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PLEASE CHECK FOR CHANGE INFORMATION AT THE REAR OF THIS MANUAL.

468
DIGITAL STORAGE OSCILLOSCOPE

SERVICE
VOLUME I

INSTRUCTION MANUAL

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SPECIFICATION

INTRODUCTION

The TEKTRONIX 468 Oscilloscope is a portable digital storage oscilloscope with a four-trace, dc-to-100 MHz, vertical deflection system. The 468 combines an easy-to-use storage function with cursor measurement of time and voltage. Measurement values are indicated on a four-digit, seven-segment LED display.

NON STORE MODE

In the NON STORE mode, the 468 operates as a conventional oscilloscope that can display CH 1, CH 2, ADD, and A TRIG VIEW (external trigger only) simultaneously. The vertical deflection system has calibrated deflection factors ranging from 5 mV to 5 V per division. The horizontal deflection system has calibrated A Sweep rates from 0.5 s to 0.02 μs per division and is capable of operating in the following sweep modes: A, A intensified by B, A alternated with delayed B, and B delayed. The calibrated B Sweep rates are from 50 ms to 0.02 μs per division.

The horizontal magnifier circuit feature increases each sweep rate by a factor of 10. This provides a maximum sweep rate of 2 ns per division when the TIME/DIV switch is in the 0.02 μs per division position.

STORAGE MODE

The 468 digital storage circuitry has a 10 MHz Useful Storage Bandwidth for the acquisition of signals, and will display the acquired waveform with a bright, flicker-free trace. With the digital storage feature, low-frequency signal analysis and waveform measurements—previously difficult or impossible to make—are easily performed. A choice of two standard and one optional signal acquisition modes are available: NORM and ENVELOPE (standard) and AVG (optional). Two storage functions are available to hold a display indefinitely for measurement and comparison: SAVE Storage Mode (stops acquisition) and SAVE REF (holds a reference display and continues acquisition in the selected Storage Mode). Using the PRE TRIG or POST TRIG Storage Window, waveform data may be acquired prior to or after the trigger. Time and voltage measurements on the acquired waveform are easily made using the VOLTS and TIME Cursor Functions, and the measurement values are indicated on a four-digit, seven-segment light-emitting diode (LED) display.

Digital storage adds three TIME/DIV switch positions, increasing the storage time base to 5 s per division (a total sweep time of 50 s). The waveshape of signals acquired at these low frequencies would be impossible to view on a conventional oscilloscope. Digital storage circuitry, however, constantly refreshes an acquired waveform to produce a directly viewable display for ease of analysis and measurement. Three added VOLTS/DIV switch positions increase the digital storage vertical deflection sensitivity up to 0.5 mV per division. Small-amplitude signals are acquired at 5 mV per division and are amplified to produce the added sensitivity.

The digital storage signal acquisition modes are NORM and ENVELOPE Storage Modes and an optional AVG Storage Mode. Selecting NORM Storage Mode causes acquisition and display of a new waveform with each trigger. The display in this mode most resembles conventional oscilloscope displays, and waveforms acquired will react to the oscilloscope front-panel controls with each trigger.

When ENVELOPE Storage Mode is chosen, the maximum and minimum waveform values for a selected number of sweeps are acquired, and the resultant waveform envelope is displayed. This mode is useful for detecting noise and spurious or erratic signals.

Choosing the optional AVG Storage Mode allows waveforms to be acquired for a selected number of sweeps and causes the averaged value of the acquired signals to be displayed. In this mode, signal-to-noise ratio is improved in direct proportion to the square root of the number of sweeps acquired, and noise accompanying the signal is either averaged out or reduced to a small level. The signal acquired in the AVG Storage Mode is processed to increase the vertical resolution of the displayed signal. This feature is very useful for displaying small-amplitude signals acquired in the 0.5, 1, and 2 mV per division positions of the VOLTS/DIV switch.

OPERATING INSTRUCTIONS

This section of the manual provides information on instrument installation and power requirements. The functions of controls, connectors, and indicators are described, and procedures intended to familiarize the operator with obtaining basic oscilloscope displays are included. For more complete operating information, refer to the 468 Operators Manual.

