APPENDIX B

OSCILLOSCOPE

OPERATION MANUAL

MODEL V-301

HITACHI DENSHI, LTD.

WARRANTY

This Hitachi Denshi, Ltd. product is warranted against defects in materials and workmanship for a period of two years from the date of shipment, except for probe. Hitachi Denshi, Ltd. will, at its option, repair or replace products which prove to be defective during the warranty period provided they are returned to authorized service agency prepaid. Repairs necessitated by misuse of the product are not covered by this warranty.
NO OTHER WARRANTIES ARE EXPRESSED OR IMPLIED. Hitachi Denshi, Ltd. IS NOT LIABLE FOR CONSEQUENTIAL DAMAGES.

NOTE

- This instrument should be adjusted at an ambient temperature of +20°C for best overall accuracy.
  Allow at least 15 minutes warmup before proceeding.

- Polyvinyle chloride (PVC) film is attached on the enclosure and the front panel of the oscilloscope to protect the metal surface. If the PVC film is damaged by scratches, remove it.
  To clean the enclosure or the front panel, use neutral detergent. Refrain from using thinner, benzine, alcohol or other chemicals.

OPERATION MANUAL

MODEL V-301 OSCILLOSCOPE

CONTENTS

1. Introduction

1.1 Outline

MODEL V-301 is a single trace oscilloscope with a bandwith of DC-30MHz and sensitivity of 1mV/DIV (Pulled X5 Gain).

The time base provides a maximum sweep speed time of 0.2μS/DIV, when magnified by 10, the sweep speed is 100nS/DIV and with signal delay line in the vertical amplifiers leading edge at high speed pulse can be easily observed. High accelerated voltage CRT, with 8 × 10DIV effective display area and post acceleration, enables high speed pulses to be clearly displayed.

Engineered for service in the field of television, VTR, and computer the V-301 is portable, easy and features convenient operation for use in education and industry.

° Wide bandwidth and high sensitivity

In addition to wide bandwidth, DC-30 MHz (-3dB), this instrument provides high sensitivity of 5mV/DIV. A 30MHz frequency is obtained with improved triggered synchronization.

° Bright CRT

By using a new, high brightness CRT, a stable accelerated CRT high voltage, calibration voltage accuracy, and time base are to be obtained.

° TV Synchronization

A circuit for extracting the synchronizing signal is equipped to trigger easily with a composite video signal. TV vertical or horizontal sync signal is automatically selected by the time base switch.

° Improvement in portability and operation

Equipped with a convenient carrying handle and designed for light weight, this unit is excellent both in portability and operation with various functions installed on the front panel.

° X-Y functions

Set the switch to X-Y position and X-Y oscilloscupe is displayed with EXT TRG OR [X] IN X axis and INPUT as Y axis.

1.2 Specifications

CRT Display	
Type	130BTB31
Acceleration Voltage	4kV
Effective display area	8 × 10 div (1 div=9.5mm)
Vertical amplifier	5mV/DIV ~ 5V/DIV
Sensitivity:	Calibrated in 10 steps (1-2-5 sequence up to 2.5 times on each position with variable control) * 1mV ~ 1V/DIV (using X5 GAIN)
Bandwidth	DC to 30MHz DC-5MHz (using X5 GAIN), Typical.
Rise time	12nSec
Signal delay time	Possible to observe the leading edge of waveform.
Input impedance	1MΩ shunted by 30pF ±5pF (direct)
Input coupling	AC, GND, DC

Max. Input voltage　600Vp-p, 300V(DC+AC peak)

Input connector　BNC

Time base

Sweep speed　0.2 μS ~ 0.2S/DIV

19 step, 1-2-5 sequence

Magnification　X10 (max speed 100 nS/DIV)

X-Y display　X = EXT TRG OR [X] IN

Y = INPUT

Sensitivity　Y axis: 5mV/DIV ~ 5V/DIV

X axis: Approx. 0.2V/DIV

Bandwidth　X axis: DC-500 kHz

X-Y phase shift　Less than 3° at 10 kHz

Synchronization

Trigger sensitivity

Frequency	INT. trig	EXT. trig
20Hz ~ 5MHz	0.5DIV	200 mV
5MHz ~ 30MHz	1.5DIV	800 mV

Mode　Automatic (sweep free-run)

Normal (sweep runs when triggered)

TV(+), TV(-)

Extracts the synchronizing signal from composite video signal and provides stable synchronization. Slope switch is selected according to polarity of video signals.

Source　INTernal or EXTernal, or LINE.

Calibration	
Waveform	Square wave 1kHz ±10% (typ)
Voltage	0.5 Vp-p ±3%
Power supply	AC100/120/220/240V
Size and weight	190(H) × 275(W) × 400(D)mm 8.5kg (7.5(H) × 10.8(W) × 15.7(D)in 18.7 lbs)

