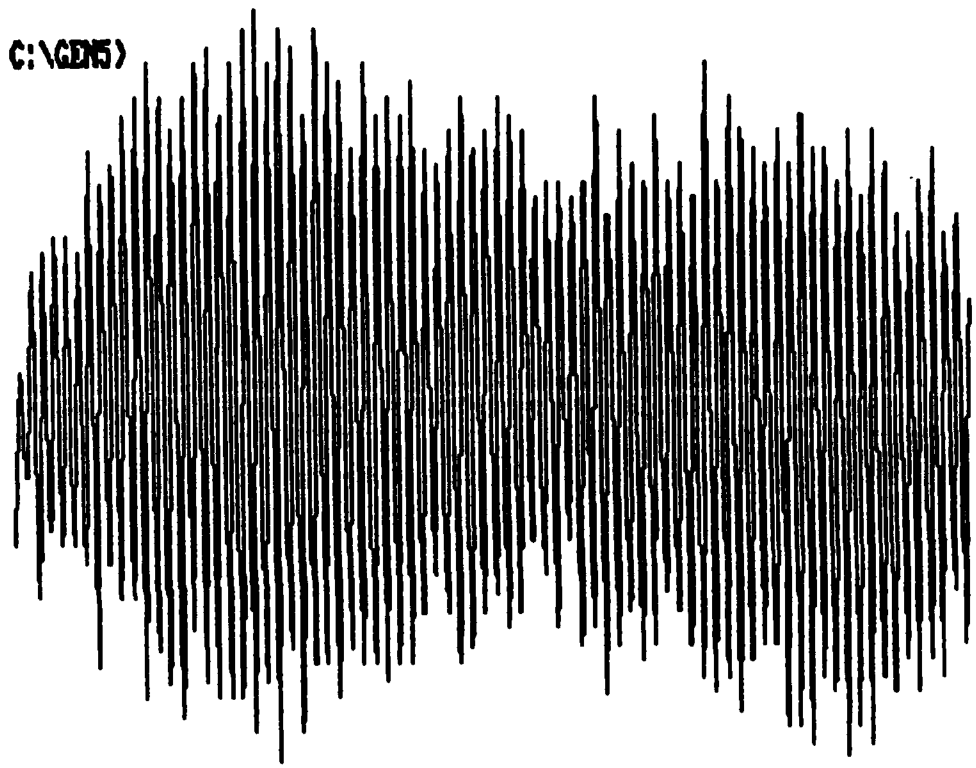

Figure 8a. Video line across a test pattern having 100 line pairs per inch using the CCD camera and 17mm, f/0.95 relay lens.

C:\GEN5>

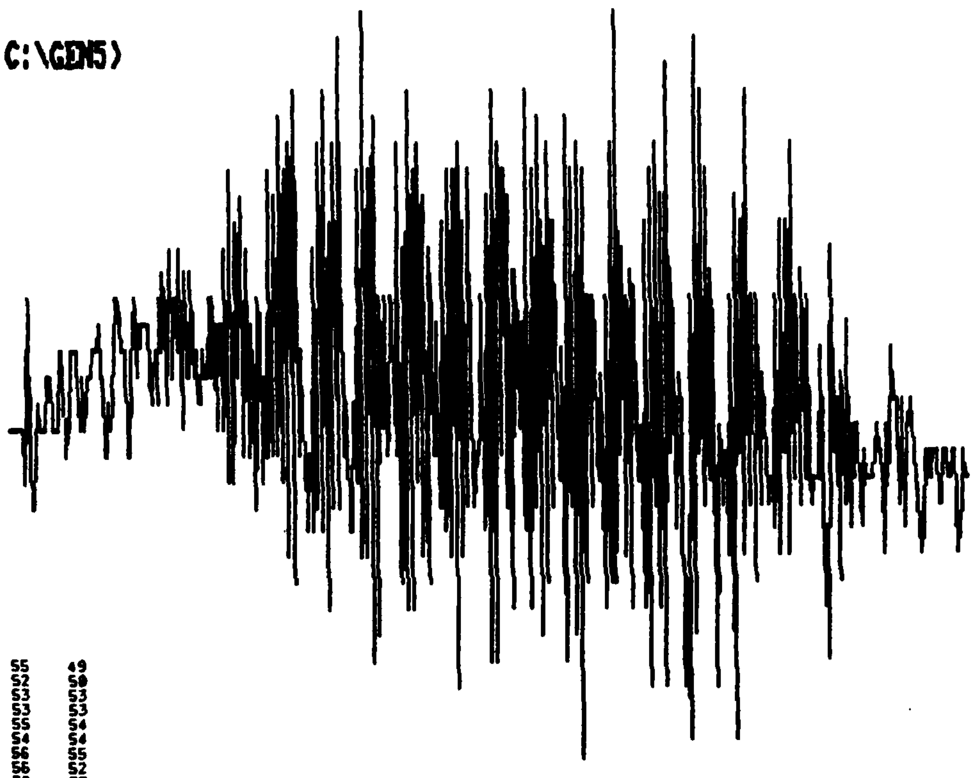

Figure 8b. Video line across a 250 line pairs per inch for pattern using the CCD camera and 17mm, f/0.95 relay lens.

50	50	50	50	50	50	50	50	40	51	55	49
47	47	49	51	50	50	50	50	52	52	52	50
50	50	50	53	53	52	49	50	50	53	53	53
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52	56	53	52	53	51	51	53	52	52	52	56
52	55	53	50	54	54	50	57	53	40	60	40
51	58	52	56	59	49	53	57	49	54	52	47
50	55	54	40	52	49	49	60	50	49	59	49
51	62	48	58	60	45	61	60	44	63	56	49
53	50	49	46	49	49	46	57	47	48	61	46
54	63	43	55	58	47	61	55	47	65	57	49
51	50	46	46	51	49	48	60	45	46	86	45
57	60	41	59	82	42	55	53	50	55	49	50
55	55	51	49	61	44	45	57	43	52	63	43
58	60	48	61	56	45	59	47	44	57	55	49
49	54	47	47	58	46	47	60	45	55	60	40
59	61	45	50	50	47	60	52	47	40	49	49
50	55	46	47	59	41	51	63	41	55	61	49
60	60	47	59	49	43	56	56	53	50	54	47
46	63	43	49	60	47	51	62	42	58	56	44
61	55	47	50	53	51	48	53	46	41	62	48
47	60	42	51	61	37	53	60	44	55	55	47
55	53	49	48	52	49	43	55	48	44	61	44
46	56	49	54	57	45	56	51	43	56	55	50
48	50	49	43	50	47	40	[illegible]	49	47	61	43
49	59	40	54	64	49	56	53	46	50	52	50
48	44	41	38	55	49	42	65	49	50	63	47
50	60	48	56	53	40	47	50	49	47	49	48
45	55	46	38	59	54	49	58	45	54	63	47
54	55	44	55	51	47	52	50	49	47	40	48
48	55	48	45	50	49	49	58	45	54	61	48
55	53	47	56	53	40	55	48	47	40	48	48
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52	51	47	54	48	46	50	48	50	50	47	46
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50	51	50	49	40	47	46	45	45	49	48	49
48	49	49	49	47	47	49	49	45	40	40	49