INSTALLATION

The 468 is shipped in its carton with its standard accessories (listed on the "Accessories" tab page at the end of Volume II of this manual). At installation time, save the shipping carton and packaging materials for repackaging. Refer to the "Maintenance" section of this manual for repackaging information.

PREPARATION FOR USE

NOTE

For instruments with Option 02 (GPIB), a firmware bug exists in both version 1.0 and version 2.0 ROM. This causes an incorrect transmission of the Y-multiplier and the Y-units of a waveform whenever the acquired waveform is vertically uncalibrated or when an ADD display is obtained with unequal VOLTS/DIV switch settings. To avoid this bug, rotate the VAR VOLTS/DIV controls into the detent position and use the same VOLTS/DIV switch setting on both channels for ADD displays when acquiring the data for transmission.

Safety Considerations

CAUTION

This instrument may be damaged if operated with either the Line Voltage Selector switch or the Regulating Range Selector switch set for the wrong applied ac-power input source voltage or if the wrong line fuse is installed.

Refer to the Safety Summary at the front of this manual for power source, grounding, and other safety considerations pertaining to the use of this instrument. Before applying power, verify that the Line Voltage Selector switch and the Regulating Range Selector switch are both set for the ac-power input voltage source available and that the proper line fuse is installed.

Line Voltage Selection

This instrument operates from either a 115-V or a 230-V nominal ac-power source with a line frequency from 48 Hz to 440 Hz. To convert the instrument for operation from one ac source to the other, disconnect the power cord from the power input source, and move the Line Voltage Selector (230/115) switch to the position indicating the available nominal voltage (see Figure 2-1). The detachable power cord may have to be changed to match the ac-power-source outlet. (See the "Power Cord" discussion in this manual for optional power cords.) Verify that the proper line fuse is installed (see Table 2-1).

Regulating Range Selection

The Regulating Range Selector (HIGH/LOW) switch is located on the right side panel near the Line Voltage Selector switch (Figure 2-1). Verify that the selector switch

Table 2-1

Fuse Selection

Line Voltage Selector Switch Position	Fuse Size
115 V Nominal	1.5 A, 3AG, Slow-blow
230 V Nominal	0.7 A, 3AG, Slow-blow

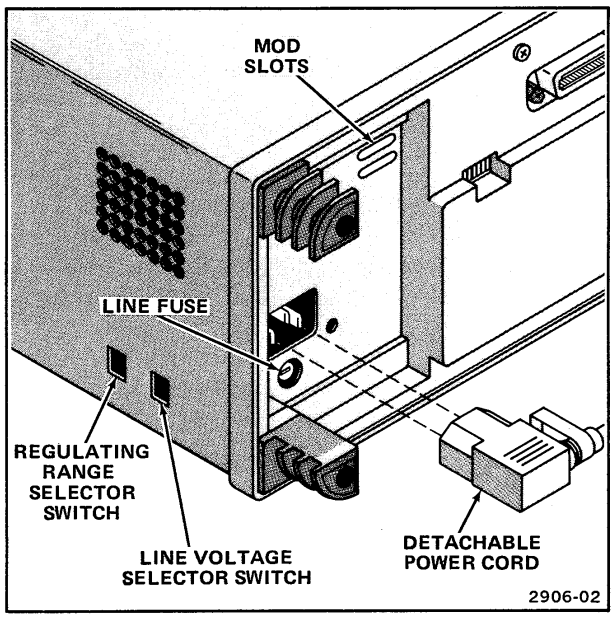


Figure 2-1. Ac-power-source switches, line fuse, and power cord.

THEORY OF OPERATION

INTRODUCTION

SECTION ORGANIZATION

This section contains a functional description of the 468 Digital Storage Oscilloscope circuitry. The discussion begins with a general summary of instrument functions broken down into conventional and digital storage operation. Following the General Description, each major circuit is explained in detail, using functional block diagrams and schematic diagrams to show the interconnections between parts of the circuitry, to indicate circuit components, and to identify interrelationships with the front-panel controls. Circuit diagrams and the larger block diagrams are located in the tabbed "Diagrams" section found in Volume II of this manual. The circuit diagram associated with each description is identified in the text and indicated on the tab of the appropriate foldout page by a numbered diamond symbol. For best understanding of the circuit being described, refer to both the appropriate circuit diagram and functional block diagram.

