DTI OSCILLOSCOPE

INSTRUCTIONAL SERVICE

5:Scope-56

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To assist you with problems or difficulties that may arise in the construction and operation of the oscilloscope, may we offer a number of "trouble-shooting" suggestions? Even though you do not encounter any serious problems with this project, you will find many helpful testing procedures which may be applied to other electronic devices.

GENERAL

Read through these instructions before making any tests. The fault may be due to an external cause or improperly adjusted controls causing distorted or unintelligible waveforms.

You have gained considerable practical experience in the construction and correct observation of the various projects including the assembly of the meter. Either a multimeter or VTVM can be used to check component values and secure operational data of the oscilloscope. For example, you can readily measure the tube plate voltage and the B+ voltage at the output of the filter, therefore, we feel it is not necessary to offer detailed instructions on these steps. Also, we assume you can determine the proper vacuum tube elements for a desired measurement, that you will make proper selection of meter ranges and be able to read the scales correctly.

Thus, the following suggestions will be in the nature of a "guide" to help isolate a fault, yet leaving the procedure of obtaining the desired information to your own initiative, ability, or experience. However, make no resistance or continuity measurements with the power switch on unless the line cord plug is removed. Also, short the filter capacitors for a moment with an insulated test lead -- this action discharges the stored charge which could in some cases damage a meter movement.

We want to remind you that one wrong connection, an omission of a connector, a wrong part, or a poorly soldered connection, can cause the entire project to be inoperative. Although the above faults are the most common, you cannot overlook the possibility of a defective part (tubes, switches, potentiometers, etc.).

Note a few words of wisdom expressed by Benjamin Franklin -- "It's no crime to make a mistake -- the crime is to make the same mistake twice". Sometimes we overlook the most obvious offender or fail to note some of the simplest causes of non-operation. We quote a remark from a student in the field -- "Seems strange how one can make the same mistake so many times. I checked and rechecked the wiring and resoldered and finally I found my mistake".

Since we do not include specific instructions for testing each individual part, if you are in doubt about the "identification" of some components, please check "color" instructions and pictorial diagrams.

INITIAL SUGGESTIONS

To begin, let's assume that the operational tests and progress reports made upon the completion of Shipments ABT, BCT, CDT, DFT, and ELT were satisfactory, but some electrical fault, damaged part, or maladjustment now exists. It is worth while to start the trouble-shooting of non-operating conditions of the oscilloscope by checking the tubes. If these are known to be good, and heat in their respective sockets, check the power supply circuits. The block diagram below indicates the dependence of the separate circuits of the oscilloscope on the proper operation of the LO and HI voltage power supplies. The overall object is to isolate the fault to a definite section, such as (1), (2), (3), etc.

OSCILLOSCOPE BLOCK DIAGRAM

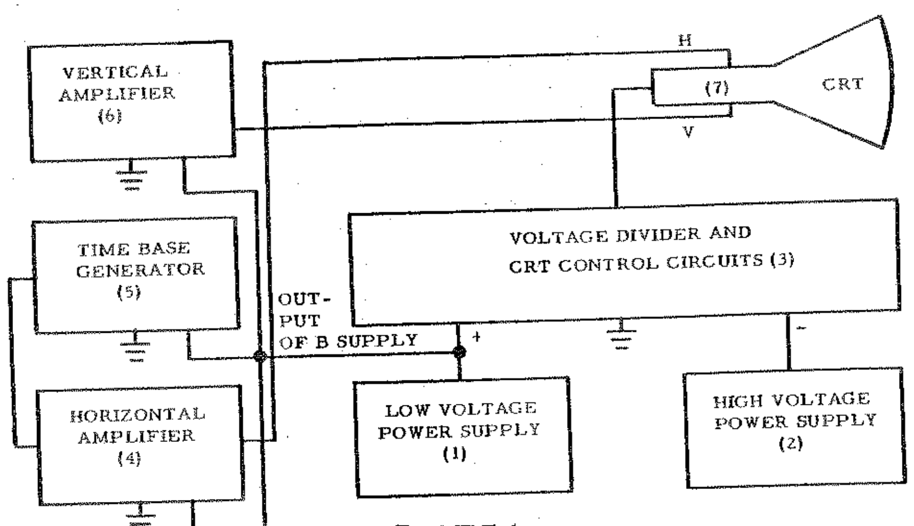

FIGURE 1

POWER TRANSFORMER OVERHEATS - (With all tubes removed from their sockets).

Possible faults:

1. Heater circuit is shorted externally or internally.
2. High voltage secondary shorted (or partially shorted).
3. Use of 60 cycle power transformer on 25 cycle source. The lamination stack of the 25 cycle power transformer (7G08 - 7K8) is approximately 3" whereas for the 60 cycle power transformer (7G06 - 7K6) it is approximate-

ly 2" high.

Suggested Tests:

(a) By observation - Disconnect all transformer leads from respective terminal strips or lugs except those of the primary leads to terminals TS-6-3 and TS-6-4. Turn on the power. Should heating continue, a transformer winding is probably shorted and the unit requires replacement. If heating stops then re-connect one pair of secondary terminals at a time, say yellow filament leads and check, then brown filament leads, etc., and note (by feel) each time if the transformer starts to overheat. Should any added pair of secondary connections cause overheating, the corresponding circuit is wired incorrectly and requires a careful visual and continuity check for a short circuit. It might be well to recheck details of power transformer circuits project instructions.

(b) Alternate test using a-c voltmeter - With selector switch on a suitable range, check for abnormally low or zero voltages across corresponding released leads of transformer secondaries. Check Figure 18, ELT. A variation of voltage readings between red - red yellow - red (leads) indicates a (partial) short of the high voltage secondary winding and the transformer should be replaced.