15	18	14	14	15	18	15	13	14	15	15	18
15	15	16	15	16	15	15	12	14	16	15	15
14	14	14	14	15	15	17	15	14	14	14	15
15	14	15	16	15	13	13	17	18	18	17	17
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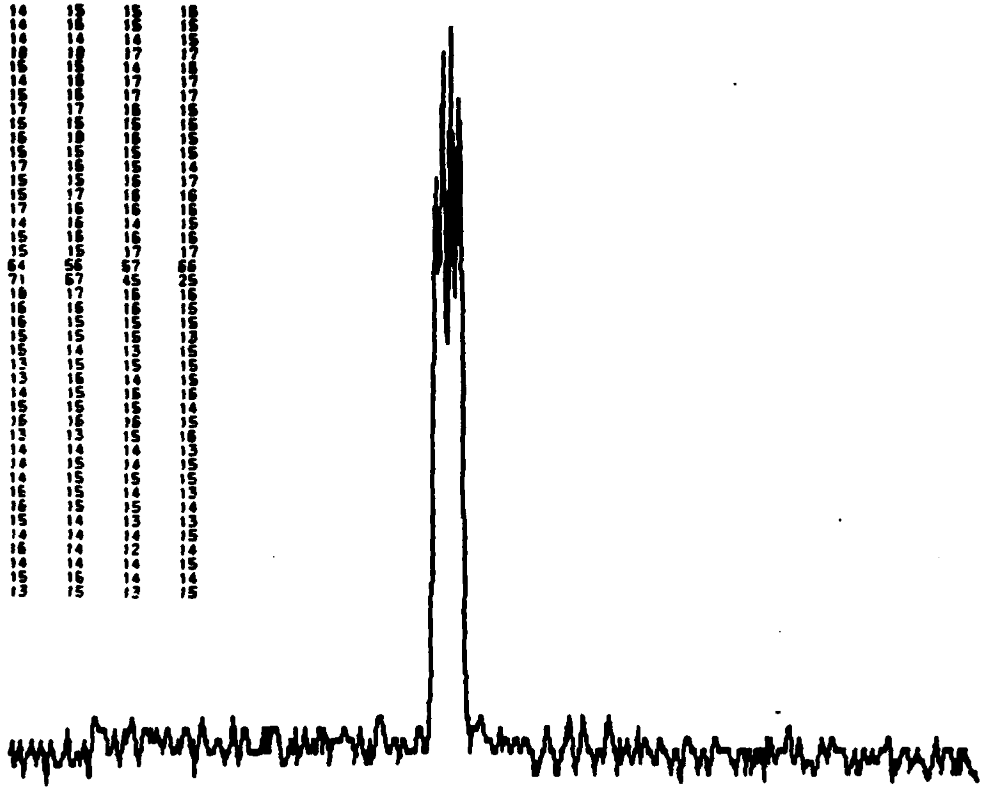

Figure 9a. Video line across the image of 4 bars, 0.25 inch wide on 0.5 inch centers using the complete system, filter position 2, 2410Å. Distance 750 inches.

14 12 10 12 13 15 15 14

12	15	15	15	13	12	12	12	15	14	15	13
11	13	14	15	14	13	13	14	14	14	14	15
15	16	14	14	13	12	13	13	14	14	14	15
14	14	14	16	16	13	14	14	15	17	16	16
14	14	14	15	14	15	15	15	15	15	14	15
15	15	15	13	15	15	17	15	13	13	13	12
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14	13	15	15	15	14	13	13	13	14	14	14
14	14	16	16	14	13	13	15	15	16	15	14
14	13	15	15	15	15	13	13	13	15	16	15
15	15	15	14	14	16	16	17	16	15	15	13
13	13	15	16	16	16	15	13	12	14	15	15
15	15	15	16	15	17	15	14	14	14	16	15
13	14	13	14	12	16	16	15	15	15	15	15
15	15	14	15	13	14	15	13	13	13	16	15
16	15	14	13	12	13	15	15	15	15	14	16
14	15	13	15	15	14	14	15	17	17	16	16
14	15	14	15	15	14	14	15	13	15	27	55
71	50	33	17	15	13	14	4	14	15	14	15
13	15	14	14	14	16	16	15	15	15	13	13
12	12	14	13	15	15	15	13	13	15	16	16
15	15	14	15	13	14	14	15	14	15	14	13
13	13	14	14	14	16	16	18	15	14	14	14
14	11	14	14	14	14	14	14	13	13	13	14
15	15	15	15	17	16	16	15	14	15	17	17
15	15	15	15	13	13	13	15	15	13	13	13
13	11	11	14	14	16	16	15	15	14	15	12
13	15	15	13	13	13	14	15	15	13	15	15
16	15	13	14	14	14	14	16	16	14	13	11
13	16	13	12	11	14	16	14	13	11	12	13
14	15	15	15	14	12	12	13	15	15	14	13
12	14	14	14	13	14	14	14	14	15	14	15
11	13	12	15	15	14	15	14	14	14	15	17
14	12	12	12	14	13	13	13	12	14	15	15
15	15	15	14	16	15	16	16	13	13	13	12
15	12	12	11	13	15	15	15	15	16	15	14
14	13	13	12	13	14	13	15	14	15	15	15
13	12	14	14	14	14	13	14	15	14	13	13
14	12	12	12	14	15	15	15	12	12	12	14
15	13	14	14	13	13	11	12	12	13	13	12
12	12	14	14	14	15	15	15	15	16	15	15

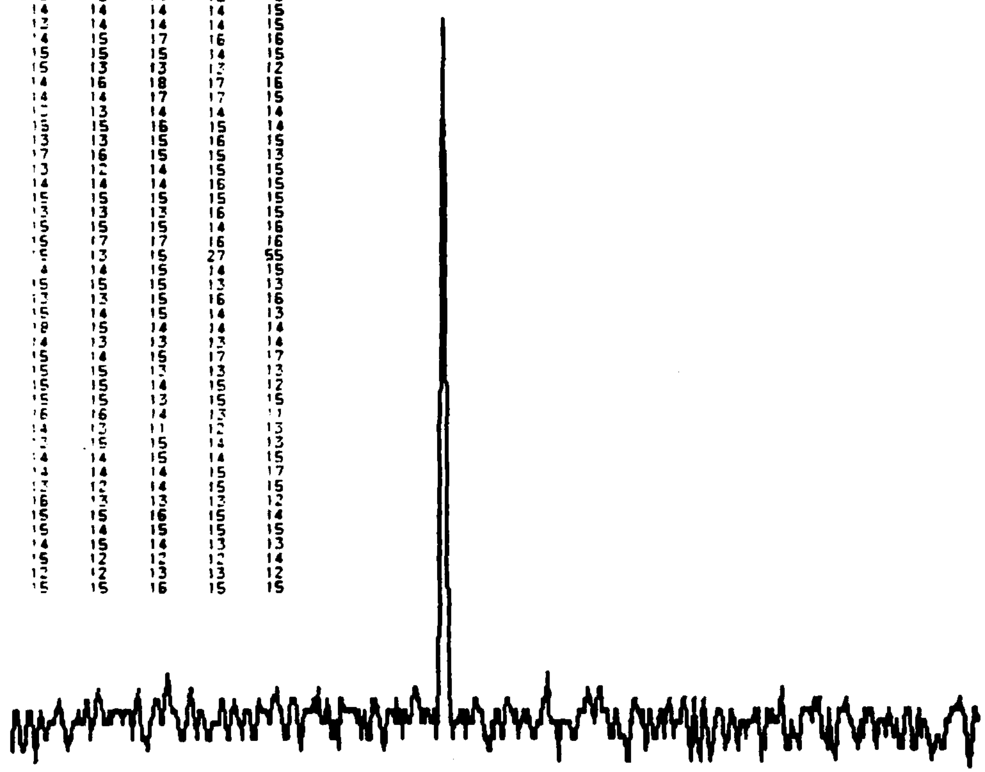


Figure 9b. Video line across single 0.25 inch wide bar.

Conditions same as 9a.