1.3 Composition

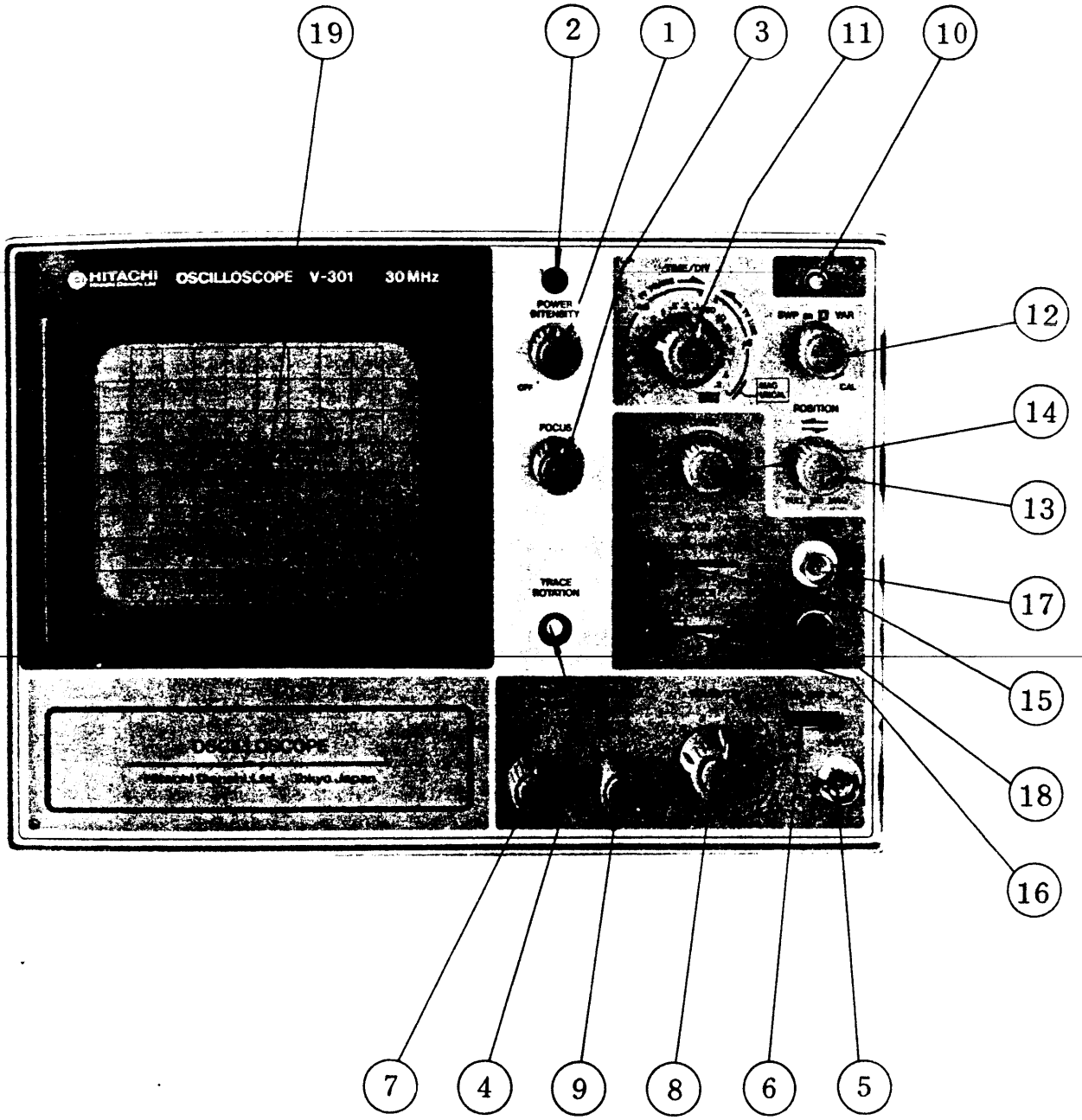
(1) V-301 oscilloscope 1

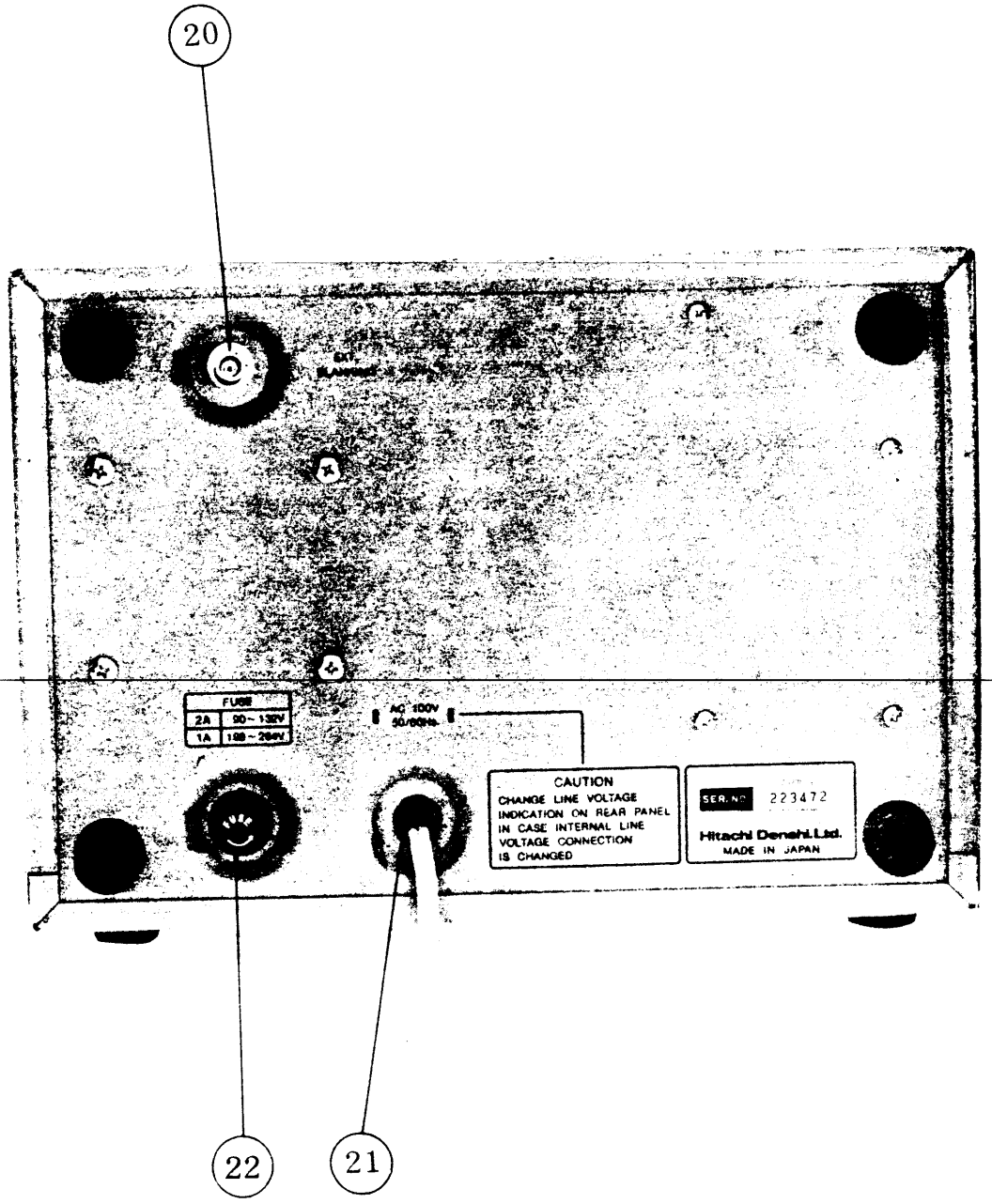
(2) AT-10AB1.5 Probe 1

(3) Operation manual 1

2. Operation

2.1 Description of Panel Functions




20
FUSE
2A 90~132V
1A 180~264V
AC 100V
50/60Hz
CAUTION
CHANGE LINE VOLTAGE
INDICATION ON REAR PANEL
IN CASE INTERNAL LINE
VOLTAGE CONNECTION
IS CHANGED
SER.NO 223472
Hitachi Denshi,Ltd.
MADE IN JAPAN
22
21

① POWER/INTENSITY

Turns the power on or off, and adjusts trace brightness on the screen.
Clockwise adjustment increases brightness;
Counterclockwise rotation decreases brightness.

② pilot lamp

Lights when the power is on.

③ FOCUS

Adjusts focus grid voltage for clarity of the display.

④ TRACE ROTATION

Corrects slight tilting of trace caused by external magnetic fields.

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⑤ INPUT

This is an input plug for use with the vertical amplifier and Y-axis (vertical axis) amplifier during X-Y operation.

Do not exceed the maximum permissible input voltage, 600Vp-p or 300V (DC+AC peak)

⑥ AC-GND-DC

(Alternating Current-Ground Switch-Direct Current)

Switches the coupling of the signal fed to the vertical axis input ⑤. DC coupling is obtained on the DC position. On AC position, the direct current component is blocked by a capacitor. The GND position grounds the input of the amplifiers and opens the input terminal ⑤.