POWER SUPPLY AND LOW B+ CIRCUIT CHECK - (Tubes in Socket)

Like the power supply you constructed, which was used to supply filament and B+ voltages for the circuits of the various projects, the power supply of the oscilloscope must function properly.

Here are possible causes of failure:

1. Wrong value part used.
2. Defective filter capacitors (both HI and LO B+ sections).
3. Electrolytic capacitors connected in reverse with respect to polarity.
4. Wiring errors, B+ terminals connected through unwanted paths to ground (may be due to faulty switches or incorrect switch wiring).
5. Shorted tubes. (Be sure tubes are known to be good).

4 K Filter Resistor Overheats - Smokes

Overheating of the 4 K resistor between TS-5-4 and TS-5-5 is caused by excessive B+ supply current and is evidence of a circuit wiring error or a faulty part.

Faults indicated by "2" and "3" in the above section should be checked first. With the power off, disconnect the positive leads of the filter at TS-5-4. Make a visual check for correct polarity. A defective filter capacitor will usually get warm (and spongy if of the cardboard type) to the touch. Check the capacitor connected to TS-5-5 too.

With power on observe whether or not overheating of the 4 K resistor continues. If not, the fault has been isolated to the output filter capacitor. If heating continues the trouble is in the other B+ circuits of the scope as indicated by faults 1, 4 or 5 above. Check the capacitor (electrolytic) connected to TS-5-2, those connected to screen grid terminals of V_1 and V_4, and related components in the B+ bus line.

Should the above test indicate a faulty filter capacitor it will be necessary to make an individual test of each unit. Observe proper polarity of test leads. A low resistance, less than 25,000 ohms approximately, and an unusually warm part is evidence of appreciable leakage current. The capacitor requires replacement.

TROUBLE CENTERED TO HIGH VOLTAGE SECTION

Much like the troubles in low voltage B+ circuits, similar faults can exist in HI voltage supplies. In the DTI scope, the high voltage output point (plate of V_6) is negative with respect to chassis or ground. If zero or low output voltage is noted, the probable fault could be -- a defective rectifier tube or filter capacitor (.05 µf oil filled can).

For a test, interchange rectifier tubes and check for voltage in low B+ section. If tube is okay, release connections to one or both the HI voltage filter capacitors. If HI B+ is restored, capacitor is faulty and should be replaced. Make a resistance check of suspicious capacitor to verify observations.

Excessive HI voltage:

If excessive high voltage (negative) exists between the plates of tube V_6 and chassis, (measurement here could be beyond range of DTI multimeter) a faulty (open) or wrong part could exist in the voltage divider section. Also, the line voltage at the point of operation could be greater than normally encountered. Allow for considerable voltage variation if the line voltage is higher than 117 volts. Referring to scope schematic diagram, Figure 18, ELT, make a recheck of parts in the voltage divider section. You might start at the plates of V_6 and trace the divider circuit (resistor components) to point TS-5-3 (chassis).

LOCALIZING FAULTY SECTION - (Tube Circuit B+)

Referring again to the block diagram of Figure 1 of this form, and Figure 18, from ground there are several parallel d-c paths to TS-5-4 (LO B+ point). For example, tracing from ground or chassis of the vertical amplifier section, there is a direct current path through the 330 ohm resistor to the cathode, through tube V_2 to the plate pin 5, through a 10 K resistor to TS-3-4, to TS-1-2, to TS-5-4.

Assume a previous resistance measurement indicated low resistance between TS-5-4 and chassis, but releasing the lead to Ts-3-4, at Ts-1-2, provides a reading near normal. Trouble is then isolated to the d-c circuit from TS-3-4, even though a former check indicated the 8 µf screen grid bypass capacitor and tube V_2 to be okay. To continue the assumption, suppose the actual fault was found to be a leaky 8 µf capacitor showing tendency of breaking down after a period of operation.

If perchance your first "guess" at the separate parallel path that could contain the fault was wrong, then a similar plan of isolating other faulty sections can be followed. The block diagram of Figure 1 will serve as a rough guide.

The same basic plan could be followed through, making d-c voltage measurements at various B+ test points -- but here scope operation with a fault may unnecessarily overheat or damage parts.

RECHECK OF CRT CONNECTIONS

Using the basing diagram of Figure 2 below, make certain that the cathode ray tube socket is wired in the proper "direction". It is possible for the tube to heat and "light up" even though the tube socket is wired in the reverse direction.

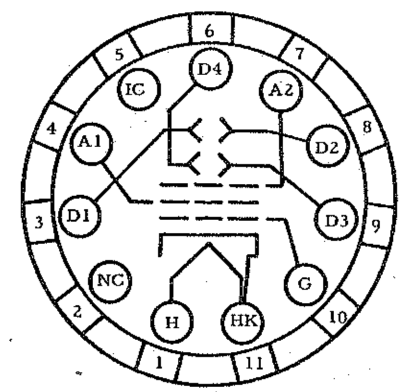

FIGURE 2

CR Tube Heater Doesn't Heat:

Recheck carefully all soldered connections to the tube socket. With the socket off the base of the tube, and with the scope power on, measure a-c voltage between socket pins 1 and 11. Approximately 6.3 volts should be available.

With scope power off and the socket off the tube base, measure resistance between pins 1 and 11 of the cr tube. The normal resistance is approximately 2.5 ohms. If the crt filament check shows an open or very high resistance, the tube is faulty and requires replacement. Please write for instructions covering the return of the cr tube.