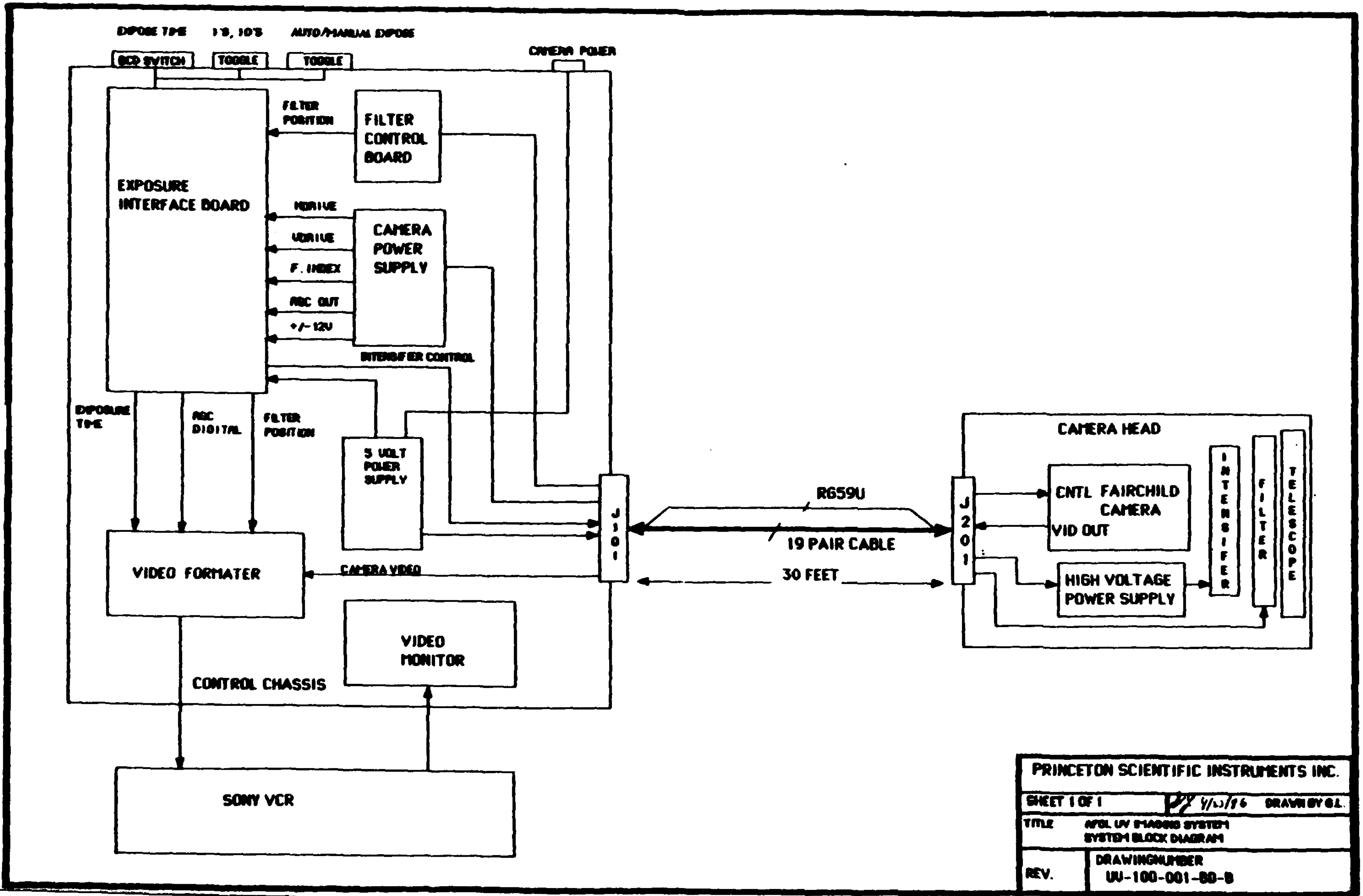
APPENDIX

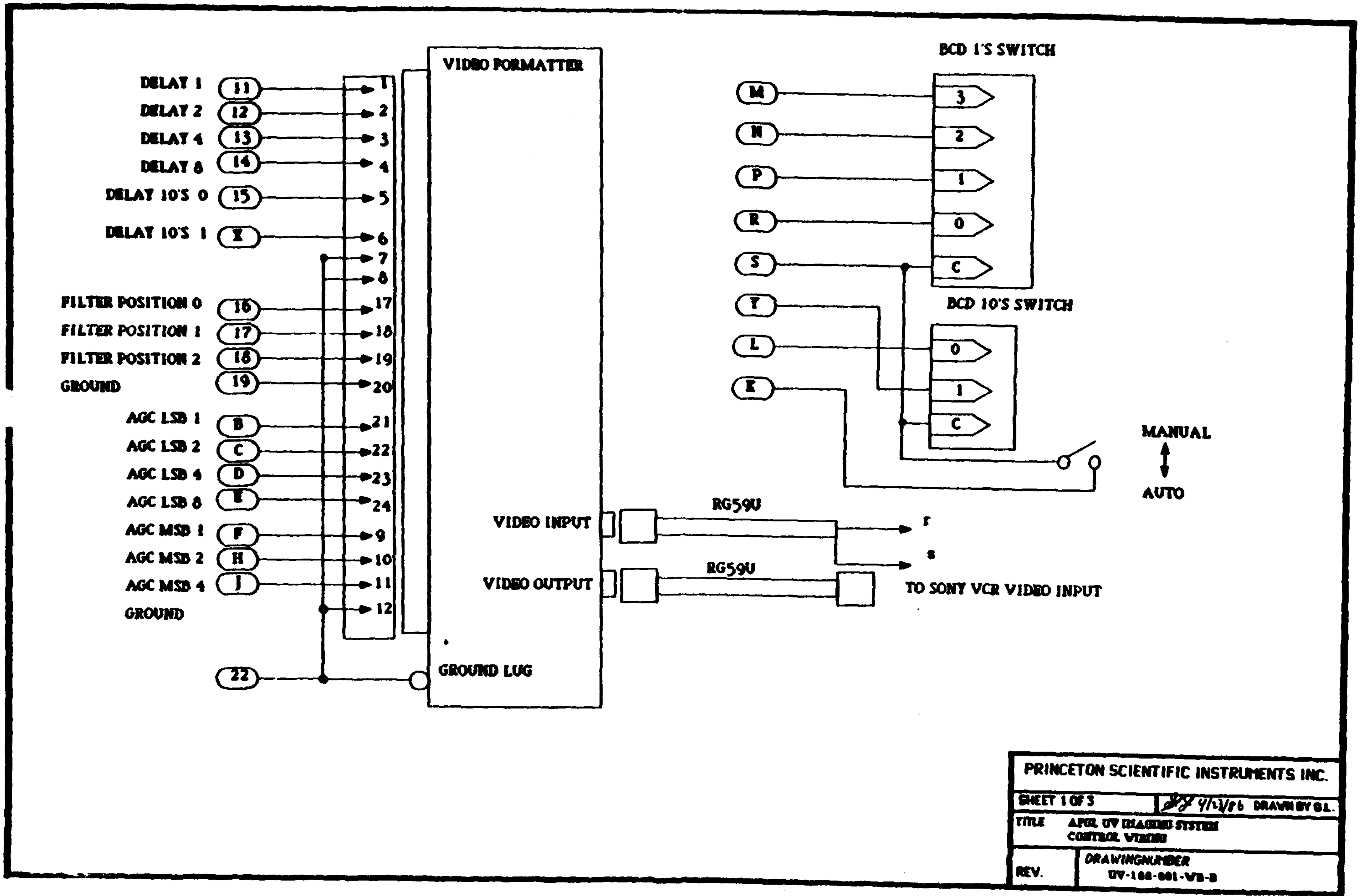
1. System Block Design

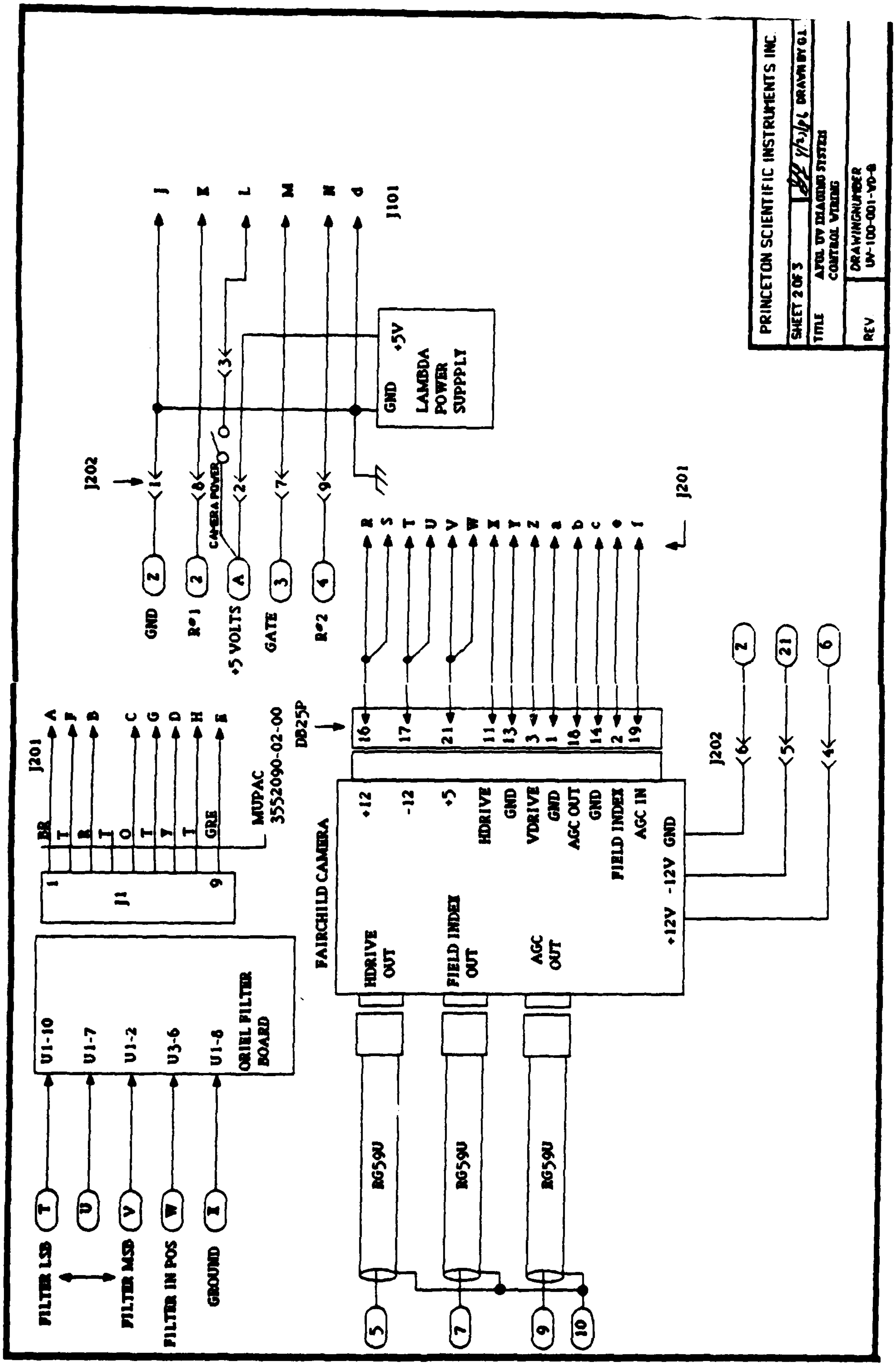
2. Control Chassis Wiring Diagram

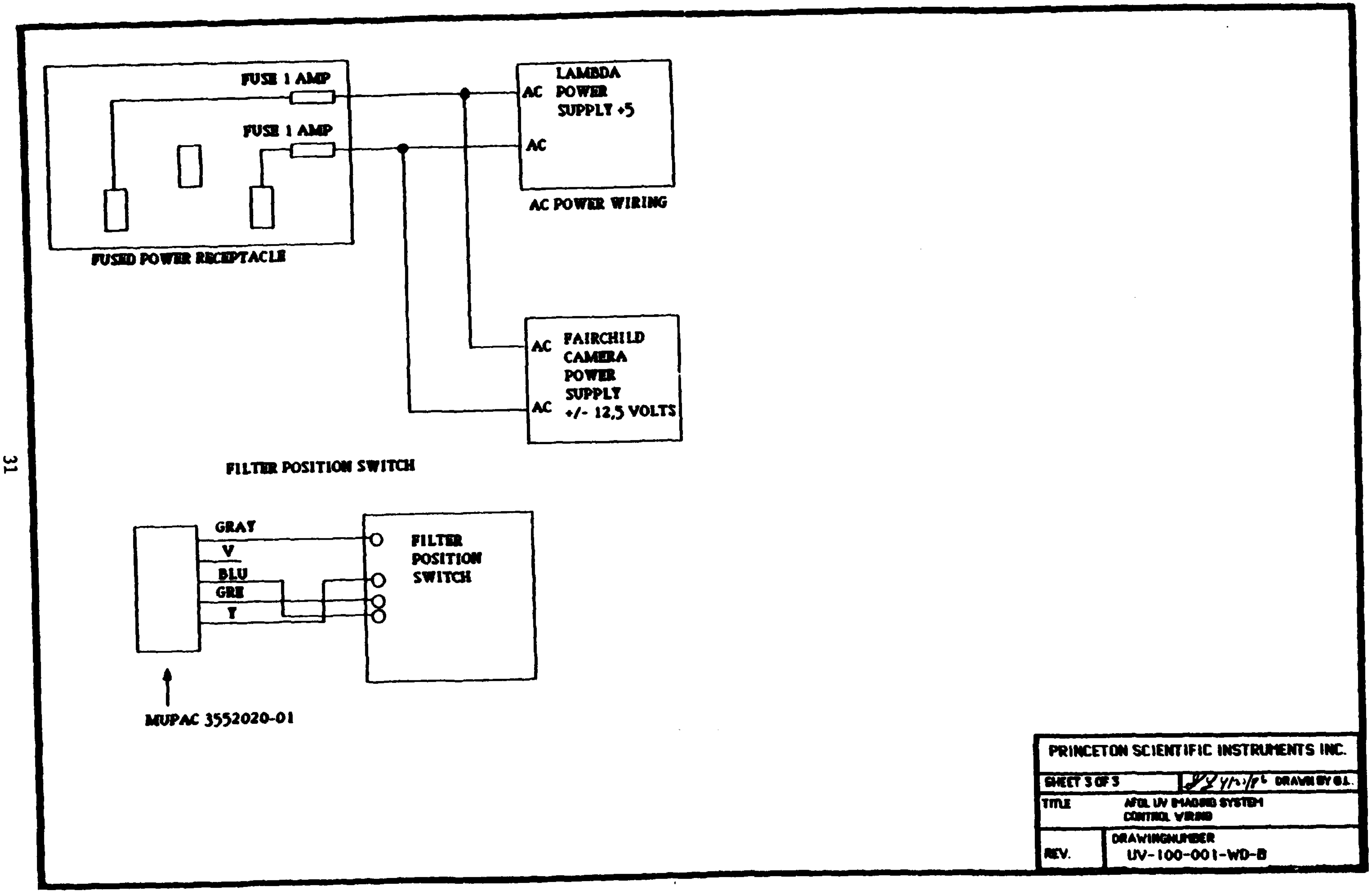
3. Head Wiring Diagram

4. Exposure Interface Board Schematics, Layout, Cable, etc.


EXPOSE TIME
1'S, 10'S
AUTO/MANUAL EXPOSE
BCD SWITCH
TOGGLE
TOGGLE
CAMERA POWER
FILTER POSITION
FILTER CONTROL BOARD
EXPOSURE INTERFACE BOARD
HDRIVE
VDRIVE
F. INDEX
AGC OUT
+/- 12V
CAMERA POWER SUPPLY
INTENSIFIER CONTROL
EXPOSURE TIME
AGC DIGITAL
FILTER POSITION
5 VOLT POWER SUPPLY
J101
VIDEO FORMATER
CAMERA VIDEO
VIDEO MONITOR
CONTROL CHASSIS
SONY VCR
R659U
19 PAIR CABLE
30 FEET
CAMERA HEAD
J201
CNTL FAIRCHILD CAMERA
VID OUT