⑦ Position (PULL X5 GAIN)

↓↑(Vertical position adjustment)

Clockwise rotation will move pattern up, and counter-clockwise rotation will move pattern down.

When the knob is pulled, the vertical axis sensitivity at each range of volts/DIV is increased by 5 times.

⑧ VOLTS/DIV

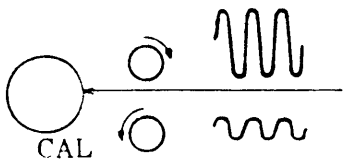
This is a knob for switching the sensitivity of the input signal fed to INPUT ⑤. Switching action is accomplished in 10 steps from 5mV/DIV to 5V/DIV. On X-Y operation, the knob functions to change the sensitivity of the Y-axis.

To measure by the use of the indicated voltage sensitivity, be sure to set the VARIABLE ⑨ to CAL by turning it fully clockwise. If the signal is applied to the input terminal ⑤ by the use of a 1/10 low capacitance probe, the values are ten times the indicated voltage.

⑨ VARIABLE

This is a vertical axis sensitivity fine adjuster which is capable of attenuating to less than 1/2.5 by indication of each range of VOLTS/DIV.

VARIABLE knob



Amplitude increases

Amplitude decreases

To measure a voltage by the use of voltage sensitivity indicated by VOLTS/DIV, turn the VARIABLE clockwise fully to CAL.

⑩ CAL .5V (Calibration wave)

Signal output terminal for amplitude and probe calibration. The frequency is approx. 1KHz.