INTEGRATED CIRCUIT DESCRIPTIONS

Digital Logic Conventions

Digital logic circuits perform many functions within this instrument. Function and operation of the logic circuits are represented by logic symbology and terminology. Most logic functions are described using the positive logic convention. Positive logic is a system of notation whereby the more positive of two levels is the TRUE, or 1 state; the more negative level is the FALSE or 0 state. In this logic description the TRUE state is referred to as HI, and the FALSE state is referred to as LO. The specific voltages which constitute a HI or a LO state vary between specific devices.

In the discussion of the General Purpose Interface Bus (GPIB) option, signals are described as asserted (TRUE) or unasserted (FALSE) rather than HI or LO. The GPIB uses negative logic signals for bus operation. Circuitry in the 468 GPIB interface convert the negative-logic GPIB signals to positive logic signals for use within the 468.

Linear Devices

The functioning of individual linear integrated circuit devices is described in this section using waveforms or other techniques to illustrate their operation.

GENERAL DESCRIPTION

In the following overall functional description of the 468 Digital Storage Oscilloscope, refer to basic block diagrams Figures 3-1 and 3-2 and to the detailed block diagrams located in the "Diagrams" section of this manual. Each major block in the diagrams represents a major circuit within the instrument. In Figure 3-1, the numbered diamond symbol in each block refers to the appropriate schematic diagram number.

CONVENTIONAL OPERATION

Signals to be displayed on the crt are applied to the CH 1 OR X input connector or the CH 2 OR Y input connector. These input signals are then amplified by the Preamplifier circuitry. Each channel includes separate vertical deflection factor, input coupling, balance, gain, and variable attenuation switches or controls. A trigger pickoff

CALIBRATION

This section is in two parts. It contains a Performance Check and an Adjustment Procedure. The Performance Check is used to verify that the instrument meets the Performance Requirements listed in the Specification, while the Adjustment Procedure is used to restore the instrument to its original Performance Requirements.

The test equipment listed in Table 4-1, or an equivalent piece of test equipment, is required to accomplish a complete Performance Check and Adjustment Procedure. In Table 4-1, the specifications given for the equipment are the minimum necessary to provide accurate results. Therefore, the equipment used must meet or exceed the listed specifications. Detailed operating instructions for the test equipment are not provided in these procedures. Refer to the appropriate test equipment instruction manual if more operating information is required.

Table 4-1

Test Equipment Required

Description	Minimum Specification	Purpose	Examples of Suitable Test Equipment
1. Variable Autotransformer	Capable of supplying 1.5 A over a range of 108 to 132 V.	Power Supply Regulation check.	General Radio W8WT3VM Variac Autotransformer.
2. Digital Voltmeter	Range, 0 to 140 V; dc voltage accuracy, ±0.15%; 4 1/2 digit display.	Low-Voltage Power Supply checks and adjustments. CRT Grid Bias adjustment. Vertical and Horizontal Centering adjustments. Calibrator Output adjustment.	a. TEKTRONIX DM501A Digital Multimeter.[a] b. TEKTRONIX DM44 Digital Multimeter. c. Any digital multimeter that meets minimum specification.
3. DC Voltmeter	Range, 0 to 2500 V, calibrated to 1% accuracy at −2450 V.	High-Voltage Power Supply check.	a. Triplett Model 630-NA. b. Simpson Model 262.
4. Test Oscilloscope with 10X probe and 1X probe (1X probe is optional accessory)	Bandwidth, dc to 100 MHz; minimum deflection factor, 5 mV/div; accuracy, ±3%, dual trace. Probe, 10X scale-factor switching.	Power Supply Ripple check. CRT Z-Axis compensation. Vertical Gain adjustment. A Trigger Holdoff check. A and B + Gate Output Signal check.	a. TEKTRONIX 465B Oscilloscope with 2 (included) 10X probes. b. TEKTRONIX 475 Oscilloscope with 2 (included) 10X probes. c. TEKTRONIX P6101 Probe (1X). Part Number 010-6101-03.

[a] Requires a TM500-Series Power Module.