HIGH VOLTAGE POWER SUPPLY
INTENSIFER
FILTER
TELESCOPE
PRINCETON SCIENTIFIC INSTRUMENTS INC.
SHEET 1 OF 1
DRAWN BY G.L.
TITLE AFGL UV IMAGING SYSTEM SYSTEM BLOCK DIAGRAM
REV.
DRAWINGNUMBER
UU-100-001-00-B


VIDEO FORMATTER
DELAY 1
DELAY 2
DELAY 4
DELAY 8
DELAY 10'S 0
DELAY 10'S 1
FILTER POSITION 0
FILTER POSITION 1
FILTER POSITION 2
GROUND
AGC LSB 1
AGC LSB 2
AGC LSB 4
AGC LSB 8
AGC MSB 1
AGC MSB 2
AGC MSB 4
GROUND
11
12
13
14
15
X
16
17
18
19
B
C
D
E
F
H
J
22
1
2
3
4
5
6
7
8
17
18
19
20
21
22
23
24
9
10
11
12
VIDEO INPUT
VIDEO OUTPUT
GROUND LUG
RG59U
RG59U
r
s
TO SONY VCR VIDEO INPUT
BCD 1'S SWITCH
BCD 10'S SWITCH
M
N
P
R
S
T
L
K
3
2
1
0
C
0
1
C
MANUAL
AUTO
PRINCETON SCIENTIFIC INSTRUMENTS INC.
SHEET 1 OF 3
DRAWN BY G.L.
TITLE
CONTROL WIRING
REV.
DRAWINGNUMBER