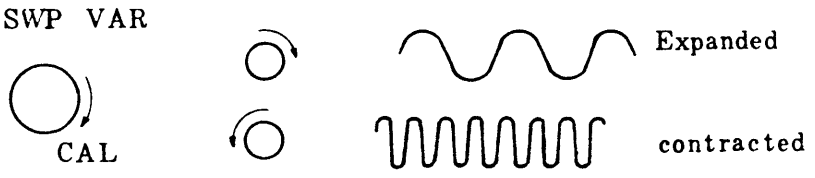
⑪ TIME/DIV (Sweep speed selection)

This is sweeptime change switch. A 19-position switch from 0.2 μ S/DIV to 0.25/DIV selects 19 fixed sweep speeds. When making a measurement at a given TIME/DIV setting, adjust variable knob ⑫ fully clockwise to CAL. When the switch is set to (X-Y) position, X-Y oscilloscope works with EXT. TRIG OR [X] IN as X axis and INPUT as Y axis.

⑫ SWP OR [X] VAR (Time adjustment of Sweep Time and sensitivity fine adjustment of X axis)

This is fine adjustment covering time not covered by Time change-steps.

When measuring with an indication of TIME/DIV, turn VARIABLE fully clockwise to CAL.



In X-Y operation, this is a horizontal axis sensitivity fine adjuster which is capable of attenuating from about 0.2V/DIV to zero.

⑬ POSITION (PULL X10 MAG)

The knob is used to position the trace in the horizontal direction. When the knob is pulled out, the sweep is magnified by a factor of 10.

⑭ LEVEL (Slope)

The control knob is used to adjust the triggering level of the sweep.

In operation, the knob is generally at the AUTO setting. When triggered sweep is desired against the positive slope of waveforms displayed on the screen, set this switch to (+) position, and against negative slope, set it to (-) position.

⑮ MODE

° AUTO : When there is no signal or a signal stepping out of synchronization, the sweep line will appear automatically.

° NORM : This mode provides synchronizing sweep only when synchronization is required. If there is no signal or a signal stepping out of synchronization, the sweep line will not appear. This mode is employed for synchronizing a low frequency signal of more than 20Hz.

° TV(+), TV(-)

Video signals synchronized with horizontal sync pulse and vertical sync pulse is observed. Composite video signals can be observed at various stages of the TV receiver to determine whether circuits are performing normally.

⑯ SOURCE

INT : Used when synchronization is make by observing signal for INPUT.

LINE : Used when observing a signal synchronized with the frequency of AC power source.

EXT : Used when synchronization is make by a signal applied to EXT input connector ⑰, independently from observation signal.

⑰ EXT TRG OR ☒ IN : This is an input BNC connector for external sync signal or X axis.

⑱ GND : This is the ground terminal of oscilloscope.

⑲ Graticule

The size of graticule is 8 by 10 div (1 div=9.5). A sub-scale at intervals of 1/5 DIV is imprinted on the X and Y axis of the graticule to facilitate of making measurement. Vertical Voltage sensitivity (VOLT/DIV) and Sweep time (TIME/DIV) is calibrated and can be read with reference to the sub-scales.

⑳ EXT. BLANKING

This is a terminal for applying a blanking signal from an external source.

The trace displayed on the screen may be intensity - modulated where pulse signal or time-scale marks are required. 5V AC signal applied at the connector on the rear of the oscilloscope will provide alternate brightness and blanking of the trace. Positive voltage input decreases brightness.

㉑ AC cord

㉒ FUSE

The fuse is released when the cap is rotated counter-clockwise.

FUSE: 1A 6.35ø × 31.8 (mm)

Caution - Replace only with same type and rating fuse.

2.2 Precautions

(1) Power Source Voltage

Apply a power source voltage that is within±10% of the rated values as given in the table below. Operation with a voltage less than 10% of rated value may result in improper performance and a voltage more than 10% of rated value may damage power supply circuitry.

Rated Voltage Values	Applicable Voltage Ranges	Fuse
AC 100V	90 - 110V	2A
AC 120V	108 - 132	Fast Blow
AC 220V	198 - 242	1A
AC 240V	216 - 264	Fast Blow

(2) Signal Input

Vertical input terminal	INPUT	MAX 600V (AC peak), 300V (DC + AC peak)
External synchronizing signal and X input terminal		50V (DC + AC peak)
EXT BLANKING		30V (DC + AC peak)

(3) Horizontal Trace Tilt

Horizontal Trace, in some case, tilts due to the earth's magnetism.

(4) Operation in a Powerful Magnetic Field

Operation in a powerful magnetic field will cause distortion of waveforms or make traces tilt excessively. Special care should be exercised when operating the instrument close to machinery or equipment using a large transformer.

(5) FUSE

Note the type and rating of the fuse used.

(6) Operation in a Hot and Humid Place

This instrument is designed to operate in a temperature range of 0°C to +40°C and humidity range of 40 to 90%. Operation in a severe environment may shorten the life of the instrument.

(7) Intensity

A burn-resisting fluorescent material is used in the cathode ray tube. If the cathode ray tube is left with a bright dot or bright line, or with unnecessarily raised intensity, its fluorescent screen may be damaged. When observing waveforms the intensity should be maintained at the minimum necessary level. If the instrument is left on for extended periods, lower the intensity and obscure the focus.

(8) EXT. BLANKING

When a cable is connected to the EXT BLANKING connector don't place the oscilloscope in an upright position to prevent damage to the cable.

(9) The highest sweep speed is 100 ns/DIV.

Sweep time switch can be changed from 0.2 μs/DIV to 0.2s/DIV in accordance with your requirements, and by using the knob (14), the sweep time is magnified by 10 in each range.