POSSIBLE TROUBLES

Misread or Misinterpreted Instructions:

There is a possibility of observing a high B+ voltage at lug No. 7 (control grid) of the 12AU7 (V_3) tube or excessive heating of the 560 ohm resistor. This is a result of connecting TS-3-4 to lug C of the sweep frequency selector switch instead of lug C of the sync selector switch. When the oscilloscope is operated any great length of time with this wiring erro, damage to various parts is very apt to occur.

Spot Off Screen:

If the spot is off the screen, and adjustment of normal controls does not provide proper return to the center of the tube, there is a good chance that improper connection has been made to the horizontal and vertical positioning controls. A careful check of parts should be made -- particularly that of the voltage divider section. A quick check can be made of these points -- terminals 1 of the vertical and horizontal positioning controls should be the same negative voltage. The voltage should be the same at terminals 3 of both the vertical and horizontal positioning controls. In this case the voltage will be positive with respect to ground.

No Spot:

A faulty .1 µf coupling capacitor, connected to terminal strip TS-3-2 could be at fault. A leaky capacitor would provide a high B+ voltage at this terminal, and tend to maintain a high positive voltage on the cathode ray tube deflection plate No. 6, and as a result tend to hold the spot off the screen. Check the capacitor for possible leakage, or try another unit in this position for a test.

No Control of Vertical Amplitude:

This trouble usually is due to a faulty 1 megohm potentiometer. Release connections from two terminals and check from terminal lug 2 to 1 and from 2 to 3, then watch ohmmeter indicator as control is varied.

Unusual Observations: (Voltages OK)

A double trace effect or a trailing ghost effect (a sine wave pattern with a displaced but weaker image) could be caused by a faulty 6AQ5 tube.

An erratic or intermittent signal (sometimes known as hash) riding on a normal pattern could be caused by a faulty 12AU7 tube. (Even though a tube may check good on a tube tester, it is possible for it to function erratically in a critical electron device such as an oscilloscope).

Also, it is possible for voltages to check okay, yet as a result of a faulty socket, the stage could be inoperative. For example, if the small sleeve in the socket does not touch the tube base pin (grid circuit) tests might show voltages reasonably okay and circuit correct, but fail to function. Check: Gently rock the tube in a slightly circular fashion while in the socket and power on. Make observation of intermittent results.

CATHODE RAY TUBE RESISTANCE CHECK:

If the cathode ray oscilloscope provides erratic operation, a resistance check between elements of the crt should be made. Referring to the basing diagram of Figure 2 and with the socket off the base of the tube, check for leakage resistance between the cathode pin 11 and all the other pins (a low reading between pins 1 and 11 is normal. This is the internal filament circuit). Note, however, pins 2 and 5 have no internal electrode connection.

As seen from the basing diagram there should be no leakage resistance (current path) between any of the active elements when the socket is off the tube base. If there is any indication of resistance on the high ohms range of the meter then the CRT is faulty and requires replacement.

CHECKING THE CR TUBE:

There is no simple method of checking the crt without adequate equipment. However, it is necessary for certain conditions to exist before the crt can operate properly. The following procedure will help to determine the "worth" of the tube.

Referring to the complete schematic diagram of the oscilloscope as a guide, make certain that pins No. 3, 7, and 9 of V_7 are grounded. Make sure that the 2.2 meg resistors connected to pins 6 and 8 are not defective. Examine the crt socket to see that the connections are good. Make continuity checks of the lugs from base side of pin to top of socket side of the same pin (that is, for example, check from the bottom of socket pin 10 to the top of socket pin 10).

Disconnect the two .1µf coupling capacitors from the output of the vertical and horizontal amplifiers, V_2 and V_4. Turn on the oscilloscope and make certain the crt heater glows. Remove the socket from base of crt and measure the d-c voltages on the various pins of the crt socket, using the V_7 chart on page 14. Note any wide variations from normal operating potentials.

If operating conditions exist and the crt still does not show a spot of light on the screen, it can be assumed readily that the crt is defective.

If normal operating voltages are not found, then the fault may not be in the crt, and proper operating conditions must be made. Correction can be made by carefully following the suggestions of this service.

NON-LINEARITY IMPRESSION:

From the standpoint of design the DTI oscilloscope provides good horizontal sweep linearity. However, we realize the component tolerance may be accumulative and distortion, in more extreme cases, may require a careful check of sawtooth forming capacitors.

For optimum and more accurate waveform observation, it is preferable to view only 2 complete cycles of the test signal, and then confine the waveform to the central area of the screen. At sweep frequencies less than 30 cycles, it is normal for some slight distortion at the left side of the screen, particularly if the horizontal sweep width is excessive and more than 2 cycles are being observed.

If distortion of the waveform seems severe, check the 5 µf capacitor between lugs 6 of the B and D sections of the sweep frequency selector switch. A replacement may be tried if resistance check of the capacitor is inconclusive. Alternately, a .1 µf capacitor may be tried for any improvement in waveform.

CRT MAY BE REVERSED 180°:

In order to check whether or not the cr tube may be positioned 180° from normal, the locating or guide pin on the base of the crt should be pointing toward the top surface of the chassis. Although not directly to the chassis, the guide pin should point downward between 8 and 4 on the face of a clock.

MODIFICATION OF POSITIONING CIRCUITS:

An unusual condition may exist whereby the vertical or horizontal positioning control has inadequate range.

The fault could be a defective (leaky) .1 µfd plate coupling capacitor. As a check, release one end of each of the horizontal and vertical coupling capacitors. If full positioning control of the spot is had, then replace suspicious capacitors. If no improvement in spot positioning is obtained, circuit changes can be made.