PRINCETON SCIENTIFIC INSTRUMENTS INC.
SHEET 2 OF 3
DRAWN BY G.L.
TITLE AFGL UV IMAGING SYSTEM CONTROL WIRING
DRAWING NUMBER
REV
FAIRCHILD CAMERA
LAMBDA POWER SUPPLY
ORIEL FILTER BOARD
MUPAC 3552090-02-00
DB25P
J201
J202
J101
J1
CAMERA POWER
GND
+5 VOLTS
GATE
FILTER LSB
FILTER MSB
FILTER IN POS
GROUND
HDRIVE OUT
FIELD INDEX OUT
AGC OUT
RG59U
RG59U
RG59U


FUSE 1 AMP
FUSE 1 AMP
FUSED POWER RECEPTACLE
AC
AC
LAMBDA POWER SUPPLY +5
AC POWER WIRING
AC
AC
FAIRCHILD CAMERA POWER SUPPLY +/- 12,5 VOLTS
FILTER POSITION SWITCH
GRAY
V
BLU
GRE
Y
FILTER POSITION SWITCH
MUPAC 3552020-01
PRINCETON SCIENTIFIC INSTRUMENTS INC.
SHEET 3 OF 3
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TITLE
AFGL UV IMAGING SYSTEM CONTROL WIRING
REV.
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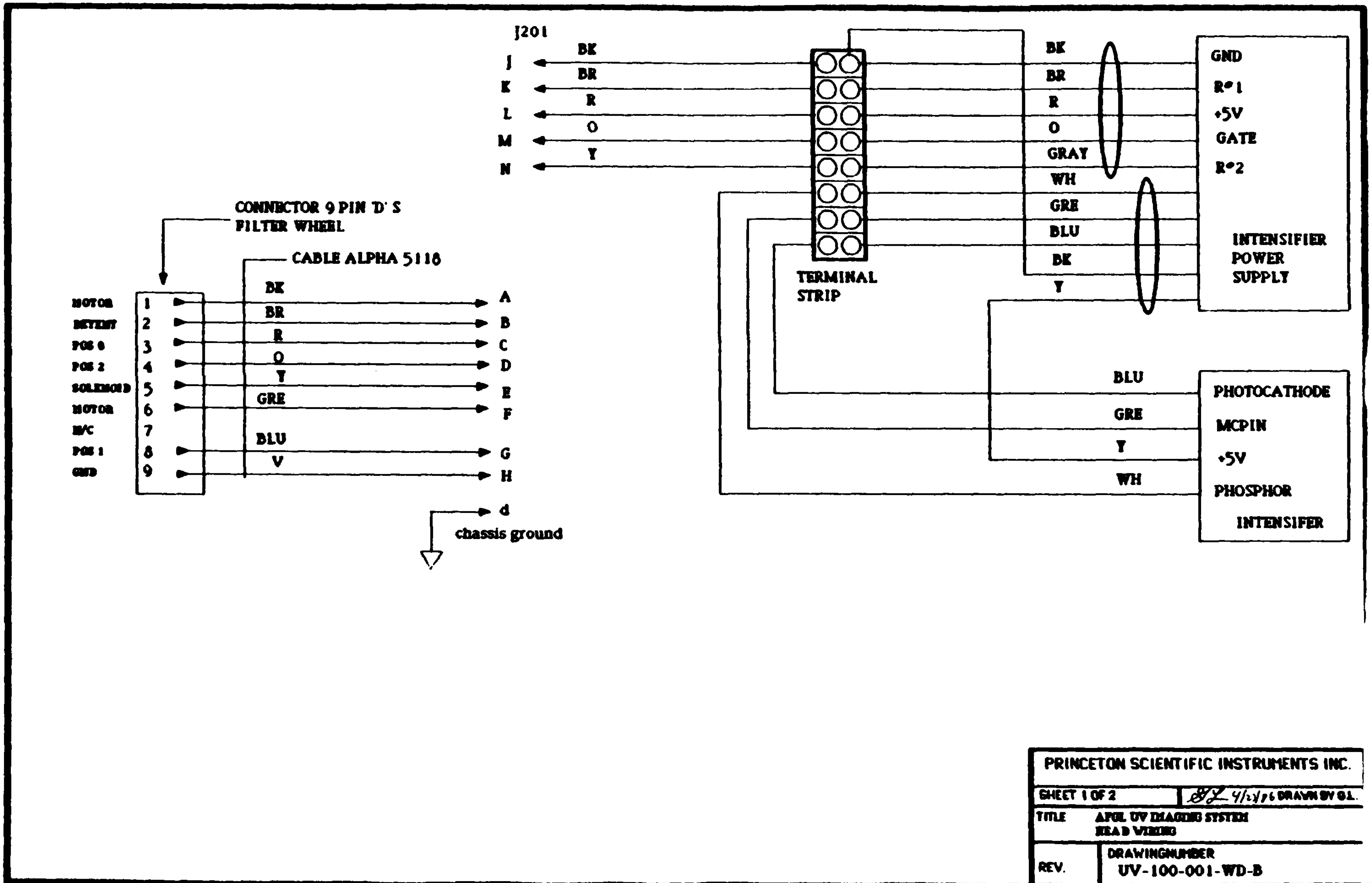
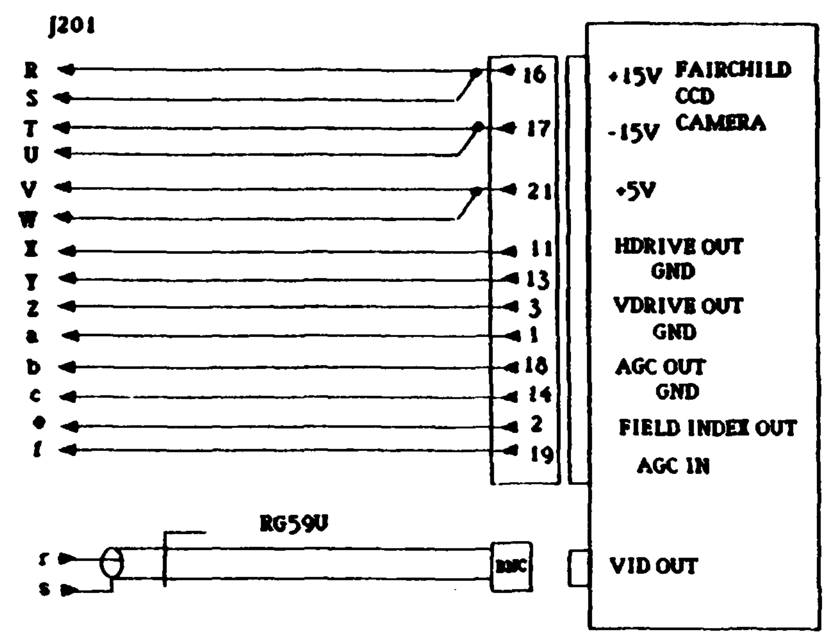
UV-100-001-WD-B


J201
BK
BR
R
O
Y
J
K
L
M
N
TERMINAL STRIP
BK
BR
R
O
GRAY
WH
GRE
BLU
BK
Y
GND
R#1
+5V
GATE
R#2
INTENSIFIER POWER SUPPLY
BLU
GRE
Y
WH
PHOTOCATHODE
MCPIN
+5V
PHOSPHOR
INTENSIFER
CONNECTOR 9 PIN 'D' S
FILTER WHEEL
CABLE ALPHA 5118
MOTOR
POS 0
POS 2
SOLENOID
MOTOR
POS 1
GND
1
2
3
4
5
6
7
8
9
BK
BR
R
O
Y
GRE
BLU
V
A
B
C
D
E
F
G
H
d
chassis ground
PRINCETON SCIENTIFIC INSTRUMENTS INC.
SHEET 1 OF 2
DRAWN BY G.L.
TITLE
REV.
DRAWINGNUMBER
UV-100-001-WD-B