Therefore, as permissive ranges of magnified sweep speed one 0.1μs/DIV ~ 0.2s/DIV, don't use X10 MAG at 0.2 μs/DIV, 0.5 μS/DIV.

2.3 Fundamental Operation Instructions

Thefundamental operation for observing waveforms with the Oscilloscope V-301 are described below.

(1) Preparation

Before using the V-301 set the controls as follows.

In addition, use these setting when checking proper operation of the instrument.

1.	FOCUS (3)	Midposition
2.	AG-GND-DC (6)	DC
3.	Position (7)	Midposition (push)
4.	VOLTS/DIV. (8)	10 mV
5.	VARIABLE (9)	Turn fully clockwise to CAL
6.	TIME/DIV (11)	0.5mS/DIV
7.	SWP OR X VAR (12)	Turn fully clockwise to CAL
8.	Position (13) (PULL X10 MAG)	Midposition (PUSH IN X 1)
9.	LEVEL (14)	Midposition
	PULL (-) SLOPE	Push-in (+) SLOPE
10.	MODE (15)	AUTO
11.	SOURCE (16)	INT

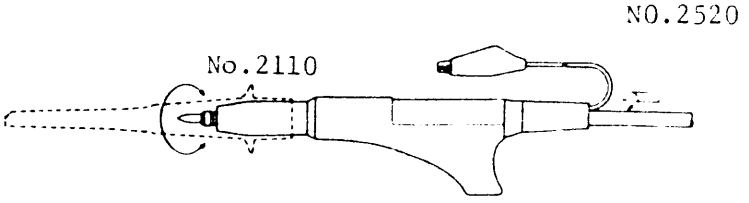
After all settings are made, set the POWER/INTENCITY switch (1) ON, and adjust the knob at midpositions. After about 10 seconds, a bright line will appear on screen. Adjust the FOCUS (3) controls for a clear display of the traces.

12. Connect the attached probe to INPUT (5) and CAL (10) terminals. For use of the probe, refer to Section: "How to Use a Low-capacity/Direct Probe."

(2) Check of Gain by Calibrated Waves

After all settings are made as shown in 2.3 (1) ascertain that a square wave with an amplitude of 5 DIV. is displayed on the screen.
This indicates that the instrument is operating properly.

(3) How to use a Low-capacitance/Direct Probe



ITEM	SPECIFICATIONS	ACCESSORIES
Bandwidth	DC ~ 30MHz (±1dB) DC ~ 40MHz (±3dB)	Pincher tip No.2110 Cable marker No.2520
Input R	=10MΩ	
Input C	=22pF (at oscilloscope input 25pF)	
ATT Ratio	1/10	
MAX Input voltage	600V (DC+AC Peak)	

The knob and hook cover may be turned in any direction, but care must be used not to disconnect the ground over that holds the hook cover in place by an internal spring, which could loosen or break.

(4) Measurement

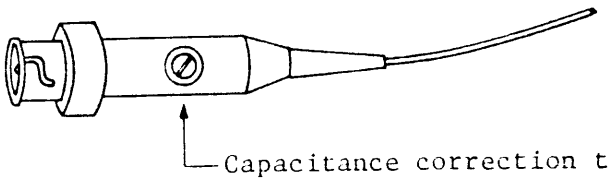
The probe exhibits high resistance and low capacitance at X 10 however, the input voltage is attenuated to 1/10 and. This must be accounted for in voltage measurements.

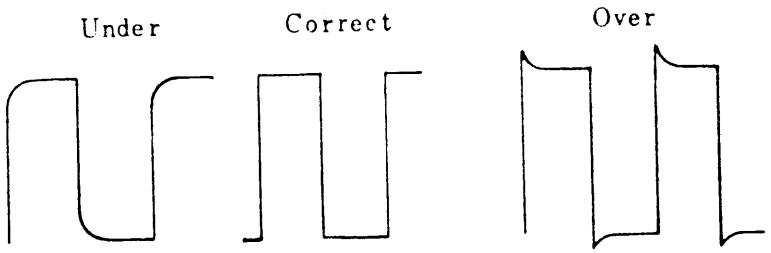
Measured voltage = Sensitivity of oscilloscope V/DIV. X screen amplitude div X 10 At X 10, it is necessary to correct the pulse characteristic by adjusting the capacitor in the probe for flat top of the square wave calibration voltage.

(5) Adjustment of Probe

When observing the signal waveforms of high impedance circuits, the operation of the signal source and waveforms on the screen may change due to the input impedance of the oscilloscope, parallel capacitance of a coupling line, induction noise and other effects leading to measurement error. The use of a low-capacitance probe avoids these effects. A low-capacitance probe avoids these effects. a low-capacitance should be used for high impedance circuitry measurements. Its input impedance is 10MΩ at 22pF.

When adjusting the probe observing CAL (10) , adjust the capacitance correction trimmer in the probe using a small screw driver, to provide proper square wave compensation.





(6) Precautions on Direct Connection and Using a Probe

Two different methods are available for applying signals. One is to connect a lead wire to the input terminal of the oscilloscope directly, and another is to use a probe.

