NO. 2, 2B and 3 ESS/AIS
TEKTRONIX MODEL 465 (ITE-5237B)
TEKTRONIX MODEL 453A (ITE-5237A)
TEKTRONIX MODEL 453 (ITE-5237)
OSCILLOSCOPE OPERATING INSTRUCTIONS

CONTENTS

1. GENERAL INFORMATION

1.1 Purpose

1.11 This section provides information on the calibration and application of the Tektronix Oscilloscope. Type 453 (ITE-5237), Type 453A (ITE-5237A), and Type 465 (ITE-5237B), as used in testing the No. 2, 2B and 3 Electronic Switching Systems and Automatic Intercept System. ITE-5237 and ITE-5237A cannot be used for testing No. 2B and 3 Electronic Switching Systems.

1.2 References

1.21 Detailed information on the features of the oscilloscopes is contained in the instruction manual furnished with each instrument. One full-size manual is included in the material found in the shipping case. Under normal conditions it will be necessary to refer to the manual when using the scope.

1.3 Tests

1.31 A brief test of the oscilloscope is included in this section to verify that the instrument is undamaged and to explain the use of the controls used most frequently. For particular applications, the required settings of the panel controls will be described in the associated handbook section.

1.4 WARNING

1.41 THESE OSCILLOSCOPES ARE EXPENSIVE LABORATORY GRADE PRECISION TEST INSTRUMENTS. FOLLOW THE INSTRUCTIONS CAREFULLY IN DETAIL AND HANDLE THE INSTRUMENT WITH GREAT CARE. TEST PROGRESS MAY BE HANDICAPPED SEVERELY IF THE OSCILLOSCOPE IS NOT FUNCTIONING DURING THE TEST INTERVAL. TAKE PARTICULAR CARE IN HANDLING THE PROBES. DO NOT DROP, JAR, OR STRIKE ON ANY SURFACE.

1.5 HAZARDOUS VOLTAGES

1.51 POTENTIALS AS HIGH AS 10,000 VOLTS ARE PRESENT IN THE TYPE 453. POTENTIALS AS HIGH AS 14,000 VOLTS ARE PRESENT IN THE TYPE 453A. POTENTIALS AS HIGH AS 18,500 VOLTS ARE PRESENT IN THE TYPE 465. SUCH VOLTAGES ARE EXTREMELY DANGEROUS. EVERY POSSIBLE SAFETY PRECAUTION SHOULD BE TAKEN TO AVOID CONTACT WITH THIS VOLTAGE. AN INSTRUMENT SHOULD NOT BE OPERATED OUTSIDE ITS CABINET EXCEPT FOR REPAIR. UNDER SUCH CONDITIONS OBSERVE THE PRECAUTIONS FURNISHED WITH THE INSTRUMENT.

1.6 Voltage Limits

1.61 The maximum voltages which may be applied to the probe are 250 volts DC and 500 volts AC. This voltage is normally well beyond the limits of any voltage in the No. 2, 2B, and 3 ESS and AIS, but the precaution of avoiding excessive high voltage should be noted.

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1.7 Cathode-Ray Tube Damage

1.71 When using the intensity control take great care in limiting the brightness to prevent damaging the face of the Cathode-ray tube. The brightness of any trace will be a function of the time duration of the sweep across the face of the tube. At very fast sweeps, the intensity may require brightening to indicate the trace. At slower sweeps, decrease intensity accordingly.

1.72 A sharply focused line or spot of high intensity should not be permitted to remain stationary on the screen for any considerable length of time. Under such conditions the entire energy of the beam is concentrated over a small area. The phosphor coating on the inner face of the tube can be burned beyond repair by an excessive beam.

1.73 NEVER TURN UP INTENSITY TO THE POINT WHERE A HALO FORMS AROUND THE MOVING SPOT. In all applications, the beam should be swept across the screen, if possible. If a stationary spot is needed, reduce intensity as low as possible when observing the spot.

2. SERVICE INTERVALS AND REPAIRS

2.1 Cleaning

2.11 When routine cleaning or lubrication is required, refer to Section 4 of the Instruction Manual for specific information.

2.2 Service Intervals

2.21 It should not be expected that the scopes will hold their calibration and adjustments indefinitely. A recheck of calibration should be made either at the completion of each job, every 2 years, or as often as is required to maintain correct operation of the oscilloscope.

2.22 At the end of job use, refer to calibration record (ID-1268) on scope for return service date of scope. If recalibration is in order, inform local and central test set control as to whether set is due for recheck or available for another job.

2.3 Defective Instruments

2.31 Information on normal maintenance of the oscilloscope is contained in the instruction manual furnished with the instrument. Beyond making minor adjustments, it is recommended that major repair or recalibration not be attempted in the field.

2.32 If the scope cannot be properly serviced on the job, it should be returned to the nearest Field Engineering Office of Tektronix, Inc., for servicing.

2.33 Table 1 indicates the Tektronix, Inc., Field Engineering Office locations as of April, 1971.

3. EQUIPMENT DESCRIPTION

3.1 Full descriptive information of the oscilloscope is given in the instruction manual furnished with each oscilloscope.

3.2 Type 453 and 453A Oscilloscopes - These instruments are wide range general purpose oscilloscopes. Two time-base generator circuits are of very similar configuration and operating principles. There are, however, some noticeable differences.

3.3 The time-base circuits incorporated in the 453 and 453A oscilloscopes permit an accurate, continuously variable delay in the presentation of the sweep from 0.2 usec to 50 sec after delaying sweep start. This feature permits observation of a small portion of the normal sweep, accurate measurements of a waveform pattern, precise time measurements as well as many conventional uses. See Instruction Manual for detailed description on setup of measurements.

3.4 The 453 and 453A oscilloscopes have a delay network in the vertical deflection circuit which permits a signal delay of 0.2 usec. This allows observation of the leading edge of the waveform that triggers the sweep. This is of important use for observing nonrecurring or single pulse displays.