PRINCETON SCIENTIFIC INSTRUMENTS INC.	
SHEET 2 OF 2	4/23/86 DRAWN BY G.L.
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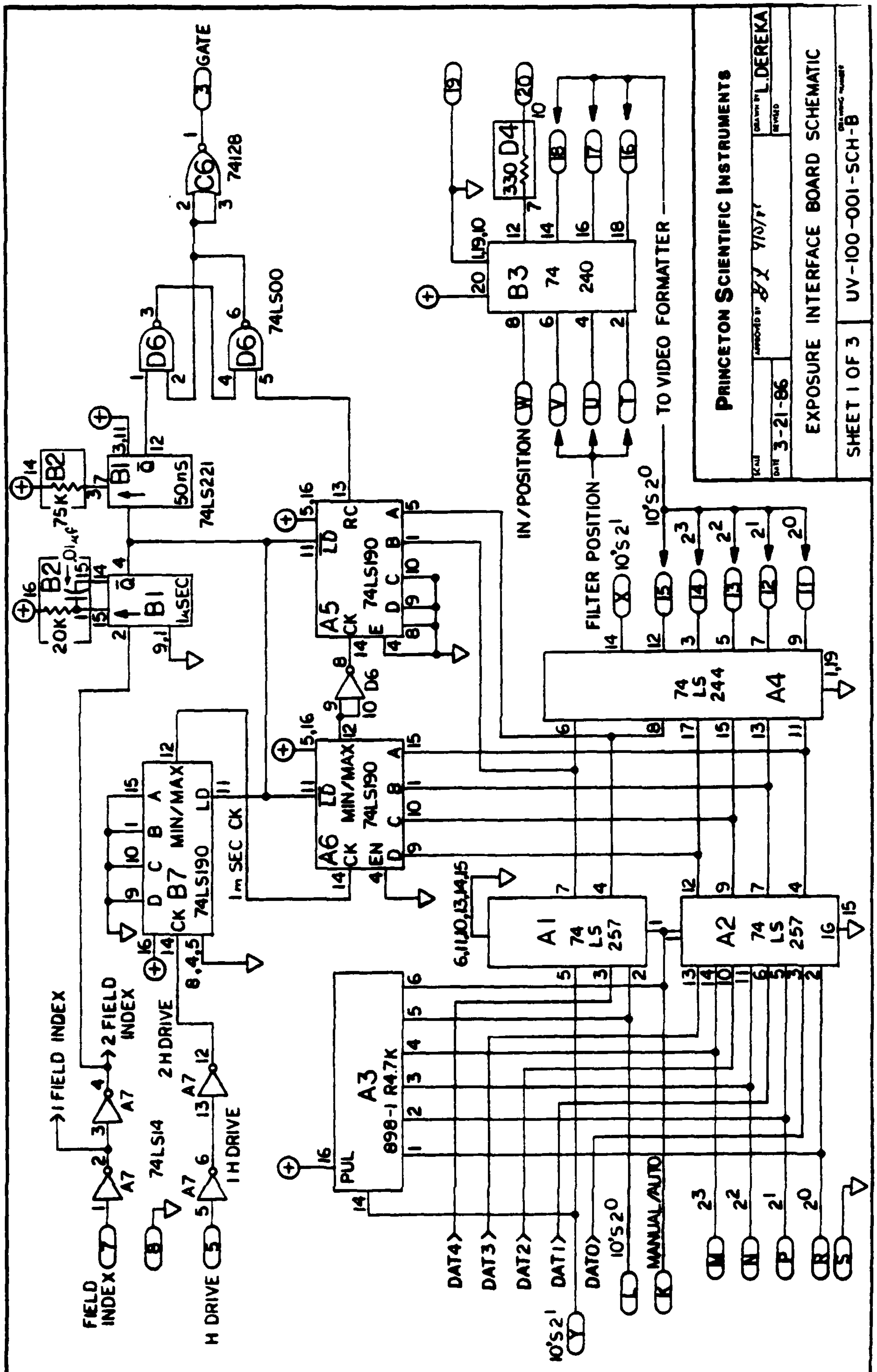