When viewing a small signal in a circuit having high signal source impedance, error may occur in measurement due to the effect of parallel capacity or induced noise in the input cable. The following precautions should be observed to avoid false readings. Generally, with the exception of a low-impedance circuit, the use of a lead wire should be avoided. If a lead wire other than the probe or shielded wire is used, make the lead as short as possible. When using a shielded wire in a circuit having high impedance, attention should be paid to the loading effects of the sum of the input capacitance of the oscilloscope and the distributed capacitance of the probe or shielded wire on the signal source. The input terminal of the oscilloscope has a capacitance of about 30pF in parallel with 1MΩ . If the effect of this paralled capacitance on the high impedance signal source cannot be ignored, the use of the low capacitance X10 probe is recommended.

(7) Low-capacitance probe

To avoid the ill effects by direct connection, use a low-capacitance probe (X10) whenever possible. When this probe is used, input impedance is 10MΩ , 22pF, making it possible to reduce the loading effects upon the signal source to a great extent.

However, when the probe is used at X10, the input signal is attenuated to 1/10. This must be taken into account in all measurements.

(8) Ground Connection

When using a probe, connect to a ground point close to the signal source and use the probe ground wire.

Triggering on waveforms

The most important factor in operating is to lock and display waveforms properly before measuring them with the oscilloscope.

(9) How to provide synchronization

- Select the position of the SOURCE switch (17), according to the connector where sync signal is supplied. Also select the position of the MODE selection (10).

Select the sweep mode by the MODE selector (15). When no input signal is applied or the trigger level is not correct, set the selector to NORM to remove waveforms on the screen.
The triggered sweep circuit of this instrument stops functioning if a trigger pulse is not produced as a sweep starting pulse. It is, therefore, necessary to select this sweep according to purpose desired. Generally, for waveforms which have a frequency of 20Hz or more and are not complex, use AUTO triggering. At AUTO triggering, the sweep circuit is automatically placed in the free-run state when the aforementioned trigger pulse is not produced and a horizontal trace is displayed irrespective of sweep time set by the knob (11).

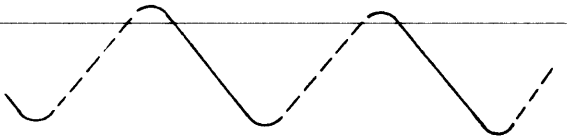
Next, set the synchronizing polarity to either PUSH (+) or PULL (-) by the LEVEL knob and provide synchronization by turning the knob to stabilize the waveform.

* Explanation of the synchronizing polarity level.

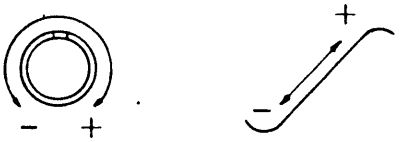
PUSH (+) SLOPE

The polarities synchronize with each other in the solid line parts.

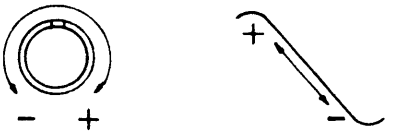
PULL (-) slope



* Explanation of the synchronizing level.



When the slope is positive (+)



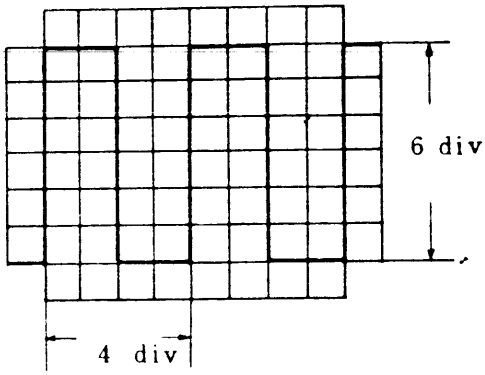
When the slope is negative (-)

(10) How to observe waveforms

If (8) VOLTS/DIV is set to 0.5V, then the amplitude is 0.5 x 6 = 3.0V

If (11) TIME/DIV is set to 0.5ms, then the period is 0.5 x 4 =0.002S

So the frequency is
1/0.002=500Hz



Example of measurement of voltage, period and frequency

Caution:

Keep the VARIABLE knob (9) at the CAL position and the SWP VAL knob (12) at the CAL position.

At the CAL position, the waveform is calibrated by the specified value of each range.

(11) Magnification of part of waveform

Turn the POSITION (PULL X10 MAG) knob (13) to locate the 1 division of trace to the horizontal graticule center and pull the knob. That part will be magnified to cover the full length of the graticule.

Any 1 division of the sweep can be displayed as a 10 division trace by use of the knob (13).

(12) Operation of X-Y

Set the knobs as follows:

⑪ TIME/DIV : set to X-Y

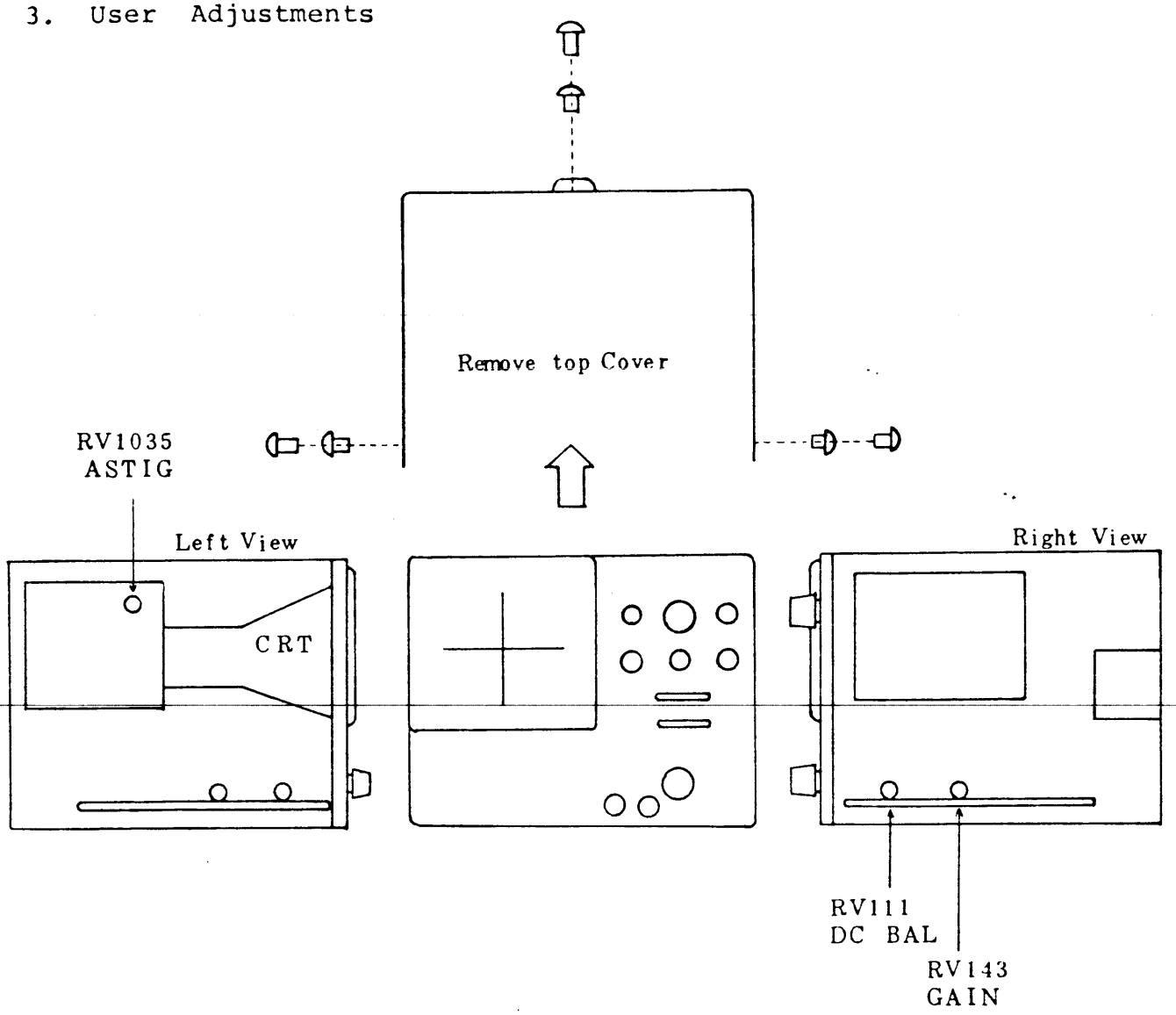
EXT.TRIG OR X IN: feed X-axis signal (horizontal-axis signal) as input.

INPUT : feed Y-axis signal (vertical-axis signal) as input.

By this setting, the Y-axis sensitivity operates by means of VOLTS/DIV and the X-axis sensitivity by X VAR.

However, the position in the Y direction (vertical direction) operates by means of ↓↑ POSITION and the position in the X direction (horizontal direction) operates by means of ⇄ POSITION.

3. User Adjustments



The following adjustments should be made by means of a screw driver.

(1) TRACE ROTATION (Trace slope)

Adjust the TRACE ROTATION (4) on the front panel when slight tilting of the trace is caused by the effect of external magnetic fields.

Make certain that tilting of the traces is not caused by the effect of unusually strong external magnetic fields due to the position of the oscilloscope.

(2) ASTIG ADJUSTMENT

Set the knob TIME/DIV (11) to X-Y observing the spot on the center of the screen.

RV1035 astigmatism adjustment provides optimum spot roundness when used in conjunction with FOCUS (3) and POWER/INTENSITY (1) control.

Little readjustment of this control is required after initial adjustment.

(3) Adjust Volts/Division Balance (STEP ATT BAL)

a. Position the trace to the center horizontal line with the vertical POSITION control.

b. Check - Change the V/DIV switch from 5m V to 10m V. Trace should not move more than 0.1 division.

c. Adjust RV111, for minimum trace shift when rotation the V/DIV switch from 5m V to 10mV. If necessary, rotate the vertical position control to keep the trace in the center of the screen.

(4) Vertical gain adjustment

Set the knob (8) to 10mV/DIV.
Connect the CAL output (10) to the INPUT connector with probe.

Check - CRT display for five divisions of deflection. Adjust the GAIN controls, RV143 for exactly five divisions of deflection.

4. Application

4.1 Measurement of rise (fall) time

The measurement of the rise time of a pulse requires not only the attention described above but also attention to measuring errors.

The relationship between the rise time of a measured pulse.