Figure 3 shows part value and circuit changes that can be tried to correct for incomplete spot swing to the right. Remove the 2.2 megohm resistor and in its place connect a 470 K and 1.5 megohm (series combination) resistors. Disconnect terminal 1 of the horizontal positioning control from the ungrounded end of the 560 K resistor. Make a connection between terminal 1 of the control and the junction of the 470 K and 1.5 megohm resistors.

Should spot movement increase be desired to the left, similar changes can be tried. Here the 1.2 megohm resistor could be replaced by a combination of 680 K and 470 K resistors, with terminal 3 of the horizontal positioning control connected to the junction of these resistors.

For possible reduction of unusual horizontal deflection that might be caused by a slight power supply ripple, try the circuit modification indicated in heavy lines in Figure 4. Components needed: 1, 10 K, 1 watt resistor, 1, 8 µf, 450 v

electrolytic (1, 2 terminal strip is preferred in order to support one end of each of the added components).

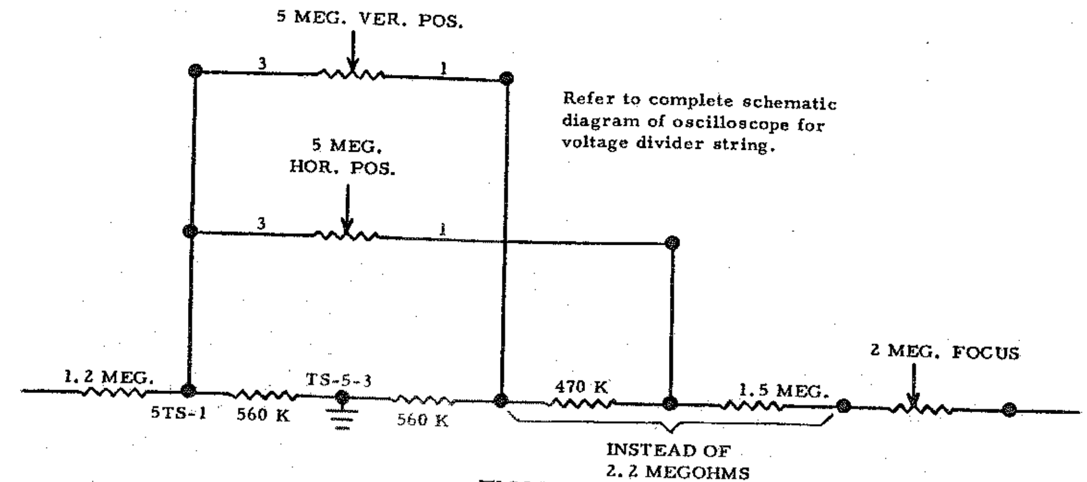

FIGURE 3

Release the B+ end of the 100 K resistor from TS-1-2. Select a suitable mounting point for the terminal strip such as a V_4 socket mounting hole. Connect the free end of the 100 K resistor to the insulated terminal strip lug. Connect a 10 K resistor between this terminal and TS-1-2. Connect the + end of 8 µf capacitor to the junction of the 100 K and 10 K resistors. Connect the - end of the capacitor to a convenient chassis ground lug. Solder all connections carefully.

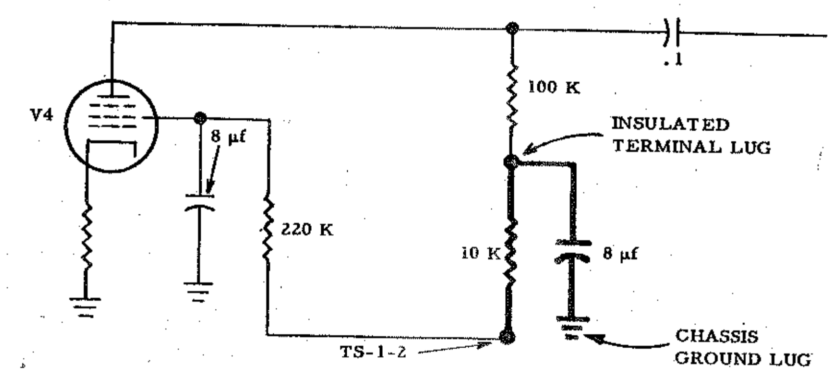

FIGURE 4

Positioning Controls Operate Backwards:

In all probability the connections to both the vertical and horizontal positioning controls are reversed in position. That is, the connection to lug No. 1 should be connected to lug No. 3 and vice versa. Make a careful check of wiring instructions regarding the proper manner of numbering the lugs for these controls.

Focus -- Completely Sharp Focus Not Observed Over the Full Width of the CRT Screen:

Generally a compromise must be made between the proper adjustment of the focus control and the intensity control in order to obtain a clear cut waveform on the cr tube screen. It is not desirable to advance the horizontal gain to sweep the entire "width" of the tube. The greatest accuracy of the waveform observed is near the central area of the screen, and there is no particular advantage in spreading the pattern more than 1 or 1-1/2 inches in either the horizontal or vertical direction from the center of the tube. Out of focus appearance and distorted conditions will be accentuated by spreading the trace "too wide". As you may know, the outer viewing surface of the glass is slightly curved, and some defraction may exist. It might be well to mention that even expensive laboratory precision oscilloscopes do not use large cr tubes for the very same reason that there is no advantage to sweep the waveform to a greater width than can be observed satisfactorily at a normal viewing distance.

There is a bare possibility for excessive defocusing observations to exist as a result of improper operation or faulty tube. Generally, a gassy tube will lead towards inability to control the focus reasonably well, and lower than normal operating potentials of the tube will have a similar tendency to defocus the tube spot.