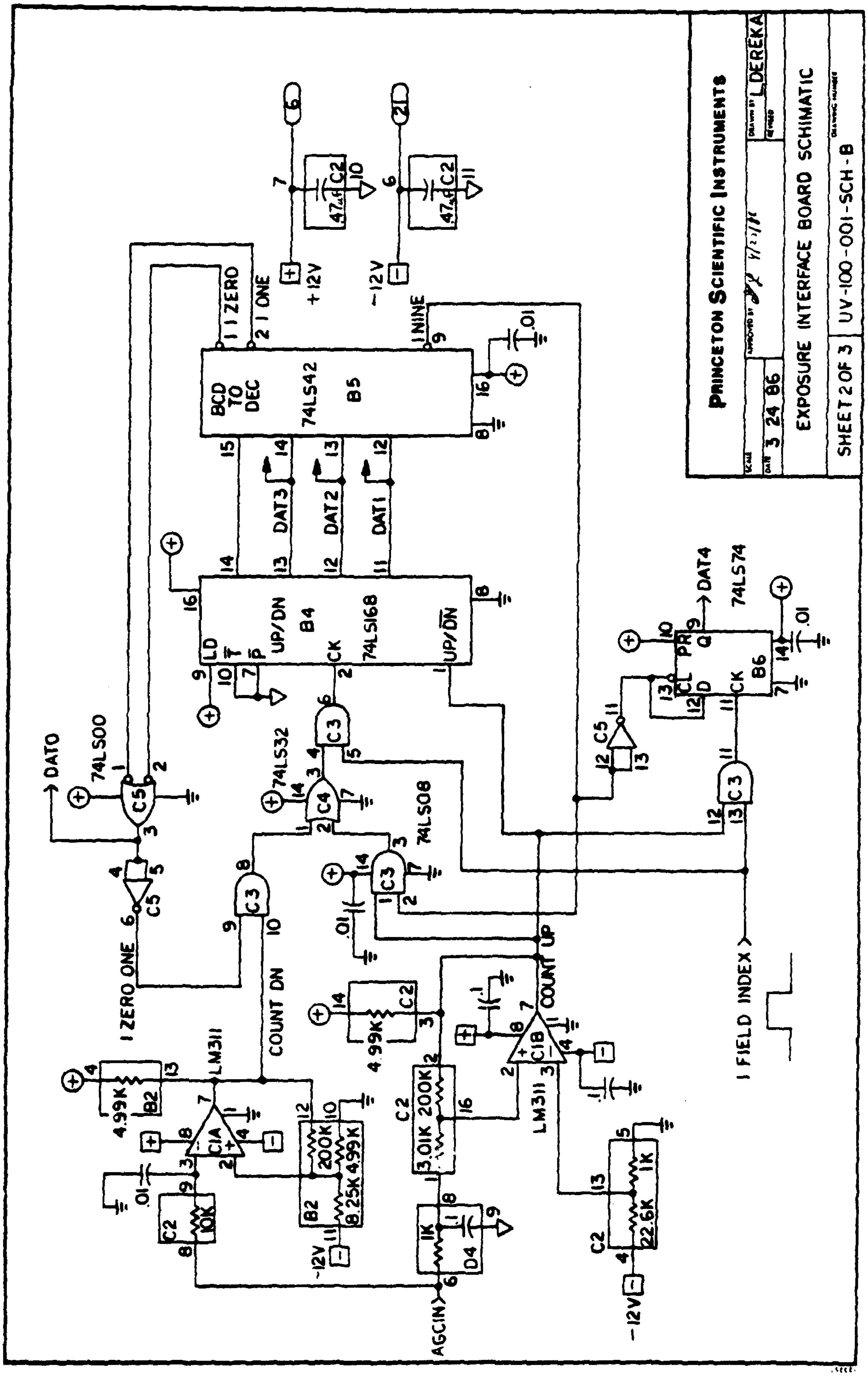
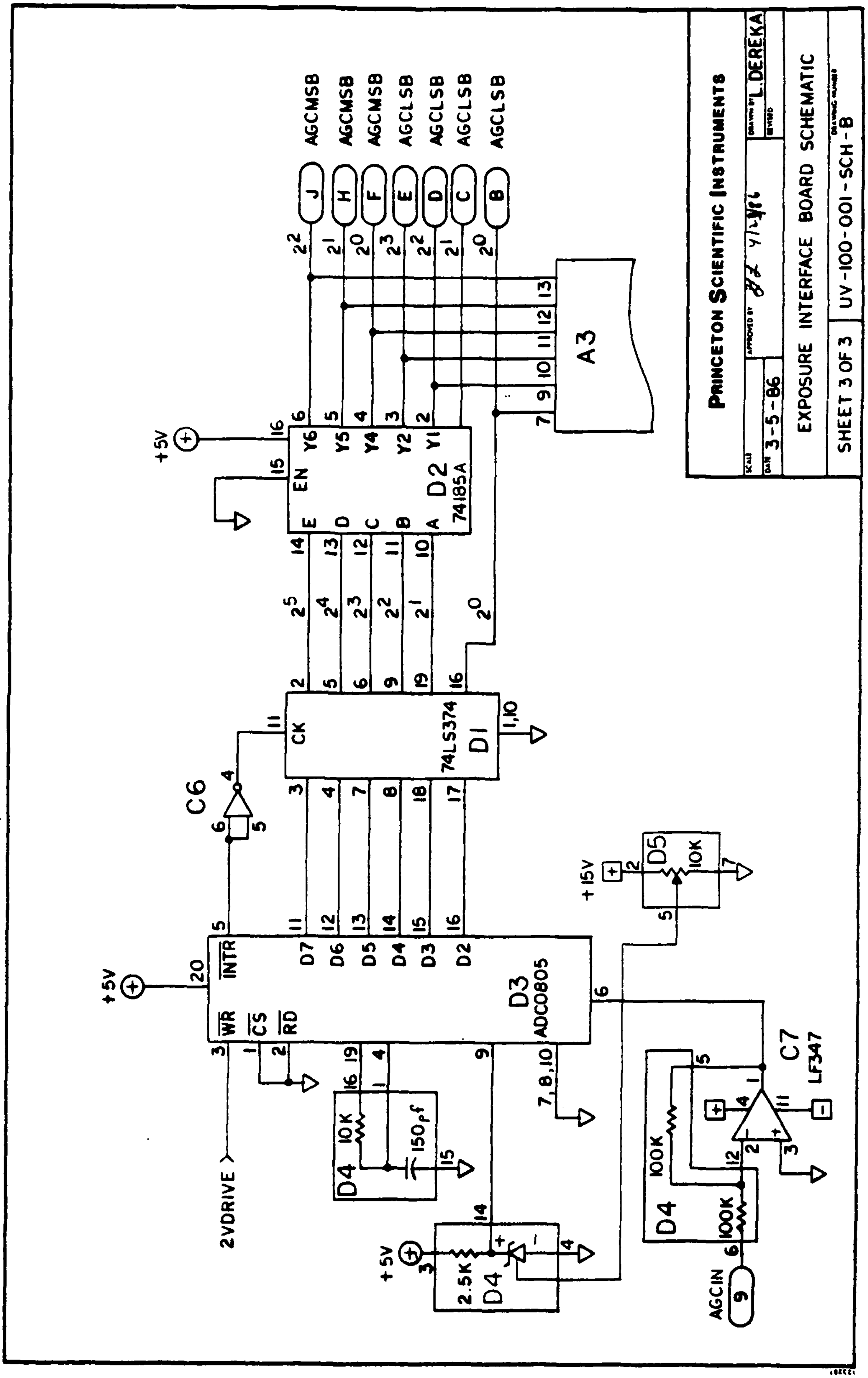
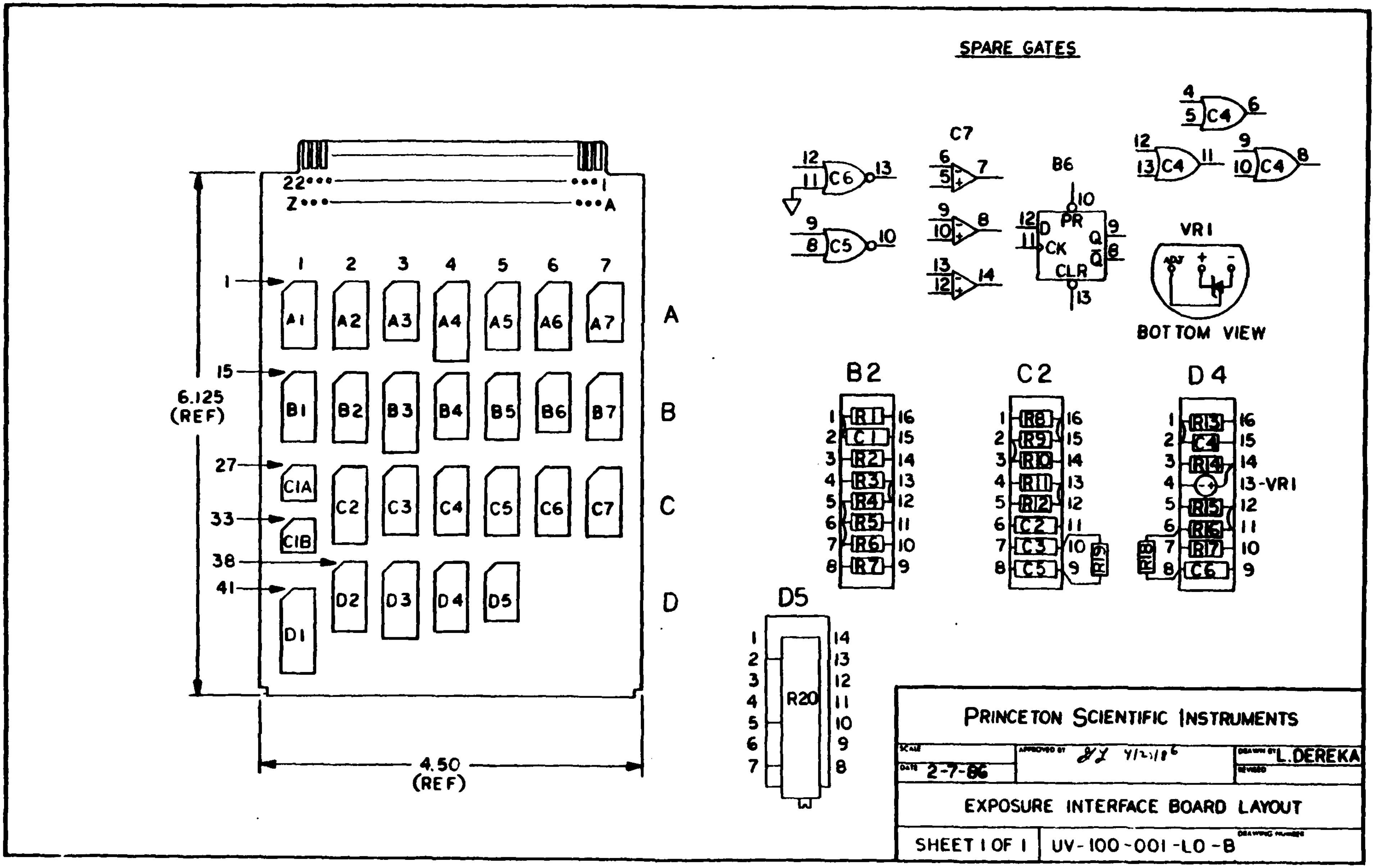
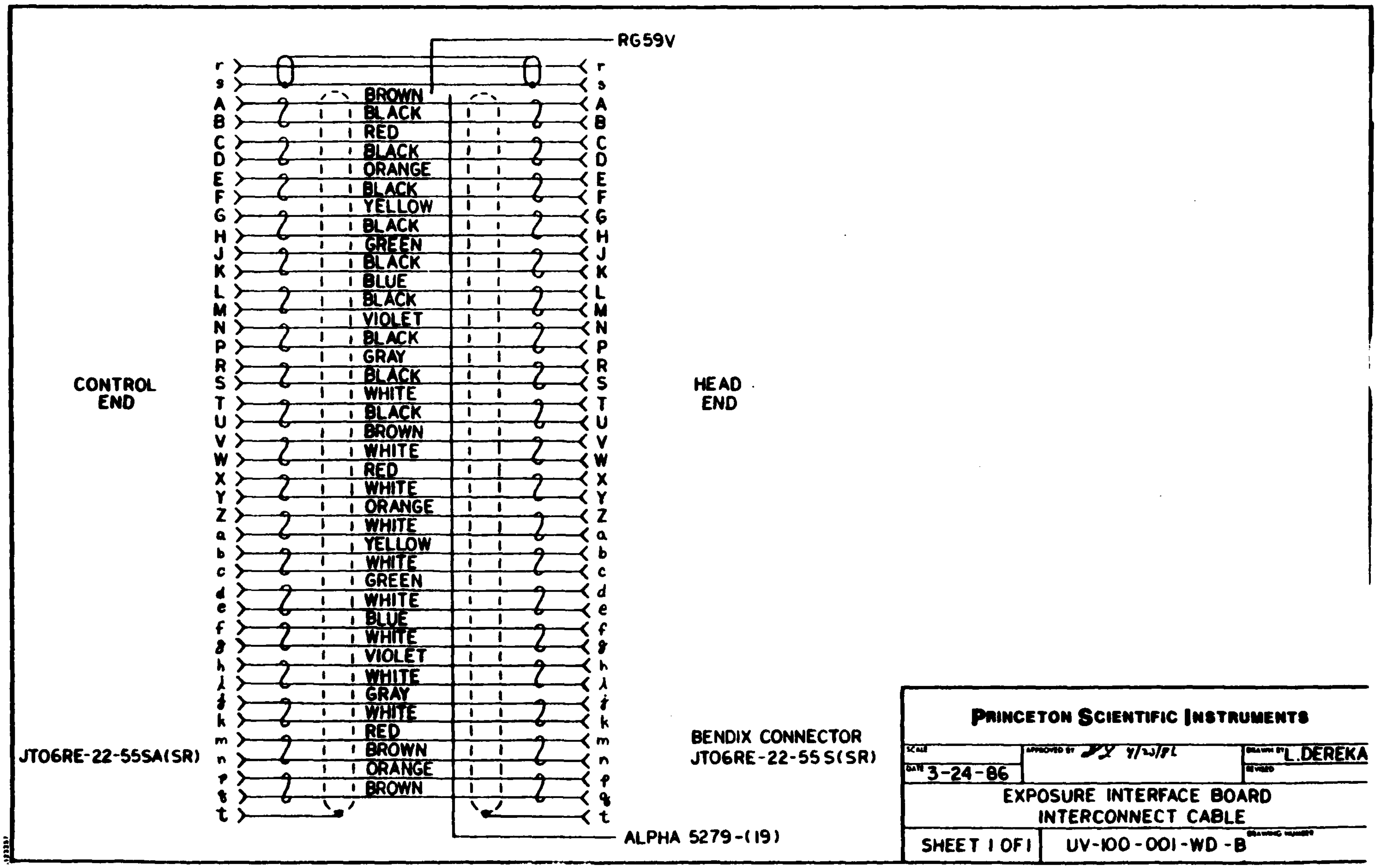
REV.	DRAWINGNUMBER UV-100-001-WR-B