Trx and the rise time of an oscilloscope Tro and the rise time shown on the screen surface Trs is as follows:

$$Trx^2 + Trs^2 = Tro^2$$

If the rise time of the measured pulse is sufficiently larger than that of the oscilloscope (12ns for this oscilloscope), the error caused by the latter on measurement may be ignored, but if the latter approximates the former to a marked degree, a measuring error is produced.

A true rise time is obtained by:

$$Trx = \sqrt{Tro^2 - Trs^2}$$

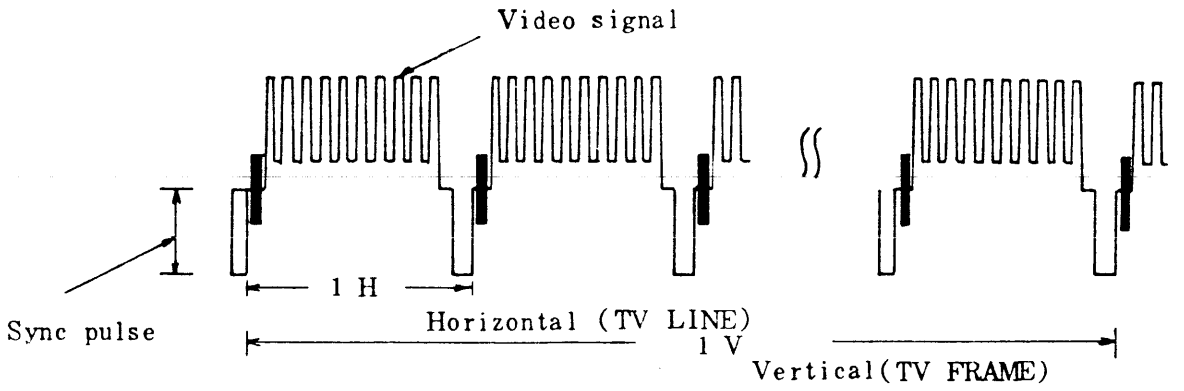
Generally speaking, for circuit which produces no waveform distortions, such as tilt, overshooting, etc. the relationship between the frequency band and the rist time can be expressed by:

$$fc \times tr \fallingdotseq 350$$

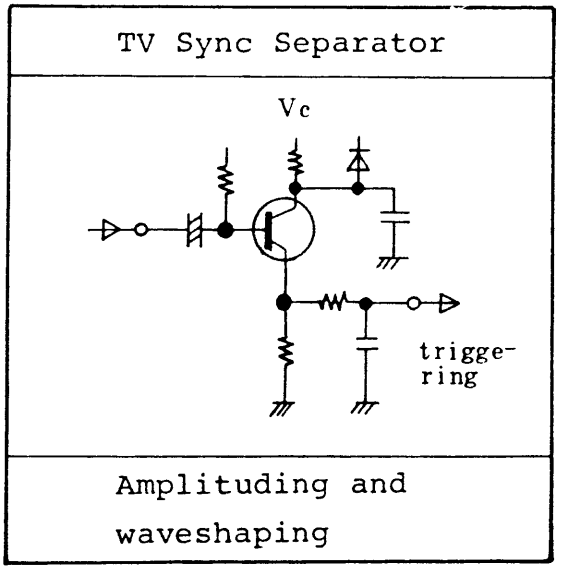
where fc = frequency band (MHz) and tr = rise time (ns).

4.2 Measurement of composite video signal

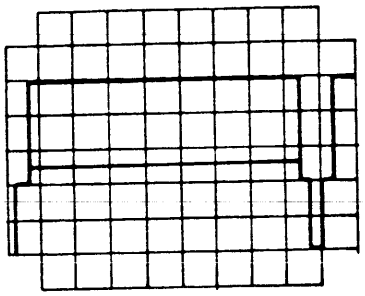
1. Video Signal



An internal TV Sync Separator circuit permits stable line or field-rate triggering from displayed composite video waveforms.

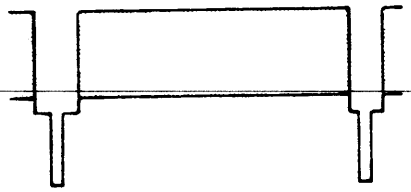


Observing the vertical signal



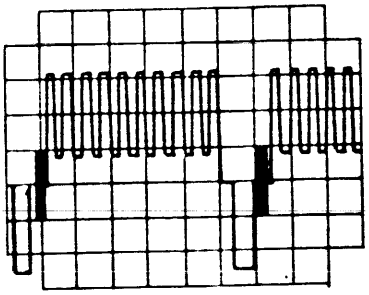
TIME/DIV range: FRAME
(0.1ms/DIV ~ 0.2s/DIV)

TV (-) : generally



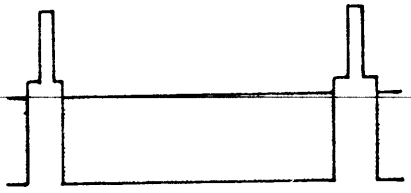
TV Sync (-)

Observing the Horizontal signal



TIME/DIV range: LINE
(50 μs/DIV ~ 0.2 μS/DIV)

TV (+)



TV Sync (+)

When the sync and blanking pulses of the displayed video signals are negative, set the MODE switch (16) to TV(-).

If the sync and blanking pulses are positive, set the switch (16) to TV(+).

Note : Using the MODE switch (16) with TV(-), don't set the slope switch (15) to (-) slope.