WAVEFORM OBSERVATIONS

Elliptical Spot or Double Trace Wave Patterns:

This fault would seem to indicate an unusual magnetic field causing undesired horizontal deflection, and as a trial attempt -- raise or lower the tilted side of the power transformer to see what effect it has on the trace. By changing the length of the spacers required, you can temporarily fix the best position and determine what additional positioning changes might be necessary in the transformer mounting such that the (assumed) magnetic field will be diverted from the electron gun structure or other signal circuits.

Learn Functions of Controls:

When following through various prescribed test procedures, very often meaningless or indistinguishable waveform patterns are merely a result of maladjustment of various controls. It is suggested that a very careful review of oscilloscope theory be made -- reviewing the regular assignments such that the function of each control is known clearly. As a matter of fact a thorough knowledge of scope operation will enable one to know its limitations and capabilities. We realize too, that it will take some "practice" to become familiar with the various control operations, and by repeating various procedures, one will become "experienced" in learning just what control to adjust in order to properly interpret a meaningless waveform.

The controls that are most commonly maladjusted are -- the sweep frequency control (selector switch), the fine frequency control, the sync amplifier control and the vertical amplifier control. In most cases, it is desirable to obtain only two waveforms on the screen of the oscilloscope. Therefore, the frequency selector switch should be positioned to provide as close as possible two waveforms and then adjusted more accurately with the fine frequency control.

The sync amplifier control should normally be kept as low as possible -- just enough to stop the waveform for observation. Excessive sync gain will have a tendency to distort the waveform and possibly introduce other undesirable waveforms or gyrations of the pattern.

Of equal importance is the proper adjustment of the vertical gain control -- the gain should be kept as low as possible, consistent with normal viewing of a suitable image -- usually a 2 inch (overall height) image is satisfactory. Experience in operating these controls will soon enable you to learn what maladjustments do to the normal waveform of a pattern. If two complete cycles are observed on the screen, then the frequency of the signal being measured is just twice the sweep frequency of the oscilloscope.

TEST SIGNAL VOLTAGE

The heater voltage of tube V_1 is used as a test signal source, and since the voltage of this tube is 6.3 volts, the open circuit voltage available, with respect to ground, at test signal points, should be 6.3 volts. However, when measuring with the DTI multimeter, on the 100 volt range, the reading will be 4 volts approximately. It looks like there might be some discrepancy here, but remember that there is a 10,000 ohm resistor connected in series between the high side of the test signal source and the test signal binding post, and thus measured with the multimeter (a-c range), the current through the meter also passes through the series dropping resistor, and thus about 4 volts will exist between the test signal binding post and the ground binding post. Using a VTVM the reading should be 6.3 v approximately, since there is very little loading by the VTVM. However, when this test signal is applied to the vertical input terminals of the oscilloscope, it is 6.3 volts, because the input circuit of the vertical amplifier does not draw current. Therefore, it merely establishes a voltage across the input circuit, and with the vertical gain control advanced full on, 6.3 volts rms would be applied to the control grid. The peak voltage applied is approximately 9 volts (6.3 × 1.41), and the peak to peak voltage (measured vertically from the peak of the wave in the positive direction to the peak of the wave in the negative direction) equals 18 volts.

OSCILLOSCOPE OPERATION NORMAL

Unusual Voltage Measurements at (Terminal Strip) TS-7-1:

Depending somewhat on the cathode ray tube characteristics, and the effect of the meter in measuring d-c potentials, there may exist quite a wide variation from those tabulated in the voltage table. Generally speaking, a measured value of (-) 500 to (-) 730 volts, measured at socket lug 10 of the cr tube is quite satisfactory. At least, as long as the scope seems to be operating normally, then a wide variation here is permissible.

Loose Cathode Ray Tube Base:

In handling the cathode ray tube, it is possible for the bakelite base to become loose from the glass envelope. Here, you might try your hand at a repair, and obtain some vinylite cement or general service cement and with the loose base pulled as far away from the glass neck as possible, coat the inner surface and edges with a good quantity of cement. Allow time to adhere so that the base will properly stick to the glass envelope when the cement becomes dry.

MISCELLANEOUS SUGGESTIONS

Oscilloscope Cabinet or Carrying Case:

We want to explain that we do not supply a case for the 5 inch oscilloscope. You see, from experience, we know that students have different ideas concerning the placement of the assembled instrument, and thus none has been included in the original cost of the entire training program.

Some of the fellows want to place the instrument in a "rack" (hidden except for the panel) on their bench, others may want to make use of a metal carrying case whereas others may desire a wooden type cover.

Plans for a scope cabinet made of 1/4" plywood are shown in Figure 5.

Scope Hood:

It is desirable to exclude as much light as possible from the viewing area of the oscilloscope screen, and you might try to improvise a shield by cutting a heavy sheet of black drawing paper to form a cylinder that will fit to the space between the panel and the cathode ray tube. Alternately, you could make a small cylinder or similar shape by cutting a piece of tin and then forming it to fit over the end of the tube, also between the edge of the tube and the panel. The inside surface of the cylinder should be painted black or possibly attach a layer of dark felt material to it.