3.5 Type 465 Dual Trace oscilloscope has a 100-MHz bandwidth and a minimum deflection factor of 5MV/DIV at BW. It has a 5 mSec/DIV maximum sweep rate and a minimum delay time of 200 ns.

4. EQUIPMENT AND ACCESSORIES LISTING

4.1 ITE-5237 consists of a Tektronix 453 oscilloscope with loose accessories.

4.2 ITE-5237A consists of a Tektronix 453A oscilloscope with loose accessories.

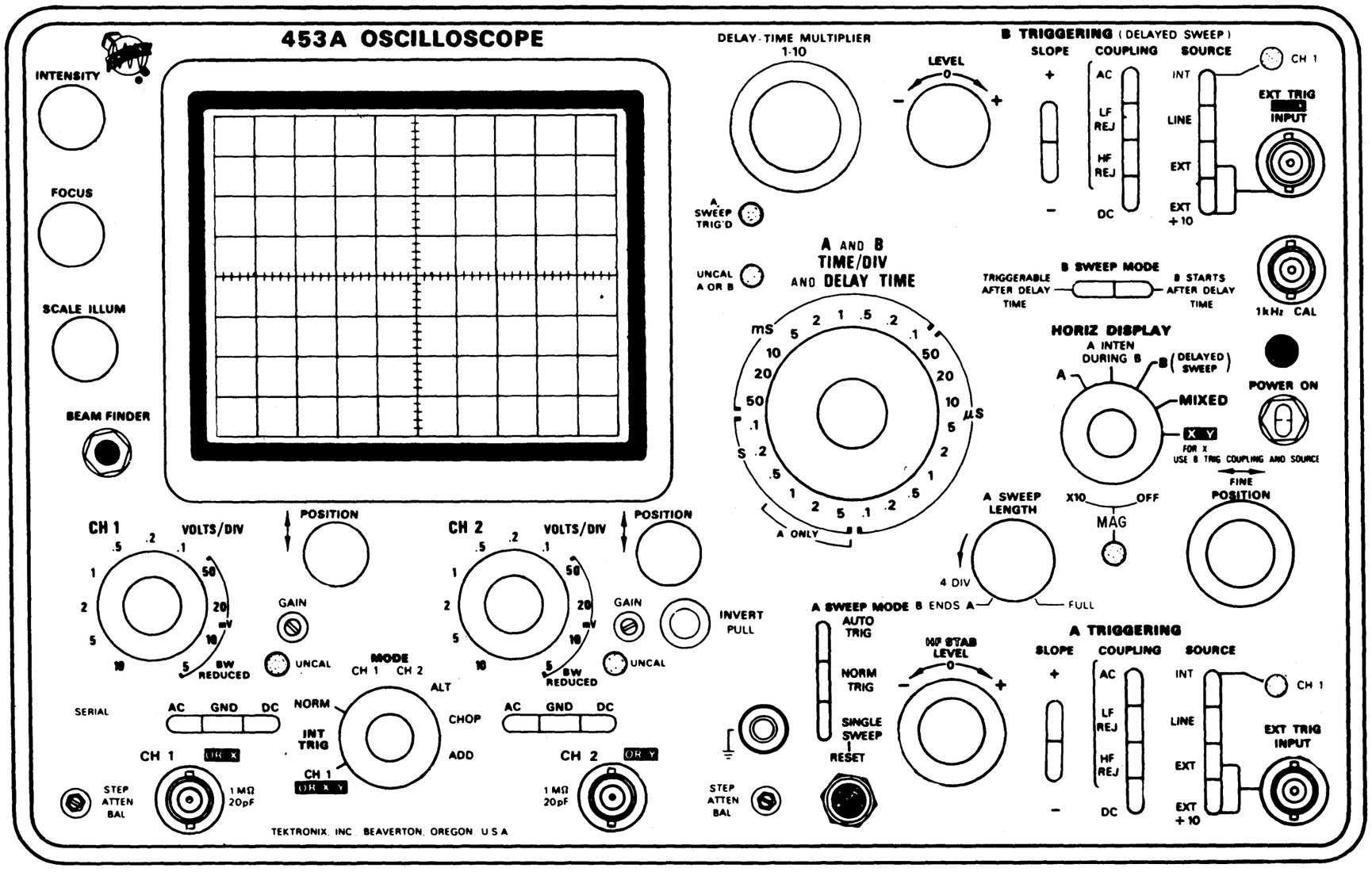
4.3 ITE-5237B consists of a Tektronix 465 oscilloscope with loose accessories.

4.4 All loose equipment furnished with the oscilloscope by the manufacturer shall be designated as "ITE-5237D-" details.

4.5 Accessories for Type 453 Tektronix oscilloscope:

DETAIL NO.	QTY.	ITEM
2	2	P6010 Probe Package, 9 Feet
3	1	18" 50 Ohm BNC Cable
4	1	BNC Jack Post
5	1	3-to-2 Wire Adapter
6	1	CRT Ornamental Ring
7	1	Smoke Grey Light Filter
8	1	Mesh Filter (installed)
9	1	CRT Face Plate Protector
10	1	Oscilloscope Dust and Rain Cover
11	2	BNC-to-Binding Post Adapter
TMO	1	Manufacturer's Instruction Manual

453A TEST SET–UP CHART



Front panel

RP-0023/**LE-5**

4.6 Accessories for Type 453A Tektronix Oscilloscope:

DETAIL NO.	QTY.	ITEM
2A	2	P6061 Probe Package, 9 Feet
3A	3	18" 50 Ohm BNC Cable
4A	1	BNC Jack Post
5A	1	Blue Light Filter
6A	1	CRT Ornamental Ring
TMO/A		Manufacturer's Instruction Manual
		Manufacturer's Operator's Manual

4.7 Common Accessories for 453 and 453A Oscilloscopes:

DETAIL NO.	QTY.	ITEM
1	1	Scopemobile Cart Type 200-1
-	2	Fuse, Fastblo 3AG, 2 AMP
-	1	Fuse, Fastblo 3AG, 1 AMP
-	1	Fuse, Fastblo 3AG, 1/2 AMP
-	1	Fuse, Fastblo 3AG, 1/4 AMP

4.8 Accessories for Type 465 Tektronix Oscilloscope:

DETAIL NO.	QTY.	ITEM
1	2	Probe package
2	1	Accessory Pouch
3	1	Blue Crt Filter
4	1	Clear Crt Filter
5	1	Scopemobile
6	1	Mesh Filter
7	1	Viewing Hood
	1	Fuse

5. OPERATING PROCEDURES FOR TYPE 453 & 453A

5.01 Preliminary Preparation

5.011 Mount the oscilloscope firmly on the Scopemobile Cart, and locate the cart in a convenient position at test location.