MAINTENANCE

This section of the manual contains information for use in preventive maintenance, troubleshooting, and corrective maintenance. Signature tables for use in signature analysis testing of the digital storage circuitry are contained at the end of this section. These table are used in conjunction with the troubleshooting charts located at the back of this volume.

PREVENTIVE MAINTENANCE

INTRODUCTION

Preventive maintenance consists primarily of cleaning and visual inspection. When performed on a regular basis, it can enhance instrument reliability. A convenient time to perform preventive maintenance is just prior to recalibration of the instrument. Operating the 468 under severe environmental conditions will necessitate a more frequent preventive maintenance schedule.

CLEANING

The cabinet minimizes accumulation of dust inside the instrument and should normally be in place when operating the instrument. The front cover provides dust protection for the front panel and crt face and should be installed whenever the instrument is stored or is being transported.

Exterior

Loose dust accumulated on the outside of the oscilloscope can be removed with a soft cloth or small camel-hair brush. The paint brush is particularly useful for dislodging dirt on and around the front-panel controls. Dirt that remains can be removed with a soft cloth dampened in a mild detergent and water solution. Do not use abrasive cleaners.

Interior

Dust and dirt inside the instrument should be removed as often as operating conditions require. Accumulation of dirt can cause overheating and component breakdown. Dirt on components acts as an insulating blanket, preventing efficient heat dissipation. It also provides an electrical conducting path that can result in instrument failure, especially under high humidity conditions.

CAUTION

Avoid the use of chemical cleaning agents that might damage the plastics used in this instrument. Do not use chemicals that contain acetone, benzene, toluene, xylene, petroleum ether, white kerosene, carbon tetrachloride, methylene chloride, trichloroethane, trichlorotrifluoroethane (Freon 113, -tf, -ta, -te, -tmc) and trichlorethylene. Recommended cleaning agents are isopropyl alcohol, kelite (1 part kelite, 20 parts water), and a solution of 1% mild detergent and 99% water.

Before performing interior cleaning, refer to the "Cabinet Removal" instructions in the Corrective Maintenance part of this section. The best way to clean the interior is to blow out the accumulated dust with dry, low-pressure air (approximately 9 pounds per square inch). Remove any remaining dirt with a soft brush or a cloth dampened with a mild detergent and water solution. A cotton-tipped applicator is useful for cleaning in narrow spaces or for cleaning ceramic terminal strips and circuit boards. Do not use an applicator on switch contacts since they tend to snag, possibly causing damage. Strands of cotton caught by the contacts can also cause intermittent electrical contact.

CAUTION

To prevent damage from electrical arcing, ensure that circuit boards and components are dry before applying power to the instrument.

The high-voltage circuits should receive special attention. Excessive accumulations of dirt in these areas may cause high-voltage arcing that can result in circuit component damage.

OPTIONS

Your instrument may be equipped with one or more options. This section provides a description of the available options and indicates, if necessary, where more detailed information is located in this manual.

OPTION 02—GPIB

When equipped with this option, the 468 has the capability to transmit a waveform message on a GPIB (General Purpose Interface Bus). During transmission, the last waveform acquired by the 468 will be sent to either a bus controller or a listener instrument. The waveform message format will conform to the Waveform Transmission Standard as specified in the Tektronix Standard, "General Purpose Interface Bus (GPIB), Codes and Formats (Rev C)."

Option 02 operating information and circuit descriptions are contained in sections 2 and 3 of this manual. The schematic diagram, circuit board illustration, and block diagram are located in section 8 of Volume II. Electrical and mechanical replaceable parts of Option 02 are integrated into the standard Replaceable Parts Lists also located in Volume II of this manual.

NOTE

Section 8 of the internal Service/Options switch must be set to the closed position for the GPIB option to be enabled. Refer to Figure 5-6 in the Maintenance section of this manual for the switch location.

OPTION 04—EMC ENVIRONMENTAL

The instrument is modified to meet certain specification requirements related to conducted and radiated electromagnetic interference. This option does not affect the basic instrument operating instructions presented in this manual. Option 04 reduces conducted interference over the frequency range of 150 kHz to 25 MHz and radiated interference over the frequency range of 150 kHz to 1 GHz by the following modifications:

1. A cathode-ray tube mesh is installed to minimize crt faceplate radiation.
2. Capacitors are added across the transformer secondary windings and from the B +GATE connector to ground to reduce conducted interference.
3. Shielding is added over the Storage Display circuit board and at the front frame to reduce radiated interference.
4. If the Option 02 GPIB circuit board is installed, additional shielding is added over the top of the board to reduce radiated interference.