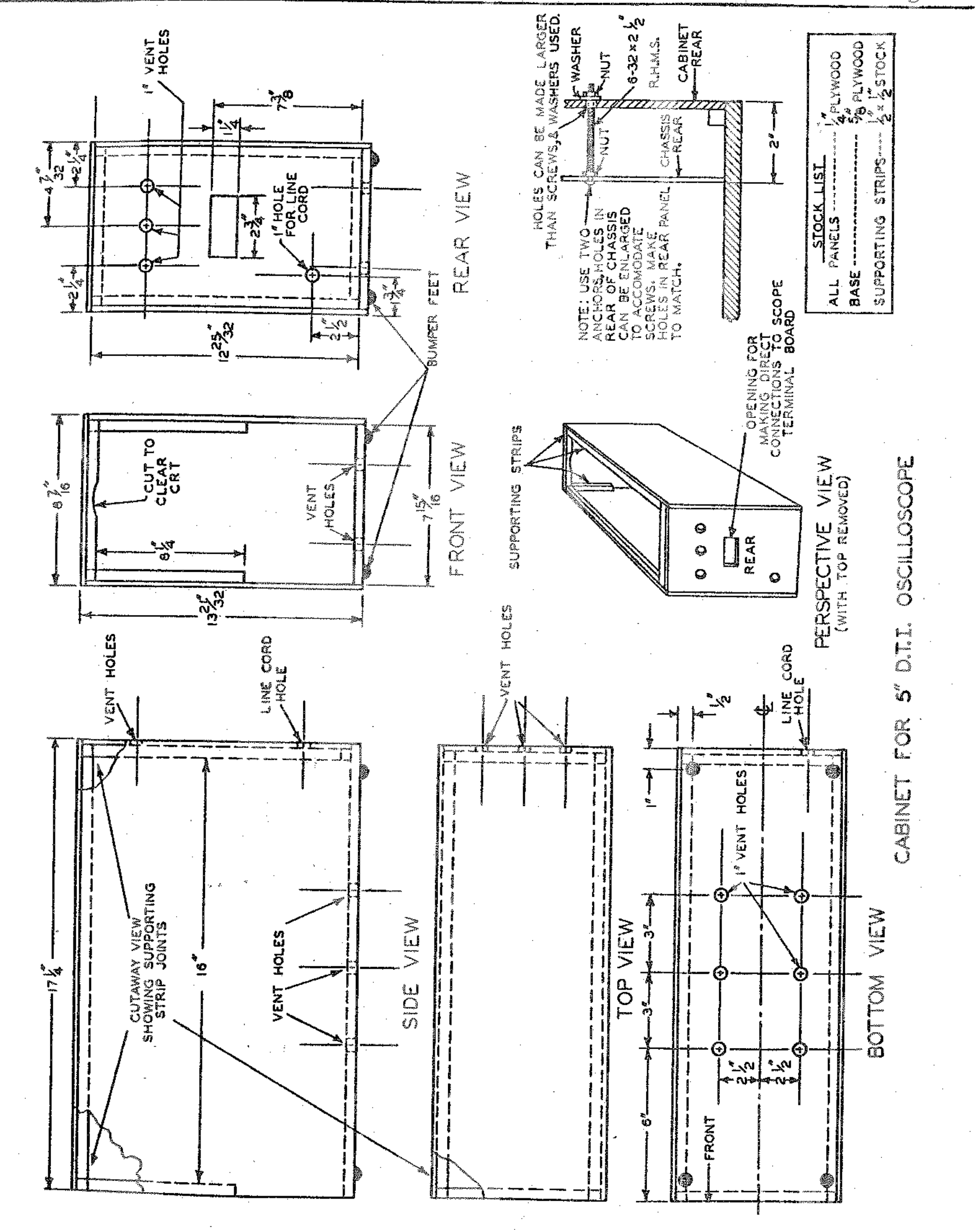

FIGURE 5

Project Waveform Observation:

The illustrated waveforms of shipment FGT are a little more idealized than it is expected that you will be able to obtain in practice. That is, it is not anticipated that you will be able to reproduce the configurations exactly. If your waveforms resemble fairly closely the corresponding sketch, then you can be reasonably sure that your results are satisfactory.

CATHODE RAY TUBE CALIBRATION SCREEN

Since the oscilloscope is essentially a peak voltmeter, its screen may be calibrated in terms of peak, rms, average or peak to peak voltage as desired. An improvised screen may be made from a suitable piece of flexoglass or celluloid, accurately ruled to form cross section lines of some specific measure such as 1/8 inch squares or 1/4 inch squares as may be desirable.

Also, it may be possible to provide a form of screen by making use of strips of graph paper fastened to the circular edges of the tube by scotch tape or other adhesive means. In effect, these strips of graph paper will form a "+" sign, and when properly positioned, the "axis" will lie in the vertical and horizontal planes. Any desired markings on the strip will serve to compare unknown waveforms with that of a known waveform of a definite input voltage used for calibration. For example, in the above mention of the test signal, 6.3 volts input is 18 volts peak to peak, and the vertical gain of the oscilloscope could be set to provide a peak to peak vertical deflection of 10 units. Then, any waveform could be compared to this -- if the unknown waveform was 20 units, then the peak to peak voltage would be 36 volts, etc. One thing to note -- the vertical gain control should be set at a specific point when the screen is calibrated, and remain in this position for measurement of unknown voltage waveforms. It may be necessary to check the calibration from time to time to maintain its relative accuracy.

QUICK D-C VOLTAGE CHECK OF SECTIONS 4, 5 AND 6.

Referring to the block diagram of Figure 1, here is a quick voltage check list to determine if "B+" is available at screen grid and plates of the tubes in sections 4, 5 and 6. Measure between socket lug and chassis with meter set on suitable range. Scope controls set in mid-position (approximately) and all tubes heating.

	Lug 1	Lug 2	Lug 3	Lug 4	Lug 5	Lug 6
V_1 - 6AU6					240-260	60-90
V_2 - 6AQ5					140-160	100-120
V_3 - 12AU7	145-180					90-110
V_4 - 6AU6					160-190	120-160

Any voltage measurement quite difference from the above approximate range of normal limits would provide some clue as to possible trouble in a measured stage. For example, suppose voltage measurement of V_4 - 6AU6 shows lug 6 (screen grid) as a low 60 volts and the plate voltage at lug 5 to be 140 volts. The fault could be a leaky 8 µf electrolytic capacitor connected between pin 6 and chassis which would require replacement.