5.012 Check that the POWER switch on the oscilloscope is off.

5.013 Check that the link is closed from GND TO Z AXIS INPUT at the rear of the scope.

5.02 Set the front-panel controls as follows:

CRT Controls:

INTENSITY	Counterclockwise
FOCUS	Midrange
SCALE ILLUM	Counterclockwise

Vertical Controls (both channels if applicable):

VOLTS DIV	20 mV
VARIABLE	CAL
POSITION	Midrange
INPUT COUPLING	DC
MODE	CH 1
TRIGGER	NORM
INVERT	Pushed in

Triggering Controls (both A and B if applicable):

LEVEL	Clockwise (+)
SLOPE	+
COUPLING	AC
SOURCE	INT

Sweep Controls:

DELAY-TIME MULTIPLIER	0.20
A and B TIME/DIV	.5 ms
A VARIABLE	CAL
HORIZ DISPLAY	A
MAG	OFF
POSITION	Midrange
A SWEEP LENGTH	FULL
A SWEEP MODE	AUTO TRIG
POWER	OFF

Side-Panel Controls:

B TIME/DIV VARIABLE	CAL
CALIBRATOR	.1 V

5.022 Connect the oscilloscope to a power source that meets the voltage and frequency requirements of the instrument.

5.023 Set the POWER switch to ON. Allow about five minutes warm-up so the instrument reaches a normal operating temperature before proceeding.

5.03 CRT Controls

5.031 Advance the INTENSITY control until the trace is at the desired viewing level (near midrange).

5.032 Connect the 1 kHz CAL connector to the Channel 1 INPUT connector with a BNC cable.

5.033 Turn the A LEVEL control toward 0 until the display becomes stable. Note that the A SWEEP TRIG'D light is on when the display is stable.

5.034 Adjust the FOCUS control for a sharp (well-defined display over the entire trace length. If focused display cannot be obtained, see Astigmatism Adjustment in the scope manufacturer's manual.)

5.035 Disconnect the input signal and move the trace with the Channel 1 POSITION control so it coincides with one of the horizontal graticule lines. If the trace is not parallel with the graticule line, see Trace Alignment Adjustment in the scope manufacturer's manual.

5.036 Rotate the SCALE ILLUM control throughout its range and notice that the graticule lines are illuminated as the control is turned clockwise (most obvious with mesh or smoke-gray filter installed). Set control so graticule lines are illuminated as desired.

5.04 Vertical Controls

5.0401 Change the CH 1 VOLTS DIV switch from 20 mV to 5 mV. If the vertical position of the trace shifts, see Step Attenuator Balance in the manual.

5.0402 Set the CH 1 VOLTS/DIV switch to 20 mV and set the Channel 1 Input Coupling switch to AC. Connect the 1 kHz CAL connector to both the Channel 1 and 2 INPUT connectors with two BNC cables and a BNC T connector.

NOTE: If the BNC cables and BNC T connector are not available, make the following changes in the procedure. Place the BNC jack post (supplied accessory) on the 1 kHz CAL connector and connect the two 10X probes (supplied accessories) to the Channel 1 and 2 INPUT connectors. Connect the probe tips to the BNC jack post. Set the CALIBRATOR switch (on side-panel) to 1 V.

5.0403 Turn the Channel 1 POSITION control to center the display. The display is a square wave, five divisions in amplitude with about five cycles displayed on the screen. If the display is not five divisions in amplitude, see Vertical Gain Adjustment in the scope manufacturer's manual.

5.0404 Set the Channel 1 Input Coupling switch to GND and position the trace to the center horizontal line.

5.0405 Set the Channel 1 Input Coupling switch to DC. Note that the baseline of the waveform remains at the center horizontal line (ground reference).

5.0406 Set the Channel 1 Input Coupling switch to AC. Note that the waveform is centered about the center horizontal line.

5.0407 Turn the Channel 1 VARIABLE control throughout its range. Note that the UNCAL light comes on when the VARKABLE control is moved from the CAL position (fully clockwise). The deflection should be reduced to about two divisions. Return the VARIABLE control to CAL.

5.0408 Set the MODE switch to CH 2.

5.0409 Turn the Channel 2 POSITION control to center the display. The display will be similar to the previous display for Channel 1. Check Channel 2 step attenuator balance and gain as described in steps 10 through 12. The Channel 2 Input Coupling switch and VARIABLE control operate as described in steps 13 through 16.

5.0410 Set both VOLTS/DIV switches to 50 mV.

5.0411 Set the MODE switch to ALT and position the Channel 1 waveform to the top of the graticule area and the Channel 2 waveform to the bottom of the graticule area. Turn the A TIME/DIV switch throughout its range. Note that the display alternates between channels at all sweep rates.

5.0412 Set the MODE switch to CHOP and the A TIME/DIV switch to 10 us. Note the switching between channels as shown by the segmented trace. Set the TRIGGER switch to CH 1 ONLY; the trace should appear more solid, since it is no longer triggered on the between-channel switching transients. Turn the A TIME/DIV switch throughout its range. A dual-trace display is presented at all sweep rates, but unlike ALT, both channels are displayed on each trace on a time-sharing basis. Return the A TIME/DIV switch to .5 ms.

5.0413 Set the MODE switch to ADD. The display should be four divisions in amplitude. Note that either POSITION control moves the display.