Electrical circuitry changes are reflected in the partial schematic diagram of the power-input and transformer circuitry shown in Figure 6-1.

Electrical and mechanical replacement parts for Option 04 are integrated into the standard Replaceable Parts Lists located in Volume II of this manual.

OPTION 05—TV SYNC SEPARATOR

This option provides the instrument with front-panel selection of additional trigger-signal processing capabilities to facilitate observation and measurement of composite video and related television waveforms. A choice of either FIELD 1 or FIELD 2 sync is made available to the A Trigger Generator via the A TRIGGER SLOPE switch.

Option 05 operating information and circuit descriptions are located in this section. The schematic diagrams and circuit board illustration are located in the Diagrams section of Volume II of this manual. Replaceable electrical and mechanical parts lists are located in Volume II of this manual.

OPTION 12—AVERAGING

This option enables the 468 digital storage circuitry to average the input signal for a selected number of sweeps. The displayed waveform will be updated at the end of each averaging cycle, and then the cycle will be repeated. Acquisition of low-amplitude waveforms is greatly enhanced by noise cancellation that occurs in the averaging process.

Operating information and circuit descriptions are located in sections 2 and 3 of this volume. Averaging option circuitry is integrated into the standard instrument schematic diagrams located in section 8 of Volume II of this manual. Electrical and mechanical replaceable parts of Option 12 are integrated into the standard Replaceable Parts List also located in Volume II of this manual.

MANUAL CHANGE INFORMATION

At Tektronix, we continually strive to keep up with latest electronic developments by adding circuit and component improvements to our instruments as soon as they are developed and tested.

Sometimes, due to printing and shipping requirements, we can't get these changes immediately into printed manuals. Hence, your manual may contain new change information on following pages.

A single change may affect several sections. Since the change information sheets are carried in the manual until all changes are permanently entered, some duplication may occur. If no such change pages appear following this page, your manual is correct as printed.

SPECIFIC NOTES

1. The procedures for running all Service Routine tests (using the Service ROM) are contained under "SERVICE TEST" in Section 5, Volume 1.

2. Use the following table to determine Sample Clock periods at TP446 TP210 and U120-13.

3. Use the following table to determine Sample Clock periods and frequencies at U120-10, 11 and 12.

Table A

TIME/DIV Switch Setting	Sample Clock Periods		
	TP446 (Diagram 14)	TP210 (Diagram 19)	U120-13 (Diagram 19)
0.02—2 μs	40 ns	40 ns	Not Running
5 μs	100 ns	100 ns	Not Running
10 μs	200 ns	200 ns	Not Running
20 μs	400 ns	40 ns	Not Running
50 μs	1 μs	100 ns	Not Running
0.1 ms	2 μs	200 ns	Not Running
0.2 ms	4 μs	400 ns	400 ns
0.5 ms	10 μs	1 μs	1 μs
1 ms	20 μs	2 μs	2 μs
2 ms	40 μs	4 μs	4 μs
5 ms	100 μs	10 μs	10 μs
10 ms	200 μs	20 μs	20 μs
20 ms	400 μs	40 μs	40 μs
50 ms	1 ms	100 μs	100 μs
0.1 s	2 ms	200 μs	200 μs
0.2 s	4 ms	400 μs	400 μs
0.5 s	10 ms	1 ms	1 ms
1 s	20 ms	2 ms	2 ms
2 s	40 ms	4 ms	4 ms
5 s	100 ms	10 ms	10 ms

Table B

Test Point	Sample Clocks	
	Period	Frequency
U120-10	40 ns	25 MHz
U120-11	100 ns	10 MHz
U120-12	200 ns	5 MHz

4. Use the following table to determine Divider Chain output periods. When observing waveforms, disregard the characteristic glitch associated with synchronous counters.