PRINCETON SCIENTIFIC INSTRUMENTS
L. DEREKA
3-21-86
EXPOSURE INTERFACE BOARD SCHEMATIC
SHEET 1 OF 3
UV-100-001-SCH-B
TO VIDEO FORMATTER
FILTER POSITION
IN/POSITION
GATE
FIELD INDEX
H DRIVE
1 FIELD INDEX
2 FIELD INDEX
1 H DRIVE
2 H DRIVE
MANUAL/AUTO
DAT4
DAT3
DAT2
DAT1
DAT0


PRINCETON SCIENTIFIC INSTRUMENTS
L DEREKA
3 24 86
EXPOSURE INTERFACE BOARD SCHIMATIC
SHEET 2 OF 3
UV-100-001-SCH-B
BCD TO DEC
74LS42
B5
74LS168
B4
UP/DN
74LS74
B6
DAT0
DAT1
DAT2
DAT3
DAT4
74LS00
74LS32
74LS08
LM311
1 ZERO
1 ONE
1 NINE
1 ZERO ONE
COUNT DN
COUNT UP
1 FIELD INDEX
AGCIN
+12V
−12V


PRINCETON SCIENTIFIC INSTRUMENTS
L. DEREKA
3-5-86
EXPOSURE INTERFACE BOARD SCHEMATIC
SHEET 3 OF 3
UV-100-001-SCH-B
AGCMSB
AGCMSB
AGCMSB
AGCLSB
AGCLSB
AGCLSB
AGCLSB
A3
D2
74185A
D1
74LS374
C6
D3
ADC0805
D5
10K
+15V
+5V
C7
LF347
D4
10K
150pf
2.5K
100K
100K
2VDRIVE
AGCIN


SPARE GATES
C7
B6
VR1
BOTTOM VIEW
B2
C2
D4
D5
13-VR1
R20
6.125
(REF)
4.50
(REF)
PRINCETON SCIENTIFIC INSTRUMENTS
2-7-86
L. DEREKA
EXPOSURE INTERFACE BOARD LAYOUT
SHEET 1 OF 1
UV-100-001-LO-B


RG59V
CONTROL END
HEAD END
r s A B C D E F G H J K L M N P R S T U V W X Y Z a b c d e f g h i j k m n p q t
BROWN
BLACK
RED
BLACK
ORANGE
BLACK
YELLOW
BLACK
GREEN
BLACK
BLUE
BLACK
VIOLET
BLACK
GRAY
BLACK
WHITE
BLACK
BROWN
WHITE
RED
WHITE
ORANGE
WHITE
YELLOW
WHITE
GREEN
WHITE
BLUE
WHITE
VIOLET
WHITE
GRAY
WHITE
RED
BROWN
ORANGE
BROWN
JT06RE-22-55SA(SR)
BENDIX CONNECTOR
JT06RE-22-55S(SR)
ALPHA 5279-(19)
PRINCETON SCIENTIFIC INSTRUMENTS
SCALE
APPROVED BY
DRAWN BY L.DEREKA
DATE 3-24-86
REVISED
EXPOSURE INTERFACE BOARD
INTERCONNECT CABLE
SHEET 1 OF 1
UV-100-001-WD-B
DRAWING NUMBER

1	+5V	A	+5V
2	R#1	B	AGC BCD LSB 2^0 OUT
3	GATE	C	AGC BCD LSB 2^1 OUT
4	R#2	D	AGC BCD LSB 2^2 OUT
5	HDRIVE IN	E	AGC BCD LSB 2^3 OUT
6	+12V	F	AGC BCD MSB 2^0 OUT
7	*FIELD INDEX IN*	H	AGC BCD MSB 2^1 OUT
8	GROUND	J	AGC BCD MSB 2^2 OUT
9	AGCIN	K	AUTO/MANUAL
10	GROUND	L	TENS 2^0 IN
11	DELAY 2^0 OUT	M	BCD SWITCH 2^3 IN
12	DELAY 2^1 OUT	N	BCD SWITCH 2^2 IN
13	DELAY 2^2 OUT	P	BCD SWITCH 2^1 IN
14	DELAY 2^3 OUT	R	BCD SWITCH 2^0 IN
15	DELAY 10'S 2^0 OUT	S	GROUND
16	FILTER 2^0 OUT	T	FILTER 2^0 IN
17	FILTER 2^1 OUT	U	FILTER 2^1 IN
18	FILTER 2^2 OUT	V	FILTER 2^2 IN
19	GROUND	W	FILTER IN POSITION IN
20	FILTER IN POSITION OUT	X	DELAY 10'S 2^1 OUT
21	−12 VOLTS	Y	DELAY 10'S 2^1 IN
22	GROUND	Z	GROUND

PRINCETON SCIENTIFIC INSTRUMENTS

SCALE	APPROVED BY [illegible] 4/23/86	DRAWN BY L. DEREKA
DATE 3 19 86		REVISED

EXPOSURE INTERFACE BOARD INPUT/OUTPUT

SHEET 1 OF 1 — DRAWING NUMBER UV-100-001-IO-B

LOCATION	CHIP	ROW	COLUM	VCC PIN	GND PIN
A1	74LS257	1	1	16	8
A2	74LS257	1	2	16	8
A3	898-1R4.7K	1	3	-	-
A4	74LS244	1	4	20	10
A5	74LS190	1	5	16	8
A6	74LS190	1	6	16	8
A7	74LS14	1	7	14	7
B1	74LS221	15	1	16	8
B2	16 PIN CAR	15	2	-	-
B3	74S240	15	3	20	10
B4	74LS168	15	4	16	8
B5	74LS42	15	5	16	8
B6	74LS74	15	6	14	7
B7	74LS190	15	7	16	8
C1A	LM311	27	1	8	1
C1B	LM311	33	1	8	1
C2	16 PIN CAR	27	2	-	-
C3	74LS08	27	3	14	7
C4	74LS32	27	4	14	7
C5	74LS00	27	5	14	7
C6	74128	27	6	14	7
C7	LF747	27	7		
D1	74LS374	41	1	20	10
D2	74185A	38	2	16	8
D3	ADC0805	38	3	20	10
D4	16 PIN CAR	38	4	-	-
D5	14 PIN CAR	38	5	-	-
D6					
D7					

PRINCETON SCIENTIFIC INSTRUMENTS

SCALE | APPROVED BY JL 4/23/86 | DRAWN BY L.DEREKA

DATE 3-20-86

EXPOSURE INTERFACE BOARD LOAD LIST

SHEET 1 OF 1 | DRAWING NUMBER UV-100-001-LL-B

END

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