5.0414 Pull the INVERT switch. The display is a straight line indicating that the algebraic sum of the two signals is zero (if the Channel 1 and 2 gain is correct).

5.0415 Set either VOLTS/DIV switch to 20 mV. The square-wave display indicates that the algebraic sum of the two signals is no longer zero. Return the MODE switch to CH 1 and both VOLTS/DIV switches to .2 (if using 10X probes, set both VOLTS/DIV switches to 20 mV). Push in the INVERT switch.

5.05 Triggering

5.051 Set the CALIBRATOR switch to 1V. Rotate the A LEVEL control throughout its range. The display free runs at the extremes of rotation. Note that the A SWEEP TRIG'D light is on only when the display is triggered.

5.052 Set the A SWEEP MODE switch to NORM TRIG. Again rotate the A LEVEL control throughout its range. A display is presented only when correctly triggered. The A SWEEP TRIG'd light operates as in AUTO TRIG. Return the A SWEEP MODE switch to AUTO TRIG.

5.053 Set the A SLOPE switch to -. The trace starts on the negative part of the square wave. Return the switch to +: the trace starts with the positive part of the square wave.

5.054 Set the A COUPLING switch to DC. Turn the Channel 1 POSITION control until the display becomes unstable (only part of square wave visible). Return the A COUPLING switch to AC: the display is again stable. Since changing trace position changes DC level, this shows how DC level changes affect DC trigger coupling. Return the display to the center of the screen.

5.055 Set the MODE switch to CH 2: the display should be stable. Remove the signal connected to Channel 1: the display free runs. Set the TRIGGER switch to NORM: the display is again stable. Note that the CH 1 lights in A and B Triggering go out when the TRIGGER switch is changed to NORM.

5.056 Connect the Calibrator signal to both the Channel 2 INPUT and A EXT TRIG INPUT connectors. Set the A SOURCE switch to EXT. Operation of the LEVEL, SCOPE, COUPLING and SOURCE controls for external triggering are the same as described in steps 5.051 through 5.053.

5.057 Set the A SOURCE to EXT ÷ 10. Operation is the same as for EXT. Note that the A LEVEL control has less range in this position, indicating trigger signal attenuation. Return the A SOURCE switch to INT.

5.058 Operation of the B Triggering controls is similar to A Triggering.

5.06 Normal and Magnified Sweep

5.061 Set the A TIME/DIV switch to 5 ms and the MAG switch to X10. The display should be similar to that obtained with the A TIME/DIV switch set to .5 ms and the MAG switch to OFF.

5.062 Turn the horizontal POSITION control throughout its range: it should be possible to position the display across the complete graticule area. Now turn the FINE control. The display moves a smaller amount and allows more precise positioning. Return the A TIME/DIV switch to .5 ms, the MAG switch to OFF and return the start of the trace to the left graticule line.

5.07 Delayed Sweep

5.071 Pull the DELAYED SWEEP knob out and turn it to 50 us (DELAY TIME remains at .5 ms). Set the HORIZ DISPLAY switch to A INTEN DURING B. An intensified portion, about one division in length, should be shown at the start of the trace. Rotate the DELAY-TIME MULTIPLIER dial throughout its range: the intensified portion should move along the display.

5.072 Set the B SWEEP MODE switch to TRIGGERABLE AFTER DELAY TIME. Again rotate the DELAY-TIME MULTIPLIER dial throughout its range and not that the intensified portion appears to jump between positive slopes of the display. Set the B SLOPE switch to -: the intensified portion of the display disappears when the B LEVEL control is out of the triggerable range. Return the B LEVEL control to 0.

5.073 Set the HORIZ DISPLAY switch to DELAYED SWEEP (B). Rotate the DELAY-TIME MULTIPLIER dial throughout its range: about one-half cycle of the waveform should be displayed on the screen (leading edge visible only at high INTENSITY control setting). The display remains stable on the screen, indicating that the B sweep is triggered.

5.074 Set the B SWEEP MODE switch to B STARTS AFTER DELAY TIME. Rotate the DELAY-TIME MULTIPLIER dial throughout its range; the display moves continuously across the screen as the control is rotated.

5.075 Rotate the DELAY-TIME MULTIPLIER dial fully counterclockwise and set the HORIZ DISPLAY switch to a INTEN DURING B. Rotate the A SWEEP LENGTH control counterclockwise: the length of the display decreases. Set the control to the B ENDS A position: now the display ends after the intensified portion. Rotate the DELAY-TIME MULTIPLIER dial and note that the sweep length increases as the display moves across the screen. Return the A SWEEP LENGTH control to FULL and the HORIZ DISPLAY switch to A.

5.08 Single Sweep

5.081 Set the A SWEEP MODE switch to SINGLE SWEEP. Remove the Calibrator signal from the Channel 2 INPUT connector. Press the RESET button: the RESET light should come on and remain on. Again apply the signal to the Channel 2 INPUT connector: a single trace should be presented and the RESET light should go out. Return the A SWEEP MODE switch to AUTO TRIG.

5.09 External Horizontal

5.091 Connect the Calibrator signal to both the Channel 2 INPUT and EXT HORIZ (B EXT TRIG INPUT) connectors. Set the B SOURCE switch to EXT. B COUPLING switch to DC and the HORIZ DISPLAY switch to EXT HORIZ. Increase the INTENSITY control setting until the display is visible (two dots displayed diagonally). The display should be five divisions vertically and about 3.7 divisions horizontally. Set the B SOURCE switch to EXT ÷ 10. The display should be reduced ten times horizontally. The display can be positioned horizontally with the horizontal POSITION or FINE control and vertically with the Channel 2 POSITION control.

5.092 Connect the Calibrator signal to both the Channel 1 and 2 INPUT connectors. Set the TRIGGER switch to CH 1 ONLY and the B SOURCE switch to INT.

5.093 The display should be five divisions vertically and horizontally with the Channel 1 POSITION control and vertically with the Channel 2 POSITION control.