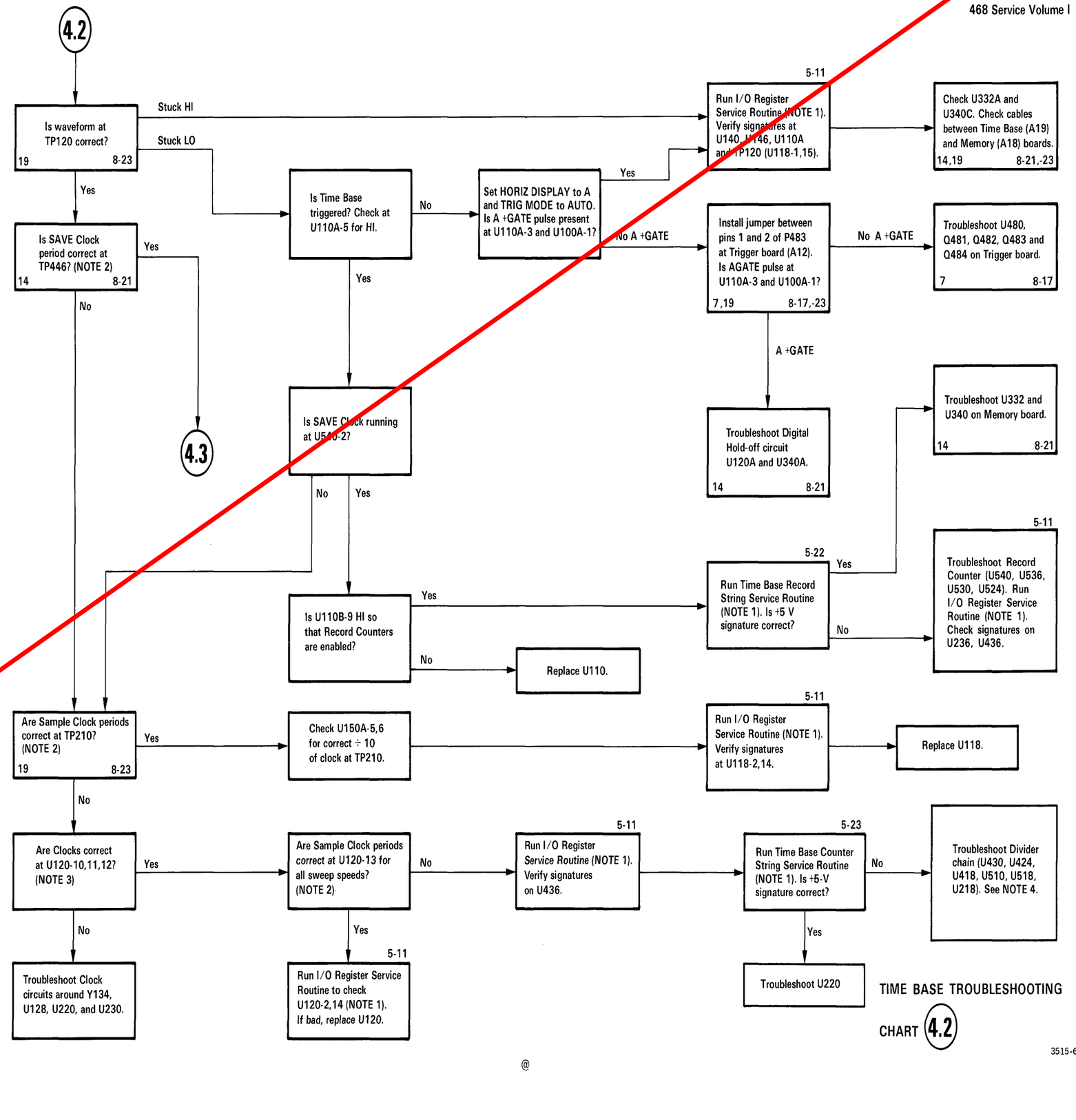
Table C

Test Point	Period	Duty Cycle (%)
U430-15	400 ns	50
U424-15	4 μs	10
U418-15	40 μs	10
U510-15	400 μs	10
U518-15	4 ms	10

GENERAL NOTES

A. Always set POWER switch to OFF before swapping, removing or replacing components, and before connecting or disconnecting leads or cables.

B. When analyzing circuitry, consider sockets and cables as possible causes of failures.



TIME BASE TROUBLESHOOTING

CHART 4.2

3515-67