A QUICK CHECK OF THE CR TUBE D-C VOLTAGES

With the DTI multimeter set on 1000 v d-c, measure between V_7 socket lugs and chassis. Note negative voltages -- red test prod on chassis and black prod to socket lug. When using a VTVM, the black prod is always on chassis. The proper function switch setting is -DC and the range is 1500 v.

	Lug 1	Lug 4	Lug 10	Lug 11
V_7 - 5BP(1) Cathode Ray Tube	-700 to -730	-350 to -450	-500 to -730	-700 to -730

Here again voltage measurements falling far outside of typical ranges could provide a clue to a fault. For example, if a low voltage is measured at socket lug 10, the .05 µf capacitor between TS-7-3 and TS-8-1 could be leaky and require replacement.

WRITING FOR ASSISTANCE WITH THE OSCILLOSCOPE PROBLEMS

If you still have difficulty in placing your oscilloscope in operating order, after having followed through the various test suggestions offered, we have attempted to make your inquirey easy to submit by asking that you fill out the questionnaire at the end of this service, and also submit one copy of a complete d-c voltage table. The answers to the various questions will help us to analyze the problem more definitely, and a voltage chart will serve to pin point possible troubles. Send these sheets with your explanations and comments to the Consultation Department, DeVry Technical Institute. Be sure to place your name and student number on each page of correspondence. Wherever possible, include sketches of patterns you observe and offer any other data which would be of value in analyzing your problem. Fill in one page of the voltage data chart and keep it for your own reference.

It is not necessary to send these sheets unless further assistance is required in the correction of your oscilloscope.

To Consultation Dept.
DeVRY TECHNICAL INSTITUTE

Student No.__________

OPERATIONAL REPORT ON SCOPE TROUBLES

General Observations:

1. Does the crt heater light up (heat)? Yes_____ No_____

2. With the intensity and focus controls turned 1/2 or 3/4 to full clockwise rotation, is there a spot or indication of fluorescence on the screen? Yes_____ No_____

3. Can you control:
   (a) the spot diameter? Yes_____ No_____
   (b) the spot intensity? Yes_____ No_____
   (c) the vertical position of the spot? Yes_____ No_____
   (d) the horizontal position of the spot? Yes_____ No_____

4. Is there a horizontal sweep trace when the selector switch is on:
   (a) external sync? Yes_____ No_____
   (b) internal sync? Yes_____ No_____
   (c) 60 cycle sync? Yes_____ No_____
   (d) horizontal amplifier position? Yes_____ No_____

(For normal operation, all answers in No. 3 and No. 4 should be "YES" except 4(d).

5. If your answers to No. 3 and No. 4 do not show proper operation, make a careful check of the corresponding section relating to it. Recheck color code of parts (if so identified). If you are suspicious of a component, release one terminal, then check it. Does anything unusual show up?

____

____

6. With a connection between the test signal binding post and the vertical input terminal (sync selector in H amp position) is there control of the line height by rotating the vertical amplifier gain control? Yes_____ No_____

7. With a connection between the test signal binding post and horizontal input terminal (sync selector in H amp position) is there control of the line width by rotating the horizontal amplifier gain control? Yes_____ No_____

8. Is the house lighting circuit a-c voltage relatively constant? Yes_____ No_____

9. The a-c voltage input to the scope power supply (receptacle) is_____v a-c.

10. Is your copy of the d-c voltage table attached?__________.

11. These measurements were made with the DTI Multimeter_____ VT VM_____

Operational Report on Scope Troubles (Cont'd.)

Comments, waveform sketches, and other observations: ____________________

Name ____________________ Student No. __________

Street ______________________________

City ________________ Zone ______ State ____________

DTI Oscilloscope

COMPOSITE D-C VOLTAGE TABLE

Student No. __________

Use highest range, unless otherwise noted. Although printed voltages are typical generally, allow 20% variations. Reading at TS-7-1 may vary more than 20% when using multimeter. Place your readings in proper columns. Observe proper polarity. Indicate whether VTVM or multimeter was used to make measurements. __________

Black Prod ON	Red Prod ON	ALL CONTROLS Clockwise Typical Multimeter	VTVM	Measured	Counterclockwise Typical Multimeter	VTVM	Measured
Int. Pot 3	Chassis	900	1050		900	1100	
TS-7-1	Chassis	720	900		760	1020	
Int. Pot 1	Chassis	720	920		710	1040	
Focus 1	Chassis	640	880		640	980	
Focus 2	Chassis	640	880		235	525	
Focus 3	Chassis	235	500		235	525	
V. Pos. 1	Chassis	60	90		60	80	
TS-8-1	Chassis	0	0		0	0	
TS-3-2	Chassis	20	80		-20	-70	
TS-1-4	Chassis	20	80		-20	-70	
Hor. Pos. 1	Chassis	60	90		60	80	
Chassis	V. Pos. Pot. 3	60	85		60	85	
Chassis	TS-5-2	315	315		285	285	
Chassis	TS-5-4	340	340		310	310	
Chassis	H. Pos. Pot 3	60	85		60	85	
Chassis	TS-1-2	340	340		310	310	
Chassis	TS-2-4	315	315		285	285	
Chassis	TS-3-4	340	340		310	310	
Chassis	Sync Sw. 5	340	340		0	0	
Chassis	Sync Sw. 7	0	0		310	310	
Chassis	Sync Sw. 1	0	0		0	0	
Chassis	Sync Sw. 3	0	0		105	125	
Chassis	Sw. Fr. Lug C	0	0		-20	-25	

TUBE SOCKET MEASUREMENTS -- Panel Controls in Mid-position.
Measure d-c voltages on 500 volt range except as indicated.