5.094 Change the CH 1 VOLTS/DIV switch to .5. The display is reduced to two divisions horizontally. Now set the CH 2 VOLTS/DIV switch to .5. The display is reduced to two divisions vertically.

5.10 BEAM FINDER

5.101 Set the CH 1 and CH 2 VOLTS/DIV switches to 10 mV. The display is not visible since it exceeds the scan area of the CRT.

5.102 Press the BEAM FINDER button. Note that the display is returned to the display area. While holding the BEAM FINDER button depressed, increase the vertical and horizontal deflection factors until the display is reduced to about two divisions vertically and horizontally. Adjust the Channel 1 and 2 POSITION controls to center the display about the center lines of the graticule. Release the BEAM FINDER and note that the display within the viewing area. Disconnect the applied signal.

5.103 Reduce the INTENSITY control setting to normal, B SOURCE switch to INT and set the HORIZ DISPLAY switch to A.

5.11 Z-Axis Input

5.111 If an external signal is available (five volts peak to peak minimum) the function of the Z AXIS INPUT circuit can be demonstrated. Connect the external signal to both the Channel 2 INPUT connector and the Z AXIS INPUT binding posts. Set the A TIME DIV switch to

display about five cycles of the waveform. The positive peaks of the waveform should be blanked and the negative peaks intensified, indicating intensity modulation.

5.112 This completes the basic operating procedure for the oscilloscope. Instrument operation not explained here, or operations which need further explanation are discussed under General Operating Information in the scope manufacturer's manual.

5.12 Probe Capacitance Adjustment

5.121 The P6010 or P6061 Probe enables connection of the oscilloscope to a circuit with minimum loading and without impedance matching. Due to slight variations in input capacitance between oscilloscopes, even of the same type, it is necessary to compensate the probe when it is connected to an instrument. Recheck compensation before making critical measurements. Lack of compensation can cause measurement error since both waveshape and magnitude of the display are affected.

5.122 With the probes connected to the Channel 1 and Channel 2 inputs, set the "CALIBRATOR" output switch to the ".1V" position (side panel).

5.123 Touch the Channel 1 probe tip to the center of the BNC connector (front panel) labelled "1 kH2 CAL."

5.124 Set the sweep rate to display several cycles of the output signal. Set the amplitude "CH 1 VOLTS/DIV" switch and control to display a trace as shown in Figure 1.

5.125 If the observed trace is incorrect (See Figure 1), rotate the capacitor (C105) through the hole in the Compensating Box with a small non-conducting screwdriver. (The Compensating Box is the cylinder with the BNC plug on the opposite end of the cable to the probe.) When the observed trace is closest to the "CORRECT" example in Figure 1, remove the screwdriver.

5.126 Repeat steps 5.123 through 5.125 using the Channel 2 probe and controls.

5.13 Applications

5.131 The Tektronix 453 or 453A oscilloscope is required for testing applications for NO. 2 ESS. It should be noted that the P6021 current probe and the Type 134 Amplifier are to be ordered separately under ITE 4669.

5.132 Comparative Voltmeter

5.1321 When performing tests with the ESS circuits, it is often necessary to determine whether a group of test points or other terminals are at the "0" state (positive voltage) or the "1" state (ground). Instead of using a meter type voltmeter, it is generally more convenient to set up the sweep trace on the oscilloscope to indicate the two levels at the lower and upper graticule lines on the screen. This arrangement provides a quick reference for a number of test points to be checked.

5.1322 To set up a standard sweep trace, set the controls as follows:

CRT CONTROLS	POSITION
INTENSITY	AS REQUIRED
FOCUS	AS REQUIRED
SCALE ILLUM	AS REQUIRED

VERTICAL CONTROLS	POSITION
VOLTS/DIV	(See PAR. 6.23)
VARIABLE	CAL
POSITION	(See PAR. 6.24)
INPUT COUPLING	DC
MODE	CH 1
TRIGGER	NORM
INVERT	PUSHED IN

TRIGGERING CONTROLS	POSITION
LEVEL	CENTERED
SLOPE	+
COUPLING	DC
SOURCE	INT

SWEEP CONTROLS	POSITION
DELAY TIME MULT.	0.20
A and B TIME/DIV.	2 MILLSEC
A VARIABLE	CALIBRATED
HORIZ DISPLAY	A
MAG.	OFF
POSITION	AS REQUIRED
A SWEEP LENGTH	FULL
A SWEEP MODE	AUTO TRIG
POWER	ON

5.1323 Since the input probe has a 10X attenuator built into the circuit, the VOLTS/DIV setting on the oscilloscope must be selected to match the voltage range under consideration. The following settings are suitable for the voltages indicated:

VOLTAGE RANGE	VOLTS/DIV SETTING
6V	.2
12V	.5
24V	1

5.1324 In the course of checking test points, the voltage shift will not generally be the full range of the setting. However, the displacement will be clear enough to be readily identifiable. Position the lower level voltage indication below the center line of the graticule to obtain maximum deflection.

5.1325 Connect probe to the CHANNEL 1 Input. Connect probe end to ground. Adjust VERTICAL POSITION control to position trace 1/2 centimeter above the bottom graticule line. Then connect probe to the position voltage for the range being checked. In the 6 volt range, the trace should jump up to approximately 1/2 division below the top graticule line. In the 12 and 24 volt range, the trace will jump to the graticule line one division above the centerline. The oscilloscope is now ready to read "high" or "low" indications as connected to the probe.

5.133 Checking Pulse Signals

5.1331 The digital type control circuits are driven by pulses from a precision time control circuit referred to as the system clock. These pulses are transmitted mainly as square wave signals, but for output pulses from associated circuits may vary from narrow spike traces to bursts of sinusoidal waves.

5.1332 To check the pulse input or output of any particular circuit, the oscilloscope is set up to indicate a horizontal sweep trace on the CRT. The CHANNEL SELECT is switched to a single input (CHANNEL 1 or CHANNEL 2 as desired). The probe is connected to the test point or terminal at which the pulse or pulses are to be observed. To observe high speed pulses at low repetition rate, adjust TRIGGERING LEVEL as closely as possible just below the level required for a full sweep. This will show a stationary spot at the left of the CRT. The incoming pulse will trigger the sweep and the pulse will be displayed during the sweep.

5.1333 If a blurry or jumping wave pattern is obtained, either the TIME/DIV setting is incorrect or triggering stability is poor. Adjust setting of TIME/DIV control to provide one or more clear traces of the pulse or pulses.

5.1334 Typical control settings for pulse observations are as follows:

CRT CONTROLS	POSITION
INTENSITY	AS REQUIRED
FOCUS	AS REQUIRED
SCALE ILLUM.	AS REQUIRED

VERTICAL CONTROLS	POSITION
VOLTS/DIV	AS REQUIRED
VARIABLE	CALIBRATED
POSITION	TRACE CENTERED
INPUT COUPLING	DC
MODE	CH1 ONLY or CH2 ONLY
TRIGGER	NORM.
INVERT	PUSHED IN

TRIGGERING CONTROLS	POSITION
LEVEL	CENTERED
SLOPE	+INT or -INT
COUPLING	DC
SOURCE	INT

SWEEP CONTROLS	POSITION
DELAY TIME MULT.	0
A AND B TIME/DIV	2 MILLISEC.
A VARIABLE	CALIBRATED
HORIZ. DISPLAY	A
MAG.	OFF
POSITION	AS REQUIRED
A SWEEP LENGTH	FULL
A SWEEP MODE	AUTO. TRIG.
POWER	ON

5.1335 When connecting to a data link to verify data transmission, the carrier signal will be displayed as a steady sinusoidal pattern. Data pulses are indicated by a momentary horizontal shift in the waveshape which indicates the frequency modulated signal.

5.1336 Digit transmission over the data link may be checked by observing the sinusoidal burst for each digit pulse on the input to the digit receiver. Detailed connecting terminal information is covered in the specific test information for each circuit.

5.134 Pulse Width Measurement

5.1341 The measurements can be made with the same setups that were used in paragraph 5.1334. However, when making most time base measurements it is convenient to be able to move the pattern being viewed across the graticule keeping the trace itself centered by not changing the position of the HORIZONTAL POSITION control This will be illustrated by using the delay circuits.

5.1342 Arrange the controls as follows:

MAIN CONTROLS	POSITION
HORIZONTAL DISPLAY	'A'DEL'D BY 'B'
MAGNIFIER	OFF
AMPLITUDE CALIBRATOR	10 VOLTS
HORIZONTAL POSITION	(See Par. 6.44)

TIME BASE A CONTROLS	POSITION
TRIGGERING MODE	AC
TRIGGER SLOPE	+ INT
TRIGGERING LEVEL	FULL RIGHT
TIME/DIV	40 USEC
VARIABLE	CALIBRATED

TIME BASE B CONTROLS	POSITION
TRIGGERING MODE	AC
TRIGGER SLOPE	+ EXT
TRIGGERING LEVEL	FULL RIGHT
DELAY TIME	.1 MILLI SEC
DELAY TIME MULTIPLIER	AS NECESSARY

CHANNEL SELECT UNIT CONTROLS	POSITION
MODE	CH1 ONLY
DC/AC	DC
VOLTS/DIV	.5
VARIABLE	CALIBRATED
POLARITY	NORMAL
VERTICAL POSITION	(See Par. 6.44)

5.1343 Connect the CHANNEL 1 probe to the ground post. Adjust the VERTICAL POSITION CONTROL so that the trace coincides with the graticule line one centimeter below the centerline. Adjust the HORIZONTAL POSITION, FOCUS, and INTENSITY controls as required.

5.1344 Connect the CHANNEL 1 probe to the CAL OUT connector. Connect a lead (not a probe) from the CAL OUT connector to the TRIGGER INPUT connector associated with TIME BASE B.

5.1345 If the pattern is not stationare or a blur appears do the following:

(a) Operate the TIME BASE B STABILITY control counterclockwise until the trace just disappears.

(b) Operate the TIME BASE B TRIGGERING LEVEL control until the pattern locks in.

5.1346 Operate the DELAY-TIME MULTIPLIER until the 5-volt level point on the rising portion of the square wave coincides with the intersection of the horizontal centerline and extreme left vertical graticule line. (Note that since we are measuring the width of this pulse at the 5 volt level point we have conveniently positioned the ground reference line so that the 5 volt level of the pulse is coincident with the center graticule line).

5.1347 Measure the distance between the rising and falling 5-volt level points of the pulse. This distance should be 9.6 CM. Since the TIME BASE A TIME DIV control

is set at 50 usec, multiply the 9.6 CM distance by this figure. The value obtained should be 480 usec which is the pulse width at the 5 volt level of the pulse. (Note that the pulse width could be measured at any voltage level depending upon the requirement).

5.135 Delay Time Measurements

5.1351 The delay time measurement between two pulses is made by a procedure very similar to that outlined in Paragraph 5.134 for a pulse width measurement.

5.1352 The basic difference is that two pulses are displayed simultaneously by using both CHANNEL 1 and 2 of the plug-in unit. The MODE control of the plug-in unit should be operated to ALTERNATE. Both the CHANNEL 1 and 2 ground references should be made to coincide on the same graticule line.

5.1353 When the pulses are made to appear as illustrated in Figure 3 the delay time between pulses at some particular voltage level can be measured by measuring the distance between graticule lines at the same voltage for the same slope. Multiplying this distance in centimeters by the setting of the TIME BASE A TIME/CM control will yield the delay time between pulses.

6. OPERATING PROCEDURE FOR TYPE 465 SCOPE

6.1 Preliminary Preparation

6.11 Mount the oscilloscope firmly on the scopemobile cart, and locate the cart in a convenient position at test location.