* Use highest d-c voltage range. ΔUse appropriate lower range.
Measure tube filament voltages on 10 v a-c range. Other "a-c" v on 100 v a-c range.
NC = No connection. For tube V_7 use rearranged socket lugs as indicated.

		V_1		V_2		V_3		V_4		V_5		V_6		V_7	
Lug 1	M	0		0		170		0		NC		NC		(1)-710*	
	V	0		0		170		0		-		NC		(1)-1000*	
Lug 2	M	0		5.5Δ		0		0		440		700ac		(3) 0	
	V	0		5.5Δ		0		0		440		700ac		(3) 0	
Lug 3	M	0		0		5Δ		0		NC		NC		(4)-400	
	V	0		0		5Δ		0		-		-		(4)-750*	
Lug 4	M	6.3		6.3		6.3		6.3		350AC		-990*		(6) 0	
	V	6.3		6.3		6.3		6.3		350AC		-1150*		(6) 0	
Lug 5	M	240		150		6.3		170		NC		NC		(7) 0	
	V	260		170		6.3		210		-		-		(7) 0	
Lug 6	M	70		90		100		100		350AC		-990*		(8) 0	
	V	90		125		120		120		350AC		-1150*		(8) 0	
Lug 7	M	.5Δ		NC		-10		5Δ		NC		NC		(9) 0	
	V	.5Δ		-		-20		5.5Δ		-		-		(9) 0	
Lug 8	M					5Δ				440		700ac		(10)-640*	
	V					5Δ				440		700ac		(10)-960*	
Lug 9	M					0								(11)-710*	
	V					0								(11)-1000*	

Note - Use back of sheet for additional comments.

DTI Oscilloscope COMPOSITE D-C VOLTAGE TABLE Student No.________

Use highest range, unless otherwise noted. Although printed voltages are typical generally, allow 20% variations. Reading at TS-7-1 may vary more than 20% when using multimeter. Place your readings in proper columns. Observe proper polarity. Indicate whether VTVM or multimeter was used to make measurements. ________

Black Prod ON	Red Prod ON	ALL CONTROLS					
		Clockwise			Counterclockwise		
		Typical		Measured	Typical		Measured
		Multimeter	VTVM		Multimeter	VTVM	
Int. Pot 3	Chassis	900	1050		900	1100	
TS-7-1	Chassis	720	900		760	1020	
Int. Pot 1	Chassis	720	920		710	1040	
Focus 1	Chassis	640	880		640	980	
Focus 2	Chassis	640	880		235	525	
Focus 3	Chassis	235	500		235	525	
V. Pos. 1	Chassis	60	90		60	80	
TS-8-1	Chassis	0	0		0	0	
TS-3-2	Chassis	20	80		-20	-70	
TS-1-4	Chassis	20	80		-20	-70	
Hor. Pos. 1	Chassis	60	90		60	80	
Chassis	V. Pos. Pot. 3	60	85		60	85	
Chassis	TS-5-2	315	315		285	285	
Chassis	TS-5-4	340	340		310	310	
Chassis	H. Pos. Pot 3	60	85		60	85	
Chassis	TS-1-2	340	340		310	310	
Chassis	TS-2-4	315	315		285	285	
Chassis	TS-3-4	340	340		310	310	
Chassis	Sync Sw. 5	340	340		0	0	
Chassis	Sync Sw. 7	0	0		310	310	
Chassis	Sync Sw. 1	0	0		0	0	
Chassis	Sync Sw. 3	0	0		105	125	
Chassis	Sw. Fr. Lug C	0	0		-20	-25	

TUBE SOCKET MEASUREMENTS -- Panel Controls in Mid-position.

Measure d-c voltages on 500 volt range except as indicated.

* Use highest d-c voltage range. ΔUse appropriate lower range.

Measure tube filament voltages on 10 v a-c range. Other "a-c" v on 100 v a-c range.

NC = No connection. For tube V_7 use rearranged socket lugs as indicated.

		V_1		V_2		V_3		V_4		V_5		V_6		V_7	
Lug 1	M	0		0		170		0		NC		NC		(1)-710*	
	V	0		0		170		0		-		NC		(1)-1000*	
Lug 2	M	0		5.5Δ		0		0		440		700ac		(3) 0	
	V	0		5.5Δ		0		0		440		700ac		(3) 0	
Lug 3	M	0		0		5Δ		0		NC		NC		(4)-400	
	V	0		0		5Δ		0		-		-		(4)-750*	
Lug 4	M	6.3		6.3		6.3		6.3		350AC		-990*		(6) 0	
	V	6.3		6.3		6.3		6.3		350AC		-1150*		(6) 0	
Lug 5	M	240		150		6.3		170		NC		NC		(7) 0	
	V	260		170		6.3		210		-		-		(7) 0	
Lug 6	M	70		90		100		100		350AC		-990*		(8) 0	
	V	90		125		120		120		350AC		-1150*		(8) 0	
Lug 7	M	.5 Δ		NC		-10		5Δ		NC		NC		(9) 0	
	V	.5 Δ		-		-20		5.5Δ		-		-		(9) 0	
Lug 8	M					5Δ				440		700ac		(10)-640 *	
	V					5Δ				440		700ac		(10)-960 *	
Lug 9	M					0								(11)-710*	
	V					0								(11)-1000*	

Note - Use back of sheet for additional comments.