6.12 Check that the power switch on the oscilloscope is off.

6.13 Check that the link is closed from GND to Z axis input at the rear of scope.

6.14 Set the front panel controls as follows:

CRT CONTROLS

INTENSITY	COUNTERCLOCKWISE
FOCUS	MIDRANGE
SCALE ILLUM	COUNTERCLOCKWISE

VERTICAL CONTROLS

VERT MODE SWITCH	CH1
VOLTS/DIV SWITCHES	PROPER POSITION DETERMINED BY AMPLITUDE OF SIGNAL TO BE APPLIED.
VOLTS/DIV VAR CONTROLS	CALIBRATED DETENT
INPUT COUPLING SWITCHES	AC
VERTICAL POSITION CONTROL	MIDRANGE
20MHz BW SWITCH	NOT LIMITED
INVERT SWITCH	BUTTON OUT

TRIGGER CONTROLS

SLOPE SWITCH	+
LEVEL CONTROL	0
SOURCE SWITCH	NORM
COUPLING SWITCH	AC
TRIG MODE SWITCH	AUTO
A TRIG HOLDOFF	NORM

HORIZONTAL SWEEP CONTROLS

TIME/DIV SWITCH	LOCKED TOGETHER AT 1ms
A TIME/DIV VAR	CALIBRATED DETENT
HORIZ DISPLAY SWITCH	A
X10 MAG SWITCH	OFF (BUTTON OUT)
POSITION CONTROL	MIDRANGE

6.15 Connect the type 465 scope to a power source that meets the voltage and frequency requirements of the instrument.

6.16 Set the power switch to on (button out). Allow several minutes for instrument warmup.

6.2 Normal Sweep Display

6.21 The oscilloscope calibrator signal or a known external signal may be used to obtain a normal sweep display.

6.22 Connect the selected signal to the CH1 input connector.

6.23 Advance the intensity control until the display is visible. If the diaplay is not visible with the intensity control at midrange, press the beam find pushbutton and adjust the CH1 VOLTS/DIV switch until the display is reduced in size vertically; then center the compressed display with the vertical and horizontal position controls; release the beam find pushbutton. Adjust the focus control for a well-defined display.

6.24 Set the CH1 VOLTS/DIV switch and CH1 position control for a display which remains in the display area vertically.

6.25 Adjust the A trigger level control for a stable display.

6.26 Set the A TIME/DIV switch and the horizontal position control for a display which remains in the display area horizontally.

6.3 Magnified Sweep Display

6.31 Preset the instrument controls and follow steps 6.21 through 6.26 for obtaining a normal sweep display.

6.32 Adjust the horizontal position control to move the area to be magnified to within the center graticule division of the CRT. If necessary, change the TIME/DIV switch setting so the complete area to be magnified is within the center division.

6.33 Set the X10 mag switch to the on position (button in) and adjust the horizontal position control for precise positioning of the magnified display.

6.4 Delayed Sweep Displays

6.41 Preset the instrument controls and follow steps 6.21 through 6.26 for obtaining a normal sweep display.

6.42 Set the HORIZ DISPLAY switch to A INTEN and the B TRIGGER SOURCE switch to starts after delay.

6.43 Pull out the B TIME/DIV switch knob and turn clockwise so the intensified zone on the display is the desired length. Adjust the intensity control to achieve the desired display brightness.

6.44 Adjust the DELAY-TIME POSITION dial to position the intensified zone to the portion of the display to be delayed.

6.45 Set the HORIZ DISPLAY switch to B DLY'D. The intensified zone on the display noted in step 6.43 is now being displayed in delay form. The delayed sweep rate is indicated by the dot on the B TIME/DIV switch knob.

6.46 For a delayed sweep display that will exhibit less jitter, set the B TRIGGER SOURCE switch to the same position as on the A TRIGGER SOURCE switch and adjust the B TRIGGER level control for a stable display. If the A TRIGGER SOURCE switch is in the line position, a sample of the line voltage will have to be supplied to the B Trigger circuit externally.

6.5 Mixed Sweep Display

6.51 Preset the instrument,controls and follow paragraphs 6.21 through 6.26 for obtaining a normal sweep display.

6.52 Pull out on the B TIME/DIV switch knob and turn clockwise to the desired sweep rate. Adjust the intensity control to achieve the desired display brightness.

6.53 Set the HORIZ DISPLAY switch to MIX. The CRT display now contains more than one time factor on the horizontal axis. The first portion of the display is at the A TIME BASE SWEEP rate and the latter part is at the B TIME BASE SWEEP rate. The start of the B TIME BASE portion of the display can be changed by adjusting the delay-time position control.

6.6 New Features

6.61 20MHz BW/TRIG VIEW - This is a dual purpose switch that, when pulled out, limits the bandwidth of the complete vertical defection system to approximately 20MHz, or when pressed causes signal present in a trigger generator circuit to be displayed on the CRT.

6.62 A TRIG HOLDOFF - provides control of holdoff time between sweeps to obtain stable displays when triggering on A periodic signals (such as complex digital words). Variable control can increase holdoff time up to at least 10 times the holdoff time of the NORM position. In the B ends a position (fully clockwise), the A sweep is reset at the end of the B sweep to provide the fastest possible sweep repetition rate for delayed sweep presentations.

6.63 Low line indicator - light that indicates the applied line voltage is below the lower limit of the regulating range selected by the regulating range selector assembly.

6.64 Probe, Ground Reference Button - this switch is located on the body of the probe and may be used to identify the signal to which the probe is connected. This is particularly useful in dual trace operation when the operator is working at some distance from the oscilloscope.

6.65 Automatic Probe Compensation - the connection of the voltage probes to CH1 or CH2 inputs automatically compensates for the attenuation factor of the probe (X1,X10,etc.). The VOLTS/DIV switch position may be read directly without using any multiplying factor.

6.7 User's Calibration

6.71 Probe compensation - connect CH1 probe to the calibrator (a combination current loop/square wave voltage output device) to obtain a normal sweep display presentation. Set the appropriate VOLTS/DIV switch to the .1V position and the input coupling to DC. Check the waveform presentation for overshoot or rolloff, and readjust compensation control (located in the end of probe connected to oscilloscope) for flat tops on the waveforms if necessary. See Figure 1.

7. AC CURRENT PROBE (ITE 4669)

7.1 Display of Current Waveform

7.11 At times it is desired to use an oscilloscope to display varying current, rather than varying voltage. But, the oscilloscope vertical-deflection system is basically a voltage sensitive amplifier.

7.12 One means of displaying a varying current is to insert a small value of resistance R in series with the circuit that carries the current desired to be displayed. The varying current in the circuit produces a voltage drop across R. The waveform of this voltage across R corresponds to the original current waveform. Thus, the waveform of the voltage drop across R, is in effect the display of the current waveform in the circuit. The amplitude of the current waveform may be found by Ohm's Law - - that is, divide the amplitude of the voltage waveform by R.

7.13 Most of the time, it isn't practical to use the series-resistance method above. For example, it may be found difficult (or even impossible) to insert a series resistor. Or the display of currents in a multiplicity of circuits may be desired - and the work of inserting series resistors is too time consuming. Or even a small series resistance may unduly disturb the circuit. In such cases use the current-probe.

7.14 The current probe utilizes a U-shaped core of magnetic material. The U-shaped core is slipped around the conductor whose current is wanted displayed. The magnetic circuit is completed by sliding a bar of magnetic material over the U. It is in effect a transformer. The circuit (wire) whose current is to be displayed forms a one-turn "primary winding." The probe itself has a secondary winding on the U-shaped core. The secondary voltage that is caused by a primary current change drives the probe cable.

7.15 The output of the probe can be connected to either a passive termination or to a small current-probe amplifier. Either the passive termination or the current-probe amplifier connects to the oscilloscope vertical input connector.

7.2 Current Probe Use

7.21 The ability of the oscilloscope to look at rapid important role in Electronic Switching Systems testing. A current-probe is furnished as an adjunct to the scope.

7.22 The P6020 AC Current-Probe and Type 134 Amplifier constitute a current detecting system for use with any wide-band oscilloscope. This system provides accurate displays for observation and measurement of AC current waveforms. Current range extends from less than 1 milliampere to 15 amperes.

7.23 Use of the current probe and amplifier combination will cause risetime and bandpass figures to deteriorate somewhat from those noted in the manual furnished with the oscilloscope with which the current-probe system is being used.

7.24 Long narrow shape and convenient thumb control make the probe easy to use. Just place probe slot over conductor and close slide with thumb - no direct electrical connection to the circuit under test is required because the probe clamps around the current-carrying wire. Impedance change and loading of the circuit under test can be considered so negligible that it can almost always be disregarded.

7.25 Increased sensitivity may be obtained by looping the conductor around the probe slot two or three times where possible.

7.3 Applications

7.31 To detect the presence of the X and Y current pulses in memory modules - Program Store or Call Store.

7.32 To measure and verify the current waveform in the X and Y axes as required in trouble location of defective stores.

7.33 To measure that bias current is of correct magnitude.

7.4 Preparation

7.41 Insert power unit (Det. 2) into a source of 117-volt 60-cycles power.

7.42 Make power connection between Type 134 amplifier and power unit with cord and connector furnished.

7.43 Mount Type 134 amplifier directly to input connector.

7.44 Adjust oscilloscope controls as required per manual instructions.

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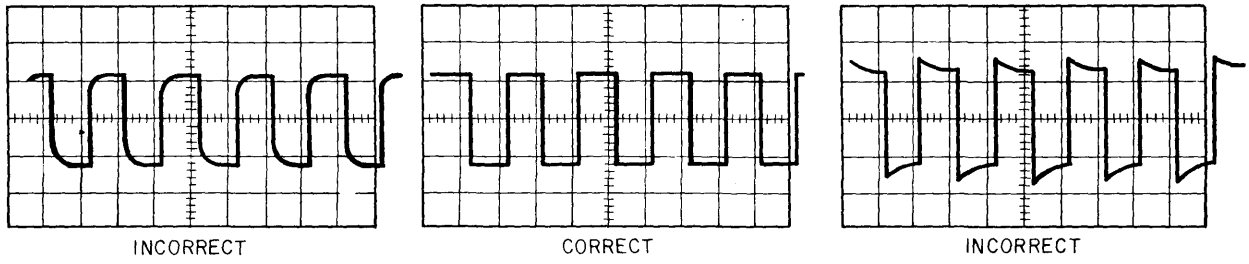

FIGURE 1

PROBE CAPACITANCE ADJUSTMENT

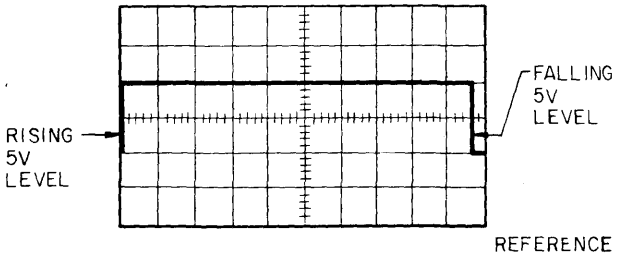

FIG. 2 PULSE WIDTH MEASUREMENT

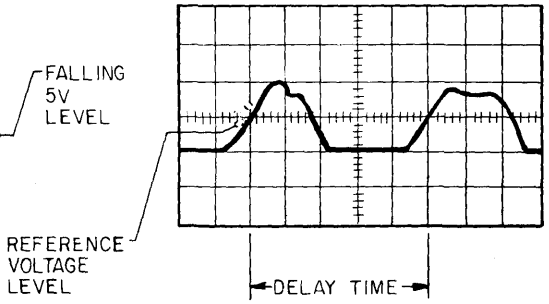

FIG. 3 DELAY TIME MEASUREMENT

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No arrows shown due to extensive changes

Manager, ESS Installation & Field Engineering

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Reason for Reissue:
To add ITE-5237B and reference to No. 2B and 3 ESS.